The results obtained in standardizing the iodine solution with pure aresenious oxide are given in Table II.

TABLE II.

Grams of As_2O_3 equivalent to one cubic centimeter of the iodine solution.

Number of determination.	By method of Smith.	By method of Avery.	By new method.
1..........	0.002894	0.002896	0.002898
2..........	0.002894	0.002896	0.002897
3..........	0.002895	0.002896	0.002898
Average..........	0.0028947	0.002896	0.0028977

C. C. HEDGES.

CORNELL UNIVERSITY,
December, 1908.

NEW PLANTS.

THE INDIANA STEEL COMPANY'S PLANT AT GARY, IND.[1]

BY W. D. RICHARDSON.

The commencement of operations in the largest metallurgical plant which has ever been planned and constructed is an event well worth recording not only in commercial, technological and engineering literature but in chemical literature as well. While to the superficial observer it may appear that in the working of a plant such as that at Gary, mechanical problems overshadow the chemical at every point, this is not strictly the case. The science of metallurgy embraces both mechanical and chemical methods, and while in the mills mechanical methods predominate, in the operation of blast furnace and open-hearth furnace chemistry comes to the fore. That the chemical operations of the blast furnace, although carefully studied for long periods of time, may yet be fundamentally improved, is well attested by the recent successful introduction of the Gayley dry blast in various furnaces throughout the country.

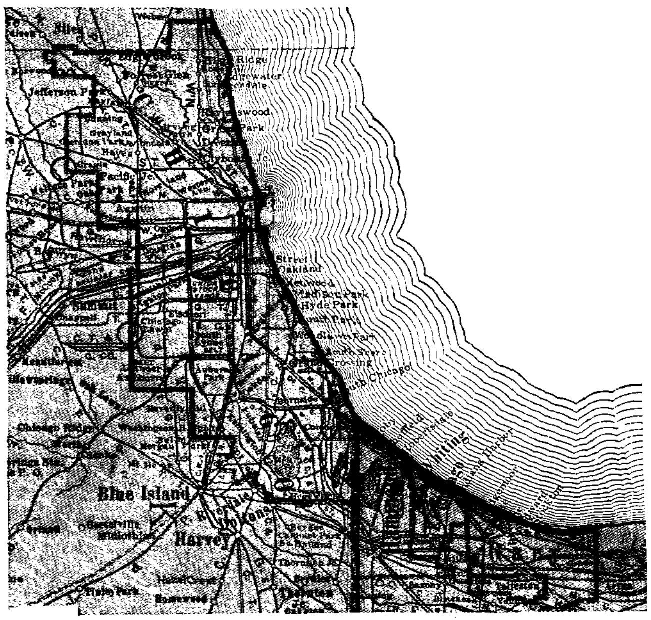

Fig. 1.—Map showing location of Gary.

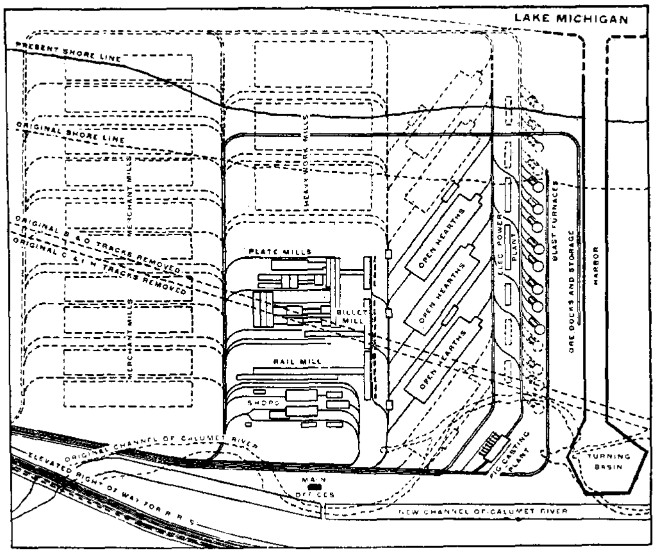

Fig. 2.—Sketch map of Gary—general plan of the new steel plant. Furnaces, mills and shops already completed or under way are indicated by solid black lines; future construction and extensions by dotted lines. To avoid confusion, duplicated railroad tracks are eliminated, the simple lines in and out of the open-hearth buildings representing six service tracks. Note how furnaces and mills have been placed to facilitate switching.

The builders of the Gary plant have done more than construct a steel works. They have in two or three years converted a waste of dune-sand and scrub oaks into a habitable region and laid the foundations of a prosperous and well-paved modern city.

The Indiana Steel Company is a subsidiary of the U. S. Steel Corporation. In 1905 the corporation set aside $10,000,000 for building the Gary works. In 1906, $21,500,000; in 1907, $18,500,000; a total of $50,000,000. No appropriation was made for 1908, inasmuch as the total amount expended even up to the present time is not greatly in excess of $40,000,000. The original announcement stated that an appropriation of $75,000,000 was contemplated from first to last. The Indiana Steel Company is a separate corporation, but is organized as a subsidiary of the Federal Steel Company. The operation of the plant, however, is carried on under lease to the Illinois Steel Company.

The President of the Indiana Steel Company is Mr. Eugene J. Buffington. The plant was designed and is being constructed under the direction of Mr. G. G. Thorp, Vice-President, Mr. A. B. Neumann, Chief Engineer, and Mr. W. P. Gleason, General Superintendent.

Location and Area.—The plant is located at the southern point of Lake Michigan, in Lake County, Indiana, about forty miles from the center of Chicago. The approximate area occupied at the present time is about 700 acres, and the area available for future extensions amounts to 1000 acres.

Water Supply.—The water supply is derived entirely from Lake Michigan, being taken from a crib one and one half miles from shore, through a six feet tunnel. The water gravitates to the pumping station, from which point it is supplied to the plant by means of horizontal-shaft direct-connected motor-driven centrifugal pumps. These are two

[1] For further descriptions, particularly of the mechanical features f the Gary plant, consult the *Iron Age*, Jan. 7th and Jan. 14th, and following numbers: The *Iron Trade Review* of Jan. 7th and succeeding numbers; *System*, Jan., '09, and *Engineering Record*, July 20, Aug. 17 and Nov. 2, 1907.

domestic pumps driven by 250 H. P. motors and two fire pumps driven by 175 H. P. motors, the combined capacity being 20,000,000 gallons in 24 hours.

