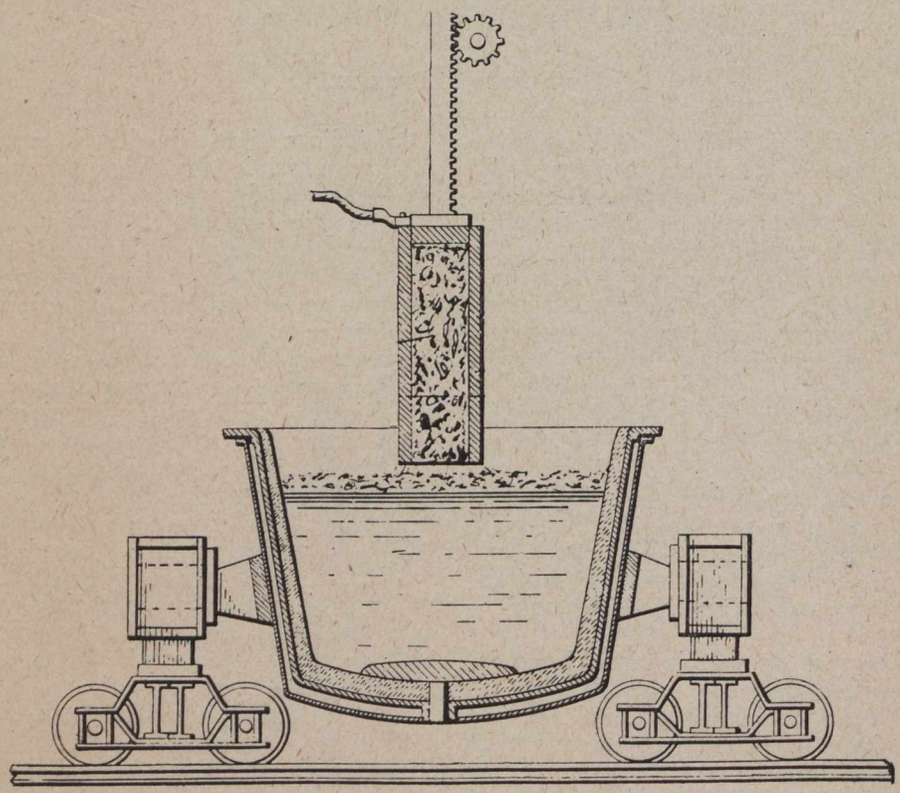
Furthermore, in this electric refining process segregation of sulphur and phosphorus are largely avoided, while any quality of steel may be produced regardless of the quality of the raw materials.

It is well known that the Bessemer converter process for making steel is far cheaper than the open-hearth process, but the quality very largely depends on the metal, ore and other materials available, and it is not possible to test the metal during the operation. The resulting steel, therefore, from high phosphorus and high sulphur charges, contains an injurious quantity of sulphur and phosphorus, which cannot be eliminated by the existing acid Bessemer process. Too much or not enough carbon, manganese, silicon or other elements can readily be corrected and gauged by the charge introduced into the converter and subsequent treatment, but phosphorus and sulphur less than .09 and preferably below .05 is desired and this is not attainable by the existing Bessemer process.

tending from 75 to 90 minutes or more, taking molten metal from an open-hearth furnace and electrically treating same with oxidizing and neutral slags, the phosphorus can be brought down to .003 per cent., and the sulphur down below .007 per cent.

By the use of the present invention with composite electrodes containing slag producing mixtures, it is possible to reduce the phosphorus to .03 or .05, which is 10 to 20 times as much as the above in a far shorter time and within practical limits for Bessemer working.

It is also well known that the carbon is always eliminated before the phosphorus, and if it is attempted to carry the reduction far enough to lower the phosphorus, in an open-hearth furnace, the metal is highly oxidized and decarburized. The present invention provides a means of taking the highly oxidized metal from the open-hearth furnace, if carried far enough to eliminate as much phosphorus as desired, and by the electric treatment with the electric arc and these special elec-



This new composite electrode process may be utilized as an auxiliary treatment to the Bessemer process for eliminating the phosphorus by employing an oxidizing slag in the bath as the molten metal is treated in the electric ladle with the arc, the auxiliary slag producing materials in the combination or composite electrode acting instantly on the metal and the slag being in a highly fluid state as it melts in the high temperature of the arc.

The highly oxidized metal from a Bessemer converter overblown may be utilized deoxidizing same in the electric ladle by this process. It may be stated that the desired end to be attained by this electric auxiliary process with the Bessemer converter for rail making, particularly, is the reduction of phosphorus to .05 or thereabouts by the oxidizing slag and electric arc, the other elements being easily controlled by existing Bessemer methods.

It is well known that with the Heroult electric furnace, having pure carbon electrodes and a treatment ex-

trodes having neutral slag mixtures, it is also possible to eliminate, if desired, nearly the last traces of sulphur, the metal being deoxidized and as much carbon being added as found desirable, producing a finished steel of any degree of perfection desired, according to the length of time the electric treatment is carried on.

It may be stated that in metal taken from an open-hearth furnace, if the reduction is carried on long enough to reduce the phosphorus to .01 per cent. or less than this amount, the carbon is eliminated. It is, of course, true that such a highly oxidized metal would be very unsatisfactory in practice, but by means of the electric furnace treatment with these composite or combination electrodes, the arc and proper slag mixtures, introduced in the molten bath, together with the proper mixture in the electrodes themselves acting as auxiliary slag producers, will bring most satisfactory results, eliminating the sulphur, adding the proper amount of carbon and deoxidizing the steel completely.