bord states that the high carbon steel is as good as corresponding grades of crucible steel, and there appears to be no reason why, in localities where water power is cheap, this furnace should not replace the crucible furnace and open-hearth furnace for the manufacture of tool steels and other special varieties of steels in which quality rather than quantity or cheapness is aimed at.

With regard to the possibility of making structural steel in the Héroult furnace, it should be remembered that the material of the charge would be largely pig iron and ore, as there would not be sufficient scrap available, and this would increase the time and electrical energy required for the operation, on the other hand the pig iron could be charged molten, and the purification of the charge need not be carried so far as was necessary for tool steel, while the larger scale of the furnace would also reduce the consumption of electrical energy per ton of product. A 50-ton furnace might be expected to require about 5,000 kilowatts, or about 25,000 amperes at 250 volts.

The cost of making structural steel in a 50-ton Héroult furnace, if a furnace of this size could be successfully operated, would probably, with electrical energy at $10.00 a horse-power year, be about the same as in a gas-fired open-hearth furnace using coal at $3.00 a ton. Assuming that the general cost of operating the two furnaces was the same, there remains for the Héroult electric furnace the cost of electric energy, which, at 0.10 horse-power years per ton would be $1.00 per ton, and the cost of electrodes, which are stated to cost 20 cents per ton, while for the open-hearth furnace there is the cost of coal, which at 700 lbs. per ton would be $1.00 and the cost of operating the gas producers and checker chambers, which would more than balance the cost of electrodes. Until larger furnaces have been built, it is not worth while to attempt to estimate in detail the cost of operating them, but the figures given are enough to show that under favorable conditions, large electric furnaces might be expected to compete with gas-fired furnaces for the manufacture of structural steel.

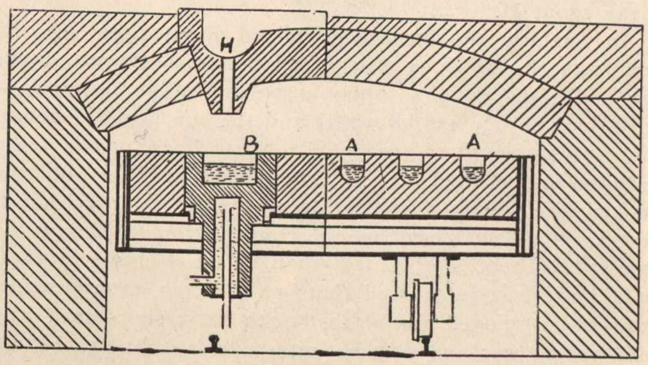
A Héroult furnace for the production of 50 tons of steel a day has been installed in the plant of the Halcomb Steel Co., in Syracuse, and it is likely that this will lead to further developments in size and efficiency. The furnace is being used in conjunction with gas-fired furnaces, and is charged with molten superoxidized steel from a Wellman furnace, the operation of refining being finished in the electric furnace.

Mr. Héroult has proposed an electrically heated steel mixer of 500 or 600 tons capacity, to receive the steel from a number of open-hearth or Bessemer furnaces, thus ensuring a uniform product, and allowing a more perfect deoxidation of the steel and separation from the slag than by the usual process of casting. Prof. Richards has suggested the use of electrical heating as an auxiliary in an ordinary open-hearth furnace for raising the temperature of the steel through the last 100° or 200° C before tapping, as a little electrical heat for reaching the highest temperature would sometimes save a good deal of time and fuel.

Keller Steel Furnace. This is substantially the same as the Héroult steel furnace and need not be further described.