Power.—There are sixteen batteries of boilers of 400 H. P. each, heated by blast furnace gas, on the plant. This gas

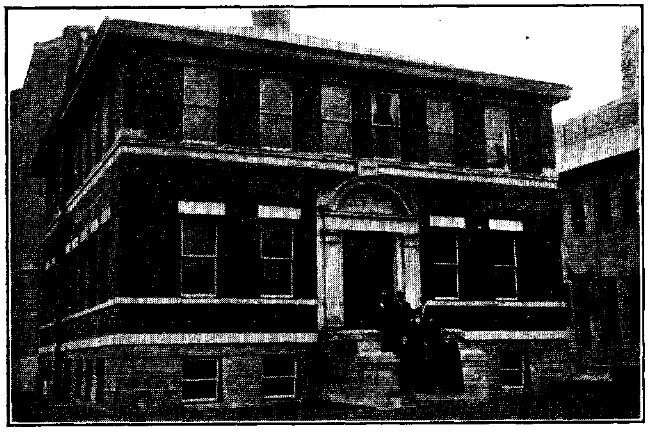

Fig. 3.—Chemical laboratory.

averages in heat value 95 B. T. U. per cubic foot. Steam is used on the plant to drive two 2,000 K. W. turbines which were installed temporarily, and prior to the starting of the

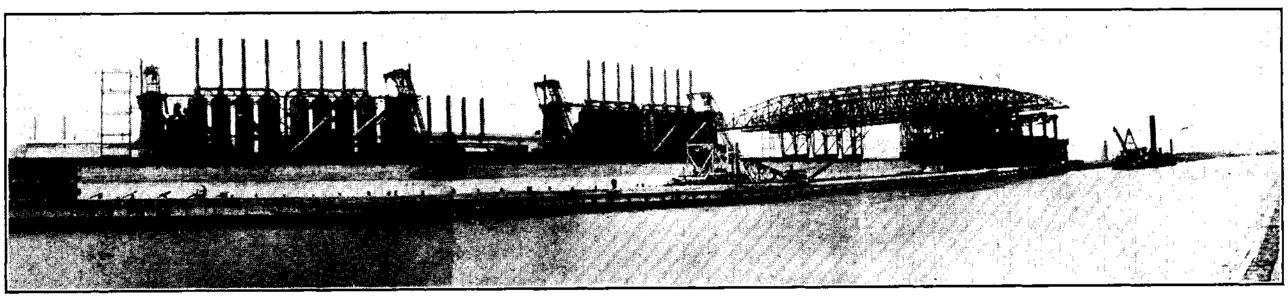

Fig 5.—Blast furnaces from water front.

gas engine-driven generators. Steam is also used on the plant in auxiliary blowing engines, pumps, turbines, hammers, gas producers, etc. Of blowing engines for the blast furnaces there are eight Westinghouse and eight Allis-Chalmers

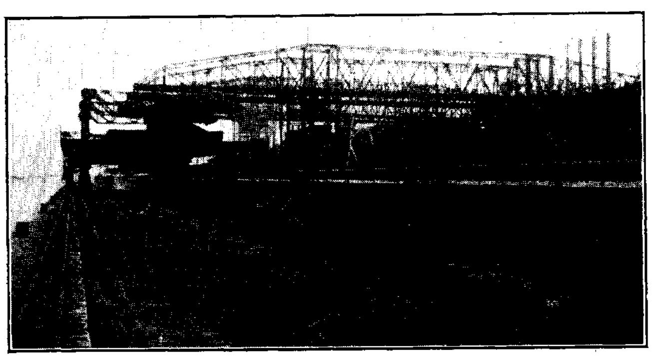

Fig. 6.—Unloaders and ore bridges.

horizontal twin-tandem of 2,000 H. P. each. They are operated by blast furnace gas and average 30,000 cubic feet of air per minute, each. The number planned for the complete plant is thirty-two, with a total H. P. of 64,000. The electric power plant equipment consists of horizontal

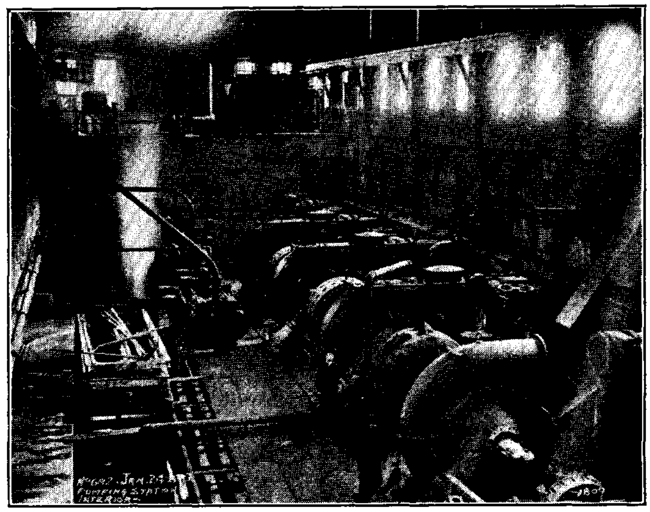

Fig. 4.—Pumping station.

twin-tandem Allis-Chalmers gas engines, direct-connected. At present seventeen of these engines are installed, with a total of 60,000 H. P., housed in a building 966 feet long by 105 feet wide. It is planned to duplicate this plant with another of the same size and this will give a total of thirty-four gas engines, with 120,000 H. P.

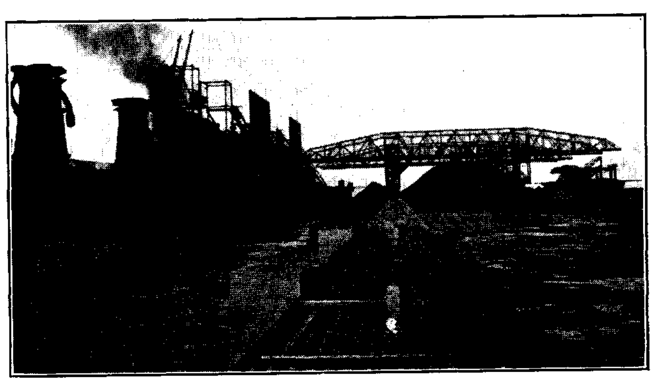

Fig. 7.—Ore bins.

