THE METALLURGICAL ARTS AT THE PARIS EXHIBITION.

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[Continued from vol. cxxix, p. 374.]

COAL AND COKE.

PRODUCTION OF COAL AND COKE IN FRANCE IN 1887, COMPARED WITH 1877.*

<i>Coal-fields.</i>	<i>1877. tonnes.</i>	<i>1887. tonnes.</i>
Northern coal-field,	6,720,000	11,317,000
Loire coal-field,	3,340,000	2,989,000
Gard coal-field,	1,660,000	1,831,000
Burgundy and Nivernais coal-field, . . .	1,380,000	1,497,000
Central coal-field,	1,020,000	994,000
Aveyron and Tarn coal-field,	975,000	1,076,000
Auvergne coal-field,	240,000	291,000
Herauld coal-field,	238,000	208,000
South Vosges coal-field,	186,000	186,000
Creuse and Corrèze coal-field,	178,000	153,000
Western coal-field,	237,000	136,000
Western Alps coal-field,	132,000	132,000
Total for coal and anthracite, . . .	16,305,000	20,810,000
Provence and Alps brown coal-fields, . .	470,000	457,000
Sundry brown coal-fields,	30,000	21,000
Total for brown coal,	500,000	478,000
Sum total,	16,805,000	21,288,000

N.B.—The French *tonne* is 1,000 kilograms.

* *Journal of Iron and Steel Inst.*, No. 2, 1889, p. 11.

PRODUCTION IN 1888.*

	1888. Coal.
<i>h :</i>	
rd and Pas de Calais,	12,364,085
<i>re :</i>	
ire,	3,357,817
ône-et-Loire,	1,611,057
lier,	988,529
re,	128,700
er,	—
<i>h :</i>	
rd,	1,827,707
veyron,	809,567
rdèche,	—
riège,	—
riénées-Orientales,	—
Total production,	22,380,813

output of the French collieries for the first half of the 1889 is stated to be as follows: †

1 and anthracite, 11,696,020 tons, an increase of 835,085 over the first half the year 1888. Lignite, 210,954 tons, a decrease of 5,842 over the first half of the year 1888.

It will be observed that the output of coal in France has increased about 40 per cent. since 1887, and that this increase has been nearly altogether in the Northern coal-

the coal consumption of France having been 31,191,000 tons in 1887 (instead of 24,144,490 tons for 1877), the foreign imports must have been 10,565,000 tons (including 4,046,000 tons of British coals), instead of 7,882,000 tons (including 3,000 tons of British coals), for 1877.

It will be observed from the above figures that the coal consumption in France in 1887 was more than a third greater than the total output of the French collieries. The importations for that year amounted to 10,565,000 tons, of which about half was British and the balance, I suppose,

Iron Age, September 5, 1888, p. 371.

Bulletin du Comité des Forges, No. 249, pp. 55-57.

Belgian and German coal. I regret I have no figures of the importations for the later years, but I understand the amount has been steadily increasing each year.

Owing to the rather distorted condition of many of the French coal-fields much of the output is broken up into such a fine condition that it cannot be used for ordinary purposes unless mixed with much coarser coal or combined with pitch and compressed into blocks. The manufacture of these blocks or *briquettes*, as they are called, has become quite an extensive industry in France. A number of the French coal companies had extensive displays of machinery for this purpose at the exhibition. Without going into detail, it will suffice to say that the industry is a rapidly developing one on the continent of Europe, and the indications are, that before long some similar system will be adopted to utilize the enormous waste heaps in the anthracite regions of our country.

The great *Northern coal-field* is represented in the Exhibition by the Anzin, Aniche, Escarpelle, Douchy, and Vicoigne collieries, situated in the department of the North, and by the Lens and Douvrin, Courrières, Bethune, Noeux, Bruay, Dourges, Fléchinelles, Lievin, Meurchin, and Drocourt collieries, situated in the Pas de Calais.

The *Loire coal-field* is represented by the four more important mining companies, viz: the Montrambert and Beraudière Company, the Loire Company, the St. Etienne Company, and the Roche-la-Molière and Firminy Company. The coal-field, as a whole, is illustrated by an interesting plan in relief.

The several collieries of the *Gard coal-field* exhibit a very fine geological plan in relief of the coal-field as a whole, and each of them, viz: the Grand Combe, Bessèges, Portes and Senechas, Rochebelle, Trelys, Cessous and Comberedonde, Salles and Montalet has also its individual exhibits.

The *Burgundy and Nivernais coal-field* is represented by the beautiful exhibit of the Blanzly collieries, and by the geological maps of the Decize colliery (owned by Messrs. Schneider & Co.).

