works considered it unnecessary, and the carbon fell below 3 per cent. On increasing the carburite to 23 lb., or double the quantity used in the last heat, the carbon was increased to over 3 per cent., but was still below that obtained when 40 lb. was used. It will be noted that the carbon was considerably higher in the furnace sample than in the metal as cast in each case; and this is somewhat difficult to explain, as one would not expect any appreciable loss of carbon between the period of sampling the bath and tapping. It is probably explained by the bath sample being taken from the surface of the metal bath in contact with the coke floating on the surface, as this top layer would probably be somewhat higher in carbon than the sample representing the average composition of the bath. This emphasizes the importance of adding a large excess of heavy carburizing-material like carburite, which will sink below the slag, if pig iron containing the normal percentage of carbon is to be produced.

Experience has shown that, although it is somewhat difficult, pig iron containing 3·5 per cent. of carbon can be produced, and the fact that in the first experiment the bath sample gave 4 per cent. showed clearly it can be done in the Snyder furnace.

To test the working-properties of the pig iron casts Nos. 9 and 10 were melted in an ordinary foundry cupola, and a number of castings made, and the ordinary test bars cast for mechanical testing. The metal ran well, and the castings were quite satisfactory, being sharp and clear. A test bar cast to test fluidity gave satisfactory results.

The mechanical tests were fairly satisfactory, although the tensile strength is slightly below the better grades of cast iron, which give a tensile of from 10 to 12 tons per square inch, compared with 9·1 tons per square inch given by this iron.

The analysis of the metal from the cupola was as follows:—

Total carbon	3·480	Sulphur	0·061
Graphitic carbon	2·886	Phosphorus	0·223
Combined carbon	0·594	Manganese	0·615
Silicon	2·279	Titanium	0·050

It will be noted that the total carbon and the sulphur are both higher than the mean of the two heats 9 and 10, and the silicon lower. This is what was to be expected, as some sulphur is always taken up by the metal from the coke during melting and some silicon oxidized. The phosphorus is lower and carbon higher, and is probably due to a little of the hæmatite pig iron from the previous charge being left in the cupola.

The conditions of the furnace at the end of No. 11 heat, the third run, was very bad, and it was doubtful how long it would stand, and it was decided therefore to make a steel heat instead of another of cast iron. Partly owing to the bad condition of the furnace, and partly owing to the large amount of slag formed by cutting-away of the hearth, this heat was not very satisfactory, although the quality of the steel produced was good. The yield was exceptionally low, the volume of slag exceptionally high, and consequently the energy consumed per ton of steel made was 11,219 units (K.W.H.), whereas the consumption should not have exceeded 3,700 to 4,000 as a maximum.

The bad results obtained in this particular heat may, however, be regarded as largely accidental, and had the furnace been in good condition far better results would have been obtained. The analysis of the finished steel was as follows:—

Carbon	0·532	Manganese	0·582
Silicon	0·143	Arsenic	0·016
Sulphur	0·035	Titanium	Trace
Phosphorus	0·034		

Very little titanium remained in the steel, and the physical properties were quite satisfactory. It forged and welded well, and the tensile strength and bending tests were satisfactory.

In my opinion the production of steel direct from the ore or sand *in one furnace* is not commercial, and two furnaces are essential—one to reduce the ore and the other to refine the metal produced and convert it into steel. When the operation is done in one furnace the process is greatly delayed by the presence of the slag produced from the ore; and, although this may be largely removed, the conditions for the rapid and effective production of varying classes of steel are difficult to obtain, and lead to delays involving increased consumption of current and increased labour charges, &c. The capital cost per ton of steel for a given output when two furnaces are used would be no greater than if the operation was carried out in one furnace, as while the metal is being converted into steel in a second furnace the first furnace can be reducing another charge of ore, and the output from the two furnaces working together would be greater than if the whole operation of steelmaking were done separately in one furnace.

The economic production of pig iron and steel on a commercial scale in New Zealand will largely depend upon the design of the furnace. In my opinion the Snyder furnace, although quite suitable for producing steel from scrap steel in the usual way, is not suitable for the production of either pig iron or steel direct from ironsands. The fact that fused oxides are in contact with the hearth for a considerable time while the reduction is taking place causes excessive wear, and I do not think it will be possible to run the furnace for a reasonable period without constant stoppages for repairs, which increases the power-consumption by cooling down the furnace, which has to be reheated after each stoppage, thus greatly reducing output and increasing wages-cost per ton, apart from the increased cost of labour and materials for repairs, &c. In this particular run only four heats were possible before the furnace-hearth gave out, and, although with further experience this result might be improved upon, the conditions are such that very frequent stoppages will be inevitable. The electrode consumption was also high, considering that graphite electrodes were used, and the power consumed