Blast Furnaces.—Of a total of sixteen blast furnaces, each of a capacity of 450 tons per 24 hours, planned for the plant, four are operating at the present time and four are under construction. There are four stoves to each furnace and for the eight furnaces either operating or now under construction, there are provided fourteen dust catchers. The flue dust delivered by them amounts to about two

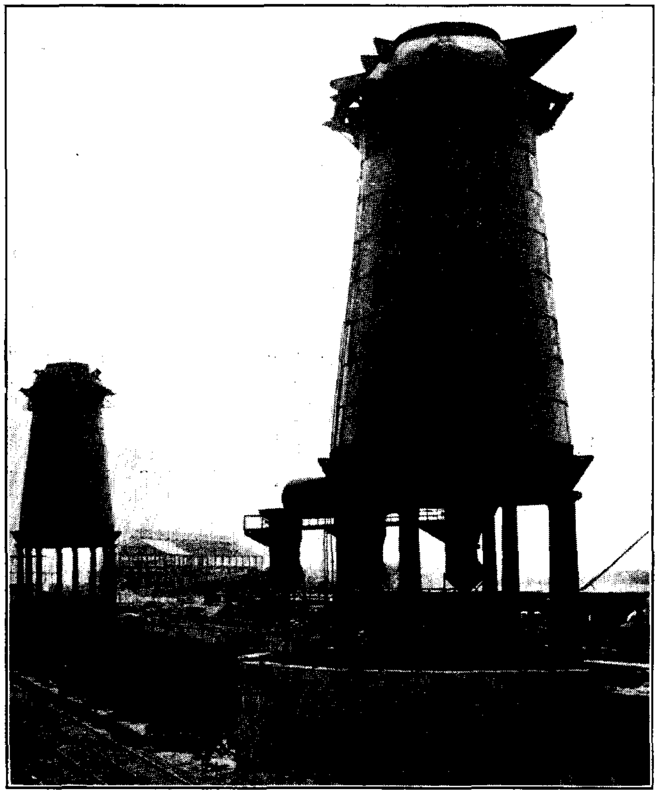

Fig. 8.—Blast furnaces under construction

carloads per furnace per day. The flue dust is not sintered. For each pair of furnaces there are provided three primary gas washers. From the primary washers the furnace gas

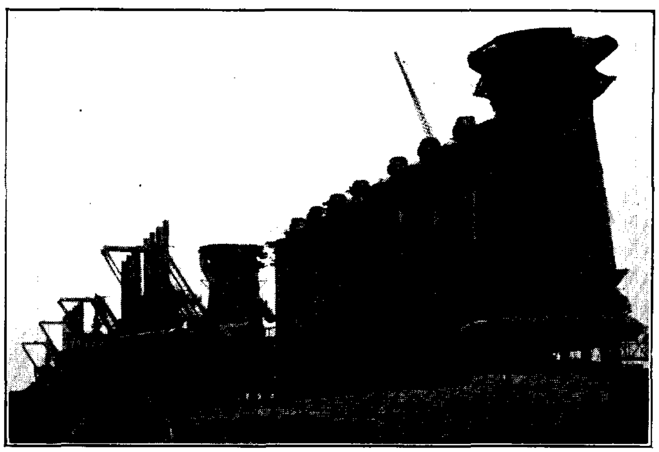

Fig. 9.—Blast furnaces and stoves under construction.

passes through a large main to the secondary washers. Two types of these are used, vertical tower washers and centrifugal washers, and for each furnace there are provided two of each type.

Supplementary to the blast furnace installation, a pig-casting equipment has been erected of sufficient capacity for handling the entire output of the blast furnaces.

The course of the gas after leaving the blast furnace is

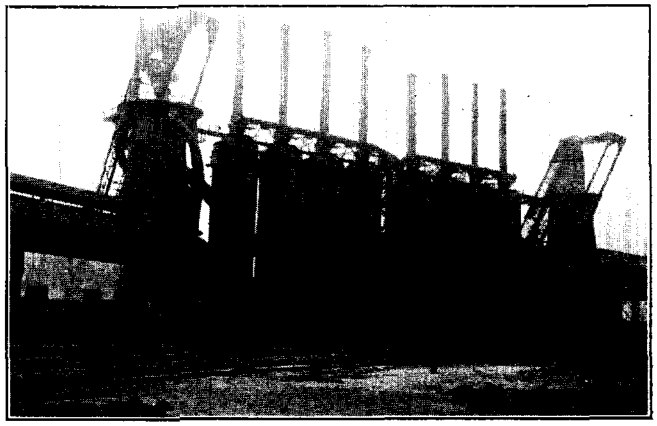

Fig. 10.—Furnaces, stoves and primary washers.

as follows: It first passes through the dust catchers, then through the primary washers, and after leaving the primary washers a fraction amounting to 30 per cent. of the total or 6,750,000 cubic feet per hour passes to the hot blast stoves. From the same point 7½ per cent. or 1,700,000 cubic feet per hour passes to the boiler house. The remainder passes

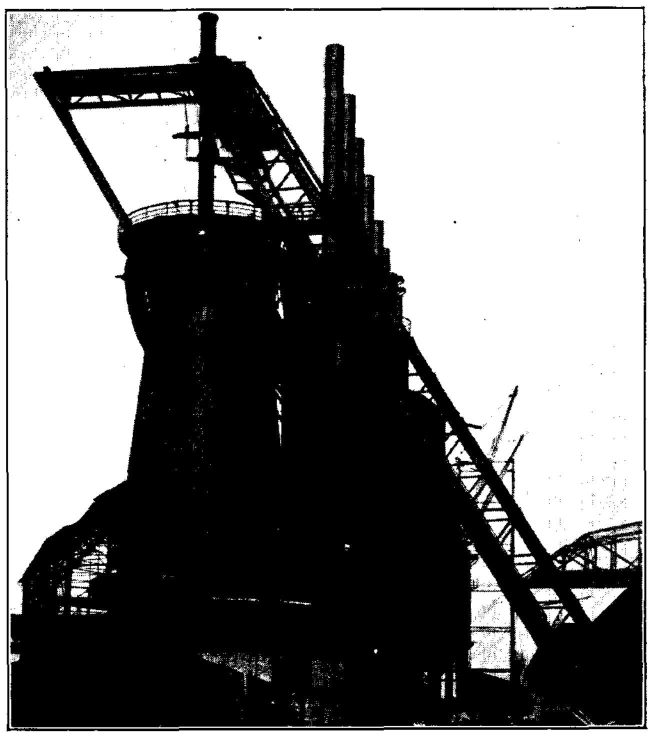

Fig. 11.—Blast furnace showing skip incline, stoves and dust catchers. Compliments of Allis-Chalmers Co.