The *Central coal-field* has sent plans in relief of the Saint

Eloi and of the Bezenet collieries, as well as models of the Commentry colliery, prepared so as to illustrate the delta theory of coal-field formations put forward by M. Fayol.

The *Aveyron collieries* are represented in the metallurgical gallery by the plans and drawings of the Aubin mines; and the *Tarn collieries* in the "Palais des Machines" by the exhibits of the Carmaux Mining Company, and of the Tarn Mining Society.

The *Ronchamp colliery*, in the South Vosges, exhibits its plans and products.

The *Graissessac mines* (Herauld) are represented in the "Metallurgical Gallery," as well as the *Bouches du Rhone lignite collieries*, which exhibit the brown coals of Greasque and the Rocher bleu.*

Coke.—Most of the coke produced in France is made in improved ovens such as the *Coppée*, *Smet*, *Carvès*, etc. The vertical *Appolt* ovens are now but little used; they are only to be seen at Blanzey, Creusot and Bezenet. The almost obsolete beehive ovens are used at only one or two collieries, the coke made in them being mostly used for foundry purposes. Messrs. Seybel & Bernard displayed at the Exhibition a number of drawings of improved coke ovens, especially intended for coking of poor coals.

The application of coke ovens to the production of tar and ammoniacal salts does not seem to have met with much success in France, for the reason, it is said, that the quality of the French coals is not so well suited to the production of by-products as the English and German coals.

Iron Ore.—The consumption of iron ore in France in 1877 and 1887 is classified as follows:

	1877. tons.	1887. tons.
Native,	2,346,000	2,298,000
Algerian,	330,000	48,000
Foreign,	647,000	1,107,000
	<hr/> 3,323,000	<hr/> 3,453,000

* *Journ. Iron and Steel Inst.*, No. 2, 1889, pp. 11-12.

It would appear from the above that the output of iron ore in France was retrograding; this, however, is only true as regards the scattered deposits of ore in the eastern and central districts, which are unable to compete in cheaper ores on the eastern portion and of the north of Spain. It is, therefore, possible that the active development going on in Meurthe and Moselle district will, in a few years, largely increase the total output of the country.

The chief cause of the large decrease is the consumption of Algerian ore is due to the diminished yield of large mines near Bona. The largest supplies of imported ore are drawn mostly from Bilbao, and in a somewhat lesser degree from Luxembourg.

The best spathic ores in France come from a few districts in the Eastern Pyrennes and Savoy. The former are used by Messrs. Holtzer & Co. in their charcoal blast furnaces at Ria, the pig from which is mostly used for making crucible steel. The oölitic ores are similar in composition to those in Northamptonshire and Lincolnshire in England. One of the best representative series is that of Micheville, near Longwy, where three beds are worked of the following composition:

	<i>Silica.</i>	<i>Aluminium.</i>	<i>Lime.</i>	<i>Iron.</i>	<i>Phosphorus.</i>
(1) Top bed (8½ feet thick), . .	13·4	6·70	18·80	27·02	1·16
(2) Middle bed (6½ feet thick), .	13·23	7·07	7·24	39·80	1·46
(3) Lower bed (4 feet thick), . .	15·85	6·87	4·77	40·80	1·45

The middle bed is found to give the best results in the furnace. About 100,000 tons of these ores are mined annually and smelted with additions of Luxembourg ores.

A remarkable series of deposits of magnetic iron ores, almost totally different from any other in Western Europe, have been recently developed near Cherbourg. These deposits occur in nearly vertical beds and belts from ten to forty-five feet in thickness in the quartzite flanking the coast cliffs, the outcrops of the beds nearest the shore alone being visible at lowest spring tides. The ore runs from fifty-five to sixty per cent. iron, eight to fourteen per cent. silica, and 0·25 to one per cent. phosphoric acid.

THE PIG IRON MANUFACTURE.

