ings, and thus gives a much surer and clearer idea of its condition than any number of sectional maps possibly can do.

The blast furnaces of Sweden—as well as in the Lancashire process of making wrought iron—are all using charcoal as fuel, and in most of the other metallurgical operations, such as the roasting of the ores, in the heating and open hearth furnaces, etc., the generator gases from wood, forest and mill refuse are used to a great extent. The coal mines of Sweden, namely, which occur only in the extreme south part, in Skane, and from which in 1896 nearly 250,000 net tons of coal were raised, are not of sufficient purity for the iron industry, but are mostly used in the manufacture of firebricks, as good fire clay is associated with the coal beds. Hence it is that sawdust and slabs from the mills, branches and stumps from the forest—in fact anything of a combustible nature—is carefully saved and used in the gas producer, where it is made into pure gaseous fuel, free from sulphur, and thus most admirably suited for the iron and steel processes. Besides the abundance of waterfalls furnishes power for this as well as most other industries, thus leaving for the smelting processes, the lumber and pulp industries, almost the exclusive use of the raw materials of the forest. And as of old the Swedish ironmasters also have been large forest owners, the interests of both these industries have been identical, and the future and continuous prosperity of both have been looked forward to by planting, as well as cutting, and by a systematic working of and most scrupulous saving of the forest products.

Of all the iron and steel exhibits at the Stockholm Exposition it can be said that this excelled in exceptionally good products, and showed an unusual taste and system in arrangement. Conspicuous was also the diversity of products from the same works, showing how few of them really confine themselves strictly to any one particular branch, and how many convert their own raw material—pig iron billets or ingots—either into a half-finished product or into even the smallest articles of trade, many also going into the manufacture of lumber, pulp and paper, etc. The reason of this is evidently to avoid being dependent on the price fluctuation of the raw material, and to enable them to throw the bulk of their working force on that branch, among the different ones pursued, which at the time promises the largest profit.

Owing to the great demand for Swedish bicycle tubes during the last few years quite a new important industry has of late sprung up—namely, the manufacture of tubes of all dimensions. Another healthy branch of the iron industry is evidently the open hearth—especially the basic—process, which is growing in great favor, and from which large castings, as well as small samples were shown at most of the exhibits that testify to the great excellence of the material.

In 1896 there were 140 blast furnaces in operation, producing 544,858 net tons of pig iron, as compared with 502,625 tons in 1890—thus showing but a slight increase, which again is principally due to the limitation of the blast furnace fuel (the charcoal). The average output per furnace and working day was 14.3 net tons in 1896, and 13 3 in 1890, and the largest furnaces (at Domnarfuet) having produced an average of 28.9 net tons, while, of course, some of the smaller furnaces make considerably below the average. The tendency of the Swedish iron industry is indicated from the following table, which gives the proportions of the different kinds of pig irons manufactured in 1892 and 1895:

	1892. Per cent.	1895. Per cent.
For Lancashire and puddling	62.12	52.70
" Bessemer and open hearth	30.53	43 46
" laundry purposes	2.05	1.69
" malleable castings	1.10	1.86
Sprigel	0.19	0.29
	100.00	100.00

For the further manufacture of the pig iron into wrought iron and steel there were, in 1895, 137 different works, and the number of furnaces and the quantity of each class of iron produced were as follows:—

	Net tons.	
306 Lancashire forges, producing	190,517	
35 Franch-Comte forges, producing 33 Walloon forges, producing 16 scrap forges, producing	15.484	
Puddling furnaces at only 4 works, producing	1,975	
		207,976
30 Bessemer converters, producing	107,247	
(Of which 19,672 tons are basic steel)		
33 open hearth furnaces, producing	109,383	
(Of which 22,060 tons are basic steel.)		
5 crucible steel furnaces, producing	659	
		217,289
6 blister steel furnaces, producing		720
Total net tons		425,985

In order to give an idea of the different kinds of manufacture, and the growth during the last few years the following table is of interest