to the secondary washers where 2½ per cent. or 600,000 cubic feet per hour is used up. From the secondary washers the gas enters the gas holder, of a capacity of 200,000 cubic feet. From the gas holder the gas passes by mains to the blowing engine house and the electric power station. In the former 12½ per cent. or 2,800,000 cubic feet per hour is used. 2½ per cent. or 600,000 cubic feet per hour is used for auxiliaries for blast furnaces themselves. The total consumption for blast furnaces then, exclusive of the stoves, is 15 per cent., or 3,400,000 cubic feet per hour. The remainder or 45 per cent. of the total, amounting to 10,000,000

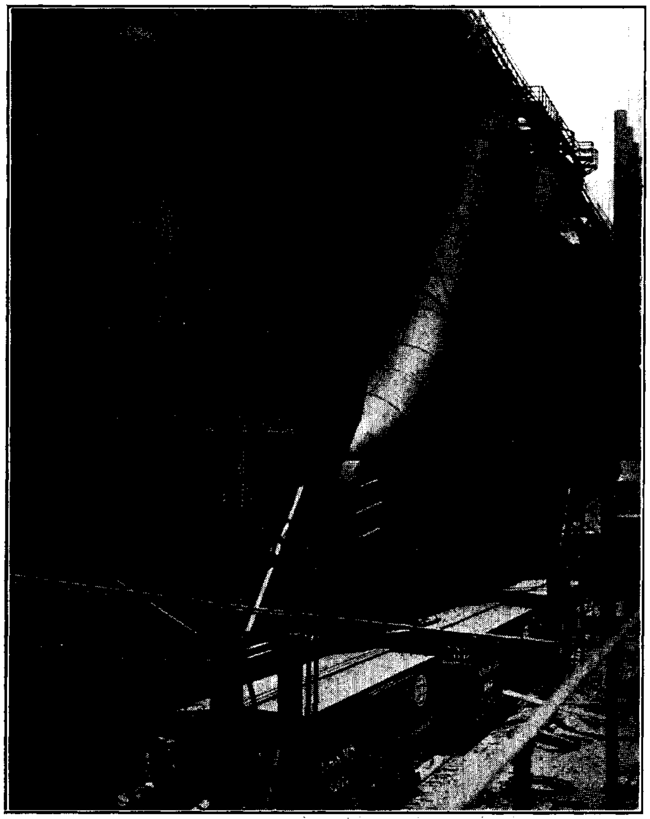

Fig. 12.—Dust catchers. Compliments of Allis-Chalmers Co.

cubic feet per hour, is used in the electric power station. The above figures are based on the production of eight blast furnaces delivering 3600 tons of pig iron per 24 hours. It is estimated that these eight furnaces will produce 22,450,000 cubic feet of gas per hour.

The Gayley dry blast has not yet been introduced at Gary.

Open-hearth Furnaces.—At present there are finished twenty-eight open-hearth furnaces each with a capacity of 60 tons. There are under construction fifty-six more which when completed, will give a total of eighty-four. For each

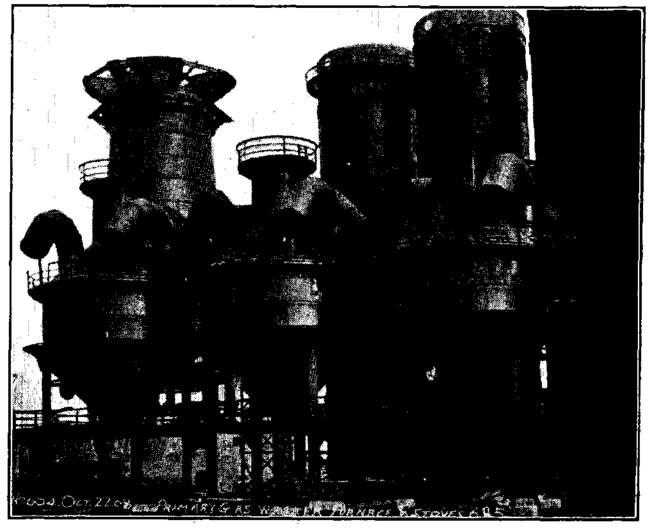

Fig. 13.—Primary gas washers.

open-hearth furnace are provided five Morgan gas producers. The first open-hearth plant will be in operation by the time this article is published. In the completed plant there will

Fig. 14.—Back of blast furnaces. Gas mains leading to boiler house and secondary gas washers. Compliments of Allis-Chalmers Co.

be a rail mill with a capacity of 100,000 tons per month. This is now ready to operate. A billet mill, an axle shop,

ANALYSES OF IRON ORES.