According to official statistics, the production in 1882, 1887 and 1888 was as follows:

North :

	1882.	1887.	1888.
Nord,	255,322	223,315	231,693
Pas-de-Calais,	53,126	97,920	85,391
Totals,	318,448	321,235	317,084

Centre :

Loire,	58,547	31,536	34,161
Saône-et-Loire,	177,740	55,001	70,107
Allier,	90,507	28,151	18,090
Rhône,	89,437	8,700	14,368
Cher,	17,959	4,590	14,525
Isère,	36,763	13,307	13,945
Totals,	472,953	141,285	165,196

South :

Gard,	144,818	73,789	54,994
Aveyron,	33,388	6,746	6,465
Ardèche,	103,316	47,214	37,933
Bouches-du-Rhône,	25,739	13,536	21,250
Arrière,	22,150	9,632	7,364
Totals,	329,411	150,917	128,006

East :

Meuse,	9,767	5,762	3,090
Meurthe-et-Moselle,	716,043	770,842	911,009
Haute-Marne,	82,865	63,148	43,589
Ardennes,	22,258	18,298	20,475
Totals,	830,933	858,050	978,163

The total product of the three years was 2,039,000 metric tons in 1882, 1,306,930 tons in 1887 and 1,688,976 tons in 1888; 60,231, 20,886 and 22,792 tons thereof being pig made with charcoal or a mixture of charcoal and coke as fuel. Of the totals named, 441,318 tons in 1882, 355,892 tons in 1887 and 382,046 tons in 1888 were foundry iron, the balance being mill iron and pig used for conversion into steel. A glance at the figures compiled for the different districts shows how high, relatively, is the position of the east, that section which adjoins and participates in the famous minette ore

fields of Luxembourg. Its percentage rose from 40·7 in 1882 to 65·6 in 1887 and fifty-eight in 1888.*

The production for the first half of 1889 is stated to have been as follows:

Description.	Forge Pig. tons.	Foundry Pig. tons.
Coke pig,	644,259	201,935
Charcoal pig,	3,643	1,035
Mixed brands,	—	2,955
Totals,	647,902	205,915

The total production thus amounted to 853,817 metric tons, against 821,824 tons in the first half of 1888, the increase being 31,993.†

The following table shows the total production in the various departments for the year 1889‡:

	Forge Pig. tons.	Foundry Pig. tons.	Totals, 1889. tons.	Totals, 1888. tons.
Allier,	23,539	9,655	33,194	26,451
Ardèche,	24,022	5,320	29,342	37,933
Ardennes,	20,770	—	20,770	20,475
Ariège,	3,153	41	3,194	7,364
Aveyron,	11,988	—	11,988	6,467
Bouches-du-Rhône, . .	14,933	839	15,772	14,414
Charente,	—	—	—	297
Cher,	—	10,351	10,351	14,525
Dordogne,	450	—	450	225
Gard,	44,605	4,366	48,971	53,363
Gironde,	—	—	—	450
Isère,	23,004	44	23,048	13,375
Landes,	50,619	5,712	56,331	50,396
Loire,	32,473	20	32,493	36,376
Loire-Inférieure, . . .	18,543	9,246	27,789	12,883
Lot-et-Garonne, . . .	—	13,590	13,590	14,357
Marne (Haute-), . . .	24,582	33,261	57,843	45,340
Meurthe-et-Moselle, . .	618,430	282,289	940,719	911,009
Meuse,	3,408	183	3,591	3,090
Nord,	178,306	38,408	216,714	231,803
Pas-de-Calais,	84,315	—	84,315	85,391
Pyrénées-Orientales, . .	3,095	—	3,095	3,816
Rhône,	8,340	1,780	10,120	12,700
Saône (Haute-), . . .	280	31	311	1,740
Saône-et-Loire, . . .	75,654	—	75,654	70,109
Tarn,	2,235	600	2,835	—
Totals,	1,306,744	415,736	1,722,480	1,683,341

* *Iron Age*, September 5, 1889, p. 371.

† *Bulletin du Comité des Forges*, No. 249, pp. 58-62.

‡ *Iron* (Eng.), March 7, 1890, p. 216.

The production of charcoal pig iron has continuously decreased. In 1887, there were only a few charcoal furnaces in blast, some of them in Southwestern France, making special gray pig for ordnance purposes; two in the Franche-Comté district; one in the Alps (Isère), and one in the Western Pyrenees.

The Brignoud blast furnace (Isère) is smelting alpine spathic ores, and produces the excellent charcoal pigs used in the Bonpertuis Steel Works for the production of steel by charcoal hearth refining.

The Ria blast furnace (Western Pyrenees), belonging to Messrs. J. Holtzer & Co., is producing, with the mangiferous brown hematites and the spathic ores of the country, gray and white mangiferous pigs, used in the Unieux Steel Works for making their celebrated products.

For a number of years it was a peculiar practice with some of the French blast furnace managers to use a mixture of coke and charcoal; the practice, however, appears to be dying out, and at the present time is only in use in a few furnaces in Eastern France.

