

merits for such a purpose, and with it all of Krupp's armor-plate is now made. The rolls of this great armor-plate mill are 4 feet in diameter and 12 feet long, and can receive an ingot 4 feet thick.

Statistics

296. COST OF MANUFACTURE. — There has been a remarkable reduction in the cost of iron and steel manufacture, a few examples of which, taken from American practice, are given in Table 17. Here we find a reduction of some 35 per cent in total cost and an even greater reduction in the cost of labor, reaching in one case even 54 per cent in a period of from seven to ten years. The reduction in the cost of labor has been brought about by improvements in administration and by mechanical appliances, and not by reduction of wages. According to Mr. Carnegie, in one of the largest American steel works the average wages in 1900 for all persons paid by the day, including laborers, mechanics, and boys, were more than \$4 a day for the 311 working days. How economical the methods of mining, transportation, and manufacture have become is shown by the fact that steel billets have sold at \$13.96 per ton, and in very large quantities at \$15 per ton, in the latter case, according to Mr. Carnegie, without further loss than that represented by interest, although the cost of each ton includes that of mining 2 tons of ore and carrying them 1000 miles, mining and coking 1.3 tons of coal and carrying its coke 50 miles, and quarrying one-third of a ton of limestone and carrying it 140 miles, besides the other items of expense in smelting the ore, converting the resultant cast iron into steel, and rolling that steel into rails.

Table 18 shows the reduction in prices. The price of wrought iron in Philadelphia reached \$155 in 1815, and, after declining to \$80, again reached \$115 in 1837. Bessemer steel rails sold at \$174 in the depreciated currency of 1868, at \$17 in 1898, and at \$28 in 1901. Note that these are extreme prices, while those in Table 18 are yearly averages.

297. INCREASE IN PRODUCTION. — In 1810 the United States made about 7 per cent, and in 1830, 1850, and 1860 not far from 10 per cent of the world's production of pig iron, though, indeed, in 1820 their production was only about one-third as great as in 1810. But after the close of the Civil War the production increased by leaps and bounds, till in 1901 it was nineteen times as

TABLE 17. — Reduction in Cost of Iron Manufacture in America — C. Kirchoff.

PLACE REPRESENTED	OPERATION REPRESENTED	PERIOD COVERED		COST, PROFIT AND PRODUCTION AT END OF PERIOD IN PERCENTAGE OF THAT AT BEGINNING OF PERIOD						
		From	To	Ore	Fuel	Labor	Total	Total excluding Raw Material	Profit per Ton	Production per Furnace, etc., per diem.
A large Southern Establishment	Manufacture of Pig Iron	1889	1898	79	64.1	51.9	63.4	—	47.9	167.7
North-eastern District	"	1890	1898	103.7	97	61.1	65.8	—	33.9	163.3
Pittsburg District	"	1887	1897	—	—	46	—	44	—	—
Eastern District	Manufacture of Bessemer Steel Ingots	1891	1898	—	—	75	64.39	—	—	107
Pittsburg	"	1887	1897	—	—	—	—	52	—	—
Not stated	Rolling Wire Rods	1888	1898	—	—	—	63.6	—	—	325

great as in 1865; and the percentage which it formed of the world's production rose to some 14 per cent in 1870, 21 per cent in 1880, and 34 per cent in 1899 and 1900. Between 1880 and 1901, though the British production increased only 21 per cent, that of the United States more than quadrupled, that of Germany and Luxemburg nearly tripled, and that of the whole world* more than doubled. The corresponding changes in case of steel are even more striking. The United States production in 1901 was nearly 1000 times that of 1865; and the proportion of the world's steel

TABLE 18. — Reduction in Price of Certain Products.

DATE	AVERAGE PRICE IN PENNSYLVANIA per ton of 2245 pounds			
	Wrought Iron	Iron Rails	Steel Rails	No. 1 Foundry Pig Iron
1800, January	\$100	—	—	—
1815, February	155	—	—	—
1824, November	80	—	—	—
1837, April	115	—	—	—
1850, Average	59.54	\$47.88	—	\$20.88
1865, "	106.38	98.62	\$158.50 *	46.12
1870, "	78.96	72.25	106.75	33.25
1880, "	60.38	49.25	67.50	28.50
1890, "	45.92	—	31.75	18.40
1898, "	23.97	—	17.62	11.66
1899, "	43.68	—	28.12	19.36
1900, "	48.16	—	32.29	19.98
1901, "	40.32	—	27.33	15.87

* 1868

which it formed rose from 3 per cent in 1865 to 10 per cent in 1870, 30 per cent in 1880, 36 per cent in 1890, and 38 per cent in 1900. Between 1880 and 1901 the production of Great Britain has increased to nearly four times, and that of the United States to nearly eleven times, their respective productions in 1880. As has been already indicated, of the combined wrought iron and steel of the United States, steel formed 2 per cent in 1865, 37 per cent in 1880, but about 85 per cent in 1899. The age of iron in these nineteen years gave place to the age of steel.

The *per capita* consumption of iron in Great Britain, excluding exports, has been calculated as 144 pounds in 1855, 250 pounds in 1890, and 292 pounds in 1900, that of the United States as

* This assertion as to the increase in the world's production is based on the production for 1900, because that for 1901 is not at hand.

62 pounds for 1850, 318 pounds for 1890, 387 pounds for 1900 and 464 pounds for 1901, or seven and a half times that of 1850. Among the chief causes of this increase in the consumption of iron by the human race we may recognize, in addition to the general advance in wealth and civilization, the increasing diversion of mankind from agricultural to manufacturing, *i. e.*, machinery-using, occupations — and nearly all machinery is necessarily made of iron; the displacement of wood by iron for ship and bridge building; the great extension of the use of iron beams, columns, and other pieces in constructing buildings of various kinds; the growth of steam and electric railways; and the introduction of iron fencing.

The increased importance of Germany and Luxemburg as producers of iron may be referred in large part to the invention of the basic Bessemer and open-hearth processes by Thomas, who by them gave an inestimable value to the phosphoric ores of these countries. That of the United States is due in part to the growth of its population; to the introduction of labor-saving machinery in iron manufacture; to the grand scale on which this manufacture is carried on; and to the discovery of the cheap and rich ores of the Mesabi region of Lake Superior. But given all these, the thousand miles which separate the ore fields of Lake Superior from the cheap coal of Pennsylvania would have handicapped the American iron industry most seriously but for the remarkable cheapening of transportation which has occurred. As this in turn is due to men of the class which developed the iron industry, it can hardly be questioned that, in further analysis, this development must in considerable part be referred to racial qualities. The same is true of the German iron development.

We may note with interest that the three great iron producers so closely related by blood — Great Britain, the United States, and Germany and Luxemburg — made in 1900 77 per cent of the world's pig iron and 79 per cent of its steel; and that the four great processes by which nearly all steel and wrought iron are made — the puddling, crucible, and both the acid and basic varieties of the Bessemer and open-hearth processes, as well as the steam-hammer and grooved rolls for rolling iron and steel — were invented by Britons (if we may count Sir C. W. Siemens as one), though in the case of the open-hearth process Great Britain must share with France the credit of the invention.