Ores.	Fe.	P.	Mn.	SiO_2.	Al_2O_3.	Fe_2O_3	CaO.	MgO.	MnO.	P_2O_5	Vol.	Moist.
Dry Basis, Per cent.												
Chapin	59.46	0.066	0.21	5.50	1.60	85.66	1.50	3.24	0.27	0.151	2.40	...
Bernhart	56.66	0.059	0.26	13.30	1.80	80.94	1.25	0.28	0.34	0.135	2.20	...
Vermont	59.46	0.075	1.27	5.26	2.75	84.94	0.61	0.14	1.64	0.171	4.86	...
Group 4	57.58	0.063	1.10	6.20	2.53	82.26	0.50	0.36	1.42	0.144	6.66	...
Group 3	57.86	0.085	1.57	6.17	2.80	82.66	0.65	0.37	2.03	0.195	5.40	...
Vermil	65.61	0.145	0.10	3.86	1.01	93.73	0.57	0.35	0.13	0.332	0.30	...
Original Basis.												
Chapin	56.10	0.062	0.20	5.15	1.50	80.14	1.40	3.03	0.26	0.142	2.25	6.43
Bernhart	51.59	0.054	0.24	12.11	1.64	73.70	1.14	0.25	0.31	0.124	2.00	8.95
Vermont	51.70	0.065	1.10	4.57	2.41	73.86	0.53	0.12	1.42	0.149	4.22	13.05
Group 4	49.34	0.054	0.94	5.31	2.17	70.49	0.43	0.31	1.21	0.124	5.71	14.31
Group 3	50.10	0.074	1.26	5.34	2.42	71.57	0.56	0.22	1.63	0.169	4.68	13.42
Vermil	65.04	0.144	0.10	3.83	1.00	92.91	0.56	0.35	0.13	0.330	0.30	0.87

a plate mill and a merchant mill are all under construction.

Raw Materials and Products.—The ores used in the plant will be from the Messaba, Menominee, Marquette and Vermillion districts. Average analyses from typical mines in these districts are as above, on the dry and original basis.

The ores are all delivered to the plant by the Steel Corporation's steamers. The coke used is from the Connellsville, Penna. district, and analyses about as follows:

	Per cent.
Vol	0.83
Fixed carbon	88.42
Sulphur	0.75
SiO_2	5.98
Fe	0.60
Al_2O_3	0.45
P	0.01
Mn	0.04
CaO	0.17
MgO	0.22

At the present time dolomite is used in the blast furnaces and hence the slag cannot be used for cement-making purposes. In case it is desired to produce cement from the slag, the change to calcite can readily be made. The dolomite comes from McCook, Ill., and from Gary, Ill. The following is a typical analysis:

	Per cent.
Moisture	1.50
SiO_2	0.53
Fe_2O_3 and Al_2O_3	0.59
P_2O_5	0.01
CaO	29.60
MgO	21.60
S	0.041

The coal used in the producers at the open-hearth plant is Dering No. 2 lump, from Westville, Ill., and analyzes as follows:

	Per cent.
Moisture	8.50
Volatile com	37.01
Fixed carbon	46.88
Ash	7.61
S	1.44
B. T. U.	11,970

The limestone spalls for the open-hearth plant comes from the well-known quarries at Bedford, Ind. A typical analysis is as follows:

	Per cent.
SiO_2	0.63
Al_2O_3 and Fe_2O_3	0.46
P	0.008
CaO	54.90
MgO	0.51
S	0.055

Flue dust from the blast furnaces shows on analysis:

	Per cent.
SiO_2	7.63
Fe	53.88
Al_2O_3	3.51
P	0.062
Mn	0.82
CaO	0.52
MgO	0.27
C	8.36

Chemical Laboratory.—Mr. H. C. Thomas is chief chemist at the Gary plant and has been instrumental in designing one of the best iron and steel laboratories in the country. The chemical work, excepting the gas analysis work which is handled in the gas laboratory located at the blast furnaces, will be performed in one central laboratory. This is a three-story and basement brick and concrete building with 10,000 square feet of floor space. In the basement of the building are located the heating plant and power machinery for the laboratory, the acid storage, the photographic room and dark room, record room, vault and toilet room. On

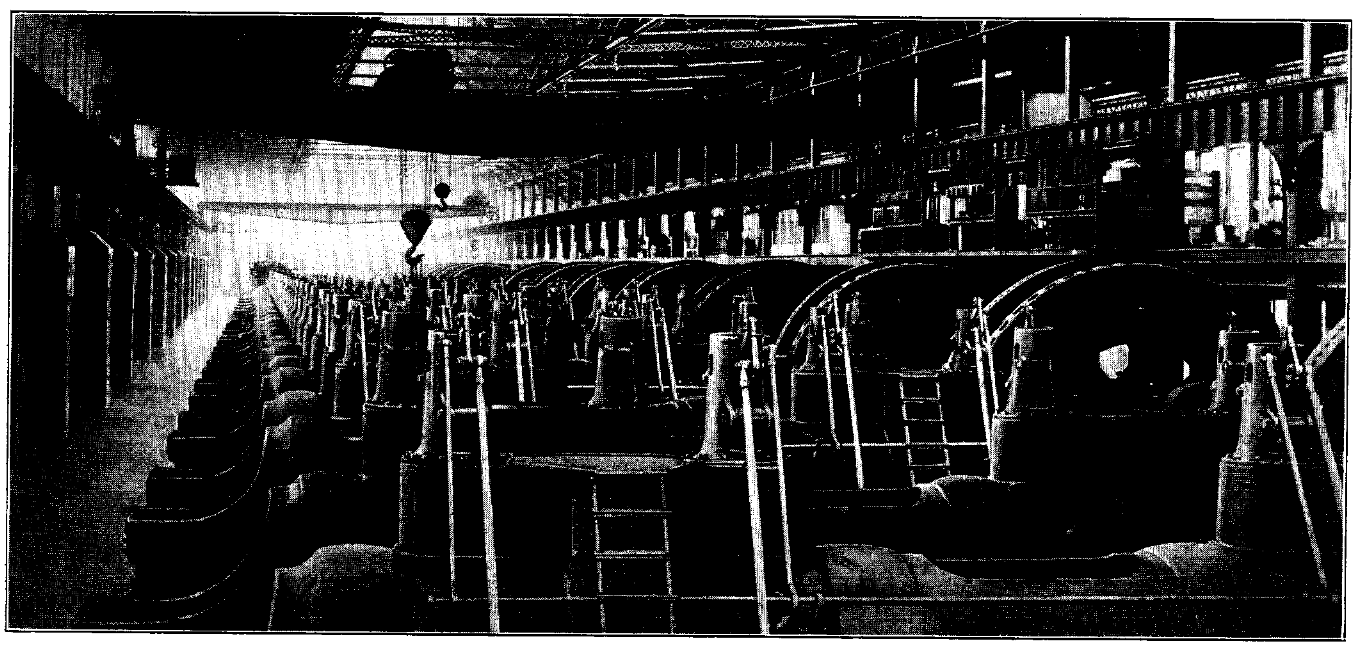

Fig. 15.—Partial view of installation where 17 Allis-Chalmers twin-tandem gas engines are direct-coupled to Allis-Chalmers generators, each unit being of 2,500 kw. capacity. Photograph taken during erection. The installation also includes 8 Allis-Chalmers twin-tandem, gas-driven blowing engines, making 25 units in all.