The following statement shows the changes in blast furnace plants which have taken place during the decade from 1877 to 1887:

IRON FURNACES IN BLAST.*

<i>Districts.</i>	<i>1877.</i>	<i>1887.</i>
North and Pas-de-Calais district,	16	12
Meurthe and Moselle district,	32	31
Champagne district,	59	14
Franche-Comté district,	9	2
Central district,	21	7
Northwestern district,	13	1
Perigord and Aveyron district,	19	4
Pyrénées and Landes district,	18	11
Loire and Rhône district,	29	10
Alpine district,	6	3
Southeastern district,	10	6
	<hr/> 232	<hr/> 101

* *Journ. Iron and Steel Inst.*, No. 2, 1889, pp. 14-15.

The total number of blast furnaces has decreased more than one-half, but the production of pig iron has nevertheless increased. From about 6,500 tons, the mean annual output per furnace has increased to 15,500 tons, and, if the details were considered, it would be found that the progress in this respect has occurred in the two first districts, and, above all, in the Meurthe and Moselle district, which, with less than one-third part of the total number of the French furnaces, has produced more than one-half of the total annual production of pig iron.

Some of the iron works in the Loire region are using, for the production of superior iron and steel with ordinary pig, a special refining process (Rollet's process). It consists in the melting of the pig with an extra-basic slag, obtained by means of fluorspar and limestone. This melting is effected in a basic-lined or water-jacketed cupola furnace, blown by hot blast. The pig iron is thus purified by the removal of the greater part of its sulphur and of a certain portion of its phosphorus. The refined metal obtained is sometimes cheaper than the pure pig made with mangiferous foreign ores. The Rollet process is not specially exhibited, but its products can be seen among the exhibits of the Holtzer and Firminy Companies.

PRODUCTION OF ROLLED IRON IN FRANCE IN 1882, 1887 AND 1888.

<i>North :</i>	1882.	1887.	1888.
Nord,	335,442	285,631	303,541
Pas-de-Calais,	308	325	430
Totals,	335,750	285,956	303,971
<i>Centre :</i>			
Loire,	84,280	37,361	37,114
Saône-et-Loire,	64,949	68,126	71,564
Allier,	38,378	29,360	31,631
Cher,	570	560	627
Isère,	14,833	5,155	4,009
Nièvre,	20,373	5,049	6,672
Totals,	223,383	145,611	151,614

South :

	1882.	1887.	1888.
Gard,	27,916	14,870	14,103
Aveyron,	19,986	11,562	10,200
Bouches-du-Rhône,	1,567	880	1,457
Ariège,	16,537	6,361	5,331
Totals,	66,006	33,373	31,091

East :

Meuse,	20,103	7,993	10,717
Meurthe-et-Moselle,	49,111	42,168	42,368
Haute-Marne,	90,773	61,657	88,718
Ardennes,	79,961	64,290	67,851
Totals,	239,948	176,108	209,654
Total product,	1,073,021	771,610	833,839

The total production of wrought iron, in 1882, was 1,073,021 metric tons, which declined to 771,610 tons in 1887, rising again to 833,839 tons in 1888.

Many changes have taken place in this industry in France since 1878. Prof. Jordan gives the following figures in relation to it and to the manufacture of steel in open fires and puddling furnaces:*

	1877.	1887.
Number of puddling furnaces (iron),	995	637
Number of puddling furnaces (steel),	51	35
Number of open-fires (iron),	243	53
Number of open-fires (steel),	6	5
	tons.	tons.
Production of puddled iron,	821,006	617,997
Production of charcoal refined iron,	63,487	16,864
Production of puddled and charcoal refined steel,	20,273	12,532

The practice of puddling iron is gradually decreasing, owing to the increased use of soft steel for structural purposes.

The following are details of the production of "finished iron" in France during 1889.†

* "Notes on the Iron and Steel Manufacture in France, in 1887." *Journ Iron and Steel Inst.*, No. 2, 1889, p. 21.

† *Iron* (Eng.) March 7, 1890, p. 216.

FINISHED IRON.

