BICYCLES AND TRICYCLES.

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By Axel Josephsson.

Table 1 is a comparative summary of the statistics for the cycle industry as returned at the censuses of 1890 and 1900, with the percentages of increase for the decade.

Table 1.—COMPARATIVE SUMMARY, 1890 AND 1900, WITH PER CENT OF INCREASE FOR THE DECADE.

	1900	1890	Per cent of increase.
Number of establishments	312	27	1,055.6
Capital	$29,783,659	$2,058,072	1,347.2
Salaried officials, clerks, etc., number	2,034	[1]128	1,489.1
Salaries	$1,758,235	[1]$123,714	1,317.2
Wage-earners, average number	17,525	1,797	875.3
Total wages	$8,189,817	$982,014	734.0
Men, 16 years and over	16,700	1,747	855.9
Wages	$7,952,257	$971,589	718.5
Women, 16 years and over	517	15	3,346.7
Wages	$175,028	$3,729	4,593.7
Children, under 16 years	308	35	780.0
Wages	$62,532	$6,746	826.9
Miscellaneous expenses	$2,252,604	$242,018	830.8
Cost of materials used	$16,792,051	$718,848	2,236.0
Value of products	$31,915,908	$2,568,326	1,142.7

[1] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table. (See Table 9.)

The census of 1890 was the first at which the manufacture of bicycles and tricycles was returned as a separate industry. Previous to the decade ending with 1880 the manufacture of cycles was spasmodic and intermittent, the only important periods being in 1819 and 1869. In the censuses prior to 1890 the statistics of the manufacture of cycles were included with those for carriages and wagons. The comparative figures presented in Table 1 cover, therefore, only the period from 1890 to 1900. During this decade, taken as a whole, the industry made extraordinary progress; but the climax was reached about the middle of the period, and since then there has been a decided decline.

During the decade from 1890 to 1900 the number of establishments increased from 27 to 312, or 285; capital from $2,058,072 to $29,783,659, or $27,725,587; the number of wage-earners from 1,797 to 17,525, or 15,728; their wages from $982,014 to $8,189,817, or $7,207,803; miscellaneous expenses from $242,018 to $2,252,604, or $2,010,586; the cost of materials used from $718,848 to $16,792,051, or $16,073,203; and the value of products from $2,568,326 to $31,915,908, or $29,347,582.

The average capital, which in 1890 was $76,225, had in 1900 increased to $95,460. This increase in the average capital is a consequence of the crisis at the end of the decade, when many of the smaller concerns were forced out of the business. It is to be noted that each of the 35 plants belonging to the American Bicycle Company reported as an individual establishment. The cost of materials used shows the largest percentage of increase. In 1890 it was $718,848, or 28 per cent of the product, and in 1900, $16,792,051, or 52.6 per cent. Of this amount $16,161,638, or 96.2 per cent, was expended for principal materials, and $630,413, or 3.8 per cent, for fuel, freight, etc. This increase in the proportion between materials and product was largely caused by the keen competition among cycle manufacturers and the attendant decrease in prices of finished products.

Table 2 presents, by states, the number of active establishments from which returns were received in 1890 and 1900 and the increase during the decade.

Table 2.—COMPARATIVE SUMMARY: NUMBER OF ACTIVE ESTABLISHMENTS IN 1890 AND 1900, WITH INCREASE, BY STATES, ARRANGED GEOGRAPHICALLY.

States.	1900	1890	Increase.
United States	312	27	285
New England states	55	9	46
Maine	1	.....	1
New Hampshire	1	.....	1
Massachusetts	25	7	18
Rhode Island	4	.....	4
Connecticut	24	2	22
Middle states	98	8	90
New York	66	4	62
New Jersey	7	1	6
Pennsylvania	24	3	21
Maryland	1	.....	1
Southern states	1	.....	1
Kentucky	1	.....	1
Central states	152	9	143
Ohio	34	2	32
Michigan	11	1	10
Indiana	19	1	18
Illinois	60	5	55
Wisconsin	23	.....	23
Minnesota	4	.....	4
Iowa	1	.....	1
Western states	2	.....	2
Nevada	1	.....	1
Colorado	1	.....	1
Pacific states	4	1	3
Oregon	.....	1	[1]1
California	4	.....	4

[1] Decrease.

Table 2 shows the territorial extension of the industry. In 1890 it was carried on in 10 states by 27 establishments; in 1900 it had extended into 20 states, with 312 establishments. The greatest gain was shown in New York, where the number of establishments increased from 4 in 1890 to 66 in 1900. Illinois followed next with an increase of 55; and then Ohio with a gain of 32. Other states showing a large increase in number of establishments were Wisconsin from none to 23, Connecticut 2 to 24, Pennsylvania 3 to 24, Indiana 1 to 19, and Massachusetts 7 to 25. Oregon was the only state which showed a decrease, having 1 in 1890 and none in 1900. In 1900, in addition to the 312 active establishments, there were 5, having a capital of $103,500, reported as idle.

Table 3 is a summary, by states, of the general statistics of the industry for 1900.

TABLE 3.—SUMMARY BY STATES: 1900.

	United States.	California.	Connecticut.	Illinois..	Indiana.	Massachusetts.	Michigan.
Number of establishments	312	4	24	60	19	25	11
Capital	$29,783,659	$19,254	$4,215,399	$7,694,658	$2,061,560	$2,646,498	$757,021
Salaried officials, clerks, etc., number	2,034	----	263	642	123	139	53
Salaries	$1,753,235	----	$251,091	$522,477	$96,996	$117,242	$39,643
Wage-earners, average number	17,525	19	2,139	4,388	1,481	1,581	311
Total wages	$8,189,817	$11,080	$1,150,736	$2,144,897	$613,840	$815,028	$141,639
Men, 16 years and over, number	16,700	19	1,995	4,143	1,352	1,543	294
Wages	$7,952,257	$11,080	$1,107,485	$2,078,334	$570,858	$798,504	$138,457
Women, 16 years and over, number	517	----	104	104	126	38	17
Wages	$175,028	----	$34,662	$38,276	$42,150	$16,524	$3,182
Children, under 16 years, number	308	----	40	141	3	----	----
Wages	$62,532	----	$8,589	$28,287	$832	----	----
Miscellaneous expenses	$2,252,604	$3,144	$323,629	$630,442	$121,260	$125,076	$59,485
Cost of materials used	$16,792,051	$25,470	$1,720,249	$4,836,585	$1,221,786	$1,307,900	$345,725
Value of products	$31,915,908	$47,670	$3,672,225	$8,960,421	$2,115,901	$2,715,310	$627,658

	Minnesota.	New Jersey.	New York.	Ohio.	Pennsylvania.	Rhode Island.	Wisconsin.	All other states.[1]
Number of establishments	4	7	66	34	24	4	23	7
Capital	$38,205	$204,465	$3,326,943	$4,074,576	$1,550,957	$24,300	$2,337,975	$831,848
Salaried officials, clerks, etc., number	2	24	267	209	110	6	160	36
Salaries	$2,320	$23,457	$216,120	$197,406	$91,681	$3,600	$134,007	$57,195
Wage-earners, average number	47	183	2,103	2,380	947	17	1,572	357
Total wages	$8,440	$71,343	$988,052	$1,017,061	$431,369	$6,100	$625,149	$165,083
Men, 16 years and over, number	47	170	2,032	2,340	891	17	1,500	357
Wages	$8,440	$68,185	$970,043	$998,218	$419,958	$6,100	$611,512	$165,083
Women, 16 years and over, number	----	12	46	40	29	----	1	----
Wages	----	$2,972	$11,009	$18,843	$7,280	----	$130	----
Children, under 16 years, number	----	1	25	----	27	----	71	----
Wages	----	$186	$7,000	----	$4,131	----	$13,507	----
Miscellaneous expenses	$4,673	$19,548	$366,501	$247,332	$128,931	$1,309	$170,266	$61,008
Cost of materials used	$30,997	$147,317	$1,856,065	$2,251,358	$1,065,461	$23,195	$1,536,592	$423,351
Value of products	$66,505	$295,226	$3,842,020	$4,099,980	$1,855,043	$43,382	$2,795,236	$779,331

[1] Includes establishments distributed as follows: Colorado, 1; Iowa, 1; Kentucky, 1; Maine, 1; Maryland, 1; Nevada, 1; New Hampshire, 1.

In 1890 returns were received from 10 states, only 4 of which had three or more establishments; in 1900 the returns were from 20 states, 13 of which had three or more establishments. In order to avoid disclosing the operations of individual establishments, states having less than three establishments are grouped under "all other states."

Table 4 presents a summary, by geographic divisions, of the statistics for 1900 of the number of establishments, capital, and value of products, and the per cent for each of these items that the several divisions and states bear to the total thereof.

TABLE 4.—SUMMARY BY STATES, ARRANGED GEOGRAPHICALLY: 1900.

STATES.	ESTABLISHMENTS.		CAPITAL.		PRODUCTS.	
	Number.	Per cent of total.	Amount.	Per cent of total.	Value.	Per cent of total.
United States	312	100.0	$29,783,659	100.0	$31,915,908	100.0
New England states	55	17.6	7,046,197	23.7	6,567,292	20.6
Massachusetts	25	8.0	2,646,498	8.9	2,715,310	8.5
Connecticut	24	7.7	4,215,399	14.2	3,672,225	11.5
All other New England states[1]	6	1.9	184,300	0.6	179,757	0.6
Middle states	98	31.4	5,701,613	19.1	6,517,665	20.4
New York	66	21.1	3,326,943	11.2	3,842,020	12.0
Pennsylvania	24	7.7	1,550,957	5.2	1,855,043	5.8
All other Middle states[2]	8	2.6	823,713	2.7	820,602	2.6
Central states	152	48.7	16,974,995	57.0	18,675,701	58.5
Ohio	34	10.9	4,074,576	13.7	4,099,980	12.8
Michigan	11	3.5	757,021	2.5	627,658	2.0
Indiana	19	6.1	2,061,560	6.9	2,115,901	6.6

[1] Includes establishments distributed as follows: Maine, 1; New Hampshire, 1; Rhode Island, 4.
[2] Includes establishments distributed as follows: Maryland, 1; New Jersey, 7.

TABLE 4.—SUMMARY BY STATES, ARRANGED GEOGRAPHICALLY: 1900—Continued.

STATES.	ESTABLISHMENTS.		CAPITAL.		PRODUCTS.	
	Number.	Per cent of total.	Amount.	Per cent of total.	Value.	Per cent of total.
Central states—Cont'd.						
Illinois	60	19.2	$7,694,658	25.8	$8,960,421	28.1
Wisconsin	23	7.4	2,337,975	7.9	2,795,236	8.8
All other Central states[1]	5	1.6	49,205	0.2	76,505	0.2
All other divisions	7	2.3	60,854	0.2	155,250	0.5
California	4	1.3	19,254	0.1	47,670	0.2
All other states[2]	3	1.0	41,600	0.1	107,580	0.3

[1] Includes establishments distributed as follows: Iowa, 1; Minnesota, 4.
[2] Includes establishments distributed as follows: Colorado, 1; Kentucky, 1; Nevada, 1.

Table 4 shows that at the close of the decade the manufacture of bicycles and tricycles was, as in 1890, almost entirely confined to the New England, Middle and Central groups, but that the relative location of the industry within those sections had undergone a considerable change. In 1890 the New England and Central groups each had 9 establishments and the Middle group 8. In 1900 the New England states showed an increase of 46 establishments, giving them 17.6 per cent of the aggregate number for the United States; the Middle states an increase of 90 establishments, giving them 31.4 per cent of the aggregate; the Central states an increase of 143, giving them 48.7 per cent of the aggregate; and all other states an increase of 6, giving them 2.3 per cent of the aggregate. In the New England states capital increased from $1,231,691 to $7,046,197, or $5,814,506, but its proportion of the

aggregate decreased from 59.8 to 23.7 per cent; in the Middle states it increased from $76,000 to $5,701,613, or $5,625,613, and its per cent of the aggregate from 3.7 to 19.1; in the Central states it increased from $746,381 to $16,974,995, or $16,228,614, and its per cent of the aggregate from 36.2 to 57. In the New England states the value of products increased from $1,150,142 to $6,567,292, or $5,417,150, but its per cent of the aggregate decreased from 44.8 to 20.6; in the Middle states it increased from $125,916 to $6,517,665, or $6,391,749, and its per cent of the aggregate from 4.9 to 20.4; in the Central states it increased from $1,276,268 to $18,675,701, or $17,399,433, and its per cent of the aggregate from 49.7 to 58.5. In 1890 Massachusetts stood first among all the states, not only in the number of establishments, but in the capital employed, and in the value of products. In 1900 New York reported the greatest number of establishments, while Illinois ranked first in capital and products, reporting 25.8 per cent of the aggregate capital and 28.1 per cent of the aggregate value of products.

Among the New England states Connecticut in 1900 stood first in capital. Capital in Massachusetts increased from $1,202,691 to $2,646,498, or $1,443,807. The value of products in Massachusetts increased from $998,342 to $2,715,310, or $1,716,968. In 1890, however, the products reported for Massachusetts constituted 38.9 per cent of the aggregate for the United States, but in 1900 only 8.5 per cent. Among the Middle states New York retained its position as first; its capital increased from $44,700 to $3,326,943, or $3,282,243, and in 1900 constituted 11.2 per cent of the aggregate; in value of products the increase was from $85,786 to $3,842,020, or $3,756,234, placing the state in third position, with 12 per cent of the aggregate. In Pennsylvania capital increased from $30,100 to $1,550,957, or $1,520,857, and was 5.2 per cent of the aggregate in 1900, and the value of products increased from $32,630 to $1,855,043, or $1,822,413, and constituted 5.8 per cent of the aggregate. Among the Central states, Illinois retained its position as first in the group and became first among all the states in capital and in value of products, the increase in capital being $7,129,046, and in value of products $7,990,421. The capital in 1900 constituted 25.8 per cent of the aggregate, and the products 28.1 per cent. This latter percentage was, however, a decrease from 1890, when Illinois produced 37.8 per cent of the total for the United States. In 1900 Ohio stood second among the Central states, with an increase of $3,956,376 in capital and of $3,978,472 in value of products. The total value of products in Ohio was $4,099,980, placing the state in that respect second among all the states. The third place among the Central states, and the fifth place among all the states, was occupied by Wisconsin, where in 1890 the industry did not exist. In 1900, 23 establishments, with a capital of $2,337,975, reported products to the value of $2,795,236, or 8.8 per cent of the aggregate for the United States. Indiana showed a considerable change; capital increased from $58,650 to $2,061,560, or $2,002,910, and value of products from $180,000 to $2,115,901, or $1,935,901.

Table 5 is a comparative summary of capital for 1890 and 1900, with the percentage of increase for the decade and the percentage of each item to the total.

TABLE 5.—COMPARATIVE SUMMARY, CAPITAL: 1890 AND 1900.

	1900		1890		Per cent of increase.
	Amount.	Per cent of total	Amount.	Per cent of total.	
Total	$29,783,659	100.0	$2,058,072	100.0	1,347.2
Land	1,501,003	5.0	22,650	1.1	6,526.9
Buildings	3,705,462	12.4	339,371	16.5	991.9
Machinery, tools, and implements	9,462,031	31.8	564,400	27.4	1,576.5
Cash and sundries	15,115,163	50.8	1,131,651	55.0	1,235.7

Table 5 shows the changes in the relative percentages of land, buildings, machinery, etc., and live capital since 1890. Land increased from $22,650 to $1,501,003, or $1,478,353; buildings from $339,371 to $3,705,462, or $3,366,091; machinery, tools, and implements from $564,400 to $9,462,031, or $8,897,631; and live capital from $1,131,651 to $15,115,163, or $13,983,512. The last item includes cash on hand, bills receivable, unsettled ledger accounts, raw materials, stock in process of manufacture, finished products on hand, and other sundries. The total in this table does not include the capital stock of the corporations engaged in the manufacture of cycles.

Table 6 shows, for 1900, the kinds, quantity, and value of products for the industry, and the per cent of each item of value to the total.

TABLE 6.—NUMBER AND VALUE OF DIFFERENT KINDS OF PRODUCTS, WITH PER CENT THAT VALUE OF EACH KIND FORMED OF TOTAL VALUE: 1900.

	Number.	Value.	Per cent of total value.
Total		$31,915,908	100.0
Bicycles	1,113,039	22,160,260	69.4
Individual—			
Chainless	41,899	1,893,821	5.9
Chain	1,067,524	20,031,600	62.8
Tandem	3,457	201,889	0.6
Motor	159	32,950	0.1
Tricycles	18,110	47,985	0.2
Automobiles	56	60,788	0.2
All other products		9,646,875	30.2

In Table 6, as in preceding tables, are included only the 312 establishments in which the manufacture of cycles was the principal industry; but in 1900 returns were also received from 16 establishments reporting cycles as a by-product.

The number and value of the bicycles and tricycles thus added is shown in Table 7.

TABLE 7.—SUMMARY OF ESTABLISHMENTS REPORTING CYCLES AS A BY-PRODUCT, WITH THE NUMBER AND VALUE OF SUCH PRODUCTS: 1900.

STATES.	Number of establishments.	CYCLES PRODUCED AS BY-PRODUCTS. Aggregate value.	Bicycles. Total. Number.	Bicycles. Total. Value.	Individual. Chainless. Number.	Individual. Chainless. Value.	Individual. Chain. Number.	Individual. Chain. Value.	Tandem. Number.	Tandem. Value.	Tricycles. Number.	Tricycles. Value.
United States	16	$1,553,177	69,811	$1,529,177	1,030	$63,508	68,598	$1,456,989	183	$8,680	8,000	$24,000
Illinois	3	447,198	18,600	447,198	.....	.....	18,543	444,633	57	2,565	.....	.....
New York	4	141,374	7,792	141,374	1,000	62,488	6,792	78,886	.....	.....	.....	.....
Ohio	4	605,994	26,231	581,994	.....	.....	26,145	577,479	86	4,515	8,000	24,000
All other states[1]	5	358,611	17,188	358,611	30	1,020	17,118	355,991	40	1,600	.....	.....

[1] Includes establishments distributed as follows: Massachusetts, 1; Michigan, 2; Pennsylvania, 2.

Table 8 combines, for 1900, the number and value of all kinds of bicycles and tricycles manufactured, whether as principal product or as by-product, and of automobiles made in cycle factories, the per cent of each kind to the total, both in number and in value, and the average price of each kind.

TABLE 8.—TOTAL PRODUCTION OF CYCLES, INCLUDING THOSE PRODUCED AS BY-PRODUCTS, WITH PERCENTAGES: 1900.

	Number.	Value.	Per cent of total number.	Per cent of total value.	Average value.
Total	1,209,016	$23,822,210	100.0	100.0	.....
Bicycles	1,182,850	23,689,437	97.8	99.4	$20.03
Individual—					
Chainless	42,929	1,957,329	3.5	8.2	45.59
Chain	1,136,122	21,488,589	94.0	90.2	18.91
Tandem	3,640	210,569	0.3	0.9	57.85
Motor	159	32,950	(1)	0.1	207.23
Tricycles	26,110	71,985	2.2	0.3	2.76
Automobiles	56	60,788	(1)	0.3	1,085.50

[1] Less than one-tenth of 1 per cent.

The total number of vehicles manufactured was 1,209,016, of which 1,182,850, or 97.8 per cent, were bicycles. The census year 1900 was one of the first in which the chainless bicycle was produced in any considerable quantity, 42,929 being manufactured. Very few tandems were manufactured, constituting only three-tenths of 1 per cent of the total number, and only 159 motor cycles. Fifty-six automobiles were manufactured in cycle factories. The number of tricycles was 26,110, or 2.2 per cent of the total. The average price of chain bicycles at the factories was $18.91; chainless, $45.59; tandems, $57.85; and motors, $207.23. Most of the tricycles were children's toys, which accounts for their very low average price. In value, the chain bicycles constituted 90.2 per cent of the total; the chainless, 8.2 per cent; the tandems, nine-tenths of 1 per cent; and the motors, one-tenth of 1 per cent. The value of the tricycles was only three-tenths of 1 per cent of the total, and of the automobiles three-tenths of 1 per cent. There were produced in cycle factories, in addition to vehicles, other products to the value of $9,646,875, or 30.2 per cent of the total for the industry. These "other products" consisted chiefly of parts for bicycles, like chains, spokes, handle bars, saddles, rims, etc. In the beginning of the industry the larger establishments made nearly all the different parts of bicycles they required, but of late factories have more and more specialized their output, and now even some of the largest bicycle manufacturers merely buy the majority of the different parts and assemble them. The American Bicycle Company, controlling the majority of the output, is an example. Certain parts of its machines are manufactured in those of its factories best adapted for the purpose, and sent to other plants to be assembled. This procedure greatly economizes the cost of manufacture.

In addition to the bicycles given in Table 8, there was undoubtedly a considerable number manufactured by the 6,328 establishments classified as bicycle and tricycle repair shops, but as the value of their product was not reported in detail, but only the gross sum received for custom work and repairing, statistics as to the number of cycles manufactured by them are not available. The value of custom work and repairing in these establishments aggregated the large amount of $13,766,033, which should be taken into consideration in connection with the value of products of the manufacture of bicycles and tricycles. The general statistics for these latter establishments will be found in the Report on Manufactures, Parts I and II, under the classification "Bicycle and tricycle repairing."

HISTORICAL AND DESCRIPTIVE.

It is safe to say that few articles ever used by man have created so great a revolution in social conditions as the bicycle. Most of its evolution and all its perfection to the point of practical usefulness having taken place during the last fifteen years, the present generation is enabled to judge of the change it has brought in its wake. Lord Charles Beresford once said, "Whoever invented the bicycle deserves the thanks of humanity," and no expression was more fit. The bicycle has been the means of bringing out for exercise in the open air millions of persons, men and women, young and old, who otherwise would have confined themselves to homes, stores, and offices. The bicycle industry has, directly and indirectly, given employment to many thousands of persons in the manufacture and sale of its product. The very wide use of the bicycle led to the formation of the League of American Wheelmen, with a membership, at one time, of more than 100,000; and this organization started the agitation for better roads, which led, in many states, to great improvements in public highways. Like all other articles depending upon public favor for their use, the bicycle has had its successive periods of prosperity and depression. The boom of a few years ago has passed, and in its place has been established a legitimate demand for the bicycle as a mode of conveyance. It is probable that a normal stage in the manufacture has been reached, and that from now on the industry will show stability and progress. Already there is hardly a spot in the known world where the bicycle has not penetrated.

The question when the first vehicle was used by man for self-propulsion is difficult to answer. Contrivances, somewhat similar to the bicycle, were not unknown even in the most ancient times, as is shown by the hieroglyphics of the Egyptians, in which appear images bearing a faint resemblance to the "hobbyhorse" of a few generations ago; and upon the frescoes of Pompeii are to be seen winged figures astride a stick connecting two wheels. Rudimentary velocipedes were mentioned in the Fifteenth and Sixteenth centuries. The first record of a bicycle is in a stained-glass window, dated 1642, in the church of Stoke Pogis, a town near Windsor, England; but, though a bicycle is pictured, there is no explanation of its origin. John Evelyn noted in his diary that in August, 1665, he called at Durdans, near Epsom, and found Dr. Wilkins, Sir William Petty, and Mr. Hooke, contriving, among other things, "a wheele for one to run races in."[1] In 1693 Ozanam read a paper before the Royal Academy of Science, describing a vehicle driven by the pedaling of a footman. Ozanam's vehicle was followed, about 1761, by another, built on a somewhat similar plan by an Englishman named Ovenden, at which time a description of the machine appeared in the Universal Magazine.

In 1690 M. de Sivrac, a Frenchman, invented a vehicle consisting of two wheels joined with a wooden frame representing the body of an animal, upon the back of which was placed a saddle for the rider. This contrivance had no handle bar, but was steered by the feet of the rider. It was called the célérifère. In the London Magazine for August, 1769, there is a description of a "chaise to go without horses." Le Journal de Paris, July 27, 1779, contains a description of the wonderful invention of MM. Blanchard and Magurier, which was called the velocipede. This, however, was only a reappearance of the célérifère with the addition of an upright bar for the support of the hands. Though this vehicle was much used, it was only with the advent of the draisine that the riding of a velocipede became fashionable.

The draisine was invented by Baron Carl von Drais, of Manheim on the Rhine, in 1816. It consisted of two wheels, tandem style, connected by a bar or perch over them, the forward wheel axled in a fork swiveled to the fore end of the perch and bearing at the top a cross-bar or handle with which to guide the machine. The rider sat astride the perch, on a saddle, propelling the vehicle on the level or on an upgrade by thrusting his feet on the ground. On a descending grade he lifted his feet and coasted. In his application for a patent Baron Drais described the capacities of his invention as follows: "1, that on a well-maintained post-road it will travel uphill as fast as a man can walk; 2, on a plain, even after a heavy rain, it will go 6 to 7 miles an hour, which is as swift as a courier; 3, when roads are dry and firm it runs on a plain at the rate of 8 to 9 miles an hour, which is equal to a horse's gallop; 4, on a descent it equals a horse at full speed." The real improvement made by von Drais was that the front wheel turned on a pivot and thus the handle bar was movable, enabling the rider to steer the wheel.

The draisine excited much attention in Germany and France and was finally brought to England, where Dennis Johnson, in 1818, patented an improved draisine under the name of a "pedestrian curricle;" this had an adjustable saddle and a rest for the elbows. The enthusiasm in England was raised to a high pitch by this machine; all the fashionables adopted its use and it was soon nicknamed "dandyhorse" and "hobbyhorse." Among the names used for the draisine in England, about 1817, were "the patent accelerator," "the velocipede or swift walker," "the manivelociter," "the bivector," etc.; and in 1819 they were called "bicipedes" and "tricipedes." The Gentlemen's Magazine for March, 1819, contains an article describing the use of the velocipedes, from which the following is an extract:

[1] Temple Bar, June, 1898.

"The new machine, entitled a velocipede, consisting of two wheels, one before the other, connected by a perch, on which the pedestrian rests the weight of his body while with his feet he urges the machine forward on the principle of skating, is already in very general use. 'The road from Ipswich to Whitton,' says the Bury paper, 'is traveled every evening by several pedestrian hobbyhorses; no less than six are seen at a time.' * * * The crowded state of London does not admit of this novel mode of exercise and it has been put down by the magistrate of police." And the Monthly Magazine for October, 1819, said: "Considerable progress continues to be made in the improvement and useful extension of the traveling vehicles named velocipedes. It being found that the propelling action of the legs led to diseases of them, it has been contrived that a propelling reaction shall be created by the energy of the arms, and Mr. Birch, who has succeeded in this new application, may soon expect to work his levers, not only by the hands, but by steam. Indeed, there can be little doubt but this triumph of mechanics will be effected within the ensuing winter."

In England the velocipede was considerably improved in 1821 by Louis Gompertz. His machine had the handle connected with a segment rack, gearing in a pinion on the front wheel, so that it could be driven either by the hands or, as before, with the feet on the ground. About this time inventive genius came to a standstill, so far as foot-propelled vehicles were concerned and remained so for more than forty years, though rival claims exist that in 1836 Kirkpatrick McMillan, of Courthill, Scotland, invented a bicycle driven by the aid of cranks and levers from the rear wheel; and that Gavin Dalzell, another resident of Scotland, about 1845, also made one on similar principles; but, as neither of these types was ever manufactured for any other person than the owner, neither claim has been recognized.

In 1865 M. Mareschal, a Frenchman, obtained a patent on a frame connecting five wheels, each having an independent axle provided with foot-cranks bearing loose pedals. Each wheel was to be mounted and driven by its own rider, the front wheel being also the guide wheel. Thus the vehicle could carry from one to five riders. The next improvement came in September, 1865, when MM. Woirin and Leconde obtained their French patent. Their machine had three wheels, two smaller rear ones on the same axle, and one larger front wheel having an axle with cranks on which were loose pedals for the feet of the rider. The frame connecting these wheels was in the shape of a wooden horse, on whose back the rider sat, well over the front wheel. From this invention sprang the tricycle, which for many years was popular.

There has been considerable controversy about who was the inventor of the first crank-driven bicycle—whether it was Ernest Michaux, the son of a French manufacturer, or Pierre Lallement, one of the workmen in the senior Michaux's shop. Most authorities seem satisfied that the honor belongs to Lallement. He conceived the idea that the foot-cranks would work as well on a two-wheeled as on a three-wheeled velocipede. He took off one of the rear wheels and set the other directly back of the front wheel, and the "bone shaker" was an accomplished fact. At that period it was generally thought impossible for anyone to balance himself on a velocipede without keeping his feet on the ground; but Lallement finally succeeded in mastering the art, and his machine was exhibited at the Paris Exposition in 1865, but he thought so little of its usefulness that he did not patent it. In 1866 Lallement came to the United States, and while looking for work he made one of these two-wheeled velocipedes and rode it on the streets of New Haven, Conn. There James Carroll, a Yankee, noticed him, and foreseeing the opportunity for establishing a new and successful industry, he and Lallement obtained a patent on the 20th of November, 1866. The velocipede described in this patent consisted of two wooden wheels, with iron tires, of nearly equal size, one before the other, surmounted by a wooden perch, from which projected downward, near its rear end, two arms on either side of the rear wheel, each pair of arms meeting at the end of the hub and forming a bearing for the end of the axle; one similar wooden bar projected from the fore end of the perch on either side the forward wheel, furnishing bearings for its axle, and arranged with a pivot in the perch so that the fore wheel could be turned in either direction. On a steel spring extending over the perch was a saddle, about midway between the wheels. The rider started the machine by pushing it along the ground with his feet, and afterwards propelled it by working the pedals, which were attached to the front wheel.

The word bicycle, thus spelled, first occurs in the English patent records in the specification of J. I. Stassen, filed April 8, 1869. For a few years previous a somewhat similar word had appeared in print, though the spelling of it varied considerably. Thus the London Daily News of that date wrote of "bysicles" and "trysicles." One of our own papers called it "bicycular velocipede," and Harper's Weekly, in 1868, called it "bicircle" and "veloce." The Franco-Prussian war of 1870 brought the flourishing velocipede industry of France to a standstill, but in England about the same time the foundation was being laid for the new industry, which, ere long, was to take such a dominating place. Improvements, however, were slow. In 1871, W. H. J. Grant proposed to use rubber pedals, so as to permit the rider to use the ball instead of the hollow of the foot; he also attached rubber tires to curved metal rims by vulcanization. By this time there was a marked increase in the size of the front wheel, while the back one grew smaller, until, in 1873, J. K. Starley, who has been called the "Father of the bicycle," produced

a machine which embodied the rudiments of the modern bicycle. It was constructed of metal and rubber and its front wheel was twice the size of the rear one. The front wheel was continually increased in size until in 1886 bicycles were built with a front wheel 60 inches in height, while the rear wheel had been reduced to 16 inches.

The first appearance of the bicycle in the United States was in 1819, when Johnson's pedestrian curricle was introduced into New York. The excitement it created rapidly spread to Boston, Philadelphia, and other places, and many riding schools were opened. On June 26, 1819, William K. Clarkson was granted a patent for improvement in a velocipede. After the first novelty had worn off, little was heard of velocipedes in the United States until Lallement's patent had been granted, nearly half a century later. Another patent was taken out in July, 1868, by the Hanlon brothers. In 1869 the new velocipede craze was at its height; rinks and riding schools were opened everywhere, but, as was the case with the hobbyhorse in 1819, the "bone-shaker" was found too cumbersome a machine to gain lasting favor, and two years later scarcely any were ridden in the United States.

In England the development of Lallement's velocipede was carried on; the first important improvement was in the construction of the wheels, which were made of steel; but progress was slow until 1874, when J. K. Starley patented the tangent wheel. In the United States nothing was done in the way of perfecting the bicycle; and until fifteen years ago the manufacture of bicycles had been more experimental and devoid of all rational theory than any other branch of the engineering industry. Up to a few years ago the designing of bicycles was thought unworthy the study of competent engineers.

The bicycle as a modern vehicle has been before the world for about thirty years. Its evolution in a diversity of patterns may be said to have taken place principally between 1868 and 1885; and its perfection, transformation, and the almost complete extinction of all but one class, in the decade 1885–1895. The first modern bicycles were imported from England in 1876 and exhibited at the Centennial Exposition in Philadelphia. There they were seen by Col. Albert A. Pope, of Boston, Mass., and he immediately recognized the opportunities that lay before this new mode of conveyance. The following year he set about carrying his idea into effect. He went to England to study the industry, which then flourished there. On his return he brought some wheels, and the same year W. S. Atwell, of Boston, built for Colonel Pope the first American bicycle. This was a very cumbersome affair, weighing 70 pounds and costing $313. After another visit to England where he found more than 100 factories busy producing bicycles, Colonel Pope decided that the field for the new vehicle in America was broad enough to warrant starting a factory. He interested the Weed Sewing Machine Company, of Hartford, Conn., in the manufacture of bicycles, and in a corner of their shop the Columbias were first manufactured.

From this small beginning evolved a chain of factories in Hartford, at times giving employment to more than 5,000 workmen, and contributing their share toward making Hartford one of the wealthiest cities in the United States. Colonel Pope bears the undisputed title "Father of the American bicycle," and a great part of the credit for the extraordinary development of the industry was due to him. The "ordinary" bicycles, however, were almost entirely built after foreign patterns. One of the American ideas to prevent "headers" was shown in the Star bicycle, patented in 1880 by G. W. Pressey, on which the small wheel was placed in front. The seat was moved so as to place the center of gravity forward of the big wheel, the feet of the rider resting upon adjustable treadles, working independent of each other.

As early as 1876 H. T. Lawson, an Englishman, invented a safety bicycle in which the rear wheel was driven by levers, but it was not until 1880 that the first rear-driving "geared" safety was built at the works of the Coventry Machinists' Company at Coventry, England, after the design of J. K. Starley. But the energies of the bicycle makers were still bent on improving the high wheel. Comparatively great as the demand was for these machines it was limited to a certain class of riders, and it was only with the advent of the "safety" that the manufacture of cycles on a large scale began. It was not until 1885 that the "safety" became a feature at the Stanley show in England, where, in the early days of the industry, all manufacturers gathered ideas.

In 1887 A. H. Overman, of Chicopee, Mass., invented a bicycle, the Victor, a machine with two wheels of the same size, set tandem style and connected by a frame on the principle of a triangular truss, with the seat at the apex of the triangle and a sprocket wheel at one end. The sprocket wheel was connected with the hub of the rear wheel by an endless chain and was turned by pedals on each side. This wheel had narrow steel tires, which were soon replaced with solid rubber, and it weighed more than 50 pounds. The history of the "safety" is a record of rapid development. Immediately after its acceptance as a popular type of a wheel, a series of changes began in design and construction, and in the ideas of manufacturers as to the necessary requirements of such a machine. Between 1885 and 1890 the evolution of the cycle industry was especially rapid; pregnant ideas and startling changes followed each other in quick succession.

A noteworthy fact is that the development of the bicycle was the result of constant experimenting, instead of being based on knowledge of the needs of the industry. While the United States took little part in the early development of the velocipede and bicycle,

it has led the world during the last decade not only in the quality and quantity of bicycles produced, but in improvements in methods of manufacture. Through the ingenuity of American engineers, tools and automatic machines have been invented by the use of which the cost of producing bicycles has been so greatly reduced as practically to place the machine within reach of all classes.

The developments which converted the velocipede into the practical bicycle of to-day may be summed up as the rubber tire, the suspension wheel, the ball bearing, weldless steel tubing, the wooden rim, the chain gearing, the coaster brake, and the chainless gear.

The rubber tire (including its later variation, the pneumatic tire) was perhaps the most important of these improvements. As early as 1845 an English civil engineer, R. W. Thompson, patented a pneumatic tire, which differed but little from the present form; but at that time there were no cyclists and little use for such a tire, so the patent was allowed to lapse without having reached any commercial importance. When the velocipede came into use in 1867, steel tires were used; later the idea was conceived of nailing rubber strips on steel rims. When the "ordinary" came into use, "U" or "V" shaped steel rims were used, into which solid rubber tires were cemented, or fastened with corrugated wires. Between 1876 and 1882 the tendency was to reduce the size of the tire. This continued until 1889, when John B. Dunlop, an Irish veterinary surgeon, fitted a piece of rubber hose to his son's bicycle.

From this inconspicuous beginning grew the pneumatic tire, the great marvel in the construction of the modern bicycle, and the basis upon which the present industry rests. At every period throughout the history of bicycle construction attempts had been made to decrease the vibration, thus at the same time contributing to the comfort of the rider and increasing velocity by lessening the rolling friction; but all efforts were in vain until the advent of the pneumatic tire. At first it was received with incredulity by the manufacturers and by the riders, who feared to meet with punctures, but it soon demonstrated its indispensability; which is abundantly proven by the fact that, though previous to 1889 a pneumatic tire was unheard of, 40 per cent of all machines manufactured were fitted with them in 1891, and two years later a bicycle fitted with any other style was a curiosity.

The general distrust of the usefulness of the pneumatic tire led to the invention of the cushion tire in 1891. This was an india-rubber tire very much larger than the solid tire, and having a small hollow air space running through it. The pneumatic and the cushion tires were made on the same principle; in the pneumatic the thickness of the outer wall was reduced to a minimum, the diameter was further increased, and air was forced inside and retained, at a pressure of about 40 pounds to the square inch. The pneumatic tires soon demonstrated their superiority over the cushions, and in a very short time they had surmounted all prejudices. The single-tube pneumatic tire was first suggested and described by Mr. I. W. Boothroyd, of London, England, who, however, did not patent his invention; at about the same time P. W. Tillinghast, of Providence, R. I., had invented, patented, and brought out in the United States a pneumatic tire on the same lines as Boothroyd's.

The suspension wheel is one of the oldest of all the parts which enter into the make-up of the modern bicycle. Both the English and the French claim the honor of having invented it—the former in 1826 and the latter in 1864. It, however, belongs to neither, as manuscripts left by an Italian, Leonardo da Vinci, a contemporary of Columbus, contain a sketch of a suspension wheel and an autographic note describing the device as one "by which wheels are strengthened and a light wheel made strong." This invention antedates 1490. A wheel in the National Museum in Washington is a reproduction from this sketch. The next record of a suspension wheel is found in the British Patent Office, where Theodore Jones, in 1826, filed his application for a patent on an "improved construction of carriage wheels, of such nature that the weight they have to carry is suspended from that part of the wheel which happens to be uppermost, instead of being supported, as is usual, by the spokes that happen to be under the axle-tree." All modern bicycle wheels are built on this principle.

The first bearing used in bicycle construction was the "plain" bearing. To this a nicely fitted and hardened sleeve was added, and this became known as the parallel bearing. The next change was to the roller bearing, which was not a success. About the same time the adjustable cone was tried. This was a male cone, threaded on the axle and fitting into a female coned space in the hub. The final and most important step in the evolution of the bearings was the innovation of interposing steel balls between these coned faces, a change which revolutionized previous theories and reduced the friction to an almost imperceptible point. The inventor of this improvement was an Englishman. These bearings have now been applied to every point in a bicycle where friction may be encountered. They are, perhaps, to be more admired than any other part of the machine. Instead of allowing the axle to slide around in its bearings hard steel balls are introduced so that the parts which come in contact roll over, and do not slide upon, one another. These balls have to be made with the greatest possible accuracy, as the least flaw in them will put the wheel out of order. It is interesting to note how little the balls lose in weight by wear in traveling. Experiments have proved that 12 balls, which, when new, weighed 25:80,400 gram, after having been ridden 1,000 miles weighed 25:80,088 gram, the loss being 3:12 milligram, which is equal to 1/20.8 grain; i. e., in running 1,000 miles each ball lost

1/250 grain. This corresponds to a wear off of the surface of only 1/158,000 of an inch.[1]

The construction of the frames of bicycles has passed through many eras. In the first hobbyhorses the connections between the wheels were made of wood; on the early velocipede the frame was made of solid steel or iron bars; then came the change from solid forgings to tubing and finally the weldless steel tube. Attempts to produce weldless tubes by a drawing process were made some thirty-five years ago. The process was, however, a costly and difficult one, and before it could reach its modern development it awaited important improvements, both in respect to the drawing appliances and to the manipulation of the ingot from which the tube was produced. W. C. Stiff, of Birmingham, England, perfected the methods of manufacture to such a degree that about 1880 weldless steel tubing began to be employed for the backbone and fork of the "ordinary" bicycle. The great demand, however, arose when the safety bicycle came into vogue. There are various modes of producing the cold-drawn steel tube, but the principle is practically the same in all. Only a very high grade of steel is suitable for the purpose, and Swedish charcoal steel containing a particular proportion of carbon has proven itself superior to all others.

Previous to 1893 a very small portion of the tubing required for bicycle manufacture was produced in the United States, and that produced was of an inferior grade, which could not be used in high-grade bicycles. In 1892 and 1893 several tube works were started in the United States, but it was not until about 1897 that the home factories could supply the demand. George F. Parker, United States consul at Birmingham, England, in his report of May 8, 1896, states that the exports of bicycle tubing from Birmingham to the United States in 1895 amounted to $507,041, and for the first quarter of 1896 the amount had risen to $231,200. The fiscal year 1897 was the first in which imports of bicycle tubing were given separately in the United States Treasury reports, the value imported for consumption in that year being $185,259; in 1898, only $33,798; in 1899, $26,413; and in 1900, $16,573. The mode of making the tubing has been greatly improved, and our manufacturers are now turning out a product superior to any made in England and are exporting large quantities to all parts of the world. An idea of the amount produced can be formed when it is remembered that every bicycle requires about 20 feet of tubing, and that, during 1900, 1,182,850 bicycles were manufactured.

The frame of the modern bicycle is a marvel of construction. It is really a bridge on wheels built for the support of a man. Until a few years ago the tendency was to reduce the weight, and tubing was used which was hardly thicker than a sheet of stout paper; but, after roadsters had been produced weighing about 16 pounds, a change took place, and the average is now about 22 pounds. Originally the different parts of the frame were joined together with drop-forge connections, but now sheet-steel stampings are almost entirely used. The joints were of three kinds, flush, outside, and lapped, of which flush joints are now used almost exclusively. After the drop forgings or stampings are finished the tubes are cut down to proper lengths and closely fitted into the open joint of the stamping connection. In order to hold them securely they are pinned through, and are then taken to the brazing furnace. The process of brazing as applied in the bicycle industry is of very recent origin. Until 1880 it was generally thought impossible to braze light tubing to solid forgings, and all connections were welded together. The difficulties were solved, however, and the brazing and the flush joints make the bicycle of to-day as solid as if it were cut out of one piece of steel. A few years ago hickory wood was substituted for steel tubing by some manufacturers, but this did not prove satisfactory and was soon discontinued. The frames have also been made of papier-maché. The diamond-frame construction was not used until 1891, when Humber, in England, made a bicycle with straight tubing; previous to this the frames had been of the most fantastic shapes. One of the improvements greatly enlarging the use of the bicycle was the drop frame, which enabled women to ride. The first drop-frame bicycle was disclosed to the Patent Office on February 2, 1886, and a patent for it was granted to E. G. Latta on March 29, 1887.

The improvement in rims has also been of far-reaching proportions. The dandy-horse had wooden rims, shod with iron, but in the more modern velocipedes these were supplanted by steel or iron rims. The first rims used for rubber tires were of solid metal, grooved to receive the tire. In 1877 J. S. Smith, of London, England, patented the hollow metal rim. Until 1891 steel and iron rims were used exclusively, but the latter year a wheel with a wooden rim was put on the market by Charles Harrington. This was a purely American innovation. Makers and riders were very skeptical as to its value, but in less than two years it had completely superseded the steel rim in the American market. The steel rim is now used only on wheels exported to England, where it is claimed that climatic conditions are unfavorable to the wooden rim. In 1896 rims of papier-maché were manufactured, but as none of the prominent manufacturers accepted them, their use was very limited, and they soon disappeared.

Of all the component parts of a bicycle, the gearing has probably caused the most brain work. Lallement's velocipedes and all the early "ordinary" bicycles were fitted with a crank directly attached to the driving wheel. In 1875 Rousseau patented a bicycle using a chain gearing applied to the big wheel. The application of the chain marked an extraordinary epoch in the development of the bicycle. Before its introduction

[1] Lecture delivered by C. Vernon Boys, A. R. S. M., at the Royal Institution, March 7, 1884.

gearing had been obtained by the working of treadles or toothed gear. At first it was thought that toothed gearing could be more accurately constructed than a chain and that it was more economical of power, but as the bevel or tooth-geared machines could not be manufactured to run as fast as the chain-geared, the latter soon had the entire field.

The first patent for a bevel-gear chainless bicycle was granted in 1885, but the first practical ones were not put on the market to any extent until 1897; since then there has been a steady increase in the number manufactured. The mechanism of the "bevel-gear" chainless bicycle consists of a pair of gear wheels at the crank bracket and another pair at the rear hub, with a connecting rod which rotates on ball bearings, and runs near the stationary rear fork of the bicycle. The gear wheels are furnished with roller-bearing pegs or teeth which engage each other nearly at right angles. Another type of chainless bicycle is the spur sprocket. This obtains its power by the interlocking of cogs in three spur wheels; the first wheel revolves with the cranks, communicating power by cogs to the intermediate wheel, and this in turn causes the third wheel, which is attached directly to the rear hub, to rotate.

One of the contrivances which has lately done much to restore the bicycle to public favor is the free wheel and coaster brake. The first patent for this was granted in 1880, since which time it has been greatly improved. The coaster brake is a device which allows the rider to rest his feet on the pedals, while allowing the driving wheel to revolve freely. A slight backward pressure on the pedal throws a clutch mechanism into action, which in turn operates a braking device. The foremost in use has an expanding rim inside a hub; by very slight application of power this ring generates a very high braking power and gives the rider complete control over the wheel. One of the most popular styles of coaster brakes consists of two hubs, i. e., an inner or driving hub, and an outer or coasting hub. While driving, the two hubs are locked together by means of a ball clutch; this is released by a backward pressure on the pedal, and when coasting the driving hub remains at rest, allowing the outer hub to revolve freely on an independent set of bearings resting on the inner hub.

It is easy to perceive the great advantage of the coaster brake over other brakes. The first brake on the "ordinary" bicycle was the remarkable drag brake, which was pivoted under the rear fork crown, and was operated by a cord passing over the backbone to the handle bar. It was applied by turning the handle, when the prongs of the drag were forced against the ground. An improvement over this was the "spoon" brake, which at first also was applied to the small wheel; later on it was applied to the big wheel. This has also been the most common brake used on the "safety."

The first crank hanger was made from a casting, for which later a drop forging was substituted. The latter was considered one of the best, but was also the most expensive form of brackets. As the demand for cheaper wheels arose, stamped brackets usually consisting of two pieces brazed together were used. The crank hanger is now usually of one piece construction, the steel being drawn into the shape of a tube by means of 5 separate operations. The 4 lugs to carry the rear forks, the lower main tube and diagonal stays, are then drawn and formed upon it through hydraulic pressure, making 12 more operations; the seat-pillar lug, while not seamless, is of the one piece construction with the 3 lugs drawn and formed in the same manner. The rear fork jaws are stamped out of crucible steel and are of what is known as semi-hollow construction—i. e., a half section of a circular tube. The basic patent is for a crank hanger formed with lugs to receive the tubes of the frame. A great many attempts have been made to invent brackets to evade this patent. The advantage of the sheet-metal bracket, besides its economy, is the preservation of the metallic skin, the toughest portion of the metal.

The first pedals on the velocipedes consisted of 2 elliptical side plates of sheet steel, joined in the center by a tube to slip over the pedal shaft, and having, on rods riveted into the ends of the side plates, 2 round rubbers for the tread. The bearing was either plain or the adjustable cone. The greatest improvement was the application of ball bearings to the pedals. Two forms are now used—rubber and rat-trap. The rubber pedals consist of rubber-covered disks for the feet to rest on and give them a cushion. Rat-trap pedals consist of toothed blades, and are largely used by racing men on account of their lightness and nonslipping qualities.

Originally all hubs were made of gun metal; flanges were very thick at the edge and tapered toward the center, in order to provide sufficient room for tapping and threading the hub flanges to allow for the direct spokes. From these the barrel hub in its different varieties evolved.

The spokes have also been greatly improved. At first they were one-quarter of an inch in diameter, made of iron, and headed at both ends. Then steel-wire spokes were used with a considerably smaller diameter. The nipple and nut spokes were abandoned about 1882 and the direct spoke was substituted. Manufacturers continued to reduce the size of the wire, and now use .069 wire. The first tangent spokes were made in England by the Coventry Tangent Company, and soon after their introduction the manufacturers inaugurated the method of swaging the spokes, that is, tapering them toward the center. A set of spokes for a modern wheel weighs only 15 ounces.

The saddle is the one of the component parts of a bicycle, the idea of which has undergone the least

change. On the early velocipede the saddle was made out of a piece of wood; later on this was covered with leather and padded. On the high wheels the saddles were formed by a base of metal covered with leather. The next type was the suspension, or hammock type, where the seat rested on a piece of leather suspended between the front and rear forks. Then followed the era of the so-called hygienic saddles, of which the pneumatic saddles were the most prominent. The use of the pneumatic and other cushion saddles has been abandoned, as they were apt to produce chafing and soreness; some of them were even apt to produce forms of internal injury. The desire has been to produce saddles of such a design as to reduce vibration to its lowest degree, and at the same time to get a saddle which will retain its form under hard usage and different conditions. The perfection is exemplified in the present rigid type of saddle. Spring frames, seat posts, and forks are other devices for such reduction.

Direct and indirect accessories to the bicycle are too many to be enumerated; among them are air pumps, lamps, shoes, clothing, carrying baskets, cyclometers, etc.

Tricycles may be divided into three classes: Children's, carriers, and vehicles for invalids. Few, except the children's, are now manufactured.

During the census year 1900 only a few motor bicycles were manufactured, and it is too early to speak of the development of this branch of the industry. The price of such machines has been considerably reduced during the last two years.

The evolution of the bicycle industry can be gauged to some extent by the number of patents issued. Since the establishment of the United States Patent Office 7,573 patents have been granted for cycles and their component parts. Of these only 16 had been granted before January 1, 1865, and the great majority were issued after 1890. The first patent issued was to J. B. Bolton, September 29, 1804, for a vehicle driven by a hand-worked toothed gear; the others issued previous to 1865 mostly covered toys. In 1892, the number of applications for patents on improvements in cycles increased at such a rate that a special division for their examination was established in the Patent Office. Patents of the velocipede class are divided into five groups, as follows: Unicycles, bicycles, dicycles, epicycles, and polycycles. All patents in this class must refer to velocipedes propelled by hand or foot, or to parts of such vehicles. Wheels and their component parts, such as hubs, spokes, rims, and tires, are not, however, included in this class, but with carriage and wagon wheels. The following tabular statement shows the number of patents that have been granted on all parts entering into the construction of cycles. The miscellaneous item includes clamps, rests, casings, mudguards, etc.

Unicycles	46
Epicycles	32
Dicycles	38
Bicycle propulsion	1,326
Polycycle propulsion	718
Frames	830
Pneumatic tires	764
Cushion and solid tires	652
Saddles	494
Brakes	451
Handlebars and handles	448
Wheels, spokes, rims, and hubs	358
Pedals and toe clips	223
Bearings	133
Miscellaneous	1,060
Total	7,573

From this tabular statement it appears that 2,044 different devices for cycle propulsion have been patented, 1,416 for rubber tires, 830 for frames, 494 for saddles, and 451 for brakes. Unicycle is a velocipede with only one wheel; dicycle is one where 2 wheels are placed side by side, and polycycle is one having 3 or more wheels placed in such a manner as to furnish a stable support. The epicycle is a vehicle very seldom seen in public. It is a portable annular track propelled by a traction wheel on the inside. The rider is seated inside the wheel in such a position that the center of gravity is a little below the axis of the annulus.

The number of patents applied for during the last two years has been considerably reduced.

The following tabular statement, taken from the reports of the United States Treasury Department, shows the exports and imports of cycles and parts thereof for the last five years of the decade. Prior to 1896 there was no separate classification for this industry, its statistics being included either with carriages and wagons, or with manufactures of iron and steel.

FISCAL YEAR.	Imports for consumption.	Exports.
1896	$56,960	$1,898,012
1897	21,122	7,005,323
1898	4,845	6,846,529
1899	4,577	5,753,880
1900	3,516	3,553,149

Almost the entire demand for bicycles in the United States and many foreign countries was, until recent years, supplied from England; but American bicycle manufacturers have had the satisfaction of reversing trade conditions, and now the United States is supplying bicycles not only to England, but also to all other parts of the world.

Table 9 shows in detail for 1900 the statistics relating to the industry.

TABLE 9.—BICYCLES AND TRICYCLES, DETAILED SUMMARY, BY STATES: 1900.

		United States.	California.	Connecticut.	Illinois.	Indiana.
1	Number of establishments	312	4	24	60	19
	Character of organization:					
2	Individual	95	3	6	17	2
3	Firm and limited partnership	54	1	3	7	2
4	Incorporated company	163	.....	15	36	15
	Capital:					
5	Total	$29,783,659	$19,254	$4,215,399	$7,694,658	$2,061,560
6	Land	$1,501,003	.....	$241,675	$478,407	$110,873
7	Buildings	$3,705,462	.....	$882,071	$561,680	$302,102
8	Machinery, tools, and implements	$9,462,031	$4,400	$1,487,357	$2,018,283	$782,015
9	Cash and sundries	$15,115,163	$14,854	$1,604,296	$4,636,288	$866,570
10	Proprietors and firm members	209	5	12	31	5
	Salaried officials, clerks, etc.:					
11	Total number	2,034	.....	263	642	123
12	Total salaries	$1,753,235	.....	$251,091	$522,477	$96,996
	Officers of corporations—					
13	Number	194	.....	16	37	19
14	Salaries	$480,787	.....	$47,733	$93,658	$35,140
	General superintendents, managers, clerks, etc.—					
15	Total number	1,840	.....	247	605	104
16	Total salaries	$1,322,448	.....	$203,358	$428,819	$61,856
	Men—					
17	Number	1,369	.....	194	406	79
18	Salaries	$1,169,087	.....	$179,335	$380,504	$53,413
	Women—					
19	Number	471	.....	53	199	25
20	Salaries	$153,361	.....	$24,023	$48,315	$8,443
	Wage-earners, including pieceworkers, and total wages:					
21	Greatest number employed at any one time during the year	27,643	30	3,476	7,052	2,320
22	Least number employed at any one time during the year	8,423	22	1,309	2,076	965
23	Average number	17,525	19	2,139	4,388	1,481
24	Wages	$8,189,817	$11,080	$1,150,736	$2,144,897	$613,840
	Men, 16 years and over—					
25	Average number	16,700	19	1,995	4,143	1,352
26	Wages	$7,952,257	$11,080	$1,107,485	$2,078,384	$570,858
	Women, 16 years and over—					
27	Average number	517	.....	104	104	126
28	Wages	$175,028	.....	$34,662	$38,276	$42,150
	Children, under 16 years—					
29	Average number	308	.....	40	141	3
30	Wages	$62,532	.....	$8,589	$28,287	$832
	Average number of wage-earners, including pieceworkers, employed during each month:					
	Men, 16 years and over—					
31	January	21,486	15	2,486	5,439	1,661
32	February	22,645	23	2,936	5,681	1,847
33	March	22,671	28	3,092	5,661	1,878
34	April	21,043	28	2,993	4,783	1,810
35	May	19,103	28	2,526	4,630	1,609
36	June	14,755	20	1,821	3,588	1,085
37	July	11,564	20	1,264	3,613	756
38	August	10,157	20	1,298	2,361	736
39	September	11,458	15	1,373	2,683	1,211
40	October	12,416	15	721	3,261	1,108
41	November	15,209	15	1,554	3,737	1,145
42	December	17,893	15	1,871	4,274	1,380
	Women, 16 years and over—					
43	January	749	.....	142	142	248
44	February	764	.....	144	128	250
45	March	720	.....	134	121	225
46	April	645	.....	133	96	200
47	May	532	.....	118	89	148
48	June	423	.....	90	78	81
49	July	327	.....	60	65	71
50	August	386	.....	78	106	86
51	September	449	.....	79	98	136
52	October	359	.....	88	98	21
53	November	413	.....	90	109	28
54	December	437	.....	92	120	21
	Children, under 16 years—					
55	January	372	.....	57	166	5
56	February	388	.....	63	179	5
57	March	394	.....	64	185	5
58	April	385	.....	64	177	5
59	May	343	.....	54	156	5
60	June	281	.....	36	116	5
61	July	249	.....	28	93	3
62	August	203	.....	25	81	1
63	September	224	.....	27	102	2
64	October	247	.....	.....	143	1
65	November	273	.....	22	141	2
66	December	337	.....	36	148	2
	Miscellaneous expenses:					
67	Total	$2,252,604	$3,144	$328,629	$630,442	$121,260
68	Rent of works	$221,381	$1,180	$26,653	$94,463	$8,200
69	Taxes, not including internal revenue	$107,709	$56	$15,656	$23,370	$11,138
70	Rent of offices, interest, insurance, etc	$1,881,997	$1,333	$277,866	$496,719	$101,922
71	Contract work	$41,517	$575	$3,454	$15,900	.....
	Materials used:					
72	Aggregate cost	$16,792,051	$25,470	$1,720,249	$4,836,585	$1,221,786
	Principal materials—					
73	Total cost	$13,957,756	$24,425	$1,514,139	$3,735,094	$1,096,173
74	Purchased in raw state	$20,405	.....	.....	.....	$8,405
75	Purchased in partially manufactured form	$13,937,351	$24,425	$1,514,139	$3,735,094	$1,087,768
76	Fuel	$341,471	$364	$32,906	$95,895	$23,127
77	Rent of power and heat	$57,957	$71	$2,509	$13,475	$7,875
78	Mill supplies	$311,775	$110	$83,251	$72,966	$15,078
79	All other materials	$1,892,107	$500	$63,208	$881,524	$54,346
80	Freight	$230,985	.....	$24,286	$87,631	$25,187

TABLE 9.—BICYCLES AND TRICYCLES, DETAILED SUMMARY, BY STATES: 1900.

Massachusetts.	Michigan.	Minnesota.	New Jersey.	New York.	Ohio.	Pennsylvania.	Rhode Island.	Wisconsin.	All other states.[1]	
25	11	4	7	66	34	24	4	23	7	1
7	4	4	1	22	9	8	3	7	2	2
6	.....	.....	1	16	5	7	1	3	2	3
12	7	.....	5	28	20	9	.....	13	3	4
$2,646,498	$757,021	$38,205	$204,465	$8,626,943	$4,074,576	$1,550,957	$24,300	$2,337,975	$831,848	5
$51,614	$6,900	.....	$13,700	$240,167	$74,587	$78,930	$4,000	$157,200	$43,000	6
$444,863	$44,893	.....	$16,000	$365,320	$437,853	$211,840	$7,000	$304,586	$127,254	7
$908,361	$117,513	$7,433	$78,668	$948,042	$1,736,524	$422,635	$7,600	$685,218	$257,982	8
$1,241,660	$587,715	$30,772	$96,097	$1,778,414	$1,825,662	$837,552	$5,700	$1,190,971	$403,612	9
19	4	4	3	57	20	26	4	13	6	10
139	53	2	24	267	209	110	6	160	36	11
$117,242	$39,643	$2,320	$23,457	$216,120	$197,406	$91,681	$3,600	$134,007	$57,195	12
9	10	.....	5	31	35	13	.....	13	6	13
$23,400	$14,462	.....	$10,480	$62,036	$69,580	$20,688	.....	$20,610	$33,000	14
130	43	2	19	236	174	97	6	147	30	15
$93,842	$25,181	$2,320	$12,977	$154,084	$127,826	$70,993	$3,600	$113,397	$24,195	16
102	34	1	14	174	129	78	5	130	23	17
$81,947	$22,003	$1,840	$11,874	$132,018	$111,913	$65,048	$3,300	$105,157	$21,235	18
28	9	1	5	62	45	19	1	17	7	19
$11,895	$3,178	$480	$1,608	$22,066	$15,913	$5,945	$300	$8,240	$2,960	20
2,407	535	61	274	3,151	3,659	1,550	36	2,469	623	21
936	127	25	61	807	965	375	9	588	98	22
1,581	311	47	188	2,108	2,380	947	17	1,572	357	23
$815,028	$141,639	$8,440	$71,343	$988,052	$1,017,061	$431,369	$6,100	$625,149	$165,083	24
1,543	294	47	170	2,032	2,340	891	17	1,500	357	25
$798,504	$138,457	$8,440	$68,185	$970,043	$998,218	$419,958	$6,100	$611,512	$165,083	26
38	17	.....	12	46	40	29	.....	1	.....	27
$16,524	$3,182	.....	$2,972	$11,009	$18,843	$7,280	.....	$130	.....	28
.....	.....	.....	1	25	.....	27	.....	71	.....	29
.....	.....	.....	$186	$7,000	.....	$4,131	.....	$13,507	.....	30
1,837	453	60	217	2,671	2,949	1,122	9	2,032	535	31
1,913	440	60	221	2,845	3,085	1,178	14	1,850	552	32
1,922	380	56	250	2,819	3,073	1,256	22	1,715	524	33
1,967	362	56	239	2,703	2,812	1,160	22	1,602	511	34
1,793	332	51	220	2,442	2,484	1,026	31	1,507	474	35
1,443	275	36	168	1,595	2,083	897	36	1,342	366	36
1,022	142	30	167	1,163	1,650	504	26	1,088	119	37
1,064	127	32	70	1,158	1,408	534	14	1,204	181	38
1,126	135	37	64	1,286	1,607	580	8	1,172	161	39
1,304	186	51	63	1,448	1,932	658	8	1,458	203	40
1,523	300	44	162	1,925	2,333	788	7	1,378	298	41
1,597	400	49	204	2,326	2,708	990	7	1,650	422	42
43	26	.....	15	44	48	40	.....	1	.....	43
42	26	.....	15	56	57	45	.....	1	.....	44
49	16	.....	15	55	57	47	.....	1	.....	45
47	13	.....	15	51	47	42	.....	1	.....	46
39	13	.....	14	53	29	28	.....	1	.....	47
40	13	.....	14	54	31	21	.....	1	.....	48
25	11	.....	10	39	26	20	.....	.....	.....	49
27	11	.....	10	36	17	14	.....	1	.....	50
32	11	.....	10	33	36	14	.....	.....	.....	51
35	11	.....	5	37	45	18	.....	1	.....	52
37	26	.....	7	46	45	24	.....	1	.....	53
43	26	.....	10	45	46	33	.....	1	.....	54
.....	.....	.....	1	26	.....	40	.....	77	.....	55
.....	.....	.....	2	26	.....	43	.....	70	.....	56
.....	.....	.....	2	27	.....	42	.....	69	.....	57
.....	.....	.....	1	25	.....	41	.....	72	.....	58
.....	.....	.....	1	24	.....	28	.....	75	.....	59
.....	.....	.....	1	16	.....	24	.....	83	.....	60
.....	.....	.....	1	25	.....	20	.....	79	.....	61
.....	.....	.....	1	11	.....	18	.....	66	.....	62
.....	.....	.....	1	29	.....	12	.....	51	.....	63
.....	.....	.....	1	25	.....	15	.....	62	.....	64
.....	.....	.....	.....	28	.....	19	.....	61	.....	65
.....	.....	.....	.....	39	.....	28	.....	84	.....	66
$125,076	$59,485	$4,678	$19,548	$866,501	$247,332	$128,931	$1,309	$170,266	$51,008	67
$11,156	$2,693	$1,184	$3,490	$34,428	$13,756	$10,597	$496	$9,807	$3,288	68
$17,311	$1,353	$74	$718	$10,628	$16,491	$1,700	$80	$7,805	$1,329	69
$96,559	$49,501	$915	$14,540	$820,148	$217,085	$110,834	$733	$147,451	$46,391	70
$50	$5,938	$2,500	$800	$1,297	.....	$5,800	.....	$5,208	.....	71
$1,307,900	$345,725	$30,997	$147,317	$1,856,065	$2,251,358	$1,065,461	$23,195	$1,536,592	$423,351	72
$1,139,814	$280,490	$29,400	$132,265	$1,675,353	$1,881,992	$951,521	$9,550	$1,109,512	$378,028	73
.....	$12,000	.....	.....	.....	.....	.....	.....	.....	.....	74
$1,139,814	$268,490	$29,400	$132,265	$1,675,353	$1,881,992	$951,521	$9,550	$1,109,512	$378,028	75
$25,652	$4,395	$745	$3,488	$42,714	$49,537	$11,701	$130	$40,328	$10,489	76
$5,801	$2,740	$132	$1,959	$7,384	$7,450	$3,565	$315	$1,110	$3,571	77
$11,323	$2,947	$110	$1,371	$31,206	$42,054	$20,210	$110	$28,323	$2,716	78
$96,223	$52,495	$300	$4,024	$72,138	$233,822	$58,051	$13,090	$342,356	$20,030	79
$29,087	$2,658	$310	$4,210	$27,270	$36,503	$20,413	.....	$14,963	$8,517	80

[1] Includes establishments distributed as follows: Colorado, 1; Iowa, 1; Kentucky, 1; Maine, 1; Maryland, 1; Nevada, 1; New Hampshire, 1.

TABLE 9.—BICYCLES AND TRICYCLES, DETAILED SUMMARY, BY STATES: 1900—Continued.

		United States.	California.	Connecticut.	Illinois.	Indiana.
	Products:					
81	Aggregate	$31,915,908	$47,670	$3,672,225	$8,960,421	$2,115,901
	Bicycles—					
82	Total number	1,113,039	579	107,419	385,951	83,964
83	Total value	$22,160,260	$26,145	$3,029,418	$7,004,441	$1,473,600
	Individual—					
	Chainless—					
84	Number	41,899	350	15,803	5,899	525
85	Value	$1,893,821	$15,270	$888,938	$134,850	$21,250
	Chain—					
86	Number	1,067,524	217	91,309	379,026	83,064
87	Value	$20,031,600	$9,025	$2,122,369	$6,823,316	$1,441,350
	Tandem—					
88	Number	3,457	6	307	1,026	375
89	Value	$201,889	$450	$18,111	$46,275	$11,000
	Motor—					
90	Number	159	6	.....	.....	.....
91	Value	$32,950	$1,400	.....	.....	.....
	Tricycles—					
92	Number	18,110	47	5,440	.....	.....
93	Value	$47,985	$4,175	$12,000	.....	.....
	Automobiles—					
94	Number	56	3	.....	.....	40
95	Value	$60,788	$2,250	.....	.....	$47,195
96	All other products	$9,646,875	$15,100	$630,807	$1,955,980	$595,106
	Comparison of products:					
97	Number of establishments reporting for both years	236	3	20	49	11
98	Value for census year	$27,039,436	$42,170	$3,512,368	$7,154,765	$1,323,377
99	Value for preceding business year	$27,045,264	$36,000	$3,157,505	$7,680,519	$1,457,770
	Power:					
100	Number of establishments reporting	260	3	20	48	18
101	Total horsepower	21,588	11	2,372	6,417	2,164
	Owned—					
	Engines—					
	Steam—					
102	Number	177	.....	19	29	18
103	Horsepower	16,858	.....	2,078	4,589	1,700
	Gas or gasoline—					
104	Number	45	1	2	14	3
105	Horsepower	661	3	37	304	89
	Water wheels—					
106	Number	19	.....	5	3	.....
107	Horsepower	568	.....	88	100	.....
	Electric motors—					
108	Number	70	.....	4	33	1
109	Horsepower	1,741	.....	90	1,012	8
	Rented—					
110	Electric, horsepower	756	8	32	71	207
111	Other kind, horsepower	1,009	.....	47	341	160
112	Furnished to other establishments, horsepower	215	.....	.....	56	35
	Establishments classified by number of persons employed, not including proprietors and firm members:					
113	Total number of establishments	312	4	24	60	19
114	No employees	9	.....	1	1	.....
115	Under 5	43	1	2	5	.....
116	5 to 20	72	3	7	12	3
117	21 to 50	65	.....	6	16	2
118	51 to 100	50	.....	1	10	3
119	101 to 250	40	.....	3	8	3
120	251 to 500	21	.....	2	4	2
121	501 to 1,000	8	.....	1	1	1
122	1,001 to 5,000	4	.....	1	3	.....

TABLE 9.—BICYCLES AND TRICYCLES, DETAILED SUMMARY, BY STATES: 1900—Continued.

Massachusetts.	Michigan.	Minnesota.	New Jersey.	New York.	Ohio.	Pennsylvania.	Rhode Island.	Wisconsin.	All other states.	
$2,715,310	$627,658	$66,505	$295,226	$3,842,020	$4,099,980	$1,855,043	$48,382	$2,795,236	$779,331	81
62,915	18,196	2,250	42	95,093	112,397	67,682	599	148,515	32,487	82
$1,792,460	$498,042	$37,375	$1,470	$2,239,962	$1,878,978	$1,490,509	$20,000	$1,951,164	$716,696	83
2,841	6,506	.....	.....	3,662	2,566	602	.....	1,044	2,101	84
$206,006	$202,920	.....	.....	$157,901	$81,650	$27,330	.....	$54,626	$103,080	85
59,708	11,676	2,250	42	90,828	109,756	66,706	595	142,042	30,305	86
$1,522,507	$292,122	$37,375	$1,470	$2,051,855	$1,793,778	$1,442,784	$19,695	$1,863,138	$610,816	87
339	.....	.....	.....	600	75	322	4	322	81	88
$53,247	.....	.....	.....	$29,006	$3,550	$20,095	$305	$17,050	$2,800	89
27	14	.....	.....	3	.....	2	.....	107	.....	90
$10,700	$3,000	.....	.....	$1,200	.....	$300	.....	$16,350	.....	91
1	42	.....	.....	1	238	12,341	.....	.....	.....	92
$724	$3,900	.....	.....	$150	$9,086	$18,000	.....	.....	.....	93
3	.....	.....	.....	2	3	4	.....	.....	1	94
$4,143	.....	.....	.....	$1,700	$2,000	$2,500	.....	.....	$1,000	95
$917,983	$125,716	$29,130	$293,756	$1,600,208	$2,209,966	$844,084	$23,382	$844,072	$61,635	96
20	7	4	4	46	26	18	3	20	5	97
$2,687,298	$546,808	$66,505	$163,329	$2,805,774	$3,911,025	$1,657,325	$35,600	$2,524,911	$658,181	98
$2,691,816	$414,161	$51,500	$146,723	$2,486,605	$3,418,181	$1,990,949	$36,000	$2,364,552	$1,082,983	99
23	10	3	7	53	25	18	3	23	6	100
1,587	323	16	216	2,119	3,282	978	26	1,711	416	101
12	5	.....	4	27	23	16	1	18	5	102
983	197	.....	153	1,742	2,606	892	8	1,575	330	103
.....	4	2	.....	6	2	1	.....	9	1	104
.....	27	18	.....	74	53	2	.....	46	13	105
4	1	.....	1	4	.....	.....	.....	.....	1	106
285	10	.....	10	74	.....	.....	.....	.....	1	107
7	.....	.....	.....	2	18	1	.....	4	.....	108
109	.....	.....	.....	4	487	3	.....	28	.....	109
88	84	3	40	37	91	5	18	.....	72	110
72	5	.....	13	188	45	76	.....	62	.....	111
60	.....	.....	.....	9	45	.....	.....	10	.....	112
25	11	4	7	66	34	24	4	23	7	113
.....	.....	.....	1	3	3	.....	.....	.....	.....	114
3	2	2	.....	12	5	5	2	2	2	115
4	4	1	1	18	4	7	1	6	1	116
8	2	1	3	15	2	4	1	4	1	117
5	.....	.....	1	8	9	2	.....	5	1	118
2	2	.....	1	7	7	4	.....	2	1	119
1	1	.....	.....	2	3	2	.....	3	1	120
2	.....	.....	.....	1	1	.....	.....	1	.....	121
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	122

AGRICULTURAL IMPLEMENTS.

AGRICULTURAL IMPLEMENTS.

By JOSEPH D. LEWIS.

The importance of the manufacture of agricultural implements and machinery regarded as an economic force, aside from the consideration of its relative importance in the capital employed, wages paid, and value of products, is sufficient to warrant giving to the industry special and detailed treatment of the most complete character possible within the necessarily narrow limits of a census report. There are few, if any, branches of manufacture in which progressive development and improvement exercise so far-reaching and fundamental an effect. It touches the life of all classes of people and has its greatest influence upon the most fundamental class of work, that of agriculture. The great diversity of its characteristics and phases, the multiplicity of its products, and the varied nature of the trades and occupations that find employment in it, make it impracticable to discuss in a census report the great industry in all its bearings. For the same reasons the difficulty of specializing the industry is considerably increased. The greater the variety of products and the more complex the processes of manufacture, the greater are the difficulties encountered in departing from the general line of treatment.

As early as 1860 the census officials felt warranted in giving the industry special treatment to the extent of publishing separately the totals for the manufacture of the several kinds of agricultural implements, as follows: Fanning mills, grain cradles and scythe snaths, grain drills, plow and other handles, hoes, mowing and reaping machines, plows, harrows and cultivators, rakes, straw cutters, thrashers, horse powers, and separators; also the totals in the manufacture of shovels, spades, forks and hoes, scythes, and cotton gins. The subject was also discussed at some length in the Agricultural Report of the Eighth Census. At the Ninth Census special tables were published showing by states the number of each of the several varieties of agricultural implements manufactured.

Previous to the census of 1880 reports of establishments engaged in the industry had been made upon the schedule used for general manufactures; at that time, however, a special schedule designed to elicit the number of each of the different kinds of implements manufactured was used. In addition, in the report on manufactures at that census, the industry was comprehensively treated by Special Agent Charles H. Fitch, D. E., in connection with his report on the Manufactures of Interchangeable Mechanism.

Practically the same line was followed in 1890 and 1900 as regards the schedule used, provision being made for a detailed report of the products. Whatever differences there were consisted in certain general features of the schedule and minor variations in products specified in the schedules, some items appearing in the schedule used at the Eleventh Census for which no provision was made in the schedule used at the Tenth Census. A more detailed statement of products manufactured was required in the present census than in that of 1890.

The principle governing the classification of the schedules as agricultural implements was that the product of chief value should come within the category of an implement or machine used for tilling the soil, for sowing or planting the seed, harvesting the crop, or in the preparation of the crop for the market. Incidental to the manufacture of what may be regarded as agricultural implements in the strict sense, there are produced miscellaneous articles, such as dairy machinery, pumps of various kinds, wagons, windmills, etc., provision for which was made on the schedule, and under this miscellaneous group are included products of many kinds and of considerable aggregate value. On the other hand, many manufactured articles escape inclusion in the statistics presented, by reason of the fact that they are the output of establishments engaged principally in the manufacture of other commodities. It has been found impossible, therefore, in the nature of the case, to include in this report all manufacturing operations which should properly fall within the scope of the inquiry or to eliminate all data which, strictly speaking, have no part therein.

The varied character of the products manufactured in this industry has its correlative in the variety of the materials used and the diversity of the trades and occupations connected therewith. The diversity in the occupations necessary in this manufacture is very forcibly presented in the following excerpt, relative to a compar-

ison of the tables of occupation included in the report of the population with the labor statistics presented in the Reports on Manufactures, at the Tenth Census:

There are, in addition, certain industries respecting which peculiar difficulties arise, from the distinct nature of the several avocations pursued under one roof in the same establishment. Thus, it might be supposed that the manufacture of "agricultural implements" is sufficiently distinct to secure a reasonably close comparison between the number of "hands employed" and the number of "agricultural implement makers" borne on the tables of occupations. But this is not so. A large establishment producing agricultural implements is really divided into a number of shops or factories, where perfectly distinct trades are carried on. There is the foundry, where the iron parts of the machine are cast, and the men working therein will report their occupation as that of foundrymen. There are carpenter shops, where the wooden parts are made and shaped by carpenters, who call themselves by this term and no other. There are also machine shops, paint shops, etc., where the artisans employed know themselves as machinists or mechanics, or as painters and varnishers, and not as makers of agricultural implements. As a result of the peculiarities of this branch of the industry, the "hands employed" in the statistics of manufactures will exceed many times over the number of persons reporting themselves as "agricultural implement makers."[1]

Table 1 shows the totals for the industry as returned at the censuses of 1850 to 1900, inclusive, with the percentages of increase for each decade.

[1] Tenth Census of the United States, Manufactures, page XXIX.

TABLE 1.—COMPARATIVE SUMMARY, 1850 TO 1900, WITH PER CENT OF INCREASE FOR EACH DECADE.

	DATE OF CENSUS.						PER CENT OF INCREASE.				
	1900	1890	1880	1870	1860	1850	1890 to 1900	1880 to 1890	1870 to 1880	1860 to 1870	1850 to 1860
Number of establishments	715	910	1,943	2,076	2,116	1,333	[1] 21.4	[1] 53.2	[1] 6.4	[1] 1.9	58.7
Capital	$157,707,951	$145,313,997	$62,109,668	$34,834,600	$13,866,389	$3,564,202	8.5	134.0	78.3	151.2	289.0
Salaried officials, clerks, etc., number	10,046	[2] 8,717	(3)	(3)	(3)	(3)	170.3	.....	.....	.....	.....
Salaries	$8,363,210	[2] $3,704,667	(3)	(3)	(3)	(3)	125.7	.....	.....	.....	.....
Wage-earners, average number	46,582	38,827	39,580	25,249	17,093	7,220	20.0	[1] 1.9	56.8	47.7	136.7
Total wages	$22,450,880	$18,107,094	$15,359,610	$12,151,504	$5,925,177	$2,167,868	24.0	17.9	26.4	105.1	173.3
Men, 16 years and over	46,174	38,327	38,313	24,634	17,086	7,211	20.5	(4)	55.5	44.2	136.9
Wages	$22,358,158	$17,998,650	(3)	(3)	(3)	(3)	24.2	.....	.....	.....	.....
Women, 16 years and over	214	288	78	12	7	9	[1] 25.7	294.5	508.3	71.4	[1] 22.2
Wages	$66,042	$75,553	(3)	(3)	(3)	(3)	[1] 12.6	.....	.....	.....	.....
Children, under 16 years	194	212	1,194	603	(3)	(3)	[1] 8.5	[1] 82.2	98.0	.....	.....
Wages	$26,680	$32,891	(3)	(3)	(3)	(3)	[1] 18.9	.....	.....	.....	.....
Miscellaneous expenses	$11,394,656	$11,129,548	(5)	(5)	(5)	(5)	2.4	.....	.....	.....	.....
Cost of materials used	$43,944,628	$31,603,265	$31,531,170	$21,473,925	$6,993,162	$2,445,765	39.1	0.2	46.8	207.1	185.9
Value of products, including custom work and repairing	$101,207,428	$81,271,651	$68,640,486	$52,066,875	$20,831,904	$6,842,611	24.5	18.4	31.8	149.9	204.4

[1] Decrease.
[2] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table. (See Table 10.)
[3] Not reported separately.
[4] Less than one-tenth of 1 per cent.
[5] Not reported.

The most noteworthy fact shown by Table 1 is that a continuous decrease in the number of establishments from 1860 to the present has accompanied the steady increase in capital invested and value of the products. The average capital and value of products per establishment at the several censuses have been as follows: 1850, capital, $2,674; products, $5,133; 1860, capital, $6,553; products, $9,845; 1870, capital, $16,780; products, $25,080; 1880, capital, $31,966; products, $35,327; 1890, capital, $159,686; products, $89,310; 1900, capital, $220,571; products, $141,549. This steady increase in the average capital and value of products per establishment excellently illustrates the fact that certain important phases of the development of the factory system from manual work find abundant expression in this industry. The magnitude of the industry in 1900 is clearly indicated by the totals for capital invested, wage-earners employed and wages paid, cost of materials used, and value of products. In point of number of skilled wage-earners and in the large increase in value added to materials used, it occupies a high place among the principal manufacturing industries of the United States.

In a country whose people are wont to supply their own varied needs, the increase in the productivity of all industries, should keep pace with the increasing demands of a growing population. The increase in the value of agricultural implements manufactured from $6,842,611 in 1850 to $101,207,428 in 1900 indicates, apparently, that this necessity has been more than fully met. This increase is far greater in proportion than the increase in the number of persons engaged in agriculture, and is chiefly due to the greater average investment by the farmers in implements required in the various processes of farming, caused principally by a marvelous improvement in their character and consequent greater value, and to a less extent, as indicated in Table 8, by the growth of exports of farming implements and machinery.

In considering the increases shown from census to census in Table 1, the changes in the scope of the census inquiries should be constantly kept in view. The earlier enumerations were, generally speaking, less complete than the later. The disproportionate increase in capital in the decade, 1880 to 1890, may be due in part to the fact that the census of 1890 was the first in

which a definite attempt was made to secure the inclusion of all live capital. Statistics of wage-earners and wages for 1890 and 1900 are not strictly comparable, as elsewhere explained. Otherwise it is believed that the rate of growth of the industry may fairly be inferred from the figures given.

In 1900, in addition to the 715 active establishments, 18 idle establishments were reported, with a capital of $2,160,362. There were also 7 establishments each manufacturing during the census year a product of less than $500 in value; they are, therefore, not included in Table 1 or subsequent tables. The capital invested in these establishments was $26,262; the number of wage-earners was 3, receiving $520 in wages; the cost of materials used was $957; the sum of the miscellaneous expenses was $452; and the total value of the products manufactured amounted to $2,257.

Table 2 is a comparative summary, by states, of the statistics for the industry for 1890 and 1900.

TABLE 2.—COMPARATIVE SUMMARY BY STATES: 1890 AND 1900.

STATES.	Year.	Number of establishments.	Capital.	SALARIED OFFICIALS, CLERKS, ETC.		AVERAGE NUMBER OF WAGE-EARNERS AND TOTAL WAGES.								Miscellaneous expenses.	Cost of materials used.	Value of products, including custom work and repairing.
						Total.		Men, 16 years and over.		Women, 16 years and over.		Children, under 16 years.				
				Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.			
United States	1900	715	$157,707,951	10,046	$8,363,210	46,582	$22,450,880	46,174	$22,358,158	214	$66,042	194	$26,680	$11,394,656	$43,944,628	$101,207,428
	1890	910	145,313,997	[1]3,717	[1]3,704,667	38,827	18,107,094	38,327	17,998,650	288	75,553	212	32,891	11,129,548	31,603,265	81,271,651
Alabama	[2]1900															
	1890	3	14,475	2	1,500	12	6,248	12	6,248					362	5,368	16,218
California	1900	20	1,852,157	81	74,900	562	322,272	562	322,272					106,011	538,568	1,357,849
	1890	35	2,072,297	70	86,072	619	468,944	619	468,944					97,958	575,776	1,617,484
Connecticut	1900	5	348,221	19	13,330	154	62,111	154	62,111					9,961	76,132	194,746
	1890	9	790,621	43	27,550	313	142,771	313	142,771					10,555	194,779	459,335
Georgia	1900	10	454,988	23	30,884	360	99,951	354	99,423			6	528	33,864	437,799	737,652
	1890	11	498,630	32	34,443	435	140,368	424	139,708			11	660	33,021	425,985	793,825
Illinois	1900	94	62,202,330	4,444	3,419,742	18,231	9,064,954	18,030	9,021,597	93	30,407	108	12,950	5,346,224	18,859,517	42,033,796
	1890	100	48,639,383	915	849,145	9,502	4,608,571	9,233	4,539,510	224	63,016	45	6,045	3,592,439	10,102,508	24,609,660
Indiana	1900	45	8,324,564	518	489,649	3,419	1,593,881	3,388	1,585,611	29	7,993	2	277	596,463	2,619,621	6,415,081
	1890	54	6,842,456	316	324,221	3,078	1,441,416	2,977	1,424,129	28	5,718	73	11,569	629,381	2,306,390	5,756,131
Iowa	1900	24	1,878,090	154	123,472	644	243,489	641	242,568	1	421	2	500	96,540	669,989	1,508,667
	1890	34	2,181,101	106	102,996	787	316,253	786	316,153	1	100			162,182	586,718	1,570,872
Kansas	1900	4	19,750	6	1,075	11	2,460	11	2,460					856	10,819	18,275
	1890	7	91,400	19	11,978	52	19,775	48	18,975			4	800	5,331	47,605	101,084
Kentucky	1900	9	1,735,595	95	124,720	680	300,106	679	299,846			1	260	148,009	466,193	1,320,714
	1890	5	1,444,685	61	60,344	699	296,838	699	296,838					110,449	540,965	1,265,799
Maine	1900	17	584,247	27	17,195	218	100,033	215	99,277	2	600	1	156	28,430	98,197	290,261
	1890	17	439,267	30	20,211	187	97,837	186	97,421	1	416			20,669	108,479	310,822
Maryland	[2]1900															
	1890	11	322,940	13	9,138	164	69,133	163	69,061			1	72	58,146	48,998	216,457
Massachusetts	1900	9	706,472	35	45,358	312	159,700	311	159,520			1	180	44,577	216,313	534,789
	1890	17	1,817,750	52	66,263	735	382,664	733	382,482			2	182	81,876	604,235	1,470,085
Michigan	1900	59	8,932,344	620	548,763	1,944	952,636	1,939	951,213	4	1,273	1	150	1,329,530	2,482,235	6,339,508
	1890	65	6,944,005	262	233,368	1,585	759,340	1,583	758,595	2	745			547,244	1,647,579	3,955,306
Minnesota	1900	18	3,730,055	182	189,832	928	423,054	924	421,637	3	1,300	1	117	241,388	718,604	1,763,780
	1890	23	5,136,542	85	108,768	517	254,312	517	254,312					410,379	418,619	1,622,951
Mississippi	1900	3	53,875	2	1,350	19	4,000	19	4,000					625	15,365	36,350
	1890	3	33,980	5	3,010	21	6,940	21	6,940					706	9,640	26,474
Missouri	1900	26	1,412,165	81	101,977	493	242,307	492	242,207			1	100	65,325	406,977	953,965
	1890	21	977,828	64	70,481	649	345,368	623	338,867			26	6,501	88,564	522,130	1,309,669
Nebraska	1900	9	184,081	11	6,705	87	41,128	83	40,728			4	400	4,646	82,856	176,446
	1890	6	55,625	3	712	27	6,627	26	6,552			1	75	2,004	6,610	18,292
New Hampshire	1900	12	112,003	4	2,300	45	16,626	44	16,326	1	300			3,485	22,364	79,891
	1890	12	145,790	12	7,829	96	37,149	96	37,149					5,250	40,939	109,614
New Jersey	1900	11	249,957	8	11,289	147	60,088	145	59,408	2	675			23,827	115,697	249,963
	1890	20	270,512	17	11,998	125	54,337	122	54,057			3	280	15,291	83,416	200,282
New York	1900	87	20,115,962	659	675,999	5,551	2,797,269	5,522	2,790,620	24	6,022	5	627	833,948	4,824,871	10,537,254
	1890	116	19,924,781	418	452,978	5,620	2,726,588	5,613	2,725,562	3	356	4	620	2,263,680	3,743,157	11,680,842
North Carolina	1900	9	77,537	7	3,970	91	20,169	86	19,719			5	450	1,971	41,047	99,128
	1890	14	132,297	11	6,854	86	28,481	85	28,329			1	152	3,768	42,371	105,875
Ohio	1900	78	23,628,442	1,588	1,368,775	6,852	3,271,163	6,795	3,254,063	44	14,588	13	2,512	1,483,605	6,059,515	13,975,268
	1890	106	29,399,930	625	684,287	7,701	3,868,475	7,682	3,864,757	8	1,900	11	1,818	2,008,481	5,654,360	14,333,258

[1] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table. (See Table 10.)
[2] Included in "all other states" in 1900.

TABLE 2.—COMPARATIVE SUMMARY BY STATES: 1890 AND 1900—Continued.