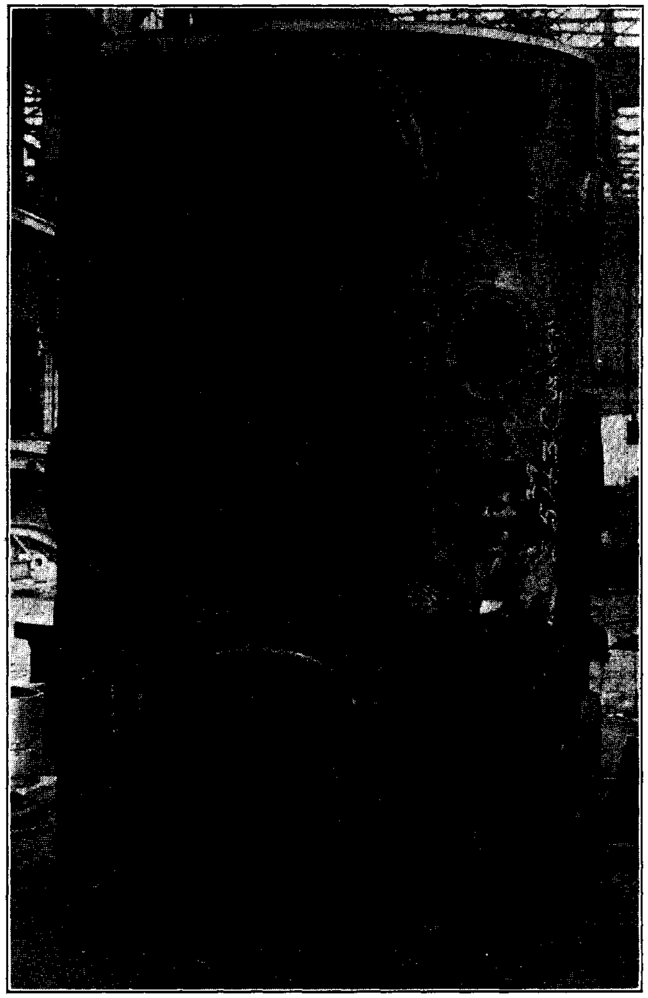

Fig. 16.—42-inch gas engine cylinder, Allis-Chalmers.

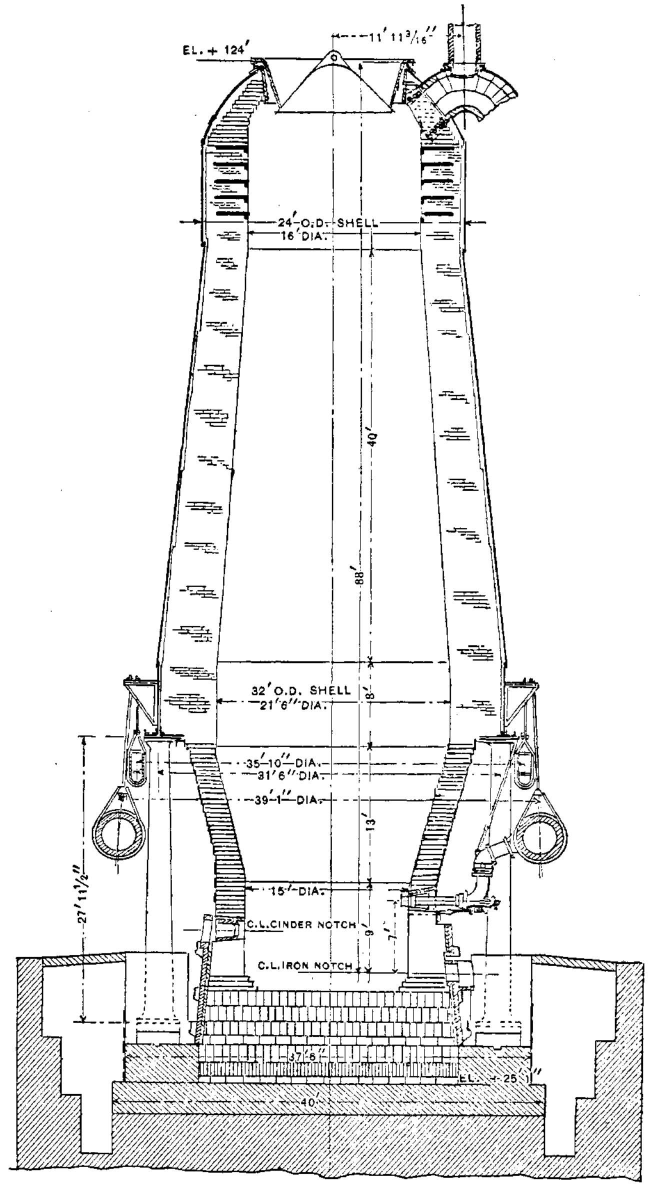

Fig. 18.—Cross-section of blast furnace.

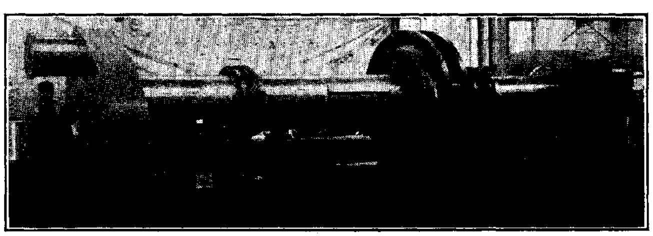

Fig. 17.—Crank shaft of 5000 H. P. Allis-Chalmers 4-cycle, double-acting twin-tandem gas engine—weight of this part, 85 tons.