	<i>Rails.</i> <i>tons.</i>	<i>Merchant</i> <i>Iron.</i> <i>tons.</i>	<i>Plates.</i> <i>tons.</i>	<i>Totals</i> <i>1889.</i> <i>tons.</i>	<i>Totals</i> <i>1888.</i> <i>tons.</i>
Aisne,	—	—	341	341	371
Allier,	197	19,368	7,888	27,453	31,631
Ardennes,	—	54,496	13,873	68,369	67,851
Ariège,	—	5,664	—	5,664	5,330
Aube,	—	5,091	—	5,091	5,476
Aveyron,	—	14,407	—	14,407	10,207
Bouches-du-Rhône,	—	1,395	—	1,395	1,457
Charente,	—	—	—	—	223
Cher,	—	—	—	—	627
Côte-d'Or,	—	6,324	556	6,880	7,870
Côtes-du-Nord,	—	3,550	—	3,550	3,945
Dordogne,	—	2,990	—	2,990	2,415
Doubs,	—	2,187	2,584	4,771	14,533
Eure,	—	5,100	—	5,100	2,900
Gard,	121	13,213	—	13,334	14,089
Garonne (Haute-),	—	1,378	—	1,378	1,286
Gironde,	—	75	—	75	180
Ile-et-Vilaine,	—	83	—	83	130
Isère,	—	2,682	—	2,682	4,006
Jura,	—	10,579	5,097	15,676	12,358
Landes,	—	6,691	—	6,691	5,053
Loire-et-Cher,	—	31	—	31	43
Loire,	—	28,005	8,719	36,724	36,523
Loire-Inférieure,	—	10,334	1,246	11,580	11,196
Lot-et-Garonne,	—	220	—	220	140
Marne (Haute-),	—	55,105	4,261	59,366	65,777
Meurthe-et-Moselle,	1	33,534	7,200	40,735	42,368
Meuse,	—	8,757	—	8,757	7,022
Nièvre,	231	6,009	70	6,310	6,672
Nord,	—	259,931	50,563	310,494	307,555
Oise,	—	16,354	1,600	17,954	13,027
Orne,	—	250	—	250	200
Pas-de-Calais,	—	521	—	521	430
Pyrénées-Orientales,	—	177	—	177	182
Rhin-Haut (Belfort),	—	160	—	160	170
Rhône,	—	20	—	20	—
Saône (Haute-),	—	11	1,143	1,154	1,075
Saône-et-Loire,	—	57,915	11,626	69,541	71,044
Sarthe,	—	33	—	33	37
Savoie,	—	15	—	15	9
Savoie (Haute-),	—	1,010	854	1,864	1,881
Seine,	—	34,261	—	34,261	53,595
Seine-Inférieure,	—	250	—	250	336

FINISHED IRON.—*Continued.*

	<i>Rails.</i> <i>tons.</i>	<i>Merchant</i> <i>Iron.</i> <i>tons.</i>	<i>Plates.</i> <i>tons.</i>	<i>Totals</i> <i>1889.</i> <i>tons.</i>	<i>Totals</i> <i>1888.</i> <i>tons.</i>
Seine-et-Oise,	—	2,500	—	2,500	2,572
Somme,	—	2,561	—	2,561	2,061
Tarne,	—	1,816	—	1,816	1,105
Vosges,	—	—	120	120	—
Yonne,	—	14	—	14	15
Totals,	550	675,067	117,741	793,358	816,973

PRODUCTION OF STEEL IN FRANCE IN 1882, 1887 AND 1888.

	<i>1882.</i>	<i>1887.</i>	<i>1888.</i>
<i>North :</i>			
Nord,	61,853	87,664	95,212
Pas-de-Calais,	—	61,462	50,985
Totals,	61,853	149,126	146,197
<i>Centre :</i>			
Loire,	132,529	54,536	67,613
Saône-et-Loire,	101,320	45,519	48,746
Allier,	23,301	11,527	10,360
Isère,	8,739	4,321	3,859
Nièvre,	5,731	9,897	9,070
Totals,	271,620	125,800	139,653
<i>East :</i>			
Meuse,	51	5,558	6,155
Meurthe-et-Moselle,	1,616	41,265	37,814
Haute-Marne,	—	9,160	16,327
Ardennes,	171	18,218	21,096
Totals,	1,838	74,201	81,392
<i>South :</i>			
Gard,	83,579	40,534	34,722
Aveyron,	25,803	—	—
Ariège,	6,223	4,496	2,087
Totals,	115,605	44,030	36,809
Total product,	458,238	493,294	525,646

PRODUCTION OF STEEL RAILS IN FRANCE.

	<i>1882.</i>	<i>1887.</i>	<i>1888.</i>
North,	59,529	114,620	94,863
Centre,	170,208	4,747	5,098
South,	106,461	32,145	23,481
East,	—	25,183	21,818
Landes,	—	26,113	30,313
Total product,	336,259	202,909	175,598

PRODUCTION OF STEEL FOR THE FIRST HALF OF 1889, COMPARED WITH
THAT OF THE FIRST HALF OF 1888.