STATES.	Year.	Number of establishments.	Capital.	SALARIED OFFICIALS, CLERKS, ETC.		AVERAGE NUMBER OF WAGE-EARNERS AND TOTAL WAGES.						Miscellaneous expenses.	Cost of material used.	Value of products, including custom work and repairing.
						Total.		Men, 16 years and over.		Women, 16 years and over.		Children, under 16 years.		
				Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	
Oregon	1900													
	1890	3	$8,027	2	$1,560	2	$1,270	2	$1,270					$403	$2,167	$6,289
Pennsylvania	1900	50	4,102,327	197	183,549	1,564	688,044	1,557	686,790	1	$261	6	$993	196,719	1,232,242	3,198,471
	1890	94	4,457,464	157	117,476	1,738	781,014	1,735	780,509	2	430	1	75	262,430	1,043,268	2,682,718
South Carolina	1900	5	14,575			10	2,606	10	2,606					931	5,394	14,090
	1890	4	38,210	2	1,600	37	9,626	37	9,626					385	19,567	35,485
South Dakota	1900	3	24,385			11	4,929	11	4,929					1,141	6,222	19,580
	1890	3	13,050	3	351	9	3,200	9	3,200					532	3,045	9,400
Tennessee	1900	11	417,689	38	35,065	373	113,425	354	110,834	3	480	16	2,111	12,170	201,712	463,406
	1890	12	383,189	23	19,956	235	101,910	229	101,190			6	720	20,740	118,625	328,856
Texas	1900	5	57,635	5	7,950	28	10,419	28	10,419					23,928	66,572	117,370
	1890	11	207,987	9	5,580	251	85,258	251	85,258					13,159	116,844	307,795
Vermont	1900	17	484,277	24	18,267	211	85,846	204	84,124	7	1,722			15,909	163,515	369,537
	1890	19	645,686	41	38,584	311	141,602	304	139,911	3	811	4	880	28,041	273,204	593,648
Virginia	1900	13	472,863	29	21,738	278	107,980	272	107,080			6	900	26,183	128,434	343,291
	1890	19	684,454	48	48,970	441	194,053	441	194,053					35,183	295,776	691,210
Wisconsin	1900	51	15,291,554	1,180	836,316	3,289	1,625,765	3,276	1,622,606			13	3,159	699,865	3,290,690	7,886,363
	1890	51	10,611,185	266	291,980	2,765	1,197,693	2,730	1,193,190	16	2,061	19	2,442	617,242	1,928,182	5,015,512
All other states	[1]1900	11	239,811	9	9,040	70	34,474	68	34,164			2	310	18,525	87,168	171,937
	[2]1890	5	88,500	5	4,524	28	13,083	28	13,083					3,697	25,970	50,458

[1] Includes establishments distributed as follows: Alabama, 1; Colorado, 1; Delaware, 1; Maryland, 2; North Dakota, 1; Utah, 2; Washington, 2; West Virginia, 1.
[2] Includes establishments distributed as follows: Rhode Island, 1; Washington, 2; West Virginia, 2.

Table 2 shows a decrease of 195 establishments during the decade, or 21.4 per cent. The capital has increased from $145,313,997 to $157,707,951, or 8.5 per cent; the number of wage-earners from 38,827 to 46,582, or 20 per cent; the cost of materials from $31,603,265 to $43,944,628, or 39.1 per cent; and the value of products from $81,271,651 to $101,207,428, an increase of 24.5 per cent.

Illinois, in 1900, as in 1890, holds the first place in the manufacture of agricultural implements, the capital invested being 39.4 per cent of the capital for the United States, and the value of products 41.5 per cent. As additional evidence of this preeminence, it may be stated that while the total increase of capital shown for the United States was $12,393,954, the increase in Illinois, $13,562,947, was greater; and of the total increase in value of products, $19,935,777, the increase in this state was $17,424,136. The states next in importance are Ohio, New York, Wisconsin, Indiana, Michigan, and Pennsylvania, in the order named, manufacturing, respectively, 13.8, 10.4, 7.8, 6.3, 6.3, and 3.2 per cent of the value of the products manufactured in the United States.

The following is a statement of the states which show a decrease in either capital or value of products, or both, between 1890 and 1900, with the amount and the percentage of the decrease:

DECREASE, 1890 TO 1900.

STATES.	Capital.	Per cent.	Products.	Per cent.
California	$220,140	10.6	$259,635	16.1
Connecticut	442,400	56.0	264,589	57.6
Georgia	43,642	8.8	56,173	7.1
Iowa	303,011	13.9	62,205	4.0
Kansas	71,650	78.4	82,809	81.9
Maine			20,561	6.6
Massachusetts	1,111,278	61.1	935,296	63.6
Minnesota	1,406,487	27.4		
Missouri			355,704	27.2
New Hampshire	33,787	23.2	29,723	27.1
New Jersey	20,555	7.6		
New York			1,143,588	9.8
North Carolina	54,760	41.4	6,747	6.4
Ohio	5,771,488	19.6	357,990	2.5
Pennsylvania	355,137	8.0		
South Carolina	23,635	61.9	21,395	60.3
Texas	150,352	72.3	190,425	61.9
Vermont	161,409	25.0	224,111	37.8
Virginia	211,591	30.9	347,919	60.3

In addition to the above states, Alabama, Maryland, and Oregon show decreases both in capital and value of products. Twenty-two states of the 31 separately presented in Table 2 show decreases between 1890 and 1900 in the statistics for either capital or value of products, or both. This is an unusual condition to be shown by an industry so important, so staple in its character, and so widely distributed as that of agricultural implements.

Table 2 and the foregoing statement considered in connection with the crop statistics of the Census Office furnish strong evidence that the activity of a state in

agriculture has but slight bearing upon its relative standing in the manufacture of the requisite implements and machinery. However it may have been at earlier periods in the history of the industry, the principal causes now controlling the location of plants of this character and the volume of their output are the availability of the raw materials, a sufficient supply of skilled labor, facilities for distributing the products in the widest fields, and, above all, the excellence and acceptability to the farmer of the implements manufactured by the several establishments. Iowa, which was second in the production of corn, oats, and hay in 1900, fourth in barley, fifth in potatoes, seventh in rye, and tenth in wheat, was ninth in the value of agricultural implements manufactured, and shows a decrease both in capital and value of products. Kansas, which was twenty-sixth in this manufacture, the value of products being only $18,275, was first in hay production, third in corn, fifth in wheat, tenth in rye and potatoes, and eleventh in oats and barley. Nebraska was only twenty-first in the manufacture of agricultural implements, the value of products being $176,446, but in crops, was fourth in corn, fifth in oats and rye, eighth in wheat, ninth in barley and hay, and eleventh in potatoes.

So closely allied is the industry, in many instances, to foundry and machine-shop work and the manufacture of dairy machinery and appurtenances, farm wagons and trucks, windmills, incubators, etc., the manufacture of one being incidental to that of the others, and the line of demarcation being consequently difficult to define, that it may have resulted, in some cases, in a difference of classification at the two census periods. Such establishments, from time to time, according to the demands of the market or other trade conditions, vary the proportions of the products manufactured, so that a report which may have been classified at the census of 1890 as "agricultural implements" would receive in 1900 the classification of "foundry and machine-shop products." Considered in connection with whatever differences in methods and ideas that may have existed in the classification of the schedules for this industry in 1890 and 1900, these difficulties, notwithstanding the utmost care taken to preserve the basis of comparison between the two periods, have doubtless affected the results shown in Table 2 for the United States and for the several states; but to what extent it is impossible to determine.

The preeminence of Illinois in the manufacture of agricultural implements is strikingly shown by a comparison of its output of certain selected implements and machines with the totals for the United States. There were 295,799 wheeled cultivators manufactured in the United States, of which 170,069 were manufactured in Illinois. Of the total number of harrows manufactured, disk and other kinds, 477,520, the number reported by establishments in Illinois was 194,375; plows, all kinds, United States, 1,074,999; Illinois, 283,050. The manufacture of plows is more widely distributed than that of any other agricultural implement; consequently the rank of this state is relatively less important in their manufacture than in that of the more elaborate, complicated, and valuable machines. There were manufactured in Illinois 182,782 harvesters and combined harvesters and binders, and 261,957 in the United States. To show more fully the relative importance of the several states in the manufacture of the principal implements, Table 3 is presented, showing the number of cultivators, harrows, plows, planters, harvesters and combined harvesters and binders, horse hayforks, horse hayrakes, mowers, scythes, and horsepower and steam-power thrashers.

TABLE 3.—NUMBER OF PRINCIPAL AGRICULTURAL IMPLEMENTS MANUFACTURED, BY STATES: 1900.

STATES.	Cultivators.	Harrows.	Plows.	Planters and drills.	Harvesters and combined harvesters and binders.	Horse hayforks.	Horse hayrakes.	Mowers.	Scythes.	Thrashers, horsepower and steam-power.
United States	504,978	477,520	1,074,999	397,640	261,957	51,770	216,345	397,561	718,453	4,965
California	249	1,089	6,590	225	180	2,274	226			
Connecticut	11	1,769	740	157					105,312	
Georgia	950	509	67,959	19,758						
Illinois	192,060	194,375	283,050	91,461	182,782	6,000	109,670	245,204		
Indiana	15,829	2,650	199,354	29,986			5,885			
Iowa	7,800	7,560	13,638	3,021	681	529	5,809	4	2,760	50
Kansas										
Kentucky	9,126	4,076	125,002	6,500	47					
Maine	561	476	1,997	671					424,788	
Massachusetts	1,030	1,340	17,850	929			1,125	3,700		
Michigan	28,979	15,486	22,141	100,356	1,945		1,825	22		940
Minnesota	1,024	11,883	3,870	3,700						
Mississippi	1,750	6,000	3,000	850						
Missouri	12,001	453	4,820	3,537		17	3,855			20
Nebraska	1,139	150		834			2,666			
New Hampshire	103	250	252				500		74,400	
New Jersey	13,628	7,865	505	4,968		100				20
New York	30,911	90,417	76,068	23,468	24,809	648	40,359	65,898	26,293	725
North Carolina	1,600	1,900	2,050	1,475						
Ohio	101,986	77,589	105,889	59,966	36,405	34,700	41,187	61,697		543
Pennsylvania	40,058	6,028	14,278	3,582	7	400	51	30		152
South Carolina	130			180						
South Dakota		75	400	50						
Tennessee	4,000	300	30,956	3,407						
Texas	125	1	3,460	24						
Vermont	40		1,660						84,900	
Virginia	6,000	4,050	35,660	800						
Wisconsin	33,888	41,014	53,110	37,720	15,000	7,102	3,222	21,000		2,470
All other states[1]		215	710	15	101		15	6		45

[1] Includes establishments in Alabama, Colorado, Delaware, Maryland, North Dakota, Utah, Washington, and West Virginia.

In Table 3, under the heads "cultivators," "harrows," and "plows," the figures shown are the totals of all styles of those implements, and under "planters and drills," as the terms imply, appear the totals of all implements specifically reported as such. Illinois occupies first place in the number of cultivators, harrows, plows, harvesters and combined harvesters and binders, horse hayrakes, and mowers manufactured; second in planters and drills; and third in horse hayforks. Ohio is first in the manufacture of horse hayforks; second in cultivators, harvesters and combined harvesters and binders, and horse hayrakes; third in harrows, planters and drills, and mowers; and fourth in the manufacture of plows. New York is second in the number of harrows; third in harvesters and combined harvesters and binders, horse hayrakes, and thrashers; fifth in cultivators, plows, and scythes; and sixth in planters and drills. Wisconsin is first in the number of thrashers manufactured; second in horse hayforks; fourth in cultivators, harrows, planters and drills, harvesters and combined harvesters and binders, and mowers; and seventh in plows and horse hayrakes. Indiana is second in the manufacture of plows; fourth in horse hayrakes; fifth in planters and drills; and seventh in cultivators. Michigan is first in the number of planters and drills manufactured; second in thrashers; fifth in harrows, and harvesters and combined harvesters and binders; sixth in cultivators; ninth in horse hayrakes: and tenth in plows. Pennsylvania is third in the number of cultivators manufactured; ninth in harrows; and twelfth in plows.

The manufacture of agricultural implements is carried on to a considerable extent in other states than the foregoing. In the manufacture of cultivators, New Jersey is eighth; Missouri, ninth; and Kentucky, tenth. In the manufacture of harrows, Minnesota is sixth; New Jersey, seventh; and Iowa, eighth. In the manufacture of plows, Kentucky is third; Georgia, sixth; Virginia, eighth; Tennessee, ninth; and Massachusetts, eleventh. In the manufacture of planters and drills, Georgia is seventh; and Kentucky eighth. California is fourth in manufacturing horse hayforks. Iowa is fifth; Missouri, sixth; and Nebraska, eighth, in the manufacture of horse hayrakes. Massachusetts is fifth in the manufacture of mowers. The manufacture of scythes is confined almost entirely to the Eastern states; in the number manufactured, Maine, Connecticut, Vermont, and New Hampshire are first, second, third, and fourth, respectively. Scythes are also made in New York and Iowa.

Table 4 is a statement of the relative rank of the leading states in the manufacture of agricultural implements, in number of establishments, capital, average number of wage-earners and wages, cost of materials used, and value of products, for 1890 and 1900, the numbers indicating the rank of the states in each of the several items.

TABLE 4.—RANK OF LEADING STATES WITH RESPECT TO PRINCIPAL ITEMS OF INQUIRY: 1890 AND 1900.

STATES.	NUMBER OF ESTABLISHMENTS.		CAPITAL.		WAGE-EARNERS.				COST OF MATERIALS USED.		VALUE OF PRODUCTS.	
					Average number.		Total wages.					
	1900	1890	1900	1890	1900	1890	1900	1890	1900	1890	1900	1890
Illinois	1	3	1	1	1	1	1	1	1	1	1	1
Ohio	3	2	2	2	2	2	2	2	2	2	2	2
New York	2	1	3	3	3	3	3	3	3	3	3	3
Wisconsin	5	7	4	4	5	5	4	5	4	5	4	5
Indiana	7	6	6	6	4	4	5	4	5	4	5	4
Michigan	4	5	5	5	6	7	6	7	6	6	6	6
Pennsylvania	6	4	7	8	7	6	7	6	7	7	7	7
Minnesota	11	10	8	7	8	13	8	13	8	14	8	8
Iowa	9	9	9	9	10	8	11	11	9	9	9	10
California	10	8	10	10	11	12	9	8	10	10	10	9
Kentucky	[1]17	21	11	12	9	10	10	12	11	11	11	13
Missouri	8	11	12	13	12	11	12	10	13	12	12	12
Massachusetts	[1]17	14	13	11	15	9	13	9	14	8	14	11

[1] Kentucky and Massachusetts each reported 9 establishments.

There have been very few important changes in the relative positions of the leading states in the industry during the decade. Wisconsin and Indiana have, in general, reversed their positions; the former state, which in 1890 held fifth place in value of products, cost of materials, and wages, was fourth in 1900; and the latter, which was fourth for the same items in 1890, dropped to fifth place in 1900. Massachusetts has dropped from the eleventh to the thirteenth place in capital invested, from ninth to thirteenth in wages paid, and from eleventh to fourteenth in value of products. Iowa has displaced California from ninth position in value of products, and Kentucky has advanced from thirteenth position to eleventh.

Table 5 presents statistics of the manufacture of agricultural implements in cities of over 20,000 population.

TABLE 5.—SUMMARY FOR CITIES HAVING A POPULATION OF OVER 20,000.

CITIES.	Number of establishments.	Capital.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Miscellaneous expenses.	Cost of materials used.	Value of products, including custom work and repairing.
			Number.	Salaries.	Average number.	Total wages.			
Total	178	$90,941,883	7,089	$5,606,902	26,416	$13,102,718	$7,396,539	$25,860,456	$59,130,503
Albany, N. Y	3	180,500	10	10,190	54	26,600	6,032	31,617	75,940
Auburn, N. Y	3	6,084,941	111	119,106	1,551	767,342	166,499	1,188,176	2,338,191
Canton, Ohio	6	2,473,863	102	99,818	586	267,619	139,608	539,262	1,184,949
Chicago, Ill	6	36,025,355	3,509	2,483,894	10,245	5,180,958	3,846,753	10,842,299	24,848,649
Dayton, Ohio	4	2,064,429	77	81,987	608	303,041	212,348	594,646	1,281,658
Decatur, Ill	5	624,830	28	32,252	193	81,979	24,664	156,946	368,405
Evansville, Ind	4	478,700	27	29,100	164	72,891	32,386	106,423	312,820
Indianapolis, Ind	6	256,891	20	17,010	51	24,333	9,642	73,409	270,390
Joliet, Ill	3	137,546	5	5,500	62	33,059	5,099	82,999	142,615
Kalamazoo, Mich	6	154,567	35	22,441	38	18,053	36,344	82,135	188,506
Kansas City, Mo	4	766,903	36	52,854	156	100,017	35,244	162,116	438,089
La Crosse, Wis	5	293,061	24	31,822	148	71,709	23,684	219,088	368,012
Louisville, Ky	4	1,583,066	90	113,420	634	282,499	144,785	480,431	1,227,288
Milwaukee, Wis	4	4,109,622	587	293,504	524	271,343	134,109	806,086	2,296,888
Minneapolis, Minn	7	317,116	27	26,780	151	64,766	16,404	112,485	302,319
Norfolk, Va	3	219,537	15	10,422	100	46,500	7,994	45,925	126,005
Omaha, Nebr	3	52,000	5	2,325	38	22,400	1,767	44,494	89,356
Peoria, Ill	8	3,311,512	92	102,062	924	498,169	291,004	1,016,314	2,372,329
Philadelphia, Pa	3	536,731	49	55,956	204	111,271	44,329	177,453	416,930
Racine, Wis	9	6,913,534	415	869,836	1,472	770,041	369,281	1,254,625	3,001,009
Rockford, Ill	5	727,062	22	21,720	344	173,160	95,497	388,589	720,959
South Bend, Ind	6	1,775,722	123	131,056	1,382	669,380	287,817	1,039,339	2,432,083
Springfield, Ohio	7	8,194,543	897	689,616	2,359	1,174,545	585,962	2,222,540	5,272,686
Utica, N. Y	3	957,393	34	23,573	186	79,557	67,760	163,596	368,509
York, Pa	4	333,410	35	26,278	314	112,141	9,721	183,506	407,417
All other cities[1]	57	12,368,999	714	754,380	3,928	1,879,345	801,806	3,896,007	8,288,551

[1] Includes establishments distributed as follows: Akron, Ohio, 2; Allegheny, Pa., 1; Anderson, Ind., 1; Atlanta, Ga., 1; Baltimore, Md., 1; Bay City, Mich., 1; Binghamton, N. Y., 1; Boston, Mass., 1; Buffalo, N. Y., 1; Chattanooga, Tenn., 1; Cleveland, Ohio, 1; Cohoes, N. Y., 1; Columbus, Ohio, 2; Council Bluffs, Iowa, 1; Dallas, Tex., 1; Davenport, Iowa, 1; Des Moines, Iowa, 1; Detroit, Mich., 2; Elmira, N. Y., 1; Hamilton, Ohio, 2; Jackson, Mich., 2; Jamestown, N. Y., 1; Los Angeles, Cal., 1; Macon, Ga., 1; New Haven, Conn., 1; New York, N. Y., 2; Portland, Me., 1; Poughkeepsie, N. Y., 2; Quincy, Ill., 2; Richmond, Va., 2; Saginaw, Mich., 2; St. Joseph, Mo., 1; St. Louis, Mo., 2; San Francisco, Cal., 2; Schenectady, N. Y., 1; Sioux City, Iowa, 1; Springfield, Ill., 1; Syracuse, N. Y., 2; Toledo, Ohio, 1; Topeka, Kans., 1; Trenton, N. J., 1; Worcester, Mass., 2; Zanesville, Ohio, 1.

Of the total number of establishments in the United States, Table 5 shows that 178, or 24.9 per cent, are located in cities of over 20,000 population. The capital invested in these establishments, however, is $90,941,833, or 57.7 per cent, and the value of products $59,130,503, or 58.4 per cent of the corresponding totals for the United States. The average capital invested and value of products per establishment for the cities included in the table are $510,909 and $332,194, respectively, as compared with $124,332 and $78,356 per establishment for all other agricultural implement works located in the smaller cities, towns, and villages, and in the rural districts.

The preeminence which Illinois holds in this industry is due in a large measure to the magnitude of the establishments located in Chicago, the capital invested in which is $36,025,355, or 22.8 per cent of the total for the United States, and the value of the products, $24,848,649, or 24.6 per cent. The average value of capital per establishment in Chicago is $6,004,226, and the average value of products is $4,141,441. The industry assumes considerable importance in the following cities, given in the order of their rank with respect to value of products, which exceeds $1,000,000 in each: Chicago, Ill.; Springfield, Ohio; Racine, Wis.; South Bend, Ind.; Peoria, Ill.; Auburn, N. Y.; Milwaukee, Wis.; Dayton, Ohio; Louisville, Ky.; and Canton, Ohio. The importance of Chicago in this industry rests on its manufacture of harvesting implements. There are no seeders or planters manufactured in that city, and only a limited number of implements of tillage, such as small cultivators and harrows, or of seed separators, fanning mills, etc. Of the more complicated and costly agricultural machines, such as combined harvesters and binders and mowers, more are manufactured in that city than in the rest of the country. There is also manufactured there a large number of miscellaneous implements and attachments of a character not specified in the returns.

In Springfield, Ohio, are manufactured horse corn planters, grain drills, grain sowers, wheel cultivators, disk and other harrows, corn harvesters, combined harvesters and binders, hay carriers, hay loaders, horse hayrakes, hay tedders, mowers, reapers, power cornshellers, and other miscellaneous implements.

Racine, Wis., is important in the manufacture of horse corn planters, cotton and potato planters, grain drills and grain sowers, listers, seed sowers, small and wheel cultivators, disk and other harrows, plows of various types—shovel, sulky or wheel, and walking—stalk cutters, hand cornshellers, fanning mills, horsepower and steam-power thrashers, combined thrashers and separators, and other miscellaneous implements. There are no harvesting implements manufactured in Racine.

The implements of chief importance manufactured in South Bend, Ind., are the various types of plows—sulky or wheel and walking plows. There were 131,852 walking plows reported for that city, which is 16.1 per cent of the total number, 819,022, manufactured in the United States. Other implements manufactured in South Bend are the following: Cotton planters, seed sowers, small and wheel cultivators, equalizers, harrows, disk and shovel plows, and stalk cutters. There were no harvesting implements or seed separators reported for that city.

In Peoria, Ill., are manufactured hand and horse corn planters, grain drills and grain sowers, listers, small and wheel cultivators, equalizers, harrows other than disk, shovel, sulky or wheel, and walking plows, stalk cutters, harvesters, horse hayrakes, hay stackers, mowers, potato diggers, combined thrashers and separators, and other miscellaneous implements.

In Auburn, N. Y., are manufactured small cultivators, disk and other harrows, harvesters, combined binders and harvesters, horse hayrakes, hay tedders, mowers, reapers, scythes, sickles, and a large number of other implements of a miscellaneous character.

The implements of chief importance manufactured in Milwaukee, Wis., are combined harvesters and binders and mowers. Hand cornshellers, fanning mills, horsepower and steam-power thrashers, and combined thrashers and separators, with other miscellaneous implements, are also manufactured to a considerable extent.

In Dayton, Ohio, are manufactured horse corn planters, corn and grain drills and grain sowers, lime spreaders, seed sowers, tobacco transplanters, small and wheel cultivators, and the various types of harrows, disk and walking plows, hay loaders, horse hayrakes, hay tedders, mowers, hand cornshellers, and other miscellaneous implements.

In Louisville, Ky., are manufactured horse corn planters, cotton planters, grain drills, tobacco transplanters, small and wheel cultivators, cotton scrapers, cotton sweeps, equalizers, harrows, all types of plows, potato coverers and hillers, rollers, stalk cutters, potato diggers, cornshellers, fanning mills, gardening tools, and other miscellaneous implements.

In Canton, Ohio, are manufactured small cultivators, disk and other harrows, walking plows, rollers, hay carriers, horse hayforks, hand hayrakes, and a large number of implements of a miscellaneous character.

Table 6 is a comparative statement of the numbers of the various kinds of agricultural implements reported at the censuses of 1900, 1890, 1880, and 1870.

TABLE 6.—NUMBER OF AGRICULTURAL IMPLEMENTS MANUFACTURED: COMPARATIVE STATEMENT, 1870 TO 1900, INCLUSIVE.

	1900	1890	1880	1870
Seeders and planters:				
Bean planters	200	.....	.....	.....
Corn planters, hand	129,515	77,501	68,691	21,709
Corn planters, horse	78,135	54,639	.....	.....
Cotton planters	45,575	56,740	19,288	2,000
Potato planters	25,338	.....	.....	.....
Drills, beet	5,302	.....	.....	.....
Drills, corn	21,940	.....	.....	.....
Drills, grain	91,635	44,880	43,222	32,033
Grain sowers	36,862	16,728	15,563	.....
Lime spreaders	474	.....	.....	.....
Listers	26,995	18,603	.....	.....
Manure spreaders	5,263	.....	8,155	.....
Seed sowers	83,283	57,716	20,289	6,900
Tobacco transplanters	3,788	.....	4,245	.....
Implements of cultivation:				
Bean cultivators	189	.....	.....	.....
Beet cultivators	2,008	.....	.....	.....
Celery hillers	180	.....	.....	.....
Cotton scrapers	15,230	.....	.....	.....
Cotton sweeps	75,311	.....	.....	.....
Cultivators, small	206,982	239,008	318,057	88,740
Cultivators, wheel	295,799	206,482	.....	.....
Equalizers	74,168	.....	.....	.....
Harrows, disk	97,261	53,980	.....	.....
Harrows, other than disk	380,259	214,985	.....	9,150
Hoes (dozens)	277,173	254,814	299,338	135,139
Markers and furrowers	854	.....	.....	.....
Plows, disk	17,845	.....	.....	.....
Plows, shovel	102,320	.....	.....	.....
Plows, steam	207	.....	.....	.....
Plows, sulky or wheel	136,105	67,286	.....	.....
Plows, walking	819,022	1,182,059	1,326,123	864,947
Potato coverers and hillers	3,052	.....	.....	.....
Rollers	12,590	5,168	3,002	4,803
Stalk cutters	13,425	21,605	.....	.....
Harvesting implements:				
Grain cradles	36,163	84,222	167,492	103,646
Harvesters, bean	1,425	.....	.....	.....
Harvesters, corn	20,707	.....	.....	.....
Harvesters, grain	187	.....	.....	3,566
Harvesters, other	6,288	[1]3,429	25,787	.....
Harvesters and binders combined	238,355	125,942	.....	.....
Hay carriers	54,303	24,351	.....	.....
Hayforks, hand (dozens)	152,840	[2]264,742	206,727	108,188
Hayforks, horse	51,770	1,823	.....	.....
Hay loaders	7,273	3,019	8,957	.....
Hayrakes, hand (dozens)	58,013	64,825	308,782	207,810
Hayrakes, horse	216,345	114,790	95,625	80,619
Hay and straw stackers	20,546	5,184	.....	.....
Hay tedders	14,510	12,176	2,334	.....
Mowers	397,561	170,893	72,090	39,486
Mowers and reapers combined	1,055	15,681	54,920	59,645
Potato diggers	21,033	4,816	33,453	.....
Potato hooks	20,860	.....	.....	.....
Reapers	35,945	8,884	35,327	60,388
Scythes	718,453	795,400	1,244,264	881,244
Scythe snaths	537,214	511,856	437,178	17,680
Sickles	446,660	.....	95,613	3,600
Seed separators:				
Bean separators	40	.....	.....	.....
Clover hullers	661	651	1,412	5,206
Corn huskers	10,726	.....	44,370	.....
Cornshellers, hand	106,381	85,488	59,157	12,941
Cornshellers, power	8,185	5,726	.....	.....
Fanning mills	30,369	21,460	45,412	19,772
Separators, other than bean and cotton seed	1,707	[3]4,577	9,103	1,131
Thrashers, horsepower	1,314	2,769	10,424	22,931
Thrashers, steam-power	3,651	2,661	.....	.....
Thrashers and separators combined	5,394	5,937	.....	.....

[1] Harvesters of all kinds, not reported separately.
[2] Hay, manure, and spading forks, not reported separately.
[3] Separators of all kinds, not reported separately.

It should not be assumed that Table 6 is an accurate presentation of the number of different kinds of agricultural implements manufactured at the several censuses. As before stated, very many articles which, properly speaking, are agricultural implements, are not included in these statistics, being manufactured by establishments whose principal product receives a different classification. Differences in the form of the schedule of inquiry at the several periods should also be considered. Certain apparent discrepancies may be understood after an analysis of the figures. Bean planters were not provided for on the schedules of inquiry at the censuses prior to 1900. The absence of data relating to horse corn planters for 1880 and 1870 is due to the fact that these machines were then used to but a limited extent, and were not provided for on the schedule. Potato planters and the various types of drills were not reported separately prior to this census. With the exception of wheel cultivators, which were reported in 1890, no statistics of the several kinds of cultivators manufactured were available prior to 1900, all having been reported under one general head. The same is true of harrows and plows. The statistics relating to harvesters are, for the same reason, of little value for comparative purposes. The excess of hayforks in 1890 over 1900 may be explained by the fact that at the last census hay, manure, and spading forks were reported under this head. Horse hayforks and hay-stackers were not reported separately prior to 1890. The decrease, shown in the table, of mowers and reapers combined, from 1890 to 1900 is explained by the fact that a number may have been reported as harvesters, or combined harvesters and binders. The decrease shown in the number of grain cradles and scythes manufactured was, according to the table, progressive from 1880 to 1900, and is undoubtedly due to their displacement by the use of mowers, the number of which increased from 72,090 in 1880, to 397,561 in 1900. The rather unexpected increase in scythe snaths is in part due to the fact that many of them were made by hand in 1870, by farmers, wheelwrights, or carpenters, and hence not included in the census returns. Sickles were not reported in 1890; a large increase, however, is shown in their manufacture from 1880 to 1900. The number of horsepower thrashers and combined thrashers and separators shows a decrease from 1890 to 1900. This is doubtless explained by the greater efficiency of those manufactured in 1900 and by the increase in the number of steam-power thrashers.

The following statement is evidence that the danger of duplicating or improperly classifying certain implements in the reports, owing to the ambiguity of the terms applied to them, has been encountered at previous censuses:

A machine for thrashing and separating is in the great majority of cases reported as one separator, but sometimes as one thrasher, and in a few instances, from the identity of numbers returned, there is a strong inference that the same machine has been returned as one thrasher and one separator.

So in the return of grain drills the production does not seem to have kept pace with the increase of operative labor in the manufacture of agricultural implements, but a portion of the return is doubtless absorbed under the heads of grain sowers and seed sowers. A variety of machines (corn and cotton planters, grain drills, pulverizers, and even harrows and hayrakes) may be adapted for sowing seed and grain, and also guano, plaster, or other fertilizers. Such machines will usually be returned in accordance with the function considered most essential and important, but there is liability to duplication.

The third class of farm machinery liable to be reported ambiguously includes the following items: Harvesters, mowers, reapers and mowers, reapers. All of these are included under the title of

harvesting machinery. The term harvester would not be applied to a mower, but might be applied to a reaper, or to a reaper and mower. Gavelers, droppers, hand-chain-self and sweep-rake reapers, as well as twine and wire self-binders, are liable to come under the caption of harvesters.[1]

But although few of the individual items at different censuses shown in Table 6, will bear direct comparison, a general view of the figures for 1900 and for 1870 gives a striking impression of the progress of the industry during the thirty years. In 1870, 25 varieties of implements were tabulated, and in 1900 there were 66. Where, for example, 32,033 grain drills and 6,900 seed sowers were reported in 1870, there were in 1900, belonging in the same general category, 91,635 grain drills, 83,283 seed sowers, 36,862 grain sowers, 21,940 corn drills, 26,995 listers, 25,338 potato planters, and 5,302 beet drills. Of the various kinds of reapers, mowers, and harvesters 696,518 were manufactured in 1900—more than four times the output of 1870, and lacking only 21 per cent of equaling the number of scythes made in 1870. When, in addition to this great increase in number and variety of implements, the complicated and expensive character of much of the modern machinery is borne in mind, some idea is gained of the marvelous advance of the three decades.

The foregoing figures convey but a poor idea of the vastly increased efficiency brought about in the various operations of the farm by the increase in the number of implements manufactured, and more especially by the remarkable improvements wrought in their construction and productive capacity. It could be stated with precision, perhaps, how much more costly an operation it would be to harvest a 50-acre field of wheat with the scythe or grain cradle than with the modern combined harvester and binder, or how much less time would be required to plant 100 acres of corn with an improved horse corn planter than by hand; but any attempt to make an accurate statement for a state or for the United States of the measure of the increased efficiency of agricultural implements and machines in use in 1900 over those employed ten, twenty, or thirty years ago would, from the nature of the case, prove futile. The following extract describes the increased productiveness made possible in certain branches of agriculture by the improvement effected in the manufacture of implements:[2]

CORN CULTIVATION AND HARVESTING.

Between 1855 and 1894 the following changes took place in cultivation of corn. The time of human labor required to produce one bushel of corn, on an average, declined from four hours and thirty-four minutes to forty-one minutes, and the cost of the human labor to produce this bushel declined from 35¾ cents to 10½ cents.

In the earlier years the plow and harrow of that period were used; the check rows were marked with the shovel plow; the seed was dropped by hand, from a bucket or pouch carried by the farmer, and covered with a hoe; the cultivating was done with a shovel plow; knives were used for cutting the stalks from the ground by hand; husking pegs were worn on the hand in husking; the stalks, husks, and blades were cut into fodder with an old-time machine turned by hand, and the corn was shelled by hand, either on a frying-pan handle or on a shovel, or by rubbing the cob against the unshelled ears.

A radical change had taken place in 1894. The earth was loosened with a gang plow, and a disk harrow very thoroughly pulverized it. A corn planter drawn by a horse planted the corn, and the top soil was pulverized afterwards with a four-section harrow.

When it came to harvesting the corn, a self-binder drawn by horses cut the stalks and bound them, and the shocks of stalks were then hauled to a machine, which removed the husks from the ears, and in the same process cut the husks and the stalks and the blades into fodder, the power of the machine being supplied by a steam engine.

Then came the shelling of the corn, which is one of the marvels of the changes which have been wrought by machines. In this case, the machine operated by steam shelled 1 bushel of corn per minute, while in the old way the labor of one man was required for one hundred minutes to do the same work.

WHEAT CULTIVATION AND HARVESTING.

The use of steam as a substitute for horsepower in plowing, in harvesting, and in thrashing wheat has not materially contributed to economy, except from a saving due to the elimination of animal power, so the more common power supplied by horses is here selected for the comparison. The years in contrast are 1830 and 1896.

It is one of the marvels of the age that the amount of human labor now required to produce a bushel of wheat from beginning to end is on an average only ten minutes, whereas in 1830 the time was three hours and three minutes. During the interval between these years the cost of the human labor required to produce this bushel of wheat declined from 17¾ cents to 3⅛ cents.

In the contrast thus presented the heavy, clumsy plow of the day was used in 1830; the seed was sown by hand, and was harrowed into the ground by the drawing of bushes over it; the grain was cut with sickles, hauled to a barn, and at some time before the following spring was thrashed with flails; the winnowing was done with a sheet attached to rods, on which the grain was placed with a shovel and then tossed up and down by two men until the wind had blown out the chaff.

In the latter year, on the contrary, the ground was plowed and pulverized in the same operation by a disk plow; the seed was sown with a mechanical seeder drawn by horses; the reaping, thrashing, and sacking of the wheat was done with the combined reaper and thrasher drawn by horses, and then the wheat was ready to haul to the granary.

HAYMAKING.

Hay is the next selection for comparison, the years being 1860 and 1894. When men mowed the grass with scythes, spread it and turned it over for drying with pitchforks, when they raked it into windrows with a hand rake, cocked it with a pitchfork, and baled it with a hand press, the time of human labor required per ton was thirty-five and one-half hours; but when for this method was substituted a mower, a hay-tedder, and a hayrake and hay gatherers and stackers drawn by horses, and a press operated by a horse, the time of human labor was reduced to eleven hours and thirty-four minutes, while the cost of human labor from the earlier to the later year was reduced from $3.06 to $1.29.

[1] Tenth Census of the United States, Report on the Manufacture of Agricultural Implements, by Charles H. Fitch, D. E., special agent, page 72.

[2] Department of Agriculture, Yearbook, 1899, pages 331–333, Progress of Agriculture in the United States, by George K. Holmes.

The more noticeable economy in haymaking is in the mowing and curing of the grass. In these two operations the time of human labor declined per ton from eleven hours to one hour and thirty-nine minutes, while the cost of the human labor declined from 83⅓ cents to 16¼ cents.

The comparisons might be extended throughout many of the crops produced by the farmer, with a constantly recurring illustration of the saving of human labor and of the diminution of the cost of production by the diminution of human labor. With regard to animal labor alone it often appears that an increased time is required in production, but where there is an increased cost it is principally due to the increased value of the labor of animals.

SAVING IN THE COST OF PRODUCING CROPS.

The potential saving in the cost of human labor on account of improved implements, machines, and processes, at the rate per bushel or ton, as the case may be, has been computed for seven of the principal crops of 1899. The comparison is between the old-time methods of production, in which hand labor was assisted only by the comparatively rude and inefficient implements of the day, and the present time, when hand labor has not only the assistance of highly efficient and perfected implements and machines, but has been considerably displaced by them. The saving in the cost of human labor in cents, per unit of product, permits a very forcible statement of its equivalent in money by means of a computation consisting of the multiplication of the saving per unit into the crop of 1899. The result expresses the potential labor saving in the production of seven crops of that year, and is not an aggregate of the saving of human labor in the cost of producing the crops for all of the years between the earlier and the later ones, during which time this economizing and displacement of human labor has taken place. In the case of the crop of corn, the money measure of the saving of human labor required to produce it in 1899, in the most available economic manner, as compared with its production in the old-time manner, was $523,276,642; wheat, $79,194,867; oats, $52,866,200; rye, $1,408,950; barley, $7,323,480; white potatoes, $7,366,820; hay, $10,034,868.

The total potential saving in the cost of human labor for these seven crops of 1899, owing to the possible utilization of the implements, machines, and methods of the present time, in place of the old-time manner of production, reaches the stupendous amount of $681,471,827 for this one year.

No adequate attempt can be made in this report to set forth in detail the values reported in the returns for all classes of implements and machines in their multifarious types and styles. The values reported are factory values, and differ widely, the degree of variance being greatest in machines distinguished by their complexity of construction and high value. The investigation into the industry was not conducted with the object of ascertaining the prices of particular products, or with any special reference thereto, and no satisfactory data can be presented as to the range of values of the several classes of implements.

For an extended discussion of this branch of the subject, the reader is referred to Bulletin No. 18 of the Department of Agriculture, entitled "The Course of Prices of Farm Implements and Machinery for a Series of Years," by George K. Holmes. In this monograph it is stated that—

Certain general conclusions can * * * be arrived at. It is conspicuously the fact that from 1860 to 1895 the retail prices of agricultural machinery and implements declined to an enormous extent, and this in spite of the fact that these implements and machines in the meantime increased in efficiency, in durability, in workability, in lightness of weight, and in strength of materials. There has been a progress from wood to iron and from iron to steel, and from large patterns to small ones; and during the same time there was an increased utilization of applied power.

From 1895 to 1900 * * * in the case of many establishments there has been an increase of prices. In connection with this it should be borne in mind that the financial depression which began in May, 1893, and continued until about 1897, had a disturbing effect upon manufacturing industries, and that when the business revival began, a considerable increase in the prices of materials used in manufacturing occurred, and that this lasted for a considerable length of time. On this account the retail prices of agricultural implements and machines as reported for the midsummer of 1900 show an increase which must be regarded as abnormal. This expresses the general consensus of opinion of the manufacturers of agricultural implements and machines in this country, and is a repetition of previous industrial experiences following financial depressions.

Table 7 is a statement of the number of the several kinds of agricultural implements manufactured and the number of establishments manufacturing each kind.

TABLE 7.—NUMBER OF ESTABLISHMENTS REPORTING EACH KIND OF IMPLEMENT, WITH THE TOTAL NUMBER MANUFACTURED: 1900.

	Number of establishments reporting.	Number of implements.
Implements of cultivation:		
Cultivators—		
Bean	5	189
Beet	6	2,008
Small	88	206,982
Wheeled	95	295,799
Cotton scrapers	7	15,230
Cotton sweeps	8	75,311
Celery hillers	1	130
Equalizers	11	74,168
Harrows—		
Disk	58	97,261
Other than disk	138	380,259
Hoes	21	[1]277,178
Markers and furrowers	10	854
Plows—		
Disk	18	17,845
Shovel	70	102,320
Steam	3	207
Sulky or wheel	48	136,105
Walking	211	819,022
Potato coverers and hillers	20	3,052
Rollers	75	12,590
Stalk cutters	30	13,425
Miscellaneous	24	2,704,623
Seeders and planters:		
Planters—		
Bean	5	200
Corn—		
Hand	14	129,515
Horse	61	78,135
Cotton	26	45,575
Potato	9	25,338
Drills—		
Beet	5	5,302
Corn	22	21,940
Grain	46	91,635
Grain sowers	18	36,862
Lime spreaders	5	474
Manure spreaders	10	5,263
Listers	21	26,995
Seed sowers	34	83,283
Tobacco transplanters	8	3,788
Miscellaneous	4	330
Harvesting implements:		
Grain cradles	16	36,163
Harvesters—		
Bean	6	1,425
Corn	11	20,707
Grain	5	187
Other	6	6,283
Harvesters and binders combined	11	233,355
Hay carriers	19	54,303
Hayforks—		
Hand	15	[1]152,840
Horse	16	51,770

[1] Dozens.

TABLE 7.—NUMBER OF ESTABLISHMENTS REPORTING EACH KIND OF IMPLEMENT, WITH THE TOTAL NUMBER MANUFACTURED: 1900—Continued.

	Number of establishments reporting.	Number of implements.
Harvesting implements—Continued.		
Hay loaders	18	7,278
Hayrakes—		
Hand	28	[1]58,013
Horse	66	216,345
Hay stackers	19	12,069
Hay tedders	14	14,510
Mowers	25	397,561
Mowers and reapers combined	3	1,055
Potato diggers	34	21,033
Potato hooks	3	20,860
Reapers	13	35,945
Scythes	11	718,453
Scythe snaths	9	587,214
Sickles	5	446,660
Stackers	2	247
Miscellaneous	7	41,067
Seed separators		
Separators—		
Bean	1	40
Other	15	1,707
Clover hullers	5	661
Corn huskers	14	10,726
Cornshellers—		
Hand	41	106,381
Power	26	8,185
Fanning mills	46	30,369
Thrashers—		
Horsepower	18	1,314
Steam power	15	3,651
Thrashers and separators combined	31	5,394
Miscellaneous	256	7,578,853
Miscellaneous:		
Animal pokes	2	32,000
Artesian-well boring tools and castings	3	80
Bean pullers	2	207
Binders	2	15
Cane mills	7	2,454
Carts	7	7,001
Check rowers	15	44,245
Churns, butter workers, etc	6	9,506
Cider and wine mills	18	6,167
Corn cleaners	2	93
Corn hooks	4	64,789
Corn knives	9	22,130
Cotton gins	2	213
Cotton presses	1	13
Ditching machines	5	25
Ensilage cutters	26	11,738
Engines and boilers	5	497
Farm trucks	6	1,376
Feed and ensilage elevators	21	2,632
Feed steamers and boilers	6	2,184
Fence machines	2	201
Fruit graders	4	195
Fruit presses	6	1,411
Gardening implements	23	1,868,099
Grinding mills	18	18,234
Grubbing machines	10	2,097
Handcarts	20	5,245
Hay cutters	18	13,835
Hay presses	22	2,510
Hayracks	15	1,091
Horsepowers	63	5,694
Incubators	2	21
Lawn mowers	3	17,019
Pea hullers	5	900
Portable sawmills	15	999
Portable steam engines	14	1,099
Pumps—		
Hand	11	51,580
Horse	1	20
Steam	2	302
Road carts	5	804
Road graders	2	103
Road scrapers	10	3,509
Shovels, spades, and scoops	4	236,400
Singletrees	17	332,722
Sirup evaporators	1	131
Sorghum binders	2	21
Sorghum evaporators	2	2,652
Sprayers	11	106,655
Straw stackers	24	8,230
Thresher trucks	8	2,437
Traction engines	26	5,470
Wagons	22	2,768
Wagon trucks	4	5,370
Water trucks	13	1,350
Weeders	23	63,186
Wind engines	1	85
Windmills	4	4,295

[1] Dozens.

The manufacture of plows is more widely distributed and is carried on by a larger number of establishments than that of any other agricultural implement, being reported by 211 establishments. Harrows and cultivators are next in importance as regards the diffusion of their manufacture throughout the states and the number of establishments reporting. In one form or another plows, harrows, and cultivators are manufactured more or less extensively in nearly every state. Reference to Table 10 and the original schedules on file shows that plows are made in 28 states, harrows in 27 states, and cultivators in 26 states. Implements of cultivation generally are manufactured in some form in 31 states, seeders and planters in 27 states, harvesting implements in 28 states and seed separators in 23 states.

The totals shown in Tables 7 and 10 for the various implements of a miscellaneous character should not be accepted as indicating the total number of such implements or machines manufactured during the census year. A large number of these "miscellaneous" implements can not be regarded as agricultural implements, but they were made a part of the inquiry for the reason that they are frequently manufactured in connection with the manufacture of agricultural implements. A large number of the articles included under "miscellaneous" products are manufactured—and frequeutly in much greater volume—by establishments whose reports were classified as "foundry and machine-shop products."

The following are examples: Artesian-well-boring tools and castings, cane mills, cider and wine mills, cotton gins, cotton presses, engines and boilers, feed steamers and boilers, grinding mills, grubbing machines, horsepowers, portable sawmills, portable steam engines, steam pumps, and traction engines. Carriage and wagon establishments manufacture a larger number of carts, farm trucks, hand carts, road carts, wagons, and wagon trucks than is shown in these tables. There were 445,517 farm wagons, trucks, and carts manufactured during the census year by distinctive carriage and wagon establishments. Corn knives were no doubt manufactured by establishments whose returns are classified as "cutlery and edge tools." Table 7 shows that there were 51,600 hand and horse pumps manufactured by agricultural implement establishments. That this number by no means represents the entire number manufactured, is shown by the fact that establishments manufacturing "pumps, not including steam pumps," reported the value of their products as $1,341,713 for the census year. Shovels, spades, and scoops are manufactured extensively by other factories than those included in this report. The same is true of churns and incubators. Windmills valued at $4,354,312 were reported by 68 establishments whose returns were so classified. This value represents a considerably greater number than is shown in the above table.

Table 8 shows the value of the exports of agricultural implements and machines from the United States to the several countries named in the table, during each year from 1891 to 1900 inclusive, divided into "mowers and reapers," "plows and cultivators," and all other classes, together with the value of detached parts of each kind.

TABLE 8.—VALUE OF EXPORTS OF AGRICULTURAL IMPLEMENTS, 1891 TO 1900, INCLUSIVE.[1]

COUNTRIES AND CLASSES.	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900
Aggregate	$3,219,130	$3,794,983	$4,657,338	$5,027,915	$5,418,075	$5,176,775	$5,240,686	$7,609,782	$12,432,197	$16,099,149
Mowers, reapers, and parts of same: Total	1,579,976	2,372,988	2,873,897	3,261,892	3,659,735	3,212,423	3,127,415	5,500,665	9,053,880	11,243,763
France	245,146	345,086	231,004	220,125	424,312	360,577	494,469	1,146,551	1,678,865	2,652,795
Germany	152,683	222,261	301,136	386,096	375,348	480,773	538,430	1,100,210	1,503,968	2,529,422
Russia	189,897	81,733	240,908	222,212	629,435	387,316	265,442	409,368	863,476	710,066
United Kingdom	251,084	414,677	379,053	337,455	447,114	333,791	360,079	874,296	1,040,059	982,188
Canada	47,087	47,404	31,001	119,123	90,297	132,945	248,359	440,878	934,962	1,192,458
Argentina	75,546	644,085	1,044,763	1,206,031	817,445	570,332	228,391	182,283	1,074,749	1,194,961
British Australasia	311,440	187,026	170,715	208,213	106,199	195,533	302,586	421,975	358,862	466,397
All other countries	307,093	430,666	475,317	562,637	769,585	751,156	689,659	925,104	1,598,889	1,515,476
Plows, cultivators, and parts of same: Total	596,728	397,735	644,390	589,721	513,913	746,604	590,779	927,250	1,545,410	2,178,098
France	1,176	7,760	10,986	11,782	39,584	15,048	7,992	49,330	59,105	68,197
Germany	7,416	2,261	1,056	3,874	19,418	6,402	11,206	15,450	38,898	227,378
Russia	7,346	2,793	70	2,592	172	23,777	3,129	29,566	14,902	45,993
United Kingdom	28,172	8,165	19,305	27,594	37,345	43,105	36,142	74,763	69,737	179,950
Canada	28,919	15,869	21,452	12,953	23,555	40,533	73,023	182,809	207,480	247,306
Argentina	66,945	80,303	202,961	116,029	63,481	161,347	104,072	151,737	440,996	388,903
British Australasia	20,624	23,905	13,167	21,768	34,003	32,450	39,527	108,116	166,035	162,109
All other countries	436,130	256,679	375,393	343,129	296,355	423,942	315,688	315,479	548,257	858,262
All other implements, and parts of same: Total	1,042,426	1,024,310	1,139,046	1,226,302	1,239,427	1,217,748	1,522,492	1,181,817	1,832,957	2,677,288
France	118,499	77,523	68,001	54,695	66,301	91,359	121,495	56,286	43,689	189,583
Germany	73,682	67,498	75,543	134,746	162,148	94,552	161,182	116,582	103,845	129,654
Russia	23,031	30,309	50,736	58,027	78,870	65,236	253,495	19,653	59,848	271,671
United Kingdom	192,517	201,298	211,961	231,882	266,223	211,654	246,096	195,966	262,597	188,305
Canada	106,481	72,390	97,912	90,083	121,565	186,166	143,455	157,728	378,612	571,442
Argentina	57,557	57,552	111,610	192,134	123,625	122,488	82,849	43,034	163,274	221,880
British Australasia	80,252	113,005	110,547	128,439	106,728	57,739	148,872	167,474	243,775	269,776
All other countries	390,407	404,735	412,736	336,296	313,967	388,554	365,048	425,094	577,317	834,977

[1] United States Treasury Department: Report on Commerce and Navigation, 1900.

Table 8 shows a gratifying and practically constant increase in our exports of agricultural implements and machines. This is notably the case with harvesting machinery, classified in the table as "mowers and reapers, and parts of." In addition to the statistics presented in the table, the total value of exports of all classes of agricultural implements in 1870 was $1,068,476, and in 1880, $2,245,742. The value of agricultural implements exported during 1900 was $16,099,149, or 15.9 per cent of the value of products manufactured during the census year. During the periods included in the above table there is no record of any imports of these products except the sum of $108 during 1900. It is therefore gratifying to note that the various operations of the farm and field in the United States are performed exclusively with implements made in American workshops.

Nothing could more forcibly demonstrate the growing favor with which agricultural implements manufactured in the United States are being received in other countries than the figures presented in Table 8. These exports were not shown separately in the published reports of the Treasury Department previous to 1864. The increase in value from $1,068,476 in 1870 to $16,099,149 in 1900, such increase being, as shown by the table, almost constant from year to year, is ample evidence that manufacturers are fully alive to the advantage of extending their trade not only at home, but also abroad.

While the articles are declared for the countries named in the table at the customhouse of export, those countries should not, in all cases, be considered as their final destination. However, by far the largest proportion find their use in the countries named, or their dependencies.

The figures are not presented in sufficient detail to indicate the value of the exports of all classes of agricultural implements separately. Of the total for 1900, $16,099,149, the value of harvesting machinery, "mowers, reapers, and parts of," was $11,243,763, or 69.8 per cent, and "plows, cultivators, and parts of," $2,178,098, or 13.5 per cent. The percentages of the total value of the first class sent to each country were as follows: France, 23.6; Germany, 22.5; United Kingdom, 8.7; Canada, 10.6; Argentina, 10.6; Russia, 6.3; British Australasia, 4.2; all other countries, 13.5. The percentages of the total value of implements of tillage sent to each country were as follows: France, 3.1; Germany, 10.4; United Kingdom, 8.3; Canada, 11.4; Argentina, 17.9; Russia, 2.1; British Australasia, 7.4; all other countries, 39.4.

That the increased trade with foreign countries is primarily due to the superior efficiency of agricultural implements and machinery manufactured in the United States goes without saying. Supplementing this are the usual efforts of successful commercial enterprise in the way of establishing branch houses abroad, exhibiting wares at popular expositions, public practical tests, etc., in fact, all practicable methods of advertising known to the manufacturers. Among the most successful of the means employed in this extension of business are the numerous reports of the United States consular officers, which are eagerly read by the manufacturers, and are frequently the direct incentive to greater efforts to obtain new business and a consequent increase in shipments to foreign countries. A complete recogni-

tion of the existing climatic and physical conditions, and the local needs and peculiarities of the foreign market are essential, in order that the best advantage may be taken of the openings presented, and a full measure of success obtained. It is necessary, also, that the fullest information obtainable be had with reference to the administrative laws and tariffs of the foreign custom-houses, and the varied interpretations placed upon their different provisions.

To show the wide distribution of American agricultural implements, the different countries to which these products were exported in 1900 are shown, as follows: Europe—Austria-Hungary, Azores and Madeira Islands, Belgium, Denmark, France, Germany, Gibraltar, Greece, Italy, Netherlands, Portugal, Roumania, Russia, Spain, Sweden and Norway, Switzerland, Turkey in Europe, United Kingdom; North America—Bermuda, British Honduras, Canada; Central American States—Costa Rica, Guatemala, Honduras, Nicaragua, Salvador; Mexico; West Indies: British, and Danish, Dutch, French, Cuba, Haiti, Porto Rico, Santo Domingo; South America—Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, British Guiana, Paraguay, Peru, Uruguay, Venezuela; Asia—Aden, Chinese Empire; British East Indies; Dutch East Indies; Hongkong, Japan, Turkey in Asia; Oceania—British Australasia, Guam, Hawaii, Philippine Islands; Africa—British Africa, Canary Islands, Egypt, French Africa, Portuguese Africa.

Table 9 presents, by states, the value of farm implements on farms in the United States, as reported at the Twelfth Census.

TABLE 9.—VALUE OF IMPLEMENTS ON FARMS, BY STATES AND TERRITORIES: 1900.

STATES AND TERRITORIES.	Value of implements on farms.	STATES AND TERRITORIES.	Value of implements on farms.
United States	$749,776,660		
Alabama	8,675,900	Montana	$8,671,900
Alaska	690	Nebraska	24,940,450
Arizona	765,200	Nevada	888,560
Arkansas	8,750,060	New Hampshire	5,163,090
California	21,311,670	New Jersey	9,380,080
Colorado	4,746,755	New Mexico	1,151,610
Connecticut	4,948,300	New York	56,006,000
Delaware	2,150,560	North Carolina	9,072,600
District of Columbia	136,060	North Dakota	14,055,560
Florida	1,963,210	Ohio	36,354,150
Georgia	9,804,010	Oklahoma	6,573,015
Idaho	3,295,045	Oregon	6,506,725
Illinois	44,977,310	Pennsylvania	50,917,240
Indiana	27,330,370	Rhode Island	1,270,270
Indian Territory	3,939,480	South Carolina	6,629,770
Iowa	57,960,660	South Dakota	12,218,680
Kansas	29,490,580	Tennessee	15,232,670
Kentucky	15,301,860	Texas	30,125,705
Louisiana	28,536,790	Utah	2,922,550
Maine	8,802,720	Vermont	7,538,490
Maryland	8,611,220	Virginia	9,911,040
Massachusetts	8,828,950	Washington	6,271,690
Michigan	28,795,380	West Virginia	5,040,420
Minnesota	30,099,230	Wisconsin	29,237,010
Mississippi	9,556,805	Wyoming	1,366,000
Missouri	28,602,680		

Table 9 shows the extent of the present demand in the United States for farming implements and machinery. Although the exports of agricultural implements are considerable, and constantly increasing, the home market still furnishes the chief demand. The vast area of arable land in the United States—a large proportion of it suitable for the operations of the best and most modern types of cultivating, planting, harvesting, and separating machinery, together with a very general recognition, by an intelligent class of purchasers, of the utility of employing improved implements—offers to the manufacturers opportunities for a constantly increasing sale of their products. The value of implements on the farms of the United States in 1900, as shown by the table, was $749,776,660, and the value of such products manufactured was $101,207,428. Deducting from the latter amount the value of exports in 1900, $16,099,149, leaves as the value of products manufactured for the home market $85,108,279, or 11.4 per cent of the total value of implements on American farms.

The following tabular statement, showing the number of patents granted in the United States on agricultural implements and parts or attachments, up to December 31, 1901, furnishes abundant evidence of activity in the ranks of inventors and mechanics directed to the end of improving such implements. The classifications used in the Patent Office are five in number, as follows: Plows, harrows and diggers, seeders and planters, harvesters and thrashers. Under each of these heads are given the number of patents granted on all implements and attachments or parts of the same coming under the several classifications. Implements and machines of an allied character, such as appliances for bee culture, dairy machinery, appliances for the care of live stock, horticultural and arboricultural implements, cotton gins, etc., are not included in the statement.

PLOWS.

Attachments	82	Fenders	196
Harrow	88	Gauge wheels and runners	49
Beams	66	Handles	47
Cleaners	82	Landsides	46
Clevises	322	Moldboards	164
Colters	204	Revolving	72
Rolling	175	Plows	951
Corn coverers	30	Ditching	168
Cotton choppers	518	Mole	139
Cotton scrapers	206	Revolving	98
Couplings	71	Shovel	496
Cultivators	1,228	Side-hill	381
Hand	69	Steam	223
Wheel	206	Wheel	1,423
Parallel	209	Points	188
Revolving	105	Ridgers	30
Rolling	83	Sod cutters	56
Rotary	208	Standards	52
Horizontal	30	Subsoilers	170
Straddle-row	320	Weed turners	72
Wheel	310		11,625
Straddle-row	1,594		
Cultivator teeth	398		

HARROWS AND DIGGERS.

Clodcrushers	19	Forks	103
Barred and corrugated rollers	25	Adjustable heads	39
Disks	17	Combined forks and shovels	7
Crush bars	23	Fodder forks	10
Crush bars and harrows	97	Potato forks and shovels	21
Toothed rollers and wheels	50	Fulcrumed	36
Geared	10	Harrows	206
		Center-hinged	129

HARROWS AND DIGGERS—Continued.

Harrows—Continued.	
Changeable form	28
Disk	131
Pivoted-gang	158
Center-cutter	14
Multiple-gang	6
Expansible	95
Flexible	59
Multiple	34
Revolving	88
Geared	13
Rotary	168
Spring tooth	111
Tooth bars	26
Tooth cleaners	23
Wheel	80
Center-hinged	30
Disk	24
Floating	48
Multiple	18
Pivoted tooth bar	9
Riding attachments	20
Spring	55
Pivoted tooth bar	36
Trailing teeth	27
Winged	26
Harrow teeth:	
Spike	20
Clamped	22
Nutted	4
Wedged	10
Spring	135
Sectional	24
Trailing and draw-cut	43
Hoes	61
Adjustable	30
Blades	21
Integral-shank	19
Integral-socket	18
Compound	35
Adjustable	20
Handles	9
Horizontal	64
Adjustable	19
Interchangeable	38
Toothed blades	13
Weeding	16
Land rollers	48
Furrowers and markers	31
Pivoted	106
Weighted cylinders	27
Weighted frames	20
Pivoted teeth	108
Pivoted tooth bars	208
Frameless	55
Pivoted tooth bars—Continued.	
Lever actuated	12
Spike tooth	96
Spring tooth	39
Trailing tooth	6
Potato diggers	52
Bearing wheel separators	30
Beet lifters	14
Cutters	28
Endless carriers	88
Receptacles	126
Graspers	5
Plow and screen	163
Plow clearers	20
Reels	15
Plow vibrating screens	9
Cam	17
Crank	45
Sidewise	46
Tappet	35
Screen cylinders	26
Sifting wheels, side delivery	59
Spiral conveyors	29
Toothed drum	97
Rakes	170
Heads	38
Rollers and harrows	80
Shovels	193
Attachments	15
Handles	40
Sifting	21
Stalk choppers	5
Draw-cut	44
Reciprocating	35
Revolving:	
Breakers	23
Horizontal	172
Vertical	19
Vine cutters	18
Stalk pullers:	
Hand	72
Wheel	47
Stone gatherers	24
Transplanters	13
Ballers	17
Dibbles	18
Pivoted jaws	94
Post-hole diggers	57
Pivoted jaws	8
Sliding jaws	7
Wheel machines	59
Tree conveyors	12
Wheel planters	27
	5,774

SEEDERS AND PLANTERS.

Broadcast	558
Centrifugal scatterers	79
Hand	47
Centrifugal scatterers	71
Revolving hoppers	23
Walking	11
Check row	386
Anchors	73
Endless belts	17
Knots	75
Reels	63
Wire doffers	79
Cups on belt	44
Cups on disk	86
Drills:	
Adjustable rank	74
Grain	698
Walking	89
Drills and broadcast combined	28
Drill teeth	242
Elastic feed wheels	17
Fertilizer distributers	405
Feeding belts	61
Hand	29
Revolving hoppers	26
Walking	54
Force feed	212
Grain-drill cleaners	27
Land markers	220
Liquid and powder	15
Pivoted seed cups	21
Planters:	
Corn	2,028
Cotton	404
Foot	10
Hand	30
Oscillating	83
Reciprocating	294
Rotating	35
Potato	175
Walking	39
Walking	1,199
Vibrating hoppers	78
Plungers	95
Preparing seed	16
Rolling hoppers	212
Screw feed	48
	8,566

HARVESTERS.

Bean harvesters	38
Binders:	
Compressors	31
Grain adjusters	137
Sheaf carriers	165
Clover harvesters	61
Combined rakes and tedders	82
Corn harvesters:	
Implements	27
Self-binders	72
Stalk cutters	166
Droppers—	
Crane	48
Direct tilting	200
Ejector	37
Endless apron	43
Horizontally moving and tilting	56
Sliding bottom	30
Strippers	45
Comb	31
Knife	28
Roller	90
Corn shockers	30
Cotton harvesters	131
Pneumatic	44
Rotating picker stems	108
Cutting apparatus:	
Endless	72
Guard fingers and finger bars	227
Reciprocating	395
Rotary	51
Vibrating	40
Droppers:	
Direct tilting	86
Miscellaneous	9
Opening and closing	37
Side delivery	91
Swinging and tilting	32
Fruit gatherers	432
Gearing	160
Grain wheels and casters	36
Hand binders:	
Attachments	17
Elevated delivery, rear	39
Elevated delivery, side	102
Flat delivery	12
Manual traction	12
Hand rakes	100
Hay loaders:	
Endless belts	308
Intermittent	57
Lifting reels	13
Walking rakes	67
Headers	111
Hedge trimmers	82
Hemp and flax harvesters	37
Horse rakes:	
Draft dumpers	362
Drags	135
Hand dumpers	395
Hay cockers	34
Rake teeth	105
Side delivery	32
Lawn mowers	383
Grass catchers	87
Manure forks	44
Miscellaneous	283
Mowers:	
Anomalies	32
Center cut	103
Front cut, one wheel	50
Two wheels	504
Rear cut, one wheel	60
Two wheels	259
Reciprocating gear	178
Thrust cut	93
Platform adjustments	192
Reels	256
Revolving horse rakes:	
Flop over	111
Wheel	147
Scythes and cradles	183
Seats	60
Self-binders:	
Clips and prepared bands	27
Cord knotters	490
General structure	526
Gleaners and binders	33
Tension and take-up devices	72
Twisters and tuckers	105
Wire twisters	193
Self-rakers:	
Endless carriers	169
Gaveling tongs	30
Platform movement	116
Reciprocating, horizontal curvilinear	181
Reciprocating, horizontal rectilinear	83
Rotary, horizontal axis	81
Rotary, vertical axis, switch	139
Rotary, vertical axis, no switch	145
Traveling, horizontal irregular path	71
Traveling, vertical irregular path	16
Tedders	171
Thrashers	91
Track clearers and dividers	106
	11,258

THRASHING.

Band cutters and feeders	498
Cane strippers	83
Clover hullers	176
Cornerибs	11
Corn-husking implements	144
Corn-husking machines	252
Corn shellers:	
Breast and cylinder	225
Disk action	193
Ear grasping	128
Implements	85
Peripheral action	22
Fans and regulators	45
Flax thrashers	22
Fruit and vegetable separators	136
Grain separators:	
Gravity	236
Oat, seed, and garlic	234
Rotary screens	165
Grain separators—Continued.	
Screens and riddles	113
Shaking screens	797
Straw carriers—	
Endless aprons	178
Overhung rakes	50
Reels	30
Shaking tables	177
Vibrators	55
Walking rakes	77
Granaries and bins	48
Stackers	16
Thrashing machines:	
Cylinder machines	499
Dust conveyors	50
Flail machines	25
Vine and seed strippers	181
	4,951

The above statement is summarized as follows:

Plows	11,625
Harrows and diggers	5,774
Seeders and planters	8,566
Harvesters	11,258
Thrashing	4,951
Total	42,174

The detailed statistics reported for the industry are shown in Table 10. This table presents separate totals for each state in which there were 3 or more establishments, and groups the statistics for other states so as not to disclose the operations of individual establishments. The establishments are classified according to the character of the ownership, which shows that 251 were owned by individuals, 169 by partnerships, and 295 by corporations. The employees are segregated so as to show for salaried officers and wage-earners, separately the number and salaries or wages of men, women, and children, respectively, and also the average number of wage-earners employed during each month of the year. Separate totals of the different materials and products are shown. The numbers of the different kinds of agricultural implements and machines are shown, together with others of a miscellaneous character. The numbers of engines, water wheels, electric motors, and other power in use, with their horsepower, are presented. The 715 establishments are also grouped according to the number of employees in each.

HISTORICAL AND DESCRIPTIVE.

No more than a brief résumé is possible in this report of the successive stages marking the great development of the industry and the improvement in its products in the United States. The fact itself is obvious on every hand. Agricultural operations, particularly in the East and the South—the older parts of the country—frequently afford, by a comparative showing, ocular evidence of the remarkable improvement effected in implements and machines designed for the various uses of the farm.

Side by side on adjoining farms, implements of comparatively primitive type may be seen in use in juxtaposition with those which show all the latest appliances for labor saving and increased efficiency.

Prior to 1850 the manufacture of agricultural implements could hardly be considered as more than a hand trade, and in no sense as a factory industry, as the term is at present understood. Ideas had been evolved, and, on a small scale, executed, which contained much that the improved processes and facilities of the latter part of the century brought to complete fruition. The industry, as such, was quite generally conducted in small shops, as the small average capital invested in 1850 proves. Reapers and thrashers were, in isolated cases, manufactured on what might be called the factory plan on a small scale, but their use was almost entirely restricted to the immediate neighborhood of their manufacture. It was impossible, in fact, to give to these and such other labor-saving machines as had been invented more than a limited distribution, owing to the lack of facilities for the transportation and manufacture of such products. These conditions, together with the inelastic and comparatively simple commercial methods of that time, while retarding development in other lines of industry as well, seemed to have exerted their full effect in this manufacture. The stimulating effects of freer intercourse between states and sections, of improved financial and commercial methods and systems, and of better industrial organization, developed later.

While the need for more effective agricultural implements was generally recognized previous to, and early in the last century, and the inventive faculties of many were exercised to meet this want, it was not until the western movement of the population had converted the rich alluvial plains of the Western states into productive farms, and the railroad systems of the country had extended their lines for the distribution of Western farm products, that the progress and development of the industry found its full expression. The evolution of the manufacture from the small shops of the blacksmith and wheelwright to the immense establishments of the present time embodies all the phases of the development of the modern factory system. A comparison of the average capital per establishment in 1850 and 1900 graphically illustrates the measure and significance of this change. In 1850 there were 1,333 establishments in operation, reporting a capital of $3,564,202, an average of $2,674 per establishment; and in 1900 there were 715 establishments in operation, reporting a capital of $157,707,951, an average of $220,571 per establishment.

The representative establishments in this industry are quick to install machinery and equipment that experience has proved economical from the standpoint of increased production or the reduction of operating expenses, and their factory organizations generally embody such features to the fullest extent. This is pointed out in the following:

> In the manufacture of agricultural implements new machinery has, in the opinion of some of the best manufacturers of such implements, displaced fully 50 per cent of the muscular labor formerly employed; as, for instance, hammers and dies have done away with the most particular labor on a plow. In one of the most extensive establishments engaged in the manufacture of agricultural implements in one of the Western states it is found that 600 men, with the use of machinery, are now doing the work that would require 2,145 men, without the aid of machinery, to perform; that is to say, there has been in this particular establishment a loss of labor to 1,545 men, the proportion of loss being as 3.57 to 1.[1]

Implements of Tillage—Plows, Harrows, and Cultivators.—From the plow of the ancients, a sharpened piece of wood or the crotched limb of a tree, to the modern gang plow drawn by steam power, is a far cry; but the period of time which has elapsed since the first

[1] Industrial Evolution of the United States, by Carroll D. Wright, United States Commissioner of Labor, page 326.

patent on a plow was granted in the United States is comparatively short. Letters patent were granted in 1797 to Charles Newbold, of Burlington county, N. J., for the first cast-iron plow constructed in America. The specifications contained in the application were as follows.

> The plow to be (excepting the handles and beam) of solid cast iron, consisting of a bar, sheath, and mold plate. The sheath serves a double purpose of coulter and sheath, and the mold plate serves for share and moldboard, that is, to cut and turn the furrow. The forms to be varied, retaining the same general principles, to meet the various uses as well as inclinations of those who use them.[1]

It is evident from the latter clause that there existed at an early date a recognition of the need of a diversity in form, depth, etc., of the moldboard and plow point. While this plow seems to have worked successfully, the inventor was compelled to abandon its manufacture, as the farmers very generally rejected it, under the singular delusion that the "cast iron poisoned the land."

There is evidence extant showing that the coulter and wheels to keep the plow steady in the furrow were applied features of the implement from a very early date. Previous to 1797 no less a personage than Thomas Jefferson had exercised his talents to perfect and simplify the plow on scientific lines.

Following Newbold's invention, while many improvements of minor importance appear to have been made, none of special note was effected until 1819, when a patent was granted to Jethro Wood. His invention embodied the characteristic feature of Newbold's plow, in that the moldboard was made of cast iron, but that which chiefly distinguished it was the adjustable cast-iron point. This marked the introduction of the most useful economy in plow manufacture—the interchangeability of parts.

From that time unremitting efforts have been made to improve this implement in the directions of increased durability, efficiency, and adaptability to the varied conditions of the soil. The most noteworthy steps in the progress toward perfection, among many that contributed in no small degree to the great improvement made, have been the invention of the chilled plow, the use of steel in point and moldboard, the introduction of sulky or riding and gang plows, and the application of steam and electric power as motive forces.

The thoroughly equipped plow works of to-day are prepared to manufacture almost countless varieties of styles and types, which are considered as fully meeting the various requirements. Among the many kinds manufactured are the following: One, two, or three horse plows; walking or riding plows; plows with steel beam and wearing parts, or wood beam and steel wearing parts; right or left hand plows; two or three furrow gang-plows; timberland, vineyard or orchard, prairie, unbroken land, and general purpose plows; plows particularly adapted to different qualities of soil and inclinations of the land; plows with hanging or rolling coulters, etc. The modern plow is manufactured with interchangeable parts, so that the moldboard, share, landside, standard, coulters, clevis, and the different bolts, braces, staples, washers etc., may be renewed when necessary.

Activity in the invention of steam plows began in 1861, and 223 patents had been issued in that class by the end of 1901. In 1888 the first patent for an electric plow was granted, which shows the electric motor carried on the plow. Up to the present year there have been 10 patents issued in this class. In some cases the system of transverse haulage is employed, using two electrically driven drums on opposite sides of the field.

Plow manufacture, which is the most widely distributed of any branch of the industry, does not require so large a factory organization as the manufacture of the more complicated harvesting machines; the largest establishments, however, in point of size, number of employees, and all the essentials of complete factory organization, compare favorably with representative establishments in other lines of manufacture.

The progress made during the last decade in the manufacture of harrows has been chiefly in the improvement and extension of the disk and spring-tooth principles. The three general classes are the spike-tooth, disk, and spring-tooth harrows. From the primitive harrow, a tree branch, or even from the simple A frame, rigid, spike-tooth harrow, to the best type of the disk, spring-tooth, or sectional lever harrows used at the present time, is a long step marking the advancement made in the manufacture of this implement. The variety of styles of the different types placed on the market appears to be quite as great as in plows.

Steel lever sectional harrows with spike teeth are made in one, two, three, or four sections, with adjustable teeth, which by means of a lever can be set at any angle required. This type can be regarded as an improvement of the old style spike-tooth harrow, the improvement consisting in greater lightness, due to making the frame of iron or steel, the possibility of setting the teeth at different angles by means of a lever, and the sectional feature.

The spring-tooth harrow, which is an American invention, was patented in 1869 by David L. Garver, of Michigan. Several improvements on this harrow as originally manufactured were subsequently made, among which may be mentioned the adjustability of the teeth to any depth or angle required, the construction of the frame of iron or steel, the application of wheels or runners which lessen the draft, and a seat for the operator. The teeth are made of tempered spring steel, and vary in number from ten to thirty-five. In some cases they are self-sharpening. The sectional and lever features are also applied to this implement.

[1] American Agricultural Implements, Part I, page 9, by R. L. Ardrey, 1894.

The disk harrow, which was used in a simple form in ancient times, the earliest record of its use being by the Japanese,[1] has received many improving modifications. The disk feature, while it has been extensively applied to plows and cultivators during the last decade, has had its greatest application to harrows. The first United States patent, distinctively showing the use of the disk in harrows, was granted in 1877, although a patent was granted on a comparatively simple type somewhat earlier, but the great development came in 1892. The disks are made either concave, convex, or straight, of varying diameters, and are in one gang or two, each controlled by an independent lever. Among the improved features of the modern type of disk harrow are automatic scrapers for cleaning purposes, anti-friction bearings, solid or cutaway disks; one, two, three, or four horse hitch, and the seeder attachment. A hoe attachment for the purpose of leveling the furrow left between the two gangs of disks is also applied.

"The progenitor of the cultivating machine is the hoe," and as the necessity for devices to lessen the onerous work of the farm led to improvement in other implements, the cultivator, used for tending growing crops, shared in such improvement, which has been generally in the same direction as harrow improvement. Both riding and walking cultivators, with and without wheels, are in use at the present time. The successive patents granted in the United States, marking the development of this implement as recorded by the United States Patent Office, are the following: Hilling cultivator, 1830; straddle row, 1835; hilling, 1837; wheel, riding, 1846; parallel, 1851; rotary, 1858; straddle row, 1869; wheel parallel, 1879; disk, riding, 1880; spring attachment, 1883 and 1884; parallel, riding, 1884; parallel, runner, 1884; straddle row, 1884.[2] Later many modifications of the foregoing types have been manufactured and placed on the market. Adaptations of the disk and spring tooth have been applied to the cultivator instead of the more general shovel feature. During the last decade many patents have been granted covering improved devices in couplings, springs, and other parts, particular activity having been evinced in the large number of patents for hammock-riding attachments. The wearing and bearing parts and frame are most commonly made of steel, and the beam and handles of wood. The gangs of shovels can be regulated at the will of the operator, lowered or raised to suit the requirements of the growing crop, and by moving the wheels in or out, the implement can be accommodated to the varying widths of the row, the wearing parts being generally interchangeable.

There are several modified forms of the three implements described above—the plow, the harrow, and the cultivator—which are properly classified as implements of tillage, designed for particular purposes or crops, but the various styles are too numerous to receive description at length in this report.

Seeders and Planters.—Ancient monuments and remains disclose the fact that broadcast seed sowing was not the only method of planting the crops employed in early times. There is evidence tending to prove that seed was planted in drills and rows by crude mechanical means as early as 680 B. C. The sowing of seed in rows or drills, so that the growing crop could be cultivated by horse power, was advocated in 1731 by Jethro Tull, of England, who might be called the author of horse-hoeing husbandry. From the records of the United States Patent Office, so far as they are conveniently accessible, it is shown that the progress of improvement in mechanical seeders and planters proceeded as follows: Wheelbarrow planter, 1825; slide broadcast seeder, a riding implement, 1835; rotary broadcast seeder, 1856; hand planter, 1856; foot planter, 1856; broadcast seeder, attachment to cultivator, 1869; grain drill, 1874; hand planter, 1876; cotton planter, 1876; broadcast seeder, attachment to harrow, 1878; walking drill, 1881; cotton planter and check rower, 1883; riding grain drill, 1884. Subsequent to the last date, remarkable improvement has been made in drills and planters, the more recent development being the application of the disk feature to the drill, and the broadcast seeder attachment to the disk harrow. From 1799, the date of the first patent in the United States for a seeding machine, the contributions which have been made from time to time to the improvement of these implements have been in the direction of reducing the labor of sowing and planting and, at the same time, increasing the results, and have been most valuable. Like other improved field implements, seeders and planters are operated to the greatest advantage on large farms of a level or nearly level surface, with few obstructions in the shape of stumps and stones, and with a light, loamy soil, although they may be used with undoubted success under more difficult conditions.

A late style of corn-planter, embodying nearly all the approved devices, is a two-horse machine, constructed almost entirely of steel, with two seedboxes, and check rower, drill, and force-drop attachments, for which are claimed absolute accuracy in dropping the seed, regularity in the number of seeds dropped, and adaptability to different inclinations of the soil, secured by a lever which forces the runners to work at equal depth under different conditions. This machine can also be adjusted to rows varying in width. The drill seeder is most extensively used for sowing wheat, rye, oats, and barley in equidistant rows; but, by shutting off or removing some of the hoes or drills, this implement may be used interchangeably for other crops,

[1] American Agricultural Implements, by R. L. Ardrey, 1894, Part I, page 21.

[2] The Growth of Industrial Art, by Hon. Benjamin Butterworth, Commissioner of Patents, 1892, pages 9 and 10.

such as beans, peas, turnips, sugar beets, corn, grass seed, etc., and for fertilizer. Drill seeders are made with a varying number of hoes, and a certain style is manufactured which is capable of seeding 17 rows. The most acceptable and efficient machines are provided with a force feed which can be gauged to drop more or less as may be suitable to the character of different crops; a land measure that accurately measures the ground covered to fractions of an acre; and a lever for forcing the hoes into the soil and regulating their depth as required. Their angle of inclination can also be changed at the will of the operator; and chain coverers after each hoe are provided to cover the seed. Disk drills containing scrapers or cleaners and other improved devices are meeting with considerable popular favor. Certain drill seeders are manufactured so as to be readily convertible into broadcast sowers by attaching scatterers to the seed feeder in place of the grain tubes. Combined cultivators and sowers are also on the market. While the styles manufactured by the different establishments vary in a considerable degree in size, efficiency, and other respects, the essential features may be said to be identical.

Harvesting Implements.—The development of the modern perfected harvesting machine by gradual progression from the time when the primitive reaping hook of bronze was used, or still earlier, when food seeds were gathered without any artificial assistance, is of a piece with the progress and improvement made in other branches of mechanical art, and if the growth of civilization is to be measured by material advancement, as true a gauge as any can be found in this industry. The first step forward was the adoption of the scythe; the next of the grain cradle, to assist in gathering the cut grain into windrows or swaths coincident with the mowing. From these two simple implements, or it might more correctly be said from the scythe and hand rake, have developed the numerous machines which are now found in practical operation on the farms of the United States and other countries in mowing, reaping, and harvesting the crops.

While the invention of a machine for cutting, reaping, or harvesting grain or hay more expeditiously than was possible by primitive processes had engaged the attention of many in the Eighteenth century in Great Britain and Europe, only the more prominent phases of the development of machines for such purposes in the United States will be discussed in this report. The first improvement which naturally suggested itself was in the cutting apparatus. One of the two main principles of motion of the cutting blade, the circular motion, which may be either continuous and advancing, or continuous with alternate motion, and the rectilinear motion, which may be either advancing only, or reciprocating and advancing, or sidelong and advancing, is or has been applied with modifications in nearly all reapers and mowers used up to the present time—the first as embodied in the lawn mower, and the second in the mower generally used in the hay field. These two principles are applied to one or more knives. The connection of the cutting apparatus of the ordinary mowing machine with the main structure or frame of the machine is either a rigid or hinged connection of the finger-bar, through which the cutter vibrates. The methods of driving the cutting bar which have been or are in use are of simple gearing with the traction wheel, friction gearing, planetary gearing, gyrating gearing, screw gearing, changeable-speed gearing, cams, belts, compressed-air piston, or chain gearing.

The first patent in the United States covering a machine for mowing by horsepower was granted in 1812. This was succeeded by other patents covering improvements in the cutting apparatus or on the machine itself, among which may be mentioned the following: Reciprocating serrater cutter, 1831; slotted guard finger and mower, 1833; two cutters reciprocating in opposite directions, 1850; endless chain cutter, 1855; rotary cutters and vibrating cutters, 1856; spokeless wheel mower and front cut one-wheel mower, 1857; spiral cutters, 1857; front cut two-wheel mower, and rear cut one-wheel mower, 1858; front center cut mower, 1863; steam mower, 1868; differential gear gyrating motion cutter, 1870; front cut two-wheel mower, 1880 and 1884.

The invention of Obed Hussey, patented in 1833, of an improved mower and cutting apparatus, more particularly the latter, was the model from which nearly all subsequent designers of mowers and reapers copied, and upon which they made their various improvements and modifications. The principal feature of this invention, the cutting apparatus, was described as follows:

> The cutting blades are of lancet-point shape, and sharp on both sides; these are fixed side by side on an iron rod, in the position of saw teeth, and receive a vibrating motion from a crank to which the iron rod is attached; these blades project forward from the front edge of the platform toward the grain, and play through a corresponding row of permanent iron guards or fingers, which also project forward from the front of the platform. As the machine progresses forward the grain or grass comes in between the stationary guards or fingers and is cut off by the vibrating blades. * * * The great point in this invention is the double finger, in combination with the vibrating blades, each finger being formed of an upper and lower half, with sufficient space between for the passage of the blades through them. The straw or grass to be cut is supported both above and below the edges of the blades, and is cut off as the blades pass through the fingers by the revolution of the crank.[1]

With some improvements, such as those which consisted in cutting away the rearmost portion of the upper part of the guard fingers to permit the shreds of grass to escape, in beveling the cutting sections beneath, and in serrating the cutting blades for reaping machines, this cutting apparatus has been applied to nearly all mowers

[1] American Agricultural Implements, Part I, pages 80 and 81 by R. L. Ardrey, 1894.

and reapers subsequently manufactured. The latest and most improved type of mower is distinguished by the following features, among others: It may be drawn by one or two horses, and is a two-wheeled machine. The structure, seat, and wearing parts are entirely of iron and steel. There is a chain or gear drive with pawls; a hinged cutter-bar, which is placed in front of the machine and can be folded for transport, with a divider attached; a lever to raise or lower the cutter-bar; and a lever for shifting the gear by which the scythe may be stopped or started. The various parts of the machine are to a considerable extent interchangeable.

Aside from the mowing and cutting apparatus, just discussed, the large number of machines or devices that have been invented for the purpose of lessening the labor of reaping and harvesting grain and other crops, forbids extended reference to each kind. The end sought to be attained has been to combine in one machine all the operations of the field, so that they shall be performed mechanically and as expeditiously as inventive genius can render possible. The development seems to have been somewhat as follows: To cut the hay or grain with machines; to cut and rake or gavel; to cut and bind; to cut and thrash. One of the first reaping machines of which history furnishes record was a stripping header used by the Gauls in the First century.

The principal steps in the progress in the United States, omitting mention of mowers and cutting apparatus previously discussed, is marked by the records of the Patent Office, as follows:[1]

Reapers.—Harvester, hand-raker, 1855; harvester, self-raker, 1856; harvester dropper, 1861; adjustable switch reel rakes, 1865, 1875, 1879, and 1884.

Harvester Binders.—Cord knotter, 1853; wire twister, 1856; straw braid twister, 1857; gleaner and binder, 1862; self-tripping cord knotter, 1867; wire twister, 1868; automatic trip, 1870; straw looper, 1870; vibrating binder, 1875; low-down binder, 1878; compressor automatic trip, 1879; low-down oblique delivery, 1884.

Bean and Clover Harvesters.—Clover harvester, 1849; clover stripping drum harvester, 1854; clover head cutter and breaker, 1856; bean stalk cutter and bundler, 1859; clover spiral drum harvester, 1861; bean underground cutter, 1865; clover head stripper, 1877; bean stalk puller, 1879.

Corn Harvesters.—Cutter, 1844; ear stripper, 1850; ear stripper, husker, and sheller, 1850; cutter and shocker, 1852, 1854, and 1856; high and low cutter, 1859; cutter and shocker, 1866; picker and husker, 1867; picker, husker, and shocker, 1869; cutter, husker, and shocker, 1875.

Cotton Harvesters.—Toothed picking disks and cylinders, 1850; hand picker, 1855; brush stripper, 1859; exhaust flexible pipe, 1859; fan blower, 1868; saw and stripper brush, 1870; electric belt, 1870; picker stem 1872; toothed cylinder, 1874; revolving picker stems, 1878; toothed cylinder, 1883; revolving picker stems, 1901.

Hemp and Flax Harvesters.—Revolving pulling drum and band, 1838; revolving pulling roller, 1852; reciprocating pulling jaw, 1863; stalk puller, 1866; side delivery, 1870 and 1871; stalk cutter, 1872.

Combined Reapers and Thrashers.—Reaper and thrasher, 1836; thrasher, separator, and sacker, 1846; head cutter and side deliverer, 1849; harvester and thrasher, 1877; steam harvester, 1879; header, thrasher, and separator, 1883.

Horse Rakes.—Flopover, 1822; spring tooth, 1839; dumping sulky, 1848; draft dumping, 1850; self-dumping, 1852; spring tooth self-dumping, 1856; draft dumping, 1856, 1859, 1866, 1876, and 1884; drag dumping, 1866 and 1870.

Hay Forks.—Spiral horse fork, 1867; harpoon horse fork, 1867; tilting horse fork, 1870; grapple horse fork, 1880; harpoon horse fork, 1881; hand fork, 1882; harpoon horse fork, 1884.

Hay Loaders.—Raker and loader, 1848 and 1850; reel raker and loader, 1858; walking reel loader, 1860; endless belt loader, 1861; side delivering raker and loader, 1864; lifting drag-rake loader, 1865; raker and loader, 1867; intermittent action loader, 1868; spiral elevator, 1870; raker and loader, 1876 and 1883.

Hay Tedders.—Tedder, 1855, 1861, and 1862; rake and tedder, 1865, 1867, and 1870; tedder, 1883.

The perfected grain harvester or harvester and binder of to-day is a machine constructed in nearly all its parts of iron and steel. It is of the utmost lightness consistent with strength and qualities of endurance, and has wide wheels and improved axle bearings to lighten the draft, adjustable cutting apparatus, grain wheel and divider to separate the standing from the cut grain, raising and lowering mechanism for adjusting the machine, a reel perfect in its operation for depositing the grain on the platform, an elevator for conducting the grain from the platform to the automatic binder, and an automatic twine binder successful in its action in binding the grain compactly in sheaves or bundles of uniform size. The automatic self-binder, invented by John F. Appleby, seems to have been the culminating improvement made in grain-harvesting machines, and is used, in one form or another, as an attachment to the harvester to bind by far the largest part of the grain harvested in this and other countries.