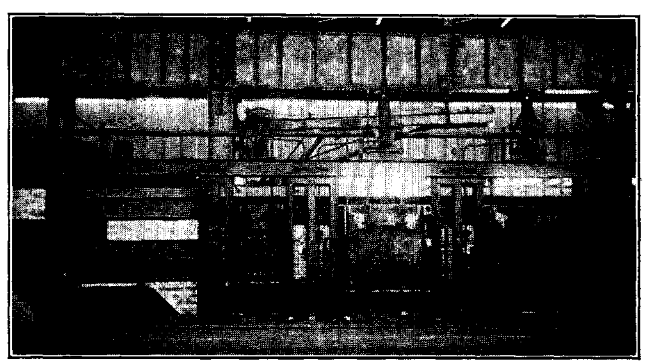

Fig. 19.—Open-hearth furnace, charging end.

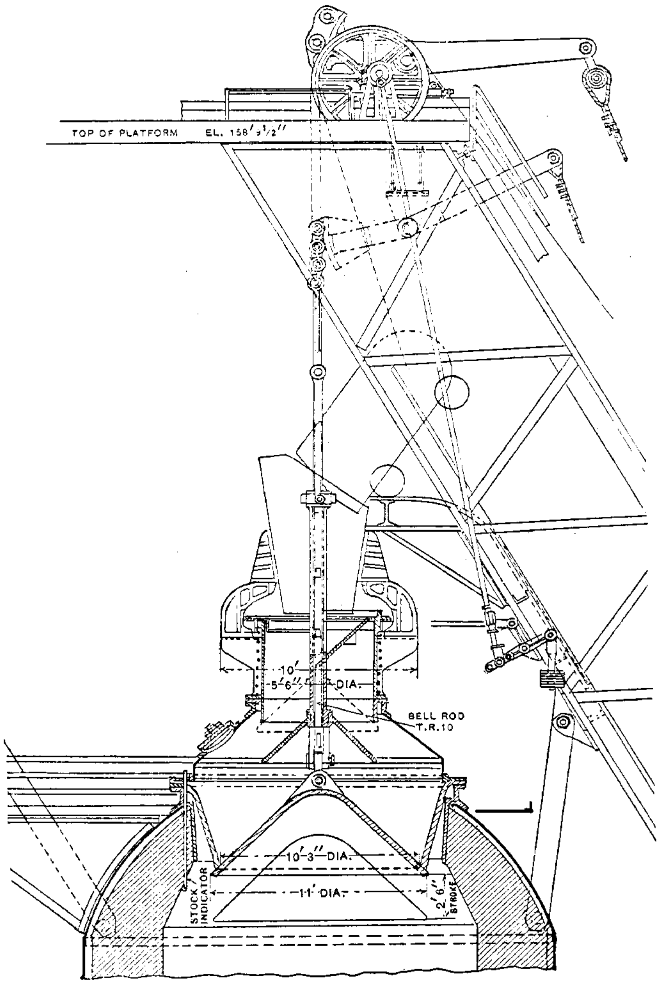

Fig. 20.—Top of blast furnace.

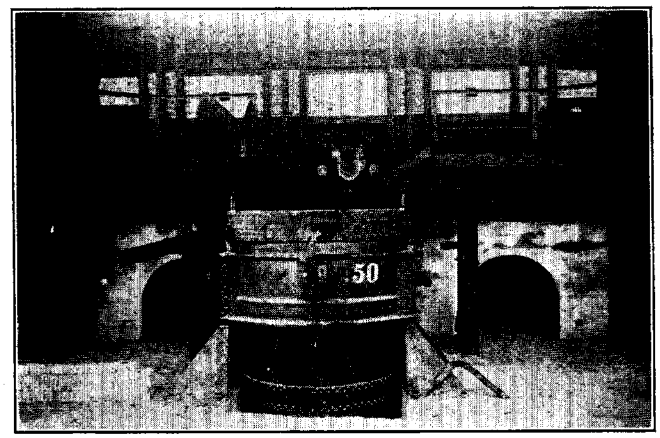

Fig. 21.—Open-hearth furnace, discharge end.

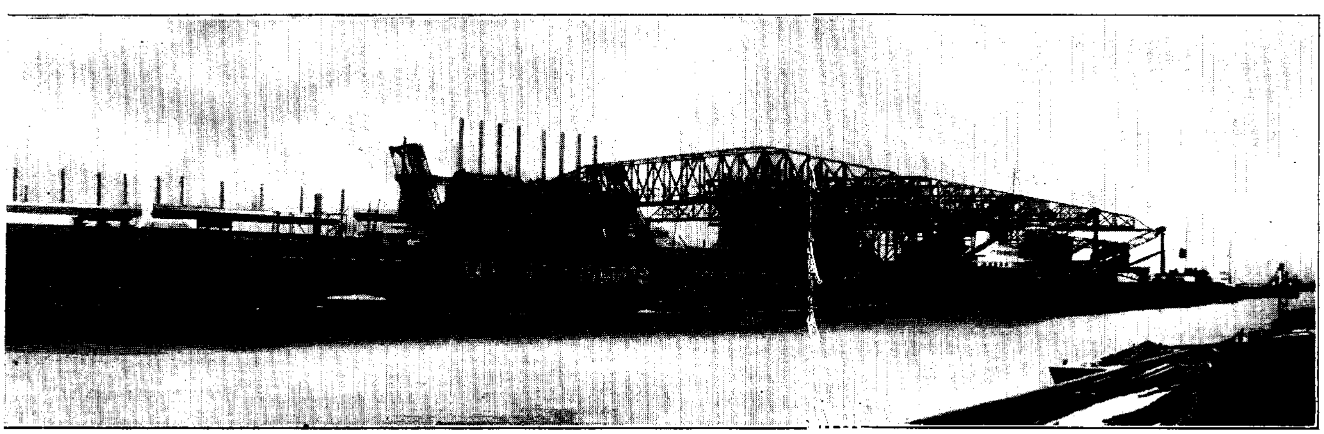

Fig. 22.—View from slip.