<i>Description.</i>	<i>First Half. 1889. tons.</i>	<i>First Half. 1888. tons.</i>	<i>Increase or Decrease. tons.</i>
Rails, Bessemer,	75,412	83,538	— 8,126
Rails, open hearth,	3,549	3,537	+ 12
Total,	75,961	87,075	— 8,114 •
Merchant steel, Bessemer,	52,529	46,905	+ 5,624
Merchant steel, open hearth,	54,794	41,796	+ 12,998
Merchant steel, puddled,	12,177	13,061	— 884
Merchant steel, cement,	776	686	+ 90
Merchant steel, crucible,	5,493	4,304	+ 1,189
Total,	125,769	106,752	+ 19,017
Plates, Bessemer,	15,192	17,925	— 2,733
Plates, open hearth,	21,820	22,655	— 835
Plates, miscellaneous,	4,346	5,217	— 871
Total,	41,358	45,797	— 4,439
Total steel,	246,088	239,624	+ 6,464

TOTAL PRODUCTION OF STEEL IN THE DIFFERENT DEPARTMENTS OF
FRANCE DURING 1889.*

	<i>Rails. * tons.</i>	<i>Bars. tons.</i>	<i>Plates. tons.</i>	<i>Totals, 1889, tons.</i>	<i>Totals, 1888, tons.</i>
Aisne,	—	—	702	702	644
Allier,	70	9,926	4,102	14,198	10,360
Ardennes,	—	8,691	14,696	23,387	22,038
Ariège,	—	4,566	—	4,566	2,931
Aube,	—	3,048	—	3,048	2,950
Charente,	—	168	—	168	—
Côte-d'Or,	60	2,587	127	2,774	604
Côtes-du-Nord,	+	18	—	18	15
Doubs,	—	7,331	1,435	8,766	1,748
Gard,	18,430	13,817	—	32,247	34,843
Ile-et-Vilaine,	—	9	—	9	—
Isère,	—	5,367	—	5,367	4,751
Jura,	—	12,139	3,360	15,499	5,496
Landes,	22,871	3,920	—	26,791	34,378
Loire,	2,093	50,457	12,178	64,728	68,490
Loire-Inférieure,	—	4,852	6,578	11,430	7,775
Marne (Haute-),	—	13,911	721	14,632	14,637
Meurthe-et-Moselle,	28,132	13,829	2,242	44,703	37,873

* *Iron* (Eng.), March 7, 1890, p. 216.

TOTAL PRODUCTION OF STEEL IN THE DIFFERENT DEPARTMENTS OF
FRANCE DURING 1889.—*Continued.*

	<i>Rails.</i> <i>tons.</i>	<i>Bars.</i> <i>tons.</i>	<i>Plates.</i> <i>tons.</i>	<i>Totals,</i> <i>1889,</i> <i>tons.</i>	<i>Totals,</i> <i>1888,</i> <i>tons.</i>
Meuse,	—	8,819	—	8,819	7,150
Morbihan,	—	—	11,950	11,950	10,000
Nièvre,	178	8,443	767	9,388	11,112
• Nord,	25,202	33,919	8,109	67,230	84,988
Oise,	—	16,825	1,108	17,993	13,053
Pas-de-Calais, . . .	42,717	7,804	—	50,521	51,002
Rhin-Haut (Belfort),	—	3,224	—	—	2,830
Rhône,	—	275	—	275	364
Saône (Haute-), . .	—	—	30	30	—
Saône-et-Loire, . . .	5,594	24,030	18,338	47,962	48,911
Savoie,	—	80	—	80	81
Seine,	—	2,942	—	2,942	2,176
Seine-Inférieure, . .	—	4	—	4	—
Tarn,	—	1,940	—	1,940	1,934
Vosges,	—	—	1,680	1,680	1,660
Works not enumer- ated,	—	32,000	—	32,000	32,500
Totals,	145,347	294,951	88,723	529,021	517,294

MANUFACTURE OF STEEL IN CONVERTERS.

Prof. Jordan states that, according to official statistics, there were twenty-four Bessemer converters at work in France during the year 1877, but no data is given of their output. In 1887, twenty-eight were in operation. The output of acid Bessemer and of basic steel is not indicated for that year, but Prof. Jordan estimates the production of basic steel at 143,000 tons. Prof. Jordan remarks that "the producing power of basic steel in the French steel works is, however, much greater than would be supposed from these figures, as well as of acid Bessemer steel. Indeed, although the official statistics indicate that some twenty-eight converters were at work in 1887, this only represents about two-thirds of the actually existing converters, which will number from forty-two to forty-four. Some Bessemer steel works have been entirely idle in 1887, such as those of Terrenoire, Givors, Saint Nazaire, Pagny on the Meuse, while some others worked with only a part of their plant.

