Composition of Charge.

	Pounds.
Ore	400
Charcoal	100
Limestone	50
Fluorspar	50

Analysis of Pig-iron Produced.

	Cast No. 136:	Cast No. 137:
Total carbon		3.50
Si	4.50	2.80
S	0.007	0.091
P	0.143	0.060
Ti (approx.)	1.00	1.30

Analysis of Slag Produced.

SiO_2	7.00
Al_2O_3	28.50
CaO	14.23
MgO	2.93
TiO_2	38.92
Fe	1.13
S	0.90

On account of the furnace being in a very bad condition the lining being eaten away by the limey slag used in the previous run the run had to be stopped and no figures as to output could be obtained.

The slag was very fluid and likely the fluorspar in the charge could have been reduced considerably or omitted altogether.

The iron obtained in cast No. 136 was probably mixed with some iron from the previous charge, when ore with high phosphorus content was used.

The Smelting of Magnetite.

It was expected that considerable difficulty would be experienced in the smelting of magnetite on account of its conductivity. It was thought that with the furnace in use, in which the electrode was immersed in the charge, the current would disseminate itself laterally from the sides of the electrode through the charge, preventing the current at the reducing and fusion zone from attaining such density as would be required for the high temperature necessary for reduction and fusion. With charcoal as a reducing agent no difficulty was experienced in this respect, nor was the inductance of the furnace increased by the presence of magnetite.

The Use of Charcoal as a Reducing Agent.

Since charcoal and peat-coke can be produced in the Provinces of Ontario and Quebec while metallurgical coke requires to be imported, it was of great importance to ascertain whether charcoal, without being briquetted with the ore, could be used instead of coal-coke. No difficulty whatever was experienced, in fact so admirably adapted was charcoal, when crushed to pass a ¾" ring, as a reducing agent in the electric furnace that coke and briquettes of coke with clay were abandoned, and all the experiments with magnetite and roasted pyrrhotite described were made with charcoal. Some of the charcoal available was of very poor quality, some of it being little better than charred wood, containing only about 56 per cent. of fixed carbon. This, and the fact that a considerable quantity of the charcoal was consumed on top of the furnace account for the large quantity of charcoal used per ton of product. A modification of the furnace, protecting the upper layer of the charge from the atmosphere, and the use of charcoal properly carbonized would decrease considerably the amount of charcoal which was actually used in the experiments and consequently reduce the cost of production as given.

Consumption of Electrode.

For the production of 42,711 pounds of pig-iron 384 pounds of electrode were consumed, the same electrode having been in commission for 13 days.

Consumption of electrode per ton of pig-iron:

$$\frac{384 \times 2000}{42711} = 17.98 \text{ pounds.}$$

During the time this electrode was in commission the material in the furnace was melted down several times, exposing the red hot electrode to the oxidizing atmosphere. The consumption of electrode was found to be greater for white iron than for grey iron, and since the 42,711 pounds of pig-iron produced included several casts of white iron, the consumption of electrode was also on that account greater than it would have been had only grey iron been produced.

Power Factor.

The power factor of the furnace was determined by Mr. Chas. Darrall, of the Canadian Westinghouse Company, of Hamilton, Ont., and was found to be 0.919. This high power factor is due to the construction of the furnace casing, which prevents the closing of the magnetic lines of force.

Since the true electric power is the apparent electrode power multiplied by the power factor, it is evident that any error made in the determination of the power factor which tends to decrease its value will appear to decrease the consumption of energy per ton of product. The large output of 12.12 tons per 1,000 E. H. P. days, i. e., the small amount of electric horse-power absorbed per ton of product in the second Livet experiments, was obtained in a furnace with the abnormally low power factor 0.564. Whatever doubt may be engendered as to the correctness of the figure obtained for the absorption of electric energy on account of this low power factor of the Keller furnace, such doubt cannot arise regarding the figures obtained with the Heroult furnace for the absorption of electric energy in the Government experiments on account of its remarkably high power factor 0.919.

Moreover, since the cost of alternate current generators increases with increase of capacity, furnaces with high power factors (which can utilize a high percentage of the capacity of the generators) will be more economical as regards the first cost of the electrical installation of an electric smelting plant than furnaces with low power factors.

Modification of Experimental Furnace for Commercial Production of Pig-iron.

Probably the largest unit which can at present be constructed on the model of the experimental furnace will not exceed 1,500 H.P. The construction of the experimental furnace to fit it for the production of pig-iron on a commercial scale will require to be modified in the following important particulars:—

(1) The top of the furnace requires to be modified to permit of the application of labor-saving machinery for charging.

(2) Provision requires to be made for the collection and utilization of the carbon monoxide produced by the reduction of the ore; this involves also the protection of the charcoal of the charge from combustion on top of the furnace.

The greater capacity insuring less loss of heat by radiation and the modification of the furnace to permit of the utilization of the carbon monoxide will materially increase the output beyond that ascertained by the experimental furnace. The experiments indicated that under **normal** conditions about 11.5 tons were produced by an expenditure of 1,000 E. H. P. days. (See runs Nos. 8 and 13.) It is, therefore, not unreasonable to assume that under similar conditions with a properly constructed plant the output per 1,000 H.P. days would certainly reach 12 tons. This figure has been adopted in calculating cost of production per ton of pig.

The protection of the charcoal of the charge from combustion on top of the furnace will materially decrease the amount of charcoal necessary for reduction and consequently lessen the cost of this item. This saving has, however, not been taken into account in the estimate of cost.

On account of the value of the product, the smelting of roasted nickeliferous pyrrhotite by the electro-thermic process, as carried out with the Government experimental plant, admits of immediate commercial application without other modification of the furnace than increase of its capacity.

Estimate for a 10,000 H.P. Plant* Producing 120 Tons of Pig Iron Per Day of 24 Hours.

Furnaces, contacts, overhead work	$24,500
Bins, chutes, elevators	14,000
Crushers	4,000
Hoists and regulators	10,500
Instruments	1,400
Cables for conductors	8,400
Building	10,500
Mixer and casting machine	10,000
Travelling crane and tracks	5,000
Ladles	1,500
Slag trucks	3,000
Ore bins	3,000
Repair shop	5,000
	$100,800
Charcoal plant	50,000
Power plant (assuming cost of developing one horse-power = $50.00)	500,000
	$650,800

*This estimate is given on the authority of Dr. P. Heroult.