Climatic conditions do not permit the use of the combined reaper and thrasher east of the Rocky Mountains, but west of them it is possible, and machines of this nature are in extensive use on the large farms of the Pacific coast. It is a combination of a header and thrasher.

The development of the corn harvester has been

[1] The Growth of Industrial Art, by Hon. Benjamin Butterworth, Commissioner of Patents, 1892, pages 8 to 22.

along the lines and following the same principles as that of the grain harvester, but, in the case of the former implement, it was not until after the latter had been perfected that a machine which could be pronounced an entire success was placed upon the market. The cutting apparatus naturally differs essentially from that used in the grain harvester. By the use of this machine the corn is cut, formed into bundles and bound, and deposited in the field, either horizontally or in a vertical position.

The development of the beet-sugar industry has given an impetus during the last decade to the improvement of beet harvesting machines. The first patent for a root harvester, primarily designed for beets, was issued in 1881. This implement cut off the top and the tap root. The next patent was in 1883, and since that time, each year has shown new patents for beet harvesters, the machines first cutting off the tops and the sunburnt crown of the beet and throwing it to one side, then lifting the beet from the ground, shaking off the dirt, and conveying it by an elevator into a receptacle at the rear or a wagon at the side.

Since the invention of the Whitney cotton gin, many efforts have been made to contrive a machine that would accomplish in harvesting the cotton crop what the gin did in cleaning or separating the cotton from the seed. A large number of patents have been granted along this line, and thousands of dollars have been expended in exploiting them. At many state and interstate expositions throughout the cotton growing states for the last twenty-five years, machines designed for the purpose of harvesting cotton have been exhibited, for which complete efficiency was claimed. The practicability of such machines, however, up to this time has not been proven. Several of them have gathered cotton, but presented serious objections in some respects. The difficulty appears to be in the fact that the cotton plant does not mature uniformly, as well as in the inability of the machines to gather the cotton free of trash. The cotton plant frequently shows at one time open cotton, bolls half matured, and blossoms. With such a difference in the degree of maturity, cotton harvesters have thus far failed to gather the open cotton and at the same time leave uninjured that which is not open or unripe. Consequently, the primitive method of harvesting has been up to this time the most general. A patent has recently been granted on a cotton harvester, however, which, it is claimed, will satisfactorily solve the difficulties which former inventions of this character have presented. So confident is the inventor of success, that it is reported he has entered into a contract, carrying a considerable forfeiture, to gather the cotton from a large acreage in the state of Mississippi during next season. The machine is of the revolving picker stem or spindle type.

Haying tools and machinery have participated in the improvement noted in the efficiency of other agricultural implements. The use of the mowing machine was followed by a demand for a more expeditious means of raking. The precursor of the modern horse rake was the wheeled hand-rake. This was followed by the spring-tooth hayrake, the dumping sulky, the draft dumping, the self-dumping, the spring-tooth dumping, etc. These implements as made at present by the several manufacturers are substantially similar in general principles and construction. The hand-dumping and self-dumping rakes are the two classes in most general use. These machines are constructed almost entirely of steel, the dumping mechanism of the former being operated by a lever and of the latter by a foot trip, throwing into connection a ratchet in the wheel to raise the teeth and leave the hay in the windrow.

The most recent improvement effected is the side-delivery rake, which is usually used in connection with a hay loader, as it leaves at the side a continuous, straight windrow.

Where weather conditions make it necessary that hay should be turned for the purpose of curing, while lying in the field, the hay tedder, embodying much the same principles of action and structural material as the horse hayrake, is used.

The hayfork and carrier for use in the field or barn, a great improvement over the common hand hayfork, as regards efficiency, is not the least of the labor-saving implements in use.

As previously noted, the principal inventions in this line have been the spiral horse fork, the single or double harpoon fork, the tilting horse fork, and the grapple horse fork. To facilitate the removal of the hay to a distance from the wagon, various styles of hay carriers in combination with the horse hayfork have been invented.

Intermittent efforts were made for many years to invent an efficient hay loader, until success was finally achieved. There are several practicable styles in use, all of which are drawn after the wagon and have two traction wheels which operate the rake or cylinder and elevator.

The use of hay and straw baling presses on farms is a comparatively recent development. While machines for this purpose have been employed to some extent for more than half a century, it was not until a later period—about fifteen or twenty years ago—that they became available for the use of farmers generally. The hay crop in earlier times was of no other value than to supply the needs of the farmer or of the contiguous community, as it could not be prepared for long-distance shipment. There were in some localities local presses, which created a market for the surplus hay of a considerable area surrounding them, but the introduction of the mounted hay-baling machine has given a definite value to the hay crop and the straw of the small

grains which they had not previously possessed. While the custom of baling hay and straw is far from being universal on the part of the farmers, it so far obtains that it might be said that a new industry has been created, and the baling press traveling from one farm to another is nearly as common a sight in some localities as the portable thrashing machine or power cornsheller.

A crude form of press was manufactured and placed upon the market in 1853, which proved awkward in operation and lacking in efficiency. Succeeding this, in 1872, a form of continuous press was invented, which has since come into quite general use. The demand for greater baling capacity than was possible with horse-power led to the application of steam power to these machines. A later improvement is a self-tying device. An improved two-horse baling press has a capacity of from 10 to 15 tons a day.

Thrashers and Separators.—The economy of using a modern steam-power thrashing machine, as compared with the simple flail, is probably greater than that of any other mechanical aid in agricultural work. The operation of separating the grain, which was formerly, and is at present on many small farms, the intermittent work of an entire winter with the flail, can be accomplished by the steam-power thrasher in a few days.

The first noteworthy thrashing or separating machine invented in the United States, which was practicable, was that of Hiram A. and John A. Pitts, of Winthrop, Me., and may be said to be the prototype of the machines in use at the present time. A patent granted to H. A. Pitts in 1830 was for an improvement on a railway or tread power, which consisted in the substitution under the movable platform, connected by an endless chain, of rollers for the leather belt. Later the idea was conceived of combining this improvement, applied to the old-fashioned thrasher, with the common fanning mill in a portable form. This operated successfully.[1] By successive development this machine was gradually improved, resulting in the effective labor-saving thrasher and separator now in use on the farms of the United States. The modern steam-power thrasher and separator is used for separating all small grains, its motive power being a traction or portable engine of from 6 to 25 horsepower. The bundles are fed to the machine, which cuts the bands, thrashes, winnows, and sieves the grain, and stacks the straw. A valuable improvement to the engine has been the adaptation of the fire box to the use of straw as fuel, thus materially reducing the fuel expense.

Hand and power cornshellers are made of varying capacity, and the improvement made in their efficiency is almost beyond measure. It has been stated that by the old hand process of shelling corn it would require the services of the entire population of the United States for one hundred days to shell the annual corn crop of the United States. Cornshellers are made to be operated by either steam power or hand, and it is claimed that certain types have a capacity of as much as 700 bushels per hour. Almost equal progress has been accomplished in clover hullers, bean separators, etc.

It seems safe to predict, in view of the development of the automobile, that within the next decade this feature of modern invention will have found an additional application as a motive force in connection with agricultural implements of tillage, planting, and harvesting. An automobile lawn mower is already meeting with considerable favor where the conditions warrant its use.

[1] American Agricultural Implements, Part I, page 105, by R. L. Ardrey, 1894.

TABLE 10.—AGRICULTURAL

		United States.	California.	Connecticut.	Georgia.	Illinois.
1	Number of establishments	715	20	5	10	94
	Character of organization:					
2	Individual	251	11	1	6	24
3	Firm and limited partnership	169	2		1	14
4	Incorporated company	295	7	4	3	56
	Capital:					
5	Total	$157,707,951	$1,852,157	$348,221	$454,988	$62,202,330
6	Land	$6,826,802	$233,832	$37,000	$101,980	$2,420,418
7	Buildings	$14,717,637	$185,669	$106,850	$38,750	$5,063,463
8	Machinery, tools, and implements	$12,184,083	$280,360	$42,275	$70,552	$3,181,227
9	Cash and sundries	$123,979,429	$1,152,296	$162,096	$243,706	$51,537,222
10	Proprietors and firm members	626	12	1	10	56
	Salaried officials, clerks, etc.:					
11	Total number	10,040	81	19	23	4,444
12	Total salaries	$8,363,210	$74,900	$13,330	$30,884	$3,419,742
	Officers of corporations—					
13	Number	590	7	2	6	130
14	Salaries	$1,317,184	$14,500	$1,100	$16,600	$319,219
	General superintendents, managers, clerks, etc.—					
15	Total number	9,456	74	17	17	4,314
16	Total salaries	$7,046,026	$60,400	$12,230	$14,284	$3,100,523
	Men—					
17	Number	8,839	70	17	17	4,057
18	Salaries	$6,786,638	$58,993	$12,230	$14,284	$2,984,389
	Women—					
19	Number	617	4			257
20	Salaries	$259,388	$1,407			$116,134
	Wage-earners, including pieceworkers, and total wages:					
21	Greatest number employed at any one time during the year	60,388	854	188	565	22,394
22	Least number employed at any one time during the year	31,524	303	141	201	13,434
23	Average number	46,582	562	154	360	18,231
24	Total wages	$22,450,880	$322,272	$62,111	$99,951	$9,064,954
	Men, 16 years and over—					
25	Average number	46,174	562	154	354	18,030
26	Wages	$22,358,158	$322,272	$62,111	$99,423	$9,021,597
	Women, 16 years and over—					
27	Average number	214				93
28	Wages	$66,042				$30,407
	Children, under 16 years—					
29	Average number	194			6	108
30	Wages	$26,680			$528	$12,950
	Average number of wage-earners, including pieceworkers, employed during each month:[1]					
	Men, 16 years and over—					
31	January	49,694	489	182	489	18,523
32	February	51,850	520	182	480	19,653
33	March	53,250	621	179	423	20,467
34	April	51,612	678	179	284	19,634
35	May	48,765	696	178	230	18,760
36	June	45,419	718	167	218	17,131
37	July	41,440	592	34	213	16,043
38	August	40,001	429	114	245	16,164
39	September	38,351	503	145	309	15,506
40	October	40,398	520	151	385	16,775
41	November	44,745	503	159	454	18,337
42	December	48,563	475	172	515	19,363
	Miscellaneous expenses:					
43	Total	$11,394,656	$106,011	$9,961	$33,864	$5,946,224
44	Rent of works	$62,404	$335	$460	$780	$9,672
45	Taxes, not including internal revenue	$535,275	$8,204	$2,519	$3,309	$158,179
46	Rent of offices, interest, insurance, and all sundry expenses not hitherto included.	$10,658,831	$96,672	$6,982	$29,775	$5,176,360
47	Contract work	$138,146	$300			$2,013
	Materials used:					
48	Total cost	$43,944,628	$538,568	$76,132	$437,799	$18,859,617
	Principal materials—					
49	Purchased in raw state	$47,377				$15,377
50	Purchased in partially manufactured form	$36,075,970	$403,671	$52,920	$387,979	$15,951,148
51	Fuel	$1,312,912	$21,875	$8,492	$6,313	$592,309
52	Rent of power and heat	$30,259	$120		$1,860	$19,652
53	Mill supplies	$485,864	$6,683	$3,231	$1,170	$166,169
54	All other materials	$4,109,995	$52,233	$7,458	$29,239	$1,464,447
55	Freight	$1,882,251	$53,986	$4,031	$11,238	$650,415
	Products:					
56	Total value, including custom work and repairing	$101,207,428	$1,357,849	$194,746	$737,652	$42,033,796
57	Products	$98,010,506	$1,066,624	$192,706	$731,152	$41,359,006
58	Custom work and repairing	$3,196,922	$291,225	$2,040	$6,500	$674,790
	Kinds and quantities of products:					
	Implements of cultivation—					
	Cultivators—					
59	Bean, number	189	10			
60	Beet, number	2,008	10			1,354
61	Small, number	206,982	205		950	20,637
62	Wheeled, number	295,799	24	11		170,069
	Scrapers—					
63	Cotton, number	15,230			565	
64	Celery hillers, number	130				
65	Cotton sweeps, number	75,311			63,000	5,250
66	Equalizers, number	74,168				58,688
	Harrows—					
67	Disk, number	97,261	204	1,753		35,372
68	Other than disk, number	380,259	885	16	509	159,008
69	Hoes, dozens	277,173		27,350		
70	Markers and furrowers, number	854				
	Plows—					
71	Disk, number	17,345	24	665	500	8,178
72	Shovel, number	102,320			1,545	13,531
73	Steam, number	207	5			
74	Sulky or wheel, number	136,105	1,072			89,162
75	Walking, number	819,022	5,489	75	65,914	172,184
76	Potato coverers and hillers, number	3,052				100
77	Rollers, number	12,590	13			690
78	Stalk cutters, number	13,425				7,983
79	Miscellaneous, number	2,704,623	5			10,580

[1] The average number of women, 16 years and over, and children, under 16 years, employed during each month, are not included in the table, because of the small number reported.

IMPLEMENTS, BY STATES: 1900.

Indiana.	Iowa.	Kansas.	Kentucky.	Maine.	Massachusetts.	Michigan.	Minnesota.	Mississippi.	Missouri.	
45	24	4	9	17	9	59	18	3	26	1
11	3	1	2	6	3	25	6	2	11	2
3	6	3	3	4	3	14	2	1	7	3
31	15	.....	4	7	3	20	10	.....	8	4
$8,324,564	$1,878,090	$19,750	$1,735,595	$584,247	$706,472	$8,932,344	$3,730,055	$53,875	$1,412,165	5
$596,712	$71,940	$400	$169,400	$56,500	$16,700	$271,764	$111,066	$6,025	$129,735	6
$1,060,832	$214,367	$1,500	$189,887	$114,916	$37,300	$627,208	$319,719	$4,300	$176,565	7
$803,077	$195,067	$3,850	$240,550	$111,827	$122,733	$604,075	$110,569	$16,500	$283,845	8
$5,863,943	$1,396,716	$14,000	$1,135,758	$301,004	$529,739	$7,429,297	$3,188,701	$26,550	$822,020	9
20	16	10	6	15	9	60	10	5	25	10
518	154	6	95	27	35	620	182	2	81	11
$489,649	$123,472	$1,075	$124,720	$17,195	$45,358	$548,768	$189,832	$1,350	$101,977	12
55	24	.....	12	7	2	44	20	.....	21	13
$98,700	$34,934	.....	$34,100	$4,300	$12,000	$84,318	$45,745	.....	$41,963	14
463	130	6	83	20	33	576	162	2	60	15
$390,949	$88,538	$1,075	$90,620	$12,895	$33,358	$464,445	$144,087	$1,350	$60,014	16
429	116	6	82	17	33	532	152	2	59	17
$379,444	$84,622	$1,075	$90,360	$11 975	$33,358	$447,060	$139,687	$1,350	$59,294	18
34	14	.....	1	3	.....	44	10	.....	1	19
$11,505	$3,916	.....	$260	$920	.....	$17,385	$4,400	.....	$720	20
4,258	992	30	975	294	378	2,531	1,193	37	741	21
2,661	394	20	376	131	266	1,160	567	19	358	22
3,419	644	11	680	218	312	1,944	928	19	493	23
$1,593,881	$243,489	$2,460	$300,106	$100,033	$159,700	$952,636	$423,054	$4,000	$242,307	24
3,388	641	11	679	215	311	1,939	924	19	492	25
$1,585,611	$242,568	$2,460	$299,846	$99,277	$159,520	$951,213	$421,637	$4,000	$242,207	26
29	1	.....	.....	2	.....	4	3	.....	.....	27
$7,993	$421	.....	.....	$600	.....	$1,278	$1,300	.....	.....	28
2	2	.....	1	1	1	1	1	.....	1	29
$277	$500	.....	$260	$156	$180	$150	$117	.....	$100	30
3,539	594	11	922	227	307	2,144	1,076	30	470	31
3,652	617	11	874	232	309	2,144	1,070	30	596	32
3,693	776	13	784	252	320	2,133	1,070	30	473	33
3,722	805	25	611	265	326	2,149	1,037	30	500	34
3,660	776	30	500	252	336	1,922	839	21	532	35
3,476	680	21	408	218	331	1,707	866	15	569	36
3,347	587	1	407	181	326	2,027	911	3	507	37
3,336	606	1	506	151	247	1,973	874	3	443	38
3,246	587	1	621	165	268	1,661	839	5	444	39
2,752	549	1	724	215	304	1,525	735	12	462	40
2,939	559	1	856	209	320	1,862	818	14	454	41
3,294	551	5	929	208	341	1,977	958	32	459	42
$596,463	$96,540	$856	$148,009	$28,430	$44,577	$1,329,530	$241,388	$625	$65,325	43
$2,380	$1,807	$138	$914	$402	$11,277	$2,503	$1,504	.....	$3,591	44
$63,517	$7,085	.....	$12,072	$2,699	$7,791	$32,129	$7,792	$150	$4,712	45
$528,426	$87,545	$358	$135,023	$25,329	$25,509	$1,268,627	$229,602	$475	$56,092	46
$2,140	$103	$360	.....	.....	.....	$36,271	$2,490	.....	$930	47
$2,619,621	$669,989	$10,819	$466,193	$98,197	$216,313	$2,482,235	$718,604	$15,365	$406,977	48
$3,964	$178	.....	.....	$67	$566	$610	$348	.....	.....	49
$2,037,126	$575,165	$9,760	$355,468	$57,434	$186,458	$2,237,456	$616,615	$12,295	$328,845	50
$90,467	$18,444	$229	$10,117	$12,089	$7,142	$51,673	$22,805	$410	$14,445	51
$449	$1,533	.....	$200	$1,167	$40	$850	$526	.....	.....	52
$17,662	$4,752	$100	$3,595	$8,602	$1,895	$14,734	$6,544	$150	$4,200	53
$326,269	$46,409	$55	$71,630	$10,887	$20,200	$137,980	$39,829	$1,910	$25,125	54
$143,684	$23,508	$675	$25,193	$7,951	$12	$38,932	$31,937	$600	$34,362	55
$6,415,081	$1,508,667	$18,275	$1,320,714	$290,261	$534,789	$6,339,508	$1,763,780	$36,350	$953,965	56
$6,195,750	$1,488,232	$18,200	$1,319,609	$279,387	$502,565	$6,051,656	$1,727,085	$36,325	$943,018	57
$219,331	$20,435	$75	$1,105	$10,874	$32,224	$287,852	$36,695	$25	$10,947	58
.....	.....	.....	24	.....	.....	50	.....	.....	.....	59
.....	300	.....	.....	.....	.....	300	.....	.....	.....	60
9,127	.....	.....	5,000	561	400	9,902	1,024	1,750	6,826	61
6,702	7,500	.....	4,102	.....	630	18,727	.....	.....	5,175	62
115	.....	.....	10,000	.....	.....	.....	.....	.....	50	63
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	64
.....	.....	.....	5,056	.....	.....	.....	.....	.....	1,405	65
3,600	5,000	.....	1,000	.....	.....	200	5,660	.....	.....	66
.....	140	.....	76	364	325	.....	.....	.....	.....	67
2,650	7,420	.....	4,000	112	1,015	15,486	11,883	6,000	453	68
1,500	34,560	.....	.....	251	9,104	34,039	.....	.....	.....	69
.....	.....	.....	.....	.....	80	.....	.....	.....	.....	70
180	.....	.....	1,000	.....	.....	.....	.....	.....	212	71
6,306	150	.....	18,106	500	200	160	.....	3,000	691	72
.....	.....	.....	200	.....	.....	.....	.....	.....	.....	73
11,681	2,655	.....	3,000	100	140	1,500	.....	.....	383	74
181,187	10,833	.....	102,696	1,397	17,510	20,481	3,870	.....	3,584	75
.....	.....	.....	1,000	312	150	.....	.....	.....	.....	76
.....	8	.....	4	124	300	1,634	.....	.....	4	77
125	.....	.....	1,000	116	237	1,347	.....	.....	624	78
108,300	854	86	.....	.....	.....	.....	.....	12,000	.....	79

TABLE 10.—AGRICULTURAL

		Nebraska.	New Hampshire.	New Jersey.	New York.	North Carolina.
1	Number of establishments	9	12	11	87	9
	Character of organization:					
2	Individual	1	9	8	33	4
3	Firm and limited partnership	4	3	2	23	4
4	Incorporated company	4		1	31	1
	Capital:					
5	Total	$184,081	$112,003	$249,957	$20,115,962	$77,537
6	Land	$4,100	$6,870	$24,400	$634,917	$3,330
7	Buildings	$10,950	$16,600	$55,891	$2,262,183	$12,600
8	Machinery, tools, and implements	$79,163	$27,000	$44,935	$1,618,470	$24,600
9	Cash and sundries	$89,868	$61,533	$124,731	$15,600,392	$37,007
10	Proprietors and firm members	9	15	13	80	14
	Salaried officials, clerks, etc.:					
11	Total number	11	4	8	659	7
12	Total salaries	$6,705	$2,300	$11,289	$675,999	$3,970
	Officers of corporations—					
13	Number	4		3	54	1
14	Salaries	$2,700		$6,900	$152,623	$1,500
	General superintendents, managers, clerks, and etc.—					
15	Total number	7	4	5	605	6
16	Total salaries	$4,005	$2,300	$4,389	$523,376	$2,470
	Men—					
17	Number	6	4	5	516	6
18	Salaries	$3,755	$2,300	$4,389	$489,809	$2,470
	Women—					
19	Number	1			89	
20	Salaries	$250			$33 567	
	Wage-earners, including pieceworkers, and total wages:					
21	Greatest number employed at any one time during the year	170	74	213	7,602	127
22	Least number employed at any one time during the year	61	32	80	2,921	82
23	Average number	87	45	147	5,551	91
24	Total wages	$41,128	$16,626	$60,083	$2,797,269	$20,169
	Men, 16 years and over—					
25	Average number	83	44	145	5,522	86
26	Wages	$40,728	$16,326	$59,408	$2,790,620	$19,719
	Women, 16 years and over—					
27	Average number		1	2	24	
28	Wages		$300	$675	$6,022	
	Children, under 16 years—					
29	Average number	4			5	5
30	Wages	$400			$627	$450
	Average number of wage-earners, including pieceworkers, employed during each month:					
	Men, 16 years and over—					
31	January	107	50	170	6,197	93
32	February	125	53	186	6,450	93
33	March	131	59	200	6,756	98
34	April	126	70	205	6,830	92
35	May	82	68	179	6,701	90
36	June	43	62	135	6,198	83
37	July	85	6	86	4,899	82
38	August	85	7	88	3,929	78
39	September	75	23	93	3,362	79
40	October	43	38	102	4,083	80
41	November	47	43	146	5,093	78
42	December	51	45	156	5,767	85
	Miscellaneous expenses:					
43	Total	$4,646	$3,485	$23,827	$833,948	$1,971
44	Rent of works	$817	$300	$60	$6,919	$35
45	Taxes, not including internal revenue	$374	$359	$1,018	$59,652	$427
46	Rent of offices, interest, insurance, and all sundry expenses not hitherto included.	$3,455	$2,776	$22,449	$760,590	$1,024
47	Contract work		$50	$300	$6,787	$485
	Materials used:					
48	Total cost	$32,856	$22,364	$115,697	$4,824,871	$41,047
	Principal materials—					
49	Purchased in raw state		$1,849		$3,921	
50	Purchased in partially manufactured form	$74,598	$14,316	$68,036	$3,836,042	$32,700
51	Fuel	$2,407	$1,730	$2,958	$165,173	$3,070
52	Rent of power and heat		$60	$10	$193	
53	Mill supplies	$716	$502	$1,295	$72,248	$485
54	All other materials	$620	$2,925	$37,619	$565,653	$2,460
55	Freight	$4,515	$982	$5,779	$181,641	$2,332
	Products:					
56	Total value, including custom work and repairing	$176,446	$79,891	$249,963	$10,537,254	$99,128
57	Products	$173,946	$79,116	$243,013	$10,071,310	$97,766
58	Custom work and repairing	$2,500	$775	$6,950	$465,944	$1,362
	Kinds and quantities of products:					
	Implements of cultivation—					
	Cultivators—					
59	Bean, number				45	
60	Beet, number				44	
61	Small, number		3	11,144	25,686	1,600
62	Wheeled, number	1,139	100	2,484	5,136	
	Scrapers—					
63	Cotton, number					
64	Celery hillers, number					
65	Cotton sweeps, number					400
66	Equalizers, number					
	Harrows—					
67	Disk, number		150		20,661	900
68	Other than disk, number	150	100	7,865	69,756	1,000
69	Hoes, dozens		13	254	61,467	
70	Markers and furrowers, number			170	312	
	Plows—					
71	Disk, number				20	
72	Shovel, number				5,103	
73	Steam, number					
74	Sulky or wheel, number			15	2,879	
75	Walking, number		252	490	68,066	2,050
76	Potato coverers and hillers, number				1,178	
77	Rollers, number			11	1,565	
78	Stalk cutters, number					25
79	Miscellaneous, number		6,000			2,538,500

IMPLEMENTS, BY STATES, 1900—Continued.

Ohio.	Pennsylvania.	South Carolina.	South Dakota.	Tennessee.	Texas.	Vermont.	Virginia.	Wisconsin.	All other states.[1]	
78	50	5	3	11	5	17	13	51	11	1
15	26	2	2	5	2	6	6	19	1	2
21	15	2	1	2	1	8	5	9	6	3
42	9	1	.....	4	2	3	2	23	4	4
$23,628,442	$4,102,327	$14,575	$24,385	$417,689	$57,635	$484,277	$472,863	$15,291,554	$239,811	5
$1,031,012	$184,407	$450	$2,100	$27,465	$1,225	$20,500	$49,231	$600,163	$13,160	6
$2,199,087	$554,284	$1,750	$2,000	$60,850	$10,650	$64,700	$68,945	$1,222,771	$32,000	7
$1,898,782	$440,382	$2,975	$8,500	$65,538	$12,353	$67,776	$86,320	$1,716,253	$24,529	8
$18,499,611	$2,923,254	$9,400	$11,785	$263,836	$33,407	$331,301	$268,367	$11,752,367	$169,522	9
58	64	7	4	11	4	19	20	42	11	10
1,588	197	.....	.....	38	5	24	29	1,180	9	11
$1,368,775	$183,549	.....	.....	$35,065	$7,950	$18,267	$21,738	$836,316	$9,040	12
109	13	.....	.....	8	4	1	2	59	2	13
$283,027	$14,270	.....	.....	$16,500	$7,700	$2,000	$2,720	$116,165	$3,600	14
1,479	184	.....	.....	30	1	23	27	1,121	7	15
$1,085,748	$169,279	.....	.....	$18,565	$250	$16,267	$19,018	$720,151	$5,440	16
1,401	167	.....	.....	25	1	23	25	1,065	6	17
$1,051,095	$164,040	.....	.....	$17,164	$250	$16,267	$17,852	$694,076	$5,050	18
78	17	.....	.....	5	.....	.....	2	56	1	19
$34,653	$5,239	.....	.....	$1,401	.....	.....	$1,166	$26,075	$390	20
9,021	1,932	22	15	524	42	262	477	4,296	121	21
4,072	1,415	12	9	246	21	207	197	2,079	59	22
6,852	1,564	10	11	373	28	211	278	3,289	70	23
$3,271,163	$688,044	$2,606	$4,929	$113,425	$10,419	$85,846	$107,980	$1,625,765	$34,474	24
6,795	1,557	10	11	354	28	204	272	3,276	68	25
$3,254,063	$686,790	$2,606	$4,929	$110,834	$10,419	$84,124	$107,080	$1,622,606	$34,164	26
44	1	.....	.....	3	.....	7	.....	.....	.....	27
$14,588	$261	.....	.....	$480	.....	$1,722	.....	.....	.....	28
13	6	.....	.....	16	.....	.....	6	13	2	29
$2,512	$993	.....	.....	$2,111	.....	.....	$900	$3,159	$310	30
7,612	1,718	16	10	432	40	202	256	3,733	55	31
7,922	1,726	16	12	438	40	211	273	3,879	56	32
8,187	1,716	11	12	425	31	219	271	3,781	69	33
7,946	1,719	12	13	313	22	236	278	3,426	79	34
7,158	1,633	12	14	279	22	234	272	3,215	74	35
6,674	1,590	10	10	184	21	234	268	3,303	79	36
5,649	1,441	10	10	233	22	193	266	3,192	87	37
5,494	1,438	10	10	329	22	155	269	2,907	88	38
5,334	1,447	8	10	354	22	169	265	2,733	77	39
5,968	1,395	8	10	397	22	196	277	2,612	57	40
6,356	1,404	3	9	424	30	204	268	3,107	48	41
7,246	1,457	10	8	444	40	201	296	3,430	48	42
$1,483,605	$196,719	$931	$1,141	$12,170	$23,928	$15,909	$26,183	$699,365	$18,525	43
$2,423	$3,173	$300	$120	$245	$120	$169	$3,500	$7,410	$550	44
$106,929	$11,948	$31	$221	$1,669	$418	$2,303	$2,672	$35,911	$1,185	45
$1,846,122	$153,028	$600	$800	$10,196	$3,190	$13,437	$20,011	$647,588	$16,790	46
$28,131	$28,570	.....	.....	$60	$20,200	.....	.....	$8,956	.....	47
$6,059,515	$1,282,242	$5,394	$6,222	$201,712	$66,572	$163,515	$128,434	$3,290,690	$87,168	48
$6,480	$12,767	.....	.....	.....	.....	$240	$510	$500	.....	49
$4,994,124	$948,507	$4,759	$3,601	$123,905	$61,937	$117,542	$102,015	$2,401,560	$79,998	50
$132,978	$36,896	$171	$515	$8,478	$1,555	$9,345	$7,843	$81,081	$1,902	51
$946	$40	.....	.....	$100	.....	$110	$325	$628	$1,450	52
$121,233	$15,245	$60	$106	$11,160	$315	$2,256	$1,302	$18,945	$509	53
$392,913	$153,461	$224	$1,400	$47,888	$1,745	$27,480	$14,378	$625,000	$2,558	54
$410,841	$65,326	$180	$600	$10,181	$1,020	$6,542	$2,061	$162,976	$751	55
$13,975,268	$3,198,471	$14,090	$19,580	$463,406	$117,370	$369,587	$343,291	$7,886,363	$171,987	56
$13,053,868	$3,136,576	$13,990	$9,580	$461,786	$117,270	$355,094	$333,791	$7,794,137	$157,948	57
$921,400	$61,895	$100	$10,000	$1,620	$100	$14,443	$9,500	$92,226	$13,989	58
.....	60	.....	.....	.....	.....	.....	.....	.....	.....	59
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	60
59,029	36,854	.....	.....	4,000	125	40	6,000	6,119	.....	61
42,957	3,144	130	.....	.....	.....	.....	.....	27,769	.....	62
.....	.....	.....	.....	4,500	.....	.....	.....	.....	.....	63
.....	130	.....	.....	.....	.....	.....	.....	.....	.....	64
200	.....	.....	.....	.....	.....	.....	.....	.....	.....	65
.....	.....	.....	25	.....	.....	.....	.....	.....	.....	66
27,551	1,375	.....	.....	.....	.....	.....	1,700	6,690	.....	67
50,088	4,653	.....	75	300	1	.....	2,350	34,324	215	68
58,283	8,400	.....	.....	35,000	.....	6,952	.....	.....	.....	69
.....	292	.....	.....	.....	.....	.....	.....	.....	.....	70
2,081	.....	.....	.....	1,090	3,400	.....	.....	.....	.....	71
43,311	549	.....	.....	4,993	.....	.....	3,550	625	.....	72
.....	2	.....	.....	.....	.....	.....	.....	.....	.....	73
25	.....	.....	.....	.....	.....	.....	.....	23,243	250	74
60,472	13,727	.....	400	24,873	50	1,660	32,110	29,242	460	75
.....	12	.....	.....	.....	.....	.....	.....	300	.....	76
3,978	3,749	.....	.....	.....	.....	.....	500	10	.....	77
1,376	100	.....	.....	.....	.....	.....	.....	492	.....	78
32,623	.....	100	.....	.....	25	.....	.....	.....	50	79

[1] Includes establishments distributed as follows: Alabama, 1; Colorado, 1; Delaware, 1; Maryland, 2; North Dakota, 1; Utah, 2; Washington, 2; West Virginia, 1.

TABLE 10.—AGRICULTURAL

		United States.	California.	Connecticut.	Georgia.	Illinois.
	Kinds and quantities of products—Continued.					
	Seeders and planters—					
	Planters—					
80	Bean, number	200				
	Corn—					
81	Hand, number	129,515				7,958
82	Horse, number	78,135				51,300
83	Cotton, number	45,575			19,674	12,737
84	Potato, number	25,338				40
	Drills—					
85	Beet, number	5,302				352
86	Corn, number	21,940				7,195
87	Grain, number	91,635	225	157	84	11,879
88	Grain sowers, number	36,862	224			10,817
89	Lime spreaders, number	474				
90	Manure spreaders, number	5,268			3,000	
91	Listers, number	26,995				19,759
92	Seed sowers, number	33,283	763			3,297
93	Tobacco transplanters, number	3,788				
94	Miscellaneous, number	330				200
	Harvesting implements—					
95	Grain cradles, number	36,163				
	Harvesters—					
96	Bean, number	1,425				
97	Corn, number	20,707				18,098
98	Grain, number	187	180			
99	Other, number	6,283				4,217
100	Harvesters and binders combined, number	233,355				160,467
101	Hay carriers, number	54,303				20,700
	Hayforks—					
102	Hand, dozens	152,840				
103	Horse, number	51,770	2,274			6,000
104	Hay loaders, number	7,273				4,517
	Hayrakes—					
105	Hand, dozens	58,013		2,753		
106	Horse, number	216,345	226			109,670
107	Hay stackers, number	12,069	50			8,004
108	Hay tedders, number	14,510				258
109	Mowers, number	397,561				245,204
110	Mowers and reapers combined, number	1,055				
111	Potato diggers, number	21,033				1,832
112	Potato hooks, number	20,860				100
113	Reapers, number	35,945				16,387
114	Scythes, number	718,453		105,312		
115	Scythe snaths, number	537,214				
116	Sickles, number	446,660				396,239
117	Stackers, number	247				
118	Miscellaneous, number	41,067				4,489
	Seed separators—					
	Separators—					
119	Bean, number	40				
120	Other, number	1,707				863
121	Clover hullers, number	661				
122	Corn huskers, number	10,726				1,086
	Corn shellers—					
123	Hand, number	106,381				26,707
124	Power, number	8,185				3,620
125	Fanning mills, number	30,369	100			1,244
	Thrashers—					
126	Horsepower, number	1,314				
127	Steam power, number	3,651				
128	Thrashers and separators combined, number	5,394	80			
129	Miscellaneous, number	7,578,853	41,042	900,353		2,121,101
	Miscellaneous—					
130	Animal pokes, number	32,000				
131	Artesian-well boring tools and castings, number	80	50			30
132	Bean pullers, number	207				
133	Binders, number	15				
134	Cane mills, number	2,454				4
135	Carts, number	7,001	5			6,546
136	Check rowers, number	44,245				39,653
137	Churns, butter workers, etc., number	9,506				
138	Cider and wine mills, number	6,167		33		1,118
139	Corn cleaners, number	93				85
140	Corn hooks, number	64,789				
141	Corn knives, number	22,130		7,848		376
142	Cotton gins, number	213			200	
143	Cotton presses, number	13				
144	Ensilage cutters, number	11,738				440
145	Hay cutters, number	18,835				
146	Ditching machines, number	25				
147	Engines and boilers, number	497	10			75
148	Farm trucks, number	1,376	2			773
149	Feed and ensilage elevators, number	2,632				242
150	Feed steamers and boilers, number	2,184				114
151	Fence machines, number	201				200
152	Fruit graders, number	195	15			
153	Fruit presses, number	1,411	50			
154	Gardening implements, number	1,368,099				21,269
155	Grinding mills, number	13,234				2,843
156	Grubbing machines, number	2,097	35			
157	Handcarts, number	5,245				2,395
158	Hay presses, number	2,510	6		75	427
159	Hayracks, number	1,091	25			
160	Horsepowers, number	5,694	42			2,218
161	Incubators, number	21				1
162	Lawn mowers, number	17,019			1	10,000
163	Pea hullers, number	900			200	
164	Portable sawmills, number	999			25	40
165	Portable steam engines, number	1,090	5			2
	Pumps:					
166	Hand, number	51,580				1,206
167	Horse, number	20				
168	Steam, number	302	300			

IMPLEMENTS, BY STATES: 1900—Continued.

Indiana.	Iowa.	Kansas.	Kentucky.	Maine.	Massachusetts.	Michigan.	Minnesota.	Mississippi.	Missouri.	
										80
				20		70,800				81
3,151	2,021		1,000	651	929	2,874		50		82
400			1,500			1,000		800	1,322	83
						18,956				84
	300					25				85
6,028	700								2,165	86
20,407			4,000			6,701	3,700		50	87
15,698						2,394	1,600			88
					125					89
					25	63				90
	1,000	100				250			3,862	91
47,976				7	3,000	901	510		1,200	92
30			1,000							93
										94
2,221	3,720					7,819				95
						945				96
	681									97
										98
			47			1,000				99
										100
400	3,775									101
	10,980					33,627				102
	529								17	103
	130						15			104
				1,500	3,039					105
5,885	5,809				1,125	1,825			3,855	106
120	1,360	28							865	107
					562	100				108
	4				3,700	22				109
33	328		400		10					110
										111
										112
	2,760			424,788						113
3,874	79,296					122,616				114
147				20,568			100			115
						29,232			36	116
										117
										118
		6	315				20		38	119
117										120
40									75	121
	142		526		929	200			2,987	122
	125					49			38	123
2,200			300	82	110	4,098	15,097		39	124
						107			7	125
	50					833			13	126
1,320						245	910			127
508,577	58,003		452	18,171	6,581	70,149	33,539		8,062	128
										129
										130
						147				131
										132
			740					50		133
					250					134
574	2,218									135
					250	8,459				136
			400	729	75				310	137
	8									138
	100			24,986		29,693				139
	96			1,656						140
									18	141
									18	142
										143
100			126	2,412	1,287	1,525				144
	3				400	300			950	145
							6			146
							12			147
							100			148
				66	100	75				149
						560				150
1										151
										152
				1,039	300					153
1,200			10,000		2,000	230,082			1,800	154
	3,361				2,500				1,350	155
	271				354		155			156
	1,103			157	510					157
114						40			1,417	158
						494				159
37			10	50	10	236	25		42	160
20										161
										162
50							300			163
138			58	27	20				23	164
38										165
						152				166
										167
										168

TABLE 10.—AGRICULTURAL

		Nebraska.	New Hampshire.	New Jersey.	New York.	North Carolina.
	Kinds and quantities of products—Continued.					
	Seeders and planters—					
	Planters—					
80	Bean, number				180	
	Corn—					
81	Hand, number				6,737	
82	Horse, number				961	
83	Cotton, number					1,475
84	Potato, number			463		
	Drills—					
85	Beet, number			4,505	120	
86	Corn, number					
87	Grain, number	834			15,470	
88	Grain sowers, number					
89	Lime spreaders, number				3	
90	Manure spreaders, number				504	
91	Listers, number					
92	Seed sowers, number				1,726	
93	Tobacco transplanters, number				300	
94	Miscellaneous, number					100
	Harvesting implements—					
95	Grain cradles, number					
	Harvesters—					
96	Bean, number				480	
97	Corn, number				1,093	
98	Grain, number					
99	Other, number				1,018	
100	Harvesters and binders combined, number				22,218	
101	Hay carriers, number		4	100	500	
	Hayforks—					
102	Hand, dozens				30,500	
103	Horse, number			100	648	
104	Hay loaders, number				8	
	Hayrakes—					
105	Hand, dozens		9,050		15,000	
106	Horse, number	2,666	500		40,359	
107	Hay stackers, number	1,333				
108	Hay tedders, number				8,402	
109	Mowers, number				65,898	
110	Mowers and reapers combined, number				1,000	
111	Potato diggers, number			18	429	
112	Potato hooks, number					
113	Reapers, number				16,868	
114	Scythes, number		74,400		26,293	
115	Scythe snaths, number		2,400			
116	Sickles, number		120		5,733	
117	Stackers, number					
118	Miscellaneous, number		7,250			
	Seed separators—					
	Separators—					
119	Bean, number				40	
120	Other, number				35	5
121	Clover hullers, number					
122	Corn huskers, number	3,960			5	
	Corn shellers—					
123	Hand, number				1,131	
124	Power, number			25		
125	Fanning mills, number	150		6	382	
	Thrashers—					
126	Horse power, number			20	42	
127	Steam power, number				683	
128	Thrashers and separators combined, number			43	290	
129	Miscellaneous, number	4,166	37,475	112,100	582,707	
	Miscellaneous—					
130	Animal pokes, number					
131	Artesian well boring tools and castings, number					
132	Bean pullers, number					
133	Binders, number				11	
134	Cane mills, number					
135	Carts, number					
136	Check rowers, number					
137	Churns, butter workers, etc., number			12		
138	Cider and wine mills, number			22		
139	Corn cleaners, number					
140	Corn hooks, number					
141	Corn knives, number			4,512	6,339	
142	Cotton gins, number					
143	Cotton presses, number					
144	Ensilage cutters, number				610	
145	Hay cutters, number			50	300	
146	Ditching machines, number				11	
147	Engines and boilers, number					
148	Farm trucks, number				1	
149	Feed and ensilage elevators, number				114	
150	Feed steamers and boilers, number					
151	Fence machines, number					
152	Fruit graders, number					
153	Fruit pressers, number			10	12	
154	Gardening implements, number			722	600	
155	Grinding mills, number				1,046	
156	Grubbing machines, number				362	
157	Handcarts, number					4
158	Hay presses, number	132			190	50
159	Hayracks, number				237	
160	Horsepowers, number			17	65	
161	Incubators, number					
162	Lawn mowers, number				18	
163	Pea hullers, number					
164	Portable sawmills, number				30	
165	Portable steam engines, number			6	76	
	Pumps—					
166	Hand, number					
167	Horse, number					
168	Steam, number				2	

IMPLEMENTS, BY STATES: 1900—Continued.

Ohio.	Pennsylvania.	South Carolina.	South Dakota.	Tennessee.	Texas.	Vermont.	Virginia.	Wisconsin.	All other states.[1]	
	20									80
24,000								20,000		81
9,086	1,650			262	24		725	3,501		82
692	800	180		3,045			75	1,875		83
			50					5,829		84
										85
5,752				100						86
20,486	1,112							6,515	15	87
3,042								3,087		88
40	306									89
221		1,450								90
								2,024		91
573	9,350							13,980		92
1,288				300				900		93
										94
3,048	10,355	600					300		8,100	95
										96
785									100	97
	7									98
									1	99
35,670								15,000		100
20,150	2							8,672		101
19,257	24,881			2,000		31,595				102
34,700	400							7,102		103
2,498	75							30		104
14,547	515			1,400		10,209				105
41,187	51							3,222	15	106
									309	107
5,052	111							25		108
61,697	30							21,000	6	109
25	30									110
16,693	647			57				585	1	111
						20,760				112
2,665								25		113
						84,900				114
126,504	4,500					204,024				115
						24,000				116
										117
								60		118
										119
300						25			100	120
519	25									121
5,040								520		122
16,661	10,089			31,500			1,800	13,709		123
658	3,320						350			124
175	125							6,261		125
123	128							842	45	126
420	24							1,628		127
704	1,501					119		182		128
589,945	39,127		40	3,602		30,021	2,333,575	78,850	1,265	129
32,000										130
										131
50	10									132
									4	133
				1,598			62			134
								200		135
								1,800		136
560				50		175				137
2,515	600						365			138
										139
								10,000		140
					3			1,300		141
										142
										143
6,109	345							1,422		144
4,560	4,468							169		145
5										146
80	320									147
500										148
1,050	101						750	134		149
1,010								500		150
										151
	180									152
										153
430,826	669,600									154
1,879	6							229	20	155
50	530							34		156
249	200							627		157
					34		20		5	158
	325		10							159
801	643					317		1,679	2	160
										161
7,000										162
		350								163
87	550							1		164
839	48							76		165
										166
50,125	47							50		167
20										168

[1] Includes establishments distributed as follows: Alabama, 1; Colorado, 1; Delaware, 1; Maryland, 2; North Dakota, 1; Utah, 2; Washington, 2; West Virginia, 1.

TABLE 10.—AGRICULTURAL

		United States.	California.	Connecticut.	Georgia.	Illinois.
	Kinds and quantities of products—Continued.					
	Miscellaneous—Continued.					
169	Road carts, number	804	697	7		
170	Road graders, number	103				
171	Road scrapers, number	3,509	550			20
172	Shovels, spades, and scoops, number	236,400				
173	Singletrees, number	332,722	456		900	153,834
174	Sirup evaporators, number	131			131	
175	Sorghum binders, number	21				15
176	Sorghum evaporators, number	2,652				
177	Sprayers, number	106,655	5			
178	Straw stackers, number	8,230				1,008
179	Thrasher trucks, number	2,437				
180	Traction engines, number	5,470	20			329
181	Wagons, number	2,768	531			1,031
182	Wagon trucks, number	5,370	310			
183	Water trucks, number	1,350				
184	Weeders, number	63,186				300
185	Wind engines, number	85				
186	Windmills, number	4,295				3,184
	Comparison of products:					
187	Number of establishments reporting for both years	518	17	5	8	70
188	Value for census year	$92,772,476	$1,249,524	$194,746	$681,152	$38,386,447
189	Value for preceding business year	$77,202,840	$1,044,555	$197,757	$686,818	$31,098,762
	Power:					
190	Number of establishments reporting	595	17	4	5	85
191	Total horsepower	77,189	736	630	409	34,918
	Owned—					
	Engines—					
192	Steam, number	678	18	3	8	145
193	Horsepower	61,147	570	145	334	28,104
194	Gas or gasoline, number	75	10			6
195	Horsepower	1,055	108			84
196	Water wheels, number	159	1	14		11
197	Horsepower	6,758	6	485		731
198	Electric motors, number	193	3			104
199	Horsepower	6,543	47			4,757
200	Other power, number	2				1
201	Horsepower	320				300
	Rented—					
202	Electric, horsepower	1,100	5			932
203	Other kind, horsepower	266			75	10
204	Furnished to other establishments, horsepower	338	35	50		20
	Establishments classified by number of persons employed, not including proprietors and firm members:					
205	Total number of establishments	715	20	5	10	94
206	No employees	29	1			2
207	Under 5	154	2	1	1	13
208	5 to 20	223	8		5	22
209	21 to 50	109	3	3	1	12
210	51 to 100	65	2		1	11
211	101 to 250	80	4	1	1	16
212	251 to 500	24			1	7
213	501 to 1,000	20				6
214	Over 1,000	11				5

IMPLEMENTS, BY STATES: 1900—Continued.

Indiana.	Iowa.	Kansas.	Kentucky.	Maine.	Massachusetts.	Michigan.	Minnesota.	Mississippi.	Missouri.	
100	.....	.....	.....	.....	.....	.....	.....	.....	.....	169
.....	.....	.....	.....	.....	.....	3	.....	.....	.....	170
.....	.....	.....	.....	9	90	.....	.....	.....	.....	171
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	172
.....	2,587	.....	75,000	825	91,000	100	.....	.....	.....	173
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	174
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	175
.....	.....	.....	1,890	.....	.....	.....	.....	.....	.....	176
.....	.....	.....	.....	.....	.....	87,726	.....	.....	.....	177
1,680	349	.....	.....	.....	.....	1,541	580	.....	.....	178
705	.....	.....	.....	.....	.....	1,308	.....	.....	27	179
933	.....	.....	.....	.....	25	1,302	466	.....	.....	180
1,040	.....	.....	.....	12	.....	10	.....	.....	27	181
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	182
35	.....	.....	.....	126	.....	108	.....	.....	.....	183
1,035	10,524	.....	.....	1,056	2,150	391	.....	.....	.....	184
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	185
.....	.....	.....	.....	.....	.....	298	.....	.....	.....	186
38	20	.....	5	12	5	47	10	3	18	187
$6,132,178	$1,348,455	.....	$1,308,009	$284,711	$527,440	$6,264,741	$1,569,581	$36,350	$911,015	188
$5,593,736	$932,485	.....	$1,058,989	$204,571	$469,137	$5,822,436	$1,061,782	$28,500	$827,829	189
42	21	1	6	14	7	46	15	3	21	190
4,121	1,035	22	959	1,451	752	4,096	1,038	75	937	191
47	18	.....	8	6	3	57	15	3	22	192
3,563	913	.....	896	144	410	3,407	952	75	882	193
11	3	1	2	.....	.....	7	3	.....	4	194
265	21	22	13	.....	.....	96	47	.....	55	195
5	.....	.....	.....	19	6	6	.....	.....	.....	196
250	.....	.....	.....	1,280	340	183	.....	.....	.....	197
1	1	.....	.....	2	.....	20	2	.....	.....	198
30	5	.....	.....	5	.....	375	20	.....	.....	199
.....	.....	.....	.....	1	.....	.....	.....	.....	.....	200
.....	.....	.....	.....	20	.....	.....	.....	.....	.....	201
13	.....	.....	50	2	2	35	12	.....	.....	202
.....	96	.....	.....	.....	.....	.....	7	.....	.....	203
.....	.....	.....	.....	150	.....	.....	.....	.....	.....	204
45	24	4	9	17	9	59	18	3	26	205
.....	.....	.....	1	2	1	4	1	.....	.....	206
3	2	2	.....	5	3	13	3	.....	7	207
11	10	1	4	6	1	24	7	3	9	208
12	5	1	1	1	.....	8	1	.....	6	209
7	2	.....	1	3	3	3	2	.....	1	210
7	5	.....	1	.....	1	2	3	.....	3	211
3	.....	.....	.....	.....	.....	3	.....	.....	.....	212
1	.....	.....	1	.....	.....	2	1	.....	.....	213
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	214

TABLE 10.—AGRICULTURAL

		Nebraska.	New Hampshire.	New Jersey.	New York.	North Carolina.
	Kinds and quantities of products—Continued.					
	Miscellaneous—Continued.					
169	Road carts, number					
170	Road graders, number					
171	Road scrapers, number				2,515	
172	Shovels, spades, and scoops, number					
173	Singletrees, number		600		50	2,000
174	Sirup evaporators, number					
175	Sorghum binders, number					
176	Sorghum evaporators, number					
177	Sprayers, number			102	7,202	
178	Straw stackers, number				38	
179	Thrasher trucks, number				18	
180	Traction engines, number				503	
181	Wagons, number				3	34
182	Wagon trucks, number				16	
183	Water trucks, number			312	228	
184	Weeders, number		17,150		1,372	
185	Wind engines, number					
186	Windmills, number					
	Comparison of products:					
187	Number of establishments reporting for both years	3	8	8	59	6
188	Value for census year	$91,415	$74,611	$224,018	$10,020,653	$76,875
189	Value for preceding business year	$68,480	$75,085	$168,184	$8,048,567	$60,650
	Power:					
190	Number of establishments reporting	7	11	10	79	7
191	Total horsepower	215	533	280	8,247	178
	Owned—					
	Engines—					
192	Steam, number	6	1	7	86	6
193	Horsepower	207	6	106	6,439	89
194	Gas or gasoline, number	2		2	5	
195	Horsepower	8		20	79	
196	Water wheels, number		13	7	34	5
197	Horsepower		482	154	1,691	89
198	Electric motors, number				4	
199	Horsepower				19	
200	Other power, number					
201	Horsepower					
	Rented—					
202	Electric, horsepower				4	
203	Other kind, horsepower		45		15	
204	Furnished to other establishments, horsepower				25	
	Establishments classified by number of persons employed, not including proprietors and firm members:					
205	Total number of establishments	9	12	11	87	9
206	No employees	1		2	3	
207	Under 5	1	8	2	23	1
208	5 to 20	3	3	5	23	7
209	21 to 50	3	1	1	16	
210	51 to 100	1			9	1
211	101 to 250			1	7	
212	251 to 500				1	
213	501 to 1,000				3	
214	Over 1,000				2	

IMPLEMENTS, BY STATES: 1900—Continued.

Ohio.	Pennsylvania.	South Carolina.	South Dakota.	Tennessee.	Texas.	Vermont.	Virginia.	Wisconsin.	All other states.[1]	
										169
100										170
	325									171
	230,400					6,000				172
5,000	300				10					173
										174
6										175
				762						176
11,600								20		177
598	224							2,217		178
304	57					18				179
778	200							914		180
54								16	10	181
5,044										182
310	200							31		183
27,633	1,400					175				184
								85		185
								813		186
68	31	3	2	8	3	12	8	37	9	187
$12,645,760	$2,756,452	$11,640	$18,280	$460,211	$45,160	$338,790	$229,454	$6,724,496	$165,312	188
$11,094,051	$2,645,982	$11,400	$16,750	$387,533	$25,925	$324,139	$217,464	$4,884,852	$146,471	189
66	41	4	2	7	2	16	11	37	8	190
8,498	2,240	76	18	568	67	980	443	3,509	158	191
95	45	4	1	9	2	8	10	42	8	192
7,606	2,067	76	10	565	65	370	377	2,682	87	193
8	2		1		1	1		5	1	194
96	53		8		2	22		50	6	195
4	10					16	2	5	1	196
126	112					578	56	160	85	197
29						1		26		198
662						8		615		199
										200
										201
8				3		2		2	30	202
	8						10			203
								54	4	204
78	50	5	3	11	5	17	13	51	11	205
2	4					2		3		206
17	14	2	1	4	4	4	1	14	3	207
17	12	3	2	2		6	6	16	7	208
12	9			3	1	3	2	4		209
8	4					2	2	1	1	210
12	6			1			2	7		211
5				1				3		212
4	1							1		213
1								2		214

[1] Includes establishments distributed as follows: Alabama, 1; Colorado, 1; Delaware, 1; Maryland, 2; North Dakota, 1; Utah, 2; Washington, 2; West Virginia, 1.

METAL-WORKING MACHINERY.

METAL-WORKING MACHINERY.

By EDWARD H. SANBORN, *Expert Special Agent.*

This report embraces statistics relating to machinery for working metals, so far as it has been practicable to identify distinct types of tools or machinery used for such purposes and to separate them from the general group of "foundry and machine shop products." The chief difficulty has been the definition of the products which it was desired to include, and the determination of the limits of the group of industries manufacturing this class of machines. The term "metal-working machinery" is so comprehensive and so elastic that it might readily be stretched to embrace everything from a rolling mill to a watchmaker's lathe. The classification naturally narrows itself, however, to a few distinct types of machines, the uses of which are well defined and the designations of which are clearly established among the manufacturers. This limitation reduces the inquiry to establishments devoted, for the most part, to the exclusive manufacture of this class of machines, so that it is possible not only to present statistics relating to products, but also to embody in this report figures regarding capital, wage-earners, wages, miscellaneous expenses, and cost of materials used.

The term "metal-working machinery," as used in this report, is understood to embrace power-operated machines for working metals in the form of bars, rods, wire, plates, sheets, or castings, excluding such machinery as is used in the production of the metals themselves in these various forms. Rolling-mill machinery might properly be considered as "metal working;" but the equipment of a rolling mill embraces so many auxiliary appliances, many of them equally applicable to other industries, that any attempt to separate the machines strictly devoted to the working of the metal itself would be confusing and would convey no correct idea of the amount of machinery manufactured for this particular branch of production. Furthermore, much of the machinery used in rolling mills is made in establishments where other products are also manufactured, and the distinctive character of the industry is thus obscured.

With the exclusion of rolling-mill machinery, the manufacture of machines for working metal is a well-defined branch of industry, and one in which records are customarily kept with detail and accuracy frequently lacking in many other lines of manufacture.

Table 1 is a summary for the industry by states, 1900.

TABLE 1.—METAL-WORKING MACHINERY: SUMMARY BY STATES, 1900.

	United States.	Connecticut.	Delaware.	Illinois.	Indiana.	Iowa.
Number of establishments	397	48	6	42	7	4
Capital:						
Total	$54,293,812	$8,374,701	$2,197,106	$2,821,655	$245,480	$192,117
Land	$4,281,817	$583,005	$358,000	$254,270	$13,500	$16,949
Buildings	$8,600,496	$1,596,781	$455,602	$341,000	$20,943	$34,470
Machinery, tools, and implements	$16,307,673	$2,510,602	$679,061	$816,347	$84,491	$46,698
Cash and sundries	$25,103,826	$3,684,313	$704,443	$1,410,038	$126,546	$94,000
Proprietors and firm members	325	24	3	38	6	3
Salaried officials, clerks, etc:						
Number	1,985	225	63	138	11	20
Salaries	$2,434,643	$354,324	$94,062	$157,923	$6,672	$18,754
Wage-earners, including pieceworkers, and total wages:						
Average number	29,436	4,146	1,016	1,680	182	183
Wages	$15,216,884	$2,341,738	$471,129	$894,295	$75,285	$78,895
Men, 16 years and over	29,145	4,003	1,015	1,677	181	183
Wages	$15,144,807	$2,310,448	$470,985	$893,853	$75,015	$78,895
Women, 16 years and over	144	118	.....	.....	1	.....
Wages	$42,852	$27,282	.....	.....	$270	.....
Children, under 16 years	147	25	1	3	.....	.....
Wages	$29,225	$4,008	$144	$442	.....	.....
Miscellaneous expenses:						
Total	$2,550,447	$264,930	$78,402	$154,617	$9,826	$37,418
Rent of works	$218,861	$17,651	$1,250	$21,839	$807	$484
Taxes, not including internal revenue	$280,931	$37,907	$5,458	$10,493	$1,482	$374
Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$2,035,631	$209,122	$70,494	$120,586	$7,537	$36,560
Contract work	$65,024	$250	$1,200	$1,699	.....	.....
Materials used:						
Total cost	$16,257,345	$2,103,295	$887,596	$940,094	$74,360	$102,043
Principal materials, including mill supplies and freight	$15,664,257	$2,007,249	$828,863	$903,208	$70,371	$97,731
Fuel, including rent of power and heat	$593,088	$96,046	$63,733	$36,886	$3,989	$4,312
Value of products, including custom work and repairing	$44,385,229	$5,729,766	$1,730,719	$2,657,277	$219,795	$273,561

TABLE 1.—METAL-WORKING MACHINERY: SUMMARY BY STATES, 1900.—Continued.

	Massachusetts.	Michigan.	Minnesota.	Missouri.	New Hampshire.	New Jersey.
Number of establishments	56	15	3	3	5	11
Capital:						
Total	$4,990,723	$616,293	$36,095	$8,300	$268,000	$1,707,437
Land	$462,771	$61,764	$500	$200	$9,400	$53,250
Buildings	$786,060	$65,124	$2,500	$200	$43,900	$428,045
Machinery, tools, and implements	$1,288,235	$223,386	$17,075	$6,600	$79,200	$504,498
Cash and sundries	$2,453,657	$266,019	$16,020	$1,300	$135,500	$721,644
Proprietors and firm members	42	22	6	4	6	13
Salaried officials, clerks, etc.:						
Number	179	45	.....	.....	5	56
Salaries	$203,621	$31,026	.....	.....	$5,100	$53,027
Wage-earners, including pieceworkers, and total wages:						
Average number	3,398	409	28	12	185	1,066
Wages	$1,687,416	$184,888	$11,831	$5,756	$97,658	$575,217
Men, 16 years and over	3,378	405	28	11	185	1,066
Wages	$1,683,206	$184,230	$11,831	$5,600	$97,658	$575,217
Women, 16 years and over	3	2	.....	.....	.....	.....
Wages	$1,232	$305	.....	.....	.....	.....
Children, under 16 years	17	2	.....	1	.....	.....
Wages	$2,978	$348	.....	$156	.....	.....
Miscellaneous expenses:						
Total	$268,153	$42,776	$2,570	$1,325	$11,159	$53,948
Rent of works	$34,967	$3,982	$420	$515	$180	$3,000
Taxes, not including internal revenue	$45,846	$2,497	$82	$45	$1,088	$4,960
Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$175,140	$33,297	$2,068	$765	$9,891	$45,888
Contract work	$12,200	$3,000	.....	.....	.....	$100
Materials used:						
Total cost	$1,554,248	$197,049	$12,820	$4,048	$95,987	$478,288
Principal materials, including mill supplies and freight	$1,500,135	$184,150	$12,130	$3,658	$91,068	$461,589
Fuel, including rent of power and heat	$54,113	$12,899	$690	$390	$4,874	$16,699
Value of products, including custom work and repairing	$4,676,475	$551,846	$36,475	$16,152	$262,669	$1,479,757

	New York.	Ohio.	Pennsylvania.	Rhode Island.	Vermont.	Wisconsin.	All other states.[1]
Number of establishments	54	68	31	18	4	10	12
Capital:							
Total	$5,640,569	$11,171,334	$11,179,822	$2,977,598	$474,900	$691,319	$700,363
Land	$641,067	$472,820	$926,370	$305,216	$30,600	$47,150	$44,935
Buildings	$701,403	$1,484,215	$1,591,017	$808,489	$58,149	$127,500	$55,098
Machinery, tools, and implements	$1,653,624	$3,421,945	$3,553,741	$864,486	$101,534	$247,587	$208,563
Cash and sundries	$2,644,475	$5,792,354	$5,108,694	$999,407	$284,617	$269,082	$391,717
Proprietors and firm members	55	56	17	10	.....	8	12
Salaried officials, clerks, etc.:							
Number	254	378	344	178	25	36	33
Salaries	$285,752	$446,179	$423,375	$247,044	$31,844	$36,170	$39,770
Wage-earners, including pieceworkers, and total wages:							
Average number	2,775	6,123	4,150	2,966	199	446	472
Wages	$1,541,198	$2,952,575	$2,227,015	$1,532,162	$97,100	$188,826	$253,905
Men, 16 years and over	2,768	6,120	4,100	2,922	199	438	471
Wages	$1,537,631	$2,951,701	$2,214,387	$1,515,413	$97,100	$187,792	$253,845
Women, 16 years and over	2	2	.....	16	.....	.....	.....
Wages	$1,240	$624	.....	$11,899	.....	.....	.....
Children, under 16 years	10	1	50	28	.....	8	1
Wages	$2,327	$250	$12,628	$4,850	.....	$1,034	$60
Miscellaneous expenses:							
Total	$464,324	$423,790	$301,455	$229,329	$56,982	$66,940	$82,503
Rent of works	$55,915	$42,993	$16,023	$13,818	$200	$3,380	$1,437
Taxes, not including internal revenue	$17,529	$36,303	$35,187	$22,398	$4,850	$1,665	$2,767
Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$385,019	$341,644	$247,620	$193,113	$44,074	$49,995	$62,813
Contract work	$5,861	$2,850	$2,625	.....	$7,858	$11,900	$15,481
Materials used:							
Total cost	$1,316,539	$4,105,151	$2,699,517	$1,025,486	$73,997	$258,935	$327,942
Principal materials, including mill supplies and freight	$1,268,273	$4,031,063	$2,594,714	$980,457	$70,172	$249,941	$314,490
Fuel, including rent of power and heat	$48,266	$74,088	$104,803	$45,029	$3,825	$8,994	$13,452
Value of products, including custom work and repairing	$4,408,860	$10,012,739	$6,989,252	$3,515,499	$354,832	$662,060	$807,555

[1] Includes establishments distributed as follows: California, 2; Georgia, 1; Kentucky, 2; Maine, 2; Maryland, 2; North Carolina, 1; Oregon, 1; Washington, 1.

During the census year 397 establishments were engaged in the manufacture of metal-working machinery as defined in this report. Their capital aggregated $54,293,812, and their products of all kinds, including custom work and repairing, amounted in value to $44,385,229.

The item of "contract work" which appears under miscellaneous expenses, should not be confused with the piecework system, which prevails to a great extent in the manufacture of machinery. A very large proportion of the amount paid in wages represents the earnings of machinists who worked on the piecework or contract system.

Inasmuch as this is the first tabulation of statistics relating to metal-working machinery ever made at a census of the United States, separate from the general group of foundry and machine-shop products, it is not possible to make any comparison between figures for 1900 and previous census periods. It is a matter of common knowledge in this branch of trade, however, that the manufacture of metal-working machinery, and more especially that part of it commonly designated as machine tools, has grown steadily during the past ten years, the increase being both in number of establishments and value of products.

It will be noted that Ohio, with 68 establishments, 6,123 wage-earners, and an aggregate of products valued at $10,012,739, ranks first in these items, and that the capital invested in the industry in that state, amounting to $11,171,334, is but a few thousand dollars less than the

capital reported by Pennsylvania. With $11,179,822 of capital and only 31 establishments, Pennsylvania stands second in value of products, the total for the state being $6,989,252. Connecticut ranks third, with 48 establishments, $8,374,701 of capital, and products valued at $5,729,766. So far as products are concerned, Massachusetts comes next, with 56 establishments, $4,990,723 of capital, and products valued at $4,676,475. New York shows 54 establishments, with $5,640,569 of capital, and $4,408,860 of products. It is worthy of note that among the states that figure prominently in this industry, Rhode Island shows the largest number of wage-earners and the greatest value of products in proportion to the amount of capital invested. In that state there were 18 establishments making metal-working machinery, with $2,977,598 of capital, employing 2,966 wage-earners, and producing machinery of an aggregate value of $3,515,499. This is the only important state in which the value of the products was in excess of the amount of capital invested.

Table 2 shows, by states, the number and value of each type or class of metal-working machines manufactured during the census year, so far as it has been found practicable to classify them.

TABLE 2.—METAL-WORKING MACHINERY: KIND, QUANTITY, AND VALUE OF PRODUCTS, BY STATES, 1900.

	United States.	Connecticut.	Delaware.	Illinois.	Indiana.	Iowa.
Number of establishments reporting	397	48	6	42	7	4
Hammers—steam, power, and drop:						
Number	857	140	.....	24	.....	25
Value	$671,287	$115,559	.....	$45,446	.....	$2,300
Forging machines, including bolt headers, and all other machines for forging hot metal with dies and by pressure:						
Number	821	60	.....	48	.....	.....
Value	$424,774	$56,210	.....	$44,811	.....	.....
Stamping, flanging, and forming machines for plate and sheet metal:						
Number	7,895	645	.....	1,205	6	.....
Value	$1,180,960	$216,728	.....	$122,240	$1,325	.....
Punching and shearing machines:						
Number	5,269	1,156	553	134	140	24
Value	$1,219,605	$149,400	$254,572	$68,771	$40,450	$8,859
Bending and straightening rolls:						
Number	914	682	25	3	40	.....
Value	$202,230	$14,275	$60,000	$1,750	$14,000	.....
Riveting machines:						
Number	202	76	.....	10	.....	.....
Value	$139,295	$20,728	.....	$1,982	.....	.....
Lathes:						
Hand—						
Number	3,945	123	.....	1,447	.....	.....
Value	$306,081	$16,716	.....	$98,456	.....	.....
Engine—						
Number	12,089	1,175	.....	21	2	.....
Value	$4,451,867	$547,795	.....	$7,515	$490	.....
Turret, including all automatic or semiautomatic lathes for making duplicate pieces—						
Number	3,687	810	68	128	3	.....
Value	$2,449,121	$465,803	$80,250	$67,100	$1,310	.....
Boring and turning mills or vertical lathes:						
Number	534	151	50	3	.....	.....
Value	$1,123,314	$238,308	$131,650	$3,500	.....	.....
Boring and drilling machinery, including all machines using drills or boring bars:						
Number	22,890	1,093	32	2,936	978	.....
Value	$2,779,983	$166,786	$35,620	$145,088	$96,335	.....
Planers, including plate-edge planers:						
Number	1,543	60	34	3	.....	.....
Value	$1,808,955	$52,782	$68,994	$3,850	.....	.....
Slotters and shapers:						
Number	3,076	457	24	4	1	.....
Value	$1,136,350	$149,664	$24,100	$1,180	$165	.....
Milling machines, including all machines using a milling cutter:						
Number	4,119	431	.....	55	34	24
Value	$2,171,966	$141,402	.....	$85,281	$14,650	$7,512
Sawing machines:						
Number	2,846	277	.....	1,998	.....	.....
Value	$222,563	$11,947	.....	$77,310	.....	.....
Grinding and polishing machinery, including all machines using abrasive cutters:						
Number	10,014	722	27	1,963	3	.....
Value	$880,965	$77,442	$24,050	$92,464	$120	.....
Bolt, nut, and pipe threading and tapping machines:						
Number	2,088	62	.....	5	13	37
Value	$698,362	$19,002	.....	$1,055	$4,550	$2,590
Pneumatic hand tools:						
Number	6,751	100	.....	6,431	.....	.....
Value	$143,325	$20,000	.....	$107,000	.....	.....
All other metal-working machines, value	$2,726,901	$681,456	$91,564	$158,795	.....	$4,680
All other products, value	$16,375,956	$2,464,082	$179,300	$1,268,872	$4,425	$236,594
Amount received for custom work and repairing	$3,271,369	$103,681	$780,619	$254,816	$41,975	$10,966
Total value of all products	$44,385,229	$5,729,766	$1,780,719	$2,657,277	$219,795	$273,501

	Massachusetts.	Michigan.	Minnesota.	Missouri.	New Hampshire.	New Jersey.
Number of establishments reporting	56	15	3	3	5	11
Hammers—steam, power, and drop:						
Number	2	.....	73	.....	.....	18
Value	$5,080	.....	$7,500	.....	.....	$4,200
Forging machines, including bolt headers, and all other machines for forging hot metal with dies and by pressure:						
Number	455	.....	.....	.....	.....	.....
Value	$4,257	.....	.....	.....	.....	.....
Stamping, flanging, and forming machines for plate and sheet metal:						
Number	918	8	.....	.....	.....	196
Value	$38,060	$675	.....	.....	.....	$77,329

TABLE 2.—METAL-WORKING MACHINERY: KIND, QUANTITY, AND VALUE OF PRODUCTS, BY STATES, 1900—Continued.

	Massachusetts.	Michigan.	Minnesota.	Missouri.	New Hampshire.	New Jersey.
Punching and shearing machines:						
Number	132	45	.....	1	.....	432
Value	$7,008	$18,000	.....	$200	.....	$82,242
Bending and straightening rolls:						
Number	50	.....	.....	.....	.....	11
Value	$1,000	.....	.....	.....	.....	$1,995
Riveting machines:						
Number	.....	.....	.....	.....	.....	.....
Value	.....	.....	.....	.....	.....	.....
Lathes:						
Hand—						
Number	411	7	.....	.....	.....	53
Value	$49,975	$625	.....	.....	.....	$10,752
Engine—						
Number	3,986	36	.....	.....	430	128
Value	$1,237,084	$16,175	.....	.....	$184,766	$229,722
Turret, including all automatic or semiautomatic lathes for making duplicate pieces—						
Number	137	10	.....	.....	6	15
Value	$61,109	$2,435	.....	.....	$1,925	$4,047
Boring and turning mills or vertical lathes:						
Number	71	.....	.....	.....	18	54
Value	$79,629	.....	.....	.....	$29,840	$177,089
Boring and drilling machinery, including all machines using drills or boring bars:						
Number	7,383	32	1	1	.....	149
Value	$489,504	$10,975	$42	$100	.....	$132,193
Planers, including plate-edge planers:						
Number	368	1	.....	.....	69	90
Value	$262,100	$400	.....	.....	$54,877	$277,000
Slotters and shapers:						
Number	238	159	.....	.....	75	203
Value	$79,050	$59,250	.....	.....	$18,273	$79,750
Milling machines, including all machines using a milling cutter:						
Number	437	12	.....	.....	.....	155
Value	$317,818	$3,066	.....	.....	.....	$167,510
Sawing machines:						
Number	.....	1	.....	.....	.....	2
Value	.....	$20	.....	.....	.....	$240
Grinding and polishing machinery, including all machines using abrasive cutters:						
Number	1,798	301	2	500	75	50
Value	$124,447	$11,568	$48	$6,000	$3,000	$6,601
Bolt, nut, and pipe threading and tapping machines:						
Number	389	1	.....	.....	.....	.....
Value	$43,959	$23	.....	.....	.....	.....
Pneumatic hand tools:						
Number	.....	.....	35	30	.....	.....
Value	.....	.....	$7,525	$1,000	.....	.....
All other metal-working machines, value	$44,239	$59,550	$4,980	.....	.....	$46,781
All other products, value	$1,548,209	$310,548	$11,500	$6,952	$16,633	$138,928
Amount received for custom work and repairing	$283,947	$58,541	$4,880	$1,900	$3,355	$48,428
Total value of all products	$4,676,475	$551,846	$36,475	$16,152	$262,669	$1,479,757

	New York.	Ohio.	Pennsylvania.	Rhode Island.	Vermont.	Wisconsin.	All other states.[1]
Number of establishments reporting	54	68	31	18	4	10	12
Hammers—steam, power, and drop:							
Number	233	58	225	13	46	.....	.....
Value	$109,968	$53,552	$300,021	$3,561	$24,100	.....	.....
Forging machines, including bolt headers, and all other machines for forging hot metal with dies and by pressure:							
Number	2	230	2	23	.....	.....	1
Value	$260	$290,300	$5,000	$21,436	.....	.....	$2,500
Stamping, flanging, and forming machines for plate and sheet metal:							
Number	2,362	1,709	2	605	.....	43	201
Value	$541,226	$67,622	$770	$92,162	.....	$2,573	$20,250
Punching and shearing machines:							
Number	861	395	82	999	.....	288	27
Value	$154,773	$319,690	$44,499	$36,111	.....	$81,700	$3,330
Bending and straightening rolls:							
Number	2	65	16	1	.....	18	1
Value	$80	$78,382	$31,898	$50	.....	$3,300	$500
Riveting machines:							
Number	25	6	81	2	.....	.....	2
Value	$13,200	$300	$102,370	$15	.....	.....	$700
Lathes:							
Hand—							
Number	1,500	184	8	110	.....	42	60
Value	$93,584	$15,725	$375	$15,731	.....	$2,142	$1,500
Engine—							
Number	534	4,520	282	96	.....	2	877
Value	$123,087	$1,674,001	$355,959	$18,470	.....	$400	$106,403
Turret, including all automatic or semiautomatic lathes for making duplicate pieces—							
Number	33	1,417	3	496	367	194	.....
Value	$7,833	$934,338	$1,925	$299,635	$284,411	$287,006	.....
Boring and turning mills or vertical lathes:							
Number	10	140	14	23	.....	.....	.....
Value	$9,428	$412,800	$23,985	$17,085	.....	.....	.....
Boring and drilling machinery, including all machines using drills or boring bars:							
Number	1,792	7,847	458	128	.....	44	16
Value	$83,308	$1,120,286	$397,455	$75,135	.....	$3,090	$24,071
Planers, including plate-edge planers:							
Number	31	646	188	10	.....	.....	43
Value	$18,230	$691,362	$248,812	$4,625	.....	.....	$125,923
Slotters and shapers:							
Number	334	1,354	115	112	.....	.....	.....
Value	$78,165	$421,229	$177,732	$47,792	.....	.....	.....

[1] Includes establishments distributed as follows: California, 2; Georgia, 1; Kentucky, 2; Maine, 2; Maryland, 2; North Carolina, 1; Oregon, 1, Washington, 1.

TABLE 2.—METAL-WORKING MACHINERY: KIND, QUANTITY, AND VALUE OF PRODUCTS, BY STATES, 1900—Continued.

	New York.	Ohio.	Pennsylvania.	Rhode Island.	Vermont.	Wisconsin.	All other states.[1]
Milling machines, including all machines using a milling cutter:							
Number	783	1,060	79	698	18	329	4
Value	$297,621	$438,725	$110,605	$445,842	$17,100	$122,884	$2,500
Sawing machines:							
Number	4	16	193	4	.....	351	.....
Value	$580	$2,303	$99,953	$200	.....	$30,010	.....
Grinding and polishing machinery, including all machines using abrasive cutters:							
Number	1,353	295	797	1,868	6	219	35
Value	$54,604	$17,126	$143,468	$266,804	$4,550	$48,410	$263
Bolt, nut, and pipe threading and tapping machines:							
Number	259	975	266	9	.....	1	71
Value	$128,709	$363,896	$97,034	$5,603	.....	$25	$31,916
Pneumatic hand tools:							
Number	.....	.....	155	.....	.....	.....	.....
Value	.....	.....	$7,800	.....	.....	.....	.....
All other metal-working machines, value	$39,906	$316,520	$1,174,409	$100,134	.....	$1,750	$2,125
All other products, value	$1,930,057	$2,382,538	$3,498,401	$1,898,862	$5,220	$126,202	$348,638
Amount received for custom work and repairing	$724,179	$417,044	$166,281	$166,746	$19,451	$52,624	$136,936
Total value of all products	$4,408,860	$10,012,739	$6,989,252	$3,515,499	$354,832	$662,060	$807,555

[1] Includes establishments distributed as follows: California, 2; Georgia, 1; Kentucky, 2; Maine, 2; Maryland, 2; North Carolina, 1; Oregon, 1; Washington, 1.

The appearance of Ohio as the leading state in the manufacture of metal-working machinery points to one of the interesting phases of the development of this industry during the past ten years. Within this decade there has been a marked tendency toward specialization, particularly among the new establishments that have started business in recent years. Most of the older manufacturers of machine tools, whose business runs back for twenty or thirty years, produce a variety of machines, in some cases embracing nearly everything required for the equipment of a new shop. In late years, however, manufacturers starting in this branch of industry have very generally limited their operations to the production of a single type of machine, or at the most to one class embracing tools of similar types. For example, there are large establishments in which nothing is manufactured but engine lathes, other works are devoted exclusively to planers, while in others milling machines are the specialty.

This tendency has prevailed in Cincinnati perhaps more than in any other city, and has been one of the characteristic features of the rapid expansion of the machine-tool industry in that city during the past ten years. During the census year there were in Cincinnati 30 establishments devoted to the manufacture of metal-working machinery, almost exclusively of the classes generally designated as machine tools, and their aggregate product amounted to $3,375,436. In 7 shops engine lathes only were made, 2 were devoted exclusively to planers, 2 made milling machines only, drilling machines formed the sole product of 5 establishments, and only shapers were made in 3 shops. Several other manufacturers made two or more of these classes of tools, but for the most part the industry was very strikingly specialized. Cincinnati manufacturers made during the census year 3,924 engine lathes, out of a total of 12,089 for the entire country, or almost exactly one-third of the whole number. Out of 3,076 slotters and shapers made in the United States, 1,019, or nearly one-third, were made in Cincinnati. There were also made in the same city 816 milling machines and 1,622 drilling and boring machines.

Philadelphia is one of the largest of machinery centers; 11 establishments reported an aggregate product of metal-working machinery valued at $3,095,574. These products include a wide range of tools with less of the specialization that is characteristic of Cincinnati and other localities where the industry is of more recent growth.

Providence, R. I., ranks third in the manufacture of metal-working machinery, the product of 14 establishments amounting, during the census year, to $2,929,141. Here, again, the industry is diversified rather than specialized. A large amount of automatic and semiautomatic machinery, such as screw machines, turret lathes, and gear cutters, and also milling machines of various types, are made in Providence, and these might be said to be the chief characteristic of the industry.

Hartford, Conn., stands next to Providence, and shows about the same features in the machine-tool trade, with a wide range of products, among which automatic and semiautomatic machines might be mentioned as most significant. During the census year 11 establishments in Hartford reported the production of metal-working machinery to the value of $2,796,935.

Worcester, Mass., is another important center for the manufacture of machine tools, with much of the same specialization that is manifest in Cincinnati. Twenty-four establishments reported for the census year products aggregating $2,009,357 in value. Engine lathes are one of the specialties in Worcester, and of these 2,667 were made during the census year. These, with the 3,924 made in Cincinnati, embrace more than one-half of the entire number of engine lathes made during the census year. Drilling machines of various types, particularly small sizes, are another important item in the Worcester products, 4,552 of these having been made during the census year.

While New York and Chicago are large distributing centers for machinery of every description, they do not

figure prominently in the manufacture of the classes of machinery embraced in this report.

The specialization which has been pointed out in Cincinnati and Worcester also shows itself in a great many individual establishments in different cities. The five large centers of the metal-working machinery industry which have been mentioned represent about one-third of the entire output of this class of machinery. The balance of the product comes from many cities, and also from a considerable number of small towns where there is a single establishment, usually making only one type or class of machines.

While there has been in recent years a marked growth of this industry in some of the older centers—as, for example, in Cincinnati—at the same time there has been a widespread scattering of new factories in the smaller cities and towns.

The effect of this specialization in the manufacture of metal-working machinery has been manifest in the improvement of the product and the economy of its manufacture. With but few exceptions, it may be said that the general tendency in machine tools has been toward more efficient machines rather than in the direction of lower prices. While the cost of some machine tools is higher now than it was five or ten years ago, the machine of to-day is the more economical because of its greater efficiency. The manufacturer who makes nothing but lathes, and manufactures 500 or 1,000 of them in a year, is able, as a rule, to build them better and more cheaply than the maker who builds only a few in a long list of other tools. Concentration on the details of a single kind of machine or tool has been productive of marked progress in construction, and has led to the gradual evolution of new and advanced types.

Specialization in the manufacture of machine tools has followed closely the differentiation of processes in other lines of industry, and thus there has been created a multitude of special machines, each designed to perform some single and often very simple operation. The bicycle industry furnishes a striking illustration of the readiness with which the machine-tool builders met the demand for special tools to produce the various parts required in the construction of a bicycle. The advent of the chainless wheel called for a machine which would cut small bevel gears accurately, rapidly, and economically, and such machines were quickly forthcoming. This, indeed, is a characteristic tendency of the machine-tool industry—the effort to create new types of tools which will do more and at less cost than can be done by any of the ordinary appliances at the command of the machinist.

Progress in machine tools and machine-shop practice during the past decade has been marked by the following significant features:

1. The automatic and semiautomatic principles have been extended to new and larger classes of work than before.

2. The forming tool has become a recognized shop appliance.

3. The "oil-tube drill" has been developed from an exceptional to a regularly used tool.

4. Compressed-air portable tools have been developed substantially *de novo*.

5. The application of the power press has been greatly extended.

6. Electrical driving has come into general use.

7. The system of heavy portable machine tools in conjunction with a massive iron floor plate has been originated.

8. The grinding machine has been largely increased in size, power, and extent of use.

Closely related to machine-shop practice, though scarcely coming within machine-tool classification, may be mentioned:

9. The development of traveling cranes.

10. The origin of high-speed steels for cutting tools.

These lines of development may be discussed briefly in the above order.

1. The extension of the semiautomatic principle, as illustrated by the hand-operated turret lathe, has been chiefly toward the execution of larger and heavier work, while the use of the entirely automatic turret lathe has been not only in the same direction, but has been adapted to entirely new classes of work. An illustration of the first line of development is found in several types of turret lathes which, although employing certain methods of attacking the work which were not known before their advent, is nevertheless essentially an extension of the turret principle to larger work than had before been done by it.

An illustration of the second line of development is to be found in the "magazine feed" full automatic turret lathe. Prior to the advent of this machine, the full automatic machine had been employed exclusively for making screws, studs, etc., from bar stock which was fed to the machine through the hollow live spindle, the pieces being first turned, threaded, etc., and then cut off, when the bar of stock was fed downward and another piece made, the operation continuing until the bar of stock was used up. The new machine applied the automatic principle to the machining of parts which, when in the rough, were already in separate pieces, i. e., castings or drop forgings. In doing such work the finished piece must be taken bodily from the machine and a new rough piece inserted. This is a fundamentally different operation from merely pushing a long bar of stock to a new position. It is effected by the "magazine feed," the magazine being filled with rough parts by the workman, these parts then being automatically inserted in the machine and removed therefrom when finished. The line of development exemplified by the machine first mentioned belongs to the entire decade, while that exemplified by the other belongs to its close.

Another line of development in this class of machines which should be mentioned is the use of multiple spin-

dles, whereby the output of certain classes of work is very greatly increased—to the extent of a threefold ratio in some instances. An outgrowth of this development has been the making of small brass screws and similar articles without money consideration, the chips cut off in making the articles being accepted as sufficient payment for doing the work.

2. The use of the forming tool goes back of the decade under consideration, but its use prior to 1890 was chiefly, if not entirely, for the making of articles from very soft composition castings, examples of the work being seen in the caps of salt and pepper boxes. The application of the principle to harder material came about in connection with the bicycle industry, one of its final applications to articles of steel being in the making of bicycle-wheel hubs. If this is not the first application of the method to steel, at least it familiarized the mechanical public with it, and from this it has come to have quite an extended application.

3. By the "oil-tube drill" is meant a drill—either flat or twist—having an oil tube or oil channel leading to or near its point, through which a current of oil may be forced to lubricate and cool the cutting edges and to wash away the chips. It is used chiefly for deep drilling in steel and usually in machines of the lathe class, in which the work revolves against a fixed drill, although the arrangement is also used in upright drilling machines, in which the tool revolves. The history of this appliance is almost exactly parallel to that of the forming tool. It was known and used to a limited extent before 1890, having been first used for the drilling of gun barrels; but its more extensive application must, like that of the forming tool, be credited to the bicycle industry, the development of the two tools being, in fact, simultaneous. The forming tool having been successfully applied to the machining of the outside of bicycle-wheel hubs, it was found that a portion of the gain due to its faster action was lost because the simultaneous drilling of the hole required more time than the work upon the outside of the piece. This condition of things led to the adoption of the oil-tube drill for this work, and from this application the use of the appliances has become widely extended. Of the two, the oil-tube drill is no doubt the more important. The increasing use of hollow-spindle lathes and automatic and hand-operated turret lathes, in which the spindles are necessarily hollow, not to mention milling and other machines having hollow spindles, has given a wide field of usefulness to this tool.

4. The numerous class of small and unpretentious pneumatic tools which came into prominence and extended use during the decade under review may, it is quite possible, be looked upon as the most important single machine tool development of the decade. Of these, the first in order of importance as well as of time is the pneumatic hammer. Originally devised as a substitute for the hand hammer and chisel in the machine shop and in stonecutting, it has extended its field of usefulness to many other fields, and is to-day an indispensable tool in shipbuilding and in the erection of steel-frame buildings. Of the general class of compressed-air tools, the next in importance to the hammer is perhaps the rotary drill, which, in its numerous forms and applications, has introduced mechanical power in place of hand labor for classes of work to which the application of mechanical power seemed almost hopeless. These and numerous other applications of compressed air to machine and similar work stand almost wholly to the credit of the decade 1890 to 1900, the hammer alone having been in use prior to 1890.

5. The great expansion in the use of power presses which has taken place during this decade must be credited largely to the growth of the electrical industries. The advent of the laminated armature for electric generators and motors called for accurately made punchings of sheet metal of a size and in numbers previously unknown. The power press furnished the natural method of making them, and in its development the capabilities of the machines were demonstrated as they had never been before.

6. The electric motor as a means of driving machine tools was first seriously proposed about or shortly before the middle of the decade, and was generally looked upon by mechanical men as a fad of the electrician. The innovation nevertheless obtained a foothold, and advantages which were not foreseen were found to attend it. It has become the accepted method of driving factories (*a*) which are composed of many departments, the flexibility and economy of the system in distributing power over a considerable area from a central station being here the factor of dominating importance, and (*b*) those which are of a nature requiring tools and machines to be located at considerable distances apart, especially if they are also to be intermittently operated. It is also making rapid progress in machine shops, to which the above limitations do not apply, though in such applications opinion regarding its merit is still unsettled. A leading controversial point is the attachment of individual motors to each machine tool versus group-driving of several machines through a single motor and a line shaft. There are well-defined conditions under which each method is suitable, but there is still a wide intervening field of debatable ground. As a matter of fact, in this field the individual motor is making rapid progress—more so perhaps than can be readily explained.

