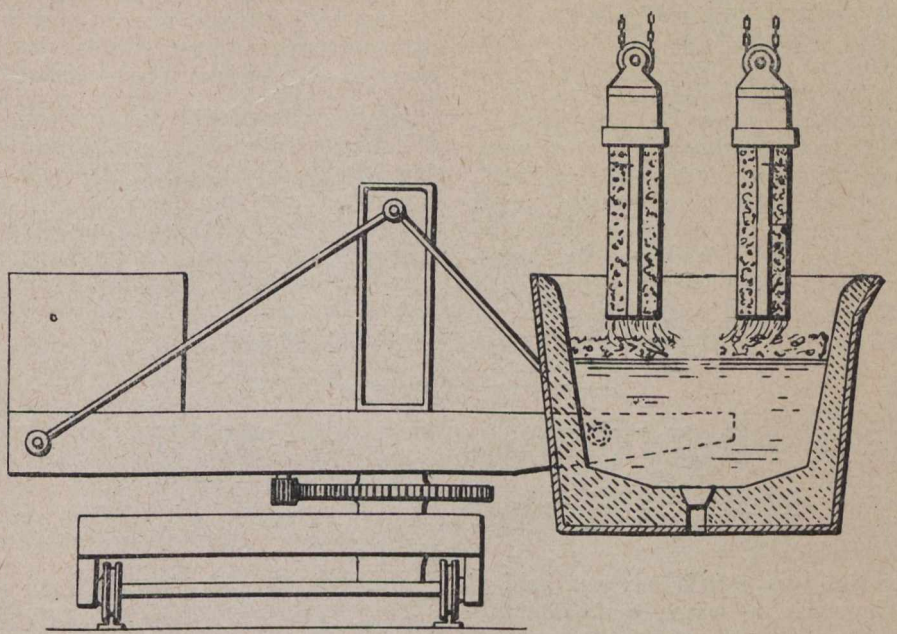
The proper mixtures can be introduced into the molten bath and also provided in the electrode mixture to remove the sulphur on account of the high temperature of the electric arc even though the slags selected could not be used by any other than the electric treatment without addition of other slag materials to lower the melting point, and this would interfere with the efficiency of operation. The slag mixture is also melted to a highly fluid state at the arc largely from the mixture in the electrode itself, placed there for this purpose, of slag from oxygen in the air so that no further oxidation takes place.

The determining questions of the electric refining of steel are cost and output. By shortening the time of treatment with the special composite electrodes combined with slag producing mixtures, and refining only down to such percentages of phosphorus and sulphur as are essential for rails and structural steel, the electric power consumed is so low and the time required so short as to be practical for this work.



in addition to that supplied in the ordinary way on the top of the bath.

Ordinarily there is great trouble, and it is very costly to deoxidize the metal by existing processes, and it is claimed that the pipes and blow holes are produced in the ingot and other difficulties result from the presence of iron oxides. It is also maintained that when ferro-silicon and ferro-manganese are used to prevent these troubles, the oxides which result stay in the steel as an "emulsion" in a finely divided state.

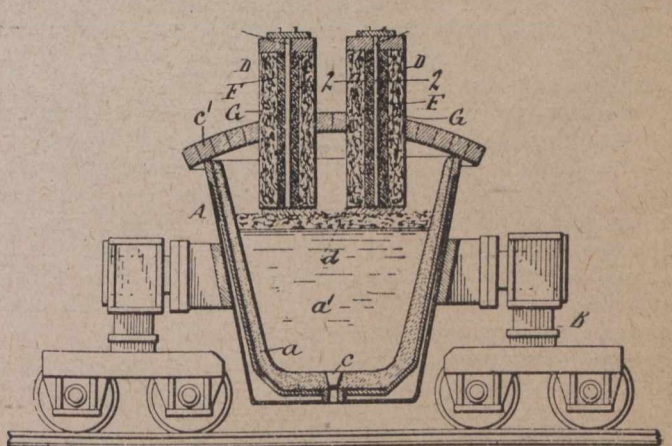
With these special electrodes and the use of an electric arc for refining purposes, materials can be used in the electrodes or added to the bath for a neutral slag, as it is maintained that a thorough deoxidation of the steel is not possible when there are iron oxides in the slag, as they will react to a certain extent with the molten bath of steel.

It is held that adding carbon under ordinary conditions will not result in complete deoxidation, as both iron carbide and ferrous oxide readily exist together. By means of the electric process of steel refining with these combination or composite electrodes, however, carbon or a mixture of carbon and iron may be added to the slag as an auxiliary to the carbon mixture of the electrode, forming calcium carbide and resulting in deoxidation without the slightest difficulty at no great expense, and on any scale desired by providing electric arc apparatus for several electric furnace ladle cars arranged for serving various Bessemer converters or open-hearth furnaces.

The desired amount of manganese can be added for counteracting the bad effects from the ferrous oxide, the carbon reducing the manganese ore which has been added to the slag and taking out the last traces of ferrous-oxide, leaving the steel bath protected by the layer

By this process cheap ore can be used having higher phosphorus and sulphur, these ores being abundant, while high grade ores are nearly exhausted.

By this process of only taking the metal from the converter or open-hearth furnace when it is nearly finished steel and molten, only completing the refining operation electrically, only one-quarter of the electric power and less time is required than when electrically heating from cold metal. It is of value as an auxiliary process to the Bessemer converter and open-hearth fur-



nace, taking the molten metal with little loss of heat and refining same to any degree, according to time taken, the mixtures of carbon and iron or steel combination electrodes used and nature of slags employed.

While this process is specially adapted to the refining of molten steel taken from the Bessemer converter and open-hearth furnaces and treated in an electric furnace