The Kjellin Steel Furnace, Fig. 27, is of the induction type, and resembles a step-down transformer. In the figure, A is the primary winding to which an alternating current of 90 amperes at 3,000 volts is supplied. B is a circular trough containing the molten steel, and corresponds electrically to a secondary winding of one turn. C is the magnetic circuit which passes through both the primary and the secondary windings. The alternating current in the primary windings induces an alternating current in the ring of molten steel, the current being estimated at 30,000 amperes and 7 volts. This furnace has the great advantage of requiring no electrodes, which is not only a gain as regards trouble and expense, but avoids any contamination of the steel by the material of the electrode. The heat is generated uniformly throughout the steel, which is contained in a closed receptacle, under conditions which resemble those of the crucible steel furnace. The electrical furnace has, however, the advantage of holding as much steel as many crucibles, and of being quite free from furnace gases which are liable to enter even a closed crucible.

Compared with the Héroult furnace, the Kjellin furnace has the objection that the annular groove containing the steel is very long in comparison with its cross section, which will cause the loss of heat to be excessive and the weight of steel to be small for a furnace of a given size. The furnace does not form a very efficient transformer, and it appears to be limited in size, the power factor becoming smaller as the furnace becomes larger, unless the frequency of the current is correspondingly reduced. On the other hand the current can be used at high voltages of 3,000 or even 5,000 or 6,000 volts which would permit of the generation of the current and its transmission over moderate distances without the use of a step-down transformer at the furnace.



Section at X. Y.

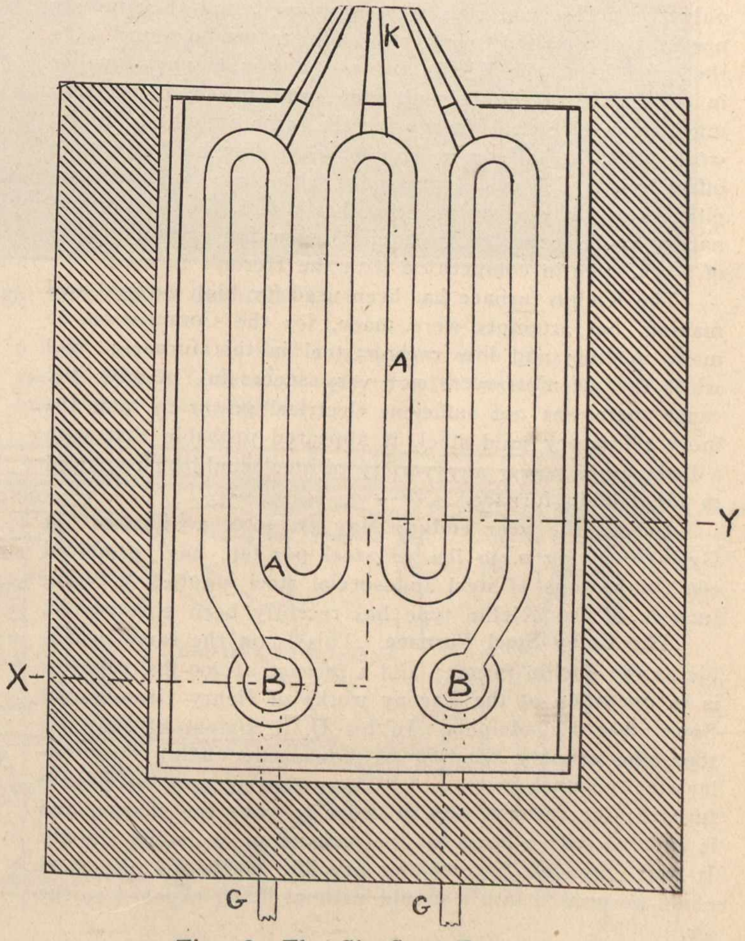


Fig. 28 The Gin Steel Furnace.

The Kjellin furnace was in operation at Gysinge, Sweden, when visited by the Commission in 1904, and was usually making a high class of tool steel from pure pig iron and scrap steel, for which purpose it seems particularly adapted. In operating the furnace the molten steel from one run is not tapped out completely, but about one third of it is left in the groove to act as a conductor to carry the current at the beginning of the next run; the fresh charge of charcoal, pig iron and pure iron or steel scrap is added to the superheated steel as fast as it can take it without chilling. No refining is attempted in this furnace, the operation being merely one of melting a metallic charge, made