7. Like the increased development of power presses, the floor-plate portable tool system of attacking heavy work must be credited to the electrical industries, which in this instance, curiously enough, furnished both the work for which the system was first devised and the means for doing the work. It was the machining of the ring or magnet frames of large electric generators to which the system was first applied, and the electric motor supplied the only practicable method of

driving the tools which form part of the system. The system has not yet found much application outside of electrical works, although a beginning has been made, and this growth will doubtless continue.

8. The grinding machine was first devised during the past decade as a means of doing superior work, but it was not long before it became evident that it was a source of economy as well as a means of securing superior workmanship. The full significance of this was, however, slow to be realized, and it was not until toward the close of the decade that the movement began toward a very marked increase in capacity, weight, and power of the machine.

9. In no feature of machine-shop practice has there been greater progress in American shops during this decade than in the provision of crane facilities. Twenty years ago the absence of these facilities was a national reproach, but to-day there is undoubtedly better crane service in the United States than exists elsewhere. This development is to be credited to the electric motor, without which it is at least doubtful if the present stage of progress could ever have been reached. The mere transmission of the power required for cranes of present capacities by the old square shaft or flying rope would be a serious problem. Electricity furnishes, in fact, an ideal method of driving cranes, and the necessary installation of an electric plant for operating cranes has no doubt greatly furthered the adoption of electric power for other purposes.

10. Within the last few years discoveries have been made whereby certain classes of tool steel are made to endure cutting speeds which before were impossible. Like all other useful things these steels have certain limitations and it is too early to state definitely what their ultimate economic importance will be. It is reasonably certain, however, to be considerable.

MOTIVE-POWER APPLIANCES.

MOTIVE-POWER APPLIANCES.

By EDWARD H. SANBORN, *Expert Special Agent.*

It is intended to embrace within this report statistics relating to the manufacture of the common types of primary powers—that is, appliances used for the generation of power—excluding locomotives and motor vehicles which produce power only for their own propulsion. The classification of primary powers has been made to conform, as far as possible, to trade usages. As the value of the motive-power appliances manufactured in the establishments covered by this report represents but little more than one-third of the aggregate value of all their products, the totals of capital invested, wage-earners employed, wages paid, and materials used bear no significant relation to the production of motive-power appliances. This report, therefore, deals only with products.

The 1,170 establishments covered by this report produced during the census year 40,533 steam boilers, representing an aggregate of 2,928,983 horsepower, with a total value of $25,663,445. Of steam engines of all types there were manufactured 29,120, representing 2,210,727 horsepower, and valued at $28,019,971. The number of internal-combustion engines, using gas, petroleum, or other vapors, produced by these establishments was 18,531, their aggregate horsepower was 164,662, and their total value amounted to $5,579,398. There were also manufactured 2,680 water motors, including overshot and undershot wheels, turbines, and impact wheels, with an estimated total of 367,934 horsepower, and an aggregate value of $1,520,849. The totals for all primary powers, exclusive of steam boilers, were as follows: Number of units, 50,331; aggregate horsepower, 2,743,323; total value, $35,120,218. The other products of these 1,170 establishments amounted in value to $84,754,239; the amounts received for custom work and repairing reached a total of $26,664,243, and the total output of all products and all classes of work represented a value of $172,202,145.

Table 1 shows the number, aggregate horsepower, and total value of each kind of motive-power appliances produced by these establishments during the census year.

TABLE 1.—NUMBER, AGGREGATE HORSEPOWER, AND VALUE OF PRIMARY POWERS: 1900.

Number of establishments	1,170
Steam boilers:	
Fire tube—	
Number	35,802
Aggregate horsepower	1,943,222
Total value	$18,037,451
Water tube—	
Number	4,731
Aggregate horsepower	985,761
Total value	$7,625,994
Steam engines:	
Marine—	
Number	767
Aggregate horsepower	396,047
Total value	$7,018,369
Fixed cut-off throttling—	
Number	21,806
Aggregate horsepower	658,111
Total value	$7,963,805
High speed variable automatic cut-off—	
Number	3,823
Aggregate horsepower	314,668
Total value	$3,282,787
Low speed variable automatic cut-off—	
Number	2,724
Aggregate horsepower	841,901
Total value	$9,755,010
Internal-combustion engines:	
Number	18,531
Aggregate horsepower	164,662
Total value	$5,579,398
Overshot or undershot water wheels:	
Number	58
Aggregate horsepower	1,257
Total value	$12,250
Turbine water wheels:	
Number	1,665
Aggregate horsepower	311,527
Total value	$1,232,090
Impact water wheels:	
Number	957
Aggregate horsepower	55,150
Total value	$276,509
Primary powers, all kinds:	
Number	50,331
Aggregate horsepower	2,743,323
Total value	$35,120,218

Table 2 presents in detail statistics of the manufacture of various kinds of power-generating appliances in the different states during the census year.

TABLE No. 2.—MOTIVE-POWER APPLIANCES: QUANTITY AND VALUE OF PRODUCTS, BY STATES, 1900.

STATE.	Number of establishments.	Total value of all products.	STEAM BOILERS.					
			Fire tube.			Water tube.		
			Number.	Aggregate horsepower.	Value.	Number.	Aggregate horsepower.	Value.
United States	1,170	$172,202,145	35,802	1,943,222	$18,037,451	4,731	985,761	$7,625,994
Alabama	8	549,193	107	6,710	66,060			
Arkansas	4	71,678	54	1,802	20,570			
California	50	10,526,607	670	52,138	853,856	32	12,300	229,500
Colorado	15	1,216,105	180	8,455	67,408			
Connecticut	19	1,564,480	353	35,420	349,907	20	940	6,100
Delaware	4	3,561,594	24	14,300	242,470	37	27,585	185,523
Georgia	12	1,246,299	521	25,201	279,810			
Illinois	87	11,148,362	2,666	150,007	1,713,340	109	25,285	238,906
Indiana	44	5,528,699	3,046	161,212	1,105,923	12	3,250	21,000
Iowa	40	1,618,665	608	29,625	276,192			
Kansas	7	395,617	129	3,617	29,932	1	13	130
Kentucky	9	726,917	152	12,820	98,455			
Louisiana	10	845,963	30	4,509	36,975	125	13,000	92,000
Maine	12	1,372,984	135	14,008	136,675	4	8,500	30,000
Maryland	14	4,303,720	169	26,320	221,540			
Massachusetts	58	6,661,316	1,836	145,823	1,083,179	9	16,100	48,900
Michigan	79	7,033,491	3,278	107,522	1,109,527	221	25,228	185,387
Minnesota	27	2,135,908	1,004	52,416	233,061			
Mississippi	7	352,400	207	8,185	59,825			
Missouri	37	3,226,129	909	48,908	431,743	160	28,062	221,086
Nebraska	3	178,700	45	2,825	26,613			
New Hampshire	6	908,758	58	6,350	22,558			
New Jersey	31	7,466,847	196	28,095	290,213	1,009	201,415	2,350,715
New York	164	16,121,145	3,708	171,139	1,814,997	453	55,509	454,237
North Carolina	7	417,170	40	1,600	20,000			
North Dakota	4	48,160	40	635	17,600			
Ohio	108	20,482,025	3,562	182,903	1,360,843	1,990	469,486	2,513,881
Oregon	6	794,586	11	1,807	16,200	3	3,000	75,000
Pennsylvania	159	40,566,457	9,967	477,877	4,748,571	416	85,658	808,183
Rhode Island	11	2,812,606	47	9,897	54,231	90	9,022	142,321
South Carolina	3	142,999	60	2,625	24,928			
Tennessee	13	1,189,249	913	51,383	449,447	3	650	7,200
Texas	3	43,925	10	250	4,000			
Vermont	6	77,816	23	347	4,675	3	20	475
Virginia	11	3,444,169	63	45,250	286,120			
Washington	20	1,211,528	161	5,970	77,475	31	623	14,000
West Virginia	3	96,735	81	2,288	18,000			
Wisconsin	65	11,934,341	730	42,048	368,882	3	115	1,450
All other states[1]	4	178,802	15	935	15,650			

STATE.	Number of establishments.	STEAM ENGINES.											
		Marine.			Fixed cut-off throttling.			High speed, variable automatic cut-off.			Low speed, variable automatic cut-off.		
		Number.	Aggregate horsepower.	Value.	Number.	Aggregate horsepower.	Value.	Number.	Aggregate horsepower.	Value.	Number.	Aggregate horsepower.	Value.
United States	1,170	767	396,047	$7,018,369	21,806	658,111	$7,963,805	3,823	314,668	$3,282,787	2,724	841,901	$9,755,010
Alabama	8				40	2,000	20,000				78	6,925	104,000
Arkansas	4	1	20	200	34	1,292	11,128	4	160	1,342			
California	50	35	41,600	479,300	88	3,513	119,205	172	4,920	105,100	15	3,090	51,100
Colorado	15				237	7,651	197,300	4	475	13,700			
Connecticut	19	10	247	2,375	90	1,350	47,620	102	3,114	66,219	2	200	1,100
Delaware	4	13	27,900	460,000	4	720	17,750				1	180	4,700
Georgia	12	2	100	1,250	111	4,170	53,850						
Illinois	87	94	11,312	145,786	288	7,516	80,771	169	16,706	195,850	291	50,742	455,505
Indiana	44	67	3,750	91,800	1,953	74,169	563,039	447	32,056	213,986	84	20,268	249,908
Iowa	40	9	4,180	39,200	140	5,511	108,550	1	25	350	77	8,940	108,098
Kansas	7				10	795	31,000				8	625	45,000
Kentucky	9				304	12,125	101,150						
Louisiana	10	4	900	3,300	7	500	2,700				6	1,291	14,624
Maine	12	21	13,253	278,000	12	220	3,516						
Maryland	14	18	13,250	277,120	53	1,085	40,563						
Massachusetts	58	33	20,350	276,500	828	37,985	302,839	177	4,458	59,969	141	32,187	272,572
Michigan	79	42	15,650	237,300	1,249	16,801	173,405	700	10,879	100,110	95	4,030	30,100
Minnesota	27	20	1,000	10,200	254	4,133	135,322				26	2,950	69,797
Mississippi	7				196	6,410	71,075	8	400	4,000	8	200	3,200
Missouri	37				833	22,270	228,425	60	707	10,816	96	27,676	262,970
Nebraska	3				9	105	900						
New Hampshire	6	1	6	200	1,302	9,125	188,900	3	40	1,000	24	3,840	84,000
New Jersey	31	94	19,045	454,182	356	10,592	274,247	225	23,685	298,591	179	22,292	342,551
New York	164	111	17,404	261,242	2,604	111,410	1,179,423	404	46,377	568,353	216	69,703	873,769
North Carolina	7				224	5,850	39,750	15	750	6,250			
North Dakota	4				16	294	7,500						
Ohio	108	17	16,000	185,000	1,214	46,370	572,632	329	69,694	559,376	344	158,787	1,464,160
Oregon	6	4	6,355	91,950	123	1,615	24,400						
Pennsylvania	159	90	121,384	3,047,288	7,804	211,305	2,581,499	827	95,633	1,016,771	411	95,272	1,125,559
Rhode Island	11	8	178	8,900	390	12,631	74,160	28	2,610	39,150	121	71,250	694,247
South Carolina	3				34	850	8,500						
Tennessee	13				291	9,230	134,100						
Texas	3				15	260	3,425	2	130	1,200			
Vermont	6				12	80	2,870						
Virginia	11	29	45,512	501,796	18	275	8,400	7	39	1,400	3	50	1,005
Washington	20	36	14,035	138,350	254	12,779	297,050						
West Virginia	3				85	2,750	25,000						
Wisconsin	65	5	2,116	26,650	384	11,874	231,841	138	1,795	18,854	498	261,403	3,547,045
All other states[1]	4	3	500	5,500				1	20	400			

[1] Includes establishments distributed as follows: Florida, 2; South Dakota, 1; Utah, 1.

TABLE No. 2.—MOTIVE-POWER APPLIANCES: QUANTITY AND VALUE OF PRODUCTS, BY STATES, 1900—Continued.

STATE.	Number of establishments.	Internal-combustion engines using gas, petroleum, or other vapor.			WATER MOTORS.									All other products.	Amount received for custom work and repairing.
					Overshot or undershot wheels.			Turbines.			Impact wheels.				
		Number.	Aggregate horsepower.	Value.	Number.	Aggregate horsepower.	Value.	Number.	Aggregate horsepower.	Value.	Number.	Aggregate horsepower.	Value.		
United States	1,170	18,531	164,662	$5,579,398	58	1,257	$12,250	1,065	311,527	$1,232,090	957	55,150	$276,509	$84,754,239	$26,664,243
Alabama	8	35	375	22,500										248,436	88,197
Arkansas	4													2,000	36,438
California	50	1,145	8,189	361,349							369	63,395	243,450	2,881,698	5,202,049
Colorado	15	6	14	1,150										572,801	363,746
Connecticut	19	435	1,662	53,150				21	666	6,450	6	15	300	957,982	73,277
Delaware	4	35	700	28,000										2,292,226	330,925
Georgia	12				1	20	800	45	1,775	8,750				526,639	375,200
Illinois	87	1,560	8,348	295,847				12	840	24,000	60	50	3,000	6,545,368	1,450,009
Indiana	44	736	4,309	211,581				35	8,075	24,000				2,516,527	530,935
Iowa	40	429	2,706	119,413				26	790	5,938				743,159	217,465
Kansas	7													169,480	120,075
Kentucky	9	136	624	31,370										423,139	72,803
Louisiana	10	178	1,424	54,580										367,394	274,390
Maine	12	33	174	8,340	4	90	350	4	250	1,200				651,417	263,486
Maryland	14	194	2,128	127,450				3	50	552				2,873,805	762,690
Massachusetts	58	46	199	10,325	1	100	2,500	331	96,230	188,675				3,324,035	1,091,822
Michigan	79	1,294	7,148	268,294				1	75	850				2,905,994	2,022,524
Minnesota	27	518	3,475	109,870										1,381,241	136,417
Mississippi	7													102,925	111,375
Missouri	37	614	6,972	310,225										983,292	777,572
Nebraska	3													136,300	14,887
New Hampshire	6	10	25	1,350							12	12	72	608,349	52,329
New Jersey	31	395	2,706	98,080				15	1,280	5,575	275	600	5,500	2,287,532	1,059,661
New York	164	1,387	11,619	466,311	3	50	500	53	3,631	7,192	221	551	20,730	7,623,588	2,850,803
North Carolina	7							45	1,222	6,300				288,250	56,620
North Dakota	4													2,500	20,560
Ohio	108	2,001	28,717	808,491	30	7	600	742	140,238	726,902	14	527	3,457	10,248,576	2,038,107
Oregon	6	2	4	450										474,372	112,214
Pennsylvania	159	2,548	45,102	1,157,910	9	190	4,500	325	56,213	223,766				22,626,760	3,225,650
Rhode Island	11	2	5	310										1,411,125	388,162
South Carolina	3													94,671	14,900
Tennessee	13	12	200	6,000										445,028	147,474
Texas	3													13,300	22,000
Vermont	6	88	548	20,150										35,246	14,400
Virginia	11	4	20	1,500				1	6	600				1,950,210	693,138
Washington	20	14	57	4,700										314,386	370,567
West Virginia	3													27,725	26,010
Wisconsin	65	4,670	27,192	940,852	10	800	3,000	6	191	1,340				5,631,363	1,163,564
All other states[1]	4	4	20	350										65,100	91,802

[1] Includes establishments distributed as follows: Florida, 2; South Dakota, 1; Utah, 1.

From these tables some interesting conclusions may be drawn relative to the average horsepower per unit of the different primary powers and the average cost per horsepower, the value or selling price being taken as the cost to the purchaser.

The average rated capacity of all the fire-tube boilers constructed during the census year was 54 horsepower per unit, and the average cost per horsepower was $9.28.

Water-tube boilers, as a rule, are of larger steam-raising capacity, the average per unit, as shown by these tables, having been 208 horsepower, while the average cost per horsepower was only $7.73.

The 767 marine engines embraced by this tabulation averaged 516 horsepower per unit, and the average cost per horsepower was $17.72.

The fixed cut-off throttling engine, usually designated as a plain slide-valve engine, is the commonest type, being made mostly in units of small size, the average for the 21,806 engines having been only 30 horsepower each. The average cost of $12.11 per horsepower is higher than the cost of any other style of engine because of the smaller size of the units and the lower efficiency of the engine as compared with other types.

The high-speed, variable, automatic cut-off engines, commonly known as automatic high-speed engines, the distinguishing characteristic of which is the fly-wheel governor, show an average of 82 horsepower each for the 3,823 engines embraced by this report, and the average cost per horsepower was $10.43.

Low-speed, variable, automatic cut-off engines, such as the Corliss type with its numerous modifications, include many units of very large size, as this class embraces the heavy engines used for power stations, rolling mills, and other purposes requiring the largest units. The average of 2,724 engines of this class constructed during the census year was 309 horsepower each, while the average cost per horsepower was $11.59.

Internal-combustion engines, including all those motors which use gas, gasoline, kerosene, or any other vaporized fuels, show the smallest average size and the highest average cost per horsepower. The 18,531 engines of this class embraced in this report were of an average of 8.88 horsepower each, while the average cost per horsepower was $33.88. The high cost per horsepower in this case is obviously due to the small-sized motors, for while many gas engines of 100 horsepower and upward have been constructed, by far the greater proportion of motors of this class are still of small sizes, most of them developing only a few horsepower each.

Any calculations relative to the average power and

the average cost per horsepower of motors driven by water can have but little value in this compilation, owing to the fact that the power which a turbine or impact wheel will generate depends entirely upon the head of water. For example, a 48-inch turbine, calculated to yield 115 horsepower with a head of 15 feet, would develop nearly twice that amount of power with a head of 30 feet. An impact water wheel of a given size may be used with a head of water ranging from 50 to 500 feet or more, as conditions may require, and the power developed by such a wheel varies accordingly. The makers of turbines and impact wheels frequently do not know under what head the wheels they sell are to be used, and consequently the power rating of wheels is of little value unless the head of water is known. These facts should be taken into consideration in any calculations based upon the figures of waterpower given in this report.

Taking the makers' estimates of the power of water motors reported by them it appears that the 58 overshot and undershot wheels average 21 horsepower each, and their cost averaged $9.74 per horsepower. The figures relating to wheels of this type are probably very incomplete, for these old-fashioned water wheels are often homemade in remote country districts and do not figure in census returns of manufactures. Their importance, however, is trifling as compared with more modern power-generating appliances.

The 1,665 turbines made during the census year averaged 187 horsepower each, this high average being due to the considerable number of units of large capacity demanded by the great plants that have been constructed for the development of hydraulic power and its electrical conversion and transmission. An average cost of $3.95 per horsepower is shown for these turbines, the lowest cost of any form of primary power embraced by this report.

The average of 57 horsepower for the 957 impact wheels has but little significance because of the wide range of the capacity of these motors owing to the varying head of water. With greater head of water the average rating of these wheels would be very largely increased. The average cost of $5.01 per horsepower is rendered of little value by the same causes.

The largest number of fire-tube boilers was made in Pennsylvania, 9,967 being reported for that state, with an aggregate of 477,877 horsepower and a total value of $4,748,571. New York ranks second, with 3,708 boilers, aggregating 171,139 horsepower and valued at $1,814,997. In value of products Illinois stands third, with 2,666 boilers, representing 150,007 horsepower, with a total value of $1,713,340. Ohio reports more boilers with larger total horsepower, 3,562 boilers, 182,903 horsepower, and a value of but $1,360,843. Three other states each produced more than a million dollars' worth of fire-tube boilers: Michigan, 3,278 boilers of 107,522 total horsepower and a value of $1,109,527; Indiana, 3,046 boilers, representing 161,212 horsepower, with a value of $1,105,923; and Massachusetts with 1,836 boilers, aggregating 145,823 horsepower and valued at $1,083,179.

The manufacture of water-tube boilers, while scattered through a score of states, centers chiefly in Ohio and New Jersey, the prominence of these two states being due to the large output of two well-known types of boilers. In Ohio 1,990 water-tube boilers were made during the census year, aggregating 469,486 horsepower and $2,513,881 in value. New Jersey reported 1,009 water-tube boilers, representing a total of 201,415 horsepower and $2,350,715 in value.

The great prominence of the shipbuilding industry in Pennsylvania gives to that state easy leadership in the building of marine engines. Although but 90 were built in that state during the census year, their aggregate horsepower amounted to 121,384, or an average of 1,348 horsepower for each engine, while their total value was $3,047,288, an average of $33,858 each. These high averages of horsepower and value are due to the costly engines of great size for war ships and large ocean steamers.

Pennsylvania leads also in the manufacture of fixed cut-off throttling engines, or plain slide-valve engines as they are commonly called. Of this type 7,804 were built, with an aggregate of 211,805 horsepower and a total value of $2,581,499. New York ranks second, with 2,604 engines, 111,410 horsepower, and a value of $1,179,423. In these two states only did the product of this type of engine reach a value of $1,000,000 or more.

The largest number of high-speed, variable, automatic cut-off engines was made in Pennsylvania, the figures being 827 engines, of 95,633 horsepower, and valued at $1,016,771.

Wisconsin stands far ahead of all other states in the construction of heavy engines, classed for the purposes of this report as low-speed, variable, automatic cut-off. This state reported 498 engines of this type, aggregating 261,403 horsepower, and representing a total value of $3,547,045. These engines averaged 525 horsepower each and $7,122 in value. This industry centers chiefly in Milwaukee, where there are several large establishments devoted mainly to the building of heavy engines. Ohio ranks next to Wisconsin in the output of engines of this class, with 344 engines, an aggregate of 158,787 horsepower, and a total value of $1,464,160. Pennsylvania comes next, with 411 engines, aggregating 95,272 horsepower, and representing a total value of $1,125,559. The Pennsylvania engines averaged only 232 horsepower each, as compared with an average of 461 horsepower for the Ohio output.

The wide distribution of the gas-engine industry is striking evidence of the increasing popularity of internal-combustion motors, for in 1890 the makers of these powers were few in number. In 1900 Pennsylvania

showed the largest product of engines of this type, considering power and value. The number was 2,548, their aggregate horsepower was 45,102, and their total value amounted to $1,157,910. Wisconsin reported the largest number, 4,670, but they represented only 27,192 horsepower, with a total value of $940,352. The small size of these engines, averaging only about 6 horsepower each, indicates that a large proportion of them were for the propulsion of small boats, the building of naphtha launches being an important industry in Wisconsin. Ohio stands third, with 2,001 engines, aggregating 28,717 horsepower, and having a total value of $808,491.

The largest number of turbine water wheels was made in Ohio, 742 wheels, with an estimated aggregate of 140,233 horsepower, and a total value of $726,902. This embraces nearly one-half of the entire number of wheels and considerably more than one-half of the total value of the product for the United States.

California, the home of the impact water wheel, produced most of the wheels strictly entitled to this classification, the output from that state embracing 369 wheels, valued at $243,450, with a nominal rating of 53,395 horsepower. A large number of very small wheels embodying this principle were made in New York and New Jersey.

STEAM BOILERS.

In the generation of steam no radically new principles have been developed during the past decade. Steam boilers have been improved in structural details and in design, and the steady tendency toward higher steam pressures has necessitated more rigid specifications for the materials used in their construction.

Water-tube boilers have grown in favor because of their demonstrated efficiency, and many new types of this class of generators have been brought out. The vertical-tube style has come into wider use than in previous years, particularly in the large installations of blast furnaces and steel works.

Several forms of superheaters, both as attachments to the boilers themselves and also for independent installation, have come into use in late years, but their application has been limited and the economies of superheated steam have received much less attention in the United States than in Europe.

The use of mechanical stokers has increased largely, both on account of the saving of labor which they effect, and because of the economy in fuel, more even firing, and more thorough combustion of the coal which they accomplish. Municipal ordinances compelling smokeless fires have also exerted considerable influence in inducing the larger use of automatic stoking devices. Several new types of mechanical stokers have been developed, the underfeed being one of the new principles that has been embodied in several types.

As one incident of the more economical generation of steam, which has been conspicuous in recent years, the larger use of economizers to utilize the heat of escaping products of combustion for raising the temperature of feed water is worthy of mention, and the use of mechanically induced or forced draft is another phase of the same general tendency toward greater economy.

The large number of steam plants of great capacity which have been constructed in recent years in connection with central electric-lighting stations, street-railway power houses, and large industrial plants, has tended toward the introduction of many economies for which there is neither necessity nor opportunity in small steam installations. The enormous quantity of coal and ashes to be handled in large steam plants permits the use of mechanical conveyors with marked saving in the expenditures for hand labor. In this and many other ways, the arrangement and operation of large power plants has been reduced to a far more economical basis than ever before attempted, and careful study is now given to small details which formerly were considered of little consequence. All of this is the result of the constantly increasing magnitude of industrial operations and the prominence which is thus given to details formerly overlooked in smaller undertakings.

STEAM ENGINES.

The reciprocating steam engine had so nearly fulfilled its possibilities in 1890 that comparatively little advance has been made during the last decade, except in the direction of increased size and importance of the units. The opportunity for this development has been furnished by the central stations for the generation of electricity in large quantities for street-railway work or lighting. Electrical progress meantime has produced generators which may be run at rotative speeds sufficiently low to be attached directly to the main shaft of the engine. The work of rotating the revolving member of the generator attached to its own main shaft is similar to the performance of a marine engine in driving a propeller similarly situated; and, especially where the same problems of economy of space which exist in marine practice are involved, central-station practice has followed largely along the lines of the previously existing large marine engines in the adoption of vertical cylinders, the pistons of which act downward upon the several cranks.

In one instance—at the central station of the Manhattan Elevated Railroad, in New York city—the low-pressure cylinders, with the large and heavy pistons, are placed vertically, thus avoiding the necessity of carrying the weight upon the cylinder surfaces, while the high-pressure cylinders are placed horizontally and their pistons are connected with the same crank pin. This is the most powerful unit designed for stationary practice up to 1900 and consists of two compound engines operating upon the same shaft, with the cranks set at 135 degrees. The cylinders are 44 and 88 inches in diameter, with a stroke of 5 feet, designed to be run

at 75 revolutions per minute. The rated capacity is 8,000 horsepower at one-sixth cut-off in the high-pressure cylinder, with 150 pounds initial pressure and a vacuum of 26 inches, and the engine can easily develop 12,000 horsepower when required.

As an additional illustration of the tendency toward larger units, the engines of the New York Gas, Electric Light and Power Company are worthy of mention. These are of the vertical type, with 1 high-pressure cylinder 43½ inches in diameter and 2 low-pressure cylinders 75½ inches in diameter. The stroke is 60 inches and the speed is 75 revolutions per minute. With a steam pressure of 175 pounds and a vacuum of 26 inches these engines are rated at 6,000 horsepower, but are capable of developing 10,500 horsepower. The low-pressure cylinders are steam jacketed and the steam is superheated 200 degrees. The plant embraces 8 units of this size and type.

During the past ten years there has been a tendency in the direction of increased steam pressures. No higher pressures are now used than existed in 1890, but whereas at the commencement of the decade 120 pounds was an uncommon and 150 pounds an exceptionally high pressure, the lower pressure is now commonly used and most of the large plants are designed for 150 pounds. In many instances much higher pressures are used.

In 1890 compounding had made considerable progress and since then the compound engine has become popularized. All the builders have adopted it, and even the small self-contained units are bought in this form where there is any pretension to steam efficiency. In the last few years, however, there has been a marked reaction against the tendency to run a multiplicity of cylinders, which obtained earlier in the decade, and it is now very rarely that the expansion is divided into more than two stages for stationary engines on any other than pumping-engine work. In some 2-stage compound engines the low-pressure cylinder is made so large, as compared with the high, that the engine is virtually 3-stage, or triple expansion, with the intermediate cylinder removed, and the efficiencies attained appear to be so nearly those of the triple-expansion engine as not to warrant the extra expense and complication of the third cylinder.

Little has been done to determine the real effect of the steam jacket upon ultimate efficiency. Leading engineers differ as to its value and desirability, and as to the manner of its use when it is adopted, i. e., whether the jacket should be applied to all the cylinders of a compound, and if not, upon which it should be used. In Europe the general practice is to supply the cylinder with steam through the jacket; in the United States the jacket supply is usually separate.

Prof. R. H. Thurston, in a recent paper presented before the American Society of Mechanical Engineers, thus summarizes the present position of the steam engine:[1]

[1] Vol. xxi, Transactions of the American Society of Mechanical Engineers.

"The end of the nineteenth century is that of one which will always remain preeminent in history as the age in which the steam engine took shape in the hands of Watt and Sickles, and Corliss and Greene, of Porter, and their successors, and thus brought in the factory system and all our modern methods of production, in the improvement of the condition of the people, and in all the material advancement in the industrial arts, which has made the century distinctively one of supremacy of the mechanic arts. The close of the century finds the steam engine, though threatened with displacement by other motors, in the view of many writers, nevertheless the great motor of the age. Substantially all of the power employed by the civilized world is supplied by this great invention—congeries of inventions, rather—the product of a series of improvements, of an evolution effected during the hundred years or more just past. The limit to be possibly attained in its development and perfection will always remain a subject of intense interest to the profession and to the world.

"Summarizing, we may state that the limit of progress attained to date is variously measured by these figures:

APPROXIMATE DATA IN BEST PRACTICE.

Duty on basis of 1,000,000 B. T. U., foot-pounds	163,000,000
Economy measured in B. T. U., per hour per horsepower	11,160
Economy measured in B. T. U., per horsepower per minute	186
Economy, pounds steam, at 1,000 B. T. U., per pound, per hour per horsepower	11.16
Economy in best fuel, 15,000 B. T. U., per pound; boiler at 80 per cent efficiency, pounds per hour per horsepower	1
Efficiency measured against perfect engine of Carnot, per cent	84

"Reviewing the history of the growth of this form of steam engine, it will be seen that its progress has illustrated that of the machine in all its forms, and that the steam pumping engine gives the engineer a record of greater extent and of more representative character, as exemplifying the evolution of the machine, than does any other type.

"The twentieth century will very probably see a change in the curve of our lines, if not, in some respects, a decided halt or a reversed curvature, and it is perhaps even more probable that the field of the steam engine will become greatly restricted by the introduction of other heat motors, as well as by the general employment of electricity as a medium of extensive power distribution from hydraulic and pneumatic prime movers.

"The steam engine has now been so far perfected, and the practical limits of pressure are coming to be so nearly approached by steam-boiler constructors and users, that but little more can be expected of the designer; and even with the costlier types of engine, practically justifiable with exceptionally high costs of fuel, uninterrupted working, and low values of money,

as in some instances with the steam pumping engine, commercially practicable progress seems likely henceforth to prove very slow. These costly types of engine must necessarily have a comparatively narrow field. With the common case of moderate cost of fuel, intermittent duty, comparatively high value of money in the business, or absolute scarcity with the buyer, gains seem likely hereafter to be rather in the direction of cheapened methods of construction and simplification of design."

THE STEAM TURBINE.

It is rather singular that the most important steps of advancement in steam engineering during the nineteenth century—the advent of the steam turbine as a commercially practicable primary motive power—marks a return to the principles of the earliest known application of steam for power purposes, namely, the engine of Hero, which was constructed about 120 B. C., but which, so far as is known, never passed beyond the experimental stage. The principle of Hero's engine was the utilization of the reaction caused by the escape of steam from jets protruding tangentially from a hollow globe, this reaction causing the rotation of the globe.

More than seventeen hundred years later—in 1629—Giovanni Branca, an Italian inventor, devised an impact steam turbine, embodying the same principles as the familiar impact water wheel of to-day, except that a jet of steam instead of water impinged upon the vanes of the paddle wheel and caused it to revolve. The advent of the reciprocating steam engine early in the eighteenth century diverted attention from the earlier attempts to perfect a rotating engine, and it was not until near the end of the nineteenth century that the steam turbine again made its appearance as a commercial possibility. De Laval, in Sweden, in 1883, and Parsons, in England, in 1884, constructed successfully operating steam turbines, and a continuous process of development and improvement has demonstrated the practicability and commercial value of this form of motor in two distinct types, obtaining efficiencies which rank with the best reciprocating engines. The performance of the steam turbine, with the several very important advantages, justifies the belief that the field held for more than a century by the reciprocating engine of Watt is likely to be seriously invaded by this modern application of the earliest principles of steam engineering, which is made possible by the better materials and workmanship and the more intelligent skill now available.

In both the De Laval and Parsons steam turbines power is generated by the impact of a jet of steam upon buckets on the periphery of a revolving disk. The essential differences between the two types of motors are these: The De Laval turbine has a single disk with several steam jets or nozzles. The nozzle has a divergent aperture in which the expansion of the steam takes place. The single turbine disk revolves at a high rate of speed, say from 10,000 to 30,000 revolutions per minute, according to the size of the motor, this speed being reduced to about one-tenth on the main shaft by means of accurately cut spiral gears. The Parsons type of turbine, on the other hand, has a series of disks mounted upon a common shaft and alternating with parallel blades fixed within the casing of the shaft. There are buckets, or cups, upon both the revolving disks and the fixed blades, the fixed buckets being reversed in relation to the moving cups. The steam admitted first through a set of stationary blades or buckets impinges at an angle upon the first rotating disk and imparts motion, passing thence through another set of fixed blades to the second disk upon the main shaft, and thus through the entire series of alternately fixed and rotating buckets. The area of the passages increases progressively to correspond with the expansion of the steam as it is used on the successive disks. The expansion of steam is accomplished in the turbine itself instead of in the nozzle, as in the De Laval motor. There is but a single shaft instead of the two in the De Laval type, and the buckets in a given size of Parsons turbine number about 30,000, as against about 350 in a De Laval motor of the same size.

The efficiency of the steam turbine varies according to conditions, just as the economy of the reciprocating engine is similarly affected. It has been demonstrated by repeated tests that a steam turbine of, say, 300 horsepower will run at full load on a consumption of 14 pounds of steam per horsepower, and it is claimed that this can be reduced under favorable conditions in larger units to about 11 pounds. It has been abundantly shown in regular service that the steam turbine equals the best efficiency of the reciprocating engine under similar conditions.

Apart from its demonstrated economy, other important advantages are claimed for the steam turbine, some of which are worthy of brief mention.

There is an obvious advantage in economy of space as compared with the reciprocating engine. The largest steam turbine constructed in the United States is one of 3,000 horsepower, which is installed in the power house of the Hartford Electric Light Company, Hartford, Conn. The total weight of this motor is 28,000 pounds, its length over all is 19 feet 8 inches, and its greatest diameter 6 feet. With the generator to which it is directly connected it occupies a floor space 33 feet 3 inches long by 8 feet 9 inches wide.

Friction is reduced to a minimum in the steam turbine, owing to the absence of sliding parts and the small number of bearings. In one type there are practically but two bearings. The absence of internal lubrication is also an important consideration, especially when it is desired to use condensers.

As there are no reciprocating parts in a steam turbine, and as a perfect balance of its rotating parts is absolutely essential to its successful operation, vibration is reduced to such a small element that the simplest foundations will suffice, and it is safe to locate

steam turbines on upper floors of a factory if this be desirable or necessary.

The perfect balance of the moving parts and the extreme simplicity of construction tend to minimize the wear and increase the life of a turbine and at the same time to reduce the chance of interruption in its operation through derangement or damage of any of its essential parts.

Although hardly beyond the stage of its first advent in the motive-power field, the steam turbine has met with much favor, and there is promise of its wide use for the purposes to which it is particularly adapted. At present, however, its uses are restricted to service that is continuous and regular, its particular adaptability being for the driving of electrical generators, pumps, ventilating fans, and similar work, especially where starting under load is not essential.

Steam turbines are now being built in the United States in all sizes up to 3,000 horsepower. Their use abroad covers a longer period and has become more general. The largest turbines thus far attempted are those for the Metropolitan District Electric Traction Company, of London, embracing four units of 10,000 horsepower each. Several turbines of large size have been operated successfully in Germany.

The application of the steam turbine to the propulsion of ships has produced surprising speed results. The *Turbinia*, in which the first experiments were tried in England, was a vessel 100 feet long, 9 feet beam, 3 feet draft, and 44 tons displacement. As finally equipped this vessel attained a speed of 34½ knots at Spithead in 1897, with about 2,300 indicated horsepower. The torpedo-boat destroyer *Viper*, subsequently built for the British Admiralty, was 210 feet long, 21 feet beam, and 350 tons displacement, and a speed of 36.858 knots was developed.

The attention that is now centered on the steam turbine promises the development of some new ideas and the evolution of a still more efficient form of motor; and it is fair to expect a rapid multiplication of types embodying the general principle now in use.

INTERNAL-COMBUSTION ENGINES.

The large increase in the use of internal-combustion engines, the multiplication of types, the marked improvements in their construction and efficiency, and the application of their principles in units of great size together form one of the interesting phases of the problem of economical power generation as it has developed during the past ten years. The gas engine, using ordinary illuminating gas, igniting either by a hot tube or an exposed flame, practically represented the internal-combustion motor as it was known ten years ago, but since that time there has been progress perhaps more marked than in any other form of heat engine. Internal-combustion engines now are constructed for operation with illuminating, natural, or producer gas, or with gasoline, kerosene, or alcohol. The electric spark has largely taken the place of the hot tube or exposed flame for ignition of the explosive gaseous mixture in the cylinder. The increase in the size of the units is well illustrated by the fact that in the World's Columbian Exposition in Chicago in 1893, the largest gas engine exhibited was one of 35 horsepower, while at the Paris Exposition in 1900, a single-cylinder engine capable of developing 1,000 horsepower with ordinary illuminating gas was shown.

The recent extraordinary growth of the motor vehicle industry, both in the United States and abroad, has stimulated the development of small internal-combustion motors of from 3 to 40 horsepower, compact in construction and economical in their operation. Along quite similar lines the use of gasoline engines for the propulsion of small boats, and even for yachts of moderate size, has given great impetus to this industry, and has stimulated improvement. As illustrating the extent to which this application of the internal-combustion motor has been carried, it may be noted that a gasoline engine which developed 190 brake horsepower was used for the propulsion of a Holland submarine torpedo boat, while a 133 horsepower gasoline engine has been substituted for steam power in a yacht 92 feet long and 16 feet beam.

Probably the best demonstration of the economy of the internal-combustion motor as compared with the steam engine is afforded by the use of the gas engine in connection with gas producers. It has been shown that such a combination will utilize about twice as much of the energy of the fuel as can be developed by the use of the steam boiler and engine. Mr. Hawley Pettibone, in discussing the use of gas power plants for mining, says:[1]

"With plants of 250 horsepower or more, under everyday working conditions, one brake horsepower per hour is produced with from 1.25 to 1.5 pounds of bituminous or anthracite coal, or with 3 pounds of wood. The consumption of water need not exceed 2 pounds per brake horsepower per hour.

"The steam from a good boiler plant represents about 70 per cent of the heat developed by the combustion of the coal, and as a good steam engine is able to deliver about 14 per cent of the heat of the steam as power, we have a total efficiency of about 10 per cent. The gas from a power gas plant, on the other hand, contains over 80 per cent of the heat in the coal, and a gas engine delivers 25 per cent of this power, making the total efficiency 20 per cent.

"The above is a fair comparison of steam and gas mining power plants where the coal consumption for steam is 3 pounds per brake horsepower per hour and for gas 1.5 pounds per brake horsepower per hour. The results mentioned with steam are obtained only

[1] Cassier's Magazine, vol. 22, No. 1.

with the largest and best mining power plants, the general practice being 4.5 to 8 pounds of coal per brake horsepower per hour."

Approximately the same conclusion is reached by Mr. Clyde D. Gray, who presents in the Journal of the Franklin Institute[1] an exhaustive analysis of recorded tests of power, showing as an average of a number of tests of gas engines using producer gas a consumption of 1.04 pounds of coal per indicated horsepower per hour.

The most notable phase of gas-engine development is the utilization of the waste gases from blast furnaces for the operation of large engines, either for furnishing air blast for the furnaces themselves or for the operation of adjacent rolling mills. The driving of blowing engines by gas from the furnaces which they feed has the semblance of a paradox, but it has been successfully accomplished in Germany, Belgium, and Great Britain, and a large blast-furnace plant now under construction in the United States is being equipped on this plan.

It is calculated by Mr. Bryan Donkin[2] that about 400 cubic feet of blast-furnace gas must be burned under a boiler to produce 1 horsepower per hour at the engine, while about 105 to 110 cubic feet will develop the same power when exploded in an internal-combustion engine cylinder. Thus the economy is as 4 to 1—that is to say, for every horsepower developed in a steam boiler and engine, 4 horsepower could be generated in a gas engine with the same quantity of fuel.

WATER MOTORS.

The great increase in the utilization of water powers during the past decade has stimulated the development of the turbine water wheel and has led to many improvements in construction and to some increase in efficiency. It has come to be the general practice among manufacturers of turbines to construct wheels with special reference to the particular conditions under which each turbine is to be used rather than to make certain standard sizes without regard to the service that is required in each instance. This has resulted in a very careful study of not only the generation of the power, but its most economical transmission to the machinery which it is intended to drive.

For many years most of the turbine wheels in use were of the vertical type, placed at the bottom of the penstock and requiring a set of bevel gears at the top of the shaft for changing the direction of the power. The use of horizontal turbines, however, has become more and more general because of the many obvious advantages derived from such an arrangement of the machinery. It is also the common practice at the present time to use a draft tube for carrying away the tail water, thus making it possible to place the turbine above the higher level of the water in the tailrace, where all connections are readily accessible under all conditions. As the suction of the water that has passed the turbine and is flowing through the draft tube is practically equal to the pressure that the same flow of water would exert above the turbine, there is practically no loss in efficiency in the use of a draft tube of proper construction, while very decided advantage is derived from the placing of the wheel and its shaft and bearings and all connections where they can be examined without difficulty at all times.

The increased use of turbines for driving electrical generators, with the desirability of a direct connection without any intervening gearing or belting, has also tended to the larger use of the horizontal type of wheels. The coupling of two horizontal turbines with a single central discharge tube has facilitated the use of larger units, and where still greater power is desired two or more such units are coupled together to drive a common shaft.

One notable advance in turbine construction has been the production of a type of wheel especially designed for operating under much higher heads of water than were formerly considered feasible for wheels of this type. Turbines are now built for heads ranging from 100 to 1,200 feet, and quite a number of wheels are in operation under heads of from 100 to 200 feet. This is an encroachment upon the field occupied almost exclusively by wheels variously known as the "impulse," "impact," "tangential," or "jet" type, the principle of which is the impact of a powerful jet of water from a small nozzle upon a series of buckets mounted upon the periphery of a small wheel.

In contrast to the prevailing tendency toward the use of horizontal wheels is the great installation of vertical turbines at Niagara Falls, which bids fair to be for many years the most notable hydraulic installation in the world. Here units of 5,000 horsepower each are operated under a head of 150 feet; but the water being admitted from beneath, the vast weight of the wheel shaft and the dynamo on its upper end is sustained by the water pressure, thus reducing the element of friction to a nominal point.

The extensive use of turbine water wheels directly connected to electrical generators has necessitated the development of sensitive governors to regulate the supply of water to the varying loads upon the dynamo. Several types of turbine governors entirely automatic in their action have been perfected, and it is now possible to secure regulation practically as sensitive and efficient as the government of the best steam engine. The improvement of the turbines themselves has contributed to this result, in addition to the accuracy and sensitiveness of the governors.

The impact water wheel has come largely into use during the last ten years, principally in the far West,

[1] Vol. 142, No. 6.
[2] Engineering Magazine, vol. 20, page 428.

where higher heads of water are available than can be found in other parts of the country. With wheels of this type, exceedingly simple in construction and of comparatively small cost, a large amount of power is developed with great economy under the great heads that are available. With the tremendous water pressure developed by heads of 1,000 feet and upward, which in many cases are used for this purpose, wheels of small diameter develop an extraordinary amount of power. To the original type of impact wheel which first led the field have been added several styles embodying practically the same principle. Considerable study has been given to the designing of buckets with a view to securing free discharge and the avoidance of any disturbing eddies, and important improvements have resulted from the thorough investigation of the action of the water during, and subsequent to, its impact upon the buckets. The impact wheel has been adapted to a wide range of service with great variation as to the conditions under which it operates, wheels having been made in California[1] from 30 inches to 30 feet in diameter, and to work under heads ranging from 35 to 2,100 feet, and at speeds ranging from 65 to 1,100 revolutions per minute. A number of wheels of this type have been built with capacities of not less than 1,000 horsepower each.

[1] W. A. Doble, Transactions American Institute of Mining Engineers, vol. 29, page 852.

SEWING MACHINES.

SEWING MACHINES.

By JOHN A. BOSHARD

The statistics of the sewing machine industry presented in the following tables embrace the manufacture of all sewing machines for household and factory purposes used in the production of clothing and other articles from woven fabrics, leather, etc. The figures also include the statistics of establishments producing sewing machine parts and attachments, and of establishments engaged in the manufacture of sewing machine cases, which embraces cabinets, tables, covers, and other woodwork.

The Census Office experienced considerable difficulty in securing a proper separation of the products of sewing machine establishments, owing to the varied nature of the machines and attachments produced. In some instances it was found almost impossible for manufacturers to make the desired segregation of products, owing to the manner in which their accounts were kept, and in several cases the office was compelled to accept estimates in the absence of more exact information.

After a thorough consideration of the sewing machine from a manufacturing and commercial standpoint, and the acceptation of suggestions from persons familiar with the details of the industry, a number of special inquiries were formulated, which, it was thought, would elicit information which would be of statistical and commercial value. The large variety of sewing machines manufactured, covering, as they do, a great diversity of uses, would render impracticable any attempt to differentiate them according to the work they are designed to execute. A number of groupings were decided upon, which classify, in a general way, the different varieties of machines manufactured. The most important distinction between sewing machines is their use for household or factory purposes, and this was made the base of the first separation.

Sewing machines for household use form a distinct class, and vary little in regard to size and general design. The most important differences are found in the style of stitch used, and the manner in which it is executed. Of the two stitches produced by the household sewing machines the lock-stitch is by far the more extensively used. For ordinary sewing it has been demonstrated by experience that a chain-stitch is inferior to a lock-stitch in many respects, and, as a consequence, the manufacture of chain-stitch machines for household use has been practically discontinued.

On the other hand, chain-stitch machines are extensively manufactured for factory use. This is due, in a large degree, to the extreme elasticity of the stitch, which makes it especially desirable for sewing knit goods and other materials inclined to stretch. The lock-stitch machines were divided into three classes, distinguished by the nature of the shuttle used to assist in executing the stitch, whether by a rotary, a vibratory, or an oscillating motion. The vibrating shuttle is most extensively used in connection with household sewing machines. The chain-stitch machines were classified so as to show separately the number and value of those using the single thread and those using the double thread. It was thought best, on account of the wide difference in value of the cabinetwork of machines, to report separately the value of the heads, and the value of the stands and woodwork. The value of the latter varies greatly according to the style of machine for which it is intended, so that any general statement of the average value of a completed machine would be misleading and of little commercial use. Many of the sewing machines for export do not include the stand, as hand power is used in their operation and no stand is required. The machines for factory use also rarely include a stand.

It was thought advisable, in the case of sewing machines for factory use, to make a segregation so as to show separately those using wax thread and those using dry thread. These were again subdivided in the same manner as the household machines, according to the stitch executed, the lock-stitch machines being further classified according to the shuttle used, and the chain-stitch machines separated so as to show those using the single and those using the double thread.

In addition to the above, a tabulation was made of the reports of establishments engaged in the manufacture of sewing machine cases, cabinets, tables, stands, etc. Only the total value of these was shown, as any state-

ment attempting to itemize the different classes of sewing machine cases manufactured would require greater detail than the result would justify.

A duplication occurs here which will require some explanation. While it is true that a large part of the sewing machine cases and cabinets manufactured in the United States by the 7 establishments engaged exclusively in that industry are for export, it is equally true that a large portion of them are used by that class of sewing machine manufacturers who do not make their own cabinetwork, but purchase the stands, and treat them in their report as partially manufactured material. Thus the finished product of the one establishment is shown as partially manufactured material for the other, and its value again reported in the product, thereby making a duplication which would probably amount, in this report, to nearly $2,000,000.

The sewing machine woodwork for export, as a rule, is forwarded in an unfinished form, either glued up or in a "knockdown" shape, for greater convenience in transportation. Under the item "all other products" are included the value of attachments for sewing machines, duplicate parts, and all other products not previously enumerated.

Table 1 presents the principal statistics for the industry as returned at the censuses from 1860 to 1900, inclusive. with the per cent of increase for each decade.

TABLE 1.—COMPARATIVE SUMMARY, 1860 TO 1900, WITH PER CENT OF INCREASE FOR EACH DECADE.

	DATE OF CENSUS.					PER CENT OF INCREASE.			
	1900	1890	1880	1870	1860	1890 to 1900	1880 to 1890	1870 to 1880	1860 to 1870
Number of establishments	65	66	124	69	88	[1]1.5	[1]46.8	79.7	[1]21.6
Capital	$20,072,800	$17,473,539	$13,243,180	$9,521,231	$1,494,450	14.9	31.9	39.1	537.1
Salaried officials, clerks, etc., number	682	[2]304	[3]	[3]	[3]	124.3	.....	.....	.....
Salaries	$908,965	[2]$454,353	[3]	[3]	[3]	100.1	.....	.....	.....
Wage-earners, average number	13,288	10,659	11,375	8,421	2,452	24.8	[1]6.3	35.1	243.5
Total wages	$7,279,118	$5,602,927	$5,319,437	$5,781,221	$1,143,384	29.9	5.3	[1]8.0	405.7
Men, 16 years and over	12,592	9,706	10,168	7,784	2,406	29.7	[1]4.5	30.6	223.5
Wages	$7,101,624	$5,304,525	[3]	[3]	[3]	33.9	.....	.....	.....
Women, 16 years and over	467	547	248	345	46	[1]14.6	120.6	[1]28.1	650.0
Wages	$141,769	$195,084	[3]	[3]	[3]	[1]27.3	.....	.....	.....
Children, under 16 years	229	406	959	292	.....	[1]43.6	[1]57.7	228.4	.....
Wages	$35,725	$103,318	[3]	[3]	.....	[1]65.4	.....	.....	.....
Miscellaneous expenses	$946,223	$1,946,446	[3]	[4]	[4]	[1]51.4	.....	.....	.....
Cost of materials used	$9,343,676	$4,492,612	$6,068,506	$3,641,695	$700,776	108.0	[1]25.6	66.7	419.6
Value of products	$21,129,561	$15,072,698	$15,928,025	$15,847,304	$4,403,206	40.2	[1]5.4	0.5	259.9

[1] Decrease.
[2] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table. (See Table 10.)
[3] Not reported separately.
[4] Not reported.

The statistics contained in Table 1 cover practically the whole range of the industry from its inception. At the time of the taking of the Seventh Census, in 1850, the manufacture of sewing machines had hardly attained to the dignity of an industry, but was still struggling in the first stages of development. No establishments for the exclusive manufacture of sewing machines were yet in operation. The little work required was either carried on in small shops or done by piecework. During the next decade the industry was attended by a very rapid growth, and at the taking of the Eighth Census, in 1860, there were in operation 88 establishments for the manufacture of sewing machines, cases, and attachments, located in 13 states. In 1900 only 65 establishments were reported, showing a decrease of 23 during the forty years. The capital invested, however, increased during the same period from $1,494,450 to $20,072,800, or over thirteenfold; the number of wage-earners increased from 2,452 to 13,288, or over fivefold; the total amount paid in wages, from $1,143,384 to $7,279,118, or over sixfold; the cost of materials used, from $700,776 to $9,343,676, or over thirteenfold; and the value of products from $4,403,206 to $21,129,561, or nearly fivefold. Miscellaneous expenses were not reported until the census of 1890, so that any comparison of these items prior to that time is impossible.

The miscellaneous expenses reported in 1900 were $946,223. This amount includes $87,086 paid for rent of works; $97,193 paid for taxes, not including internal revenue; $644,824 paid for rent of offices, interest, insurance, internal-revenue tax and stamps, repairs of buildings and machinery, advertising, and all other sundries not reported under the head of materials; and $117,120 paid for contract work. The amount paid for rent of offices, insurance, repairs, advertising, and other sundries constitutes the greatest portion of miscellaneous expenses, amounting to 68.1 per cent of the total. Of the remaining items contract work constitutes 12.4 per cent; taxes, 10.3 per cent; and rent of works, 9.2 per cent of the total.

There was a slight increase in the value of products reported from 1870 to 1880, and from 1880 to 1890 quite a decline is noticeable in all items except the amount of capital invested, which shows an increase of 31.9 per cent, and in the total wages paid and the number of women employed. During the next decade the value of products increased $6,056,863, or 40.2 per cent. The

fluctuations in the number of establishments in operation during the various years do not adequately represent the true condition of the industry. The variations as a rule do not affect the large and well established companies, but are usually confined to certain small concerns reporting a nominal capital and product. These are often establishments included in the classification of "sewing machines and attachments," which are engaged in the manufacture of certain special attachments or appliances designed to increase the utility of the ordinary sewing machine in certain classes of work. These may operate during the term of a patent and then cease manufacturing, or the device they produce may be superseded by some other of greater value, thus destroying the sale and necessarily the manufacture of the former. Of the total number of establishments in operation in the sewing machine industry during the census year, only 26 show a value of products exceeding $100,000. The value of the products of these 26 establishments aggregates $20,614,023, or 97.6 per cent of the total for the industry for 1900. Of the above 26, only 5 report products valued at over $1,000,000 each, and their combined output for 1900 aggregated $11,867,650, or 56.2 per cent of the total for the industry.

A closer comparison of the figures in Table 1 reveals the fact that a larger amount of material was handled by the same number of wage-earners in 1900 than in previous years, which, other conditions being equal, would require a greater capital, a less ratio of value of products to cost of materials, and a greater ratio of cost of materials to wages. These natural conclusions are borne out in most cases by the returns. In 1860 the cost of materials was equal to only 15.9 per cent of the value of the products; in 1870 the cost of materials equaled 23 per cent; in 1880, 38.1 per cent; in 1890, 29.8 per cent; and in 1900, 44.2 per cent of the value of the manufactured product. The amounts paid in wages during the corresponding years show a decreasing ratio to the cost of materials used. The value of the capital has shown a steady increase. Where, in 1860, the average value of capital invested per establishment was only $16,980, in 1900 the average value was $308,812, an increase of over eighteenfold. The average number of wage-earners per establishment has increased from 28 in 1860 to 204 in 1900. The large number of establishments in operation in 1880, and the correspondingly small average number of wage-earners per establishment, may be accounted for by the fact that in 1877 the disorganization of the sewing machine combination, which controlled patents covering several of the essential features of the sewing machine, was effected, and thus the field was opened to numerous small manufacturers who could not afford to pay the fee demanded for the privilege of manufacturing under these patents. They were enabled to enter without restraint into competition with the larger concerns, resulting in a surfeit of manufacturing establishments in the sewing machine industry, which was gradually diminished by competition.

Table 2 presents a comparative summary of the industry for 1890 and 1900, by states arranged geographically.

TABLE 2.—COMPARATIVE SUMMARY, BY STATES

	STATES.	Year.	Number of establishments.	CAPITAL.				
				Total.	Land.	Buildings.	Machinery, tools, and implements.	Cash and sundries.
1	United States	1900	65	$20,072,800	$959,105	$2,691,331	$3,898,430	$12,523,934
		1890	66	17,473,539	659,062	1,669,824	3,894,660	11,249,993
2	New England states	1900	15	7,272,955	192,656	575,169	1,285,679	5,219,451
		1890	15	6,512,617	316,062	249,775	970,965	4,975,815
3	Connecticut	1900	7	5,216,570	169,256	466,810	797,252	3,783,252
		1890	5	4,174,710	296,752	171,075	555,176	3,151,707
4	Massachusetts	1900	8	2,056,385	23,400	108,359	488,427	1,436,199
		1890	10	2,337,907	19,310	78,700	415,789	1,824,108
5	Middle states	1900	20	4,954,400	525,850	1,132,526	1,209,410	2,086,614
		1890	28	6,588,793	163,500	808,849	1,936,853	3,679,591
6	New Jersey	1900	4	4,317,666	425,000	1,013,676	964,956	1,914,034
		[1]1890	3	5,237,855	50,000	700,000	1,350,495	3,137,360
7	New York	1900	12	130,282	100	400	38,650	91,132
		1890	16	495,418	38,500	58,849	172,858	225,206
8	Pennsylvania	1900	4	506,452	100,750	118,450	205,804	81,448
		1890	9	855,525	75,000	50,000	413,500	317,025
9	Central states	1900	23	6,738,557	209,599	832,676	1,291,841	4,404,441
		1890	14	2,089,032	63,000	126,840	640,552	1,258,640
10	Illinois	1900	14	2,196,345	37,599	333,316	430,901	1,394,529
		1890	11	935,489	53,000	66,840	328,512	487,137
11	Indiana	1900	3	1,032,027	46,000	117,500	157,902	710,625
		[2]1890						
12	Ohio	1900	6	3,510,185	126,000	381,860	703,038	2,299,287
		[1]1890	3	1,153,543	10,000	60,000	312,040	771,503
13	All other states	[3]1900	7	1,106,888	31,000	150,960	111,500	813,428
		[3]1890	9	2,288,097	116,500	484,360	346,290	1,335,947

[1] Exclusive of 1 establishment manufacturing sewing machine cases included with "all other states."
[2] Included in "all other states."
[3] Includes establishments distributed as follows: 1900—Kansas, 1; Kentucky, 1; Missouri, 1; Minnesota, 1; New Hampshire, 1; Rhode Island, 2. 1890—California, 1; Indiana, 2 (sewing machine cases); New Jersey, 1 (sewing machine cases); Ohio, 1 (sewing machine cases); Rhode Island, 3; Vermont, 1.

ARRANGED GEOGRAPHICALLY: 1890 AND 1900.

SALARIED OFFICIALS, CLERKS, ETC.		AVERAGE NUMBER OF WAGE-EARNERS AND TOTAL WAGES.								Miscellaneous expenses.	Cost of materials used.	Value of products.	
		Total.		Men, 16 years and over.		Women, 16 years and over.		Children, under 16 years.					
Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.				
682	$908,965	13,288	$7,279,118	12,592	$7,101,624	467	$141,769	229	$35,725	$946,223	$9,343,676	$21,129,561	1
304	454,353	10,659	5,602,927	9,706	5,304,525	547	195,084	406	103,318	1,946,446	4,492,612	15,072,698	
71	159,456	2,769	1,607,325	2,607	1,560,484	146	44,441	16	2,400	340,845	1,486,351	4,573,935	2
73	132,016	2,316	1,349,988	2,052	1,249,613	221	90,635	43	9,740	905,125	1,262,189	4,141,666	
53	87,563	2,104	1,176,622	1,947	1,131,310	141	42,912	16	2,400	265,786	966,567	3,170,137	3
17	31,200	1,294	697,654	1,226	678,059	25	9,255	43	9,740	142,030	542,385	1,646,184	
18	71,893	665	430,703	660	429,174	5	1,529	.....	.....	75,059	519,784	1,403,798	4
56	100,816	1,022	652,334	826	570,954	196	81,380	.....	.....	763,095	719,804	2,495,482	
189	221,211	4,936	2,931,103	4,663	2,844,944	273	86,159	.....	.....	152,560	2,862,897	7,049,500	5
78	119,907	4,537	2,382,555	4,124	2,247,040	259	84,115	154	51,400	400,270	1,013,823	5,115,689	
132	182,931	4,701	2,809,523	4,431	2,724,924	270	84,599	.....	.....	108,801	2,717,907	6,643,348	6
16	52,492	3,931	2,071,884	3,552	1,950,577	229	70,907	150	50,400	288,620	761,365	4,177,330	
42	27,572	75	40,672	75	40,672	.....	.....	.....	.....	22,522	48,682	196,006	7
34	39,641	203	116,959	200	116,387	3	572	.....	.....	35,605	92,058	371,387	
15	10,708	160	80,908	157	79,348	3	1,560	.....	.....	21,237	96,308	210,146	8
28	27,774	403	193,712	372	180,076	27	12,636	4	1,000	76,045	160,400	566,972	
335	431,413	5,139	2,500,170	4,882	2,456,796	45	10,169	212	33,205	398,952	4,803,036	8,812,738	9
115	150,202	1,897	952,544	1,791	923,642	51	15,184	55	13,718	551,424	1,256,524	3,495,982	
137	169,910	1,522	828,799	1,463	818,980	15	1,731	44	8,088	169,795	2,017,667	3,485,373	10
39	36,642	891	462,494	847	450,430	42	11,596	2	468	154,016	486,096	1,370,982	
19	32,009	1,707	619,050	1,540	592,659	12	3,458	155	22,933	57,298	1,004,760	1,725,869	11
179	229,494	1,910	1,052,321	1,879	1,045,157	18	4,980	13	2,184	171,859	1,780,609	3,601,996	12
76	113,560	1,006	490,050	944	478,212	9	3,588	53	13,250	397,408	770,428	2,125,000	
87	96,885	444	240,520	440	239,400	3	1,000	1	120	53,866	191,392	693,388	13
38	52,228	1,909	917,840	1,739	884,230	16	5,150	154	28,460	89,627	960,076	2,319,361	

The most noteworthy feature of the statistics presented in this table is the immense growth of the industry in the Central states. The exact amount of this increase can not be arrived at, for the reason that in 1890 the statistics for one of the states reporting less than 3 establishments were placed in the group of "all other states," to avoid disclosing the operations of individual establishments. It is apparent, however, that the increase in the Central states is very large, the industry having more than doubled itself during the decade.

Comparisons may be made of the figures for the states included in the New England group. No change occurs in the number of establishments reported for the different years. The total capital invested increased from $6,512,617 in 1890 to $7,272,955 in 1900, or 11.7 per cent; the average number of wage-earners employed, from 2,316 in 1890 to 2,769 in 1900, or 19.6 per cent; the total amount paid in wages, from $1,349,988 in 1890 to $1,607,325 in 1900, or 19.1 per cent; the cost of materials used, from $1,262,189 in 1890 to $1,486,351 in 1900, or 17.8 per cent; and the value of products, from $4,141,666 in 1890 to $4,573,935 in 1900, or 10.4 per cent. The increase for the group is more than equaled by the increase for the state of Connecticut, which reported a product of $1,646,184 at the census of 1890, as compared with $3,170,137 for 1900, an increase of 92.6 per cent. On the other hand, the statistics for Massachusetts show a decline during the decade, the products for that state having decreased from $2,495,482 to $1,403,798, or 43.7 per cent.

Of the states included in the group of Middle states, comparisons of the figures may be made for New York and Pennsylvania, both of which show decreases since the census of 1890. An apparent increase occurs in the state of New Jersey, but as the figures for 1890 do not include the statistics of 1 establishment manufacturing sewing machine cases and included in "all other states," no comparison for the two years is possible. For similar reasons no comparisons can be made of the figures shown for Ohio. With the exception of New Jersey, Illinois shows the greatest actual increase of any of the states reporting. During the ten years the number of establishments for that state increased from 11 to 14, or 27.3 per cent; the capital invested, from $935,489 to $2,196,345, or 134.8 per cent; the number of wage-earners employed, from 891 to 1,522, or 70.8 per cent; the amount paid in wages, from $462,494 to $828,799, or 79.2 per cent; the cost of materials, from $486,096 to $2,017,667, or 315.1 per cent; and the value of products, from $1,370,982 to $3,485,373, or 154.2 per cent. No figures are separately shown from the state of Indiana for 1890. The 2 establishments reported at that census were engaged in the manufacture of sewing machine cases, and were included in the group of "all other states."

Table 3 presents a comparative statement of capital invested for 1890 and 1900, showing the per cent each item is to the total, and also the per cent of increase during the decade.

TABLE 3.—COMPARATIVE SUMMARY: CAPITAL, 1890 AND 1900, WITH PER CENT OF INCREASE.

	1900		1890		Per cent of increase.
	Amount.	Per cent of total.	Amount.	Per cent of total.	
Total	$20,072,800	100.0	$17,473,539	100.0	14.9
Land	959,105	4.8	659,062	3.8	45.5
Buildings	2,691,331	13.4	1,669,824	9.5	61.2
Machinery, tools, and implements	3,898,430	19.4	3,894,660	22.3	0.1
Cash and sundries	12,523,934	62.4	11,249,993	64.4	11.3

The capital invested, as shown by Table 3, increased from $17,473,539 in 1890 to $20,072,800 in 1900, a gain of 14.9 per cent. The largest item for each year was that of cash on hand, bills receivable, unsettled ledger accounts, raw materials, stock in process of manufacture, finished products on hand, and other sundries. In 1890, $11,249,993 was reported for this item, as compared with $12,523,934 in 1900, showing a gain of 11.3 per cent. The largest increases in any of the items of capital are shown in the value of land and buildings; the value of land having increased from $659,062 to $959,105, or 45.5 per cent, and the value of buildings, from $1,669,824 to $2,691,331, or 61.2 per cent. The increase in the value of machinery, tools, and implements is very slight, amounting to only one-tenth of 1 per cent.

Table 4 presents a statement of the cost of materials used for 1900 and the per cent each item is of the entire cost.

TABLE 4.—COST OF MATERIALS USED: 1900.

	Amount.	Per cent of total.
Total	$9,343,676	100.0
Purchased in raw state	76,189	0.8
Purchased in partially manufactured form[1]	9,019,601	96.5
Fuel	170,426	1.8
Rent of power and heat	6,959	(2)
Freight	70,501	0.8

[1] Includes "mill supplies" and "all other materials," which are shown separately in Table 10.
[2] Less than one-tenth of 1 per cent.

The cost of materials is first shown in this table as a total, then subdivided into the cost of those which are purchased in a raw state, those purchased in a partially manufactured form (inclusive of mill supplies and all

other materials shown separately in a later table), fuel, rent of power and heat, and freight.

The raw materials utilized in the manufacture of sewing machines constitute a very small item of the cost, and consist chiefly in sand for molding purposes. A small proportion only of the establishments engaged in the manufacture of sewing machines throughout the country extend their operations over the whole range of work. These processes include mills for the manufacture of the cabinets and cases, foundries for casting the different iron parts, and machine shops for shaping and assembling the various pieces of mechanism which enter into the finished product. A large number of the establishments confine their operations to the machine-shop work and purchase the woodwork and cast iron parts, while still others are engaged only in the process of assembling the various parts, which are secured in a finished state from manufacturers. The materials used in sewing machine manufacture are pig, bar, and sheet iron, iron and steel wire, bar and sheet steel, malleable iron, japan varnish, power and machine supplies in general, and woods for casing, besides a considerable range of other materials. The cost of materials constitutes from 40 to 45 per cent of the value of the finished product, the material being the chief item of cost.

Table 5 presents a detailed statement, by states, of the number and value of sewing machines for household use produced during the census year. Owing to the great diversity in value of the stands and woodwork for this class of sewing machines, the item has been reported apart from the "heads" in order that a more adequate determination of the average value of what is essentially the sewing machine may be arrived at. The stands and woodwork constitute on an average about 45.5 per cent of the value of the complete machine, varying, of course, according to the design. The styles range from the simple stand or table, with one or two drawers and a cover, to the handsome drop cabinets, elaborately carved and decorated.

TABLE 5.—SEWING MACHINES AND CASES FOR HOUSEHOLD USE, NUMBER AND VALUE, BY STATES: 1900.

	United States.	Connecticut.	Illinois.	Massachusetts.	New Jersey.	New York.	Ohio.	Pennsylvania.	All other states.[1]
Sewing machines and cases, aggregate value	$10,644,221	$1,032,450	$2,302,451	$1,237,969	$3,048,850	$8,500	$2,474,706	$133,035	$406,260
Heads, total number	747,587	68,830	197,096	111,471	155,006	675	184,548	9,711	20,250
Total value	$5,809,064	$550,640	$1,209,364	$894,768	$1,395,053	$3,725	$1,408,587	$78,427	$268,500
Stands and woodwork, total number	749,370	68,830	199,029	111,471	155,006	525	184,548	9,711	20,250
Total value	$4,835,157	$481,810	$1,093,087	$343,201	$1,653,797	$4,775	$1,066,119	$54,608	$137,760
Lock-stitch—									
Heads, number	745,668	68,830	195,852	111,471	155,006	.....	184,548	9,711	20,250
Value	$5,794,143	$550,640	$1,198,168	$894,768	$1,395,053	.....	$1,408,587	$78,427	$268,500
Stands and woodwork, number	747,601	68,830	197,785	111,471	155,006	.....	184,548	9,711	20,250
Value	$4,813,291	$481,810	$1,075,996	$343,201	$1,653,797	.....	$1,066,119	$54,608	$137,760
Vibrating shuttle—									
Heads, number	634,364	.....	195,852	111,471	155,006	.....	142,074	9,711	20,250
Value	$4,805,162	.....	$1,198,168	$894,768	$1,395,053	.....	$970,246	$78,427	$268,500
Stands and woodwork, number	636,297	.....	197,785	111,471	155,006	.....	142,074	9,711	20,250
Value	$3,955,891	.....	$1,075,996	$343,201	$1,653,797	.....	$730,529	$54,608	$137,760
Rotary shuttle—									
Heads, number	102,621	68,830	.....	.....	.....	.....	33,791	.....	.....
Value	$938,281	$550,640	.....	.....	.....	.....	$387,641	.....	.....
Stands and woodwork, number	102,621	68,830	.....	.....	.....	.....	33,791	.....	.....
Value	$715,928	$481,810	.....	.....	.....	.....	$234,118	.....	.....
Oscillating shuttle—									
Heads, number	8,683	.....	.....	.....	.....	.....	8,683	.....	.....
Value	$50,700	.....	.....	.....	.....	.....	$50,700	.....	.....
Stands and woodwork, number	8,683	.....	.....	.....	.....	.....	8,683	.....	.....
Value	$101,472	.....	.....	.....	.....	.....	$101,472	.....	.....
Chain-stitch—									
Heads, number	1,919	.....	1,244	.....	.....	675	.....	.....	.....
Value	$14,921	.....	$11,196	.....	.....	$3,725	.....	.....	.....
Stands and woodwork, number	1,769	.....	1,244	.....	.....	525	.....	.....	.....
Value	$21,866	.....	$17,091	.....	.....	$4,775	.....	.....	.....
Single-thread—									
Heads, number	675	.....	.....	.....	.....	675	.....	.....	.....
Value	$3,725	.....	.....	.....	.....	$3,725	.....	.....	.....
Stands and woodwork, number	525	.....	.....	.....	.....	525	.....	.....	.....
Value	$4,775	.....	.....	.....	.....	$4,775	.....	.....	.....
Double-thread—									
Heads, number	1,244	.....	1,244	.....	.....	.....	.....	.....	.....
Value	$11,196	.....	$11,196	.....	.....	.....	.....	.....	.....
Stands and woodwork, number	1,244	.....	1,244	.....	.....	.....	.....	.....	.....
Value	$17,091	.....	$17,091	.....	.....	.....	.....	.....	.....

[1] Includes establishments distributed as follows: Kansas, 1; Kentucky, 1; Minnesota, 1; Missouri, 1; New Hampshire, 1; Rhode Island, 2.

The products of the establishments engaged in the manufacture of household sewing machines, presented in Table 5, are shown separately for the 7 states reporting each three establishments or over, and the products of the other 5 states reporting less than three establishments each are grouped under the head of "all other states." The aggregate value of all household sewing machines manufactured in the United States during the census year was $10,644,221, of which Connecticut produced $1,032,450, or 9.7 per cent; Illinois, $2,302,451, or 21.6 per cent; Massachusetts, $1,237,969, or 11.6 per cent; New Jersey, $3,048,850, or 28.6 per cent; New York, $8,500, or less than one-tenth of 1 per cent; Ohio, $2,474,706, or 23.3 per cent; Pennsylvania, $133,035, or 1.3 per cent; and all others, which include Kansas, Kentucky, Minnesota, Missouri, New Hampshire, and Rhode Island, $406,260, or 3.8 per cent. Of the total value of products reported, $5,809,064 was reported for the 747,587 "heads" manufactured, and $4,835,157 for the 749,370 stands and woodwork. The item of "heads" constitutes 54.6 per cent, and stands and woodwork 45.4 per cent of the total value of products.

The number and value of lock-stitch machines manufactured are far in excess of the chain-stitch machines. Of the former class, 745,668 "heads," valued at $5,794,143 were produced, each item constituting 99.7 per cent of the total for both classes. The lock-stitch machines were classified according to the shuttle used, the vibrators being in the lead, with 634,364 "heads," valued at $4,805,162, forming 85.1 per cent and 82.9 per cent, respectively, of the total. The rotary-shuttle machines come second, with a total number of 102,621 "heads," valued at $938,281, or 13.7 per cent and 16.2 per cent, respectively, of the total. The machines using the oscillating shuttle constitute a very small proportion of the lock-stitch machines produced, the number of this class only amounting to 8,683, or 1.2 per cent, valued at $50,700, or nine-tenths of 1 per cent. The total number of heads manufactured for chain-stitch machines was 1,919, valued at $14,921. Of this number, 675, valued at $3,725, used the single thread, and 1,244, reporting a value of $11,196, used the double thread. The average values of the different classes of household machines vary little in regard to the "heads," the general average value being about $7.77 per machine.

Table 6 presents a detailed statement, by states, of products of the establishments engaged in the manufacture of sewing machines for factory use, separated so as to distinguish between the wax-thread machines and the dry-thread machines. A second separation of products is made in the same manner as in the machines for household use, in Table 5, in order to show the kind of shuttle used in the lock-stitch machines and the number of threads for the chain-stitch machines. In the case of sewing machines for factory use, the completed product rarely includes stands or woodwork, so that no special cognizance is taken of them in this tabulation.

TABLE 6.—SEWING MACHINES FOR FACTORY USE, NUMBER AND VALUE, BY STATES: 1900.

	United States.	Connecticut.	Illinois.	Massachusetts.	New Jersey.	New York.	Ohio.	All other states.[1]
Sewing machines:								
Total number	55,227	32,205	3,112	587	10,977	1,222	6,448	676
Total value	$2,395,017	$675,321	$110,000	$51,899	$1,172,145	$37,388	$138,314	$210,000
Wax-thread—								
Total number	5,047	.....	2,930	255	.....	.....	1,186	676
Total value	$379,877	.....	$103,200	$37,027	.....	.....	$29,650	$210,000
Lock-stitch—								
Total number	1,857	.....	.....	71	.....	.....	1,186	600
Total value	$195,152	.....	.....	$15,502	.....	.....	$29,650	$150,000
Vibrating-shuttle—								
Number	1,786	.....	.....	.....	.....	.....	1,186	600
Value	$179,650	.....	.....	.....	.....	.....	$29,650	$150,000
Rotary-shuttle—								
Number	71	.....	.....	71	.....	.....	.....	.....
Value	$15,502	.....	.....	$15,502	.....	.....	.....	.....
Chain-stitch—								
Total number	3,190	.....	2,930	184	.....	.....	.....	76
Total value	$184,725	.....	$103,200	$21,525	.....	.....	.....	$60,000
Single-thread—								
Number	184	.....	.....	184	.....	.....	.....	.....
Value	$21,525	.....	.....	$21,525	.....	.....	.....	.....
Double-thread—								
Number	3,006	.....	2,930	.....	.....	.....	.....	76
Value	$163,200	.....	$103,200	.....	.....	.....	.....	$60,000
Dry-thread—								
Total number	50,180	32,205	182	332	10,977	1,222	5,262	.....
Total value	$2,015,140	$675,321	$6,800	$14,872	$1,172,145	$37,388	$108,664	.....
Lock-stitch—								
Total number	30,941	30,671	.....	270	.....	.....	.....	.....
Total value	$550,361	$538,631	.....	$11,730	.....	.....	.....	.....
Rotary-shuttle—								
Number	30,799	30,671	.....	128	.....	.....	.....	.....
Value	$548,231	$538,631	.....	$9,600	.....	.....	.....	.....
Oscillating-shuttle—								
Number	142	.....	.....	142	.....	.....	.....	.....
Value	$2,130	.....	.....	$2,130	.....	.....	.....	.....
Chain-stitch—								
Total number	19,239	1,534	182	62	10,977	1,222	5,262	.....
Total value	$1,464,779	$136,690	$6,800	$3,142	$1,172,145	$37,388	$108,664	.....
Single-thread—								
Number	11,862	84	132	.....	10,891	755	.....	.....
Value	$1,171,586	$966	$4,800	.....	$1,154,395	$11,425	.....	.....
Double-thread—								
Number	7,377	1,450	50	62	86	467	5,262	.....
Value	$293,193	$135,724	$2,000	$3,142	$17,750	$25,913	$108,664	.....

[1] Includes establishments distributed as follows: Kansas, 1; Kentucky, 1; Minnesota, 1; Missouri, 1; New Hampshire, 1; Rhode Island, 2.

The total number of sewing machines for factory use produced in the United States during the census year was 55,227, valued at $2,395,017. These are of so varied a nature, and cover so wide a range of values, that any statement of average values would be of little statistical or commercial use. Of the states producing sewing machines for factory use, New Jersey leads in total value of product, with $1,172,145, or 48.9 per cent; Connecticut comes second with a product valued at $675,321, or 28.2 per cent of the total; Ohio is third, reporting a value of $138,314, or 5.8 per cent of the total; Illinois follows, with a product of $110,000, or 4.6 per cent; Massachusetts, with $51,899, or 2.2 per cent; and New York, with $37,338, or 1.5 per cent. The products reported for all other states, which include Kansas, Kentucky, Minnesota, Missouri, New Hampshire, and Rhode Island, are valued at $210,000, and constitute 8.8 per cent of the total for all states producing sewing machines for factory use.

No noticeable distinction between household sewing machines and those intended for factory use occurs in the nature of the stitch which prevails. While, on the one hand, over 99 per cent of the household machines execute the lock-stitch, on the other hand, a large majority of the factory machines also produce the lock-stitch. Of the two classes of factory machines, the one using wax and the other dry thread, the latter is much more extensively manufactured. The value of dry-thread sewing machines produced was $2,015,140, or 84.1 per cent of the total value of all machines for factory use. The balance, $379,877, or 15.9 per cent, was reported for machines using wax thread. Of the former class, $1,464,779, or 72.7 per cent, was reported for chain-stitch machines, and the balance, $550,361, for lock-stitch machines. The chain-stitch machines are also more extensively used with wax thread than the lock-stitch, exceeding the lock-stitch machines in number but not in value.

Table 7 is a statement of the value of sewing machines exported during the decade ending June 30, 1900, as published by the Bureau of Statistics of the Treasury Department, in the report for 1900 on Commerce and Navigation of the United States.

TABLE 7.—SEWING MACHINES AND PARTS OF: VALUE OF EXPORTS, 1891 TO 1900, INCLUSIVE.[1]

COUNTRIES.	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	Total for 10 years.
Totals	$2,883,577	$3,133,992	$2,476,446	$2,347,354	$2,260,189	$3,139,249	$3,340,241	$3,136,364	$3,264,344	$4,541,774	$30,523,480
EUROPE.											
Austria-Hungary	14,492	3,850	2,920	5,413	12,160	28,711	7,853	11,001	7,305	5,448	99,153
Azores and Madeira islands	416	280	291	68	.....	125	113	109	192	333	1,927
Belgium	50,626	43,302	53,938	48,363	36,200	45,998	55,879	62,431	33,946	40,949	471,632
Denmark	41	340	.....	124	1,773	18,600	1,153	114	2,210	335	24,690
France	116,046	269,387	52,757	91,246	98,566	103,024	123,606	102,809	95,953	138,392	1,191,786
Germany	609,760	616,986	563,401	255,507	472,203	676,844	761,229	861,702	688,980	1,016,591	6,523,143
Gibraltar	212	231	37	.....	.....	.....	.....	.....	9	.....	489
Greece	.....	.....	.....	.....	211	153	.....	.....	300	30	694
Italy	10,832	15,820	12,307	8,696	8,756	9,926	12,720	17,666	24,006	29,075	149,804
Netherlands	34,417	32,869	47,365	4,678	22,613	60,680	97,276	101,124	90,290	207,665	698,922
Portugal	1,666	950	.....	741	77	101	.....	.....	.....	189	3,724
Russia:											
Baltic and White seas	.....	.....	7,223	2,927	.....	5,143	16,855	13,114	4,927	16,557	66,746
Black Sea	.....	.....	.....	.....	.....	64,653	1,305	2,131	.....	7,227	75,316
Spain	3,122	166	437	1,340	1,314	1,859	97	59	50	5,345	13,789
Sweden and Norway	13,240	21,558	17,981	1,097	8,919	1,852	1,218	3,314	488	833	70,500
Switzerland	352	.....	.....	.....	100	.....	.....	.....	677	2,047	3,176
Turkey in Europe	.....	.....	.....	.....	137	51	.....	580	2,975	93	3,836
United Kingdom	848,493	809,391	848,540	712,411	645,847	938,861	1,074,489	879,650	956,424	1,329,712	9,043,818
NORTH AMERICA.											
Bermuda	.....	1,320	1,394	534	1,024	917	693	836	1,546	1,616	9,880
British Honduras	3,862	3,750	3,542	2,159	3,362	4,012	5,493	3,882	1,876	3,264	34,702
Dominion of Canada:											
Nova Scotia, New Brunswick, etc	3,800	5,368	10,774	11,709	14,746	12,795	12,017	15,164	13,236	11,977	111,586
Quebec, Ontario, Manitoba, etc	51,580	46,485	69,795	94,386	90,485	84,880	79,804	109,263	135,051	152,664	914,343
British Columbia	6,577	5,454	4,755	5,160	4,389	4,395	8,378	13,301	10,439	24,864	87,662
Newfoundland and Labrador	2,152	2,801	4,996	3,044	1,818	1,290	2,920	3,444	4,369	5,347	32,181
Central American States:											
Costa Rica	12,945	14,678	12,483	3,880	5,525	12,073	13,574	7,054	4,706	7,037	93,955
Guatemala	20,372	11,638	13,652	7,965	14,346	20,203	15,663	7,527	2,579	221	114,166
Honduras	6,696	6,042	4,711	2,985	5,616	3,509	7,251	4,151	5,054	9,006	55,021
Nicaragua	25,593	10,667	5,268	4,390	13,764	19,690	12,629	3,626	3,907	11,233	110,767
Salvador	35,024	27,976	18,521	10,687	22,363	34,500	33,507	4,072	2,690	719	190,059
Mexico	174,546	165,122	142,764	151,239	132,841	215,359	199,016	197,692	270,592	291,882	1,941,053
Miquelon, Langley, etc	410	618	65	.....	.....	278	264	159	373	685	2,852
West Indies:											
British	15,101	16,988	10,249	13,853	13,628	12,058	10,215	12,355	17,365	18,336	140,143
Cuba	112,319	246,218	95,630	212,696	16,114	14,426	8,199	2,785	12,323	99,050	814,760
Danish	87	536	776	280	185	275	389	232	470	395	3,625
Dutch	3,961	2,574	2,910	1,191	1,069	1,253	1,063	1,839	1,142	808	17,810
French	2,728	2,533	750	932	1,849	1,718	1,622	1,271	699	2,221	16,323
Haiti	7,314	6,619	9,217	11,967	4,906	5,243	3,947	938	952	1,576	52,679
Porto Rico	2,760	5,215	4,618	3,584	2,230	2,953	2,242	3,120	4,086	3,331	34,089
Santo Domingo	2,981	1,377	3,723	1,962	1,817	1,380	1,798	1,282	2,378	3,432	22,075
SOUTH AMERICA.											
Argentina	24,420	22,892	67,886	71,513	58,504	103,171	101,628	77,188	143,893	184,699	850,794
Bolivia	.....	1,294	199	295	880	80	.....	419	798	8,687	12,552
Brazil	78,393	72,976	89,832	101,719	140,054	137,520	114,555	95,966	112,398	135,522	1,078,935
Chile	17,079	22,665	19,842	18,126	21,894	35,111	18,709	7,663	13,194	21,010	195,293
Colombia	120,248	99,790	65,204	49,674	39,924	71,862	113,043	82,359	69,374	13,723	725,201
Ecuador	16,171	9,015	16,738	14,116	11,492	16,175	18,722	21,005	31,969	36,693	192,096

[1] Reports on Commerce and Navigation of the United States: United States Treasury Department.

TABLE 7.—SEWING MACHINES AND PARTS OF: VALUE OF EXPORTS, 1891 TO 1900, INCLUSIVE[1]—Continued.

COUNTRIES.	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	Total for 10 years.
SOUTH AMERICA—continued.											
Guianas:											
British	$1,093	$1,116	$1,965	$2,862	$3,189	$2,230	$1,198	$2,090	$3,074	$1,607	$20,424
Dutch		230	25	165	324	13	34	279	374	142	1,586
French	284	473	361	627	1,314	424	631	810	809	1,114	6,797
Paraguay									480	976	1,456
Peru	36,105	31,763	19,503	13,743	8,609	23,912	33,547	37,156	40,869	59,424	304,631
Uruguay	5,685	2,035	2,569	7,256	13,317	18,440	8,328	14,342	15,532	17,191	104,695
Venezuela	76,631	70,744	52,673	45,306	46,248	47,672	36,720	17,525	20,200	13,854	427,573
ASIA.											
Aden						167	81		40	122	410
Chinese Empire	2,073	5,252	5,336	2,179	2,414	5,952	9,505	3,848	4,544	7,769	48,872
East Indies:											
British	3,942	4,187	6,515	3,626	1,162	5,176	2,814	4,368	7,818	6,355	45,958
Dutch		45		107	29		28	36	601		846
French		341	300	260	172	735	368		1,046	620	3,842
Hongkong	3,948	1,704	3,547	3,173	587	2,358	2,770	2,708	7,051	12,426	40,272
Japan	1,453	1,052	2,499	1,265	3,465	9,685	7,275	5,883	5,270	11,706	49,553
Korea										50	50
Russia, Asiatic		18	847	343	107	341	7,952	910	280	984	11,782
Turkey in Asia	199	217	876	835	1,523	355	833	993	1,407	877	8,115
All other Asia	656	650	150	1,087	768	3,268	1,262	6,846	13,603	13,082	41,372
OCEANIA.											
British Australasia	268,578	366,058	73,174	310,948	224,875	215,080	249,510	274,154	321,785	479,339	2,783,501
French Oceania	4,328	5,065	2,608	2,509	3,148	2,644	6,544	2,697	2,467	4,014	36,024
Hawaii	16,289	7,026	7,318	8,818	9,968	11,337	15,804	16,757	29,132	47,363	169,812
Philippine Islands			162	228					126	130	646
Tonga, Samoa, etc						320		14	165	45	544
AFRICA.											
British Africa	6,375	3,412	4,910	4,928	6,674	12,554	10,680	9,489	9,743	7,585	76,350
Canary Islands		1,257	1,725	3,177	2,421	1,711	3,197	252	850	2,807	17,397
French Africa	1,590	2,311	925		93		1,451		59		6,429
Liberia	258	539	568	293	368	93	195	39	99	197	2,649
Portuguese Africa			25	80		595	2,620	296	523	467	4,556
Spanish Africa	2,400										2,400
Turkey in Africa—Egypt	160				275	150		408	711	759	2,463
All other Africa	125	164	142	163	413	380	760	72			2,219
All other British possessions				475	27						502
All other islands and ports	731	557	282	349	48						1,917

[1] Reports on Commerce and Navigation of the United States: United States Treasury Department.