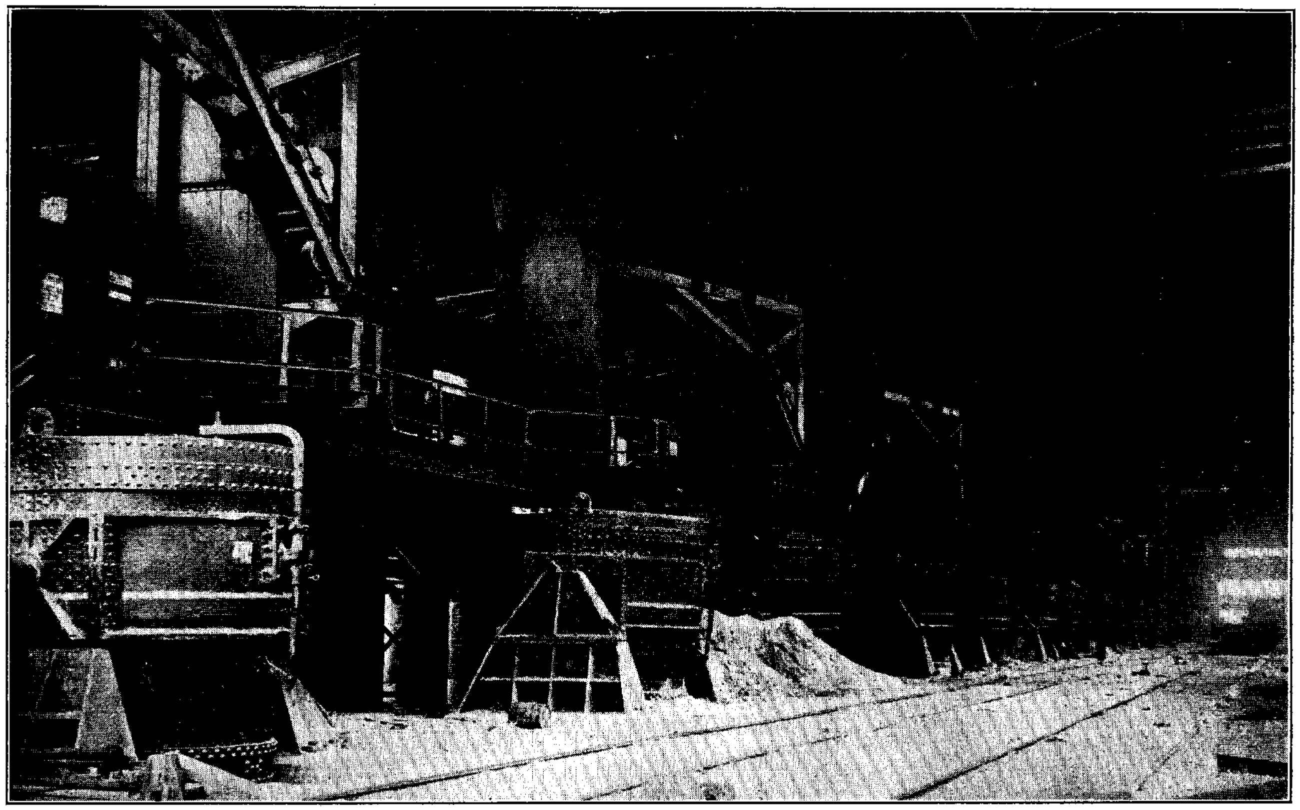

Fig. 23.—Open-hearth furnace, discharge end.

the first floor is the office of the chief chemist and the clerk's office, the main iron and steel laboratory, balance room and store room. On the second floor are located the laboratory for blast furnace and open-hearth materials; a laboratory for special work such as alloys, foundry work and waters; a laboratory for research work; a muffle room, balance room, store room, library, office and toilet room. The third floor is at present unfinished, but will be finished as the space is required. The building is so constructed that new stories can be added whenever necessary. No sampling is being done in the laboratory, but is handled in a special sampling plant located at the ore docks. This is a building 50 x 40 feet, containing 30 2-ton drying bins, 6 5x5 feet hot plates, 2 Allis-Chalmers grinders and one Allis-Chalmers and one Dodge crusher. Just now the sampling is performed by hand, the mechanical sampler not having as yet been installed.

The writer desires to express his thanks to Messrs. G. G. Thorp, Vice-President of the Indiana Steel Co., H. C. Thomas, Chief Chemist Indiana Steel Co., and Wm. Brady, Chief Chemist Illinois Steel Co., for the data furnished for this article.

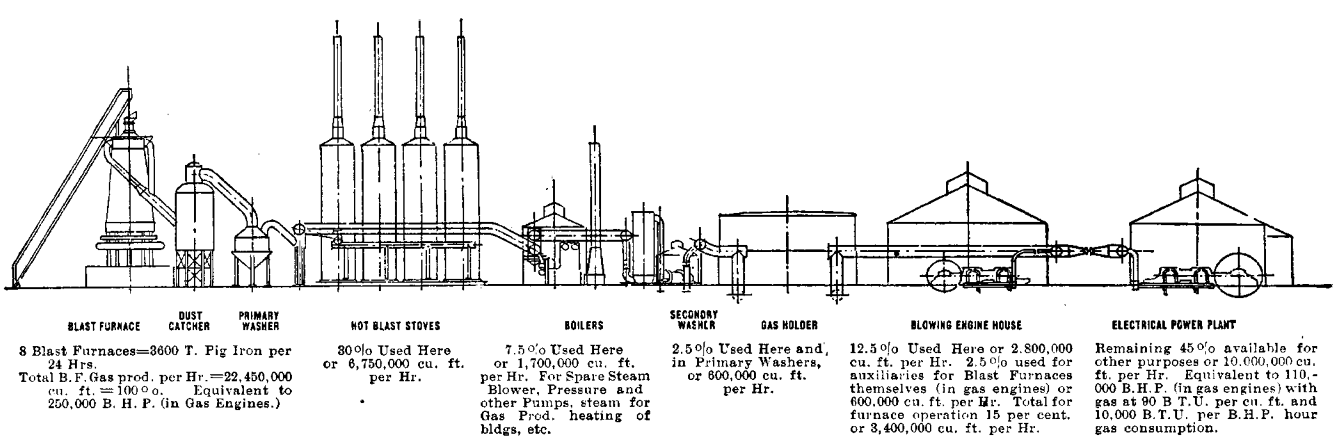

Fig. 24. Diagram for blast furnace gas.