1 metric ton = 1,102 net ton, = 0.984 gross ton.	1894. Total metric tons.	1894. Per cent. Lancashire puddling.	1894. Per cent. Bessemer and Martin.	1895. Total metric tons.	1895. Per cent. Lancashire puddling.	1895. Per cent. Bessemer and Martin.
Blooms, billets, etc., for export	8,083	0.1	99 9	9.488	0.14	99 86
Iron and steel bars	146,786	67.8	32.2	168,270	61.32	38.68
Other shaped iron and steel not hereafter specified	8,324	8 0	92 0	12,171	1.29	98 71
Hoop iron, horse nails	78,092	59.3	40.7	78,168	55.63	44.37
Wire, in coils	25.764	40 4	59 6	26,038	32.38	67 62
Heavy plates	10,850	0.7	99 3	12,028	0.51	99 49
Rails	3,644	..	100.0	2,884	..	100.00
Fish plates and rail plates	384	45.3	54.7	387	40 31	59 69
Wheel tires	1,391	..	100.0	900	..	100.00
Axles	1,975	34 9	65.1	1,897	17.34	82.66
Anchors and other heavy forgings	1,009	59.2	40.8	695	28.63	71.37
	286,302	55.3	44.7	312 926	49 86	50.14

From this we see that the percentage of Bessemer and Siemens-Martin metal in the manufacture of domestic material was below that of Lancashire and puddled iron until a couple of years ago, when it exceeded it; and the increase in this direction is steadily growing. Another table, showing the relation between hammered and rolled billets and bars and the increasing preference for the rolled product, may also be of interest:

Year.	Hammered. Tons.	Hammered. Per cent.	Rolled. Tons.	Rolled. Per cent.
1892	46,693	34.1	90,306	65.9
1893	43,072	31.8	92,479	68.2
1894	39.738	29.5	94,896	70.5
1895	37,381	24.2	117,229	75.8

Among the several iron exhibits, those of the Sandviken, Domnarfuet, Bofors and Tinspong were the most conspicuous, and the mentioning of a few of their articles will only go to demonstrate the opinion already advanced in regard to the excellent qualities of the Swedish iron and steel, as well as the superior skill displayed in the manipulation.

As samples of special skill in cold rolling long iron bands, the Sandviken Steel Company exhibited an iron band eight inches wide and 2,293 feet long, weighing 1,155 pounds, which decorated the walls and the ceiling of their pavilion, and as a contrast to this "heavy weight" we noticed a "light weight" champion of 4,205 feet in length, and 2⅜ inches in width, but only 43 pounds in weight. The thickness of this cannot be measured in the ordinary manner, as it is only about 0.0012 inch; but a still thinner one, measuring 0.0008 inch was also among these unique exhibits. Another "record breaker" was a band saw 12 inches wide and 214 feet long, handsomely polished and hardened, and "ready for work;" so was also a hot rolled band 290 feet long, 8 inches wide and 5 32 inch thick, weighing 1,241 pounds and made in one heat. This is believed to be at the same time, the heaviest and longest band ever produced in a similar manner in any part of the world. Below this coil was placed a billet of the size from which this band was formed, measuring 11 feet by 7¾ by 4¾ inches, which object lesson makes one realize with what skill and dexterity this great change of dimensions must have been accomplished—as the result of only one heat.

Domnarfuet Iron Works—the largest iron and steel works in Sweden, and the largest in the world based on charcoal as fuel—displayed some heavy chilled castings, *e.g.*, two 26-inch rolls, about 11 feet in length, and weighing 16,975 pounds each; also open hearth castings, among which two 31-inch rolls of 17,195 pounds weight, and a piston of over six feet in diameter and 3,858 pounds in weight; so also a multitude of samples which had been subjected to the most trying mechanical tests, under heavy drop hammer or by strong torsion and bending, to prove the excellent quality of the material, as none showed any sign of a break or flaw. The superiority of the Domnarfuet tool steel was proved by showing the work done by some of them (duly attested): One of the turning tools had cut and turned off 2,336 pounds of open hearth steel shavings, 566 pounds of cast-iron turnings and 50 pounds of shavings from a chilled cast-iron roll; while a 2-inch spiral drill had bored holes of together about 14 feet depth, making 130 pounds of chips. Among car wheels exhibited by the Sandviken Iron Co., one pair had served during 21 years, and traveled 458,296 miles, and a pair of locomotive tires which had been running 236,817 miles in ten years; also a car axle that, after having run 444,845 miles, was tested and had to be bent 39½ times at an angle of about 10 inches from the neutral axis before it broke.

At Bofors and Tinspong guns, armor plates and projectiles are made, of which the latter especially are renowned at home and abroad,