The figures presented in this table show a marked increase in the value of sewing machines and parts of sewing machines exported during the decade. In 1891 the exports amounted to $2,883,577, as compared with $4,541,774 for 1900, an increase of $1,658,197, or 57.5 per cent. The value of exports for the year ending June 30, 1900, was greater than any in the previous history of the industry, exceeding by nearly a million dollars that of any preceding year. Of the total value of sewing machines exported during the decade ($30,523,480), the United Kingdom, Germany, British Australasia, and Mexico furnished markets for $20,291,515, or 66.5 per cent. The United Kingdom led all other countries with a total value during the period of $9,043,818, which was equal to 29.6 per cent of the entire exports of sewing machines for the ten years. Germany was second, with $6,523,143, or 21.4 per cent of the total exports. British Australasia received $2,783,501, or 9.1 per cent, and Mexico, $1,941,053, or 6.4 per cent of the total exports for all countries. These figures, however, do not even approximately represent the value of sewing machines of American make used abroad.

In recent years American sewing machine manufacturers, finding it impossible, on account of the difference in the rates of wages, to compete by home manufacture with the manufacturers of Europe in the markets of the other continent, were forced to extend their manufacturing operations to foreign countries. Some of the leading American manufacturers now have branch establishments in Europe and elsewhere, where labor can be secured more cheaply than at home, and have them equipped with American machinery and tools for producing duplicates of the home product for the foreign markets. In some cases, these establishments are of immense proportions, their output equaling that of the home plants. It is estimated that the number of American sewing machines sold abroad each year, including the American machines made in foreign countries, is about equal to the number disposed of in the home markets by all of the American companies. The exports of American sewing machines since 1860 will aggregate about $90,000,000 in value. No greater testimony of the superiority of the American sewing machine could be demonstrated than its enormous foreign sale, as shown in part by the exports.

The system of foreign manufacture of American sewing machines has not affected the export trade to so great a degree as might at first be imagined. The figures for the last decade do not show any perceptible falling off in the exports, occasioned by the establishment of these plants, except during the years 1893, 1894, and 1895, each of which shows a decline of nearly one-third from the figures for the years immediately preceding and following. Similar fluctuations are noticeable in previous years, as, for instance, in 1884,

when the value of sewing machine exports amounted to $3,552,814 (the greatest for any year with the exception of 1900), while during the next five years there was a uniform decrease from $2,898,698 in 1885 to $2,247,875 in 1889. In 1900 the value of sewing machines exported is equal to 21.5 per cent of the total product for the United States, and in 1890 the exports amounted to 18.5 per cent of the total output for the United States of the establishments engaged in the industry during that year.

Table 8 presents the principal statistics of the industry in cities having a population of 20,000 and over.

TABLE 8.—SEWING MACHINES AND ATTACHMENTS, INCLUDING SEWING MACHINE CASES: STATISTICS OF CITIES OF OVER 20,000 IN POPULATION, 1900.

CITIES.	Number of establishments.	Capital.	SALARIED OFFICIALS, CLERKS, ETC.		AVERAGE NUMBER OF WAGE-EARNERS AND TOTAL WAGES.								Miscellaneous expenses.	Cost of materials used.	Value of products.
					Total.		Men, 16 years and over.		Women, 16 years and over.		Children, under 16 years.				
			Number.	Salaries.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.			
Total	53	$16,026,323	593	$740,932	11,233	$6,178,595	10,592	$6,010,550	440	$136,467	201	$31,578	$760,429	$7,999,529	$17,927,964
Cleveland, Ohio	4	2,681,256	137	181,167	1,328	713,906	1,303	708,722	12	3,000	13	2,184	120,792	1,195,696	2,438,357
Chicago, Ill	9	662,569	39	67,271	359	207,556	338	202,393	5	1,416	16	3,747	67,749	1,234,473	1,765,469
New Haven, Conn	3	338,550	10	10,360	529	237,400	413	209,000	100	26,000	16	2,400	42,719	136,593	497,300
New York, N. Y	11	126,282	42	27,572	75	40,672	75	40,672	.....	.....	.....	.....	22,507	48,072	194,006
All other cities[1]	26	12,217,666	365	454,562	8,942	4,979,961	8,463	4,849,763	323	106,051	156	23,247	506,662	5,384,695	13,032,832

[1] Includes establishments distributed as follows: Boston, Mass., 2; Bridgeport, Conn., 2; Camden, N. J., 1; Cincinnati, Ohio, 1; Dayton, Ohio, 1; Elizabeth, N. J. 1; Hartford, Conn., 2; Lawrence, Mass., 1; Louisville, Ky., 1; Newark, N. J., 2; Philadelphia, Pa., 2; Providence, R. I., 2; Rockford, Ill., 2; St. Louis, Mo., 1; St. Paul, Minn., 1; South Bend, Ind., 1; Syracuse, N. Y., 1; Wichita, Kans., 1; Williamsport, Pa., 1.

The tendency of manufacturing establishments toward concentration in localities which will afford the greatest commercial advantages is demonstrated in the sewing machine industry. A glance at Table 8 will show that out of the 65 establishments engaged in the sewing machine industry in the United States, 53, or 81.5 per cent, are located in cities having a population of 20,000 or over. These report a capital of $16,026,323, or 79.8 per cent of the total for the United States; 11,233 wage-earners, or 84.5 per cent of the total, receiving in wages $6,178,595, or 84.9 per cent of the total; miscellaneous expenses amounting to $760,429, or 80.4 per cent of the total; materials costing $7,999,529, or 85.6 per cent of the total; and products valued at $17,927,964, or 84.8 per cent of the total for all establishments engaged in the industry in the United States. The 53 establishments are located in 23 cities, but the statistics of only 4 of these cities can be separately shown, since the remainder report less than 3 establishments each, and the statistics of these are grouped, in order not to reveal the operations of individual establishments. Of the cities reporting 3 establishments and over, New York leads with 11, followed by Chicago with 9, Cleveland with 4, and New Haven with 3, the total number for the 4 cities being 27.

While the number of establishments located in these 4 cities is 51 per cent of the total for all cities, the capital invested is equal only to 23.8 per cent, and the value of the products equal to 27.3 per cent of the total for all cities. The average value per establishment of capital invested, and the average value of products per establishment, for New York city, is extremely low as compared with the same averages for the total of the 23 cities. This is also the case in a lesser degree in Chicago and New Haven. While the average capital for the 53 establishments located in cities of a population of 20,000 or over is $302,385, and the average production per establishment is $338,263, the corresponding figures for New York are $11,480 and $17,637; for Chicago, $73,619 and $196,163; and for New Haven, $112,850 and $165,767. The extremely low average for New York is accounted for by the fact that a majority of the establishments are engaged merely in the manufacture of attachments and parts of sewing machines, or in the manufacture of some special machine which has but a limited sale in certain localities, and these establishments are operated on a very small scale. Compared with the above averages, those of Cleveland, Ohio, are extremely high. The average value of capital invested per establishment and the average value of products are $670,314 and $609,589, respectively, which is considerably in excess of the averages for all cities.

Table 9 presents a summary of the statistics of 16 industries reported at the census of 1900, in which the sewing machine in some form is used extensively.

Sewing machines for factory purposes cover a wide range of usefulness. While the principal purpose for which they are utilized is the factory manufacture of clothing, other very important industries are dependent in a large degree, upon the sewing machine as a means of manufacture. In addition to the industries enumerated in Table 9, which report an aggregate product of $979,988,413, might be mentioned the following, in which the sewing machine is used to a greater or less extent: Belting and hose, linen and rubber; clothing, horse; clothing, men's, custom work and repairing; leather goods; mattresses; regalia and society banners and emblems; and umbrellas.

TABLE 9.--SUMMARY OF STATISTICS OF 16 INDUSTRIES IN WHICH THE SEWING MACHINE IS USED EXTENSIVELY, 1900.

INDUSTRY.	Number of establishments.	Capital.	WAGE-EARNERS.		Miscellaneous expenses.	Cost of materials used.	Value of products.
			Average number.	Total wages.			
Total for 16 industries	42,220	$407,029,429	530,040	$200,518,292	$77,580,371	$538,845,367	$979,988,418
Awnings, tents, and sails	858	4,342,728	4,400	2,038,613	523,961	6,480,685	11,728,843
Bags, other than paper	78	7,696,732	4,039	1,133,128	546,135	16,849,311	20,123,486
Bookbinding and blank book making	954	12,744,628	15,971	6,671,666	1,575,936	7,702,543	20,790,858
Boots and shoes, factory product	1,600	101,795,233	142,922	59,175,883	10,766,402	169,604,054	261,028,580
Clothing, men's, factory product	5,731	120,620,351	120,950	45,505,778	37,509,258	145,295,248	276,861,607
Clothing, men's, factory product, buttonholes	149	246,539	944	332,187	36,234	98,178	680,502
Clothing, women's, dressmaking	14,479	13,815,221	45,595	14,352,453	8,342,143	16,503,754	48,356,034
Clothing, women's, factory product	2,701	48,431,544	83,739	32,586,101	11,733,695	84,704,592	159,339,539
Corsets	216	7,481,048	12,729	3,791,509	1,030,745	6,555,467	14,878,116
Flags and banners	36	666,033	509	148,933	76,370	547,165	1,038,052
Gloves and mittens	394	9,089,809	14,345	4,182,518	567,697	9,483,130	16,926,156
Hats and caps, not including fur hats and wool hats	645	8,394,490	12,545	5,025,288	1,023,606	10,907,384	21,394,480
Pocketbooks	68	991,876	1,653	588,595	115,913	1,278,226	2,495,188
Saddlery and harness	12,934	43,354,136	24,123	10,725,647	2,996,787	33,127,926	62,630,902
Shirts	986	20,312,412	38,492	11,425,101	4,918,576	23,662,317	49,022,845
Trunks and valises	391	7,046,649	7,084	2,834,892	816,913	6,046,387	12,693,225

HISTORICAL AND DESCRIPTIVE.

The mechanical development of the sewing machine has been almost wholly confined to the United States and has been accomplished within the last half century. The census of 1860 for the first time shows the statistics of sewing machine manufacture. From the time the first sewing machine patent was issued to John J. Greenough in 1842, until the year 1900 the total number of patents issued in the United States on sewing machines and attachments was 8,493, of which only 10 were issued prior to 1850. During the four decades following 1850 the increase in the number of patents issued was remarkable, especially between 1870 and 1880, and 1880 and 1890, the number of patents issued during those decades being 2,327 and 2,807, respectively.

It was little over fifty years ago that Elias Howe, jr., patented his first sewing machine, which event marks the actual beginning of the industry in the United States. Previous efforts to produce machines for stitching cloth and other materials had either resulted in failure or met with but temporary success. Only the most important of these will be discussed. One of the earlier principles whose application to mechanical sewing was attempted was that of the through-and-through stitch and short thread, and this principle was persistently followed up by inventors long after the introduction of the eye-pointed needle and continuous thread.

The double-pointed needle with the eye located in the center was the first to be applied to mechanical sewing, and was introduced by Charles F. Weisenthal in England, where he secured a patent June 24, 1755. The needle was intended only for hand embroidery, and not until 1770 was the principle applied to sewing machines. In this year Thomas Alsop patented a machine in England which used the double-pointed needle for embroidering purposes. Later, in 1804, a machine for embroidering in a loom with a large number of needles was conceived by John Duncan, and the idea was still further carried out and perfected in Heilman's embroidering machine patented in England in 1829.[1] The first officially recorded attempt made in the United States to construct a sewing machine on the principle of the short thread and double-pointed needle was by John J. Greenough, who built and patented a machine in 1842.[2] It was designed for sewing leather and other hard material, an awl piercing a hole in advance of the needle. The material to be sewed was held between clamps provided with a rack, which was moved both ways alternately, to produce a back stitch, or continuously forward to make the shoemaker's stitch. The material was fed automatically the length of the rack bar, at a rate determined by the length of stitch required. The needle was passed through and through the material by means of pinchers traveling on a rack, the thread being drawn out by weights. When the thread became too short or was broken, the machine stopped automatically.

Greenough's sewing machine, like similar attempts at mechanical stitching which embodied the features of the through-and-through stitch and short thread, was of no practical use; but it possessed some valuable points, and holds a creditable place in the history of the industry.

Inventors early sought to apply the old crochet stitch to mechanical sewing. Among the records of the English patent office has recently been found the design of a sewing machine intended to execute the old crochet stitch, which was patented by Thomas Saint, July 17, 1790.[1] This machine is the first attempt at mechanical sewing, so far as any official record shows, and this makes more remarkable the fact that many of the essential features of the modern sewing machine are embodied in the design of the Saint machine. These features are crude, it is true, and may never have been practical in their operation; but the fact remains that the horizontal feed plate, the overhanging arm carrying on its end a ver-

[1] American Encyclopedia, vol. 14, page 799.
[2] Knight's American Mechanical Dictionary, Vol. III, page 2099.

tically reciprocating straight needle, and the intermittent automatic feed were first incorporated in a design of over a century ago. It is not known that the machine of Thomas Saint ever existed save on paper, as the only history of the inventor or his machine is the record in the English patent office. If this record had been discovered twenty years earlier it might have changed the entire course of the sewing machine trade of the world, and would have weakened, if not destroyed, more than one of the patents since granted.

The first machine on official record which was put to practical use was patented by Barthelemy Thimonnier in France in 1830, and subsequently in the United States and England. This invention was so far successful that in 1841, 80 of the machines made of wood were in use for sewing army clothing in a shop in Paris.[1] These were destroyed by a mob, as had been the Jacquard loom and similar labor-saving devices years before. Thimonnier made another attempt in Paris to introduce his sewing machine and apply it to practical uses. He succeeded in producing a set of machines capable of making 200 stitches a minute, and sewing and embroidering any material from muslin to leather. This set of machines was constructed of iron and followed the general model of the original machine, but with several improvements. In 1848 the inventor was again assailed by a mob, which destroyed all his machines and barely allowed him to escape with his life.[1] The mob was composed of misguided champions of labor who feared that the introduction of this labor-saving device would destroy the occupation of the seamstress. Time and experience have proven the fallacy of their judgment. The development of the sewing machine has opened up new fields of industry in all parts of the world and given employment to thousands of laborers. Its scope of usefulness is continually increasing, and it is constantly being introduced in varying forms into new channels of mechanical industry.

Thimonnier's machine, like the machine designed by Saint half a century earlier, was in the form which subsequent experience has justified; that is to say, it had the vertical needle descending from the end of an overhanging arm and piercing the goods, which were fed beneath upon a flat table. The needle was depressed by a treadle and cord and returned by a spring. This needle, which was a barbed or crochet needle, plunged through the goods, caught a lower thread from a thread carrier and looper beneath, and brought up a loop which it laid upon the upper surface of the cloth; descending again, it brought up another loop and enchained it with the one last made, forming a chain-stitch consisting of a series of loops on the upper side.

Thimonnier's efforts to introduce his sewing machine were made very difficult on account of his poverty, and the repeated destruction of machines built with money solicited from friends, wearied at last even the admirers of his genius and energy, and he was left, in 1857, to die in poverty.[1]

In England, in 1841, Newton and Archbold patented a chain-stitch machine, using the eye-pointed needle. The needle passed the thread through the cloth and formed a loop which was seized by a hook and carried forward. On its next trip the needle would pass through the loop thus made and form a single-chain stitch.[2]

The great advantages of the eye-pointed needle, however, were never fully appreciated until the invention of the lock-stitch, which is made by passing the thread through the fabric by means of an eye-pointed needle, and then passing another thread through the loop thus formed, the second thread interlocking with the first in the middle of the fabric. This idea was first conceived about 1834 by Walter Hunt, of New York. He built a machine embodying the eye-pointed needle and the shuttle, which, so far as is generally known, was never sufficiently perfected for practical use. He failed, however, to protect his ideas by patents, as required by law, and consequently failed to reap the reward of his genius.[3] Hunt never fully appreciated the importance of the opportunity he had allowed to slip by until years later, when Elias Howe, jr., patented a machine which was similar in the results accomplished to his own. He then attempted to assert his prior claims to a patent, which was denied him on the ground of abandonment.

The sewing machine patented by Elias Howe, jr., September 10, 1846,[4] technically marks the beginning of the industry in the United States. At this time the sewing machine was still in the experimental stage, and it was not until several years later that its manufacture became an established industry. After that its growth was rapid; and owing to the untiring energy and the ability of the inventors who applied themselves to the work of perfecting the sewing machine, it has attained in a few years a very important place among the industries of the country, and has come to be regarded as almost a household necessity.

Howe's invention combined the eye-pointed needle with the shuttle for forming the stitch and the intermittent feed for carrying the material forward as each stitch was formed. The device for thus feeding the cloth consisted of a thin strip of metal provided with a row of pins on one edge, upon which the material to be sewed was carried in a vertical position. The cloth was fed the length of the plate, and had to be rehung as often as the plate had traversed its full length on the machine. The curved, eye-pointed needle used was carried on the end of a vibrating lever, which also carried the upper thread. The shuttle, which passed the lower thread between the needle and the upper thread, was

[1] Knight's American Mechanical Dictionary, Vol. III, page 2101.

[2] Ibid., page 2100.

[3] Appleton's Encyclopedia of Applied Mechanics, vol. 2, page 734.

[4] Knight's American Mechanical Dictionary, Vol. III, page 2102.

driven in its race between two strikers carried on the end of vibrating arms worked by cams. It is not known that any of Howe's machines were ever put upon the market. In his application for renewal of patent he only claims to have built three machines, and one of these was deposited as a model in the United States Patent Office.

Not meeting with any success in securing capital in this country with which to forward his plans, Mr. Howe was compelled to dispose of his patent, and with the proceeds went to England, where his rights to a patent had been sold to a corset manufacturer for about one thousand dollars. Mr. Howe engaged to work for this manufacturer at a small salary, while perfecting the machine, and adapting it to the manufacture of corsets. Failing in this, he returned to the United States in extreme poverty, and upon his arrival at Boston, found that sewing machines infringing on his patents had been manufactured. He succeeded in securing a half interest that had been conveyed to his father before his departure for England, and commenced suits in the Boston and New York courts to enforce his rights. In the long and bitterly contested legal controversy which ensued, Mr. Howe succeeded in establishing his claims, after which manufacturers using his patents were compelled by the inventor to pay the exorbitant bounty of $25 for each machine manufactured.

The next fundamental and important step in the improvement of the sewing machine was conceived by John Bachelder, and patented May 8, 1849.[1] His machine was the first to combine the horizontal table and continuous feed device. The feed consisted of an endless band of leather set with small steel points. These points projected up through the horizontal table and penetrated the material to be sewed, carrying it by an intermittent motion to and beyond the needle. This device has been entirely superseded by Allen B. Wilson's patent, November 12, 1850,[2] of a four-motion feed, which is noted for its simplicity of action and admirable adaptability to the purpose for which it was designed. Wilson's feed device consists of a serrated plate, which rises through a groove in the table on which the material is fed, and by a horizontal motion carries the material forward the length of the stitch, when it drops below the surface of the table and is carried back to its former position at the end of the groove, thus describing a motion following the four sides of a parallelogram. The cloth is held in place by means of a presser foot descending from the head of the overhanging arm. The motion which carries the cloth forward is so regulated as to take place while the needle is above the surface, and by limiting the extent of this motion the stitch is easily adjusted. The highest degree of credit as an inventor is due to Mr. Wilson for the ingenuity displayed by him in making and perfecting the four-motion feed. His efforts, however, were not confined to this feature alone. In 1851 he patented a device for executing the lock-stitch, which consisted of a rotating hook used in place of a shuttle for interlocking the upper thread with the lower. This device, with some modifications and improvements, has become the distinguishing feature of certain modern sewing machines.

In September, 1850, Isaac M. Singer, a mechanic, of New York, who had become interested in sewing machine experiments and was familiar with one of the machines then on the market, constructed a machine from a design of his own, which was a great improvement, in many ways, over previous machines. This was the first machine which had the rigid overhanging arm to guide the vertical needle, in combination with a shuttle, and what was called a wheel feed. A patent for this machine was issued August 12, 1851.[3] The general style of the original Singer sewing machine serves as a model for a large proportion of the sewing machines that are being manufactured throughout the world to-day. A straight shaft in the overhanging arm imparted the motion to the needle, and the shuttle was driven in its race below the feed table by a mechanism deriving its motion from the shaft by means of gearing. The feed consisted of an iron wheel with a corrugated surface, the top of which was slightly elevated above the level surface of the table. By an intermittent motion the feed carried the cloth forward between stitches without injury to the fabric. This device permitted the cloth to be turned in any direction by the operator while sewing, which was impossible with the styles of feed which perforated the goods. The material was held in place by a presser foot alongside the needle. This presser foot embraced an important feature possessed by no other sewing machine up to that time—the yielding spring, which would permit of passage over seams, and adjust itself automatically to any thickness of cloth. In addition to this original lock-stitch machine, Mr. Singer afterwards contrived several inventions which contributed materially toward the improvement of the sewing machine. He produced a sewing machine which used the single chain-stitch, and also a double chain-stitch machine for ornamental work and embroidery.

The sewing machine had now arrived at a stage when all its essential features had been discovered by inventors and so far perfected as to demonstrate their practicability. It only remained for men of energy and business ability to apply themselves to the work of manufacture and to the development of facilities for marketing their products. Men who early appreciated the importance of the sewing machine as a factor in the commercial advancement of the world applied them-

[1] American Sewing Machines, One Hundred Years of American Commerce, Vol. II, page 526.

[2] American Encyclopedia, vol. 14, page 735.

[3] Knight's American Mechanical Dictionary, Vol. III, page 2107.

selves with great zeal to the promotion of the industry. Factories were established in Bridgeport, Boston, New York, and other cities for the exclusive manufacture of sewing machines. Bridgeport has always held a conspicuous place in the industry, and the history of the development and manufacture of the sewing machine will always be closely associated with that city. The importance of New York city as a commercial center was early appreciated by sewing machine manufacturers, and it was made the principal sales depot for that industry by establishments located throughout New England. One of the leading concerns then in existence for the manufacture of sewing machines carried on its operations in New York city.

In 1855 litigation arose, involving three of the principal sewing machine companies then in existence. It was claimed by each of the parties concerned that the others were infringing upon certain of their patent rights. Numerous suits were instituted on these patents, and when the contesting parties finally came together in 1856 for trying some of the cases in court, an amicable settlement was agreed upon whereby the parties to the suits were to pool their patents, thus permitting any one of them to use the patents of all the others so far as might be necessary in the construction of their sewing machines, and to protect the interests of all from infringements by outside parties. These patents and privileges were not confined to the three original parties to the combination, but were available to all manufacturers upon the payment of a fee, which was very small compared with the exorbitant bounty collected by Howe. No restrictions were placed upon manufacturers in regard to the price at which their products were to be sold, and the markets were open to fair competition by all on the merits of the several machines. The combination continued in existence, with Mr. Howe as a member, until the expiration of the extended term of his patent in 1867, and was then continued by the other members until the expiration of the Bachelder patent in 1877.

The sewing machines manufactured prior to the Singer, and many of them long after, used the vibrating arm for imparting motion to the needle. This result was accomplished either by means of the vibratory arm actuating a needle bar carrying a straight needle, or by means of the vibratory arm and curved needle. It is obvious that sewing machines constructed on either of these principles could not be enlarged or decreased in size without destroying their effectiveness: on the one hand the lengthening of the arm would naturally increase both the power required to operate it, and its liability to spring, and thus affect the proper action of the needle; on the other hand, decreasing the size of the arm would necessarily increase the curve of the needle and contract the space for turning and handling the work. Singer's arrangement of the rigid overhanging arm made it practicable to enlarge the machine to any desired extent, and added great solidity and strength to the machine, thus making it available either for doing the heaviest kinds of work or for sewing the lightest fabrics. The general style of the original Singer machine has been universally copied, and serves as a model for most of the machines now manufactured.

The work of adapting the sewing machine to the various kinds of stitching required in the variety of manufacturing and mechanical industries to which it has been applied, was early taken up by Isaac M. Singer, Allen B. Wilson, and others, and has been successfully continued by later inventors. Machines for stitching with waxed thread have been perfected for use in the factory manufacture of boots and shoes, as well as in the manufacture of saddlery and harness and various other articles of leather. Heavy power machines are used in the manufacture of awnings, tents, sails, canvas belts, and articles of a like nature. Specially constructed machines for stitching gloves, and others for sewing the seams of carpets, sewing the ends of filled bags, stitching brooms, embroidering, and doing various other work, are produced by the leading sewing machine manufacturers. Machines for working buttonholes and sewing on buttons have been made very effective in their operation, and produce a quality of work equal to the hand product at a greatly increased rate of speed.

Inventions covering the sewing machine and its attachments are numerous, and patents for them are continually being granted. The same is true of the machinery used in producing the various interchangeable parts of the sewing machine. The American principle of making all parts of the machine interchangeable has been carried to the fullest extent in this industry. Machines for producing the most intricate parts of the sewing machine are so perfected that they perform their work with remarkable speed and exactness. The special tools required to make the various parts of sewing machines often require more inventive talent in their construction than the machine manufactured. In the larger factories the experimental department is one of the most important and expensive. Here the inventor has every facility for developing new ideas and putting the results to preliminary tests. When, after a great deal of time and labor has been expended on an invention, and it has reached an apparently perfect condition, it is sent to a factory engaged in the class of work for which it is designed, and is thoroughly tested. If its operation proves satisfactory, a special plant of machinery is installed for the manufacture of the new machine or attachment, so that any number of duplicates can be made. After all this expensive preparation and experiment the invention may be soon replaced by something better, and abandoned.

In addition to the machines and devices for mechanical sewing above enumerated may be mentioned the following of more or less importance:

A short thread, running stitch, ordinary hand-needle machine, which crimped the cloth into ridges for passage over the needle, patented by B. W. Bean, March 4, 1843.

A short-thread "sewing engine," similar to Greenough's, patented by G. H. Corliss in 1843.

A running-stitch machine, similar to Bean's, patented July 22, 1844, by J. Rodgers.

A reciprocating lock-stitch machine, patented by J. A. Bradshaw, November 28, 1848.

Chain-stitch machines, patented by C. H. Morey and J. B. Johnson, and by J. S. Conant in 1849; also a horizontal table, chain-stitch machine for two or more threads, with the continuous-feed device already mentioned, patented by John Bachelder; and a lock-stitch, rotating-shuttle, continuous-feed machine, patented by S. C. Blodgett and J. A. Lerow in the same year.

A chain-stitch machine for two or more threads, patented by W. O. Grover and W. E. Baker, June 22, 1852.

A binder for binding hats, etc., patented by H. L. Sweet, December 20, 1853.

A hemmer for sewing umbrellas, by S. C. Blodgett; a buttonhole attachment, by C. Miller; a chain-stitch, two-thread machine, with embroidery attachment for carrying a third thread, by Isaac M. Singer; also a lifting presser foot, by the same inventor; a lock-stitch machine, with two needles, for overseaming and felling lap seams, by D. C. Ambler; and a shuttle carrier, by C. Parham, all in 1854.[1]

The American sewing machine from the first has enjoyed a large foreign sale on account of its recognized superiority over the machines manufactured abroad, which are usually copied after the models of the American machines. This is especially true in regard to the cases and wooden parts of the machine. The great abundance of timber products suitable for sewing machine woodwork produced in this country, and the superiority of the methods used in their production, have made possible competition by American manufacturers in the markets of Europe and elsewhere. The cases and cabinets for export are usually forwarded in a rough or unfinished state for greater convenience in shipping, and for the further reason that the labor required to complete them can be secured much cheaper abroad than in this country.

A great deal of attention has been given by inventors to the production of a suitable means of propulsion for the sewing machine, thus doing away with the labor of operating it by the ordinary foot treadle. A great number of experiments have been tried with water motors, air engines, steam engines, and springs and weights, but no effective motor was produced until the introduction of electricity for power. Electric sewing motors are now produced which are very effective in their operation and can be readily used in their smallest form in connection with the ordinary household machines, while larger sizes are available for the larger machines used for manufacturing purposes. Steam power is also extensively used in connection with the larger machines in factories, this power usually being applied by means of shafting under the long rows of tables bearing the machines, one row of shafting operating two rows of machines.

The introduction of the sewing machine has had a tendency to concentrate certain industries into large establishments, thus reducing the cost of production. This is especially true in the case of clothing manufacture, and in that of the manufacture of boots and shoes. Where formerly the manufacture of clothing was carried on in small shops employing hand labor, and in the household, it is now frequently done in immense establishments employing a great number of operatives and using hundreds of machines.

Table 10, which follows, presents in detail the statistics of the industry as returned at the census of 1900.

[1] Knight's American Mechanical Dictionary, Vol. III, pages 2105–2115.

TABLE 10.—SEWING MACHINE MANUFACTURE, BY STATES: 1900.

	United States.	Connecticut.	Illinois.	Indiana.	Massachusetts.	New Jersey.	New York.	Ohio.	Pennsylvania.	All other states.[1]
Number of establishments	65	7	14	3	8	4	12	6	4	7
Character of organization:										
Individual	13	1	3	.....	2	.....	5	1	1	.....
Firm and limited partnership	9	1	.....	1	2	.....	4	.....	.....	1
Incorporated company	43	5	11	2	4	4	3	5	3	6
Capital:										
Total	$20,072,800	$5,216,570	$2,196,345	$1,032,027	$2,056,385	$4,317,666	$130,282	$3,510,185	$506,452	$1,106,888
Land	$959,105	$169,256	$37,599	$46,000	$23,400	$425,000	$100	$126,000	$100,750	$31,000
Buildings	$2,691,331	$466,810	$333,316	$117,500	$108,359	$1,013,676	$400	$381,860	$118,450	$150,960
Machinery, tools, and implements	$3,898,430	$797,252	$430,901	$157,902	$488,427	$964,956	$38,650	$703,038	$205,804	$111,500
Cash and sundries	$12,523,934	$3,783,252	$1,394,529	$710,625	$1,436,199	$1,914,034	$91,132	$2,299,287	$81,448	$813,428
Proprietors and firm members	31	3	3	3	6	.....	13	1	1	1
Salaried officials, clerks, etc.:										
Total number	682	53	137	19	18	132	42	179	15	87
Total salaries	$908,965	$87,563	$169,910	$32,009	$71,893	$182,931	$27,572	$229,494	$10,708	$96,885
Officers of corporations—										
Number	79	12	23	1	6	3	5	16	2	11
Salaries	$249,254	$39,100	$59,303	$3,600	$57,825	$14,000	$6,582	$49,950	$3,300	$15,594
General superintendents, managers, clerks, etc.—										
Total number	603	41	114	18	12	129	37	163	13	76
Total salaries	$659,711	$48,463	$110,607	$28,409	$14,068	$168,931	$20,990	$179,544	$7,408	$81,291
Men—										
Number	485	38	78	18	10	109	34	131	7	65
Salaries	$607,989	$47,467	$92,856	$28,409	$13,248	$161,856	$19,360	$163,447	$5,900	$75,946
Women—										
Number	118	3	41	.....	2	20	3	32	6	11
Salaries	$51,722	$996	$17,751	.....	$820	$7,575	$1,630	$16,097	$1,508	$5,345

[1] Includes establishments distributed as follows: Kansas, 1; Kentucky, 1; Minnesota, 1; Missouri, 1; New Hampshire, 1; Rhode Island, 2

TABLE 10.—SEWING MACHINE MANUFACTURE, BY STATES: 1900—Continued.

	United States.	Connecticut.	Illinois.	Indiana.	Massachusetts.	New Jersey.	New York.	Ohio.	Pennsylvania.	All other states.[1]
Wage-earners, including pieceworkers, and total wages:										
Greatest number employed at any one time during the year	14,814	2,256	1,894	1,885	757	4,906	93	2,364	193	466
Least number employed at any one time during the year	11,715	1,934	1,183	1,453	583	4,382	57	1,547	137	439
Average number	13,288	2,104	1,522	1,707	665	4,701	75	1,910	160	444
Wages	$7,279,118	$1,176,622	$828,799	$619,050	$430,703	$2,809,523	$40,672	$1,052,321	$80,908	$240,520
Men, 16 years and over—										
Average number	12,592	1,947	1,463	1,540	660	4,431	75	1,879	157	440
Wages	$7,101,624	$1,131,310	$818,980	$592,659	$429,174	$2,724,924	$40,672	$1,045,157	$79,348	$239,400
Women, 16 years and over—										
Average number	467	141	15	12	5	270	.....	18	3	3
Wages	$141,769	$42,912	$1,731	$3,458	$1,529	$84,599	.....	$4,980	$1,560	$1,000
Children, under 16 years—										
Average number	229	16	44	155	.....	.....	.....	13	.....	1
Wages	$35,725	$2,400	$8,088	$22,933	.....	.....	.....	$2,184	.....	$120
Average number of wage-earners, including pieceworkers, employed during each month:										
Men, 16 years and over—										
January	11,887	1,930	1,472	1,440	629	4,145	77	1,598	156	440
February	11,935	1,944	1,456	1,448	637	4,149	78	1,633	153	437
March	12,255	1,884	1,585	1,498	641	4,272	74	1,700	161	440
April	12,493	1,822	1,640	1,558	664	4,381	72	1,759	157	440
May	12,577	1,831	1,571	1,559	676	4,453	73	1,825	156	433
June	12,589	1,897	1,342	1,581	688	4,486	71	1,944	147	433
July	12,509	1,955	1,240	1,586	689	4,526	73	1,866	141	433
August	12,599	1,945	1,319	1,635	623	4,508	79	1,910	142	438
September	12,646	1,986	1,400	1,518	634	4,519	79	1,910	158	442
October	12,965	2,015	1,452	1,529	667	4,567	78	2,045	165	455
November	13,285	2,057	1,507	1,564	670	4,585	75	2,206	172	438
December	13,364	2,097	1,573	1,560	701	4,585	74	2,153	171	450
Women, 16 years and over—										
January	443	141	17	7	6	251	.....	15	3	3
February	449	141	17	13	6	251	.....	15	3	3
March	458	141	18	14	5	259	.....	15	3	3
April	465	141	16	14	6	266	.....	16	3	3
May	469	141	15	14	6	270	.....	17	3	3
June	472	141	15	13	7	273	.....	17	3	3
July	472	141	14	13	5	275	.....	18	3	3
August	470	141	14	14	1	275	.....	19	3	3
September	470	141	14	13	2	275	.....	19	3	3
October	475	141	14	12	4	278	.....	20	3	3
November	480	141	14	12	6	280	.....	21	3	3
December	481	141	17	9	7	281	.....	20	3	3
Children, under 16 years—										
January	231	16	41	160	.....	.....	.....	13	.....	1
February	219	16	41	148	.....	.....	.....	13	.....	1
March	181	16	41	116	.....	.....	.....	7	.....	1
April	286	16	42	163	.....	.....	.....	14	.....	1
May	275	16	45	199	.....	.....	.....	14	.....	1
June	229	16	45	153	.....	.....	.....	14	.....	1
July	238	16	38	173	.....	.....	.....	10	.....	1
August	234	16	43	163	.....	.....	.....	11	.....	1
September	215	16	44	144	.....	.....	.....	10	.....	1
October	228	16	46	153	.....	.....	.....	12	.....	1
November	226	16	47	150	.....	.....	.....	12	.....	1
December	236	16	53	152	.....	.....	.....	14	.....	1
Miscellaneous expenses:										
Total	$946,223	$265,786	$169,795	$57,298	$75,059	$108,801	$22,522	$171,859	$21,237	$53,866
Rent of works	$87,086	$12,800	$23,717	$27,550	$2,084	$6,990	$6,810	$3,200	$1,020	$2,915
Taxes, not including internal revenue	$97,193	$12,482	$7,813	$7,929	$17,363	$27,317	$71	$17,420	$1,803	$4,995
Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$644,824	$125,994	$137,265	$21,819	$54,512	$74,494	$15,131	$151,239	$18,414	$45,956
Contract work	$117,120	$114,510	$1,000	.....	$1,100	.....	$510	.....	.....	.....
Materials used:										
Total cost	$9,343,676	$966,567	$2,017,667	$1,004,760	$519,784	$2,717,907	$48,682	$1,780,609	$96,308	$191,392
Principal materials—										
Total cost	$6,977,527	$765,647	$1,699,068	$946,187	$344,708	$1,359,839	$40,540	$1,563,581	$85,332	$172,625
Purchased in raw state	$76,189	$3,049	$26,419	$46,407	.....	.....	.....	$314	.....	.....
Purchased in partially manufactured form	$6,901,338	$762,598	$1,672,649	$899,780	$344,708	$1,359,839	$40,540	$1,563,267	$85,332	$172,625
Fuel	$170,426	$31,505	$6,661	$19,515	$7,337	$78,233	$572	$16,609	$2,834	$7,110
Rent of power and heat	$6,959	$100	$2,255	.....	$1,336	$850	$1,225	.....	$263	$930
Mill supplies	$143,087	$18,886	$56,256	$18,098	$4,506	$18,941	$215	$20,426	$2,829	$2,930
All other materials	$1,975,176	$144,931	$237,287	.....	$153,503	$1,258,934	$5,511	$168,850	$25	$6,135
Freight	$70,501	$5,498	$16,140	$20,960	$8,344	$1,110	$619	$11,143	$5,025	$1,662
Products:										
Total value	$21,129,561	$3,170,137	$3,485,373	$1,725,369	$1,403,798	$6,643,348	$196,006	$3,601,996	$210,146	$693,388
Sewing machines and cases—										
Household use—										
Heads, total number	747,587	68,830	197,096	.....	111,471	155,006	675	184,548	9,711	20,250
Value	$5,809,064	$550,640	$1,209,364	.....	$894,768	$1,395,053	$3,725	$1,408,587	$78,427	$268,500
Stands and woodwork, total number	749,370	68,830	199,029	.....	111,471	155,006	525	184,548	9,711	20,250
Value	$4,835,157	$481,810	$1,093,087	.....	$343,201	$1,653,797	$4,775	$1,066,119	$54,608	$137,760
Lock-stitch—										
Heads, total number	745,668	68,830	195,852	.....	111,471	155,006	.....	184,548	9,711	20,250
Value	$5,794,143	$550,640	$1,198,168	.....	$894,768	$1,395,053	.....	$1,408,587	$78,427	$268,500
Stands and woodwork, total number	747,601	68,830	197,785	.....	111,471	155,006	.....	184,548	9,711	20,250
Value	$4,813,291	$481,810	$1,075,996	.....	$343,201	$1,653,797	.....	$1,066,119	$54,608	$137,760
Vibrating-shuttle—										
Heads, number	634,364	.....	195,852	.....	111,471	155,006	.....	142,074	9,711	20,250
Value	$4,805,162	.....	$1,198,168	.....	$894,768	$1,395,053	.....	$970,246	$78,427	$268,500
Stands and woodwork, number	636,297	.....	197,785	.....	111,471	155,006	.....	142,074	9,711	20,250
Value	$3,995,891	.....	$1,075,996	.....	$343,201	$1,653,797	.....	$730,529	$54,608	$137,760
Rotary-shuttle—										
Heads, number	102,621	68,830	.....	.....	.....	.....	.....	33,791	.....	.....
Value	$938,281	$550,640	.....	.....	.....	.....	.....	$387,641	.....	.....
Stands and woodwork, number	102,621	68,830	.....	.....	.....	.....	.....	33,791	.....	.....
Value	$715,928	$481,810	.....	.....	.....	.....	.....	$234,118	.....	.....
Oscillating-shuttle—										
Heads, number	8,683	.....	.....	.....	.....	.....	.....	8,683	.....	.....
Value	$50,700	.....	.....	.....	.....	.....	.....	$50,700	.....	.....
Stands and woodwork, number	8,683	.....	.....	.....	.....	.....	.....	8,683	.....	.....
Value	$101,472	.....	.....	.....	.....	.....	.....	$101,472	.....	.....

[1] Includes establishments distributed as follows: Kansas, 1; Kentucky, 1; Minnesota, 1; Missouri, 1; New Hampshire, 1; Rhode Island, 2

TABLE 10.—SEWING MACHINE MANUFACTURE, BY STATES: 1900—Continued.

	United States.	Connecticut.	Illinois.	Indiana.	Massachusetts.	New Jersey.	New York.	Ohio.	Pennsylvania.	All other states.[1]
Products—Continued.										
Total value—Continued.										
Sewing machines and cases—Continued.										
Household use—Continued.										
Chain-stitch—										
Heads, total number	1,919		1,244				675			
Value	$14,921		$11,196				$3,725			
Stands and woodwork, total number.	1,769		1,244				525			
Value	$21,866		$17,091				$4,775			
Single-thread—										
Heads, number	675						675			
Value	$3,725						$3,725			
Stands and woodwork, number..	525						525			
Value	$4,775						$4,775			
Double-thread—										
Heads, number	1,244		1,244							
Value	$11,196		$11,196							
Stands and woodwork, number..	1,244		1,244							
Value	$17,091		$17,091							
Factory use—										
Total number	55,227	32,205	3,112		587	10,977	1,222	6,448		676
Total value	$2,395,017	$675,321	$110,000		$51,899	$1,172,145	$37,338	$138,314		$210,000
Wax-thread—										
Total number	5,047		2,930		255			1,186		676
Total value	$379,877		$103,200		$37,027			$29,650		$210,000
Lock-stitch—										
Total number	1 857				71			1,186		600
Total value	$195,152				$15,502			$29,650		$150,000
Vibrating-shuttle—										
Number	1,786							1,186		600
Value	$179,650							$29,650		$150,000
Rotary-shuttle—										
Number	71				71					
Value	$15,502				$15,502					
Chain-stitch—										
Total number	3,190		2,930		184					76
Total value	$184,725		$103,200		$21,525					$60,000
Single-thread—										
Number	184				184					
Value	$21,525				$21,525					
Double-thread—										
Number	3,006		2,930							76
Value	$163,200		$103,200							$60,000
Dry-thread—										
Total number	50,180	32,205	182		332	10,977	1,222	5,262		
Total value	$2,015,140	$675,321	$6,800		$14,872	$1,172,145	$37,338	$108,664		
Lock-stitch—										
Total number	30,941	30,671			270					
Total value	$550,361	$538,631			$11,730					
Rotary-shuttle—										
Number	30,799	30,671			128					
Value	$548,231	$538,631			$9,600					
Oscillating-shuttle—										
Number	142				142					
Value	$2,130				$2,130					
Chain-stitch—										
Total number	19,239	1,534	182		62	10,977	1,222	5,262		
Total value	$1,464,779	$136,690	$6,800		$3,142	$1,172,145	$37,338	$108,664		
Single-thread—										
Number	11,862	84	132			10,891	755			
Value	$1,171,586	$966	$4,800			$1,154,895	$11,425			
Double-thread—										
Number	7,377	1,450	50		62	86	467	5,262		
Value	$293,193	$135,724	$2,000		$3,142	$17,750	$25,913	$108,664		
Cabinets, tables, cases, and covers	2,704,506	469,624	213,076	1,342,769				679,037		
All other products	$5,385,817	$992,742	$859,856	$382,600	$113,930	$2,422,353	$150,168	$309,939	$77,111	$77,128
Comparison of products:										
Number of establishments reporting for both years..	52	7	10	3	6	1	11	6	4	4
Value for census year	$20,156,198	$3,170,137	$3,050,715	$1,725,369	$1,369,406	$6,163,555	$191,246	$3,601,996	$210,146	$673,628
Value for preceding business year	$16,412,894	$2,335,360	$2,506,225	$1,451,972	$1,277,036	$5,084,506	$168,374	$2,803,725	$211,230	$624,466
Power:										
Number of establishments reporting	52	5	11	3	8	4	9	4	3	5
Total horsepower	10,358	955	1,723	1,589	1,594	2,412	37	1,452	215	381
Owned—										
Engines—										
Steam—										
Number	66	10	14	14	6	7	2	8	2	3
Horsepower	8,966	915	1,530	1,300	920	2,400	11	1,330	210	350
Gas or gasoline—										
Number	6	1	2			1		2		
Horsepower	211	40	40			9		122		
Water wheels—										
Number	12		1	2	9					
Horsepower	740		30	75	635					
Electric motors—										
Number	6		4	2						
Horsepower	289		75	214						
Rented—										
Electric horsepower	34				8		1		5	20
Other kind of horsepower	118		48		31	3	25			11
Furnished to other establishments, horsepower..	47	7	10			30				
Establishments classified by number of persons employed, not including proprietors and firm members:										
Total number of establishments	65	7	14	3	8	4	12	6	4	7
No employees	2						1			1
Under 5	9		1		1	1	4	1	1	
5 to 20	20	2	3		5	1	5	1	1	2
21 to 50	10	1	4				2		1	2
51 to 100	3		1	1						1
101 to 250	7	1	4		1				1	
251 to 500	7	2		1		1		2		1
501 to 1,000	3				1			2		
Over 1,000	4	1	1	1		1				

[1] Includes establishments distributed as follows: Kansas, 1; Kentucky, 1; Minnesota, 1; Missouri, 1; New Hampshire, 1; Rhode Island, 2.

NEEDLES AND PINS.

NEEDLES AND PINS.

By CHARLES M. KARCH.

Although the manufacture of needles and pins was carried on in this country prior to 1860, the statistics of the censuses previous to that date were not sufficiently accurate to justify a comparison. The census of 1860 presented statistics for the manufacture of needles and pins separately, but for purposes of comparison the totals have been combined. Since 1860 the two industries have been reported under one classification. The manufacture of pins was of sufficient importance to be reported in 1850, and the census for that year shows that there were four establishments with a capital of $164,800 and a product valued at $297,550. Needles were not reported in that census, as their manufacture did not begin until after the introduction and use of the sewing machine in 1852. The growth of the needle and pin industry since 1860 is shown by the statistics presented in the following tables.

Table 1 is a comparative summary of the statistics for the manufacture of needles and pins as returned at the censuses of 1860 to 1900, inclusive, with the percentage of increase for each decade.

TABLE 1.—COMPARATIVE SUMMARY: 1860 TO 1900, WITH PER CENT OF INCREASE FOR EACH DECADE.

	DATE OF CENSUS.					PER CENT OF INCREASE.			
	1900	1890	1880	1870	1860	1890 to 1900	1880 to 1890	1870 to 1880	1860 to 1870
Number of establishments	43	45	40	39	8	[1]4.4	12.5	2.6	387.5
Capital	$3,235,158	$1,820,089	$1,144,550	$616,050	$266,700	77.7	59.0	85.8	131.0
Salaried officials, clerks, etc., number	101	[2]71	([3])	([3])	([3])	42.3	.....	.....	.....
Salaries	$126,754	[2]$78,518	([3])	([3])	([3])	61.4	.....	.....	.....
Wage-earners, average number	2,353	1,609	1,077	656	256	46.2	49.4	64.2	156.3
Total wages	$939,846	$649,484	$392,214	$286,023	$66,420	44.7	65.6	37.1	330.6
Men, 16 years and over	1,193	898	604	373	91	32.9	48.7	61.9	309.9
Wages	$611,391	$450,523	([3])	([3])	([3])	35.7	.....	.....	.....
Women, 16 years and over	1,019	691	380	226	165	47.5	81.8	68.1	37.0
Wages	$303,464	$194,286	([3])	([3])	([3])	56.2	.....	.....	.....
Children, under 16 years	141	20	93	57	([3])	605.0	[1]78.5	63.2	.....
Wages	$24,991	$4,675	([3])	([3])	([3])	434.6	.....	.....	.....
Miscellaneous expenses	$215,322	$71,674	([4])	([4])	([4])	200.4	.....	.....	.....
Cost of materials used	$972,570	$450,442	$591,013	$355,407	$272,732	115.9	[1]23.8	66.3	30.3
Value of products	$2,788,439	$1,515,865	$1,378,023	$955,854	$433,500	80.7	10.0	44.2	120.5

[1] Decrease.
[2] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table. (See Table 9.)
[3] Not reported separately.
[4] Not reported.

In 1860 the 8 establishments engaged in this industry reported a capital of $266,700, and products valued at $433,500. In 1870 the number of establishments had increased to 39, the capital reported to $616,050, and the value of products to $955,854. In the next two decades the number of establishments increased only 6, but there was an increase of $1,204,039 in the reported capital and $560,011 in the value of products, indicating a steady and satisfactory development of the industry. In comparing, however, the capital as reported at different censuses it should be borne in mind that no definite attempt was made to include live capital in the returns until the census of 1890.

The growth of the industry in previous decades has been far surpassed in the decade just completed. While the number of establishments was smaller by 2 than it was in 1890, the amount of capital was greater by $1,415,069 and the value of the products was greater by $1,222,574. There has been a rather noticeable increase in the number of children employed in the

industry. In 1890 there were only 20; in 1900 there were 141. It is evident from the figures that since 1870 the growth of the industry has been in the direction of the development of larger concerns rather than in the multiplication of independent establishments. This exemplifies the modern tendency toward concentration of industrial enterprises.

Table 2 is a comparative summary, by states, of the returns for the establishments engaged in the manufacture of needles and pins in 1890 and 1900.

TABLE 2.—COMPARATIVE SUMMARY: BY STATES, 1890 AND 1900.

STATES.	Year.	Number of establishments.	Capital.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Miscellaneous expenses.	Cost of materials used.	Value of products.
				Number.	Salaries.	Average number.	Total wages.			
United States	1900	43	$3,235,158	101	$126,754	2,353	$939,846	$215,322	$972,570	$2,738,439
	1890	45	1,820,089	[1]71	[1]78,518	1,609	649,484	71,674	450,442	1,515,865
Connecticut	1900	13	2,250,021	62	87,841	1,238	533,293	177,503	708,323	1,761,806
	1890	13	1,030,573	[1]28	[1]35,530	660	271,426	42,525	257,278	737,396
Massachusetts	1900	6	245,168	8	8,300	262	102,757	9,394	26,566	223,851
	1890	11	182,755	[1]17	[1]18,620	317	118,858	6,307	43,894	220,587
New Hampshire	1900	5	209,254	9	8,999	408	145,020	5,825	27,925	261,822
	1890	5	118,973	[1]8	[1]7,692	254	107,288	7,521	20,360	169,282
New York	1900	8	237,306	15	13,900	190	63,101	13,116	102,807	221,387
	1890	5	25,146	[1]4	[1]2,760	37	14,605	1,797	8,515	33,716
Pennsylvania	1900	4	15,665	1	720	18	7,976	781	2,029	22,100
	1890	6	70,384	[1]9	[1]8,400	65	21,965	3,793	9,914	79,803
All other states	[2]1900	7	277,744	6	6,994	237	87,699	8,703	104,921	247,473
	[3]1890	5	392,258	[1]5	[1]5,516	276	115,342	9,731	110,481	275,081

[1] Includes proprietors and firm members, with their salaries; number only reported in 1900.
[2] Includes establishments distributed as follows: Illinois, 1; Maryland, 1; Michigan, 1; Missouri, 2; New Jersey, 1; Vermont, 1.
[3] Includes establishments distributed as follows: Michigan, 1; New Jersey, 1; Ohio, 2; Vermont, 1.

As shown in Table 2, the most notable increase appears in New York state, where there was an increase of 3 in the number of establishments, of $212,160 in the capital, and of $187,671 in the value of products. Massachusetts showed a substantial increase in capital and value of products, notwithstanding the marked decrease in the number of establishments. Connecticut and New Hampshire each had the same number of establishments in 1900 as in 1890, but each reported a striking increase in capital and in value of products. Pennsylvania showed a notable decrease in all items.

Table 3 presents the number of establishments actively engaged in the manufacture of needles and pins in 1890 and 1900, and the increase during the decade.

TABLE 3.—COMPARATIVE SUMMARY: NUMBER OF ACTIVE ESTABLISHMENTS IN 1890 AND 1900, AND THE INCREASE DURING THE DECADE, BY STATES, ARRANGED GEOGRAPHICALLY.

STATES.	1900	1890	Increase 1890 to 1900.
United States	43	45	[1]2
New England states	25	30	[1]5
New Hampshire	5	5	.....
Vermont	1	1	.....
Massachusetts	6	11	[1]5
Connecticut	13	13	.....
Middle states	14	12	2
New York	8	5	3
New Jersey	1	1	.....
Pennsylvania	4	6	[1]2
Maryland	1	.....	1

[1] Decrease.

TABLE 3.—COMPARATIVE SUMMARY: NUMBER OF ACTIVE ESTABLISHMENTS IN 1890 AND 1900, AND THE INCREASE DURING THE DECADE, BY STATES, ARRANGED GEOGRAPHICALLY—Continued.

STATES.	1900	1890	Increase 1890 to 1900.
Central states	4	3	1
Ohio	.....	2	[1]2
Michigan	1	1	.....
Illinois	1	.....	1
Missouri	2	.....	2

[1] Decrease.

As shown by Table 3, the number of establishments decreased 2, or 4.4 per cent, during the decade. A majority of the establishments, both in 1890 and in 1900, were located in the New England states, although the total number for this division of the country was smaller in 1900 than in 1890. Outside of New England the number of establishments increased from a total of 15 in 1890 to a total of 18 in 1900. Of the states reporting in 1890, New York was the only state showing an increase in the number of establishments. Maryland, Illinois, and Missouri reported no establishments in 1890. Massachusetts and Pennsylvania show decreases, and Ohio, which had 2 establishments in 1890, reported none in 1900.

Table 4 is a comparative summary of the capital in its several subdivisions, with the percentages of increase

and the percentages of the several subdivisions to the total for each decade for 1890 and 1900.

TABLE 4.—CAPITAL: 1890 AND 1900.

	1900		1890		Per cent of increase.
	Amount.	Per cent of total.	Amount.	Per cent of total.	
Total	$3,235,158	100.0	$1,820,089	100.0	77.7
Land	156,000	4.8	81,100	4.5	92.4
Buildings	257,968	8.0	222,900	12.2	15.7
Machinery, tools, and implements	671,798	20.8	650,609	35.7	3.3
Cash and sundries	2,149,392	66.4	865,480	47.6	148.3

The principal item reported under the head of capital, both in 1890 and 1900, and the item showing the greatest increase was that of cash and sundries, including cash on hand, bills receivable, unsettled ledger accounts, raw materials, stock in process of manufacture, finished products on hand, and other sundries. The amounts reported for land and buildings represent only such as were owned, and constituted about the same proportion of the total in 1900 as in 1890. Although the item of machinery, tools, and implements represented a good proportion of the total capital, showing that machinery is extensively used in this industry, the small percentage of increase indicates that the extension of machinery during the past decade has been limited.

The statistics of the several items of miscellaneous expenses for 1900 are shown in Table 5.

TABLE 5.—MISCELLANEOUS EXPENSES: 1900.

	Amount.	Per cent of total.
Total	$215,322	100.0
Rent of works	84,709	39.3
Taxes, not including internal revenue	14,178	6.6
Rent of offices, insurance, interest, repairs, advertising, and other sundries	115,641	53.7
Contract work	794	0.4

A number of the establishments engaged in this industry rent their plants. The amount paid for contract work is small, as would be expected in an industry requiring the use of complicated machinery.

Table 6 shows the cost of materials used in the manufacture of needles and pins in 1900, the cost of each item, and its proportion to the total amount.

TABLE 6.—COST OF MATERIALS USED: 1900.

	Amount.	Per cent of total.
Total	$972,570	100.0
Principal materials[1]	940,124	96.7
Fuel	21,999	2.3
Rent of power and heat	4,280	0.4
Freight	6,167	0.6

[1] Includes "mill supplies" and "all other materials," which are shown separately in Table 9.

The largest item shown in Table 6 is that reported for principal materials, which includes not only the materials purchased in partially manufactured form—that is, materials upon which some manufacturing force has been expended—but also all other materials used and mill supplies. A very large proportion of this item consisted of material purchased in partially manufactured form, which cost $754,942, or 77.6 per cent of the total cost of materials. Of this amount $136,280 represented the cost of steel wire for the manufacture of needles; $522,986 the cost of brass wire for the manufacture of pins, and the remainder, $95,676, comprised the cost of iron wire, aluminum, aluminum bronze, bar steel, burr steel, sheet metal, and a variety of other materials used in the manufacture of certain varieties of needles and pins. Some establishments which were unable to separate the amount paid for freight from the cost of materials reported the two together. For this reason the $6,167 shown in Table 6 does not represent the total cost of freight, and should be considered only in connection with the cost of materials.

Table 7 is a detailed statement, by states, of the quantity and value of the different varieties of needles and pins manufactured during the census year.

TABLE 7.—QUANTITY AND VALUE OF PRODUCTS: BY STATES, 1900.

	United States.	Connecticut.	Massachusetts.	New Hampshire.	New York.	Pennsylvania.	All other states.[1]
Products:							
Aggregate value	$2,738,439	$1,761,806	$223,851	$261,822	$221,387	$22,100	$247,473
Needles and pins—							
Total value	$1,926,003	$1,153,157	$222,141	$261,822	$171,803	$20,880	$96,200
Needles—							
Total gross	1,120,532	453,503	180,113	169,388	85,498	12,845	219,185
Total value	$1,027,949	$401,698	$222,141	$261,822	$80,208	$20,880	$91,200
Knitting-machine latch—							
Gross	276,141	66,860	13,888	160,146	14,285	10,068	10,894
Value	$414,504	$103,688	$16,000	$259,816	$5,000	$18,800	$11,200
Common household dry-thread sewing-machine—							
Gross	324,476	162,424	162,052				
Value	$399,252	$212,508	$186,744				
Wax-thread sewing-machine—							
Gross	212,649	208,476	4,173				
Value	$99,533	$80,136	$19,397				
Knitting spring—							
Gross	307,266	15,743		9,242	71,213	2,777	208,291
Value	$114,660	$5,366		$2,006	$25,208	$2,080	$80,000

[1] Includes establishments distributed as follows: Illinois, 1; Maryland, 1; Michigan, 1; Missouri, 2; New Jersey, 1; Vermont, 1.

TABLE 7.—QUANTITY AND VALUE OF PRODUCTS: BY STATES, 1900—Continued.

	United States.	Connecticut.	Massachusetts.	New Hampshire.	New York.	Pennsylvania.	All other states. [1]
Products—Continued.							
Aggregate value—Continued.							
Needles and pins—Continued.							
Total value—Continued.							
Pins—							
Total gross	50,167,817	42,279,857	.....	.....	7,864,151	.....	23,809
Total value	$898,054	$751,459	.....	.....	$141,595	.....	$5,000
Common or toilet—							
Gross	47,338,429	39,752,846	.....	.....	7,585,583	.....	.....
Value	$465,605	$378,210	.....	.....	$87,395	.....	.....
Hair—							
Gross	1,189,104	1,183,104	.....	.....	6,000	.....	.....
Value	$78,155	$75,455	.....	.....	$2,700	.....	.....
Safety—							
Gross	1,640,284	1,343,907	.....	.....	272,568	.....	23,809
Value	$354,294	$297,794	.....	.....	$51,500	.....	$5,000
All other products	$812,436	$608,649	$1,710	.....	$49,584	$1,220	$151,273

[1] Includes establishments distributed as follows: Illinois, 1; Maryland, 1; Michigan, 1; Missouri, 2; New Jersey, 1; Vermont, 1.

There were produced 1,120,532 gross of needles and 50,167,817 gross of pins, or practically two-thirds of a gross of pins for every individual in the United States. These figures do not represent the total number of gross of needles and pins manufactured during the census year, as it is probable that many establishments engaged in the manufacture of needles and pins in connection with other industries failed to state that fact, and reported them under all other products. As far as this office has been able to ascertain, the quantity of needles manufactured in establishments engaged primarily in other industries amounted to 277,000 gross, valued at $327,000, and the quantity of pins so manufactured amounted to 18,721,443 gross, valued at $209,742. A combination of these quantities and values with those shown in the above table for the respective articles shows that there were 1,397,532 gross of needles, valued at $1,107,796, and 68,889,260 gross of pins, valued at $1,354,949, produced in the United States for the census year, as reported by establishments of any character. For those states which reported 3 or more establishments, the product is shown separately, but in order not to disclose the operations of individual establishments, the products for other states are shown collectively under the head of "all others." Connecticut, with 13 establishments, reported 64.3 per cent of the aggregate value of products; Massachusetts, with 6 establishments, 8.2 per cent; New Hampshire, with 5 establishments, 9.6 per cent; New York, with 8 establishments, 8.1 per cent; and Pennsylvania, Illinois, Maryland, Michigan, Missouri, and Vermont, with 11 establishments, reported but 9.8 per cent of the aggregate for the industries. In Table 7 the product is divided into needles and pins, and these groups are in turn subdivided into the different varieties reported. The item "all other products" comprises the products for which separate quantities and values have not been given, by-products, and custom work and repairing. The principal by-product was hooks and eyes, which comprised 1,131,824 gross, valued at $81,110, of which 1,131,524 gross, valued at $81,090, were made in Connecticut. It appears from Table 7 that the manufacture of sewing machine needles is confined to Connecticut and Massachusetts, and the manufacture of the different varieties of pins almost confined to Connecticut and New York.

Table 8 gives the value of the needles imported for consumption for each year from 1891 to 1900, inclusive, as shown by the bulletins issued by the Bureau of Statistics of the United States Treasury Department for the respective years.

TABLE 8.—IMPORTS FOR CONSUMPTION, OF NEEDLES: 1891 TO 1900, INCLUSIVE.

	1900	1899	1898	1897	1896	1895	1894	1893	1892	1891
Total value	$418,004	$447,717	$406,420	$362,185	$366,258	$330,035	$308,087	$411,752	$383,727	$358,838
For knitting or sewing machines, including latch needles:										
Thousands	2,166	1,482	1,887	[1]	[1]	[1]	[1]	[1]	[1]	[1]
Value	$13,201	$8,700	$12,229	[2]$45,724	[2]$50,179	[2]$28,823	[2]$14,900	[2]$18,147	[2]$24,563	[2]$19,763
Crochet, tape, and knitting needles, and all others not specially provided for, value	$37,532	$31,203	$31,471	$5,298	$3,700	$10,317	$15,319	$23,054	$21,474	$15,558
Hand sewing and darning, value	$367,271	$407,814	$362,720	$311,163	$312,379	$290,895	$277,868	$370,551	$337,690	$323,517

[1] Quantity not shown.

[2] Includes value of crochet and knitting needles.

Table 8 is interesting in that it indicates the exceedingly large importation of the common hand sewing and darning needles, and crochet, tape, and hand knitting needles for each year from 1891 to 1900. In the case of knitting and sewing machine needles the imports for the year ending June 30, 1900, were valued at only $13,201, whereas the products manufactured in this country in the year ending May 31, 1900, were valued at $1,027,949. In this item it is evident that the home manufacturer practically supplies the home trade. The importations for each year of the common hand sewing and darning needles, and crochet, tape, and hand knitting needles practically represent the value of such needles used each year, as it appears that none of these varieties are manufactured in the United States.

HISTORICAL AND DESCRIPTIVE.

PINS.

The familiar and very commonplace article known as a pin is not without a history and an ancestry as old as the oldest. When pins were first used is difficult to determine, but it is safe to assume that in some form they were used by our most remote ancestors. Nature gave man the pattern for a pin in the thorn, and the first pin used was, undoubtedly, this natural article, but later other materials were introduced for its construction. In the overhauling of ancient ruins, pins made of bone, ivory, bronze, copper, and iron have been found. The most prominent discoveries made in this line were in Egyptian and Scandinavian tombs and on sites of the ancient lake dwellings of central Europe. From the lacustrine stations in Switzerland alone more than 10,000 pins have been taken. These ancient pins are in various forms, and in cases where the ornamental head is used they are very curious and beautiful. They are longer than those now in use and differ from the modern pattern in that they taper gradually from the head to the point. Some were found in central Europe with double stems like the modern hair pin, and a few were found at Peschiera, Italy, fashioned like the modern safety-pin. Many of the single-stemmed pins varied in thickness, and others had heads formed of a loose ring in an eye at the blunt end.[1]

In ancient and mediæval times pins were made of bronze, and this was the principal material used until metallurgy had advanced far enough to give a better material in brass. It is said that the early Anglo-Saxons and Britons used ribbons, loopholes, clasps, hooks and eyes, and skewers of wood, bone, brass, silver, or gold for their fastenings instead of pins. The brass-wire pin is supposed to be an invention of the French, although by some authorities it is credited to the Dutch. In England pins of iron wire were made during the fifteenth century, but the brass-wire pin was unknown until 1543, when it was brought from France by Catharine Howard.[2]

The invention of the process of wire drawing marked the beginning of the modern pin manufacture. The process originated in France and Germany, and for two centuries these countries monopolized all industries dependent upon it. The first man to manufacture brass pins in England was John Tilsby, who, in 1626, established a plant in Gloucestershire, where he met with remarkable success, and his make of pins became famous. By 1636 the industry was so well established that the pin makers of London formed a corporation, and the trade soon found its way to Bristol and Birmingham, where, in connection with other ironwork manufacture, the industry became localized. In those cities pins were made for some time by hand labor. The construction of a single pin required from 14 to 18 different operators, and involved the following processes: Straightening and cutting the wire; cutting, printing, twisting the heads; cutting the heads; annealing the heads; stamping or shaping the heads; cleaning the pins; whitening or tinning the pins; washing, drying, and polishing; winnowing and pricking the papers to receive the pin. This method was improved upon by Timothy Harris, in 1797, who made the solid-headed brass pin by laying the blanks into a two-part mold in which prints representing the heads were cut. When the mold was closed an alloy of lead and antimony was poured in, and as soon as the pins were released the "gets" were cut off and the pins were cleansed by immersion in a solution of sulphuric acid and water, and then dipped into a solution of sulphate of copper and finished in the same way as other brass pins.[3]

William Bundy a few years later had a method of heading which was the modern process in embryo. The wire was thickened by pressure into a collar on which the head rested to prevent its slipping down, and then the head was placed on the shank in a die, while another die, working in a fly press, descended and compressed the top of the wires, thus securing the attachment of the wire head to the shank.[1]

In 1812 Bradbury and Weaver conceived the idea of heading "by means of an automatic machine." After the shanks were pointed and the heads prepared they were put into separate hoppers, where a mechanical device placed the shank and head into relation with each other. In this position the pins were pressed by screws against dies, which made the head and bound it to the shank, when they were withdrawn by hooks operated upon by parallels worked by the machine.[1]

In 1817 Seth Hunt invented a machine to make the pin with head, shaft, and point from one piece, but his invention was not a success. In 1824 W. L. Wright, an American, a native of New Hampshire, invented the solid-headed pin-making machine, which entirely revolutionized the pin manufacture. He did not have his machine patented in America, but took it to England and put it into operation. He formed in London a company with a large capital, and built a good-sized factory in Lambeth. A plant was fitted up at great expense with 60 machines, but they were never put into successful operation, as they failed in pointing the pin. Although Wright remedied this defect by a supplemental machine, the company did not succeed, and suspended operations with a great loss to those interested in the enterprise. Fortunately, in the readjustment of the company's affairs the machinery fell into the hands of D. F. Taylor, who, by interesting capitalists in the enterprise, brought about the formation of a company known as D. F. Taylor & Co., which in 1833 put upon the mar-

[1] Monroe's Lake Dwellings of Europe.
[2] Bevan's British Manufacturing Industries, Vol. III, p. 87.
[3] Bevan's British Manufacturing Industries, Vol. III, p. 89–90.

ket the first machine-made solid-headed pins sold anywhere in the world. The company met with remarkable success, and machinery soon replaced the hand method in the leading English pin-making establishments.

In the early days of this country the manufacture of pins, especially at the times when commerce with England, France, or Germany was interrupted, was several times attempted, but the product was not equal to the imported article. During the Revolutionary War, when the importation of pins from England was entirely cut off and a scarcity of the article resulted, the manufacture was carried on to a limited extent in Connecticut and the Carolinas. Again, in the War of 1812 importations were suspended and pins grew so scarce that the prices asked for them were often as high as $1 a package. At that time some pin makers came from England, bringing the necessary tools, and began the manufacture at the old States Prison at Greenwich, N. Y., employing convict labor. The enterprise was not successful, owing to a rapid decline in the prices of pins after the close of the war. The tools used in this manufacture passed into the hands of Richard Turnam, who made a contract for pauper labor, and began the manufacture in the almshouse at Bellevue, New York. The death of Mr. Turnam put an end to this enterprise, and these tools were never again used.

As early as 1812 the inventors of this country were using their energies to construct a machine for the manufacture of pins. The first machine made here, which was brought out by Moses L. Morse, of Boston, Mass., sometime during the war of 1812, proved too delicate and intricate to be used to much advantage and was soon abandoned. The man who did more to place the manufacture of pins by automatic machinery on a practical and successful basis in this country than any other one individual was Dr. J. I. Howe. In 1830 he began his labor in this direction, spending some of his time in Europe studying the methods employed there, and by the year 1832 he had patented in this country, France, and England, a machine designed to make pins similar to the English diamond pins, with heads formed of coils of small wire fastened upon the shank by pressure between dies. He brought the business to a successful issue in 1836, when the Howe Manufacturing Company was formed in New York and began operations at Birmingham, Conn. At first automatic spun-head machines were used, but in 1840 they were converted into solid-headed machines. These latter machines at first made from 40 to 50 pins per minute. They were later improved so that they made from 60 to 70 per minute.

About 1835 Samuel Slocum, an American, obtained a patent in England for a machine to make solid-headed pins. In 1838 he began with this machine the manufacture of pins in Poughkeepsie, N. Y. As he never had the machine patented here, it was operated secretly for a number of years. Until 1842 the industry made little progress because of discriminating tariffs. In this year, however, a new tariff law went into effect which was more favorable to this industry than the previous tariff act, and the above-named companies did a very profitable business. Led by exaggerated ideas which became prevalent as to the extent of the business and the profit made in it, many persons in different parts of the country invented machinery for the construction of pins. Attempts in this direction met with varying success but the articles turned out were, with a few exceptions, inferior, and the market became overstocked. In consequence of this overproduction, by 1848 all parties engaged in pin making, except the two old companies at Poughkeepsie and Birmingham, suspended operation.[1] In the year 1850 there were four establishments engaged in this industry, and the success attending them led to further improvements in the machines. A Mr. Fowler and a Mr. Atwood perfected machines to make 160 to 170 pins a minute which, on account of their capacity, soon replaced the early machines.

Following the successful introduction of a machine for making the pins, the next important step was to invent a machine that would stick them on paper. Howe and Slocum gave their attention to this matter as early as 1840. Dr. Howe invented the device for crimping the paper, and this was followed by the distributer of Mr. Slocum. The two inventions were combined and effected a great increase in the number of pins that could be stuck on paper in a day. These devices were improved upon by Mr. De Grasse Fowler, who invented the "goose neck" or "runway." For many years the sticking machines consisted of a combination of these three devices, but more recently machines of various styles have come into use that will stick from 500 to 600 packages a day, far more than the early combined machine of Howe, Slocum, and Fowler.

The old process of pin manufacture by manual labor was very slow and tedious, since each pin passed through the hands of from 14 to 18 individuals. The modern pin is made in the United States by the improved Atwood or Fowler machines. The process of pin manufacture by modern machines may be briefly described as follows: Coils of wire are placed upon a reel, whence the wire is drawn automatically by a pair of pincers between fixed studs that straighten it. A pin length is then seized by a pair of lateral jaws, from which a portion of the wire is left projecting, when a snaphead die advances and partially shapes the head. The blank is then released and pushed forward about one-twentieth of an inch, when the head is given another squeeze by the same die. By this repetition of the motion the head is completed and the blank is cut off the wire in the length desired. About one-eighth of an inch of wire is required to make a pin head. If the attempt were made to upset this with a head in one motion the wire would be more likely to double up than to thicken as desired.

[1] Report of Commissioner of Patents, 1850.

These headed blanks then drop into a receptacle and arrange themselves in the line of a slot formed by two inclined and bevel-edged bars. The opening between the bars is just large enough to permit the shank of the pin to fall through, so that the pins are suspended in a row along the slot. When the blanks reach the lower end of the inclined bar in their suspended position they are seized between two parts of the machine and passed along, rotating as they move, in front of a cylindrical cutter, with sharp grooves on its surface, that points the pins. They are then thrown from the machine properly shaped, and if they are brass pins they are cleaned by being boiled in weak, sour beer. After they are cleaned they are coated with tin. This is done by placing alternate layers of pins and grain tin in a copper can and adding water, along with some bitartrate of potash. Heat applied to this produces a solution of tin which is deposited on the surface of the pins. The pins are then taken from this solution and brightened by being shaken in a revolving barrel of bran or sawdust.[1] Lastly the operation of "papering" takes place. This process is performed now by an automatic papering machine something in the following manner: The pins to be stuck are placed in a hopper, in connection with which a steel plate is used, with longitudinal slits corresponding to the number of pins which form a row in the paper. The pins in the hopper are stirred up by a comb-like tool, the shanks drop through the slits in the steel plate, and the pins are suspended by their heads. Long narrow sheets of paper are presented by the operator to the action of the machine, by which two raised folds are crimped, and the row of pins collected in the slit steel plate is then, by being subjected to the same action, pressed through the two crimped folds. These operations are repeated until the requisite rows of pins are stuck in each paper.

NEEDLES.

Needle making was one of the first arts practiced by man, and no doubt dates back to the remote period when man first strove to shape clothing to his figure. Remains of civilized and uncivilized nations bear evidence of the use of needles made of various materials. Some excellent specimens made of fish bone, horse's bone, and bronze have been found in caves near Bruneguel, France, and on the sites of the ancient lake dwellings of central Europe. In Egyptian and Scandinavian tombs bronze needles, varying in length from 2½ to 8 inches, have been found. This material, which quite likely suggested itself for use in needle manufacture because it was an alloy easily worked, was for many centuries the material principally used, especially among the early European and western Asiatic peoples. Whether other materials than bone, ivory, and bronze were used by ancient nations for the construction of the needle we have no means of knowing. These early needles were clumsy affairs, and during the Dark Ages were superseded by steel needles.

[1] Chambers' Encyclopedia, Vol. VIII, page 189.

The steel needle was introduced in Europe by the Moors at the time of the Saracen invasion, but it is not probable that these people were the inventors, since the Chinese claim to have used steel needles from time immemorial. Gradually the industry spread from Spain, the home of the Moorish artificers, to France and Germany, and in the year 1370 steel needles were made at Nuremberg, Germany, whose artisans at that time were more skilled in working metals than those of any other European nation.

Probably the first man to manufacture this article in England was a Spanish Moor, who, some time between 1543 and 1548, made and sold needles at Cheapside, England. He moved his shop a few years later to Whitechapel. There shortly after he died, and as he had never communicated to anyone the knowledge he was supposed to possess, the manufacture of steel needles in England ceased for a time with his death. It was next taken up in that country by Elias Crouse, a German, who, some time during the reign of Queen Elizabeth, taught Englishmen how to make "Spanish" needles. A few years later this manufacture was given an impetus by Mr. Humphreys, of Saxony, who brought to England twenty-two Saxon workmen skilled in drawing steel into the kind of wire essential to needle manufacture. The industry, however, did not attain much importance until 1650, when a Mr. Demar, with Mr. Christopher Greening, began the manufacture on a small scale at Long Crendon, in Buckinghamshire. From this time the industry gradually spread to neighboring towns and counties, where needle manufacture has been brought during the past two centuries to its present degree of perfection, and where the bulk of the common hand-sewing needles used in all countries are made.

In its primitive pattern the needle was an awl-shaped instrument, which merely perforated the materials meant to be fastened together along their edges, so that they could be laced together by hand. As the use of this needle involved two operations, it was soon displaced by a needle which had a circular depression near the blunt end for holding the thread, and thus did away with the lacing operation. Since this needle, though it did well enough for coarse work, was inadequate for finer work, the needle with the eye was introduced.

Since the introduction of the steel needle the model has remained the same and progress in the art of needle making has been confined to devices for perfecting the material used and the methods of construction. In the early days of needle manufacture, when the trade was practiced at home or in small shops, the materials and devices used were very crude. After the manufacture of the needle was started in plants provided with conveniences and facilities for its production, improvements were slowly introduced in performing the different operations.

The most notable improvements prior to 1870 may be summarized as follows: Drill-eyed needles were first made in 1826 and were followed two years later by the

burnishing machine, by means of which the eye secures its beautiful finish. In 1840 the process of hardening in oil succeeded the former method of hardening in water, in which a large percentage of the needles became crooked, so that their straightening involved considerable time and expense. The stamp to impress the print of the groove and the press with a punch to pierce the eye, though suggested as early as 1800, were not in general use until 1830, and by 1886 were superseded by an automatic machine. In 1839 a simple method was invented by a Mr. Morrall for polishing many thousands of needles simultaneously, and in 1869 a machine was brought out by a Mr. Lake for doing many of the operations previously performed by hand.[1] The more recent improvements have been made in devices for heating and ventilating, and for getting rid of the injurious dust which rises from the emery wheel in the grinding process.

The process of manufacturing the common hand-sewing needle, as carried on in Germany, France, and England, is exceedingly interesting; but as this particular branch of the industry is not carried on in the United States it could not properly be described in this connection. Needle manufacture is one of Europe's prominent industries, being extensively carried on in England, Germany, and France, where each year an immense quantity is produced, including every variety, size, and shape.

To what extent, if any, the making of hand-sewing needles was carried on in America during colonial times we have no means of knowing, but it is safe to assume that they were manufactured to some extent, for Bishop in his History of American Manufactures, Volume I, states that as early as 1666 Lynn artificers applied to the court of Plymouth Colony for the sum of £15 for the purchase of tools for wire drawing to make pins and needles; which sum being granted, the tools were bought and the manufacture began. He further states that Jeremiah Wilkinson, of Cumberland, R. I., made needles in that place in 1775 from wire drawn by himself; and that the colonists of the Carolinas at a convention at Newbern, on the 3d of April, 1775, encouraged the manufacture of pins and needles by offering a bounty to the person who should manufacture the first of these articles equal to those made in England.

Needle manufacture as an industry, however, was not put on a permanent basis in the United States until after 1852, when the peculiar kind of needles used in machinery was introduced. As the sewing machine is essentially an American production, and the most important feature of the invention of the machine was the needle constructed by Elias Howe for the making of the lock stitch, it was very natural that this part of the sewing machine should be manufactured in this country. It is estimated that from 6 to 8 per cent of all the operative labor involved in the construction of the sewing machine is employed in making the needle. With the successful manufacture of the different varieties of sewing-machine needles, began the manufacture of needles for knitting machines. As the demand for sewing and knitting machines increased there was a corresponding demand for the needles used in these machines, and the industry developed rapidly.

The needles made are of various lengths and patterns to suit the requirements of the different sewing machines. Besides those differing generically, such as straight and curved, or specifically, such as long, short, round-pointed, and chisel-pointed, there are many peculiar patented needles for use in particular sewing machines. Among the endless varieties of sewing-machine needles the most prominent is the common needle used in the household sewing machine. This needle has the eye at the pointed end, with a long groove on one side and a short groove on the opposite side, and is used in connection with a shuttle or other device for carrying a second thread, which is passed through a loop of the thread in the needle, thus forming the double lock stitch. The purpose of the grooves is to protect the thread from wearing or tearing in the operation of the machine.

In addition to the common household sewing-machine needles there are needles for use in sewing leather, including many varieties to suit the various machines. Some of these needles, in distinction from the common sewing-machine needles, have a hook instead of an eye. The material to be sewed is perforated with an awl, and the thread is then pulled through by the hook. In most leather sewing machines, however, the needle itself perforates the material and pulls the thread through. In sewing cloth only the needle with a round point is used; but for sewing leather there are points of various shapes, known as twist, reverse twist, wedge, cross, chisel, reverse chisel, and diamond. A very interesting needle, used in the manufacture of boots and shoes, is that of the Goodyear welting machine. This needle is a segment of a circle in shape and puts welts upon boots and shoes with remarkable rapidity and accuracy.

The steel spring and latch needles used in making hosiery and in stockinet work are extensively manufactured in the United States. The former is constructed by reducing the working end on a taper to an approximate point, and then bending the reduced portion over upon itself so as to form an open loop, a groove having been previously made in the needle so as to come opposite the point. In the operation of the needle the point stands out at the proper time for the yarn to be taken, which is to be carried through to form the stitch. As the forward motion continues the point is depressed into the groove by coming in contact with mechanism arranged for the purpose, and thus the passage through the loop is secured with-

[1] Bevan's British Manufacturing Industries, Vol. III, page 102, and Johnson's Universal Encyclopedia, Vol. V, page 669.

out catching. The latch needle has, instead of the spring barb, a short rigid hook, which is formed by tapering the working end to an approximate point and bending it in combination with the latch. The latch is contained in a groove milled in the body of the needle and is pivoted upon a rivet which passes through the wall of the groove. As the latch, the walls between which it is riveted, and the diameter of the rivet are extremely delicate, each part being but one one-hundredth part of an inch thick, great care and skill must necessarily be exercised in manufacturing this needle. The purpose of the latch is to aid in forming and casting off the stitch by preventing the yarn from being caught under the hook except at the proper time.[1]

When the sewing-machine needle was first made here the processes of its manufacture were similar to those employed in England in making the common hand-sewing needle, and required a great deal of manual labor. The reducing of the shank to the required size and putting in of the grooves on the sides of the needle was accomplished by stamping between dies. By this method the superabundant material was thrown out at each side as a fin, cut off by hand shears, and later removed by means of a die and punch in a press, after which the needles were rounded up and pointed by filing. Gradually these operations were replaced by rolling, grinding, turning, and milling, and finally machinery was invented to do the work.

In the course of the manufacture of the sewing-machine needle it passes through the following states: Blank, reduced blank, reduced and pointed blank, grooved, eye punched, hardened and tempered, hard burr dressed, brass brushed, eye polished, first inspection, hard straightened, finish pointed, and finished. There are two methods in use for the manufacture of the modern sewing-machine needle. In most respects these processes are similar, but they differ in the manner of forming the blade. In one method the blade is formed by cutting the blank down to its required size, and in the other method the wire is cut into short pieces about one-third the required length of the needle when finished, and then by a process known as cold-swaging these are brought to the proper length.

As the modern machinery used in the first process mentioned is largely of private designs, the manufacture can not be described in detail, but it may fairly be inferred from the following method used a few years ago. At that time the needle was made from the best quality of crucible steel wire, which was received in coils, and after being straightened by means of automatic machinery was fed into a machine devised to form the large end of the needle and cut off blanks of the required length. The blanks were then sent to machines, three in number, for roughing, dressing, and smoothing. The first two worked with coarse and fine emery wheels, respectively, and the third with an emery belt. Into these machines the blanks were fed from a hopper onto a grooved endless traveling carrier, which exposed to the action of the emery wheel that portion of the blank which was to be reduced in diameter to form the shank of the needle. The portion not reduced was that designed to be placed in the end of the needle bar of the sewing machine. As the needles passed the emery wheel they were rotated by a pair of reciprocating plates, so that they were equally ground on all sides. After the process was completed by the emery belt in the third machine, the needles were passed on to another machine where the taper pointing was done. When taper pointed the blank was passed to a machine where the two grooves on the sides of the needle were made by two circular saws past which the blank was fed automatically. The saws were pressed in against the needles and then withdrawn at such times as would give the required depth and contour to the groove. The eye was then punched by a belt-driven punching machine, after which the needles were heated to a cherry red in a reverberatory furnace with a charcoal fire, taken out and immersed in whale oil. They were then placed in sheet-iron pans suspended from the arms of a revolving shaft, and tempered in an oven heated by the surplus heat of the furnace. Next, the needles were cleaned on an emery cloth, being held in bunches of about 20 between the finger and thumb and rotated while being pressed upon the cloth. They were then taken, with the grooves upward, by flat-jawed tongs carrying 70 at a time, and held against a scratch brush of brass wire, which revolved 8,000 times a minute, to polish the grooves. The brush of brass wire was soon replaced by a bristle brush, which finished the polishing of the grooves. While yet held in the clamps these needles were threaded in gangs on cotton thread, which was covered with oil and emery, and then drawn back and forth in various slanting positions so that the polishing powder would act on all parts of the eye. When removed from the thread the needles were cleaned by a revolving hair brush, and the eyes, points, and blades inspected. Imperfect ones were thrown aside and the good ones sent to the hand straightener, who rolled them on an anvil at the level of the eye of an operator, who detected any curvature and corrected it by a tap of a small hammer. The final operations were finish pointing, which was done on a fine emery wheel, and finish polishing, done by a revolving hair brush with crocus and alcohol.

In the second method of manufacture the wire is fed into a machine called the straightener and cutter, which straightens the wire and cuts the blanks into pieces about one-third the length required for the finished needle. The blanks are then placed in small iron cylinders rotated in such a manner as to keep the blanks in constant friction, and thus remove the scale and dirt. They are then ready for the cold-swaging machine. The blanks are placed in a hopper, from which they are taken automatically, one at a time, and their ends

[1] The Universal Cyclopedia, Vol. XIII, pages 389 and 390.

are presented to the action of a set of revolving sectional steel dies. By the constant opening and shutting of these dies while in rotation the ends of the blanks are compressed and drawn out to form the blades. After swaging the blank is stamped in order to identify it. In the process of swaging there results a slight variation in the length of the needles, and they are trimmed to a uniform length by the clipping and straightening machine. The prominent feature of this machine is the arrangement of the screw-feed for simultaneously carrying the needles across, so that the ends of the shanks are aligned against a fence, and forward, so that the points are presented to a cutter which trims all to a uniform length. After passing the cutter each needle is struck by a die that stamps upon its shank the descriptive number. The other processes involved in this method of needle manufacture are similar to those described in the first method.

Since the invention of these automatic machines for the different processes, the mechanism employed has been so combined as to effect a transfer of the blank from one operation to the next without the intervention of hand labor. In such combination of machinery there has been marked development during the past fifteen years, and the industry has fully kept pace with the progress of other wire-working processes.

Table 9 presents in detail the statistics relating to the manufacture of needles and pins, by states, 1900.

TABLE 9.—NEEDLES AND PINS: BY STATES, 1900.

	United States.	Connecticut.	Massachusetts.	New Hampshire.	New York.	Pennsylvania.	All other states.[1]
Number of establishments	43	13	6	5	8	4	7
Character of organization:							
Individual	19	3	3	.....	5	2	6
Firm and limited partnership	9	3	2	1	1	2	.....
Incorporated company	15	7	1	4	2	.....	1
Capital:							
Total	$8,235,158	$2,250,021	$245,168	$209,254	$287,306	$15,665	$277,744
Land	$156,000	$48,200	$5,000	$14,000	$800	$250	$87,750
Buildings	$257,968	$151,200	$25,000	$31,000	$24,500	$1,150	$25,118
Machinery, tools, and implements	$671,798	$370,371	$47,599	$55,617	$92,500	$8,500	$97,211
Cash and sundries	$2,149,392	$1,680,250	$167,569	$108,637	$119,506	$5,765	$67,665
Proprietors and firm members	39	10	8	2	7	6	6
Salaried officials, clerks, etc.:							
Total number	101	62	8	9	15	1	6
Total salaries	$126,754	$87,841	$8,300	$8,999	$13,900	$720	$6,994
Officers of corporations—							
Number	16	9	1	2	3	.....	1
Salaries	$38,680	$27,100	$1,400	$2,780	$5,000	.....	$2,400
General superintendents, managers, clerks, etc.—							
Total number	85	53	7	7	12	1	5
Total salaries	$88,074	$60,741	$6,900	$6,219	$8,900	$720	$4,594
Men—							
Number	59	39	6	3	8	1	2
Salaries	$78,154	$55,105	$6,400	$5,039	$7,500	$720	$3,390
Women—							
Number	26	14	1	4	4	.....	3
Salaries	$9,920	$5,636	$500	$1,180	$1,400	.....	$1,204
Wage-earners, including pieceworkers, and total wages:							
Greatest number employed at any one time during the year	2,622	1,402	270	465	205	28	252
Least number employed at any one time during the year	2,095	1,097	255	338	173	12	220
Average number	2,353	1,238	262	408	190	18	237
Wages	$939,846	$533,293	$102,757	$145,020	$63,101	$7,976	$87,699
Men, 16 years and over—							
Average number	1,193	581	132	231	91	11	147
Wages	$611,391	$321,207	$71,169	$99,263	$41,741	$6,474	$71,537
Women, 16 years and over—							
Average number	1,019	566	99	177	88	2	87
Wages	$303,464	$195,828	$26,205	$45,757	$19,360	$572	$15,742
Children, under 16 years—							
Average number	141	91	31	.....	11	5	3
Wages	$24,991	$16,258	$5,383	.....	$2,000	$930	$420
Average number of wage-earners, including pieceworkers, employed during each month:							
Men, 16 years and over—							
January	1,205	577	133	243	90	11	151
February	1,204	583	132	240	90	9	150
March	1,213	593	132	239	90	9	150
April	1,225	602	133	234	92	16	148
May	1,216	600	132	234	98	16	136
June	1,182	587	133	214	98	17	133
July	1,123	539	133	209	98	9	135
August	1,162	567	130	228	88	8	141
September	1,173	572	130	225	88	10	148
October	1,181	570	130	231	85	11	154
November	1,207	585	132	239	85	11	155
December	1,225	595	130	242	92	11	155
Women, 16 years and over—							
January	1,025	567	95	183	89	2	89
February	1,044	580	95	189	89	2	89
March	1,055	590	93	192	89	2	89
April	1,087	628	100	183	91	2	88
May	1,074	612	100	181	93	2	86
June	988	563	100	150	93	2	80
July	950	527	99	149	93	2	80
August	969	530	101	165	85	2	86
September	983	538	101	170	85	2	87
October	1,003	548	100	184	80	2	89
November	1,023	564	102	186	80	2	89
December	1,027	551	104	192	89	2	89
Children, under 16 years—							
January	146	98	31	.....	10	4	3
February	151	103	31	.....	10	4	3
March	149	101	31	.....	10	4	3
April	155	104	31	.....	11	6	3
May	154	104	31	.....	12	4	3
June	148	98	31	.....	12	4	3

[1] Includes establishments distributed as follows: Illinois, 1; Maryland, 1; Michigan, 1; Missouri, 2; New Jersey, 1; Vermont, 1.