The Bessemer steel manufacture was first introduced in

France in Messrs. Jackson & Co.'s works at Saint-Seurin-on-l'Isle, near Bordeaux, and afterwards in Messrs. Petin, Gaudet & Co.'s works at Assailly (Loire). It was afterwards developed in various districts, especially in the Centre, at the Imphy and Montluçon Works; in the Loire district, at the Terrenoire, Creusot, Saint Etienne, and Givors Works; and in the Gard district, at the Besseges Iron Works. The pig iron used by these works was made with mixtures of local ores and ores imported from Algiers and Spain, these last being somewhat dear, owing to the sea and railway freights. Hence, the new steel works, established during the last ten or twelve years, have been located in the closer neighborhood of seaports, such as the Denain Steel Works (the first built), the Isbergues, Saint Nazaire, Boucau, and Beaucaire Steel Works, the first four being intended for using Spanish and the last for Algerian ores.

The Isbergues Steel Works (Pas-de-Calais), belonging to the Acieries of France Company, are provided with two eight-ton American type converters and are supplied with pig iron from two large blast furnaces. They announce their annual steel-producing power as 100,000 tons. These works exhibit their raw materials and their steels, classed in five categories, according to their hardness and mechanical properties. They have hitherto produced all kinds of steel rails, steel girders, blooms and billets.

The Adour forges or Boucau Steel Works, near Bayonne, belonging to the "Acieries de la Marine et des Chemins de Fer" Company, having two converters, also exhibit a ground-plan of their works, their raw materials and their products, accompanied by interesting analyses. They produce cast steel, distributed into fifteen numbers or classes, from the hardest to the softest. These works have also Siemens-Martin furnaces. They were established in 1883, specially for making steel rails, but since that time they have been obliged to look for other markets.

It is the same with the Denain Steel Works, which exhibit only their products in the special annex of the northern forges, and which possess also open-hearth furnaces.

The manufacture of basic Bessemer steel, or so-called Thomas-Gilchrist steel, is effected in the four following works :

Jœuf	Steel Works, 6 converters, of together 64 tons capacity.				
Longwy	"	3	"	"	45
Valenciennes	"	2	"	"	20
Creusot	"	2	"	"	20

Adding the works in course of erection, Pagny-on-the-Meuse Steel Works, two converters, of together twenty tons capacity, the sum total is fifteen converters with an aggregate capacity of 169 tons, equal to about 500,000 tons of steel annually.

The three first steel works are specially converting Meurthe and Moselle pigs obtained from the local oölitic ores; the fourth (Creusot) converts pig iron made with its own oölitic Mazenay ores.

The Jœuf Works (Messrs. de Wendel) have not exhibited anything; the Creusot Works (Messrs. Schneider & Co.) have only exhibited their phosphoric mineral manures in the Agricultural Section.

The Longwy Steel Works make 250 to 300 tons of basic steel per day with their own pig (of which the composition is given above). They produce especially soft, very soft, and extra soft steels (Nos. 6, 7, 8 of the Longwy hardness scale), and also particularly extra soft steels (No. 9) for making wire, nails, etc. The breaking-stress for this last-named steel is less than 5,000 pounds per square inch, and the elongation is more than twenty eight per cent. Its composition is given as follows :

	<i>Per Cent.</i>
Carbon,	0·08
Manganese,	0·25 to 0·30
Sulphur,	spur.
Phosphorus,	0·03 to 0·05

These works are delivering to the trade blooms, billets, bars of every description, plates and rails, as also wire rods.

The North and East Steel Works, at Valenciennes, are also using basic pigs of the Meurthe and Moselle district, mixed sometimes with extra-phosphorous pigs, imported from Germany or from the North of England. They give the

possible output of their two converters as 80,000 to 100,000 tons of basic steel annually. They sell rails, girders, bars, billets and blooms, and their exhibits can be seen in the North of France special annex.

The Stenay Iron and Steel Works, in the Meuse Department, are about the only works in France working their process. They decarbonize pig iron so as to obtain rolled or cast products into small (one ton or about) converters, according to the Robert Patented Process.* Their exhibit includes numerous specimens of the products."†

MANUFACTURE OF STEEL IN OPEN-HEARTH FURNACES.