TABLE 9.—NEEDLES AND PINS: BY STATES, 1900—Continued.

	United States.	Connecticut.	Massachusetts.	New Hampshire.	New York.	Pennsylvania.	All other states.[1]
Average number of wage-earners, including pieceworkers, employed during each month—Continued.							
Children, under 16 years—Continued.							
July	127	77	31	.....	12	4	3
August	124	75	31	.....	10	5	3
September	123	74	31	.....	10	5	3
October	139	81	31	.....	19	5	3
November	138	89	31	.....	10	5	3
December	138	88	31	.....	11	5	3
Miscellaneous expenses:							
Total	$215,322	$177,503	$9,394	$5,825	$13,116	$781	$8,703
Rent of works	$84,709	$78,300	$1,025	$225	$3,460	$474	$1,225
Taxes, not including internal revenue	$14,178	$10,145	$1,679	$968	$53	$20	$1,313
Rent of offices, interest, insurance, and all sundry expenses n t hitherto included	$115,641	$88,344	$6,690	$4,632	$9,603	$287	$6,085
Contract work	$794	$714	.....	.....	.....	.....	$80
Materials used:							
Total cost	$972,570	$708,323	$26,565	$27,925	$102,807	$2,029	$104,921
Purchased in partially manufactured form	$754,942	$539,635	$16,745	$19,281	$84,487	$1,330	$93,464
Fuel	$21,999	$11,404	$2,660	$2,367	$2,701	$270	$2,597
Rent of power and heat	$4,280	$1,725	$350	$75	$1,710	$150	$270
Mill supplies	$36,210	$25,036	$4,747	$2,282	$3,390	$112	$643
All other materials	$148,972	$126,267	$1,744	$2,541	$10,375	$167	$7,878
Freight	$6,167	$4,256	$319	$1,379	$144	.....	$69
Products:							
Needles and pins—							
Aggregate value	$2,738,439	$1,761,806	$223,851	$261,822	$221,387	$22,100	$247,473
Total value	$1,926,003	$1,153,157	$222,141	$261,822	$171,803	$20,880	$96,200
Needles—							
Total gross	1,120,532	453,503	180,113	169,388	85,498	12,845	219,185
Total value	$1,027,949	$401,698	$222,141	$261,822	$30,208	$20,880	$91,200
Knitting machine latch—							
Gross	276,141	66,860	13,888	160,146	14,285	10,068	10,894
Value	$414,504	$103,688	$16,000	$259,816	$5,000	$18,800	$11,200
Common household dry-thread sewing machine—							
Gross	324,476	162,424	162,052	.....	.....	.....	.....
Value	$399,252	$212,508	$186,744	.....	.....	.....	.....
Wax sewing machine—							
Gross	212,649	208,476	4,173	.....	.....	.....	.....
Value	$99,533	$80,136	$19,397	.....	.....	.....	.....
Knitting, spring—							
Gross	307,266	15,743	.....	9,242	71,213	2,777	208,291
Value	$114,660	$5,366	.....	$2,006	$25,208	$2,080	$80,000
Pins—							
Total gross	50,167,817	42,279,857	.....	.....	7,864,151	.....	23,809
Total value	$898,054	$751,459	.....	.....	$141,595	.....	$5,000
Common or toilet—							
Gross	47,338,429	39,752,846	.....	.....	7,585,583	.....	.....
Value	$465,605	$378,210	.....	.....	$87,395	.....	.....
Hair pins—							
Gross	1,189,104	1,183,104	.....	.....	6,000	.....	.....
Value	$78,155	$75,455	.....	.....	$2,700	.....	.....
Safety pins—							
Gross	1,640,284	1,343,907	.....	.....	272,568	.....	23,809
Value	$354,294	$297,794	.....	.....	$51,500	.....	$5,000
All other products	$812,436	$608,649	$1,710	.....	$49,584	$1,220	$151,273
Comparison of products:							
Number of establishments reporting for both years	40	12	5	5	8	4	6
Value for census year	$2,721,239	$1,750,306	$223,151	$261,822	$221,387	$22,100	$242,473
Value for preceding business year	$2,559,160	$1,685,209	$198,144	$225,363	$189,824	$20,300	$240,320
Power:							
Number of establishments reporting	40	12	6	5	8	4	5
Total horsepower	2,557	1,632	148	207	433	17	120
Owned:							
Engines:							
Steam—							
Number	27	14	2	4	3	1	3
Horsepower	1,242	802	89	95	139	6	111
Gas or gasoline—							
Number	3	.....	1	.....	1	1	.....
Horsepower	21	.....	15	.....	2	4	.....
Water wheels—							
Number	16	11	.....	3	2	.....	.....
Horsepower	472	290	.....	82	100	.....	.....
Electric motors—							
Number	17	7	1	1	8	.....	.....
Horsepower	672	525	30	25	92	.....	.....
Rented:							
Total horsepower	150	15	14	5	100	7	9
Electric	114	.....	10	5	90	.....	9
Other kind	36	15	4	.....	10	7	.....
Horsepower furnished to other establishments	12	12	.....	.....	.....	.....	.....
Establishments classified by number of persons employed, not including proprietors and firm members:							
Total number of establishments	43	13	6	5	8	4	7
No employees	.....	.....	.....	.....	.....	.....	.....
Under 5	7	1	2	.....	3	1	.....
5 to 20	17	4	2	.....	3	3	5
21 to 50	5	3	1	1	.....	.....	.....
51 to 100	7	2	.....	3	1	.....	1
101 to 250	5	1	1	1	1	.....	1
251 to 500	1	1	.....	.....	.....	.....	.....
501 to 1,000	1	1	.....	.....	.....	.....	.....
Over 1,000	.....	.....	.....	.....	.....	.....	.....

[1] Includes establishments distributed as follows: Illinois, 1; Maryland, 1; Michigan, 1; Missouri, 2; New Jersey, 1; Vermont, 1.

TYPEWRITERS.

TYPEWRITERS.

By HARRY E. BARBOUR.

Although typewriters were manufactured in the United States prior to 1880, the industry was not classified separately in census reports until 1890, and therefore no statistics before that date are available. The reports for "typewriter repairing" are not included in these statistics, that industry being provided for in a separate classification so named. In 1900 the receipts from typewriter repairing for the United States amounted to $367,176. A comparative summary for the manufacture of typewriters and typewriter supplies, for 1890 and 1900, with percentages of increase, is presented in Table 1.

TABLE 1.—COMPARATIVE SUMMARY, 1890 AND 1900, WITH PER CENT OF INCREASE FOR THE DECADE.

	1900	1890	Per cent of increase.
Number of establishments	47	30	56.7
Capital	$8,400,431	$1,421,783	490.8
Salaried officials, clerks, etc., number	532	[1]104	411.5
Salaries	$480,468	[1]$132,727	262.0
Wage-earners, average number	4,340	1,631	166.1
Total wages	$2,403,604	$945,476	154.2
Men, 16 years and over	3,979	1,472	170.3
Wages	$2,289,168	$897,413	155.1
Women, 16 years and over	294	157	87.3
Wages	$102,839	$47,809	115.0
Children, under 16 years	67	2	3,250.0
Wages	$11,597	$254	4,465.7
Miscellaneous expenses	$714,721	$119,773	496.7
Cost of materials used	$1,402,170	$632,723	121.6
Value of products	$6,932,029	$3,630,126	91.0

[1] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table. (See Table 8.)

This industry shows a remarkable development during the past ten years in each of the particulars shown in Table 1. During the decade there was an increase of 17 establishments, or 56.7 per cent, while the capital increased $6,978,648, or 490.8 per cent. In 1900 the average capital per establishment was $178,733, compared with $47,393 in 1890, indicating that the growth of the industry was due to increase in the size of establishments as well as to the inauguration of new companies. Wage-earners increased 2,709, or 166.1 per cent, and the wages paid $1,458,128, or 154.2 per cent. In 1890 the amount paid in wages represented 26 per cent of the value of products; in 1900 the corresponding per cent was 34.7. The cost of materials increased $769,447, or 121.6 per cent. The value of products increased $3,301,903, or 91 per cent, showing an average value per establishment of $147,490 in 1900, compared with $121,004 in 1890.

The following graphic chart shows the comparative growth of capital, cost of materials, and value of products from 1890 to 1900, the unit of growth being $1,000,000:

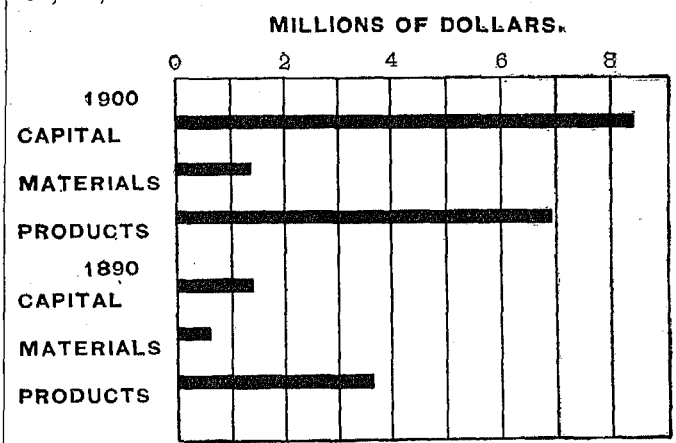

Table 2 is a comparative summary of the number of active establishments in 1890 and 1900, with the increase during the decade, by states arranged geographically.

TABLE 2.—NUMBER OF ESTABLISHMENTS, 1890 AND 1900, WITH INCREASE, BY STATES ARRANGED GEOGRAPHICALLY.

STATES.	1900	1890	Increase.
United States	47	30	17
New England states	7	6	1
Massachusetts	3	3	.....
Connecticut	4	3	1
Middle states	31	18	13
New York	21	13	8
New Jersey	5	2	3
Pennsylvania	4	3	1
District of Columbia	1	.....	1
Southern states	1	.....	1
Georgia	1	.....	1
Central states	8	6	2
Ohio	1	2	[1]1
Illinois	6	1	5
Minnesota	.....	1	[1]1
Iowa	1	.....	1
Missouri	.....	2	[1]2

[1] Decrease.

The greatest increase in number of establishments was 8, in the state of New York. In Ohio, Minnesota, and Missouri, the number of establishments was less in 1900 than in 1890, the latter two states reporting none in 1900.

Table 3 is a comparative summary of capital, 1890 and 1900, with the proportion of each item to the total, and the percentage of increase.

TABLE 3.—CAPITAL, 1890 AND 1900, WITH PER CENT OF INCREASE FOR THE DECADE.

	1900		1890		Per cent of increase.
	Amount.	Per cent of total.	Amount.	Per cent of total.	
Total	$8,400,431	100.0	$1,421,783	100.0	490.8
Land	278,307	3.3	35,350	2.5	687.3
Buildings	568,043	6.8	47,050	3.3	1,107.3
Machinery, tools, and implements	2,108,564	25.1	533,548	37.5	295.2
Cash and sundries	5,445,517	64.8	805,835	56.7	575.8

The most important item was that of cash and sundries, which in 1890 amounted to 56.7 per cent of the total, and in 1900 to 64.8 per cent, the increase being $4,639,682. Although the amounts invested in land and buildings increased $242,957 and $520,993, respectively, each of these items represented a comparatively small percentage of the total both in 1890 and in 1900. In 1890, 37.5 per cent of the total was invested in machinery, tools, and implements, while in 1900 this investment represented only 25.1 per cent, although the increase was $1,575,016. The statistics for land, buildings, and machinery represent only such as were owned by the establishments engaged in the industry, not including leased property. The amount paid for rent of works is included in Table 4.

Table 4 shows, for 1900, the cost of materials used, with the proportion of each item to the total.

TABLE 4.—COST OF MATERIALS USED: 1900.

	Amount.	Per cent of total.
Total	$1,402,170	100.0
Purchased in partially manufactured form[1]	1,344,176	95.9
Fuel	28,352	2.0
Rent of power and heat	8,731	0.6
Freight	20,911	1.5

[1]Includes "mill supplies" and "all other materials," shown separately in Table 8.

Materials purchased in partially manufactured form, including "mill supplies" and "all other materials," which are shown separately in Table 8, represent 95.9 per cent of the total. "Mill supplies" are materials which, while not entering into the product, are indispensable in the process of manufacture, and include oil, waste, belting, and other necessaries; "all other materials" comprise those not elsewhere specified, and include boxes, packages, etc. None of the establishments reported raw materials; that is, materials upon which no manufacturing force had been expended. Fuel includes that used for motive power and heat. Some manufacturers, in this as in other industries, were unable to separate the amount paid for freight from the cost of materials and reported them together. For this reason, the $20,911 given in Table 4 as the cost of freight does not represent the actual cost, and should be considered only in connection with the cost of materials.

Table 5 is a summary for 1900 of the quantity and value of products, by states arranged geographically.

TABLE 5.—QUANTITY AND VALUE OF PRODUCTS, BY STATES ARRANGED GEOGRAPHICALLY: 1900.

STATES.	Total value.	TYPEWRITERS.		All other products.
		Number.	Value.	
United States	$6,932,029	144,873	$5,624,172	$1,307,857
New England states	1,113,585	23,698	875,229	238,356
Massachusetts	329,763	3,839	169,043	160,720
Connecticut	783,822	19,859	706,186	77,636
Middle states	5,011,741	106,995	4,060,956	950,785
New York	3,823,992	88,087	3,225,923	598,069
New Jersey	744,680	11,175	615,267	229,413
Pennsylvania	443,069	7,733	319,766	123,303
Central states	584,288	12,137	520,337	63,951
Illinois	584,288	12,137	520,337	63,951
All other states[1]	222,415	2,043	167,650	54,765

[1]Includes establishments distributed as follows: District of Columbia, 1; Georgia, 1; Iowa, 1; Ohio, 1.

The products are classified in this table as typewriters and all other products, the latter class including chiefly typewriter supplies and attachments, by-products, and incidental custom work and repairing. For states having more than 3 establishments the products are shown separately, but in order to avoid disclosing the operations of individual establishments the products of states with less than 3 are shown collectively under the head of "all other states." New York ranked first, producing 55.2 per cent of the entire output for the year; Connecticut, second, with 11.3 per cent; and New Jersey, third, with 10.7 per cent. Twenty of the establishments included in this report manufactured typewriter supplies only, the total value of their products being $645,192. They were distributed as follows: New York, 10; Illinois, 2; Massachusetts, 2; New Jersey, 2; and Connecticut, Georgia, Ohio, and Pennsylvania, 1 each.

Table 6 is a summary for cities having a population of 20,000 or over.

TABLE 6.—STATISTICS OF CITIES OF 20,000 POPULATION OR OVER: 1900.

CITIES.	Number of establishments.	Capital.	SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Miscellaneous expenses.	Cost of materials used.	PRODUCTS.			
			Number.	Salaries.	Average number.	Total wages.			Total value.	Typewriters.		All other products.
										Number.	Value.	
Total	36	$5,785,976	365	$326,222	2,705	$1,420,145	$452,074	$933,823	$4,236,720	90,060	$3,379,426	$857,294
New York, N. Y	14	997,719	96	87,102	466	251,365	75,300	269,228	910,604	35,790	641,699	268,905
Chicago, Ill	4	357,365	63	33,650	231	121,822	51,056	61,276	279,480	5,434	265,400	14,080
All other cities[1]	18	4,430,892	206	205,470	2,008	1,046,958	325,718	603,319	3,046,636	48,836	2,472,327	574,309

[1] Includes establishments distributed as follows: Atlanta, Ga., 1; Aurora, Ill., 1; Bayonne, N. J., 1; Boston, Mass., 1; Bridgeport, Conn., 1; Buffalo, N. Y., 1; Cleveland, Ohio, 1; Des Moines, Iowa, 1; District of Columbia, 1; Harrisburg, Pa., 1; Newark, N. J., 2; Philadelphia, Pa., 1; Rochester, N. Y., 2; Springfield, Mass., 2; Syracuse, N. Y., 1.

Of the 47 establishments reported in 1900, 36, or 76.6 per cent, were located in cities of 20,000 inhabitants or over. These establishments employed 62.3 per cent of the wage-earners, and the value of their products was 61.1 per cent of the total. Both in number of establishments and value of products New York ranked first and Chicago second. In New York city were located 29.8 per cent of all establishments, and these produced 13.1 per cent of the total value of products. Owing to the fact that New York and Chicago were the only cities reporting 3 or more establishments, it is necessary, in order to avoid the disclosure of individual returns, to combine the figures for other cities and report them collectively under the head of "all other cities."

Table 7 is a comparative summary of the exports of typewriters from 1897 to 1900, inclusive, as shown by the reports of the Bureau of Statistics of the Treasury Department.

TABLE 7.—EXPORTS OF TYPEWRITERS AND PARTS THEREOF: 1897 TO 1900, INCLUSIVE.[1]

COUNTRIES TO WHICH EXPORTED.	1900	1899	1898	1897
Total	$2,697,544	$2,449,205	$1,902,158	$1,458,117
Europe	2,244,585	2,091,025	1,649,050	1,235,060
Austria-Hungary	17,230	31,907	15,210	4,088
Azores and Madeira islands		100		
Belgium	149,106	55,775	36,875	39,782
Denmark	16,239	13,550	5,511	3,564
France	177,440	160,357	94,608	99,222
Germany	454,625	507,000	425,614	228,710
Gibraltar	250			35
Greece		2,061	100	
Greenland, Iceland, etc		159		
Italy	53,996	35,665	29,281	7,665
Malta, Gozo, etc	493			
Netherlands	69,963	53,387	17,046	17,142
Portugal	278		204	135
Roumania	610	620	616	
Russia:				
Baltic and White seas	167,483	129,730	95,660	87,706
Black Sea	2,397	1,857	4,515	542
Spain	4,787	783	485	610
Sweden and Norway	12,495	18,742	10,544	3,889
Switzerland	22,928	25,210	15,810	10,768
Turkey in Europe	1,543	110	396	50
United Kingdom	1,092,722	1,054,060	896,575	731,152
North America	170,949	137,604	88,849	78,420
Bermuda	136	161	403	75
British Honduras	305	431	255	86
British America:				
Dominion of Canada—				
Nova Scotia, New Brunswick, etc	7,158	7,171	5,258	4,689
Quebec, Ontario, Manitoba, etc	42,285	43,277	42,378	22,783
British Columbia	5,482	4,400	3,234	2,628
Newfoundland and Labrador	1,248	4,475	812	610

[1] Annual Reports on Commerce and Navigation, United States Treasury Department, 1900. Statistics prior to 1897 were included in "machinery, not elsewhere specified."

TABLE 7.—EXPORTS OF TYPEWRITERS AND PARTS THEREOF: 1897 TO 1900, INCLUSIVE—Continued.

COUNTRIES TO WHICH EXPORTED.	1900	1899	1898	1897
North America—Cont'd.				
Central American states:				
Costa Rico	$748	$127	$515	$490
Guatemala	587	818	621	5,990
Honduras	539	239	441	2,381
Nicaragua	251	260	100	2,671
Salvador	834	565	428	1,652
Mexico	63,324	45,824	28,975	25,298
Miquelon, Langley, etc		75		
West Indies:				
British	6,225	5,081	3,692	4,611
Cuba	36,003	19,769	1,457	2,745
Danish	181			80
Dutch	327	212		354
French	191	103	40	125
Haiti	157	179	90	295
Porto Rico	4,516	4,229	65	590
Santo Domingo	452	208	90	267
South America	76,132	67,222	42,012	31,193
Argentina	36,946	31,164	18,187	11,914
Bolivia		1,186	175	
Brazil	11,719	6,135	4,945	4,006
Chile	12,640	13,459	6,785	5,177
Colombia	2,507	3,942	4,228	3,995
Ecuador	1,868	1,989	1,434	770
Guianas:				
British	334	1,747	1,669	860
Dutch	130		161	115
French	50			
Peru	4,240	4,552	2,718	1,749
Uruguay	2,784	1,808	145	198
Venezuela	2,414	1,740	1,615	2,409
Asia	53,293	33,613	21,013	18,134
Aden		70		
Chinese Empire	8,476	5,799	2,642	3,672
China—Russian	586			
East Indies:				
British	17,321	12,981	9,014	7,608
Dutch	1,165	967	110	135
Hongkong	5,068	2,647	3,203	1,678
Japan	17,446	7,262	4,220	4,858
Korea	200			
Russia—Asiatic	879	2,574	697	
Turkey in Asia	130	153	109	103
All other Asia	2,022	1,160	1,018	80
Oceania	123,874	88,114	64,887	70,688
British Australasia	100,135	77,285	60,089	67,622
French Oceania			92	
Hawaii	9,018	7,893	4,756	3,066
Philippine Islands	14,336	2,836		
Tonga, Samoa, etc	385	100		
Africa	28,711	31,627	36,342	19,622
British Africa	23,569	30,332	31,155	19,513
Canary Islands				9
French Africa	30			
Madagascar			57	
Portuguese Africa	4,840	649	193	50
Turkey in Africa—Egypt	272	146	750	
All other Africa			4,187	50

It is impossible to show the value of exports before 1897, because prior to that date typewriters were reported, together with many other articles, under the head "machinery, not elsewhere specified." However, the figures presented indicate clearly the steady de-

velopment of the export trade. The foreign demand for American typewriters is one of the greatest testimonials to their excellence. At no time in the history of this industry have American manufacturers been compelled to meet the competition of foreign-made machines in their own market. The value of the exports in 1900 was $2,697,544, or 38.9 per cent of the total value of products; during the three years from 1897 to 1900 the exports increased in value $1,244,427, or 85.6 per cent. Europe has always been the largest purchaser of American typewriters, receiving, in 1900, 83.3 per cent of the total, and showing an increase of 81.7 per cent over 1897. In 1900 the United Kingdom received 48.7 per cent of the exports to Europe, or 40.5 per cent of the total, being followed by Germany, France, and Belgium, ranking in the order named.

The exports to the countries of North America increased 118 per cent from 1897 to 1900, and for the latter year represented 6.3 per cent of the total. In 1900 Mexico led all North American countries in the value of typewriters purchased from the United States, the Dominion of Canada being second, and Cuba third. To these countries were sent 90.2 per cent of the total exports to this group. From 1897 to 1900, exports to South America increased 144.1 per cent, Argentina receiving the greatest amount, Chile ranking second, and Brazil third; in 1900 Asia's imports of American typewriters showed an increase of 193.9 per cent for the three years, Japan leading all other Asiatic countries, followed closely by the British East Indies, while the Chinese Empire was third in 1900. Exports to Oceania showed an increase of 75.2 per cent from 1897 to 1900, British Australasia receiving more than four-fifths of the total exports to this group in 1900. Exports to Africa increased 46.3 per cent from 1897 to 1900, British Africa being the largest consumer.

Table 8 is a detailed summary of the industry, by states, for 1900.

TABLE 8.—TYPEWRITERS AND SUPPLIES: DETAILED SUMMARY BY STATES, 1900.

	United States.	Connecticut.	Illinois.	Massachusetts.	New Jersey.	New York.	Pennsylvania.	All other states.[1]
Number of establishments	47	4	6	3	5	21	4	4
Character of organization:								
Individual	7	1	1	.....	.....	4	.....	1
Firm and limited partnership	6	.....	.....	1	2	1	1	1
Incorporated company	34	3	5	2	3	16	3	2
Capital:								
Total	$8,400,431	$1,142,454	$768,848	$223,622	$1,015,459	$3,782,014	$416,075	$1,051,959
Land	$278,307	$66,850	.....	.....	$55,944	$150,513	$5,000	.....
Buildings	$568,043	$75,500	.....	.....	$124,757	$347,786	$20,000	.....
Machinery, tools, and implements	$2,108,564	$429,217	$265,408	$104,707	$238,838	$919,422	$86,746	$74,226
Cash and sundries	$5,445,517	$570,887	$513,440	$118,915	$595,920	$2,864,293	$304,329	$977,733
Proprietors and firm members	23	1	1	2	5	7	4	3
Salaried officials, clerks, etc.:								
Total number	532	24	118	37	91	157	74	31
Total salaries	$480,468	$39,104	$86,420	$22,492	$60,283	$178,651	$67,974	$25,544
Officers of corporations—								
Number	40	3	9	3	4	17	2	2
Salaries	$106,839	$15,136	$18,200	$5,044	$10,500	$37,759	$15,000	$5,200
General superintendents, managers, clerks, etc.—								
Total number	492	21	109	34	87	140	72	29
Total salaries	$373,629	$23,968	$68,220	$17,448	$49,783	$140,892	$52,974	$20,344
Men—								
Number	384	13	83	14	73	117	61	23
Salaries	$326,843	$19,748	$54,094	$9,700	$46,432	$130,548	$48,477	$17,844
Women—								
Number	108	8	26	20	14	23	11	6
Salaries	$46,786	$4,220	$14,126	$7,748	$3,351	$10,344	$4,497	$2,500
Wage-earners, including pieceworkers, and total wages:								
Greatest number employed at any one time during the year	5,151	770	569	265	774	2,103	419	191
Least number employed at any one time during the year	3,581	577	264	140	549	1,684	232	135
Average number	4,340	693	442	223	649	1,848	328	157
Wages	$2,403,604	$374,452	$235,912	$118,760	$389,923	$1,083,939	$178,947	$71,671
Men, 16 years and over—								
Average number	3,979	588	420	157	592	1,745	326	151
Wages	$2,289,168	$340,486	$229,141	$94,328	$326,902	$1,050,373	$178,647	$69,291
Women, 16 years and over—								
Average number	294	97	20	66	10	93	2	6
Wages	$102,839	$31,806	$6,511	$24,432	$5,272	$32,138	$300	$2,380
Children, under 16 years—								
Average number	67	8	2	.....	47	10	.....	.....
Wages	$11,597	$2,160	$260	.....	$7,749	$1,428	.....	.....
Average number of wage-earners, including pieceworkers, employed during each month:								
Men, 16 years and over—								
January	3,848	593	393	160	556	1,658	342	146
February	3,902	602	409	166	556	1,661	344	164
March	3,971	598	429	175	564	1,687	350	168
April	4,000	591	445	179	563	1,700	351	171
May	3,914	565	448	182	571	1,720	254	174
June	3,797	553	471	173	544	1,673	252	131
July	3,733	545	468	102	546	1,686	258	128
August	3,711	543	326	100	547	1,706	359	130
September	4,008	586	391	152	652	1,742	355	130
October	4,180	606	425	157	646	1,842	351	153
November	4,298	626	429	168	673	1,897	350	155
December	4,386	652	410	172	682	1,967	347	156
Women, 16 years and over—								
January	281	96	19	63	10	79	2	7
February	289	100	19	70	10	81	2	7
March	290	98	19	69	10	85	2	7
April	301	97	19	73	10	93	2	7
May	290	89	19	69	10	94	2	7
June	290	91	17	69	10	94	2	7
July	275	87	19	53	11	97	2	6
August	280	94	19	47	11	101	2	6
September	303	98	22	64	11	100	2	6
October	307	99	24	69	11	96	2	6
November	311	102	24	72	10	95	2	6
December	317	107	22	73	10	97	2	6

[1] Includes establishments distributed as follows: District of Columbia, 1; Georgia, 1; Iowa, 1; Ohio, 1.

TABLE 8.—TYPEWRITERS AND SUPPLIES: DETAILED SUMMARY BY STATES, 1900—Continued.

	United States.	Connecticut.	Illinois.	Massachusetts.	New Jersey.	New York.	Pennsylvania.	All other states.[1]
Average number of wage-earners, including pieceworkers, employed during each year—Continued.								
Children, under 16 years—								
January	38	8	.....	.....	24	6	.....	.....
February	40	9	.....	.....	27	4	.....	.....
March	48	9	.....	.....	33	6	.....	.....
April	49	9	.....	.....	31	9	.....	.....
May	53	6	.....	.....	35	12	.....	.....
June	71	7	.....	.....	52	12	.....	.....
July	88	5	2	.....	64	17	.....	.....
August	82	5	2	.....	60	15	.....	.....
September	84	7	5	.....	57	15	.....	.....
October	80	8	5	.....	57	10	.....	.....
November	85	9	5	.....	63	8	.....	.....
December	83	12	5	.....	61	5	.....	.....
Miscellaneous expenses:								
Total	$714,721	$41,876	$85,786	$30,783	$90,735	$375,234	$50,172	$40,135
Rent of works	$53,390	$812	$6,938	$6,268	$5,568	$22,915	$5,915	$4,974
Taxes, not including internal revenue	$20,052	$2,660	$1,196	$231	$1,490	$13,893	$951	$231
Rent of offices, interest, insurance, etc	$637,495	$38,404	$76,332	$24,284	$81,813	$338,426	$43,306	$34,930
Contract work	$3,184	.....	$1,320	.....	$1,864	.....	.....	.....
Materials used:								
Aggregate cost	$1,402,170	$162,502	$137,995	$67,211	$231,759	$682,826	$75,417	$44,460
Purchased in partially manufactured form	$1,111,902	$105,891	$111,868	$60,302	$126,123	$612,595	$66,275	$28,908
Fuel	$28,352	$4,821	$1,814	$633	$3,628	$16,284	$1,097	$75
Rent of power and heat	$8,731	$500	$1,155	$1,995	$300	$3,166	$200	$1,415
Mill supplies	$49,554	$5,320	$1,150	$493	$23,823	$16,411	$1,993	$364
All other materials	$182,660	$42,766	$19,683	$3,000	$75,476	$25,598	$5,700	$10,437
Freight	$20,911	$3,204	$2,325	$788	$2,409	$8,772	$152	$3,261
Products:								
Aggregate value	$6,932,029	$783,822	$584,288	$329,763	$744,680	$3,828,992	$443,069	$222,415
Machines—								
Total number	150,410	20,032	12,137	4,082	11,175	93,208	7,733	2,043
Total value	$5,675,397	$706,729	$520,337	$170,888	$515,267	$3,274,760	$319,766	$167,650
Typewriters—								
Number	144,873	19,859	12,137	3,839	11,175	88,087	7,733	2,043
Value	$5,624,172	$706,186	$520,337	$169,043	$515,267	$3,225,923	$319,766	$167,650
Tabulators—								
Number	5,337	173	.....	243	.....	4,921	.....	.....
Value	$50,845	$543	.....	$1,845	.....	$48,457	.....	.....
Other varieties—								
Number	200	.....	.....	.....	.....	200	.....	.....
Value	$380	.....	.....	.....	.....	$380	.....	.....
All other products, value	$1,256,632	$77,093	$63,951	$158,875	$229,413	$549,232	$123,303	$54,765
Comparison of products:								
Number of establishments reporting for both years	32	4	4	2	4	15	.....	3
Value for census year	$6,102,586	$783,822	$485,408	$329,263	$719,338	$3,586,340	.....	$198,415
Value for preceding business year	$4,787,729	$643,993	$332,491	$267,448	$571,944	$2,832,103	.....	$139,750
Power:								
Number of establishments reporting	41	3	6	2	4	18	4	4
Total horsepower	2,778	441	636	125	365	986	202	23
Owned—								
Engines—								
Steam—								
Number	20	2	2	1	5	10	.....	.....
Horsepower	1,696	375	81	100	355	785	.....	.....
Gas or gasoline—								
Number	3	.....	1	.....	.....	1	1	.....
Horsepower	54	.....	22	.....	.....	7	25	.....
Water wheels—								
Number	6	1	.....	.....	.....	2	3	.....
Horsepower	355	60	.....	.....	.....	120	175	.....
Electric motors—								
Number	3	2	1	.....	.....	.....	.....	.....
Horsepower	506	6	500	.....	.....	.....	.....	.....
Rented—								
Electric, horsepower	64	.....	3	.....	.....	36	2	23
Other kinds, horsepower	103	.....	30	25	10	38	.....	.....
Furnished to other establishments, horsepower	60	.....	.....	.....	.....	.....	60	.....
Establishments classified by number of persons employed, not including proprietors and firm members:								
Total number of establishments	47	4	6	3	5	21	4	4
No employees	1	.....	.....	1	.....	.....	.....	.....
Under 5	5	1	.....	.....	.....	2	.....	2
5 to 20	14	.....	3	.....	1	9	1	.....
21 to 50	5	.....	.....	.....	1	4	.....	.....
51 to 100	6	.....	1	.....	1	2	1	1
101 to 250	10	2	1	2	1	2	1	1
251 to 500	3	1	1	.....	.....	.....	1	.....
501 to 1,000	3	.....	.....	.....	1	2	.....	.....

[1] Includes establishments distributed as follows: District of Columbia, 1; Georgia, 1; Iowa, 1; Ohio, 1.

HISTORICAL AND DESCRIPTIVE.

The manufacture of typewriters is one of the many industries the development of which belongs distinctively to the century just passed. The idea of a mechanical letter-writer seems to have first occurred to an Englishman, for the earliest record of a patent for such a device is of one granted by the English Government to Henry Mill in 1714.[1] Had this machine met the hopes and expectations of its inventor, the history of the typewriter would perhaps have dated its inception more than a century earlier than it does, for this invention was described as "an artificial machine or motive for impressing or transcribing of letters, singularly or progressively, one after another in writing, whereby all writings whatsoever may be engrossed on paper or parchment so neat and exact as not to be distinguished from print." But the theories of the inventor were so far in advance of the mechanical skill of his time that the machine was never perfected, and it was not until well along in the Nineteenth century that any actual

[1] Universal Cyclopedia, vol. 12, pages 7 and 8.

progress was made. In 1833, a Frenchman, Xavier Progrin, of Marseilles, was granted a patent by his Government for a machine which the inventor claimed would print "almost as rapidly as one could write with an ordinary pen." While the modest claims of the inventor were to an extent realized, the machine proved too slow and cumbersome to be of any practical value.

While many patents have been granted in Europe for writing machines, the real history of the typewriter belongs to the United States; it was in this country that the first practical typewriter was made, and from the very beginning the superiority of the American machine has been recognized in all parts of the world. Therefore the history of the evolution of the practical typewriter of to-day may be gleaned from an account of the failures and successes of American inventors. It is impossible to mention here the numerous attempts to construct a practical typewriter, or the various inventors who labored patiently toward that end. While most of these men failed to produce a perfect machine, their efforts contributed to the final success, and to each of them a share of the credit is due. In this connection, however, it may prove interesting to consider briefly some of the earlier types of the machine and to note various changes in its development.

The first typewriter invented in the United States, called the "typographer," was patented in 1829 by William Austin Burt, of Detroit, Mich., also the inventor of the solar compass. This machine was a primitive affair, and could be manipulated only slowly. No practical results were accomplished by the Burt machine, and to-day it is known merely as the starting point of a great American industry. In 1843 Charles Thurber, of Worcester, Mass., patented a writing machine which produced good results in every respect except speed. This machine was constructed with a horizontal wheel, on the periphery of which were a number of perpendicular rods having types at the bottom and finger keys at the top. In operating this machine the wheel was turned until the rod bearing the desired letter was directly over the printing point, when, by pressing the key, the character was printed on the paper, being aided in the alignment by fixed guides. A ratchet and pawl device served to move lengthwise the cylinder bearing the paper, thus producing the proper letter spacing, while interlinear spacing was secured by turning the cylinder. An inked roller, over which the face of the type passed, produced the inking. Although this machine was a failure because of its lack of speed, it will readily be seen it embodied some of the principles involved in the construction of the modern typewriter.

Another step in the evolution of the present-day typewriter was the invention of A. Ely Beach, of New York, who in 1847 and in 1856 secured patents on a machine involving the system of type-bearing levers arranged in a circle, swinging toward and printing at a common center. The inked ribbon, and also the bell indicating the end of the line, were features of this machine, which, although slow in action, embodied principles which have since been successfully utilized and are to-day prominent features of the typewriting machine. In 1857 Dr. S. W. Francis, of Newport, R. I., patented a machine provided with a circle of type-bearing hammers attached to a keyboard. Pressure on a key caused the type to strike upward, making an impression on the paper through an inked ribbon, the printing point being the center of the circle. This machine was fitted with the bell attachment and also with a coiled spring which moved the frame bearing the paper, rewinding when the frame was drawn back after reaching the end of the line. It was large and cumbersome, and only one was ever constructed under this patent.

In 1868 C. Latham Sholes, Samuel W. Soule, and Carlos Glidden, all of Milwaukee, Wis., were granted a patent on a machine which was a decided improvement over its predecessors. This typewriter embodied an extension of many of the principles involved in former inventions, together with certain features of its own. The inventor continued to make improvements and succeeded in bringing it to a state of practical usefulness, crude though it was when compared with the finished typewriters of the present day. James Densmore became interested in the Sholes patents; he made a contract with E. Remington & Sons, gun manufacturers at Ilion, N. Y., for the manufacture of typewriters on a large scale, and the improved machine has ever since been called the Remington. In 1873, George W. N. Yost, then connected with the Remington factory, was actively engaged in the manufacture of one of the early machines.

The first person to make a practical business use of the typewriter was Mr. S. N. D. North, of Boston, Mass. This was in 1872, at Utica, N. Y. "I have often wished that I had kept that original machine," wrote Mr. North in 1896, "for it would have illustrated better than any other mechanism with which I am familiar the marvelous rapidity with which American ingenuity advances to the point of perfection any labor-saving instrument, the underlying principle of which has been successfully worked out. This machine was heavy and cumbersome in comparison with the delicate mechanism of to-day, but the principle of construction was essentially the same, except that the carriage, instead of being restored to position by the hand at the end of each line as now, was brought back by means of a foot pedal, and it came with a jar that made the machine tremble in every part. My machine did neither elegant nor uniform work, but after a week or two I was enabled to accomplish all my editorial writing upon it, and I began to realize dimly what an unspeakable boon to all weak-eyed persons lay here in embryo."

It was not until 1874 that the typewriter was placed on the market for general sale. Like many other inventions which have grown to be considered indispensable, the typewriter was first greeted by the public with scepticism. The use of the machine involved such radical changes in certain methods of business that its advantages had to be clearly demonstrated before the business world would accept it. The first machines wrote only with capital letters, and were otherwise imperfect, but these imperfections were soon remedied. Even then but few persons saw the advantages of the typewriter, and during its first few years in the market only a small number were sold.[1] People were not merely indifferent, but were antagonistic. But the typewriter had a usefulness which was not to be ignored; among the first to recognize this fact were court stenographers, who found that with the aid of the typewriter several copies of the record could be turned out at once with neatness and despatch. Lawyers, having the advantage of the machine thus brought home to them, soon began to adopt it for private use. Courts of law, which for centuries had required all papers to be submitted in handwriting, began to require such papers to be typewritten; and to-day the handwritten legal document is the exception rather than the rule. The large business houses, having an extensive correspondence, being always ready for improvements and time-saving methods, were next to adopt the typewriter, and the commercial world in general soon followed their example. The work of the typewriter was its own best recommendation. As typewritten letters and papers were spread throughout the country, there was awakened a general interest in the machine and its work. It began to find its way into every branch of business and professional life; authors and newspaper men have adopted it; telegraph companies have made it a part of their equipment, for so rapidly can messages be transcribed that the receiving operator can not only keep pace with the sender, but can maintain speed so great as to bring about the abbreviation of the telegraphic code. In fact, there is not a single business or profession in which the typewriter has not established its usefulness.

The use of the typewriter for miscellaneous correspondence became general in all the departments of the Government, except the Department of State, during the early eighties; it was first used for instructions to diplomatic and consular officers of the United States by the Department of State, in April, 1895. The official communications of the Department to diplomatic officers of foreign countries accredited to the United States continued to be handwritten until May, 1897. Ceremonial letters addressed to sovereigns are still handwritten.

One of the advantages of the use of the typewriting machine over hand labor has been demonstrated in an interesting manner by an investigation by the United States Department of Labor.[2] In this instance the unit required was the copying of 1,000 words of statute law; this was accomplished by the typewriter in 19.5 minutes, or at the rate of 51 words per minute, while a copyist with a pen required 1 hour and 14.8 minutes, or about four times as long. The quantity of work done by the typewriter depends to a great extent upon the skill of the operator, but it is true also that the proficiency of the copyist enters largely into the quantity of work performed by him. However, it is possible to determine an average, and the figures given may be accepted as a fair and reasonable comparison of the two methods.

The rise of the typewriter has been most remarkable. Looked upon at first as rather an article of amusement than one of any practical value, it has received, within the past quarter of a century, the unqualified approval of the commercial and professional worlds; it has been given the sanction of statute by almost every state and national legislature, and adopted by every civilized government in the world, thousands of the machines being used by the United States Government. It promises soon to become, if it is not already such, the universal writing machine. During the past twenty-five years hundreds of patents have been granted for improved attachments, and also for new styles of typewriting machines. Many of these have proved useful, and there are to-day several different types of the machine on the market, all of which are doing excellent work.

Among the most notable advancements in the art of typewriting during recent years has been the development and perfecting of "book typewriters." The following patents disclose various features of this kind of machine: Fisher, 569,625, 569,627, October 20, 1896; Elliott, 573,081, December 15, 1896, and 615,017, December 29, 1898.

At the present time inventors are actively at work improving what are known in the art as "power typewriters." In this class of machines the operator has merely to touch the key with sufficient force to release latch mechanism, whereupon power from some external source completes the impression. Examples of this class of machines are: Selden, 557,239, March 31, 1896; Blickensderfer, 656,085, August 14, 1900; and Allen, 684,163, October 8, 1901.

Many improvements have been made in recent years in electrical typewriters, examples of which are: Davis, 560,572 and 560,573, May 19, 1896; and Cahill, 566,442, August 25, 1896, and 604,001, May 10, 1898. In this class of machines the impression mechanism is operated by magnets, the circuit being closed by the operator touching the key. The Cahill patents also dis-

[1] One Hundred Years of American Commerce, Vol. II, pages 545 to 548.

[2] Annual Report of the Commissioner of Labor, 1898. Hand and Machine Labor, page 411.

close a permutation system of type-selecting means, which involves fewer keys than the ordinary keyboards of typewriters, the combination of two or more keys being required to operate a single type bar.

In the class of typewriters 1,856 patents have been issued.

Another aspect to be considered in connection with the typewriter is its industrial effect. Not only has the steadily increasing demand opened a new field for skilled labor in the manufacture, but the effort to secure the best possible results from the use of the machine has created a new profession. Not long after the machine was introduced, the need of skilled operatives became apparent. The result of this has been the giving of employment to thousands of persons. Business colleges and private schools have introduced courses which train students to become expert operatives, and, in many cities, similar courses have been introduced in the public schools.

MUSICAL INSTRUMENTS AND MATERIALS.

MUSICAL INSTRUMENTS AND MATERIALS.

By FREDERICK S. HALL, Ph. D.

The statistics of the manufacture of musical instruments in the United States during the census year are presented in this report under three general heads: Pianos and materials, organs and materials, and musical instruments and materials not specified. Table 1 presents the statistics for the 3 industries in a summarized form.

TABLE 1.—MUSICAL INSTRUMENTS AND MATERIALS: SUMMARY, 1900.

	Musical instruments, all classes.	Pianos.[1]	Organs.	Musical instruments, not specified.
Number of establishments	621	263	129	229
Capital	$47,751,582	$38,843,494	$5,011,987	$3,896,101
Land	$3,233,659	$2,865,118	$196,371	$172,170
Buildings	$5,923,074	$4,885,171	$667,641	$370,262
Machinery, tools, and implements	$4,334,315	$3,002,426	$602,313	$729,576
Cash and sundries	$34,260,534	$28,090,779	$3,545,662	$2,624,093
Salaried officials, clerks, etc., number	1,682	1,250	274	158
Salaries	$2,164,171	$1,722,991	$299,435	$141,745
Wage-earners, average number	23,765	17,925	3,435	2,405
Total wages	$12,801,767	$9,849,001	$1,720,727	$1,232,039
Miscellaneous expenses	$3,786,929	$2,912,051	$603,785	$271,093
Cost of materials	$18,607,537	$15,182,035	$2,220,165	$1,205,337
Value of products	$44,514,463	$35,428,225	$5,691,504	$3,394,734

[1] Includes the statistics for 2 establishments, the schedules for which were received too late to be included in the totals for this industry, as presented in the Report on Manufactures, Parts I and II.

Table 1 indicates that the manufacture of pianos and materials is by far the most important of the three industries. More than four-fifths of the total capital, more than three-fourths of the total number of wage-earners, and nearly four-fifths of the total value of products were reported for this industry.

It should be noticed, however, that the operations of the three industries overlap somewhat. A considerable number of establishments manufacture both pianos and organs, and a few combine these operations with the manufacture of certain musical instruments which are included in the third class. Such establishments have been classified as piano or organ factories, according as the predominating product was pianos or organs. As a result of this method of treatment, organs manufactured in piano factories are included among the products of the piano industry, and pianos manufactured in organ factories are included among the products of the organ industry. Special tables are presented, however (pages 6 and 18), which show the entire production of pianos and organs, irrespective of the factory in which they were produced.

Statistics of the manufacture of musical instruments have been gathered with more or less completeness since the first census of manufactures, taken in 1810. The census of 1860 contained a special report of eight pages upon the musical instrument industry, but since that time no special report has been made until at the present census.

The successful manufacture of musical instruments requires a skill on the part of both manufacturers and workmen which is only attained by long experience. For this reason the industries included in this report were slow in establishing themselves in the United States, buyers of musical instruments being for a long period very largely dependent upon foreign manufacturers. The change in this particular is shown in Table 2, which presents the value of musical instruments and parts of musical instruments imported during the fiscal years 1872 to 1900.

TABLE 2.—MUSICAL INSTRUMENTS AND MATERIALS: VALUE OF IMPORTS, 1872 TO 1900.

FISCAL YEAR.	Value.	FISCAL YEAR.	Value.
1900	$1,090,541	1885	$1,425,485
1899	1,058,424	1884	1,749,349
1898	920,094	1883	1,652,528
1897	1,147,926	1882	1,580,144
1896	1,307,154	1881	1,474,771
1895	918,253	1880	917,778
1894	619,466	1879	627,722
1893	994,866	1878	561,867
1892	1,031,485	1877	564,530
1891	1,444,755	1876	773,811
1890	1,703,129	1875	786,122
1889	1,721,428	1874	870,348
1888	1,843,344	1873	1,026,028
1887	1,577,895	1872	1,050,218
1886	1,449,071		

It appears from Table 2 that there was a general, though not steady, increase in the value of imports from 1878 to 1888 and a general decrease since that date. The change is shown more strikingly in Table 3, which presents the value of imports of musical instru-

ments in 1870, 1880, 1890, and 1900 in comparison with the value of the musical instrument products reported at the censuses of 1870, 1880, 1890, and 1900.

TABLE 3.—MUSICAL INSTRUMENTS AND MATERIALS: VALUE OF PRODUCTS, 1870, 1880, 1890, AND 1900, AND VALUE OF IMPORTS, 1872, 1880, 1890, AND 1900.

FISCAL YEAR.	Value of products.	Value of imports.	Per cent of imports to products.
1900	$44,514,463	$1,090,541	2.4
1890	36,868,169	1,703,129	4.6
1880	19,254,739	917,778	4.8
1870	13,905,908	[1]1,050,218	7.6

[1] Figures are for 1872, the first year in which musical instruments were reported separately.

It appears from Table 3 that the value of imports of all kinds of musical instruments in 1872 was equal to 7.6 per cent of the value of all such instruments manufactured in the country in 1870, the nearest census year, as compared with but 2.4 per cent in 1900.

The three musical instrument industries are each very much subdivided into special smaller industries, which manufacture musical instrument parts. Establishments of this sort are more conveniently described at this point than under each of the three industries, for in many cases both organ and piano parts or piano and small stringed instrument parts are made by the same establishments.

Several establishments in the country manufacture piano and organ keys. Three such factories in one county in Connecticut used over a hundred tons of elephant ivory for this purpose during the census year. Leominster, Mass., near the city of Worcester, is an important center for the manufacture of piano cases. Its location is a little remarkable, since considerable quantities of the pine, chestnut, and hard-maple wood used in the manufacture are brought from New Hampshire, while for certain special work imported woods are used.

Other establishments make a specialty of sounding boards, piano actions, cast-iron plates, hammers, piano legs, piano felts, etc. This subdivision is most marked in New York city, where there were 22 such establishments in operation during the census year. The specialization in the piano industry has become so great that but few manufacturers any longer make their instruments entire, while many are assemblers only, purchasing practically all of the parts used. Specialization has not gone so far in the organ industry, reeds and pipes being the most important parts made in special establishments. Massachusetts leads in these specialties. Among small stringed instrument parts, whose manufacture has been made a specialty, may be mentioned drum and banjo heads, gut and wire strings, etc.

PIANOS AND MATERIALS

Table 4 shows the statistics of the manufacture of pianos and piano materials, as returned at the censuses of 1860 to 1900, inclusive. At the census of 1850 statistics for the piano manufacture were included under the general heading "musical instruments." For this reason it is not possible to give a separate statement for the industry in that year.

TABLE 4.—PIANOS AND PIANO MATERIALS: COMPARATIVE SUMMARY, 1860 TO 1900, WITH PER CENT OF INCREASE FOR EACH DECADE.

	DATE OF CENSUS.					PER CENT OF INCREASE.			
	1900[1]	1890	1880	1870	1860	1890 to 1900.	1880 to 1890.	1870 to 1880.	1860 to 1870.
Number of establishments	263	236	174	156	110	11.4	35.6	11.5	41.8
Capital	$38,843,494	$18,430,872	$9,869,577	$6,019,311	$3,644,250	110.8	86.7	64.0	65.2
Salaried officials, clerks, etc., number	1,250	[2]625	[3]	[3]	[3]	100.0	.....	.....	.....
Salaries	$1,722,991	[2]$978,382	[3]	[3]	[3]	76.1	.....	.....	.....
Wage-earners, average number	17,925	12,432	6,575	4,141	3,482	44.2	89.1	58.8	18.9
Total wages	$9,849,001	$8,369,347	$4,663,193	$3,071,392	$1,929,664	17.7	79.5	51.8	59.2
Men, 16 years and over	17,032	12,211	6,449	4,054	3,479	39.5	89.4	59.1	16.5
Wages	$9,633,398	$8,292,742	[3]	[3]	[3]	16.2	.....	.....	.....
Women, 16 years and over	465	181	57	19	3	156.9	217.5	200.0	533.3
Wages	$129,848	$69,535	[3]	[3]	[3]	86.7	.....	.....	.....
Children, under 16 years	428	40	69	68	.....	970.0	[4]42.0	1.5	.....
Wages	$85,755	$7,070	[3]	[3]	.....	1,112.9	.....	.....	.....
Miscellaneous expenses	$2,912,051	$1,394,513	[5]	[5]	[5]	108.8	.....	.....	.....
Cost of materials used	$45,182,035	$10,470,779	$5,283,119	$2,924,777	$1,727,885	45.0	98.2	80.6	69.3
Value of products, including custom work and repairing	$35,428,225	$25,766,368	$12,264,521	$8,329,594	$5,260,907	37.5	110.1	47.2	58.3

[1] The figures reported for 1900 include the statistics for two establishments, the schedules for which were received too late to be included in the totals for this industry as presented in the Report on Manufactures, Parts I and II.
[2] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table. (See Table 14.)
[3] Not reported separately. [4] Decrease. [5] Not reported.

*

It appears from Table 4 that the manufacture of pianos had attained considerable importance by 1860. There were 110 establishments in operation, with 3,482 wage-earners and products valued at $5,260,907. The great growth of the industry since that year is shown by comparing these figures with those given for 1900. The number of wage-earners employed in 1900 was more than five times that reported in 1860, while the value of products in 1900 was nearly seven times as great. The absolute increase in the value of products for each decade was as follows:

DECADE.	Absolute increase.
1860 to 1870	$3,068,687
1870 to 1880	3,934,927
1880 to 1890	13,501,847
1890 to 1900	9,661,857

The greatest absolute increase took place during the decade ending with the year 1890, but a fairly steady increase is shown for the entire period. The greatest percentage of increase in the value of products, 110.1 per cent, was shown also for the decade ending with 1890.

The increase in the number of establishments from 110 in 1860 to 263 in 1900 has been less marked. That this has been due to the development of large-scale production during the period is indicated by the increased size of the average establishment. In 1860 the average number of wage-earners employed per establishment was 32; in 1870, 27; in 1880, 38; in 1890, 53; and in 1900, 68.

Table 5 shows the number of establishments in the several states engaged in the manufacture of pianos and materials at the censuses of 1860 to 1900, inclusive.

This table indicates very clearly the generally westward movement which has taken place in the industry during the last forty years. The rank of the principal sections of the country was the same in 1900 as in 1860, the Middle states leading, with 146 establishments, followed by the New England states, with 53 establishments, and the Central states, with 52 establishments. In each section the number of establishments shows a considerable increase, but the growth has been proportionally most rapid in the Central states, from 10 in 1860 to 52 in 1900. In 1860, 64.5 per cent of the total number of establishments were in the Middle states, as compared with but 55.5 per cent in 1900. In 1860, 22.7 per cent of the total number of establishments were in the New England states, compared with but 20.2 per cent in 1900. In the Central states the opposite tendency is indicated, 14.7 per cent of the total number of establishments being reported for this section in 1870, compared with 19.8 per cent in 1900.

TABLE 5.—PIANOS AND MATERIALS: NUMBER OF ESTABLISHMENTS, BY STATES, ARRANGED GEOGRAPHICALLY, 1860 TO 1900.

	1900	1890	1880	1870	1860
United States	263	236	174	156	110
New England states	53	64	51	23	25
Maine	1	.....	.....	.....	1
New Hampshire	4	4	3	1	1
Vermont	1	2	.....	.....	.....
Massachusetts	37	53	45	21	22
Connecticut	10	5	3	1	1
Middle states	146	127	93	105	71
New York	118	107	82	89	55
New Jersey	10	4	2	5	.....
Pennsylvania	14	12	5	11	12
Maryland	4	4	4	.....	4
Southern states	5	6	6	2	2
Virginia	.....	.....	.....	.....	1
Georgia	.....	2	.....	.....	.....
Kentucky	4	3	5	2	1
Tennessee	1	.....	.....	.....	.....
Louisiana	.....	1	.....	.....	.....
Texas	.....	.....	1	.....	.....
Central states	52	29	18	23	10
Ohio	12	7	1	14	.....
Michigan	7	3	1	.....	1
Indiana	1	3	2	3	.....
Illinois	30	3	5	3	2
Wisconsin	.....	2	2	.....	3
Minnesota	1	1	.....	.....	.....
Iowa	.....	1	.....	.....	.....
Missouri	1	4	7	3	4
Western states	2	.....	.....	.....	.....
Nebraska	1	.....	.....	.....	.....
Colorado	1	.....	.....	.....	.....
Pacific states	5	10	6	3	2
California	5	10	6	3	2

The relative importance of the piano industry in the several states in 1890 and 1900 is indicated more accurately in Table 6, which shows the value of products distributed by states at each of these censuses.

TABLE 6.—PIANOS AND MATERIALS: VALUE OF PRODUCTS, BY STATES, 1890 AND 1900.

	1900		1890		Per cent of increase.
	Value of products.	Per cent of total.	Value of products.	Per cent of total.	
United States	$35,428,225	100.0	$25,766,368	100.0	37.5
California	54,310	0.2	180,860	0.7	[1]70.0
Connecticut	3,256,816	9.2	1,557,993	6.1	109.0
Illinois	7,060,733	19.9	755,450	2.9	834.6
Kentucky	112,020	0.3	13,500	0.1	729.8
Maryland	827,371	2.3	1,291,165	5.0	[1]35.9
Massachusetts	4,981,966	14.1	5,681,773	22.1	[1]12.3
Michigan	776,789	2.2	363,750	1.4	113.6
New Hampshire	393,257	1.1	80,019	0.3	391.5
New Jersey	559,693	1.6	45,760	0.2	1,123.1
New York	14,419,914	40.7	14,455,068	56.1	[1]0.2
Ohio	1,337,454	3.9	443,155	1.7	213.1
Pennsylvania	978,331	2.8	576,800	2.2	69.6
All other states[2]	619,571	1.7	321,075	1.2	93.0

[1] Decrease.

[2] Includes establishments distributed as follows: 1900—Colorado, 1; Indiana, 1; Maine, 1; Minnesota, 1; Missouri, 1; Nebraska, 1; Tennessee, 1; Vermont, 1. 1890—Georgia, 2; Iowa, 1; Louisiana, 1; Minnesota, 1; Vermont, 2; Wisconsin, 2; also including Indiana, 3, product, $179,805, and Missouri, 4, product, $29,100; both states included in 1900 under "all other states."

In eight of the states, shown separately in Table 6, there was an increase during the decade in the value of products. These states, with the absolute increase in each case, are as follows:

STATES.	Absolute increase.
Illinois	$6,305,283
Connecticut	1,698,823
Ohio	944,299
New Jersey	513,933
Michigan	413,039
Pennsylvania	401,531
New Hampshire	313,238
Kentucky	98,520

In California, Maryland, Massachusetts, and New York there was a decrease in the value of products.

The most striking facts, brought out by these two lists of states, are the great increase shown for Illinois, and the decrease shown for New York and Massachusetts, the two leading states in the industry in 1890, and the states also in which it was first carried on upon a large scale. The value of products in Illinois in 1890 constituted but 2.9 per cent of the total for the United States, as compared with 19.9 per cent in 1900. New York's percentage fell from 56.1 in 1890 to 40.7 in 1900. Massachusetts' percentage fell from 22.1 in 1890 to 14.1 in 1900. In 1890 Illinois ranked below New York, Massachusetts, Connecticut, and Maryland, but in 1900 only New York ranked higher, its value of products constituting 40.7 per cent of the total, as compared with 19.9 per cent for Illinois.

Table 7, showing the value of products for 1900, by states arranged geographically, indicates that the Middle states led in the production of pianos and materials in 1900, with 47.4 per cent of the total, the Central states ranking next with 27.6 per cent of the total, followed by the New England states with 24.5 per cent of the total. The industry in the Southern, Western, and Pacific states was relatively unimportant, their value of products constituting altogether but one-half of 1 per cent of the total.

TABLE 7.—PIANOS AND MATERIALS: VALUE OF PRODUCTS, BY STATES, ARRANGED GEOGRAPHICALLY, 1900.

	Value of products.	Per cent of total.
United States	$35,428,225	100.0
New England states	8,667,019	24.5
New Hampshire	393,257	1.1
Massachusetts	4,981,966	14.1
Connecticut	3,256,816	9.2
Other states[1]	34,980	0.1
Middle states	16,785,309	47.4
New York	14,419,914	40.7
New Jersey	559,693	1.6
Pennsylvania	978,331	2.8
Maryland	827,371	2.3
Southern states[2]	119,820	0.3
Central states	9,770,592	27.6
Ohio	1,387,454	3.9
Michigan	776,789	2.2
Illinois	7,060,733	19.9
Other states[3]	545,616	1.6
All other states[4]	85,485	0.2

[1] Includes establishments distributed as follows: Maine, 1; Vermont, 1.
[2] Includes establishments distributed as follows: Kentucky, 4; Tennessee, 1.
[3] Includes establishments distributed as follows: Indiana, 1; Minnesota, 1; Missouri, 1.
[4] Includes establishments distributed as follows: California, 5; Nebraska, 1; Colorado, 1.

All of the above tables give an incomplete showing of the piano industry in the United States because of the necessity, explained above, of considering pianos made in organ and other factories as part of the products of those industries. It has been possible, however, in Tables 8 and 9, to present a complete statement of the number and value of the various varieties of pianos manufactured during the census year in establishments of any character. These tables, therefore, include pianos made in piano factories, in organ factories, and in a few factories engaged chiefly in other lines of manufacture. The value of piano materials manufactured in various parts of the country, and the amounts received for custom work and repairing, are, however, not included. For these reasons the statistics given in Tables 8 and 9 do not agree with those given for the piano manufacture elsewhere in this report, and in the Report on Manufactures Parts I and II.

TABLE 8.—PIANOS AND MATERIALS: NUMBER AND VALUE OF GRAND, UPRIGHT, AND SQUARE PIANOS MANUFACTURED, BY STATES, 1900.

	Total number.	Total value.	GRAND.		UPRIGHT.		SQUARE.	
			Number.	Value.	Number.	Value.	Number.	Value.
United States	171,138	$27,024,667	4,251	$1,701,420	166,786	$25,294,297	101	$28,950
California	200	47,750	.....	.....	200	47,750	.....	.....
Connecticut	7,269	944,994	10	3,650	7,259	941,344	.....	.....
Illinois	46,134	5,691,747	110	48,460	46,024	5,643,287	.....	.....
Kentucky	377	110,870	.....	.....	377	110,870	.....	.....
Maryland	2,210	824,696	300	178,100	1,892	640,296	18	6,300
Massachusetts	16,809	3,566,662	937	389,445	15,872	3,177,217	.....	.....
Michigan	1,971	262,235	50	20,000	1,921	242,235	.....	.....
New Hampshire	373	64,713	.....	.....	373	64,713	.....	.....
New Jersey	4,331	671,034	12	4,800	4,319	666,234	.....	.....
New York	71,855	11,862,257	2,581	962,865	69,191	10,876,742	83	22,650
Ohio	8,862	1,214,068	166	63,775	8,696	1,150,293	.....	.....
Pennsylvania	5,804	1,023,775	.....	.....	5,804	1,023,775	.....	.....
All other states[1]	4,943	739,866	85	30,325	4,858	709,541	.....	.....

[1] Includes establishments distributed as follows: Colorado, 1; Indiana, 2; Maine, 1; Minnesota, 2; Missouri, 1; Nebraska, 1; Tennessee, 1; Vermont, 1.

Table 8 indicates in a more satisfactory manner than any of the preceding tables the rank of the different states in the manufacture of pianos. New York leads with 43.9 per cent of the total value of pianos manufactured, followed by Illinois with 21.1 per cent of the total, Massachusetts with 13.2 per cent, Ohio with 4.5 per cent, and Pennsylvania with 3.8 per cent. No other state reported a manufacture valued at $1,000,000 or over.

Of the 171,138 pianos manufactured in the country during the census year, 166,786, or 97.4 per cent, were upright pianos; 4,251, or 2.5 per cent, were grand pianos; and 101, or but one-tenth of 1 per cent, were square pianos. Grand pianos were made chiefly in New York, Massachusetts, and Maryland, Illinois ranking only fifth in the manufacture of this variety. Illinois ranked second, however, in both number and value of upright pianos manufactured. Square pianos were made only in New York and Maryland.

The average value of upright pianos manufactured in the 5 leading states was as follows:

STATES.	Average value.
Massachusetts	$200
Pennsylvania	176
New York	157
Ohio	132
Illinois	122

It should be noted that the average value is not retail or even wholesale value, but value at the factory. It does not include the cost of selling, advertising, boxing for shipment, and freight charges to the wholesaler or jobber.

Table 9 presents the statistics of the manufacture of other varieties of pianos for the United States as a whole. Statistics for these products can not be shown by states without revealing the operations of establishments engaged in the manufacture of certain well-known specialties.

TABLE 9.—PIANOS AND MATERIALS: NUMBER AND VALUE OF OTHER VARIETIES OF PIANOS MANUFACTURED, SUMMARY FOR THE UNITED STATES, 1900.

VARIETIES.	Number.	Value.
Total	6,477	$667,493
Piano players	5,236	520,139
Piano-playing attachments	922	87,734
Self-playing pianos	224	44,745
Street pianos	95	13,875

The most significant figures included in Table 9 are those relating to the manufacture of piano players. The great development of this industry during the past few years is referred to later in this report.

Table 10 presents statistics for the manufacture of pianos and materials in cities which had a population of 20,000 or over in 1900.

TABLE 10.—PIANOS AND MATERIALS: STATISTICS OF CITIES HAVING A POPULATION OF 20,000 OR OVER, 1900.

CITIES.	Number of establishments.	Capital.	SALARIED OFFICIALS, CLERKS, ETC.		AVERAGE NUMBER OF WAGE-EARNERS AND TOTAL WAGES.					Miscellaneous expenses.	Cost of materials used.	Value of products, including custom work and repairing.
					Total.		Average number.					
			Number.	Salaries.	Average number.	Wages.	Men, 16 years and over.	Women, 16 years and over.	Children, under 16 years.			
Total	197	$30,571,955	991	$1,397,154	13,894	$7,749,705	13,154	347	393	$2,470,902	$11,597,408	$27,562,248
Baltimore, Md	4	1,184,650	31	41,980	447	222,748	444	.....	3	33,697	358,630	827,371
Boston, Mass	17	4,071,544	96	162,477	1,219	816,539	1,168	51	.....	299,600	897,353	2,641,523
Cambridge, Mass	6	1,043,260	29	31,600	733	325,135	611	122	.....	25,069	550,555	1,168,662
Chicago, Ill	21	9,138,083	299	382,291	3,373	1,758,781	3,065	86	222	750,211	2,292,735	5,802,718
Cincinnati, Ohio	4	790,601	23	30,931	513	226,011	493	20	.....	76,747	489,288	931,274
New York, N. Y	95	11,371,771	375	554,036	5,664	3,397,522	5,501	6	157	1,021,742	5,560,933	12,650,905
Philadelphia, Pa	7	375,042	27	34,650	184	119,716	176	.....	8	36,047	138,791	446,108
Rochester, N. Y	3	255,148	15	19,048	268	99,805	267	.....	1	8,601	238,700	442,032
San Francisco, Cal	3	32,150	.....	.....	13	11,320	13	.....	.....	1,708	7,776	38,100
All other cities[1]	37	2,309,706	96	140,141	1,480	772,128	1,416	62	2	167,480	1,062,647	2,613,555

[1] Includes Albany, N. Y., 2; Auburn, N. Y., 1; Aurora, Ill., 1; Bloomington, Ill., 1; Buffalo, N. Y., 1; Chester, Pa., 1; Cleveland, Ohio, 1; Denver, Colo., 1; Detroit, Mich., 2; Erie, Pa., 2; Everett, Mass., 1; Grand Rapids, Mich., 1; Hoboken, N. J., 1; Jamestown, N. Y., 1; Knoxville, Tenn., 1; Lawrence, Mass., 1; Louisville, Ky., 1; Meriden, Conn., 2; Muskegon, Mich., 1; New Haven, Conn., 1; Omaha, Nebr., 1; Orange, N. J., 1; Paterson, N. J., 2; Quincy, Mass., 1; Saginaw, Mich., 1; St. Louis, Mo., 1; Schenectady, N. Y., 1; Scranton, Pa., 1; Toledo, Ohio, 1; Trenton, N. J., 1; Worcester, Mass., 2.

It appears from Table 10 that the manufacture of pianos is essentially a city industry. Of the total value of products for the industry in the United States—$35,428,225—$27,562,248, or 77.8 per cent, was reported for the cities named. The rank of the 4 leading cities in the industry, with the percentage of the value of products in each to the total for the United States, is as follows:

CITIES.	Value of products.	Per cent of the United States.
New York, N. Y	$12,650,905	35.7
Chicago, Ill	5,802,718	16.4
Boston, Mass	2,641,523	7.5
Cambridge, Mass	1,168,662	3.3

It thus appears that New York city is preeminently the center of the piano manufacture of the country, its

value of products constituting more than one-third of the total for the United States.

Table 11 shows the establishments engaged in the manufacture of pianos and materials, grouped according to the number of employees.

TABLE 11.—PIANOS AND MATERIALS: ESTABLISHMENTS CLASSIFIED BY NUMBER OF EMPLOYEES (NOT INCLUDING PROPRIETORS AND FIRM MEMBERS), BY STATES, 1900.

STATES.	Total number of establishments.	NUMBER OF ESTABLISHMENTS REPORTING— No employees.	Under 5.	5 to 20.	21 to 50.	51 to 100.	101 to 250.	251 to 500.	501 to 1,000.	Over 1,000.
United States.	263	12	26	63	44	49	47	19	2	1
California	5	.....	2	3	.....	.....	.....	.....	.....	.....
Colorado	1	.....	.....	1	.....	.....	.....	.....	.....	.....
Connecticut	10	.....	.....	.....	1	1	5	2	1	.....
Illinois	30	.....	3	7	2	7	6	3	1	1
Indiana	1	.....	.....	.....	.....	.....	.....	1	.....	.....
Kentucky	4	2	.....	1	.....	.....	1	.....	.....	.....
Maine	1	.....	.....	1	.....	.....	.....	.....	.....	.....
Maryland	4	.....	2	.....	.....	1	.....	1	.....	.....
Massachusetts	37	1	2	11	6	6	8	3	.....	.....
Michigan	7	1	.....	1	1	.....	4	.....	.....	.....
Minnesota	1	.....	.....	1	.....	.....	.....	.....	.....	.....
Missouri	1	.....	.....	1	.....	.....	.....	.....	.....	.....
Nebraska	1	.....	1	.....	.....	.....	.....	.....	.....	.....
New Hampshire	4	1	.....	.....	1	1	1	.....	.....	.....
New Jersey	10	1	1	2	3	2	1	.....	.....	.....
New York	118	3	11	26	27	26	17	8	.....	.....
Ohio	12	3	1	2	1	1	3	1	.....	.....
Pennsylvania	14	.....	2	5	2	4	1	.....	.....	.....
Tennessee	1	.....	.....	1	.....	.....	.....	.....	.....	.....
Vermont	1	.....	1	.....	.....	.....	.....	.....	.....	.....

Table 11 indicates that the largest number of establisments was reported for the class giving employment to 5 to 20 persons, while but 2 establishments, located in Connecticut and Illinois, gave employment to 500 to 1,000 persons, and but 1 establishment, located in Illinois, gave employment to over 1,000 persons.

The largest number of establishments in New York state was reported for the class "21 to 50 employees;" the largest number in Illinois and Massachusetts for the class "5 to 20 employees."

Table 12 shows the development of the export trade in pianos during the fiscal years 1870 to 1900.

TABLE 12.—VALUE OF PIANOS EXPORTED FROM THE UNITED STATES: 1870 to 1900.

FISCAL YEAR.	Value.	FISCAL YEAR.	Value.
1900	$355,665	1884	$300,626
1899	253,950	1883	382,823
1898	232,144	1882	457,822
1897	214,849	1881	353,799
1896	246,083	1880	261,624
1895	233,043	1879	320,669
1894	178,822	1878	303,018
1893	760,447	1877	330,156
1892	246,425	1876	276,594
1891	214,309	1875	261,628
1890	213,369	1874	226,166
1889	191,316	1873	208,616
1888	208,765	1872	185,220
1887	200,554	1871	189,619
1886	228,601	1870	144,601
1885	244,382		

Table 12 indicates that the value of piano exports in 1900 was more than double that of 1870. A few earlier years, namely, 1882, 1883, and 1893, however, show larger values than that reported for 1900.

Table 13 shows the value of products reported for the piano industry at the censuses of 1870, 1880, 1890, and 1900 in comparison with the value of exports during these years.

TABLE 13.—PIANOS AND MATERIALS: VALUE OF PRODUCTS AND EXPORTS OF PIANOS, 1870, 1880, 1890, AND 1900.

YEAR.	Value of pianos and materials manufactured.	Value of pianos exported.	Per cent of value of pianos exported to value of pianos and materials manufactured.
1900	$35,428,225	$355,665	1.0
1890	25,766,368	213,369	0.8
1880	12,264,521	261,624	2.1
1870	8,329,594	144,601	1.7

Table 13 indicates that the increase in the value of exports has not kept pace with the increase in the value of products and, as a result, the percentage of the former to the latter has fallen from 1.7 per cent in 1870 to 1 per cent in 1900.

Detailed statistics of the manufacture of pianos and materials are presented in Table 14 (pages 12 to 15).

HISTORICAL AND DESCRIPTIVE.

PIANOS.

The word "pianoforte," ordinarily abbreviated to piano, is traced back to 1598, and is said to have originated with an Italian musical instrument maker who speaks of an instrument called "piano e forte," the Italian for "soft and loud." Nothing is known, however, of the instrument referred to, and the expression, contracted to pianoforte, first became established when the Italian Cristofori, the father of the modern piano, applied it to his invention in 1709.[1]

The significance of the name arose from the character of the two instruments which the piano superseded, the clavichord and the harpsichord. Each of these instruments had a different origin. The monochord of the ancient Greeks, a long box of thin wood with a wire stretched across it, led in the Middle Ages to the invention of the clavichord. In this instrument the wires were made to vibrate by means of a keyboard similar to that already in use in organs. Hammers were raised, pressed, and held against the wires, the player being able to feel their elasticity.[2] A very delicate tone was obtained, which had something in it "charmingly hesi-

[1] History of the American Pianoforte, by Daniel Spillane, page 17.
[2] Evolution of the Stringed Instruments, by Morris Steinert.—The New York Herald, January 5, 1890.

tating and tremulous, capable of reflecting the most tender gradations of the touch of the player." For this reason it was a favorite instrument with John Sebastian Bach, who preferred it to the pianoforte. Mozart also used the clavichord in composing several of his masterpieces, and Beethoven is reported to have said at one time: "Among all keyed instruments, the clavichord is that on which one can best control tone and expressive interpretation." Its great fault, however, was the weakness of its tone.

The rival instrument, the harpsichord, was an evolution of the psaltery or modified harp, a small instrument, played with a plectrum or small piece of iron, bone, or metal, fastened by rings to the hand of the performer. In the harpsichord, the harp-shaped frame was inclosed in a box, and the wires were plucked mechanically by quills attached to the end of each key. Its very unmelodious tone was aptly described as "a scratch with a sound at the end of it."[1] In spite, however, of this tone quality, and the impossibility of obtaining soft effects or, in fact, any dynamic modification of the tone,[2] the harpsichord was extensively used by Beethoven, Mozart, Handel, and other eminent composers,[3] especially for concert work, because of its brilliancy of tone as compared with the subdued tone of the clavichord.

It remained for Cristofori, of Florence, in 1709, to produce an instrument capable of both "soft and loud" effects, the "piano e forte." In this instrument the wire, instead of being pressed or rubbed by means of a wedge, as in the clavichord, or plucked by means of a quill, as in the harpsichord, was struck with a hammer, which immediately rebounded. A lighter or heavier stroke of the key, therefore, produced the "piano" or "forte" effects desired.

Piano factories were established in 1760 by Zumpf in England, and by Silberman in Germany. In 1767, however, fifty-eight years after its invention, the piano was introduced on the stage of Covent Garden Theater as "a new instrument." This long delay in the introduction of pianos was due partly to conservatism and partly to an almost sentimental attachment to the clavichord. A musical critic in Leipzig wrote in 1782, "In the grand piano, the heart can not express itself," while Forkel declared in his Musical Almanac, in the same year, that he preferred the clavichord to all other keyed instruments.[2] Joseph Haydn was one of the first of the great masters to accept the piano. Mozart wrote concertos and other compositions for it, and finally, through Beethoven, it received full acknowledgment.

Cristofori's pianoforte contained the essential principle of the modern piano, but the improvements since that time have been extensive. The damper and soft pedals were introduced about the year 1780 by John Broadwood, an Englishman.[4] Upright pianos were first successfully made in 1807, when William Southwell, of Dublin, brought out his "cabinet pianoforte."[5]

Almost all the pianos used in the United States at the close of the eighteenth and at the beginning of the nineteenth century were imported, John Jacob Astor, of New York, importing one of the first in 1784. It soon appeared, however, that instruments, constructed for the comparatively uniform and moist climate of England, shrank and opened at the seams when brought into the dryer atmosphere of the United States, with its severe winters, and the general custom of heating houses by means of stoves. This, added to the oxidation of the wires during the ocean voyage, and the loosening of the keys, greatly impaired or destroyed the tone and durability of the instruments, and led naturally to the establishment of the industry in the United States.

The first piano known to have been built in this country was made in Philadelphia in 1775 by John Behrent. Ten years later one George Ulschoefer began manufacturing in New York. In Boston, Benjamin Crehore and William and Adam Bent began work in 1797 and 1800, respectively, and, lastly, the manufacture was probably carried on in Baltimore by John Harper as early as 1802.[6] Between the years 1815 and 1825 a great business depression prevailed in Great Britain, and a number of young and skilled English piano makers and artisans emigrated to the United States and began making pianos. Their arrival gave a great stimulus to the industry.

Between 1825 and 1840 several manufacturers, conspicuously Jonas Chickering, of Boston,[6] introduced an improvement in their pianos, which has been called the creative feature of the piano of to-day.[7] The frames of all early pianos had been made of wood. Since this alternately swelled and contracted with atmospheric changes, the strings stretched upon it were never subjected to the same strain, and were therefore continually out of tune.[8] The improvement mentioned above consisted in the use of an iron frame, cast in a single solid piece. This allowed a much greater tension of the strings, with a corresponding improvement in tone quality, for a string stretched to its utmost limit yields its largest, purest, and most brilliant tone.[9] In all early pianos the strings were strained hardly to the tension of a violin string.[10] By 1876 frames were made capable of sustaining a string tension of 12½ tons. In that year Theodore Steinway, of New York, completed a series

[1] Eighth Census of the United States, Manufactures, page cxlviii.
[2] Evolution of stringed instruments, supra cit.
[3] Eighth Census, supra cit, page cxlviii.
[4] History of the American Pianoforte, page 21.
[5] Ibid., page 36.
[6] Ibid., pages 46, 51, 52, 70, 72, 92, and 127.
[7] A Noble Art, by Fanny Morris Smith, page 78.
[8] Ibid., page 79.
[9] Ibid., page 119.
[10] Ibid., page 82.

of metallurgical experiments which had lasted more than six years, and had taken him to many of the leading iron works of Europe. These experiments resulted in the perfection of a frame capable of sustaining a tension of 30 tons.[1]

The cast-iron frame, perfected by Jonas Chickering, of Boston, and others, and the method of overstringing, perfected and patented by Steinway and Sons, of New York, in 1859 and 1862,[2] constitute probably the most important contributions the United States has made to the manufacture of pianos. Both of these improvements have been very generally adopted in Europe as well as in the United States.

The position of the piano industry in the United States as early as 1851 is indicated by the statement of an English writer regarding the pianos exhibited at the International Exhibition in London in 1851, that "England had far outstripped every other nation, with the exception of America, in the manufacture of pianos."[3] Since that date, as shown by statistics given earlier in this report, the progress of the industry has been very great. At the same time the art of piano making has been brought to great perfection. Almost all the important inventions, within the last half century, by which the tone and durability of pianos have been enhanced and increased have originated with American manufacturers, many of these improvements being imitated in Europe as soon as the details became known. "No grand piano of foreign make has ever been publicly heard in the United States since the advent of Thalberg, now nearly forty years ago; but many first-class American concert pianos have been and are at present publicly used in the art centers of Europe by the greatest artists."[4]

The manufacture in the United States has been favored by the abundance of wood suitable for soundingboards as well as for piano cases. The president of the New York Piano Makers' Association remarked in an address some years ago, "Just as Italian and Tyrolese forests made Amati violins possible in Cremona, so American lumber has made it possible to bring piano making to its highest perfection in this country."

The history of the piano manufacture in the United States is characterized by the rise of two schools, the "New York School" and the "Boston School." It is curious to note how cities comparatively near each other were able for many years to maintain technical conceptions and customs in relation to piano construction, so considerably at variance. The full cast-iron frame originated in Boston and was soon generally adopted in that city. Manufacturers in New York, however, refused for years to see its superior advantages. On the other hand, Boston manufacturers clung to an inferior piano action long after the improved action had been generally introduced into pianos made in New York.[5]

The Boston School was American, such traditions as it possessed being chiefly English;[6] and its instruments were light in action, and thin, sensitive, and very musical in tone. The New York School, on the other hand, was essentially German in its antecedents.

In 1850 the overwhelming majority of piano artisans were of American nativity, while since that time, and now for many years, almost all are either foreign born (mostly German) or sons of foreign-born parents.

Nearly all pianos made in the United States during the first half of the Nineteenth century were square pianos. A species of upright pianos had been made by Loud & Bros., of Philadelphia, as early as 1826, and Jonas Chickering, one of the pioneers of the American piano industry, had constructed the first American grand piano in 1840. Up to the year 1866, however, fully 97 per cent of all the pianos made in the United States were square pianos. Since that date a complete revolution has taken place in the piano industry. The manufacture of square pianos has now almost entirely ceased. The production in the United States in 1900 consisted of 97.4 per cent upright, 2.5 per cent grand, and one-tenth of 1 per cent square pianos. The manufacture of pianos in the United States was formerly confined to New York, Boston, Baltimore, and Philadelphia. Between 1880 and 1890 the industry began to assume importance in Chicago, and this city in 1900 ranked next to New York in the value of pianos produced.

PIANO PLAYERS.

The most striking feature of the piano industry during the census year, and since that year, has been the development of piano players. The principle upon which these instruments are constructed has been known for nearly forty years, but they first became commercially important at the end of the last decade.

In Table 9 a distinction was made between piano players, piano-playing attachments, and self-playing pianos. Piano players are cabinet keyboard players which may be rolled up to a piano and removed at pleasure. Self-playing attachments are placed inside the piano case and operate upon the "action" rather than upon the keyboard. They may be added to any piano and do not interfere with its being played by hand, but they are not detachable at pleasure. In self-playing pianos the attachments are built into the piano at the factory. In practically all of these devices at present the perforated paper music sheet is used. The motive power may be supplied by the feet or by electricity, and the action may be pneumatic or entirely mechanical. Inventions

[1] A Noble Art, by Fannie Morris Smith, page 120.
[2] History of the American Pianoforte, page 218.
[3] The History of the Pianoforte, by Edgar Brinsmead, page 58.
[4] One Hundred Years of American Commerce—American Musical Instruments, by William Steinway, page 512.
[5] History of the American Pianoforte, page 163.
[6] A Noble Art, pages 105 and 110.

have followed these various lines, but pneumatic piano players operated by the feet have attained the greatest popularity.

The mechanism common to all these instruments—the perforated music sheet—appears first in a French patent, dated January 24, 1842, and in a United States patent, dated January 2, 1849. The first patent in the United States for a keyboard piano player was issued December 18, 1860, to E. D. Bootman. The first pneumatic keyboard piano player was patented in France in 1863 by M. Fourneaux. In the United States there was one patent issued in each of the years 1863, 1871, and 1873. Beginning with 1879 these patents increased rapidly, and by January 1, 1902, a total of 55 had been issued. Among the many names in this list, mention should be made of William F. Schmoele and H. Schmoele, jr., of Philadelphia, Pa.; R. H. Bishop, of Islington, England; and William Down, of Vicars, England.

In view of the numerous efforts to perfect devices of this character, it is remarkable that success was delayed so long. Shortly after 1887 E. Klaber, of New York City, formed the Automaton Piano Company to manufacture a piano-playing device, but the venture met with only slight success. A sample cabinet piano player—one of the first to be built in this country—was constructed about 1895 by Joseph Courville, an employee of the Farrand Organ Company, of Detroit, Mich. This instrument, which embodied all the essential features of the modern piano players except the expression devices, is still in existence and in good operating order.

In 1895 Messrs. Wilcox & White, of Meriden, Conn., began manufacturing an interior attachment, and in February, 1897, built their first "Angelus," a cabinet piano player.[1] This instrument, the invention of E. H. White, may be regarded as the pioneer of the various similar instruments which have since been placed upon the market. Shortly after this time Theodore P. Brown, of Worcester, Mass., patented the Aerial piano. This instrument, which was manufactured by Mr. Brown for the Aeolian Company, was a self-playing piano, and was somewhat larger than an ordinary piano. In 1898 the Aeolian Company, of Meriden, Conn., which had been manufacturing self-playing organs since 1887, produced their first cabinet piano player, the "Pianola."

At about the same time J. N. Goolman, of Los Angeles, Cal., designed a piano-playing attachment, the patents for which he sold in 1898 to Messrs. Roth & Engelhardt, of St. Johnsville, N. Y., who then began to manufacture a self-playing piano on these lines—the "Peerless"—and in 1899 began the manufacture of a cabinet piano player, the "Harmonist." In the same year the Farrand Organ Company, of Detroit, Mich., put upon the market their first piano player, the "Cecilian," and in 1900 the Melville Clark Piano Company, of Chicago, Ill., began the manufacture of a piano player, the "Apollo."

The increase since the census year in the number of companies manufacturing instruments of this character has been remarkable, more than thirty being in the field in April, 1902. The older piano-player companies have enlarged their plants; and one company, at least, which has now a capacity of 800 instruments a month, has begun exporting to London. Another company now manufactures six different varieties of piano players, piano-playing attachments, and self-playing pianos, while all the leading companies find it difficult to keep pace with the demand for their instruments.

Competition among inventors and manufacturers has centered chiefly about the pneumatic piano player which is operated by the feet. The popularity of these instruments during the last five years has been due to devices by which the performer is able to control tempo, volume of sound, and accentuation of particular notes or parts; and it is improvements of this sort which have raised piano players to their position of true musical instruments. Nearly all piano players now on the market have distinctive names, which are usually designedly euphonious.

An account of the development of self-playing organs will be found on page 466. These instruments were perfected earlier than piano players, but in point of popularity they have been very greatly surpassed by the latter, due to the greater popularity of piano music in general. The total value of self-playing organs manufactured during the census year was but $272,824, as compared with $652,618, the total value of piano players, piano-playing attachments, and self-playing pianos manufactured.

[1] The piano-playing attachment, manufactured between 1895 and 1897, was also called the "Angelus."

*

TABLE 14.—PIANOS AND

		United States.[1]	California.[1]	Connecticut.	Illinois.[1]	Kentucky.
1	Number of establishments	263	5	10	30	4
	Character of organization:					
2	Individual	88	3	.....	10	1
3	Firm and limited partnership	67	1	.....	2	2
4	Incorporated company	107	1	10	18	1
5	Miscellaneous	1	.....	.....	.....	.....
	Capital:					
6	Total	$38,843,494	$47,150	$3,505,205	$10,403,402	$118,250
7	Land	$2,865,118	$9,500	$85,564	$581,262	$9,500
8	Buildings	$4,885,171	$6,000	$337,851	$1,061,130	$15,000
19	Machinery, tools, and implements	$3,002,426	$4,850	$292,762	$523,912	$36,250
0	Cash and sundries	$28,090,779	$26,800	$2,789,028	$8,237,098	$57,500
11	Proprietors and firm members	241	4	.....	18	4
	Salaried officials, clerks, etc.:					
12	Total number	1,250	.....	70	345	3
13	Total salaries	$1,722,991	.....	$131,807	$441,271	$1,440
	Officers of corporations—					
14	Number	193	.....	15	35	.....
15	Salaries	$577,741	.....	$65,650	$108,762	.....
	General superintendents, managers, clerks, etc.—					
16	Total number	1,057	.....	55	310	3
17	Total salaries	$1,145,250	.....	$66,157	$332,509	$1,440
	Men—					
18	Number	887	.....	47	270	2
19	Salaries	$1,058,644	.....	$61,095	$308,840	$1,260
	Women—					
20	Number	170	.....	8	40	1
21	Salaries	$86,606	.....	$5,062	$23,669	$180
	Wage-earners, including pieceworkers, and total wages:					
22	Greatest number employed at any one time during the year	20,393	22	1,954	4,576	169
23	Least number employed at any one time during the year	16,137	18	1,438	3,836	23
24	Average number	17,925	20	1,784	3,904	43
25	Wages	$9,849,001	$15,420	$845,621	$2,081,481	$21,885
	Men, 16 years and over—					
26	Average number	17,082	20	1,656	3,594	42
27	Wages	$9,633,398	$15,420	$813,470	$2,003,796	$21,705
	Women, 16 years and over—					
28	Average number	465	.....	124	88	.....
29	Wages	$129,848	.....	$31,862	$24,531	.....
	Children, under 16 years—					
30	Average number	428	.....	4	222	1
31	Wages	$85,755	.....	$789	$53,154	$180
	Average number of wage-earners, including pieceworkers employed during each month:					
	Men, 16 years and over—					
32	January	16,944	20	1,673	3,498	38
33	February	17,127	20	1,659	3,592	46
34	March	17,459	20	1,685	3,797	66
35	April	17,549	22	1,694	3,932	106
36	May	17,537	20	1,696	3,981	164
37	June	16,783	20	1,652	3,952	5
38	July	16,270	19	1,449	3,799	5
39	August	16,584	19	1,512	3,812	5
40	September	17,477	18	1,635	3,989	5
41	October	17,792	18	1,725	4,023	5
42	November	16,442	21	1,737	2,356	24
43	December	16,420	21	1,761	2,344	30
	Women, 16 years and over—					
44	January	441	.....	126	81	.....
45	February	454	.....	130	84	.....
46	March	466	.....	137	86	.....
47	April	469	.....	135	92	.....
48	May	481	.....	131	95	.....
49	June	457	.....	129	94	.....
50	July	415	.....	96	93	.....
51	August	443	.....	104	102	.....
52	September	479	.....	112	100	.....
53	October	505	.....	120	100	.....
54	November	479	.....	131	63	.....
55	December	491	.....	137	64	.....
	Children, under 16 years—					
56	January	439	.....	3	228	1
57	February	445	.....	4	232	1
58	March	444	.....	3	232	3
59	April	440	.....	5	226	3
60	May	433	.....	4	222	3
61	June	442	.....	5	236	1
62	July	468	.....	3	264	.....
63	August	455	.....	1	264	.....
64	September	469	.....	3	267	.....
65	October	433	.....	3	235	.....
66	November	327	.....	4	126	.....
67	December	341	.....	4	135	.....
	Miscellaneous expenses:					
68	Total	$2,912,051	$2,478	$162,433	$782,689	$2,258
69	Rent of works	$303,508	$840	$3,975	$25,215	$120
70	Taxes, not including internal revenue	$185,415	$168	$12,868	$53,979	$426
71	Rent of offices, insurance, interest, etc	$2,240,395	$1,470	$134,257	$700,040	$912
72	Contract work	$182,733	.....	$11,338	$3,455	$800
	Materials used:					
73	Aggregate	$15,182,035	$13,866	$1,520,203	$2,836,704	$70,770
	Principal materials—					
74	Total	$13,322,327	$10,700	$1,273,265	$2,528,788	$65,177
75	Purchased in raw state	$498,014	.....	$493,789	.....	$3,000
76	Purchased in partially manufactured form	$12,824,313	$10,700	$779,476	$2,528,788	$62,177
77	Fuel	$227,224	.....	$31,868	$50,644	$2,010
78	Rent of power and heat	$26,960	.....	$1,710	$2,575	$180
79	Mill supplies	$60,239	.....	$14,522	$14,022	$210
80	All other materials	$1,397,014	$2,800	$143,236	$222,049	$1,054
81	Freight	$148,271	$366	$55,602	$18,626	$2,139

[1] Includes the statistics for 2 establishments, the schedules for which were received too late to be included in the tables, presented in the Report on Manufactures, Parts I and II. These establishments are distributed as follows: California, 1; Illinois, 1.

MATERIALS: BY STATES, 1900.

Maryland.	Massachusetts.	Michigan.	New Hampshire.	New Jersey.	New York.	Ohio.	Pennsylvania.	All other states.[2]	
4	37	7	4	10	118	12	14	8	1
2	13	2	1	5	44	1	5	1	2
1	7	.....	1	3	36	5	4	5	3
1	17	5	2	2	37	6	5	2	4
.....	.....	.....	.....	.....	1	.....	.....	.....	5
$1,184,650	$6,153,597	$673,818	$262,745	$813,743	$12,897,946	$1,269,913	$863,099	$649,976	6
$91,342	$596,691	$18,250	$7,200	$102,000	$1,184,962	$88,250	$67,100	$23,497	7
$166,000	$869,686	$64,933	$44,145	$112,100	$1,798,376	$232,887	$121,200	$55,863	8
$76,635	$493,053	$50,069	$37,019	$362,090	$901,243	$110,361	$72,436	$41,746	9
$850,673	$4,194,167	$540,566	$174,381	$237,553	$9,013,365	$888,415	$602,303	$528,870	10
4	28	2	3	11	130	13	13	11	11
31	164	29	16	19	435	44	45	49	12
$41,980	$257,983	$28,502	$17,268	$12,942	$636,789	$59,282	$60,051	$33,666	13
2	28	7	4	2	70	13	11	6	14
$16,000	$95,129	$10,050	$7,865	$2,560	$210,975	$22,150	$24,500	$14,100	15
29	136	22	12	17	365	31	34	43	16
$25,980	$162,854	$18,452	$9,403	$10,382	$425,814	$37,132	$35,561	$19,566	17
27	103	14	9	10	308	27	31	39	18
$25,210	$145,296	$14,942	$8,400	$6,740	$399,955	$35,512	$34,000	$17,394	19
2	33	8	3	7	57	4	3	4	20
$770	$17,558	$3,510	$1,003	$3,642	$25,859	$1,620	$1,561	$2,172	21
450	2,901	578	254	408	7,347	907	499	328	22
446	2,242	457	210	237	5,918	624	416	272	23
447	2,546	518	235	329	6,650	725	433	291	24
$222,748	$1,494,973	$284,780	$99,668	$158,450	$3,861,359	$333,639	$265,267	$163,710	25
444	2,373	480	235	299	6,476	704	420	289	26
$222,410	$1,448,762	$272,984	$99,668	$153,867	$3,831,639	$323,202	$263,067	$163,408	27
.....	173	38	.....	5	15	21	.....	1	28
.....	$46,211	$11,796	.....	$1,206	$4,055	$10,437	.....	$250	29
3	.....	.....	.....	25	159	.....	13	1	30
$338	.....	.....	.....	$3,377	$25,665	.....	$2,200	$52	31
444	2,292	478	244	318	6,597	618	433	291	32
444	2,295	476	241	320	6,674	623	421	316	33
444	2,355	499	239	332	6,660	627	419	316	34
444	2,339	510	250	317	6,561	640	424	310	35
444	2,323	500	248	300	6,476	648	426	311	36
443	2,247	497	220	295	6,126	661	394	271	37
443	2,224	446	223	293	6,028	675	395	271	38
443	2,276	462	227	255	6,177	706	419	271	39
446	2,447	475	228	269	6,445	775	474	271	40
446	2,533	485	230	274	6,506	796	476	275	41
446	2,586	474	235	296	6,680	834	478	275	42
445	2,523	454	239	316	6,678	846	478	285	43
.....	164	30	.....	8	15	16	.....	1	44
.....	164	35	.....	9	15	16	.....	1	45
.....	168	35	.....	8	15	16	.....	1	46
.....	165	40	.....	5	15	16	.....	1	47
.....	174	45	.....	4	15	16	.....	1	48
.....	153	45	.....	4	15	16	.....	1	49
.....	153	37	.....	4	15	16	.....	1	50
.....	164	37	.....	4	15	16	.....	1	51
.....	183	38	.....	4	15	26	.....	1	52
.....	196	38	.....	4	15	31	.....	1	53
.....	195	38	.....	4	16	31	.....	1	54
.....	199	40	.....	4	15	31	.....	1	55
3	.....	.....	.....	29	161	.....	13	1	56
3	.....	.....	.....	32	159	.....	13	1	57
3	.....	.....	.....	31	158	.....	13	1	58
3	.....	.....	.....	31	158	.....	13	1	59
3	.....	.....	.....	29	158	.....	13	1	60
3	.....	.....	.....	25	158	.....	13	1	61
3	.....	.....	.....	25	159	.....	13	1	62
3	.....	.....	.....	14	159	.....	13	1	63
3	.....	.....	.....	19	163	.....	13	1	64
3	.....	.....	.....	20	158	.....	13	1	65
3	.....	.....	.....	21	159	.....	13	1	66
3	.....	.....	.....	30	155	.....	13	1	67
$83,697	$430,097	$47,186	$10,995	$56,393	$1,124,314	$115,287	$63,197	$31,027	68
$450	$36,610	$5,929	$1,000	$5,885	$208,165	$6,027	$6,682	$2,610	69
$12,280	$28,070	$2,981	$698	$1,399	$64,173	$5,350	$1,823	$1,205	70
$70,967	$267,292	$38,276	$9,297	$48,709	$785,561	$103,910	$54,692	$25,012	71
.....	$98,125	.....	.....	$400	$66,415	.....	.....	$2,200	72
$358,630	$1,985,401	$285,801	$98,775	$246,771	$6,443,196	$687,621	$402,349	$282,448	73
$344,268	$1,518,731	$260,184	$89,137	$206,745	$5,994,480	$608,235	$336,285	$86,332	74
.....	.....	.....	.....	.....	$1,225	.....	.....	.....	75
$344,268	$1,518,731	$260,184	$89,137	$206,745	$5,993,255	$608,235	$336,285	$86,332	76
$4,012	$26,885	$5,859	$780	$4,935	$75,190	$7,623	$14,141	$3,277	77
.....	$1,912	$2,137	.....	$100	$17,406	$535	$225	$180	78
$800	$5,116	$1,576	$629	$1,011	$18,366	$1,511	$1,829	$647	79
$9,550	$365,392	$11,981	$132	$28,414	$317,822	$63,273	$43,652	$187,659	80
.....	$17,365	$3,564	$8,097	$5,566	$19,932	$6,444	$6,217	$4,353	81

[2] Includes establishments distributed as follows: Colorado, 1; Indiana, 1; Maine, 1; Minnesota, 1; Missouri, 1; Nebraska, 1; Tennessee, 1; Vermont, 1.

TABLE 14.—PIANOS AND

		United States.[1]	California.[1]	Connecticut.	Illinois.[1]	Kentucky.
	Products:					
82	Aggregate value	$35,428,225	$54,310	$3,256,816	$7,060,733	$112,020
	Pianos—					
83	Total number	170,864	232	8,740	43,848	377
84	Total value	$26,609,819	$49,670	$1,171,008	$5,395,611	$110,870
	Grand pianos—					
85	Number	4,136	.....	10	110	.....
86	Value	$1,661,070	.....	$3,650	$48,460	.....
	Upright pianos—					
87	Number	161,505	200	7,259	43,738	377
88	Value	$24,415,306	$47,750	$941,344	$5,347,151	$110,870
	Other varieties—					
89	Number	5,223	32	1,471	.....	.....
90	Value	$533,443	$1,920	$226,014	.....	.....
	Organs—					
91	Total number	37,397	.....	2,428	32,168	.....
92	Total value	$1,389,047	.....	$182,279	$1,020,106	.....
	Pipe organs—					
93	Total number	57	.....	.....	35	.....
94	Total value	$106,566	.....	.....	$55,172	.....
	$1,500 and under—					
95	Number	21	.....	.....	21	.....
96	Value	$16,350	.....	.....	$16,350	.....
	Over $1,500—					
97	Number	36	.....	.....	14	.....
98	Value	$90,216	.....	.....	$38,822	.....
	Reed organs—					
99	Number	36,246	.....	1,626	31,841	.....
100	Value	$1,150,159	.....	$64,644	$950,247	.....
	Other varieties—					
101	Number	1,094	.....	802	292	.....
102	Value	$132,322	.....	$117,635	$14,687	.....
	All other products—					
103	Total value	$7,429,359	$4,640	$1,903,529	$645,016	$1,150
	Comparison of products:					
104	Number of establishments reporting for both years	209	5	9	20	3
105	Value for census year	$30,987,995	$54,310	$3,130,758	$6,254,544	$13,700
106	Value for preceding business year	$25,641,166	$44,430	$2,652,119	$5,359,981	$12,200
	Power:					
107	Number of establishments reporting	181	.....	10	26	1
108	Total horsepower	17,714	.....	1,943	3,973	172
	Owned—					
	Engines—					
109	Steam, number	164	.....	24	24	2
110	Horsepower	14,600	.....	1,642	3,173	140
111	Gas or gasoline, number	10	.....	.....	.....	.....
112	Horsepower	196	.....	.....	.....	.....
113	Water wheels, number	20	.....	7	3	.....
114	Horsepower	797	.....	170	180	.....
115	Electric motors, number	24	.....	2	9	4
116	Horsepower	924	.....	110	571	32
117	Other power, number	1	.....	.....	.....	.....
118	Horsepower	2	.....	.....	.....	.....
	Rented—					
	Furnished by this establishment—					
119	Horsepower	120	.....	.....	10	.....
	Furnished to this establishment—					
120	Electric, horsepower	419	.....	21	.....	.....
121	Other kind	816	.....	.....	69	.....
	Establishments classified by number of persons employed, not including proprietors and firm members:					
122	Total number of establishments	263	5	10	30	4
123	No employees	12	.....	.....	.....	2
124	Under 5	26	2	.....	3	.....
125	5 to 20	63	3	.....	7	1
126	21 to 50	44	.....	1	2	.....
127	51 to 100	49	.....	1	7	.....
128	101 to 250	47	.....	5	6	1
129	251 to 500	19	.....	2	3	.....
130	501 to 1,000	2	.....	1	1	.....
131	Over 1,000	1	.....	.....	1	.....

[1] Includes the statistics for 2 establishments, the schedules for which were received too late to be included in the tables, presented in the Report on Manufactures, Parts I and II. These establishments are distributed as follows: California, 1; Illinois, 1.

MATERIALS: BY STATES, 1900—Continued.

Maryland.	Massachusetts.	Michigan.	New Hampshire.	New Jersey.	New York.	Ohio.	Pennsylvania.	All other states.[2]	
$827,371	$4,981,966	$776,789	$393,257	$559,693	$14,419,914	$1,387,454	$978,331	$619,571	82
2,210	16,328	5,285	373	3,042	71,855	8,862	5,499	4,213	83
$824,696	$3,434,087	$493,309	$64,713	$432,748	$11,862,257	$1,214,068	$956,291	$600,491	84
300	824	50	.....	12	2,581	166	.....	83	85
$178,100	$349,895	$20,000	.....	$4,800	$962,865	$63,775	.....	$29,525	86
1,892	15,504	1,671	373	3,030	69,191	8,696	5,444	4,130	87
$640,296	$3,084,192	$204,625	$64,713	$427,948	$10,876,742	$1,150,293	$948,416	$570,966	88
18	.....	3,564	.....	.....	83	.....	55	.....	89
$6,300	.....	$268,684	.....	.....	$22,650	.....	$7,875	.....	90
.....	.....	22	.....	.....	1,701	1,018	60	.....	91
.....	.....	$51,394	.....	.....	$63,821	$65,447	$6,000	.....	92
.....	.....	22	.....	.....	.....	.....	.....	.....	93
.....	.....	$51,394	.....	.....	.....	.....	.....	.....	94
.....	.....	.....	.....	.....	.....	.....	.....	.....	95
.....	.....	.....	.....	.....	.....	.....	.....	.....	96
.....	.....	22	.....	.....	.....	.....	.....	.....	97
.....	.....	$51,394	.....	.....	.....	.....	.....	.....	98
.....	.....	.....	.....	.....	1,701	1,018	60	.....	99
.....	.....	.....	.....	.....	$63,821	$65,447	$6,000	.....	100
.....	.....	.....	.....	.....	.....	.....	.....	.....	101
.....	.....	.....	.....	.....	.....	.....	.....	.....	102
$2,675	$1,547,879	$232,086	$328,544	$126,945	$2,493,836	$107,939	$16,040	$19,080	103
3	31	4	4	7	97	10	11	5	104
$607,371	$4,393,368	$594,455	$393,257	$512,708	$12,222,998	$1,379,994	$861,116	$569,416	105
$523,952	$3,370,232	$386,356	$329,881	$402,238	$10,202,655	$1,071,819	$743,965	$541,388	106
2	28	6	3	6	76	9	10	4	107
645	2,069	570	255	348	6,072	867	467	338	108
2	23	5	3	5	56	9	10	1	109
500	1,901	515	255	320	4,798	780	451	125	110
.....	.....	.....	.....	.....	6	.....	1	3	111
.....	.....	.....	.....	.....	105	.....	8	83	112
.....	2	.....	.....	.....	5	.....	.....	3	113
.....	96	.....	.....	.....	236	.....	.....	115	114
5	.....	.....	.....	2	.....	2	.....	.....	115
145	.....	.....	.....	6	.....	60	.....	.....	116
.....	.....	.....	.....	1	.....	.....	.....	.....	117
.....	.....	.....	.....	2	.....	.....	.....	.....	118
.....	.....	.....	.....	.....	85	25	.....	.....	119
.....	16	.....	.....	.....	339	25	8	10	120
.....	56	55	.....	20	594	2	.....	.....	121
4	37	7	4	10	118	12	14	8	122
.....	1	1	1	1	3	3	.....	.....	123
2	2	.....	.....	1	11	1	2	2	124
.....	11	1	.....	2	26	2	5	5	125
.....	6	1	1	3	27	1	2	.....	126
1	6	.....	1	2	26	1	4	.....	127
.....	8	4	1	1	17	3	1	.....	128
1	3	.....	.....	.....	8	1	.....	1	129
.....	.....	.....	.....	.....	.....	.....	.....	.....	130
.....	.....	.....	.....	.....	.....	.....	.....	.....	131

[2] Includes establishments distributed as follows: Colorado, 1; Indiana, 1; Maine, 1; Minnesota, 1; Missouri, 1; Nebraska, 1; Tennessee, 1; Vermont, 1.

ORGANS AND MATERIALS.

Table 15 shows the statistics of the manufacture of organs and materials, as returned at the censuses of 1860 to 1900, inclusive. At the census of 1850 the statistics of the organ manufacture were included under the general heading "musical instruments," and it is not possible, therefore, to present a separate statement for the industry in that year. These statistics include the manufacture of both pipe and reed organs.

TABLE 15.—ORGANS AND MATERIALS: COMPARATIVE SUMMARY, 1860 TO 1900, WITH PER CENT OF INCREASE FOR EACH DECADE.

	DATE OF CENSUS.					PER CENT OF INCREASE.			
	1900	1890	1880	1870	1860	1890 to 1900.	1880 to 1890.	1870 to 1880.	1860 to 1870.
Number of establishments	129	145	171	98	60	[1]11.0	[1]15.2	74.5	63.3
Capital	$5,011,987	$9,890,288	$3,922,338	$2,183,850	$603,000	[1]49.3	152.2	79.6	262.2
Salaried officials, clerks, etc., number	274	[2]381	(3)	(3)	(3)	[1]28.1	.....	.....	.....
Salaries	$299,435	[2]$422,286	(3)	(3)	(3)	[1]29.1	.....	.....	.....
Wage-earners, average number	3,435	4,608	4,202	1,967	716	[1]25.5	9.7	113.6	174.7
Total wages	$1,720,727	$2,674,191	$2,142,539	$1,404,265	$348,116	[1]35.7	24.8	52.6	309.3
Men, 16 years and over	3,271	4,469	3,948	1,928	712	[1]26.8	13.2	104.8	170.8
Wages	$1,672,909	$2,622,987	(3)	(3)	.....	[1]36.2	.....	.....	.....
Women, 16 years and over	92	117	89	28	4	[1]21.4	31.5	217.9	600.0
Wages	$32,559	$47,072	(3)	(3)	.....	[1]30.8	.....	.....	.....
Children, under 16 years	72	22	165	11	.....	227.3	[1]86.7	1,400.0	.....
Wages	$15,259	$4,132	(3)	(3)	.....	269.3	.....	.....	.....
Miscellaneous expenses	$603,785	$821,315	(4)	(4)	(4)	[1]26.5	.....	.....	.....
Cost of materials used	$2,220,165	$3,454,720	$2,692,332	$977,118	$326,375	[1]35.7	28.3	175.5	199.4
Value of products, including custom work and repairing	$5,691,504	$9,213,188	$6,136,472	$3,556,850	$971,725	[1]38.2	50.1	72.5	266.0

[1] Decrease.
[2] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table. (See Table 25.)
[3] Not reported separately.
[4] Not reported.

It appears from Table 15 that the manufacture of organs was not of great importance in 1860. There were but 60 establishments in operation, with 716 wage-earners, and products valued at $971,725. The growth of the industry between that year and 1890 was very marked. The number of wage-earners employed in 1890 was more than four times that reported in 1860, while the value of products in 1890 was nearly six times that reported in 1860. Between 1890 and 1900 there was a general decrease in the industry, a decrease amounting to 38.2 per cent in the value of products. The absolute increase or decrease in the value of products for each decade was as follows:

DECADE.	Absolute increase.
1860 to 1870	$2,585,125
1870 to 1880	2,579,622
1880 to 1890	3,076,716
1890 to 1900	[1]3,521,684

[1] Decrease.

The greatest absolute increase took place during the decade ending with the year 1900, but a fairly steady increase is shown for the entire period, with the exception of the last decade. The greatest percentage of increase in value of products, 266 per cent, is shown for the decade ending with 1870. The reasons for the rise and decline of the manufacture are discussed on page 22.

The increase in the number of establishments from 60 in 1860 to 145 in 1890 was less marked than the increase in other particulars. That this was due to the development of large-scale production during the period is indicated by the increased size of the average establishment. In 1860 the average number of wage-earners employed per establishment was 12; in 1870, 20; in 1880, 25; and in 1890, 32. The decline in the industry between 1890 and 1900 is reflected in the decline in the average number of wage-earners to 27 in the latter year.

Table 16 shows the number of establishments in the several states engaged in the manufacture of organs and materials at the censuses of 1860 to 1900, inclusive.

This table indicates that there has been a generally westward movement in the industry during the last forty years. In both the New England and Middle states the number of establishments increased between 1860 and 1880 and has declined since that date. In the Central states, however, the number shown in 1880 has been practically maintained since that date. The New England states led the other sections in 1860 with 29 establishments, but fell to third place in 1900 with 34 establishments. The Middle states ranked second in 1860 with 24 establishments, and first in 1900 with 45 establishments. The Central states, which ranked third in 1860 with 6 establishments, had risen to the second place in 1900 with 41 establishments. In 1860, 48.3 per cent of the total number of establishments were in the New England states, as compared with but 26.4 per cent in 1900. In 1860, 40 per cent of the total number of establishments were in the Middle states, compared with but 34.9 per cent in 1900. In the Central states the opposite tendency is indicated, 10 per cent of the total number of establishments being reported for this section in 1860, compared with 31.8 per cent in 1900.

TABLE 16.—ORGANS AND MATERIALS: NUMBER OF ESTABLISHMENTS BY STATES, ARRANGED GEOGRAPHICALLY, 1860 TO 1900.

	1900	1890	1880	1870	1860
United States	129	145	171	98	60
New England states	34	42	48	45	29
Maine	.....	1	4	8	3
New Hampshire	1	1	3	6	5
Vermont	2	3	2	2	.....
Massachusetts	24	30	31	22	17
Rhode Island	2	1	1	.....	.....
Connecticut	5	6	7	7	4
Middle states	45	53	76	31	24
New York	17	23	52	19	15
New Jersey	5	6	5	2	3
Pennsylvania	17	19	15	10	5
Delaware	.....	.....	1	.....	.....
Maryland	5	5	3	.....	1
District of Columbia	1	.....	.....	.....	.....
Southern states	4	5	4	.....	.....
Virginia	1	1	1	.....	.....
North Carolina	.....	1	1	.....	.....
South Carolina	.....	1	.....	.....	.....
Georgia	.....	.....	1	.....	.....
Kentucky	2	1	1	.....	.....
Louisiana	.....	1	.....	.....	.....
Texas	1	.....	.....	.....	.....
Central states	41	40	41	22	6
Ohio	6	4	8	4	.....
Michigan	4	4	4	.....	2
Indiana	4	5	5	.....	1
Illinois	16	17	17	9	.....
Wisconsin	3	3	2	1	1
Minnesota	3	3	3	.....	.....
Iowa	1	.....	1	.....	.....
Missouri	4	4	3	8	2
Western states	1	.....	.....	.....	.....
Colorado	1	.....	.....	.....	.....
Pacific states	4	5	2	.....	1
California	4	5	2	.....	1

The relative importance of the organ industry in the several states in 1890 and 1900 is indicated more accurately in Table 17, which shows the value of products distributed by states at each of these censuses.

TABLE 17.—ORGANS AND MATERIALS: VALUE OF PRODUCTS BY STATES, 1890 AND 1900.

	1900		1890		Per cent of increase.
	Value of products.	Per cent of total.	Value of products.	Per cent of total.	
United States	$5,691,504	100.0	$9,213,188	100.0	[1]38.2
California	30,100	0.5	34,416	0.4	[1]12.5
Connecticut	138,952	2.5	564,367	6.1	[1]75.4
Illinois	1,191,197	20.9	2,790,889	30.3	[1]57.3
Indiana	314,719	5.5	162,573	1.8	93.6
Maryland	114,916	2.0	100,475	1.1	14.4
Massachusetts	1,189,585	20.9	2,164,990	23.5	[1]45.1
Michigan	403,053	7.1	575,878	6.2	[1]29.8
Minnesota	53,370	0.9	97,640	1.0	[1]45.3
Missouri	36,490	0.7	46,340	0.5	[1]21.3
New Jersey	772,485	13.6	326,234	3.5	136.8
New York	326,517	5.7	670,017	7.3	[1]51.3
Ohio	63,406	1.1	112,500	1.2	[1]43.6
Pennsylvania	509,802	9.0	585,883	6.4	[1]13.0
Wisconsin	18,488	0.3	24,600	0.3	[1]24.8
All other states[2]	523,424	9.3	958,386	10.4	[1]44.9

[1] Decrease.
[2] Includes establishments distributed as follows: 1900—Colorado, 1; Iowa, 1; Kentucky, 2; New Hampshire, 1; Rhode Island, 2; Texas, 1; Vermont, 2; Virginia, 1. 1890—Kentucky, 1; Louisiana, 1; Maine, 1; New Hampshire, 1; North Carolina, 1; Rhode Island, 1; South Carolina, 1; Virginia, 1; also Vermont, 3, reporting in 1900 as under 3; product, $794,346.

In 11 of the states shown separately in Table 17 there was a decrease during the decade in the value of products. The 5 states in which the absolute decrease was greatest are as follows:

STATES.	Absolute decrease.
Illinois	$1,599,692
Massachusetts	975,405
Connecticut	425,415
New York	343,500
Michigan	170,825

In Indiana, Maryland, and New Jersey there was an increase in the value of products.

It is apparent from these figures that the decline in the industry since 1890 has been very nearly general throughout the country. At each census Illinois led all other states with 30.3 per cent of the total value of products in 1890 and 20.9 per cent in 1900. It is possible that this smaller percentage of the total in 1900 is due to a change in the classification of a few large establishments whose predominating product was organs in 1890 and pianos in 1900. Massachusetts ranked second at each census, its percentage of the total falling from 23.5 per cent in 1890 to 20.9 per cent in 1900. New York ranked third in 1890, but in 1900 this position was taken by New Jersey.

Table 18 shows the value of products for 1900, by states arranged geographically.

TABLE 18.—ORGANS AND MATERIALS: VALUE OF PRODUCTS, BY STATES, ARRANGED GEOGRAPHICALLY, 1900.

	Value of products.	Per cent of total.
United States	$5,691,504	100.0
New England states	1,741,242	30.6
Massachusetts	1,189,585	20.9
Connecticut	138,952	2.4
Other New England states[1]	412,705	7.3
Middle states	1,723,720	30.3
New York	326,517	5.7
New Jersey	772,485	13.6
Pennsylvania	509,802	9.0
Maryland	114,916	2.0
Southern states[2]	112,600	2.0
Central states	2,081,842	36.6
Ohio	63,406	1.1
Michigan	403,053	7.1
Indiana	314,719	5.5
Illinois	1,191,197	20.9
Wisconsin	18,488	0.3
Missouri	36,490	0.7
Other Central states[3]	54,489	1.0
All other states[4]	32,100	0.5

[1] Includes establishments distributed as follows: New Hampshire, 1; Vermont, 2; Rhode Island, 2.
[2] Includes establishments distributed as follows: Virginia, 1; Kentucky, 2; Texas, 1.
[3] Includes establishments distributed as follows: Minnesota, 3; Iowa, 1.
[4] Includes establishments distributed as follows: California, 4; Colorado, 1.

Table 18 indicates that the Central states led in the production of organs and materials in 1900, with 36.6 per cent of the total, the New England states ranking next, with 30.6 per cent, followed by the Middle states,

with 30.3 per cent. The industry in the Southern, Western, and Pacific states was relatively unimportant, their value of products constituting altogether but 2.5 per cent of the total.

All of the above tables give an incomplete showing of the organ industry in the United States because of the necessity, explained above, of considering organs made in piano and other factories as part of the products of those industries. It has been possible, however, in Tables 19 and 20 to present a complete statement of the number and value of the various varieties of organs manufactured during the census year in establishments of any character. These tables, therefore, include organs made in organ factories, in piano factories, and in a few factories which were engaged chiefly in other lines of manufacture. The value of organ materials manufactured in various parts of the country and the amounts received for custom work and repairing are not included. For these reasons the statistics given in Tables 19 and 20 do not agree with those given for the organ manufacture elsewhere in this report, and in the Report on Manufactures, Parts I and II.

TABLE 19.—ORGANS AND MATERIALS: NUMBER AND VALUE OF PIPE AND REED ORGANS MANUFACTURED, BY STATES, 1900.

STATES.	Total value.	PIPE ORGANS.						REED ORGANS.	
		Total number.	Total value.	$1,500 and under.		Over $1,500.		Number.	Value.
				Number.	Value.	Number.	Value.		
United States	$5,276,769	572	$1,188,696	273	$287,303	299	$901,393	107,830	$4,088,073
California	26,000	9	26,000	1	1,500	8	24,500	.....	.....
Connecticut	171,044	9	41,600	2	2,700	7	38,900	3,066	129,444
Illinois	1,821,033	87	105,157	61	39,950	26	65,207	53,643	1,715,876
Indiana	175,439	2	2,100	2	2,100	.....	.....	3,697	173,339
Maryland	93,391	50	80,035	17	18,640	33	61,395	318	13,356
Massachusetts	556,092	137	365,510	57	87,423	80	278,087	3,323	190,582
Michigan	448,592	22	51,394	.....	.....	22	51,394	9,624	397,198
Minnesota	46,795	6	4,750	6	4,750	.....	.....	1,388	42,045
Missouri	29,765	21	29,765	13	14,665	8	15,100	.....	.....
New Jersey	529,672	7	20,000	2	2,000	5	18,000	11,339	509,672
New York	279,941	73	216,120	27	23,675	46	192,445	1,701	63,821
Ohio	132,822	23	34,250	14	18,550	9	15,700	1,643	98,572
Pennsylvania	426,428	80	150,990	41	45,000	39	105,990	6,240	275,438
Wisconsin	15,475	8	15,475	2	2,000	6	13,475	.....	.....
All other states[1]	524,280	38	45,550	28	24,350	10	21,200	11,848	478,730

[1] Includes establishments distributed as follows: Colorado, 1; District of Columbia, 1; Iowa, 1; Kentucky, 2; New Hampshire, 1; Rhode Island, 2; Texas, 1; Vermont, 2; Virginia, 1.

Table 19 indicates in a more satisfactory manner than any of the preceding tables, the rank of the different states in the manufacture of organs. It is possible here to distinguish between two very different products—pipe organs and reed organs. It appears that the reed-organ manufacture is by far the more important, its value of products constituting 77.5 per cent of the total for the two varieties. It appears also from Table 19 that 299 of the pipe organs constructed were valued at more than $1,500 each, while 273 were valued at $1,500 or under. Massachusetts led in the manufacture of pipe organs, with 30.7 per cent of the total value; followed by New York, with 18.2 per cent; Pennsylvania, with 12.7 per cent; Illinois, with 8.8 per cent; Maryland, with 6.7 per cent; and Michigan, with 4.3 per cent. No other state reported a manufacture valued at $50,000 or over. The average value of pipe organs manufactured in the 6 leading states was as follows:

STATES.	Average value.[1]
New York	$2,961
Massachusetts	2,668
Michigan	2,336
Pennsylvania	1,887
Maryland	1,601
Illinois	1,209

[1] See explanation of "average value," supra, page 7.

Illinois led in the manufacture of reed organs among the states shown separately in Table 19, with 42 per cent of the total value of products; followed by New Jersey, with 12.5 per cent; Michigan, with 9.7 per cent; Pennsylvania, with 6.7 per cent; Massachusetts, with 4.7 per cent; Indiana, with 4.2 per cent; and Connecticut, with 3.2 per cent. The average value of reed organs in each of the 7 leading states was as follows:

STATES.	Average value.[1]
Massachusetts	$57
Indiana	47
New Jersey	45
Pennsylvania	44
Connecticut	42
Michigan	41
Illinois	32

[1] See explanation of "average value," supra, page 7.

Table 20 presents the statistics of other varieties of organs for the United States as a whole. Statistics for these products can not be shown by states without revealing the operations of establishments engaged in the manufacture of certain well-known specialties.

TABLE 20.—ORGANS AND MATERIALS: NUMBER AND VALUE OF OTHER VARIETIES OF ORGANS MANUFACTURED, SUMMARY FOR THE UNITED STATES, 1900.

VARIETIES.	Number.	Value.
Total	13,047	$412,264
Self-playing organs	1,738	272,824
Street organs	260	14,455
Other varieties	11,049	124,985

The most significant figures included in Table 20 are those relating to the manufacture of self-playing organs. The development of this manufacture in recent years is referred to on page 22. This class of instruments includes cabinet or reed organs, equipped with self-playing attachments, which usually do not interfere with the use of the instruments in the ordinary manner. Large orchestrions, which are usually equipped with pipes as well as reeds, are also included. The characteristic common to all these instruments is the use of a music roll of perforated paper. The class "other varieties" includes a considerable number of reed organs whose construction is so radically different from that of ordinary reed organs that it was not considered proper to include them in Table 19.

Table 21 presents complete statistics for the manufacture of organs and materials in cities which had a population of 20,000 or over in 1900.

TABLE 21.—ORGANS AND MATERIALS: STATISTICS OF CITIES HAVING A POPULATION OF 20,000 OR OVER, 1900.

CITIES.	Number of establishments.	Capital.	SALARIED OFFICIALS, CLERKS, ETC.		AVERAGE NUMBER OF WAGE-EARNERS AND TOTAL WAGES.					Miscellaneous expenses.	Cost of materials used.	Value of products, including custom work and repairing.
					Total.		Average number.					
			Number.	Salaries.	Average number.	Wages.	Men, 16 years and over.	Women, 16 years and over.	Children under 16 years.			
Total	77	$2,870,887	148	$192,667	2,070	$1,065,934	1,946	64	60	$391,705	$1,383,759	$3,568,170
Baltimore, Md	4	37,100	3	2,180	21	13,108	21	.....	.....	2,551	13,006	44,440
Boston, Mass	4	111,738	9	6,600	112	86,621	109	3	.....	10,226	41,613	197,928
Chicago, Ill	9	601,824	38	42,760	684	274,881	634	.....	50	143,491	436,950	999,061
New York, N. Y	10	145,900	1	2,500	85	71,012	83	.....	2	11,327	93,362	230,299
Philadelphia, Pa	6	40,822	1	780	52	33,850	51	1	.....	5,944	18,550	74,411
St. Louis, Mo	4	43,380	.....	.....	28	13,916	28	.....	.....	3,555	12,457	36,490
Worcester, Mass	3	270,211	7	13,800	255	132,334	206	49	.....	21,424	148,235	382,486
All other cities[1]	37	1,619,912	89	124,047	833	440,212	814	11	8	193,187	619,586	1,603,055

[1] Includes Albany, N. Y., 1; Austin, Tex., 1; Binghamton, N. Y., 1; Bridgeport, Conn., 1; Buffalo, N. Y., 1; Burlington, Iowa, 1; Cambridge, Mass., 2; Cleveland, Ohio, 1; Denver, Colo., 1; Detroit, Mich., 2; Easton, Pa., 1; Erie, Pa., 2; Evansville, Ind., 1; Fort Wayne, Ind., 1; Hartford, Conn., 1; Los Angeles, Cal., 1; Louisville, Ky., 2; Lowell, Mass., 1; Milwaukee, Wis., 2; New Haven, Conn., 1; Oakland, Cal., 1; Orange, N. J., 1; Providence, R. I., 2; Saginaw, Mich., 1; St. Paul, Minn., 1; Springfield, Mass., 1; Utica, N. Y., 1; Waltham, Mass., 1; Washington, D. C., 1; York, Pa., 2.

It appears from Table 21 that the manufacture of organs is essentially a city industry. Of the total value of products for the industry in the United States—$5,691,504—$3,568,170, or 62 7 per cent, was reported for the cities named. The rank of the 4 leading cities shown separately in this table, with the percentage of the value of the products in each to the total for the United States, is as follows:

CITIES.	Value of products.	Per cent of the United States.
Chicago, Ill	$999,061	17.6
Worcester, Mass	382,486	6.7
New York, N. Y	230,299	4.0
Boston, Mass	197,928	3.5

The most striking fact revealed by this list is the comparatively low rank of New York city in this industry, although in the piano industry it far surpasses any other center.

Table 22 shows the establishments engaged in manufacturing organs and materials, grouped according to the number of employees.

TABLE 22.—ORGANS AND MATERIALS: ESTABLISHMENTS CLASSIFIED BY NUMBER OF EMPLOYEES (NOT INCLUDING PROPRIETORS AND FIRM MEMBERS), BY STATES, 1900.

STATES.	Total number of establishments.	NUMBER OF ESTABLISHMENTS REPORTING.						
		No employees.	Under 5.	5 to 20.	21 to 50.	51 to 100.	101 to 250.	251 to 500.
United States	129	11	37	38	20	12	8	3
California	4	2	.....	2	.....	.....	.....	.....
Colorado	1	.....	1	.....	.....	.....	.....	.....
Connecticut	5	.....	.....	3	2	.....	.....	.....
District of Columbia	1	.....	1	.....	.....	.....	.....	.....
Illinois	16	1	3	3	4	3	1	1
Indiana	4	.....	1	1	1	.....	1	.....
Iowa	1	.....	1	.....	.....	.....	.....	.....
Kentucky	2	.....	.....	2	.....	.....	.....	.....
Maryland	5	.....	2	2	.....	1	.....	.....
Massachusetts	24	1	7	7	4	2	3	.....
Michigan	4	1	.....	1	.....	1	1	.....
Minnesota	3	1	1	.....	.....	1	.....	.....
Missouri	4	.....	3	.....	1	.....	.....	.....
New Hampshire	1	1	.....	.....	.....	.....	.....	.....
New Jersey	5	.....	.....	2	1	.....	1	1
New York	17	.....	8	6	2	1	.....	.....
Ohio	6	1	1	2	2	.....	.....	.....
Pennsylvania	17	2	5	5	2	2	1	.....
Rhode Island	2	.....	1	1	.....	.....	.....	.....
Texas	1	.....	1	.....	.....	.....	.....	.....
Vermont	2	.....	.....	.....	1	.....	.....	1
Virginia	1	.....	.....	.....	.....	1	.....	.....
Wisconsin	3	1	1	1	.....	.....	.....	.....

Table 22 indicates that the largest number of establishments in the United States was reported for the class employing from 5 to 20 persons, while but 3 establishments, located in Illinois, New Jersey, and Vermont, gave employment to 251 to 500 persons, no establishments employing more than 500 persons. The largest number of establishments in Illinois was reported for the class "21 to 50 employees;" the largest number in Massachusetts and Pennsylvania for the classes "1 to 5" and "5 to 20 employees;" and the largest number in New Jersey for the class "5 to 20 employees."

Table 23 shows the development of the export trade in organs during the fiscal years 1870 to 1900.

TABLE 23.—VALUE OF ORGANS EXPORTED FROM THE UNITED STATES: 1870 TO 1900.

FISCAL YEAR.	Value.	FISCAL YEAR.	Value.
1900	$993,309	1884	$641,188
1899	985,997	1883	673,314
1898	742,963	1882	687,114
1897	799,132	1881	599,382
1896	729,403	1880	530,112
1895	640,718	1879	447,307
1894	539,278	1878	438,664
1893	897,870	1877	578,864
1892	772,582	1876	532,949
1891	954,507	1875	363,132
1890	750,583	1874	292,151
1889	681,567	1873	215,698
1888	570,266	1872	197,961
1887	462,859	1871	95,069
1886	512,854	1870	101,557
1885	584,279		

Table 23 indicates that the value of organ exports in 1900 was nearly ten times that of 1870, and that the increase during the entire period has been fairly steady.

Table 24 shows the value of products reported for the organ industry at the censuses of 1870, 1880, 1890, and 1900 in comparison with the value of exports during these years.

TABLE 24.—ORGANS AND MATERIALS: VALUE OF PRODUCTS AND VALUE OF ORGANS EXPORTED, 1870 TO 1900.

Year.	Value of organs and materials manufactured.	Value of organs exported.	Per cent of value of organs exported to value of organs and materials manufactured.
1900	$5,691,504	$993,309	17.5
1890	9,213,188	750,583	8.1
1880	6,136,472	530,112	8.6
1870	3,556,850	101,557	2.9

Table 24 indicates that the increase in the value of exports has been much more rapid than the increase in the value of products and, as a result, the percentage of the former to the latter has risen from 2.9 per cent in 1870 to 17.5 per cent in 1900.

Detailed statistics of the manufacture of organs and materials are presented in Table 25 (pages 24 to 27).

HISTORICAL AND DESCRIPTIVE.

PIPE ORGANS.

The pipe organ is the largest, the most complicated, and the most expensive of musical instruments. The word is of Greek origin and signifies an "instrument" of any class. The panpipe of the Greeks—a set of pipes of unequal length joined together side by side—seems to have been the prototype of the modern organ. At an uncertain date this was improved by fastening the pipes in a wind chest, and blowing into this rather than into each of the pipes, as in the panpipe.[1] The player used his fingers to stop all the pipes except the one producing the tone desired. This became impossible when the number of pipes was increased, and valves were placed inside the wind chest, one under each pipe, to cut off the wind. These valves were opened and closed by means of levers arranged in a row. Ctesibius, a barber of Alexandria, is said to have made this important improvement about 200 B. C.

It will be noticed that the three essential features of the modern pipe organ were all found in this primitive instrument—the wind chest, the pipes, and the keyboard. When organs began to be used in churches in western Europe, after the year 670 A. D., their greatest development began, but for three hundred years the changes were chiefly in size. One instrument, used in Winchester Cathedral, England, in 951, had 26 pairs of bellows, and required 70 men to fill it with wind. During all this time the keyboard remained practically the same—a row of not more than sixteen great levers, sometimes 5 or 6 inches wide, played by being struck with the clenched fist. The organist was known as an "organorum pulsator" or organ striker, and the expression "He plays with a delicate fist," was not uncommon.

During the Fourteenth century a most important improvement was made in the structure of the organ, the keys being so reduced in size that they could be played with the fingers.[2] This made possible an increase in the compass of organs to three octaves, and later—in the Sixteenth century—to four octaves. Half notes were introduced in the Twelfth century at Venice; pedals, or keys played with the feet, were added by Bernhard, a German, in 1470; and large pipes, 16 to 32 feet in length began to be made about the same time. In the Sixteenth century reed pipes were invented to imitate the tone of other instruments, the posaune, trumpet, vox-humana, etc.,[3] and in 1712 the swell box was added. This last improvement, which is now found in all pipe organs, consisted in enclosing a part of the pipes in a box which could be opened or closed at the will of the performer, thus making possible crescendo and diminuendo effects.

[1] Manual for the Organ, by H. D. Nicholson, pages 6 and 7.
[2] A Manual for the Organ, page 10.
[3] Ibid., pages 11 and 12.

The chief improvements in organ building since 1712 have been the "voicing" of pipes in order to improve their tone quality, and the perfection of various mechanical arrangements. In all large instruments electrical and water motors have taken the place of hand power for operating the bellows, while pneumatic and electric actions have superseded the heavy system of wooden trackers. This last improvement has made it possible to place the keyboard wherever the organist desires—a great advantage to the organist who is also choir master. This same improvement has allowed the use of an echo organ in parts of halls or churches at a distance from the main organ.

One of the first organs in America, if not the very first, was that belonging to Mr. Thomas Brattle, of Boston, in 1711, probably the same one which was presented by him to Queen's (afterwards King's) Chapel, in August, 1713.[1]

The first organ built in the United States appears to have been erected by John Clark in 1743 for the Episcopal Church in Salem, Mass. Mr. William M. Goodrich, of Boston, is, however, generally admitted to have been the first organ builder in the country deserving the name. This talented self-taught artist built his first organ in 1805, and soon organs of his construction were to be found in nearly every state. It is said that during the whole time of his business career only three church organs were imported into Boston from abroad. In 1853 there were 4 large organ factories in Boston and another one was started at Bellows Falls, Vt. For many years the industry was confined to New England and a few firms in New York, Pennsylvania, and the South. More recently, however, several large establishments have begun business in the West. Although the production has greatly increased during the last half century, the industry has probably not kept pace with the general advance—a fact due in part at least to the increased use of large reed organs in small churches and chapels.

No statistics on this point were presented in the first part of this report, since pipe organs were not shown separately at the census of 1890. It is, therefore, impossible to state whether the decline during the last decade in the combined pipe and reed organ manufacture has been true of the pipe-organ industry, or has been confined to the reed-organ industry. Statistics of pipe organs were, however, shown separately in 1870, and a comparison with that year shows that during the thirty years there was a decrease of 37 in the number of pipe organs built—609 in 1870, compared with 572 in 1900. In Massachusetts, the leading state in the industry, the number of instruments built declined from 345 in 1870 to 137 in 1900. There was a similar decline in New York, the second state in the industry, from 191 in 1870 to 73 in 1900. The opposite tendency is shown in the case of Illinois, where the number increased from 10 in 1870 to 87 in 1900. The average value of the pipe organs built in the country during the thirty years increased from $1,500 to $2,078, and the total value was therefore considerably greater in 1900 than in 1870.

The pipe-organ industry is quite distinct from the manufacture of reed organs. The two classes of instruments are very seldom made in the same establishment. Of the 129 organ establishments reported for the United States, 64, or almost exactly half the total, were pipe-organ building establishments. In value of products, however, the reed-organ industry was by far the more important.

The manufacture of pipe organs is carried on quite largely in small establishments. Of the 64 establishments, 26 reported products valued at less than $5,000, many of these establishments building but one, two, three, or four instruments during the year. The chief centers for the industry in 1900 were Boston, Mass.; Chicago, Ill.; Brooklyn, N. Y.; Weston, Mass.; New York, N. Y.; Erie, Pa.; Philadelphia, Pa.; and Hagerstown, Md. In addition to these cities there were 39 other cities and towns in which the industry was carried on during the census year.

REED ORGANS.

The reed organ, although not invented in the United States, has been so greatly improved in this country that it is distinctively an American instrument. Reed instruments played with the mouth are of great antiquity, the tone being produced by the vibration of a tongue of wood or metal. In the early years of the Nineteenth century reeds of this sort were attached directly to a pair of bellows operated by the hands. The air was admitted by means of a series of keys also attached to the bellows, and the instrument was known as the accordion. When this was enlarged and its scale extended, it became unwieldy, and a natural improvement followed, namely, the separation of the keyboard from the bellows, so that the latter could be operated by the feet. The first instrument of this type was called the seraphine, and this with slight modifications became the melodeon.

Until 1835 nearly all melodeons used in the United States were imported from France, the few factories in existence in this country being confined to Boston and New England towns. Between 1835 and 1845 the manufacture in the United States had an important development, and during the next decade, which was marked by the invention of the suction or "American organ" as it came to be called, the foundation was laid of several houses which have since won international fame.

In the melodeon, as in all earlier reed instruments, the tone had been produced by blowing air through the reeds. In 1846, Mr. J. Carhart, of New York, perfected the method of acting on the reeds by suction. This was so great an improvement, in promptness of response to the touch and in purity of tone secured, that the manufacture of melodeons soon ceased in this country. The quality of tone was further improved in 1850 by certain discoveries which revolutionized the art

[1] Eighth Census of the United States, Manufactures, 1860, pages cl and cli.

of curving the reed—a process called voicing. These discoveries were made by Emmons Hamlin, a brilliant mechanic in the factory of the Prince Company, of Buffalo, N. Y., and with other patented improvements, they brought "American organs" to such perfection and cheapness that by 1860 they were sold throughout Europe, and in Australia, India, and the Sandwich Islands.

For a long time by far the greater part of the reed-organ manufacture was carried on in the Eastern states, especially in Boston, but in recent years the West, with Chicago as its center, has become the great reed-organ producing territory. This section enjoys the advantage of cheaper lumber and closeness to the large western market for these instruments. The industry has never taken high rank in New York city.

The general decline in the manufacture of reed organs since 1890 has been due partly to a change of taste, and partly to the fact that pianos have become less expensive and have thus found their way into homes where, earlier, reed organs had been used. Many of the standard manufacturers of reed organs have added the manufacture of pianos, and several have been very successful.

SELF-PLAYING ORGANS.

Self-playing organs have been manufactured in the United States for at least twenty years. The essential principle of such instruments—the perforated music sheet—is a French invention and appears in a French patent dated January 24, 1842. The device was first patented in the United States in 1849. It is probable that self-playing organs using such a perforated sheet were built during the next thirty years, but this office has received no information concerning the manufacture of such instruments until the year 1883. About that time a Mr. Gally produced a small self-playing organ or organette which used a perforated paper music roll, and was played by means of a hand crank. The instrument was manufactured for Mr. Gally by the Woods Organ Company.

In 1887 the Aeolian Company, of Meriden, Conn., took over several companies, then engaged in the industry, and in 1890 the Wilcox & White Company, also of Meriden, placed their first self-playing organ—the "Symphony"—upon the market. These companies then began a series of improvements which have raised self-players—pianos, as well as organs—into the class of true musical instruments. These improvements allow the performer to control both tempo and volume of sound, and thus to give to any selection the musical interpretation desired. The same principle has since been successfully applied to pipe organs, and one company, at least, manufactures an instrument which is a self-playing organ and piano player combined.

TABLE 25.—ORGANS AND

		United States.	California.	Connecticut.	Illinois.	Indiana.	Maryland.
1	Number of establishments	129	4	5	16	4	5
	Character of organization:						
2	Individual	67	4	3	8	2	4
3	Firm and limited partnership	37	.....	1	6	1	1
4	Incorporated company	25	.....	1	7	1	.....
	Capital:						
5	Total	$5,011,987	$34,240	$81,250	$807,698	$331,073	$68,100
6	Land	$196,371	$4,750	$1,400	$34,100	$4,498	$6,000
7	Buildings	$667,641	$3,800	$6,700	$88,524	$61,194	$19,000
8	Machinery, tools, and implements	$602,313	$4,330	$11,500	$86,355	$23,446	$9,650
9	Cash and sundries	$3,545,662	$20,860	$61,650	$598,719	$241,935	$33,450
10	Proprietors and firm members	150	4	6	15	4	6
	Salaried officials, clerks, etc.:						
11	Total number	274	2	14	50	20	10
12	Total salaries	$299,435	$2,240	$13,900	$52,440	$22,181	$5,462
	Officers of corporations—						
13	Number	68	.....	4	19	2	.....
14	Salaries	$130,324	.....	$5,000	$26,900	$4,750	.....
	General superintendents, managers, clerks, etc.—						
15	Total number	206	2	10	31	18	10
16	Total salaries	$169,111	$2,240	$8,900	$25,540	$17,431	$5,462
	Men—						
17	Number	146	2	7	22	16	9
18	Salaries	$148,630	$2,240	$7,300	$21,254	$16,751	$5,287
	Women—						
19	Number	60	.....	3	9	2	1
20	Salaries	$20,481	.....	$1,600	$4,286	$680	$175
	Wage earners, including pieceworkers and total wages:						
21	Greatest number employed at any one time during the year	3,901	26	101	883	213	78
22	Least number employed at any one time during the year	3,242	15	83	809	183	65
23	Average number	3,435	20	79	817	192	76
24	Wages	$1,720,727	$18,720	$44,145	$337,099	$100,391	$40,608
	Men, 16 years and over—						
25	Average number	3,271	20	73	760	185	76
26	Wages	$1,672,909	$18,720	$41,767	$325,575	$99,161	$40,608
	Women, 16 years and over—						
27	Average number	92	.....	5	3	.....	.....
28	Wages	$32,559	.....	$1,774	$624	.....	.....
	Children, under 16 years—						
29	Average number	72	.....	1	54	7	.....
30	Wages	$15,259	.....	$604	$10,900	$1,230	.....
	Average number of wage-earners, including pieceworkers, employed during each month:						
	Men, 16 years and over—						
31	January	3,205	21	84	752	183	73
32	February	3,255	21	85	757	183	73
33	March	3,254	19	85	771	183	74
34	April	3,336	20	85	776	196	75
35	May	3,332	19	64	782	195	75
36	June	3,215	19	64	785	195	75
37	July	3,218	22	64	790	175	75
38	August	3,264	22	64	789	175	76
39	September	3,238	21	64	787	182	77
40	October	3,333	20	64	795	183	77
41	November	3,244	18	73	666	182	81
42	December	3,358	18	81	673	182	82
	Women, 16 years and over—						
43	January	92	.....	8	3	.....	.....
44	February	92	.....	8	3	.....	.....
45	March	95	.....	8	3	.....	.....
46	April	92	.....	8	3	.....	.....
47	May	92	.....	3	3	.....	.....
48	June	91	.....	3	3	.....	.....
49	July	90	.....	3	3	.....	.....
50	August	89	.....	3	3	.....	.....
51	September	95	.....	3	3	.....	.....
52	October	95	.....	3	3	.....	.....
53	November	95	.....	3	3	.....	.....
54	December	86	.....	3	3	.....	.....
	Children, under 16 years—						
55	January	69	.....	2	53	7	.....
56	February	71	.....	2	53	7	.....
57	March	72	.....	3	53	7	.....
58	April	71	.....	2	53	7	.....
59	May	70	.....	.....	53	7	.....
60	June	69	.....	.....	54	7	.....
61	July	69	.....	.....	54	7	.....
62	August	69	.....	.....	54	7	.....
63	September	73	.....	.....	53	7	.....
64	October	75	.....	.....	53	7	.....
65	November	76	.....	.....	54	7	.....
66	December	80	.....	2	55	7	.....
	Miscellaneous expenses:						
67	Total	$603,785	$3,458	$8,880	$152,994	35,299	$4,829
68	Rent of works	$56,975	$848	$2,100	$22,230	.....	$1,150
69	Taxes, not including internal revenue	$25,812	$120	$170	$5,226	$1,467	454
70	Rent of offices, insurance, interest, and all sundry expenses not hitherto included.	$467,048	$2,990	$5,510	$74,613	$33,882	$2,975
71	Contract work	$54,950	.....	$1,100	$50,925	.....	$250
	Materials used:						
72	Aggregate	$2,220,165	$9,184	$50,172	$517,458	$131,425	$45,251
	Principal materials—						
73	Total	$1,884,397	$6,059	$41,919	$373,207	$119,766	$34,774
74	Purchased in raw state	.....	.....	.....	.....	.....	.....
75	Purchased in partially manufactured form	$1,884,397	$6,059	$41,919	$373,207	$119,766	$34,774
76	Fuel	$60,068	.....	$1,567	$12,951	$4,524	$631
77	Rent of power and heat	$5,983	$200	$500	$1,190	$15	$80
78	Mill supplies	$17,465	.....	$610	$4,696	$500	$305
79	All other materials	$212,175	$2,785	$3,934	$121,542	$20	$8,770
80	Freight	$40,077	$140	$1,642	$3,872	$6,600	$691

MATERIALS: BY STATES, 1900.

Massachusetts.	Michigan.	Minnesota.	Missouri.	New Jersey.	New York.	Ohio.	Pennsylvania.	Wisconsin.	All other states.[1]	
24	4	3	4	5	17	6	17	3	12	1
14	2	1	2	3	10	2	9	3	5	2
4	.....	1	2	1	7	2	6	.....	5	3
6	2	1	.....	1	.....	2	2	.....	2	4
$853,507	$588,354	$68,430	$43,380	$593,150	$269,336	$79,523	$526,281	$24,825	$692,840	5
$29,400	$4,300	$4,200	$4,300	$24,000	$22,000	$9,800	$25,423	$2,900	$19,300	6
$97,729	$21,752	$15,500	$20,100	$96,000	$32,000	$12,500	$72,180	$7,250	$113,412	7
$138,851	$84,330	$16,591	$1,330	$39,650	$66,900	$7,870	$38,062	$3,475	$118,978	8
$587,527	$477,472	$32,139	$17,650	$438,500	$148,436	$49,353	$390,616	$11,200	$441,155	9
29	2	3	6	5	28	7	23	3	14	10
37	34	4	.....	52	4	9	19	.....	19	11
$59,660	$40,509	$3,020	.....	$31,430	$4,000	$1,680	$31,235	.....	$31,378	12
14	6	1	.....	2	.....	6	9	.....	5	13
$40,000	$10,000	$1,200	.....	$7,600	.....	$1,480	$17,694	.....	$15,700	14
23	28	3	.....	50	4	3	10	.....	14	15
$19,660	$30,509	$1,820	.....	$23,830	$4,000	$500	$13,541	.....	$15,678	16
16	27	3	.....	19	3	2	9	.....	11	17
$16,570	$30,093	$1,820	.....	$16,580	$3,650	$200	$13,125	.....	$13,760	18
7	1	.....	.....	31	1	1	1	.....	3	19
$3,090	$416	.....	.....	$7,250	$350	$300	$416	.....	$1,918	20
734	253	51	34	500	176	82	334	16	420	21
562	235	6	22	408	124	67	271	10	332	22
629	242	35	28	434	151	46	274	15	397	23
$408,049	$93,330	$12,436	$13,916	$201,933	$101,900	$23,924	$149,738	$6,508	$178,000	24
578	238	34	28	433	143	45	266	15	382	25
$387,420	$91,950	$12,112	$13,916	$201,583	$99,700	$23,804	$147,010	$6,508	$168,075	26
55	2	1	.....	1	5	1	6	.....	13	27
$20,467	$600	$324	.....	$350	$1,500	$150	$2,270	.....	$4,500	28
1	2	.....	.....	.....	3	.....	2	.....	2	29
$162	$780	.....	.....	.....	$700	.....	$458	.....	125	30
535	241	47	28	419	130	40	257	14	381	31
561	248	47	30	419	134	40	255	14	393	32
557	243	46	30	411	142	40	253	14	386	33
566	245	47	32	427	156	70	253	13	375	34
568	244	47	33	435	157	72	252	15	374	35
537	244	9	31	432	143	37	259	15	370	36
551	238	7	31	428	147	38	264	15	373	37
571	233	8	31	428	156	37	265	16	393	38
575	230	5	20	434	145	39	266	16	377	39
601	231	47	19	435	139	40	273	15	394	40
623	232	47	24	437	129	40	291	15	386	41
629	233	47	24	492	148	41	298	13	397	42
52	2	2	.....	1	5	1	6	.....	12	43
52	2	2	.....	1	5	1	6	.....	12	44
54	2	2	.....	1	5	1	6	.....	13	45
52	2	2	.....	1	5	1	6	.....	12	46
56	2	2	.....	1	5	1	6	.....	13	47
56	2	1	.....	1	5	1	6	.....	13	48
56	1	1	.....	1	5	1	6	.....	13	49
55	1	.....	.....	1	5	1	6	.....	14	50
59	2	1	.....	1	5	1	6	.....	14	51
59	2	2	.....	1	5	1	6	.....	13	52
58	2	2	.....	1	5	1	6	.....	14	53
51	2	1	.....	1	5	1	6	.....	13	54
1	.....	.....	1	.....	3	.....	.....	.....	2	55
1	.....	.....	1	.....	3	.....	2	.....	2	56
1	.....	.....	1	.....	3	.....	2	.....	2	57
1	.....	.....	1	.....	3	.....	2	.....	2	58
1	1	.....	1	.....	3	.....	2	.....	2	59
.....	1	.....	.....	.....	3	.....	2	.....	2	60
.....	1	.....	.....	.....	3	.....	2	.....	2	61
.....	1	.....	.....	.....	3	.....	2	.....	2	62
.....	6	.....	.....	.....	2	.....	3	.....	2	63
1	6	.....	.....	.....	2	.....	4	.....	2	64
1	6	.....	.....	.....	2	.....	4	.....	2	65
1	6	.....	.....	.....	3	.....	4	.....	2	66
$85,819	$76,987	$3,016	$3,555	$129,577	$17,858	$3,892	$38,343	$2,032	$87,246	67
$12,160	$4,726	.....	$186	$360	$7,634	$220	$2,889	.....	$1,972	68
$6,965	$2,099	$366	$362	$2,577	$803	$335	$664	$151	$4,068	69
$66,535	$70,162	$2,650	$3,007	$126,390	$9,321	$3,337	$32,774	$1,881	$31,071	70
$159	.....	.....	.....	$250	$100	.....	$2,016	.....	$150	71
$366,689	$188,745	$25,610	$12,457	$316,262	$119,339	$22,115	$210,879	$5,781	$198,798	72
$329,849	$170,090	$20,617	$9,462	$291,062	$96,804	$19,666	$190,387	$4,936	$175,799	73
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	74
$329,849	$170,090	$20,617	$9,462	$291,062	$96,804	$19,666	$190,387	$4,936	$175,799	75
$11,151	$3,086	$2,040	$102	$5,114	$2,132	$415	$4,065	$334	$11,956	76
$1,639	$12	.....	.....	$25	$1,074	$300	$888	.....	$60	77
$1,204	$609	$151	$5	$4,491	$548	$115	$1,451	$15	$2,765	78
$21,889	$9,014	$622	$2,422	$6,070	$18,135	$850	$11,797	$250	$4,075	79
$957	$5,934	$2,180	$466	$9,500	$646	$769	$2,291	$246	$4,143	80

[1] Includes establishments distributed as follows: Colorado, 1; District of Columbia, 1; Iowa, 1; Kentucky, 2; New Hampshire, 1; Rhode Island, 2; Texas, 1; Vermont, 2; Virginia, 1.

TABLE 25.—ORGANS AND

		United States.	California.	Connecticut.	Illinois.	Indiana.	Maryland.
	Products:						
81	Aggregate	$5,691,504	$30,100	$138,952	$1,191,197	$314,719	$114,916
	Organs—						
82	Total number	82,608	9	1,449	20,718	3,699	568
83	Total value	$4,226,478	$26,000	$106,400	$767,781	$175,439	$105,391
	Pipe organs—						
84	Total number	507	9	9	52	2	50
85	Total value	$1,070,455	$26,000	$41,600	$49,985	$2,100	$80,035
	$1,500 and under—						
86	Number	245	1	2	40	2	17
87	Value	$261,778	$1,500	$2,700	$23,600	$2,100	$18,640
	Over $1,500—						
88	Number	262	8	7	12	.....	33
89	Value	$808,677	$24,500	$38,900	$26,385	.....	$61,395
	Reed organs—						
90	Number	70,448	.....	1,440	20,666	3,697	318
91	Value	$2,890,081	.....	$64,800	$717,796	$173,339	$18,356
	Other varieties—						
92	Number	11,658	.....	.....	.....	.....	200
93	Value	$265,942	.....	.....	.....	.....	$12,000
	Pianos—						
94	Total number	5,248	.....	.....	2,286	689	.....
95	Total value	$904,731	.....	.....	$296,136	$138,200	.....
	Grand pianos—						
96	Number	115	.....	.....	.....	2	.....
97	Value	$40,350	.....	.....	.....	$800	.....
	Upright pianos—						
98	Number	5,031	.....	.....	2,286	687	.....
99	Value	$841,381	.....	.....	$296,136	$137,400	.....
	Other varieties—						
100	Number	142	.....	.....	.....	.....	.....
101	Value	$29,000	.....	.....	.....	.....	.....
	All other products—						
102	Total value	$554,295	$4,100	$32,552	$127,280	$1,080	$9,525
	Comparison of products—						
103	Number of establishments reporting for both years	112	4	3	15	3	5
104	Value for census year	$5,361,899	$30,100	$98,772	$1,130,197	$808,219	$114,916
105	Value for preceding business year	$4,445,355	$14,800	$82,361	847,056	$241,413	$103,700
	Power:						
106	Number of establishments reporting	73	1	5	12	3	1
107	Total horsepower	4,039	10	173	1,062	220	53
	Owned—						
	Engines—						
108	Steam, number	55	.....	4	10	3	2
109	Horsepower	3,658	.....	101	975	220	53
110	Gas or gasoline, number	10	.....	.....	.....	.....	.....
111	Horsepower	115	.....	.....	.....	.....	.....
112	Water wheels, number	4	.....	1	.....	.....	.....
113	Horsepower	75	.....	50	.....	.....	.....
114	Electric motors, number	2	.....	.....	2	.....	.....
115	Horsepower	40	.....	.....	40	.....	.....
116	Other power, number	1	.....	.....	.....	.....	.....
117	Horsepower	1	.....	.....	.....	.....	.....
	Rented—						
	Furnished by this establishment—						
118	Horsepower	80	.....	.....	.....	.....	.....
	Furnished to this establishment—						
119	Electric, horsepower	74	10	22	10	.....	.....
120	Other kind	76	.....	.....	37	.....	.....
	Establishments, classified by number of persons employed, not including proprietors and firm members:						
121	Total number of establishments	129	4	5	16	4	5
122	No employees	11	2	.....	1	.....	.....
123	Under 5	37	.....	.....	3	1	2
124	5 to 20	38	2	3	3	1	2
125	21 to 50	20	.....	2	4	1	.....
126	51 to 100	12	.....	.....	3	.....	1
127	101 to 250	8	.....	.....	1	1	.....
128	251 to 500	3	.....	.....	1	.....	.....
129	501 to 1,000	.....	.....	.....	.....	.....	.....
130	Over 1,000	.....	.....	.....	.....	.....	.....

MATERIALS: BY STATES, 1900—Continued.

Massachusetts.	Michigan.	Minnesota.	Missouri.	New Jersey.	New York.	Ohio.	Pennsylvania.	Wisconsin.	All other states.[1]	
$1,189,585	$403,053	$53,370	$36,490	$772,485	$326,517	$63,406	$509,802	$18,488	$528,424	81
3,962	9,627	1,394	21	11,346	10,953	641	6,268	68	11,885	82
$751,979	$397,798	$46,795	$29,765	$529,672	$268,120	$58,200	$421,428	$17,930	$521,780	83
137	.....	6	21	7	73	16	80	8	37	84
$365,510	.....	$4,750	$29,765	$20,000	$216,120	$25,075	$150,990	$15,475	$43,050	85
57	.....	6	13	2	27	7	41	2	28	86
$87,423	.....	$4,750	$14,665	$2,000	$23,675	$9,375	$45,000	$2,000	$24,350	87
80	.....	.....	8	5	46	9	39	6	9	88
$278,087	.....	.....	$15,100	$18,000	$192,445	$15,700	$105,990	$13,475	$18,700	89
3,323	9,624	1,388	.....	11,339	.....	625	6,180	.....	11,848	90
$190,582	$397,198	$42,045	.....	$509,672	.....	$33,125	$269,438	.....	$478,780	91
502	3	.....	.....	.....	10,880	.....	8	60	.....	92
$195,887	$600	.....	.....	.....	$54,000	.....	$1,000	$2,455	.....	93
481	.....	41	.....	1,289	102	.....	360	.....	.....	94
$132,575	.....	$1,175	.....	$238,286	$23,000	.....	$75,359	.....	.....	95
113	.....	.....	.....	.....	.....	.....	.....	.....	.....	96
$39,550	.....	.....	.....	.....	.....	.....	.....	.....	.....	97
368	.....	41	.....	1,289	.....	.....	360	.....	.....	98
$93,025	.....	$1,175	.....	$238,286	.....	.....	$75,359	.....	.....	99
.....	.....	.....	.....	.....	142	.....	.....	.....	.....	100
.....	.....	.....	.....	.....	$29,000	.....	.....	.....	.....	101
$305,031	$5,255	$5,400	$6,725	$4,527	$27,397	$5,206	$13,015	$558	$6,644	102
21	3	2	3	5	15	4	17	2	10	103
$1,059,028	$393,238	$5,525	$34,790	$772,485	$309,984	$46,050	$509,802	$16,488	$527,305	104
$895,270	$297,508	$9,225	$31,779	$695,856	$248,611	$28,030	$449,147	$12,712	$488,387	105
15	2	1	.....	4	9	4	9	1	6	106
688	242	6	.....	403	135	201	270	14	562	107
7	3	.....	.....	6	3	2	8	.....	7	108
627	242	.....	.....	403	67	170	245	.....	555	109
1	.....	1	.....	.....	3	1	2	1	1	110
12	.....	6	.....	.....	34	25	20	14	4	111
3	.....	.....	.....	.....	.....	.....	.....	.....	.....	112
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	113
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	114
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	115
.....	.....	.....	.....	.....	.....	1	.....	.....	.....	116
.....	.....	.....	.....	.....	.....	1	.....	.....	.....	117
.....	80	.....	.....	.....	.....	.....	.....	.....	.....	118
.....	.....	.....	.....	.....	24	5	.....	.....	3	119
24	.....	.....	.....	.....	10	.....	5	.....	.....	120
24	4	3	4	5	17	6	17	3	12	121
1	1	1	.....	.....	.....	1	2	1	1	122
7	.....	1	3	.....	8	1	5	1	5	123
7	1	.....	.....	2	6	2	5	1	3	124
4	.....	.....	1	1	2	2	2	.....	1	125
2	1	1	.....	.....	1	.....	2	.....	1	126
3	1	.....	.....	1	.....	.....	1	.....	.....	127
.....	.....	.....	.....	1	.....	.....	.....	.....	1	128
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	129
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	130

[1] Includes establishments distributed as follows: Colorado, 1; District of Columbia, 1; Iowa, 1; Kentucky, 2; New Hampshire, 1; Rhode Island, 2; Texas, 1; Vermont, 2; Virginia, 1.

MUSICAL INSTRUMENTS AND MATERIALS, NOT SPECIFIED.

Table 26 shows the statistics of the manufacture of musical instruments and materials, not specified, as returned at the censuses of 1860 to 1900, inclusive. At the census of 1850 the statistics of this manufacture were included under the general heading "musical instruments," and it is therefore impossible to present a separate statement for the industry in that year.

TABLE 26.—MUSICAL INSTRUMENTS AND MATERIALS, NOT SPECIFIED: COMPARATIVE SUMMARY, 1860 TO 1900, WITH PER CENT OF INCREASE FOR EACH DECADE.

	DATE OF CENSUS.					PER CENT OF INCREASE.			
	1900	1890	1880	1870	1860	1890 to 1900.	1880 to 1890.	1870 to 1880.	1860 to 1870.
Number of establishments	229	293	84	88	53	[1]21.8	248.8	1.2	56.6
Capital	$3,896,101	$1,329,329	$654,850	$1,351,600	$184,650	193.1	103.0	[1]51.6	632.0
Salaried officials, clerks, etc., number	158	[2]326	(3)	(3)	(3)	[1]51.5	.....	.....	.....
Salaries	$141,745	[2]$257,067	(3)	(3)	(3)	[1]44.9	.....	.....	.....
Wage-earners, average number	2,405	1,056	573	1,059	263	127.7	84.3	[1]45.9	302.7
Total wages	$1,232,039	$605,110	$293,062	$631,634	$105,740	103.6	106.5	[1]53.6	497.3
Men, 16 years and over	2,144	981	528	1,019	263	118.6	85.8	[1]48.2	287.4
Wages	$1,167,923	$583,888	(3)	(3)	(3)	100.0	.....	.....	.....
Women, 16 years and over	226	54	29	21	(3)	318.5	86.2	38.1	.....
Wages	$57,610	$17,427	(3)	(3)	(3)	230.6	.....	.....	.....
Children, under 16 years	35	21	16	19	(3)	66.7	31.3	[1]15.8	.....
Wages	6,506	3,795	(3)	(3)	(3)	71.4	.....	.....	.....
Miscellaneous expenses	$271,093	$178,488	(4)	(4)	(4)	51.9	.....	.....	.....
Cost of materials used	$1,205,337	$510,664	$385,776	$932,657	$90,038	136.0	32.4	[1]58.6	935.8
Value of products, including custom work and repairing	$3,894,734	$1,888,613	$853,746	$2,019,464	$315,800	79.7	121.2	[1]57.7	539.5

[1] Decrease.
[2] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table. (See Table 34.)
[3] Not reported separately.
[4] Not reported.

It appears from Table 26 that the manufacture of musical instruments, not specified, was not of great importance in 1860. There were but 53 establishments in operation, with 263 wage-earners and products valued at $315,800. The growth of the industry since that year is shown by comparing these figures with those given for 1900. The number of wage-earners employed in 1900 was more than nine times that reported in 1860, while the value of products in 1900 was more than ten times that reported in 1860. The absolute increase in the value of products for each decade was as follows:

DECADE.	Absolute increase.
1860 to 1870	$1,703,664
1870 to 1880	[1]1,165,718
1880 to 1890	1,034,867
1890 to 1900	1,506,121

[1] Decrease.

The greatest absolute increase appears to have taken place during the decade ending with the year 1870. The greatest percentage of increase in the value of products, 539.5 per cent, is shown also for this decade.

The increase in the number of establishments, from 53 in 1850 to 229 in 1900, has been less marked. That this has been due to the development of production on a larger scale during the period is indicated by the increased size of the average establishment. In 1860 the average number of wage-earners employed per establishment was 5; in 1900, 11.

Table 27 shows the number of establishments in the several states engaged in the manufacture of musical instruments and materials, not specified, at the censuses of 1860 to 1900, inclusive.

TABLE 27.—MUSICAL INSTRUMENTS AND MATERIALS, NOT SPECIFIED: NUMBER OF ESTABLISHMENTS, BY STATES, ARRANGED GEOGRAPHICALLY, 1860 TO 1900.

	1900	1890	1880	1870	1860
United States	229	293	84	88	53
New England states	88	53	15	27	13
Maine	.....	3	1	1	1
Vermont	.....	.....	1	.....	4
New Hampshire	1	2	2	4	.....
Massachusetts	34	42	10	17	5
Rhode Island	1	3	.....	1	1
Connecticut	2	3	1	4	2
Middle states	93	136	36	34	22
New York	58	81	16	14	7
New Jersey	13	4	4	.....	.....
Pennsylvania	20	44	9	11	14
Maryland	2	7	6	9	1
District of Columbia	.....	.....	1	.....	.....
Southern states	5	27	2	4	1
Virginia	.....	2	.....	.....	.....
Georgia	.....	5	.....	.....	.....
Kentucky	2	7	.....	.....	1
Tennessee	.....	1	2	1	.....
Alabama	.....	.....	.....	1	.....
Arkansas	.....	1	.....	.....	.....
Louisiana	1	4	.....	2	.....
Texas	2	7	.....	.....	.....
Central states	82	62	26	16	17
Ohio	16	16	7	.....	15
Michigan	5	4	.....	12	.....
Indiana	6	4	5	.....	.....
Illinois	27	14	1	1	1
Wisconsin	4	5	.....	.....	1
Minnesota	8	4	3	.....	.....
Iowa	6	.....	.....	3	.....
Missouri	10	15	10	.....	.....
Western states	3	3	1	.....	.....
Nebraska	1	1	.....	.....	.....
Colorado	2	.....	.....	.....	.....
Kansas	.....	2	1	.....	.....
Pacific states	8	12	4	2	.....
Washington	1	.....	.....	.....	.....
Oregon	1	.....	.....	2	.....
California	6	12	4	.....	.....

Table 27 indicates the generally westward movement which has taken place in the industry during the last forty years. The rank of the principal sections of the country was the same in 1900 as in 1860, the Middle states leading, with 93 establishments, followed by the the Central states, with 82 establishments, and the New England states, with 38 establishments. In each section the number of establishments shows a considerable increase, but the growth has been most rapid in the Central states, from 17 in 1860 to 82 in 1900. In 1860, 41.5 per cent of the total number of establishments were in the Middle states, as compared with but 40.6 per cent in 1900. In 1860 24.5 per cent of the total number of establishments were in the New England states, compared with but 16.6 per cent in 1900. In the Central states the opposite tendency is indicated, 19.3 per cent of the total being reported for this section in 1870, compared with 35.8 per cent in 1900.

The relative importance of the industry in the several states in 1890 and 1900 is indicated more accurately in Table 28, which shows the value of products distributed by states at each of these censuses.

TABLE 28.—MUSICAL INSTRUMENTS AND MATERIALS, NOT SPECIFIED: VALUE OF PRODUCTS, BY STATES, 1890 AND 1900.

STATES.	1900		1890		Per cent of increase.
	Value of products.	Per cent of total.	Value of products.	Per cent of total.	
United States	$3,394,734	100.0	$1,888,618	100.0	79.8
California	27,513	0.8	16,073	0.9	71.2
Connecticut	(1)	.....	3,100	0.2	.....
Georgia	(1)	.....	15,675	0.8	.....
Illinois	514,393	15.2	239,960	12.7	114.4
Indiana	205,700	6.1	136,636	7.2	50.5
Iowa	70,148	2.1	.....	.....	.....
Kentucky	(1)	.....	14,300	0.8	.....
Louisiana	(1)	.....	27,120	1.4	.....
Maine	.....	.....	3,950	0.2	.....
Maryland	(1)	.....	13,686	0.7	.....
Massachusetts	469,239	13.8	224,599	11.9	108.9
Michigan	37,710	1.1	25,495	1.3	47.9
Minnesota	38,976	1.1	13,555	0.7	187.5
Missouri	45,181	1.3	41,065	2.2	10.0
New Jersey	879,521	25.9	10,580	0.6	8,213.1
New York	763,408	22.5	588,834	31.2	29.6
Ohio	70,219	2.1	37,230	2.0	88.6
Pennsylvania	221,064	6.5	418,941	22.2	[2] 47.2
Rhode Island	(1)	.....	4,061	0.2	.....
Texas	(1)	.....	27,400	1.4	.....
Wisconsin	9,740	0.3	8,080	0.4	20.5
All other states[3]	41,922	1.2	18,273	1.0	129.4

[1] Statistics for 1900 included in "all other states."
[2] Decrease.
[3] Includes establishments distributed as follows: 1900—Colorado, 2; Connecticut, 2; Kentucky, 2; Louisiana, 1; Maryland, 2; Nebraska, 1; New Hampshire, 1; Oregon, 1; Rhode Island, 1; Texas, 2; Washington, 1. 1890—Arkansas, 1; Kansas, 2; Nebraska, 1; New Hampshire, 2; Tennessee, 1; Virginia, 2.

In all but one of the states shown separately in Table 28 there was an increase during the decade in the value of products. The 5 states in which there was the greatest absolute increase in the value of products are as follows:

STATES.	Absolute increase.
New Jersey	$868,941
Illinois	274,433
Massachusetts	244,640
New York	174,574
Indiana	69,064

In Pennsylvania there was a decrease in the value of products. The striking fact brought out by this list is the great increase in New Jersey. The value of products in this state in 1890 constituted but six-tenths of 1 per cent of the total for the United States, as compared with 25.9 per cent of the total in 1900. New York ranked next to New Jersey in 1900, but its value of products constituted but 22.5 per cent of the total in that year, compared with 31.2 per cent in 1890. Illinois ranked third in 1900, its value of products constituting 15.2 per cent of the total in that year, compared with but 12.7 in 1890. Massachusetts ranked fourth in 1900, its value of products constituting 13.8 per cent of the total in that year, compared with 11.9 per cent in 1890.

Table 29 shows the value of products for 1900, by states and groups of states.

TABLE 29.—MUSICAL INSTRUMENTS AND MATERIALS, NOT SPECIFED: VALUE OF PRODUCTS, BY STATES, ARRANGED GEOGRAPHICALLY, 1900.

	Value of product.	Per cent of total.
United States	$3,394,734	100.0
New England states	474,859	14.0
Massachusetts	469,239	13.8
Other New England states[1]	5,620	0.2
Middle states	1,866,793	55.0
New York	763,408	22.5
New Jersey	879,521	25.9
Other Middle states[2]	223,864	6.6
Southern states[3]	20,758	0.6
Central states	992,067	29.2
Ohio	70,219	2.1
Michigan	37,710	1.1
Indiana	205,700	6.0
Illinois	514,393	15.2
Wisconsin	9,740	0.3
Minnesota	38,976	1.1
Iowa	70,148	2.1
Missouri	45,181	1.3
Western states[4]	8,770	0.3
Pacific states	31,487	0.9
California	27,513	0.8
Other Pacific states[5]	3,974	0.1

[1] Includes establishments distributed as follows: New Hampshire, 1; Rhode Island, 1; Connecticut, 2.
[2] Includes establishments distributed as follows: Pennsylvania, 20; Maryland, 2.
[3] Includes establishments distributed as follows: Kentucky, 2; Louisiana, 1; Texas, 2.
[4] Includes establishments distributed as follows: Nebraska, 1; Colorado, 2.
[5] Includes establishments distributed as follows: Washington, 1; Oregon, 1.

Table 29 indicates that in 1900 the Middle states led in the production of musical instruments and materials, not specified, with 55 per cent of the total, the Central states ranking next with 29.2 per cent, followed by the New England states with 14 per cent. The industry in the Southern, Western, and Pacific states was relatively unimportant.

Table 30 is a statement of the principal products of this industry for 1900 by states.

TABLE 30.—MUSICAL INSTRUMENTS AND MATERIALS, NOT SPECIFIED: QUANTITY AND VALUE OF SPECIFIED PRODUCTS, BY STATES, 1900.

STATES.	ALL CLASSES.	BAND INSTRUMENTS, BRASS.	VIOLINS.		MANDOLINS AND MANDOLAS.		GUITARS.		BANJOS.		All other products, including custom work and repairing.
	Total value.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	
United States	$3,394,734	$255,741	1,503	$103,731	78,389	$360,218	78,444	$326,486	18,512	$120,818	$2,227,740
California	27,513	180	193	13,225	290	1,250	367	1,250	.....	.....	11,608
Illinois	514,393	7,825	77	2,281	30,400	131,261	40,530	138,757	7,022	28,430	205,839
Indiana	205,700	146,000	.....	.....	1,075	10,900	2,080	16,900	.....	.....	31,900
Iowa	70,148	.....	25	1,510	117	2,580	222	2,958	7	105	62,995
Massachusetts	469,239	29,742	256	18,930	6,460	37,534	4,200	34,100	1,786	21,750	327,183
Michigan	37,710	18,135	49	2,420	700	7,000	300	3,000	201	2,025	5,130
Minnesota	38,976	.....	59	3,680	52	786	580	5,800	.....	.....	28,710
Missouri	45,181	.....	12	1,200	3,202	13,032	3,702	12,332	.....	.....	18,617
New Jersey	879,521	2,500	12	400	12,219	35,828	12,723	32,878	456	1,063	806,852
New York	763,408	3,750	525	45,530	17,748	76,903	7,933	33,431	6,460	41,600	562,194
Ohio	70,219	2,700	58	5,415	638	4,744	1,240	7,780	.....	.....	49,580
Pennsylvania	221,064	44,609	53	1,420	2,650	28,250	2,587	27,250	2,500	25,345	94,190
Wisconsin	9,740	.....	34	1,200	720	3,600	500	2,000	.....	.....	2,940
All other states[1]	41,922	300	150	6,520	2,118	6,550	1,480	8,050	80	500	20,002

[1] Includes establishments distributed as follows: Colorado, 2; Connecticut, 2; Kentucky, 2; Louisiana, 1; Maryland, 2; Nebraska, 1; New Hampshire, 1; Oregon, 1; Rhode Island, 1; Texas, 2; Washington, 1.

Table 31 is a statement for the United States as a whole, giving the values of certain other musical instruments which are included in Table 30 under the head of "all other products." Statistics for these products could not be shown by states without revealing the operations of establishments engaged in the manufacture of certain well-known specialties.

TABLE 31.—MUSICAL INSTRUMENTS AND MATERIALS, NOT SPECIFIED: ALL OTHER PRODUCTS, SUMMARY FOR THE UNITED STATES, 1900.

PRODUCTS.	Value.
Total	$2,227,740
Automatic banjos	128,000
Music boxes and materials	722,093
Strings	209,524
Zithers, Apollo harps, and autoharps	292,559
Other products, including custom work and repairing	875,564

Tables 30 and 31 indicate that music boxes and materials are the most important of the various products specified, the value reported under this head, $722,093, constituting 21.3 per cent of the total for the industry. Mandolins and mandolas ranked next, their value, $360,218, constituting 10.6 per cent of the total for the industry. Guitars ranked third, with 9.6 per cent of the total; zithers, Apollo harps, and autoharps, fourth, with 8.6 per cent, and brass instruments for bands fifth, with 7.5 per cent.

Table 30 indicates that mandolins and mandolas were made most largely in Illinois, 36.4 per cent of the total value of these instruments being reported for this state. New York, Massachusetts, New Jersey, and Pennsylvania ranked next in the order named. Illinois led also in the manufacture of guitars, with 42.5 per cent of the total value of products, followed by Massachusetts, New York, and New Jersey. Indiana led in the manufacture of brass instruments for bands, with 57.1 per cent of the total value, followed by Pennsylvania, Massachusetts, and Michigan. Banjos were made most largely in New York, Illinois, Pennsylvania, and Massachusetts, and violins in New York and Massachusetts.

Table 32 presents complete statistics for the manufacture of musical instruments and materials, not specified, in cities which had a population of 20,000 or over in 1900.

TABLE 32.—MUSICAL INSTRUMENTS AND MATERIALS, NOT SPECIFIED; STATISTICS OF CITIES HAVING A POPULATION OF 20,000 OR OVER, 1900.