According to Prof. Jordan's statements there were in 1877 fifty-one open-hearth furnaces in France. Their number appears to have decreased in 1887, owing to the closing of the Sireuil Works, in which Messrs. Martin were the pioneers of this new manufacture. The official statistics furnish the following data for 1887:

Number of open-hearth furnaces in work,	69
	tons.
Output in 1887,	143,764
viz: Rails,	13,709
Bars,	99,498
Plates and sheets,	39,557

But the number of furnaces in working order in 1889 is notably greater, and may be estimated at about seventy-five furnaces of various systems and sizes.

Since the time of the introduction by Messrs. Martin of the new process in their Sireuil Works, the size of the open-hearth furnace has always been increasing. Instead of the three to four-ton furnaces first used, ten-ton furnaces, twenty-ton furnaces, and even, as in some steel works of the Loire district, thirty-five ton furnaces can now be found.

In reference to the manner of constructing the furnace, the majority are of the fixed type, the so-called Siemens-Martin furnace, designed at first by the Messrs. Martin themselves, and having regenerators situated underneath the

* The Robert process will be specifically treated further on.

† *Journ. Iron and Steel Inst.*, No. 2, 1887, pp. 24-25.

hearth, and the reversing valves on one of the small sides. In two or three steel works only can the Pernot furnaces be found, with a revolving circular basin or hollow hearth, or the Batho furnace, with a round hearth, supported by an iron plate, free underneath, and with round regenerators with plate-iron casing placed laterally and above ground.

The mode of working is usually the "*scrap process*." What is known as the "*ore process*" does not appear to be used in France. The continued use of scrap and ore known as the "Landore process," is used only at the Alleyard Works. Prof. Jordan states that the nature of the lining varies in the different works, and according to the description of materials used. Sometimes the lining is *acid*; that is, it is made with sand, gannister, or silicious puddle; sometimes it is *basic*—that is, made with magnesia bricks or puddle (according to the system patented in 1869 by Mr. Emile Muller), or with dolomitic bricks and blocks; at other times the lining is *neutral*; that is, made with chrome ore (according to the Valton-Remaury process). When the lining is made with chrome ore, Messrs. Valton and Remaury state that no material is taken from the lining either by the molten metal or by the slag, so that no corrosion takes place, and it becomes possible to act on the metal either by scraps or by ores, or by various agents in such a manner as to effect a complete dephosphorization, and to produce various descriptions of steel. Messrs. Valton and Remaury exhibit drawings of furnaces neutrally lined, specimens of their chrome ore and linings, and products of some steel works working their process.

French steel works, such as Fourchambault and Alais, for instance, choose the neutral lining rather than the basic one, which, they say, is sooner worn out, and above all when some iron ore is used in the process.

The properly-called dephosphorizing mode of working; that is, the conversion of truly phosphoretic pigs (such as those of Meurthe and Moselle) in cast steel by the open-hearth process, is not yet much used in France. This description of pig iron is sooner dephosphorized in the basic Bessemer converter. M. Fould-Dupont, however, shows in his beautiful

exhibit (Central Gallery) cast steel of every form obtained in open-hearth furnaces from his Pompey pig iron.

On the other hand, in many steel works, the basic or neutral lining is used for making open-hearth steel with ordinary pig and scrap, not free enough from phosphorus to yield good steel on an acid lining, and too low in phosphorus to be worked in the basic converter. Some of them are even working pure pig and scrap upon basic and neutral hearths, and produce soft and extra soft steels of very high quality; these steels being, besides, either simply carbon steels, or steels into whose composition enter silicon, manganese, and chrome, inasmuch as the open-hearth furnace is a very convenient and adaptable one, which allows the easy introduction and stirring of any reagent in the metallic bath.

[*To be continued.*]

MEMOIR OF FREDERIC GRAFF.

FREDERIC GRAFF, Civil Engineer, whose sudden death upon the 30th of March, 1890, his fellow-members have to mourn, was the son of Frederic Graff and Judith Swyer, his wife, and was born in Philadelphia, March 21, 1817.

His great-grandfather, Jacob Graff, came to this country from Hildesheim, Germany, in 1741, and established a brickyard in Philadelphia, where he conducted a large business. His son, Jacob Graff, Jr., was a builder, and owned the house in Market Street, above Seventh, where Mr. Jefferson wrote the Declaration of Independence.

Jacob Graff, Jr., left two sons, Charles and Frederic, who were well known to many of us. Frederic, Sr., was born in 1774, in the house above-mentioned. In 1779, he was engaged as draughtsman and assisting engineer in erecting the city water works, in Centre Square, of which he was appointed Superintendent, in 1805, continuing in that position as long as they were used. These works were begun in May, 1799. They were started January 1, 1801, and were used until September 5, 1815, and were finally taken down in 1827.