CITIES.	Number of establishments.	Capital.	SALARIED OFFICIALS, CLERKS, ETC.		AVERAGE NUMBER OF WAGE-EARNERS AND TOTAL WAGES.					Miscellaneous expenses.	Cost of materials used.	Value of products, including custom work and repairing.
					Total.		Average number.					
			Number.	Salaries.	Average number.	Wages.	Men, 16 years and over.	Women, 16 years and over.	Children, under 16 years.			
Total	193	$2,740,786	112	$110,531	1,648	$812,636	1,444	170	34	$189,519	$771,385	$2,263,963
Albany, N. Y	3	6,600	.....	.....	6	4,200	6	.....	.....	710	51,008	71,150
Boston, Mass	18	116,833	8	8,050	148	85,014	145	3	.....	16,723	80,605	237,258
Camden, N. J	3	7,375	.....	.....	7	8,000	7	.....	.....	482	2,787	15,135
Chicago, Ill	26	346,561	24	20,267	425	213,867	409	2	14	38,798	165,770	507,293
Cincinnati, Ohio	7	107,780	.....	.....	9	4,350	9	.....	.....	1,726	8,345	20,999
Indianapolis, Ind	3	23,468	1	1,200	37	17,000	37	.....	.....	2,749	5,975	28,000
Jersey City, N. J	3	498,800	20	19,911	324	130,733	287	28	9	22,693	95,237	259,554
Kansas City, Mo	3	8,315	1	920	23	13,840	23	.....	.....	600	6,990	27,200
Milwaukee, Wis	3	13,135	.....	.....	7	4,488	6	.....	1	684	1,706	9,040
Minneapolis, Minn	5	6,200	.....	.....	7	3,050	7	.....	.....	1,075	2,448	11,095
New York, N. Y	42	997,279	30	39,246	350	197,191	298	44	8	43,893	209,184	566,167
Philadelphia, Pa	16	152,008	7	3,830	70	40,703	69	1	.....	5,856	32,645	120,188
St. Louis, Mo	5	3,700	.....	.....	1	520	1	.....	.....	808	1,500	6,667
St. Paul, Minn	3	6,950	3	1,000	9	5,220	9	.....	.....	1,254	2,705	27,881
San Francisco, Cal	3	10,800	.....	.....	5	3,595	5	.....	.....	809	847	8,988
All other cities[1]	50	434,982	18	16,107	220	80,865	126	92	2	50,715	103,688	347,358

[1] Includes Allegheny, Pa., 1; Austin, Tex., 1; Baltimore, Md., 2; Buffalo, N. Y., 1; Cambridge, Mass., 1; Cleveland, Ohio, 2; Columbus, Ohio, 2; Davenport, Iowa, 1; Detroit, Mich., 1; Denver, Colo., 2; Evansville, Ind., 2; Everett, Mass., 1; Hartford, Conn., 1; Holyoke, Mass., 1; Grand Rapids, Mich., 1; Los Angeles, Cal., 2; Louisville, Ky., 1; Lowell, Mass., 1; Lynn, Mass., 2; Meriden, Conn., 1; Newark, N. J., 2; New Brunswick, N. J., 1; New Orleans, La., 1; North Adams, Mass., 1; Omaha, Nebr., 1; Oshkosh, Wis., 1; Portland, Oreg., 1; Providence, R. I., 1; Rochester, N. Y., 1; Sacramento, Cal., 1; Saginaw, Mich., 2; Seattle, Wash., 1; Sioux City, Iowa, 1; Syracuse, N. Y., 1; Toledo, Ohio, 2; Trenton, N. J., 1; Williamsport, Pa., 1; Worcester, Mass., 2; Youngstown, Ohio, 1.

It appears from Table 32 that the manufacture of musical instruments and materials, not specified, is essentially a city industry. Of the total value of products for the industry in the United States ($3,394,734) $2,263,963, or 66.7 per cent, was reported for the cities named. The rank of the 4 leading cities in this industry, with the percentage of the value of product in each to the total for the United States, is as follows:

CITIES.	Value of products.	Per cent of the United States.
New York, N. Y	$566,167	16.7
Chicago, Ill	507,293	14.9
Jersey City, N. J	259,554	7.6
Boston, Mass	237,258	7.0

The value of products in these 4 cities constituted 46.3 per cent of the total for the United States.

Table 33 shows the establishments engaged in the manufacture of musical instruments and materials, not specified, grouped according to the number of persons employed.

TABLE 33.—MUSICAL INSTRUMENTS AND MATERIALS NOT SPECIFIED: ESTABLISHMENTS CLASSIFIED BY NUMBER OF EMPLOYEES (NOT INCLUDING PROPRIETORS AND FIRM MEMBERS), 1900.

STATES.	Total number of establishments.	NUMBER OF ESTABLISHMENTS REPORTING—						
		No employees.	Under 5.	5 to 20.	21 to 50.	51 to 100.	101 to 250.	251 to 500.
United States	229	79	71	48	18	6	5	2
California	6	3	3	.....	.....	.....	.....	.....
Colorado	2	1	1	.....	.....	.....	.....	.....
Connecticut	2	1	1	.....	.....	.....	.....	.....
Illinois	27	4	14	5	2	1	.....	1
Indiana	6	3	.....	1	1	.....	1	.....
Iowa	6	3	2	1	.....	.....	.....	.....
Kentucky	2	1	1	.....	.....	.....	.....	.....
Louisiana	1	.....	.....	1	.....	.....	.....	.....
Maryland	2	2	.....	.....	.....	.....	.....	.....
Massachusetts	34	13	9	6	4	2	.....	.....
Michigan	5	3	.....	1	1	.....	.....	.....
Minnesota	8	4	2	2	.....	.....	.....	.....
Missouri	10	7	1	1	1	.....	.....	.....
Nebraska	1	1	.....	.....	.....	.....	.....	.....
New Hampshire	1	1	.....	.....	.....	.....	.....	.....
New Jersey	13	4	1	2	1	1	3	1
New York	58	12	22	17	5	1	1	.....
Ohio	16	7	3	6	.....	.....	.....	.....
Oregon	1	1	.....	.....	.....	.....	.....	.....
Pennsylvania	20	4	8	4	3	1	.....	.....
Rhode Island	1	1	.....	.....	.....	.....	.....	.....
Texas	2	1	1	.....	.....	.....	.....	.....
Washington	1	1	.....	.....	.....	.....	.....	.....
Wisconsin	4	1	2	1	.....	.....	.....	.....

Table 33 indicates that the largest number of establishments was reported for the class in which the proprietor or proprietors worked alone, while but 2 establishments, located in Illinois and New Jersey, employed from 251 to 500 persons. There were no establishments in the country which gave employment to over 500 persons.

There is no classification of export and import figures corresponding to the census classification "musical instruments and materials, not specified." It is therefore impossible to present a statement of foreign trade in this part of the report.

Detailed statistics of the manufacture of musical instruments and materials, not specified, are presented in Table 34, (pages 34 to 37).

HISTORICAL AND DESCRIPTIVE.

In the early years of the century practically all the small wind and stringed instruments used in the United States were imported. This has been so greatly modified by the constantly growing perfection of the American manufacture that the importation is no longer of great importance.[1] At the present time violins and violoncellos, harps, guitars, and banjos, clarinets and flutes, concertinas, accordions, dulcimers, drums, tambourines, trumpets, bugles, saxhorns, and other brass and German-silver instruments are successfully produced by American manufacturers in many of the large cities of the country. The American-made instruments in which wood plays a part have a greater power of resistance against climatic effects than the imported instruments can ever possess. Recently, Chicago seems to have made the greatest progress in this direction.

The production of several of these instruments is shown separately in Tables 30 and 31. The most important production is of instruments which have a general use—mandolins, guitars, violins, and banjos—as compared with those which are confined in their use to bands and orchestras. The great importance of music boxes and automatic banjos, measured by the value of the production, is in conformity with the general development of self-playing instruments already noted under the head of pianos and organs.

[1] One Hundred Years of American Commerce; American Musical Instruments, by William Steinway, page 515.

TABLE 34.—MUSICAL INSTRUMENTS AND

		United States.	California.	Illinois.	Indiana.	Iowa.
1	Number of establishments	229	6	27	6	6
	Character of organization:					
2	Individual	167	6	20	4	4
3	Firm and limited partnership	33	.....	2	2	2
4	Incorporated company	29	.....	5	.....	.....
	Capital:					
5	Total	$3,896,101	$14,905	$350,061	$174,843	$15,125
6	Land	$172,170	.....	$5,600	$25,150	.....
7	Buildings	$370,262	.....	$6,200	$10,200	.....
8	Machinery, tools, and implements	$729,576	$2,555	$69,020	$26,652	$5,950
9	Cash and sundries	$2,624,093	$12,350	$269,241	$112,841	$9,175
10	Proprietors and firm members	236	6	25	8	8
	Salaried officials, clerks, etc.:					
11	Total number	158	.....	24	19	3
12	Total salaries	$141,745	.....	$20,267	$8,584	$150
	Officers of corporations—					
13	Number	34	.....	4	.....	.....
14	Salaries	$45,150	.....	$4,280	.....	.....
	General superintendents, managers, clerks, etc—					
15	Total number	124	.....	20	19	3
16	Total salaries	$96,595	.....	$15,987	$8,584	$150
	Men—					
17	Number	94	.....	20	8	3
18	Salaries	$82,847	.....	$15,987	$4,840	$150
	Women—					
19	Number	30	.....	.....	11	.....
20	Salaries	$13,748	.....	.....	$3,744	.....
	Wage-earners, including piece workers, and total wages:					
21	Greatest number employed at any one time during the year	2,851	8	500	239	10
22	Least number employed at any one time during the year	2,117	7	383	215	7
23	Average number	2,405	8	430	227	9
24	Wages	$1,232,039	$5,395	$216,367	$116,396	$4,740
	Men, 16 years and over—					
25	Average number	2,144	8	414	213	9
26	Wages	$1,167,923	$5,395	$214,136	$111,300	$4,740
	Women, 16 years and over—					
27	Average number	226	.....	2	14	.....
28	Wages	$57,610	.....	$325	$5,096	.....
	Children, under 16 years—					
29	Average number	35	.....	14	.....	.....
30	Wages	$6,506	.....	$1,906	.....	.....
	Average number of wage-earners, including piece workers employed during each month:					
	Men, 16 years and over—					
31	January	2,218	8	425	221	10
32	February	2,218	8	409	221	10
33	March	2,217	8	406	223	10
34	April	2,139	7	407	220	8
35	May	2,093	7	396	215	8
36	June	1,955	7	377	200	7
37	July	1,950	7	377	200	7
38	August	1,992	7	393	200	7
39	September	2,110	8	411	210	8
40	October	2,226	8	442	210	8
41	November	2,275	8	461	220	10
42	December	2,335	8	468	220	10
	Women, 16 years and over—					
43	January	244	.....	.....	14	.....
44	February	243	.....	.....	14	.....
45	March	251	.....	.....	14	.....
46	April	230	.....	.....	14	.....
47	May	224	.....	.....	14	.....
48	June	186	.....	.....	14	.....
49	July	183	.....	2	14	.....
50	August	198	.....	2	14	.....
51	September	221	.....	3	14	.....
52	October	232	.....	6	14	.....
53	November	242	.....	7	14	.....
54	December	258	.....	7	14	.....
	Children, under 16 years—					
55	January	37	.....	18	.....	.....
56	February	37	.....	16	.....	.....
57	March	34	.....	11	.....	.....
58	April	30	.....	11	.....	.....
59	May	30	.....	9	.....	.....
60	June	30	.....	8	.....	.....
61	July	34	.....	14	.....	.....
62	August	37	.....	18	.....	.....
63	September	36	.....	15	.....	.....
64	October	39	.....	14	.....	.....
65	November	39	.....	16	.....	.....
66	December	37	.....	16	.....	.....
	Miscellaneous expenses:					
67	Total	$271,093	$2,157	$39,185	$39,649	$2,864
68	Rent of works	$69,212	$1,107	$16,578	$1,299	$1,259
69	Taxes, not including internal revenue	$11,405	$30	$1,612	$1,807	$52
70	Rent of offices, insurance, interest, etc	$184,222	$620	$20,595	$36,543	$1,553
71	Contract work	$6,254	$400	$350	.....	.....
	Materials used:					
72	Aggregate	$1,205,337	$3,415	$167,696	$39,104	$32,552
	Principal materials—					
73	Total	$1,030,282	$2,786	$119,711	$35,367	$31,314
74	Purchased in raw state	$27,996	.....	$7,600	.....	$27
75	Purchased in partially manufactured form	$1,002,286	$2,786	$112,111	$35,367	$31,287
76	Fuel	$22,536	$37	$4,464	$815	$120
77	Rent of power and heat	$13,287	.....	$920	$400	$36
78	Mill supplies	$7,698	.....	$555	$542	$10
79	All other materials	$121,917	$430	$41,376	$1,225	$1,000
80	Freight	$9,617	$162	$670	$755	$72

MATERIALS, NOT SPECIFIED: BY STATES, 1900—Continued.

Massachusetts.	Michigan.	Minnesota.	Missouri.	New Jersey.	New York.	Ohio.	Pennsylvania.	Wisconsin.	All other states.[1]	
34	5	8	10	13	58	16	20	4	16	1
23	3	7	8	8	45	11	13	3	12	2
7	1	.....	1	1	6	1	6	.....	4	3
4	1	1	1	4	7	4	1	1	.....	4
$336,521	$52,918	$13,150	$26,555	$1,109,878	$1,146,213	$150,436	$438,746	$15,665	$51,085	5
$620	$700	.....	$3,250	$16,200	$37,200	$50,000	$25,700	.....	$7,750	6
$910	$600	.....	$6,000	$177,402	$50,650	$50,000	$49,400	.....	$18,900	7
$61,092	$12,183	$3,625	$2,990	$291,407	$173,038	$6,617	$63,977	$4,230	$6,240	8
$273,899	$39,485	$9,525	$14,315	$624,869	$385,325	$43,819	$299,669	$11,435	$18,195	9
37	6	7	10	10	56	13	27	3	20	10
11	1	3	2	34	42	5	14	.....	.....	11
$11,890	$920	$1,000	$1,520	$39,278	$47,346	$2,760	$8,030	.....	.....	12
3	1	3	.....	7	14	1	1	.....	.....	13
$5,100	$920	$1,000	.....	$14,720	$17,150	$780	$1,200	.....	.....	14
8	.....	.....	2	27	28	4	13	.....	.....	15
$6,790	.....	.....	$1,520	$24,558	$30,196	$1,980	$6,830	.....	.....	16
6	.....	.....	2	23	21	2	9	.....	.....	17
$5,990	.....	.....	$1,520	$22,242	$26,148	$600	$5,370	.....	.....	18
2	.....	.....	.....	4	7	2	4	.....	.....	19
$800	.....	.....	.....	$2,316	$4,048	$1,380	$1,460	.....	.....	20
302	38	19	44	846	573	54	178	13	27	21
206	27	12	27	636	410	38	130	4	15	22
248	33	16	32	740	443	40	152	7	20	23
$134,131	$15,371	$8,270	$19,360	$365,439	$237,495	$19,748	$77,000	$4,488	$7,839	24
235	31	16	32	596	387	35	146	6	16	25
$129,307	$14,747	$8,270	$19,360	$330,883	$223,891	$18,340	$75,897	$4,188	$7,469	26
13	2	.....	.....	135	48	5	6	.....	1	27
$4,824	$624	.....	.....	$32,476	$11,604	$1,408	$1,103	.....	$150	28
.....	.....	.....	.....	9	8	.....	.....	1	3	29
.....	.....	.....	.....	$2,080	$2,000	.....	.....	$300	$220	30
267	31	18	33	608	392	36	139	12	18	31
268	31	19	33	617	399	36	145	4	18	32
271	34	19	34	614	396	39	140	3	20	33
248	36	19	34	583	390	36	133	2	16	34
242	36	15	32	560	391	41	132	2	16	35
208	30	12	32	539	363	33	133	.....	14	36
197	25	13	28	545	355	29	156	.....	11	37
203	25	13	29	551	361	35	152	8	8	38
204	27	15	31	602	386	29	155	8	16	39
243	32	15	31	620	404	29	157	9	18	40
230	31	16	34	635	405	39	159	9	18	41
239	30	18	34	680	403	41	156	10	18	42
18	2	.....	.....	142	54	6	6	.....	2	43
18	2	.....	.....	143	54	6	6	.....	.....	44
19	2	.....	.....	143	60	7	6	.....	.....	45
16	2	.....	.....	127	60	6	5	.....	.....	46
14	2	.....	.....	127	56	6	5	.....	.....	47
6	2	.....	.....	123	33	3	5	.....	.....	48
4	2	.....	.....	115	35	3	6	.....	2	49
4	2	.....	.....	123	43	3	5	.....	2	50
4	2	.....	.....	143	44	3	6	.....	2	51
17	2	.....	.....	143	40	3	7	.....	.....	52
17	2	.....	.....	144	44	5	7	.....	2	53
18	2	.....	.....	144	55	7	9	.....	2	54
.....	.....	.....	.....	10	6	.....	.....	1	2	55
.....	.....	.....	.....	9	7	.....	.....	1	4	56
.....	.....	.....	.....	10	8	.....	.....	1	4	57
.....	.....	.....	.....	7	7	.....	.....	1	4	58
.....	.....	.....	.....	10	6	.....	.....	1	4	59
.....	.....	.....	.....	9	8	.....	.....	1	4	60
.....	.....	.....	.....	9	8	.....	.....	1	2	61
.....	.....	.....	.....	8	8	.....	.....	1	2	62
.....	.....	.....	.....	10	8	.....	.....	1	2	63
.....	.....	.....	.....	10	12	.....	.....	1	2	64
.....	.....	.....	.....	10	10	.....	.....	1	2	65
.....	.....	.....	.....	10	8	.....	.....	1	2	66
$25,473	$6,107	$2,329	$2,223	$62,804	$52,116	$14,799	$16,335	$769	$4,333	67
$11,656	$1,205	$1,758	$1,224	$1,511	$23,926	$2,736	$1,679	$480	$2,794	68
$653	$70	$63	$142	$3,024	$2,650	$310	$654	$8	$330	69
$13,064	$3,209	$508	$857	$58,269	$24,040	$10,358	$13,221	$281	$1,109	70
$100	$1,623	.....	.....	.....	$1,500	$1,400	$781	.....	$100	71
$174,814	$6,385	$5,153	$10,907	$364,737	$305,749	$21,382	$61,409	$1,977	$9,607	72
$142,445	$3,449	$4,475	$7,935	$337,903	$262,949	$20,180	$52,443	$1,115	$8,210	73
$590	$11	.....	.....	$6,000	$13,520	$240	$8	.....	.....	74
$141,855	$3,438	$4,475	$7,935	$331,903	$249,429	$19,940	$52,435	$1,115	$8,210	75
$3,350	$108	$217	$527	$5,566	$4,095	$423	$2,036	$122	$156	76
$2,752	$377	$75	.....	$4,005	$3,730	$446	$246	.....	$300	77
$2,363	$203	$21	$20	$1,168	$2,371	$61	$361	$3	$20	78
$22,502	$2,102	$290	$2,125	$13,457	$31,314	$595	$3,910	$731	$860	79
$902	$146	$75	$300	$2,638	$1,290	$127	$2,413	$6	$61	80

[1] Includes establishments distributed as follows: Colorado, 2; Connecticut, 2; Kentucky, 2; Louisiana, 1; Maryland, 2; Nebraska, 1; New Hampshire, 1; Oregon, 1; Rhode Island, 1; Texas, 2; Washington, 1.

TABLE 34.—MUSICAL INSTRUMENTS AND

		United States.	California.	Illinois.	Indiana.	Iowa.
	Products:					
81	Total value	$3,394,734	$27,513	$514,393	$205,700	$70,148
	Band instruments, brass—					
82	Value	$255,741	$180	$7,825	$146,000	.....
	Violins—					
83	Number	1,503	193	77	.....	25
84	Value	$103,731	$13,225	$2,281	.....	$1,510
	Mandolins and mandolas—					
85	Number	78,389	290	30,400	1,075	117
86	Value	$360,218	$1,250	$131,261	$10,900	$2,580
	Guitars—					
87	Number	78,444	367	40,530	2,080	222
88	Value	$326,486	$1,250	$138,757	$16,900	$2,958
	Banjos—					
89	Number	18,512	.....	7,022	.....	7
90	Value	$120,818	.....	$28,430	.....	$105
91	All other products (including custom work and repairing)	$2,227,740	$11,608	$205,839	$31,900	$62,995
	Comparison of products—					
92	Number of establishments reporting for both years	183	5	24	3	6
93	Value for census year	$3,126,534	$26,413	$491,464	$203,000	$70,148
94	Value for preceding business year	$2,897,379	$20,787	$469,973	$180,000	$58,486
	Power:					
95	Number of establishments reporting	88	.....	12	3	2
96	Total horsepower	1,430	.....	213	113	7
	Owned—					
	Engines—					
97	Steam, number	31	.....	1	1	1
98	Horsepower	830	.....	150	40	5
99	Gas or gasoline, number	11	.....	3	1	.....
100	Horsepower	67	.....	34	3	.....
101	Water wheels, number	8	.....	.....	2	.....
102	Horsepower	185	.....	.....	60	.....
103	Electric motors, number	3	.....	.....	.....	.....
104	Horsepower	13	.....	.....	.....	.....
105	Other power, number	1	.....	.....	.....	.....
106	Horsepower	3	.....	.....	.....	.....
	Rented—					
	Furnished by this establishment—					
107	Horsepower	10	.....	.....	.....	.....
	Furnished to this establishment—					
108	Electric, horsepower	182	.....	3	10	2
109	Other kind	150	.....	26	.....	.....
	Establishments classified by number of persons employed, not including proprietors and firm members:					
110	Total number of establishments	229	6	27	6	6
111	No employees	79	3	4	3	3
112	Under 5	71	3	14	.....	2
113	5 to 20	48	.....	5	1	1
114	21 to 50	18	.....	2	1	.....
115	51 to 100	6	.....	1	.....	.....
116	101 to 250	5	.....	.....	1	.....
117	251 to 500	2	.....	1	.....	.....
118	501 to 1,000	.....	.....	.....	.....	.....
119	Over 1,000	.....	.....	.....	.....	.....

MATERIALS, NOT SPECIFIED: BY STATES, 1900—Continued.

Massachusetts.	Michigan.	Minnesota.	Missouri.	New Jersey.	New York.	Ohio.	Pennsylvania.	Wisconsin.	All other states.[1]	
$469,239	$37,710	$38,976	$45,181	$879,521	$763,408	$70,219	$221,064	$9,740	$41,922	81
$29,742	$18,135	.....	.....	$2,500	$3,750	$2,700	$44,609	.....	$300	82
256	49	59	12	12	525	58	58	34	150	83
$18,930	$2,420	$3,680	$1,200	$400	$45,530	$5,415	$1,420	$1,200	$6,520	84
6,460	700	52	3,202	12,219	17,748	638	2,650	720	2,118	85
$37,534	$7,000	$786	$13,032	$35,828	$76,903	$4,744	$28,250	$3,600	$6,550	86
4,200	300	580	3,702	12,723	7,933	1,240	2,587	500	1,480	87
$34,100	$3,000	$5,800	$12,332	$32,878	$33,431	$7,780	$27,250	$2,000	$8,050	88
1,786	201	.....	.....	456	6,460	.....	2,500	.....	80	89
$21,750	$2,025	.....	.....	$1,063	$41,600	.....	$25,345	.....	$500	90
$327,183	$5,130	$28,710	$18,617	$806,852	$562,194	$49,580	$94,190	$2,940	$20,002	91
27	4	8	8	10	42	14	17	2	13	92
$461,659	$25,610	$38,976	$42,317	$814,327	$634,155	$64,679	$212,964	$2,920	$37,902	93
$393,560	$21,332	$36,200	$36,300	$820,053	$573,069	$57,875	$198,959	$2,450	$28,335	94
15	2	2	1	10	21	6	11	1	2	95
246	18	15	6	392	220	26	149	6	19	96
5	.....	.....	1	10	4	1	7	.....	.....	97
85	.....	.....	6	321	78	10	135	.....	.....	98
.....	.....	1	.....	.....	3	1	1	1	.....	99
.....	.....	5	.....	.....	8	1	10	6	.....	100
5	.....	.....	.....	.....	1	.....	.....	.....	.....	101
90	.....	.....	.....	.....	35	.....	.....	.....	.....	102
.....	.....	.....	.....	1	1	.....	.....	.....	1	103
.....	.....	.....	.....	10	1	.....	.....	.....	2	104
.....	.....	.....	.....	.....	1	.....	.....	.....	.....	105
.....	.....	.....	.....	.....	3	.....	.....	.....	.....	106
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	107
21	18	10	.....	60	30	7	4	.....	17	108
50	.....	.....	.....	1	65	8	.....	.....	.....	109
74	5	8	10	13	58	16	20	4	16	110
13	3	4	7	4	12	7	4	1	11	111
9	.....	2	1	1	22	3	8	2	4	112
6	1	2	1	2	17	6	4	1	1	113
4	1	.....	1	1	5	.....	3	.....	.....	114
2	.....	.....	.....	1	1	.....	1	.....	.....	115
.....	.....	.....	.....	3	1	.....	.....	.....	.....	116
.....	.....	.....	.....	1	.....	.....	.....	.....	.....	117
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	118
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	119

[1] Includes establishments distributed as follows: Colorado, 2; Connecticut, 2; Kentucky, 2; Louisiana, 1; Maryland, 2; Nebraska, 1; New Hampshire, 1; Oregon, 1; Rhode Island, 1; Texas, 2; Washington, 1.

WATCHES AND WATCH CASES.

WATCHES AND WATCH CASES.

By WILLIAM A. COUNTRYMAN.

The first systematic manufacture of watch movements in the world, by machinery, began in the United States in 1851, and of watch cases shortly afterwards. The census of 1900, therefore, was taken at substantially the completion of a half century in the history of this remarkable revolution, during which automatic machinery for the most delicate operations has been brought forward toward perfection in a more wonderful degree, perhaps, than in any other manufacture. A review of the manufacture is, therefore, of unusual interest at this time.

Unfortunately, early methods of census taking were not as accurate as those of to-day. At the census of 1860 the manufacture of watches was classified with "watches, watch repairing, and materials" for the United States, although occasionally for a state it was classified separately. It is a matter of regret that even in such a state it is impossible to trace the industry statistically, the establishments being fewer than three in number. Massachusetts, which was the pioneer in the manufacture, and which produces watch movements in greater quantity and value than any other state, was, for instance, necessarily included under "all other states" at the census of 1900, as at certain other censuses. Only those familiar with the industry know that Massachusetts has always led in the manufacture of watches. Illinois, which appears first among the states shown separately, is second, a position it has occupied for years. The manufacture of watch cases is most largely carried on in the states of New York, Pennsylvania, and New Jersey. The first statistics available for comparative purposes, either for watches or watch cases, are those of the census of 1870.

The census manufacturing classification of watches comprises those establishments of which watch movements are either the whole or the principal product. A watch is technically the movement and the case together, but the corporations owning and operating watch-movement factories are legally and commercially known as watch companies. Moreover, the two classifications of watches and watch cases, long known to the Census Office, are convenient and not wholly inaccurate, for the movement has been denominated the "watch proper." In order, however, to present a complete survey of watch manufacture, it is necessary to give the combined statistics for watches and watch cases. This is done in Table 1, which is the summary for 1900.

TABLE 1.—WATCHES AND WATCH CASES: SUMMARY FOR THE UNITED STATES, 1900.

	Total.	Watches.	Watch cases.
Number of establishments	43	13	30
Capital:			
Total	$22,354,483	$14,235,191	$8,119,292
Land	$1,001,236	$572,051	$429,185
Buildings	$2,298,869	$1,686,544	$612,325
Machinery, tools, and implements	$6,885,504	$5,405,472	$1,480,032
Cash and sundries	$12,168,874	$6,571,124	$5,597,750
Salaried officials, clerks, etc., number	400	165	235
Salaries	$583,815	$294,449	$289,366
Wage-earners, average number	10,787	6,880	3,907
Total wages	$5,511,570	$3,586,723	$1,924,847
Miscellaneous expenses	$889,982	$572,080	$317,902
Cost of materials used	$5,684,965	$1,291,318	$4,393,647
Value of products	$14,606,571	$6,822,611	$7,783,960

WATCHES.

The analysis of the statistics shown in the tables under this head is really an analysis of the manufacture of watch movements. Table 2 is a comparative summary from 1870 to 1900, inclusive, with the percentages of increase for each decade.

TABLE 2.—WATCHES: COMPARATIVE SUMMARY, 1870 TO 1900, WITH PER CENT OF INCREASE FOR EACH DECADE.

	DATE OF CENSUS.				PER CENT OF INCREASE.		
	1900	1890	1880	1870	1890 to 1900	1880 to 1890	1870 to 1880
Number of establishments	13	19	11	37	[1] 31.6	72.7	[1] 70.3
Capital	$14,235,191	$10,106,114	$4,144,827	$2,666,133	40.9	143.9	55.4
Salaried officials, clerks, etc., number	165	[2] 80	([3])	([3])	106.3	.....	.....
Salaries	$294,449	[2] $101,119	([3])	([3])	191.2	.....	.....
Wage-earners, average number	6,880	6,595	3,346	1,816	4.3	97.1	84.3
Total wages	$3,586,723	$3,587,808	$1,712,276	$1,304,304	([4])	109.5	31.3
Men, 16 years and over	3,381	3,935	2,127	1,202	[1] 14.1	85.0	77.0
Wages	$2,247,617	$2,575,068	([3])	([3])	[1] 12.7	.....	.....
Women, 16 years and over	3,473	2,640	1,219	592	31.6	116.6	105.9
Wages	$1,336,332	$1,007,340	([3])	([3])	32.7	.....	.....
Children, under 16 years	26	20	.....	22	30.0	.....	.....
Wages	$2,774	$5,400	.....	([3])	[1] 48.6	.....	.....
Miscellaneous expenses	$572,080	$733,404	([5])	([5])	[1] 22.0	.....	.....
Cost of materials used	$1,291,318	$995,740	$982,224	$412,783	29.7	1.4	138.0
Value of products	$6,822,611	$6,051,066	$3,271,244	$2,819,080	12.8	85.0	16.0

[1] Decrease.
[2] Includes proprietors and firm members, with their salaries; number only reported in 1900.
[3] Not reported separately.
[4] Less than one-tenth of 1 per cent decrease.
[5] Not reported.

The value of products as shown in Table 2 is not large compared with such values in manufactures of articles of less durability, or of greater necessity, but the increase of $4,003,531, or 142 per cent, during the last thirty years, notwithstanding the fall in prices, is noticeable. It will be observed that the period of greatest absolute increase, as well as the greatest percentage of increase, was during the decade from 1880 to 1890. The average number of women employed has gradually increased and the number of men has gradually decreased, which is explainable by the increasing adaptability of women to the delicate operations of automatic machinery and to the assembling of the parts. There are practically no children employed in the industry. The table shows 26 in the entire United States in 1900. In some of the larger factories, making the higher grade movements, there were none. The amount paid in wages in 1900 was 52.6 per cent of the value of the products; but a better way of showing the large proportionate amount of labor expended upon the manufacture is to state that, of the total cost of materials used and wages paid, wages constituted 73.5 per cent. The diminution in the number of establishments during the thirty years from 1870 was 64.9 per cent, the greatest part of which was shown at the census of 1880. At the following census there was an increase, and at the census of 1900 there was a decrease.

Table 3 is a summary by states for 1900.

TABLE 3.—WATCHES: SUMMARY BY STATES, 1900.

	United States.	Illinois.	New Jersey.	All other states.[1]
Number of establishments	13	3	3	7
Capital:				
Total	$14,235,191	$6,353,411	$910,592	$6,971,188
Land	$572,051	$340,000	$76,051	$156,000
Buildings	$1,686,544	$812,518	$155,125	$718,901
Machinery, tools, and implements	$5,405,472	$2,548,581	$336,410	$2,520,481
Cash and sundries	$6,571,124	$2,652,312	$343,006	$3,575,806
Salaried officials, clerks, etc., number	165	56	14	95
Salaries	$294,449	$69,266	$35,026	$190,157
Wage-earners, average number	6,880	2,578	525	3,777
Total wages	$3,586,723	$1,384,152	$261,135	$1,941,436
Men, 16 years and over	3,381	1,275	289	1,817
Wages	$2,247,617	$857,277	$190,255	$1,200,085
Women, 16 years and over	3,473	1,303	210	1,960
Wages	$1,336,332	$526,875	$68,106	$741,351
Children, under 16 years	26	.....	26	.....
Wages	$2,774	.....	$2,774	.....
Miscellaneous expenses	$572,080	$119,040	$95,473	$357,567
Cost of materials used	$1,291,818	$246,392	$134,259	$910,667
Value of products	$6,822,611	$1,839,792	$551,444	$4,431,375

[1]Includes establishments distributed as follows: Connecticut, 1; Massachusetts, 2; New York, 1; Ohio, 2; Pennsylvania, 1.

The apparent center of the manufacture is the state of Illinois, but the statistics included under "all other states" are mostly those of Massachusetts, which is really the principal center. This table shows that the 26 children employed in the industry were all in New Jersey. The percentage of wages to total wages and materials was largest in Illinois.

The distribution of establishments by geographical divisions and states for 1890 and 1900, and the increase or decrease, with the number established since 1890, are shown in Table 4.

TABLE 4.—WATCHES: NUMBER OF ESTABLISHMENTS, 1890 AND 1900, AND INCREASE DURING THE DECADE, BY GEOGRAPHICAL DIVISIONS AND STATES.

STATES.	1900	1890	Increase.
United States	13	19	[1]6
New England states	3	3	.....
Massachusetts	2	2	.....
Connecticut	1	1	.....
Middle states	5	10	[1]5
New York	1	7	[1]6
New Jersey	3	2	1
Pennsylvania	1	1	.....
Central states	5	6	[1]1
Ohio	2	2	.....
Illinois	3	4	[1]1

[1] Decrease.

The net decrease of establishments is shown principally in the Middle states, but for that same group the returns show that two factories were established during the decade. The New England states had neither gain nor loss, and the Central states lost one. This is in accord with the tendency toward concentration in a manufacture where the capital must be large, owing to the costly character of the machinery.

A comparative summary of the capital, in its several subdivisions, with percentages of increase and of the total for each decade, for 1890 and 1900, is presented in Table 5.

TABLE 5.—WATCHES: COMPARATIVE SUMMARY, CAPITAL, 1890 AND 1900.

	1900		1890		Per cent of increase.
	Amount.	Per cent of total.	Amount.	Per cent of total.	
Total	$14,235,191	100.0	$10,106,114	100.0	40.9
Land	572,051	4.0	679,971	6.7	[1]15.9
Buildings	1,686,544	11.8	1,554,510	15.4	8.5
Machinery, tools, and implements	5,405,472	38.0	2,706,786	26.8	99.7
Cash and sundries	6,571,124	46.2	5,164,897	51.1	27.2

[1] Decrease.

The investment in land, as in buildings and in live capital, was a much less proportion of the total in 1900 than in 1890, but the proportion of the value of machinery, tools, and implements was much greater. In this item also was the greatest increase, showing in part the importance and costliness of automatic machinery and the necessity of its frequent replacement with even more ingenious mechanisms. The slight valuation of land is an indication of the surburban location of the manufacture.

The miscellaneous expenses can not be divided for 1890, but they are divided for 1900 in Table 6.

TABLE 6.—WATCHES: MISCELLANEOUS EXPENSES, 1900.

	Amount.	Per cent of total.
Total	$572,080	100.0
Rent of works	300	(1)
Taxes, not including internal revenue	90,300	15.8
Rent of offices, insurance, interest, repairs, advertising, and other sundries	481,480	84.2

[1] Less than one-tenth of 1 per cent.

Naturally, in an industry that must be housed in expensive buildings of a peculiar construction, the expenditure for rent was so small as hardly to be measured statistically. There was no expenditure for contract work, also a natural condition in a manufacture where there is such extensive use of automatic machinery requiring the most careful supervision. The amount for rent of offices, etc., includes a large sum for advertising, which is an essential of the successful manufacture.

An analysis of the cost of materials used in 1900, with a showing, broadly, of their character, is found in Table 7.

TABLE 7.—WATCHES: COST OF MATERIALS, 1900.

	Amount.	Per cent of total.
Total	$1,291,318	100.0
Purchased in partially manufactured form[1]	1,214,770	94.1
Fuel	57,292	4.4
Rent of power and heat	171	(2)
Freight	19,085	1.5

[1] Includes mill supplies and all other materials, which are shown separately in Table 9.
[2] Less than one-tenth of 1 per cent.

In the manufacture of watches the component materials used are wholly of the partly manufactured kind, such as brass, silver, steel, and other metals or alloys. Under the broad classification of materials used are fuel, rent of power and heat, and freight. Of the aggregate cost of all materials, the partly manufactured was 94.1 per cent.

Table 8, one of the most interesting of the series, is a summary, by states, of the kind, quantity, and value of the products of watch factories for 1900.

TABLE 8.—WATCHES: KIND, QUANTITY, AND VALUE OF PRODUCTS, BY STATES, 1900.

STATES.	Aggregate value.	WATCH MOVEMENTS.		WATCH CASES.										All other products.
		Number.	Value.	Total.		Silver.		Gold filled.		Silverene.		Other varieties.		
				Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	
United States	$6,822,611	1,825,769	$6,036,240	296,424	$395,259	25,271	$75,813	38,229	$191,145	209,246	$104,623	23,678	$23,678	$391,112
Illinois	1,839,792	505,468	1,834,328	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,464
New Jersey	551,444	308,421	478,181	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	78,263
All other states[1]	4,431,375	1,011,880	3,728,731	296,424	395,259	25,271	75,813	38,229	191,145	209,246	104,623	23,678	23,678	307,385

[1] Includes establishments distributed as follows: Connecticut, 1; Massachusetts, 2; New York, 1; Ohio, 2; Pennsylvania, 1.

According to the statistics given in this table the average value, at the shop or factory, of the watch movements made in the United States was $3.31. The combined states included in "all other states" show an average of $3.68, which is practically that of Massachusetts. Illinois shows an average of $3.63, and New Jersey only $1.53. There are other elements of cost before the movement gets to the jobber and retailer; and many additional also in the value of the complete watch, with case, before it reaches the final purchaser. Machine processes have greatly reduced the cost, while, at the same time, the accuracy of the watch has been constantly improved. In addition to the watch movements shown in this table, 298,207, valued at $725,695, were made in other than watch factories, and reported as by-products, raising the total number for the United States to 2,123,976 and the value to $6,761,935.

In this showing are not included low-priced or "dollar" watches; these are made exclusively in clock factories as a by-product, and their value appears under "clocks." This by-product for 1900 was 1,211,662 watch movements, valued at $566,147, and 703,249 watch cases, valued at $74,860.

Table 9 is a detailed summary, by states, for 1900. In this table the cost of materials used is divided into the cost of the partially manufactured, showing the principal component parts, excluding mill supplies and all other materials, in order that these may be shown separately, and into fuel, rent of power and heat, and freight.

TABLE 9.—WATCHES: DETAILED SUMMARY, BY STATES, 1900.

	United States.	Illinois.	New Jersey.	All other states.[1]
Number of establishments	13	3	3	7
Capital:				
Total	$14,235,191	$6,358,411	$910,592	$6,971,188
Land	$572,051	$340,000	$76,051	$156,000
Buildings	$1,686,544	$812,518	$155,125	$718,901
Machinery, tools, and implements	$5,405,472	$2,548,581	$336,410	$2,520,481
Cash and sundries	$6,571,124	$2,652,312	$343,006	$3,575,806

[1] Includes establishments distributed as follows: Connecticut, 1; Massachusetts, 2; New York, 1; Ohio, 2; Pennsylvania, 1.

TABLE 9.—WATCHES: DETAILED SUMMARY, BY STATES, 1900—Continued.

	United States.	Illinois.	New Jersey.	All other states.
Proprietors and firm members	2	----	1	1
Salaried officials, clerks, etc.:				
Total number	165	56	14	95
Total salaries	$294,449	$69,266	$35,026	$190,157
Officers of corporations—				
Number	21	6	4	11
Salaries	$89,660	$28,600	$21,060	$40,000
General superintendents, managers, clerks, and salesmen:				
Total number	144	50	10	84
Total salaries	$204,789	$40,666	$13,966	$150,157
Men—				
Number	130	47	7	76
Salaries	$196,463	$39,406	$12,218	$144,839
Women—				
Number	14	3	3	8
Salaries	$8,326	$1,260	$1,748	$5,318
Wage-earners, including pieceworkers, and total wages:				
Greatest number employed at any one time during the year	7,534	2,976	586	3,972
Least number employed at any one time during the year	6,462	2,456	448	3,558
Average number	6,880	2,578	525	3,777
Wages	$3,586,723	$1,384,152	$261,135	$1,941,436
Men, 16 years and over—				
Average number	3,381	1,275	289	1,817
Wages	$2,247,617	$857,277	$190,255	$1,200,085
Women, 16 years and over—				
Average number	3,473	1,303	210	1,960
Wages	$1,336,332	$526,875	$68,106	$741,351
Children, under 16 years—				
Average number	26	----	26	----
Wages	$2,774	----	$2,774	----
Average number of wage-earners, including pieceworkers, employed during each month:				
Men, 16 years and over—				
January	3,421	1,460	256	1,705
February	3,411	1,401	286	1,724
March	3,427	1,372	294	1,761
April	3,392	1,313	294	1,785
May	3,308	1,221	295	1,792
June	3,309	1,221	287	1,801
July	3,134	1,074	264	1,796
August	3,390	1,242	299	1,849
September	3,413	1,248	294	1,871
October	3,430	1,253	292	1,894
November	3,461	1,254	303	1,904
December	3,465	1,245	299	1,921
Women, 16 years and over—				
January	3,582	1,540	177	1,865
February	3,529	1,420	200	1,909
March	3,525	1,383	205	1,937
April	3,487	1,359	204	1,924
May	3,424	1,278	208	1,938
June	3,442	1,278	212	1,952
July	3,163	1,033	191	1,939
August	3,433	1,251	214	1,968
September	3,462	1,248	220	1,994
October	3,527	1,275	226	2,026
November	3,546	1,286	229	2,031
December	3,551	1,281	237	2,033
Children, under 16 years—				
January	26	----	26	----
February	26	----	26	----
March	26	----	26	----
April	26	----	26	----
May	26	----	26	----
June	25	----	25	----
July	25	----	25	----
August	26	----	26	----
September	26	----	26	----
October	26	----	26	----
November	26	----	26	----
December	26	----	26	----
Miscellaneous expenses:				
Total	$572,080	$119,040	$95,473	$357,567
Rent of works	$300	----	----	$300
Taxes, not including internal revenue	$90,300	$21,137	$1,775	$67,388
Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$481,480	$97,903	$93,698	$289,879
Materials used:				
Total cost	$1,291,318	$246,392	$134,259	$910,667
Purchased in partially manufactured form	$934,311	$169,722	$98,521	$666,068
Fuel	$57,292	$23,124	$2,326	$31,842
Rent of power and heat	$171	$171	----	----
Mill supplies	$27,501	$5,537	$11,688	$10,276
All other materials	$252,958	$36,832	$18,674	$197,452
Freight	$19,085	$11,006	$3,050	$5,029
Products:				
Aggregate value	$6,822,611	$1,839,792	$551,444	$4,431,375
Movements—				
Number	1,825,769	505,468	308,421	1,011,880
Value	$6,036,240	$1,834,328	$473,181	$3,728,731
Cases—				
Number	296,424	----	----	296,424
Value	$395,259	----	----	$395,259
Silver—				
Number	25,271	----	----	25,271
Value	$75,813	----	----	$75,813
Gold filled—				
Number	38,229	----	----	38,229
Value	$191,145	----	----	$191,145
Silverene—				
Number	209,246	----	----	209,246
Value	$104,623	----	----	$104,623
Other varieties—				
Number	23,678	----	----	23,678
Value	$23,678	----	----	$23,678
All other products	$391,112	$5,464	$78,263	$307,385
Comparison of products:				
Number of establishments reporting for both years	13	3	3	7
Value for census year	$6,822,611	$1,839,792	$551,444	$4,431,375
Value for preceding business year	$5,751,125	$1,440,172	$475,814	$3,835,139

TABLE 9.—WATCHES: DETAILED SUMMARY, BY STATES, 1900—Continued.

	United States.	Illinois.	New Jersey.	All other states.
Power:				
Number of establishments reporting	12	3	3	6
Total horsepower	1,990	880	170	940
Owned—				
Engines, steam—				
Number	16	5	3	8
Horsepower	1,755	650	170	935
Electric motors—				
Number	34	34	.....	.....
Horsepower	228	228	.....	.....
Rented—				
Electric, horsepower	7	2	.....	5
Furnished to other establishments, horsepower	32	20	12	.....
Establishments classified by number of persons employed, not including proprietors and firm members:				
Total number of establishments	13	3	3	7
Under 5	1	.....	.....	1
5 to 20	1	.....	1	.....
21 to 50	1	1	.....	.....
51 to 100	1	.....	.....	1
101 to 250	2	.....	.....	2
251 to 500	3	1	2	.....
501 to 1,000	2	.....	.....	2
Over 1,000	2	1	.....	1

WATCH CASES.

The manufacture of watch cases was not shown separately at the censuses of the United States previous to 1870, and comparable statistics can not, therefore, be given for any decade before that year. Table 10 is a comparative summary from 1870 to 1900, inclusive, with the percentages of increase for each decade.

TABLE 10.—WATCH CASES: COMPARATIVE SUMMARY, 1870 TO 1900, WITH PER CENT OF INCREASE FOR EACH DECADE.

	DATE OF CENSUS.				PER CENT OF INCREASE.		
	1900	1890	1880	1870	1890 to 1900	1880 to 1890	1870 to 1880
Number of establishments	30	45	27	43	[1]33.3	66.7	[1]37.2
Capital	$8,119,292	$4,727,100	$1,584,740	$730,500	71.8	198.3	116.9
Salaried officials, clerks, etc., number	235	[2]190	[3]	[3]	23.7	.....	.....
Salaries	$289,366	[2]$219,099	[3]	[3]	31.7	.....	.....
Wage-earners, average number	3,907	3,679	1,758	703	6.2	109.3	150.1
Total wages	$1,924,847	$1,896,587	$976,041	$555,018	1.5	94.3	75.9
Men, 16 years and over	2,929	2,944	1,418	619	[1]0.5	107.6	129.1
Wages	$1,642,939	$1,699,661	[3]	[3]	[1]3.3	.....	.....
Women, 16 years and over	866	710	139	73	22.0	410.8	90.4
Wages	$262,843	$192,800	[3]	[3]	36.8	.....	.....
Children, under 16 years	112	25	201	11	348.0	[1]87.6	1,727.3
Wages	$19,065	$4,126	[3]	[3]	362.1	.....	.....
Miscellaneous expenses	$317,902	$443,175	[4]	[4]	[1]28.3	.....	.....
Cost of materials used	$4,393,647	$5,022,455	$2,812,922	$1,152,979	[1]12.5	78.6	144.0
Value of products	$7,783,960	$8,618,479	$4,589,314	$2,333,340	[1]9.7	87.8	96.7

[1] Decrease.
[2] Includes proprietors and firm members, with their salaries; number only reported in 1900.
[3] Not reported separately.
[4] Not reported.

The increase in the value of products during the thirty years was $5,450,620, or 233.6 per cent, much greater than the increase in the value of watch movements. The percentage of wages of value of products in 1900 was 24.7, and of total wages of total wages and materials 30.5, both of which percentages are less than half those shown for watch movements. The average number of women has increased during the thirty years, but even in 1900 there were few compared with the number in watch factories. That a small number of children were employed is notable also. The manufacture of watch cases requires fewer wage-earners than the manufacture of watch movements; while the value of products in 1900 was 14.1 per cent more, the average number of wage-earners was 43.2 per cent less.

Table 11 is a summary, by states, for 1900.

TABLE 11.—WATCH CASES: SUMMARY BY STATES, 1900.

	United States.	Illinois.	New Jersey.	New York.	All other states.[1]
Number of establishments	30	4	5	13	8
Capital:					
Total	$8,119,292	$730,894	$1,371,137	$2,582,472	$3,434,789
Land	$429,185	$200,685	$28,000	$110,500	$90,000
Buildings	$612,325	$37,550	$193,000	$205,412	$176,363
Machinery, tools, and implements	$1,480,032	$158,941	$320,984	$497,303	$502,804
Cash and sundries	$5,597,750	$333,718	$829,153	$1,769,257	$2,665,622
Salaried officials, clerks, etc., number	235	27	38	69	101
Salaries	$289,366	$18,884	$49,420	$106,358	$114,704
Wage-earners, average number	3,907	407	637	1,075	1,788
Total wages	$1,924,847	$170,919	$305,268	$630,782	$817,878
Men, 16 years and over	2,929	274	515	960	1,180
Wages	$1,642,939	$142,361	$255,900	$596,460	$648,218
Women, 16 years and over	866	101	107	104	554
Wages	$262,843	$23,938	$44,868	$32,177	$161,860
Children, under 16 years	112	32	15	11	54
Wages	$19,065	$4,620	$4,500	$2,145	$7,800
Miscellaneous expenses	$317,902	$21,389	$34,535	$126,751	$135,227
Cost of materials used	$4,393,647	$294,491	$730,871	$2,031,910	$1,336,375
Value of products	$7,783,960	$560,934	$1,258,601	$3,165,512	$2,798,913

[1] Includes establishments distributed as follows: Kentucky, 1; Maryland, 1; Massachusetts, 2; Ohio, 2; Pennsylvania, 2.

In this table, as in the corresponding table for watch movements and for the same reason, the statistics of one of the leading states are necessarily concealed in the classification "all other states." Pennsylvania was a great center of the manufacture, although New York led in value of products. The percentage of wages of wages and materials was largest in "all other states;" but of the states separately shown Illinois led in this respect.

Table 12 shows the number of establishments in 1890 and 1900, with the increase and number established during the decade, by geographical divisions and states.

TABLE 12.—WATCH CASES: NUMBER OF ESTABLISHMENTS, 1890 AND 1900, AND INCREASE DURING THE DECADE, BY GEOGRAPHICAL DIVISIONS AND STATES.

STATES.	1900	1890	Increase.
United States	30	45	[1]15
New England states	2	6	[1]4
Massachusetts	2	5	[1]3
Rhode Island	.....	1	[1]1
Middle states	21	32	[1]11
New York	13	20	[1]7
New Jersey	5	4	1
Pennsylvania	2	7	[1]5
Maryland	1	1	.....
Southern states	1	1	.....
Kentucky	1	1	.....
Central states	6	5	1
Ohio	2	1	1
Illinois	4	3	1
Missouri	.....	1	[1]1
Western states	.....	1	[1]1
Colorado	.....	1	[1]1

[1] Decrease.

The principal decrease shown in this table was, as with watch movements, in the Middle states, and here also were the greatest number of new establishments. The only Western state—Colorado—that had a part in the manufacture in 1890, disappeared from the industry in 1900.

A comparative summary of the capital in its several subdivisions, with percentages of increase, and of the total for 1890 and 1900, is presented in Table 13.

TABLE 13.—WATCH CASES: COMPARATIVE SUMMARY, CAPITAL, 1890 AND 1900.

	1900		1890		Per cent of increase.
	Amount.	Per cent of total.	Amount.	Per cent of total.	
Total	$8,119,292	100.0	$4,727,100	100.0	71.8
Land	429,185	5.3	127,850	2.7	235.7
Buildings	612,325	7.6	404,500	8.6	51.4
Machinery, tools, and implements	1,480,032	18.2	963,641	20.4	53.6
Cash and sundries	5,597,750	68.9	3,231,109	68.3	73.2

The slight decrease in the proportion of machinery, tools, and implements, and the increase in the land investment to the total capital are noticeable features in this table, but the percentage of increase in each subdivision shows that the capital, in all respects, was greater, perhaps necessarily, in 1900 than in 1890.

Miscellaneous expenses can not be divided for 1890, but they are shown for 1900 in Table 14.

TABLE 14.—WATCH CASES: MISCELLANEOUS EXPENSES, 1900.

	Amount.	Per cent of total.
Total	$317,902	100.0
Rent of works	18,218	5.7
Taxes, not including internal revenue	17,480	5.5
Rent of offices, insurance, interest, repairs, advertising, and other sundries	282,204	88.8

That no expenditure for contract work is shown is characteristic of the manufacture of watch cases, which, like that of watch movements, is of a delicate nature and highly specialized in factories with automatic machinery.

A division of the cost of materials is possible for 1900 and is given, with percentages of the total, in Table 15.

TABLE 15.—WATCH CASES: COST OF MATERIALS, 1900.

	Amount.	Per cent of total.
Total	$4,393,647	100.0
Purchased in raw state	326,850	7.4
Purchased in partially manufactured form [1]	4,018,450	91.5
Fuel	36,412	0.8
Rent of power and heat	5,626	0.1
Freight	6,309	0.2

[1] Includes mill supplies and all other materials, which are shown separately in Table 17.

While in the manufacture of watch movements no raw material was used for component parts, in the manufacture of watch cases, as shown in this table, 7.4 per cent of the total material of all kinds (including rent of power and heat, and freight) was purchased in a raw state. This is quite small, however, the partly manufactured reaching 91.5 per cent of the total.

The kind, quantity, and value of watch cases made in 1900 are shown in Table 16.

TABLE 16.—WATCH CASES: KIND, QUANTITY, AND VALUE OF PRODUCTS, BY STATES, 1900.

STATES.	Aggregate value.	WATCH CASES.												All other products.
		Total.		Gold.		Silver.		Gold filled.		Silverene.		Other varieties.		
		Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	
United States	$7,783,960	1,819,362	$7,175,157	233,993	$3,170,629	171,837	$461,882	848,735	$3,187,103	356,126	$233,391	208,671	$122,152	$608,803
Illinois	560,934	292,162	547,434	8,900	130,500	28,278	42,947	82,843	275,804	10,316	6,515	161,825	91,668	13,500
New Jersey	1,258,601	339,075	1,103,080	18,304	231,000	67,671	175,000	198,615	662,030	54,485	35,000	.....	.....	155,571
New York	3,165,512	422,198	2,838,510	177,170	2,293,908	35,517	114,052	115,823	392,993	93,688	37,557	.....	.....	327,002
All other states [1]	2,798,913	765,927	2,686,183	29,619	515,221	40,371	129,883	451,454	1,856,276	197,637	154,319	46,846	30,484	112,730

[1] Includes establishments distributed as follows: Kentucky, 1; Maryland, 1; Massachusetts, 2; Ohio, 2; Pennsylvania, 2.

Of the states shown separately New York led both in quantity and value, New Jersey being second. The total for "all other states" is made up largely of Pennsylvania's products, and the company having the largest output in the United States was reported from that state. The average value, at the shop or factory, of the watch cases made in the United States in 1900 was $3.94. New York showed the greatest average value—$6.72—and Illinois the least—$1.87; New Jersey's average was $3.25. The gold-filled cases predominated, constituting 46.7 per cent of the number manufactured. Silverene came next with 19.6 per cent, and gold third with 12.8 per cent. Silver had 9.4 per cent and other varieties 11.5 per cent. Pennsylvania is the home of the gold-filled case, and in 1900 returned the largest number, which is not separately shown, being included under "all other states." Pennsylvania also made the most of the kind called silverene, also variously denominated silveroid, silverore, nickel silver, and nickel—all these alloys having nickel for their base.

The details of the watch-case manufacture for 1900 are shown in Table 17.

TABLE 17.—WATCH CASES: DETAILED SUMMARY, BY STATES, 1900.

	United States.	Illinois.	New Jersey.	New York.	All other states.[1]
Number of establishments	30	4	5	13	8
Capital:					
Total	$8,119,292	$730,894	$1,371,137	$2,582,472	$3,434,789
Land	$429,185	$200,685	$28,000	$110,500	$90,000
Buildings	$612,325	$37,550	$103,000	$205,412	$176,363
Machinery, tools, and implements	$1,480,032	$158,941	$320,984	$497,303	$502,804
Cash and sundries	$5,597,750	$333,718	$829,153	$1,769,257	$2,665,622
Proprietors and firm members	23	3	2	10	8
Salaried officials, clerks, etc.:					
Total number	235	27	38	69	101
Total salaries	$289,366	$18,884	$49,420	$106,358	$114,704
Officers of corporations—					
Number	31	4	5	13	9
Salaries	$115,700	$6,800	$18,200	$45,700	$45,000
General superintendents, managers, clerks, and salesmen—					
Total number	204	23	33	56	92
Total salaries	$173,666	$12,084	$31,220	$60,658	$69,704
Men—					
Number	148	16	26	44	62
Salaries	$150,926	$8,770	$27,450	$56,122	$58,584
Women—					
Number	56	7	7	12	30
Salaries	$22,740	$3,314	$3,770	$4,536	$11,120
Wage-earners, including pieceworkers, and total wages:					
Greatest number employed at any one time during the year	4,215	445	681	1,151	1,938
Least number employed at any one time during the year	3,279	387	423	995	1,474
Average number	3,907	407	637	1,075	1,788
Wages	$1,924,847	$170,919	$305,268	$630,782	$817,878
Men, 16 years and over—					
Average number	2,929	274	515	960	1,180
Wages	$1,642,939	$142,361	$255,900	$596,460	$648,218
Women, 16 years and over—					
Average number	866	101	107	104	554
Wages	$262,843	$23,938	$44,868	$32,177	$161,860
Children, under 16 years—					
Average number	112	32	15	11	54
Wages	$19,065	$4,620	$4,500	$2,145	$7,800
Average number of wage earners, including pieceworkers, employed during each month:					
Men, 16 years and over—					
January	2,656	277	385	933	1,111
February	2,848	281	526	920	1,121
March	2,903	284	535	940	1,144
April	2,937	290	537	943	1,167
May	2,951	288	541	936	1,186
June	2,906	260	535	929	1,182
July	2,944	258	535	971	1,180
August	2,951	261	537	944	1,209
September	3,039	276	539	1,004	1,220
October	3,045	279	540	997	1,229
November	3,031	283	542	997	1,209
December	2,938	251	480	1,008	1,199
Women, 16 years and over—					
January	731	100	69	73	489
February	805	100	109	100	496
March	827	100	109	104	514
April	856	102	110	105	539
May	878	101	110	111	556
June	883	98	110	112	563
July	893	100	111	111	571
August	903	100	111	110	582
September	902	103	112	103	584
October	904	103	112	105	584
November	904	103	114	104	583
December	895	105	102	105	583
Children, under 16 years—					
January	83	27	14	10	32
February	86	27	15	10	34
March	92	27	15	10	40
April	94	27	15	11	41
May	100	27	15	11	47
June	103	27	15	10	51
July	121	35	15	12	59
August	129	35	15	12	67
September	134	37	16	13	68
October	137	37	16	12	72
November	138	37	16	13	72
December	135	37	16	13	69

[1] Includes establishments distributed as follows: Kentucky, 1; Maryland, 1; Massachusetts, 2; Ohio, 2; Pennsylvania, 2.

TABLE 17.—WATCH CASES: DETAILED SUMMARY, BY STATES, 1900—Continued.

	United States.	Illinois.	New Jersey.	New York.	All other states.
Miscellaneous expenses:					
Total	$317,902	$21,389	$34,535	$126,751	$135,227
Rent of works	$18,218	$2,335	$920	$8,338	$6,625
Taxes, not including internal revenue	$17,480	$989	$4,120	$6,856	$5,515
Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$282,204	$18,065	$29,495	$111,557	$123,087
Materials used:					
Total cost	$4,393,647	$294,491	$730,871	$2,031,910	$1,336,375
Purchased in raw state	$326,850				$326,850
Purchased in partially manufactured form	$3,830,707	$275,674	$669,628	$1,943,672	$941,733
Fuel	$36,412	$5,346	$5,145	$10,082	$15,839
Rent of power and heat	$5,626	$455	$770	$2,016	$2,385
Mill supplies	$16,594	$1,998	$1,465	$999	$12,132
All other materials	$171,149	$9,905	$52,815	$71,468	$36,961
Freight	$6,309	$1,113	$1,048	$3,673	$475
Products:					
Aggregate value	$7,783,960	$560,934	$1,258,601	$3,165,512	$2,798,913
Cases—					
Total number	1,819,362	292,162	339,075	422,198	765,927
Total value	$7,175,157	$547,434	$1,103,030	$2,838,510	$2,686,183
Gold—					
Number	233,993	8,900	18,304	177,170	29,619
Value	$3,170,629	$130,500	$231,000	$2,293,908	$515,221
Silver—					
Number	171,837	28,278	67,671	35,517	40,371
Value	$461,882	$42,947	$175,000	$114,052	$129,883
Gold filled—					
Number	848,735	82,843	198,615	115,823	451,454
Value	$3,187,103	$275,804	$662,030	$392,993	$1,856,276
Silverene—					
Number	356,126	10,316	54,485	93,688	197,637
Value	$233,391	$6,515	$35,000	$37,557	$154,319
Other varieties—					
Number	208,671	161,825			46,846
Value	$122,152	$91,668			$30,484
All other products	$608,803	$13,500	$155,571	$327,002	$112,730
Comparison of products:					
Number of establishments reporting for both years	24	3	4	10	7
Value for census year	$7,187,311	$541,384	$1,257,001	$2,758,826	$2,630,100
Value for preceding business year	$5,588,510	$465,465	$1,114,099	$2,208,181	$1,800,765
Power:					
Number of establishments reporting	28	4	5	11	8
Total horsepower	1,884	253	304	447	880
Owned—					
Engines—					
Steam—					
Number	15	2	3	5	5
Horsepower	1,555	180	290	385	700
Gas or gasoline—					
Number	1			1	
Horsepower	10			10	
Water wheels—					
Number	1	1			
Horsepower	5	5			
Electric motors—					
Number	7	4			3
Horsepower	86	60			26
Other power—					
Number	2				2
Horsepower	15				15
Rented—					
Electric, horsepower	59	3	6	20	30
Other kind, horsepower	154	5	8	32	109
Furnished to other establishments, horsepower	20			20	
Establishments classified by number of persons employed, not including proprietors and firm members:					
Total number of establishments	30	4	5	13	8
Number of employees	1			1	
Under 5	2			1	1
5 to 20	9	1	2	4	2
21 to 50	5	2	1	1	1
51 to 100	3			3	
101 to 250	4			2	2
251 to 500	3	1	2		
501 to 1,000	2			1	1
Over 1,000	1				1

HISTORICAL AND DESCRIPTIVE.

The watch came to the United States from the Old World perfect in principle. There have been no improvements for many years in arrangement of train, in escapements, or in other parts of movements. Its evolution from the clock with its pendulum, through the table clock with its lever, and thus to the perfect pocket timepiece, is a part of the history of Germany, of Great Britain, of France, and of Switzerland.

The English are said to have been the first successful watchmakers, and about a century and a half ago applied to the industry a division of labor which at one time had multiplied into 102 distinct branches. The Swiss adopted this principle and extended it, giving employment to families—men, women, and children—at their homes. As the price of this labor was very low, and there were few other industries at which employment could be found, the Swiss became the watchmakers of the world, not only furnishing some of the most costly timepieces, but also some of the cheapest and most worthless. While the Swiss still manufacture a great many watches, which are sent to many parts of the world, it is a significant fact that some jobbers, who handled their goods a few years ago under an American name, advertised that the movements were made "by

the most improved American automatic machinery, insuring accuracy and precision." It is said to be a common practice thus to advertise Swiss movements, excepting those of the costliest varieties, upon which the hand work is of the most skillful and painstaking character or expended in fanciful combinations. It is asserted by manufacturers in the United States that the "American" machinery used in Switzerland has been rendered obsolete here by the advance of invention; but its adoption there is a most substantial recognition of the superiority of machine-made watches. It is also asserted that, while the Swiss watch trade fell off a few years ago, this loss has been partly recovered by the adoption of these American machines and American methods.

The earliest watches made in Europe took a year, it is said, in their making, cost the equivalent of $1,500 apiece, and varied in their timekeeping from forty minutes to an hour a day. At the Waltham, Mass., factory nearly 600,000 watch movements were made during the census year 1900, or nearly 2,000 complete movements for each working day—not quite one a day per employee—more than any other factory in the world and a greater yearly production than any other country except Switzerland. The effort is now being made to raise this production to one per day per employee, which would be a total of 3,000 a day, or over 900,000 a year. The cost of these movements varies from $3 to $75, and their timekeeping quality is best shown by the fact that the three American watches, which received the highest award for accuracy of rate at the Centennial Exposition at Philadelphia in 1876, showed an average daily variation of only twenty-three hundredths of a second.

The unanswerable arguments showing the superiority of machine-made watches are now widely known and admitted, but they were made only a few years ago with most disheartening results. Almost everybody preferred a handmade watch, notwithstanding its greater cost, when of any worth as a timepiece, and the lack of interchangeable parts with which it could be cheaply repaired, on the theory that hand work was more accurate; but now conditions are reversed, and an American machine-made watch is preferred by the great number of persons who desire accuracy and durability at a reasonable price. An inventor puts the argument briefly thus: "If one of the qualities demanded in any certain kind of work be the highest attainable degree of uniformity, it will be readily admitted that the individual workman, with the certainty of constantly recurring periods of fatigue, which make imperative corresponding periods of rest, is at a great disadvantage when in competition with an impersonal and tireless machine which is capable of producing work of a like kind. * * * It is also evident that if the large number of required pieces, whose function is the same, can be made with dimensions exactly uniform, there would result a great reduction in cost of manufacture because of the avoidance of any individual or special fitting of the various parts."[1] In the hand system it is impossible that parts, upon which a hundred different personalities have been stamped, should come together with the precision required for such a delicate mechanism as a watch. The further the division of hand labor is carried the greater become the chances of imperfection; but with automatic machinery the most delicate processess are accomplished with complete uniformity and finish.

M. Edouard Favre-Perret states that 40,000 workmen in Switzerland each make an average of 40 watches yearly. But the average in the United States in 1880 was 150; at Waltham in 1900 it was over 250. It takes about five months to complete a single watch of the highest grade; but all processes are going on simultaneously, and the flow of the product is therefore continuous. In a lecture before the Horological Institute of London, more than thirty years ago, an English watchmaker who had visited the Waltham factory remarked: "On leaving the factory, I felt that the manufacture of watches on the old plan was gone."[2]

Various sporadic attempts, beginning, it is said, as early as 1809, had been made in this country to manufacture watches by hand, but all had ended in dismal failure, owing to inability to compete in price with the Swiss-made watch. When competition with Europe was thus found impossible, inventors in the United States thought they might construct them successfully by machinery, and in 1838 Pitkin Brothers established a plant at Hartford, Conn., for the manufacture of watches by machinery. After manufacturing about eight hundred movements, they were compelled to abandon their project. At this time the Swiss were using machines for special operations in making watches. In 1839 Gischot established a factory at Geneva, Switzerland, for making the movements of a watch by machinery, and a few years after F. P. Ingold, another Swiss, elaborated a series of both case and movement machines, but they never made a success of their manufacture in factories.

The systematic beginning of watchmaking by machinery in the United States was in 1851, at Roxbury, Mass., and the machinery then used, while advanced for the times, now seems crude, so great have been the improvements. It is difficult to realize the primitive conditions of fifty years ago, and a half century hence the machines of to-day may likewise seem crude, for at no time have changes been so numerous or so radical as during the last few years. The effort has been not only to make a cheaper watch, but to make it a more accurate timepiece, and in effecting these results the great system of interchangeable mechanism in manufacturing has

[1] The Evolution of Automatic Machinery, by E. A. Marsh, page 11.

[2] Watchmaking in America, Appleton's Journal, July 2 and 9, 1870.

been promoted in a remarkable manner. Prof. W. P. Trowbridge, of the Sheffield Scientific School of Yale University, a chief special agent at the census of 1880, in submitting the report on the manufactures of interchangeable mechanism, compiled under his direction by Mr. Charles H. Fitch, wrote that "it may not be too much to say that, in some respects, this system has been one of the chief influences in the rapid increase of the national wealth;" that "the growth of the system is due to the inventive characteristics of our people, and their peculiar habit of seeking the best and most simple mechanical methods of accomplishing results by machinery, untrammelled by traditions or hereditary habits and customs;" and that "the art of making complete machines or implements, each part of which may be introduced into any machine of the same kind, and especially the adaptation of special tools, by which handwork in fitting the parts is often entirely avoided, is, I believe, of American origin."[1] One of the manufactures briefly treated in that report was the manufacture of watches.

To Aaron L. Dennison, born in Freeport, Me., in 1812, belongs the honor of founding the systematic manufacture of watches by automatic machinery in the United States. He learned the watchmaker's trade, and while a journeyman in Boston became impressed, by his experience with Swiss and English watches, with the necessity of securing greater uniformity of parts. At the United States armory at Springfield, Mass., muskets were made upon the interchangeable plan, and it was while working there that he became confirmed in his belief that a machine-made watch was a possibility. In 1849 he succeeded in impressing Edward Howard, a practical clock maker of Boston, with the importance of his undertaking, and these two interested a capitalist, Samuel Curtis, of the same city, who invested $20,000. Mr. Howard himself says of this interesting beginning: "Mr. Dennison being a watch repairer, and myself a clock maker, we made a good combination to systematize watchmaking, and to invent labor-saving machinery for producing perfect and interchangeable parts. * * * It is almost needless to say that we met with many obstacles. We were told by importers and dealers in watches that we would never be able to carry out our plans, and that our project would be an utter failure. Some of our friends even told us we were crazy to attempt such an undertaking, but we were Yankees, both of us, and had sufficient quantity of the proverbial 'grit,' and at least believed in ourselves, even if others did not have so much faith."[2]

Mr. Dennison went to Europe, where he investigated the English division of hand labor, cheerfully writing back that his theory "of Americans not finding any difficulty in competing with the English, especially if the interchangeable system and manufacturing in large quantities was adopted, may be accepted as reasonable." A factory was built at Roxbury, Mass., and in 1851 a model watch was completed. It was an eight-day watch, but, being found impracticable, was abandoned for the ordinary thirty-six-hour watch. The first hundred movements were finished and put on the market in 1853. The factory at Roxbury was in a dusty place, and this drawback, together with the necessity of more room and the desire to make homes in a pleasant spot for the operatives, led to a removal to the present site at Waltham, on the Charles River, about 10 miles west of Boston.

In 1857 financial embarrassments compelled a sale of the property, which was bought by Mr. Royal E. Robbins, of New York, and others, by whom and their successors it has been conducted ever since through storm to sunshine. Mr. Robbins is still interested in active management as the treasurer of the American Waltham Watch Company.[1] The factory, situated on the edge of the river, is five stories in height, built of brick, having innumerable windows to secure the abundance of light required for such delicate operations. The surrounding grounds are neatly laid out and diversified with shrubbery and flowers. If the annexes were arranged on a line with the main building, the entire frontage would extend more than 2,500 feet, or almost half a mile. Nearly 3,000 operatives are employed in making—by over 3,700 processes—the more than 150 parts contained in a watch movement. Most of the processes are accomplished by the most ingeniously devised and constructed automatic machines. Under one roof, but in a multitude of departments, all parts of a watch movement are made, including the cutting and polishing of the jewels; but the primary or foundation department is the machine shop, where all the machines used in the manufacture are made from designs furnished by the company's own inventors and master mechanics. This latter plan, which in 1850 was a necessity, because of the lack of watch machines and of outside experts capable of designing and constructing them, has continued to be recognized as a desirable feature ever since, perhaps being no less a necessity now than it was then, owing to the delicate evolution of automatic machinery. Although many patents have been issued for designs and processes and for labor-saving machinery in the watch manufacture during the last half century, the number of such patents by no means registers the real activity of inventors in these lines. The watch companies now seldom patent an automatic machine, preferring to trust for protection to a thorough safeguarding of the complexity of the mechanism.

The panic of 1857 worked serious injury to the enterprise at Waltham, but the outlook became better in 1858, and in 1860 a 5 per cent dividend was declared. When the Civil War broke out, the depression deepened again,

[1] Tenth Census of the United States, Manufactures, folio 615.

[2] One Hundred Years of American Commerce, Vol. II, page 541.

[1] History of Middlesex County, Mass., Vol. III, Waltham, pages 738 and 739.

and so disastrously that only the machine shop was continued, and in that a few lathes were built and sold. But as the war went on a large demand sprang up among the soldiers. Had the watches furnished been of the high quality required to-day the demand could not have been met; there were not enough skilled and experienced mechanics available. The watches, such as they were, were made in sufficient quantities, and as prices were high, the manufacture became exceedingly prosperous. In 1868 the surplus was capitalized and the stock distributed to the stockholders as a special dividend.

As a result of the founding of the watch manufacture at Waltham a number of experts from the parent factory started an establishment at Nashua, N. H., but this was not a success and the Waltham Company bought it in 1862 and consolidated it with the home shop, retaining also the services of some of the experts. This Nashua watch was a valuable three-quarter plate movement, highly esteemed by the public. Some of the people who had been interested in the Nashua company went to Chicago and, with other experts, founded the now well-known factory at Elgin, Ill., one of the leading establishments in the manufacture. Other enterprises were offshoots of the Waltham idea, but many of them proved only experiments. It is noteworthy that the centers of the manufacture are still in the states of Massachusetts and Illinois.

The policy of the pioneer company was to utilize the skill and ingenuity of men who had been engaged either in the manufacture of watches or of interchangeable parts of any kind, or who had displayed inventive ability. Among these were Oliver and David Marsh, expert mechanicians and watchmakers of Boston, Charles S. Moseley, a leading inventor and the originator of many of the machines now used in all watch factories, Nelson P. Stratton, who was connected with the watch factory at Hartford in 1838, Ambrose Webster, and James T. Shepard who had been employed at the Springfield Armory, where the system of interchangeable mechanism had attracted Mr. Dennison's attention. Among others called in then or later were George Hunter, who afterwards went to Elgin, Charles W. Fogg, Charles Vander Woerd, Edward A. Marsh, and D. H. Church, all of them notable inventors of automatic machinery. Of these Mr. Moseley and Mr. Church are selected as representatives, "the first as being to a certain extent a pioneer in the field of designing and building watchmaking machinery, and the second as one who has by his fertility and originality in the field of invention, achieved so much in the embodiment of automatic features as to render his recent machines wonders of mechanism."[1]

It is said that the number of scientific and mechanical appliances that have been brought out in the manufacture of watches is greater than in any other industry, with the possible exception of the production and use of electricity. And it is probable that the ingenuity of inventors of automatic machinery is shown to greater advantage in this industry than in any other. The processes required are of the most perfect kind, and some of the products are so small as to be distinguishable in character under the glass only. The watch factories of the United States are filled with these automatic and semiautomatic machines, which not only make large numbers of parts of perfect uniformity at small cost, but have, in many cases, done away with the need of special skill in the individual workman. Frequently an operator can care for six or seven machines, and sometimes, as in the pioneer factory at Waltham, a track is laid on the floor and chairs are provided with grooved rolls, so that the attendant can glide easily and quickly the whole length of the line.

The only practicable way of treating the evolution of automatic machinery in watchmaking is to consider certain representative machines accomplishing certain representative results, and thus going from headland to headland, bridge the half century of progress and triumph in the United States. This Edward A. Marsh, of Waltham, has done. First he presents the "draw-in-chuck" and lathe, tracing their development by Ambrose Webster, Charles V. Woerd, and Charles S. Moseley into the self-closing, three-bearing slide-spindle lathe, with its application to the manufacture of watch plates. Within seven years two wholly automatic machines have been built for plate turning, their novelty being in the number of turnings they perform. Six recesses are turned in the train side of the pillar plate—for the barrel, escape wheel, pallets, balance, and for the center pinion, and a bearing for the intermediate setting wheel. The blank plates, faced on both sides, are taken from a tube at the left end of the machine one at a time by a swinging-carrier arm and placed in spindle after spindle until the six recesses are made, each unlike in size, position, and form. Bossing, when desired, is accomplished through a modification of the tool movement. By a change of chucks the turnings on the dial side of the plate can be made in a similar manner. "The boldness in the conception of this machine will be appreciated when it is realized that the watch plate must be placed in each succeeding chuck in a different position, and that it is required to be placed on three pins which fit in the three dial feet holes."[1] This is the work of one of these machines; the other by a somewhat similar process, utilizing self-closing chucks instead of pins, receives and faces the plates on both sides.

The history of watchmaking in the United States also goes back to the time when the arbors, staffs, and pinions, which constitute the moving parts of the watch, were made by the lathe and slide-rest, the feed screw of which was operated by hand. The first improvement

[1] The Evolution of Automatic Machinery, by E. A. Marsh, pages 149 and 150.

[1] Evolution of Automatic Machinery, pages 25 and 26.

was the semiautomatic turning lathe; then came an improved form in which there was a combination of levers designed to provide for turnings of various lengths without changing feed cams. But the great defect was that each piece had to be affixed by hand to its appropriate dog, making it impossible for one operator to run more than a single lathe; and, owing to the minuteness of the smaller staff blanks, like pallet arbors, only a small amount of metal could be removed at each turning. In some cases ten or twelve turnings were required, and they had to be alternated from end to end to avoid springing. Mr. Woerd some twenty years ago invented an automatic machine to make the rough turnings; but each of the finish turnings still required the application of a driving dog. The evolution of this into the Church battery of staff-turning lathes all on a single bed and driven by a single belt was a noteworthy event, but the dog was still essential. The triumph came within the past five years, when Mr. Church produced a completely automatic machine, adapting it to the most difficult, delicate, and complicated staff in the whole watch movement, namely, the balance staff. Four hundred of these, completely turned from start to finish, including both pivots, are made by each machine each day. This machine is one of the wonders of the Waltham factory, where automatic wonders abound, and it is asserted that "nothing in the way of turning has heretofore been done which could at all compare with the work of these machines in delicacy, complexity, and accuracy."[1] The balance staff is so minute that it can be handled only with great difficulty, having a diameter scarcely larger than that of a No. 9 sewing needle, and requiring a magnifying glass for its inspection.

For the cutting of pinions the Church automatic cutter is a higher development, as it secures axial truth by performing the cutting, in direct connection with the turning, from a long rod of wire. The evolution of the crown-wheel cutter is nearly as interesting a study, while the machines for the manufacture of the minute screws and stud pins, and those for vibrating balances and hairsprings, furnish a rare collection of ingenious American inventions.

Watch hairsprings were imported years ago, but for over a quarter of a century they have been made in the United States. The pioneer machine has been improved into a series of machines now nearly automatic in their action. The wire is drawn to the exact diameter required, then flattened by repeated rollings and polished. It is admitted that the coiling of hairsprings seems to be susceptible of no marked improvement in processes of production. A notable device for forming and confining the overcoil of the Breguet spring so that it can be tempered complete is that of the late John Logan, of Waltham. It is said of Mr. Logan and his brother that they "have probably made more watch hairsprings than all the other makers in the world put together, all of them high-class springs."[1] Until within a few years the adaptation of these hairsprings which requires absolute exactness, an indispensable requisite for correct time, was secured by repeated trials, a spring being found to meet the requirements of the individual balance. Mr. Logan devised a system of tests of springs by a standard balance, and of all balances by a standard spring, and then grading the springs according to strength. Resort to a schedule of gradings indicates at once the proper spring for any balance.

The minuteness of some of the screws made in a watch factory may be measured by the statement that it takes nearly 150,000 of a certain kind to weigh a pound. Under the microscope they appear in their true character—perfectly finished bolts. The pivot of the balance wheel is only one two-hundredths of an inch in diameter, and the gauge with which pivots are classified measures to the ten-thousandth part of an inch. Each jewel hole into which a pivot fits is about one five-thousandths of an inch larger than the pivot to permit sufficient play. The finest screw for a small-sized watch has a thread of 260 to the inch and weighs one one hundred and thirty thousandths of a pound. Jewel slabs of sapphire, ruby, or garnet are first sawed into slabs one-fiftieth of an inch thick, and are shellacked to plates so that they may be surfaced. Then the individual jewels are sawed or broken off, drilled through the center, and a depression made in the convex side for an oil cup. A pallet jewel weighs one one hundred and fifty thousandths of a pound; a roller jewel a little more than one two hundred and fifty-six thousandths. The largest round hairspring stud is four-hundredths of an inch in diameter and about nine-hundredths of an inch in length.

It is only the finishing department of a watch factory in the United States that requires the services of skilled watchmakers. Even the assembling of a watch is done by others, the hairsprings being selected by girls with the aid of machines and put in on the balance, within an error of ten seconds per hour or four minutes per day, which is readily corrected by the time screws of the balance. The finishing department is of most interest to watchmakers, because it is in this that the movement is adjusted, being put through all the tests for heat and cold, from 95° down to 38° or 40°; tests in three vertical positions, and in "dial-up" and "dial-down." The balance in most modern watches is required to make 18,000 vibrations an hour. The change of one beat will cause an error of four and four-fifths seconds at the end of twenty-four hours. This statement indicates the extreme delicacy of the tests and the necessity of the demagnetizing of all the parts of the escapement so that electrical disturbances in whatever form will have

[1] The Evolution of Machinery, page 49.

[1] The Watch Adjusters' Manual, by Charles Edgar Fritts, pages 46 and 47.

no effect whatsoever. Not many years ago a watch would have been ruined by magnetic influences. Now it is made with a balance, roller, hairspring, pallet, and fork of nonmagnetic metals or alloys which are elastic in just the proper proportions to meet the varying conditions of heat and cold.

Between the manufacturers of the higher grades of watch movements and what may be called the "dollar" grade, including case, are a number who make a variety of grades of great utility and of considerable value. Much of the work is done by automatic machinery, but the hand finish is not so complete nor the testing so minute. These manufactures are a development of the cheap watch. Such movements are made largely by regular watch establishments, but in one case at least, possibly in others, are made by clock companies and classed as a by-product.

The rise of the low-priced grade of watches dates from the time of the long-wind Waterbury watch. The foundation patent for this was issued to D. A. A. Buck, May 21, 1878. The feature that made the watch a success was the improvement of the old duplex escapement, by which the parts were simplified so that they could be cheaply stamped out. None of these watches are now made. They have given place to a much higher grade, in which, however, the improved duplex escapement is still used. But the demand they excited continued and had to be satisfied. A number of clock companies now make the low-priced watches, case and all, as a by-product. Whether the evolution can be traced wholly to the Waterbury may be questioned. The clock companies for years have been making clocks of increasingly small dimensions, all with lever movements, such as the marine and the small shelf and alarm clocks. Some of these sizes became quite small for clocks, and at least one was made as an experiment for a pocket piece. It was thick and large, and used as a toy and for advertising purposes, retailing in some instances for $2.50, whereas to-day a much better watch, both in appearance and in accuracy, can be bought for $1, guaranteed for a year. But it was a beginning. The movement was that of a clock, with a pin escapement. Hence the cheap watch is sometimes called a "clock-watch," although it is true that the high-grade watches of to-day are also a development of the clock idea, but at a long remove, the definite line of variation having appeared many years ago. The secretary of a clock company making these low-priced watches writes: "In the evolution of this article from our regular goods, the progress has been so gradual that at no distinct time have we felt that we could draw the line where the 'clock' stopped and the 'watch' began. It is identical in character with our small clocks, and we have felt that the term 'pocket clock' was a legitimate and more accurate description than to class it as a watch. It does not have the element of value and solid construction usually associated with a watch."

The cheap watches are now made as small as ladies' size, are stem-winding, and will last, it is said, five years, including a year or two of fairly accurate timekeeping. The dials are of various colors and designs, the effort now being, in some instances, to make railroad and world's time dials. The remarkable cheapness of the low-grade watch is chiefly due to automatic machinery and the factory system. Not much finish, which is a costly matter, is possible. There are no jewels used against which the pivots may rest, as in the higher grade watches, to insure close accuracy and durability by lessening friction; nearly all parts are stamped out, not cut out; the mainsprings and hairsprings are of the quality required for comparatively rough work, and have been greatly reduced in cost by modern processes of manufacture in the United States; and the time devoted to testing and adjustment is necessarily limited. What can be expected in a movement and case which, perhaps, must be sold at wholesale at the rate of 60 cents the watch? The marvel is that it is possible to give so much.

The manufacture of these watches is limited to Connecticut and New York. At one establishment the maximum daily product is stated to be 2,000 watches. The demand for them in the United States is constant and it is yet far from being fully supplied. They are urged upon the public as really better than the cheapest of Swiss watches, which are so imperfect as frequently to require expensive repairs. Exportations of them have been made ever since the beginning of their manufacture, and the demand has been increased of late, it is said, by the presence of the American soldier abroad. When the home market becomes better supplied manufacturers assert that they will take up the export problem in earnest. The question arises: Will the clock manufacturers, with whom watches are a by-product, come to be watch manufacturers, with clocks as a by-product? The answer to this, as given by a clock manufacturer, is that it is not probable, at least in the immediate future. The destruction of clocks seems to be greater than that of watches. A person gets attached to a watch, even a cheap watch, and will expend much more than its cost in repairs, but when a clock becomes out of order he will buy another. There is, therefore, a greater proportional consumption of clocks than of watches, and, other things being equal, this will keep the cheap watch a by-product when made in a clock factory.

The imports and exports of watches and parts thereof vary with a variety of causes, but it is noteworthy that the net imports decreased from $3,018,447 in 1870, to $1,403,302 in 1900, or 53.5 per cent, while during the same time the domestic exports increased from $4,335 to $787,620, or over one hundred and eighty-fold. Of the imports in 1900, those from Switzerland were valued at $1,023,967 and constituted 73 per cent of the total net imports; France sent a value of $140,067; Germany,

$114,886; and Great Britain, $89,525. Watches from the United States are now exported to most of the countries of the world. In 1900 Canada received a value of $274,537, or 34.9 per cent of the total; Japan, $162,014; South America, $125,692; Great Britain, $82,315; British Australasia, $36,995; British Africa, $32,174; the Philippines, $18,003; China, $9,170; Hawaii, $8,341; and Cuba, $1,006.

When pocket timekeepers first came into general use, the cases were made with exposed glass fronts over the face and hands, now distinguished by the term "open face." That style prevailed in the United States as late as seventy years ago. The style called "hunter's" or "hunting" case was invented to accommodate the demands of Englishmen, whose vigorous riding in the hunting field necessitated better protection for their watches. In the United States a similar necessity arose, particularly among the more active classes—the pioneers and hunters of that period. In consequence of the frequent breaking of the crystal the idea of an entire metallic covering was naturally suggested. But there is a rapidly growing demand for open-face watches, the use of thick beveled-edge glasses rendering the case quite as reliable a protection as the cover of a "hunting" case, beside being more nearly dust proof.

Few, if any, watch cases are now made by the high-grade watch-movement factories, the manufacture having become specialized. Watch movements and watch cases are made for each other according to standard sizes, so that the jobber or dealer may order them to fit, in style according to the caprice of himself or his customer, just as he can order interchangeable parts of the watch movement by number for repair work, with no misgivings as to their fitting. The watch-case industry shows the same kind of evolution as the manufacture of watch movements. The effort has been to lower the cost, improve the quality, and increase the uniformity of the product by automatic machinery and at the same time to furnish a rich variety of effects. In old times crude tools were used, but when the machine-made watch appeared improved methods became necessary to meet the increased demand. Cases were made at first by watch-movement factories, but their manufacture was gradually dropped for the more delicate fabrication. The automatic machines devoted to watch-case making are marvels, and the system of interchangeable parts prevails as in the manufacture of watch movements. The general system of division of labor is similar in the two manufactures. The metal for the cases undergoes several processes, from the furnace where it is melted, mixed, and shaped, through the cutting, rolling, turning, and stamping, until it reaches the several skilled mechanics who finish it in its final beauty of design.

One of the revolutionizing events in the history of the case industry was the invention of the popular filled case, about the year 1859. By this the people are provided with a tasty, serviceable, and durable gold case at about half the cost of a solid gold one. Besides the gold filled, the kinds of cases in most common use are silver, nickel—including silverene, silverore, silveroid, and nickel silver, which are the same under different trademarks—and German silver. Gun metal is also used, and in the very low-priced grades, brass, nickel plated, is employed.

The gold case gives the artisan excellent opportunities for ornamentation, by its beautiful luster and richness of color. It is often delicately enameled or exquisitely engraved, and ornamented with gems. The prime requisite, however, in selecting material for the case, is to have it of sufficient stiffness to protect the delicate interior from injury by external pressure. The case should also be so constructed as to exclude all dust and moisture, two great hindrances to perfect timekeeping.