Our workers continually increase the production of high-grade metal. New methods and advanced technology are systematically introduced in the Works. It is difficult to describe in one article all the improvements put into practice in our Works and we shall deal here only with the most important ones.

The adoption of vacuum treatment of liquid metal in the ladle prior to teeming constituted the most effective measure for the improvement of transformer steel quality. More than 15,000 tons of steel was vacuum treated; hence the improvement in the electrotechnical characteristics of steel is not an accidental one. Previously only 40-45% of steel batches were rated, on the basis of tests, as high grade steel E 330; with vacuum treatment of metal in the ladle the percentage increased to 90%, reaching 96 - 97% in some months (October-November, 1956).

Recently a still more effective method of metal treatment was tried out: the evacuation during transfer of metal from one ladle to another, the stream of metal passing through the rarified space. Such a method should ensure a higher degree of degasification and contribute to the production of high quality steel. Over 15,000 tons of various grade steel was treated by the method of transfer under vacuum. The testing of metal from the first experimental batches by the method of stepped turning revealed that the amount of steps containing a large number of cracks constituted 3.5% for steel treated under vacuum in the ladle, and 2% for the steel treated by the method of transfer under vacuum, while for the unevacuated steel it constituted 6.9%.

Oxygen is widely utilized in our Works in electric steelmaking. The use of oxygen in the process of charge melting reduces the time of melting by about 15 - 20 minutes and correspondingly increases the operating efficiency of the furnace, lowers the electric power consumption and assists in the decarbonization of metal during the oxidizing period of the heat.

Considerable difficulties were experienced in the introduction of oxygen into metal by means of iron tubes. It was not always possible to obtain these tubes (of relatively small diameter, 19 - 25 mm) in the necessary quantity and of the grade required.

A water cooled tuyere (Fig. 1) for the injection of oxygen into liquid metal was successfully developed and adopted in the electric furnaces at the end of 1956. The tuyere, fixed above the roof of the furnace, passes through an opening in the roof and in its working position is about 150 - 200 mm above the slag level. The movement and control of the tuyere are carried out by an operator from a panel near the furnace. The adoption of the tuyere sharply reduced the consumption of the scarce iron tubings, improved the working conditions of the operators and completely eliminated the time losses which previously were necessary for the replacement of burnt tubes by new ones. With careful operation the life of water-cooled tuyeres is 40 - 60 heats.

The increase in the number of steel grades manufactured with application of oxygen and the extension of this method to batches obtained by remelting alloy wastes, raised the metal output considerably and reduced the consumption of ferroalloys and the cost of steel (see table).
On the application of oxygen the economic indices of electric furnace operation improved, the reason being an increased utilization of alloy wastes in the charge and a sharp reduction in the use of expensive soft iron.

Until recent times it was maintained that oxygen should not be used for blowing-through of the metal containing tungsten and vanadium, as both these elements burn out strongly during the oxidation process. However, tests showed that as far as tungsten is concerned this assumption is incorrect. Of course, the intense heating of the bath on oxygen blowing does not favor the course of the tungsten oxidation reaction, which takes place with heat evolution. Extensive practical evidence shows that the application of oxygen somewhat lowers the tungsten loss in burning. The vanadium loss in burning increases markedly on oxygen application, especially if there is a high vanadium content in the charge. Therefore, when the charge contains vanadium, oxygen as a process intensifier should be used only to a limited extent.

Fig. 1. Equipment of water cooled tuyere at the top of the furnace, for oxygen delivery.

Some difficulties may be encountered in the process of phosphorus removal during the operation with oxygen because a successful dephosphorization requires lowering of temperature while oxygen strongly increases the bath temperature. Two methods can be recommended for a possible complete removal of phosphorus. In order to obtain a very low phosphorus content (about 0.005% or less), oxidation of the metal to 0.10% of carbon should be made with iron ore, and the oxidation to a lower carbon content (e.g., in making transformer steel— to 0.02% C) should be carried out with oxygen. Special attention should be given to maintaining basic lime slags and to their continuous renewal so as to prevent a back transfer of phosphorus from slag to metal at the end of the oxidation period when the bath is very hot.

In ordinary steelmaking such a high degree of dephosphorization is not required; hence there is no need to complicate the oxidation period. In that case the second method may be applied: to maintain an adequate basicity of the slag during the process and at the end of the melting period. On using 2.5—3.0% of lime and applying oxygen (about 0.15—0.17% C burns out under such conditions) it is possible to obtain 0.018—0.023% P, whereas the phosphorus content usually is 0.05—0.07%.

The application of oxygen in the process of steelmaking by the method of remelting alloy waste and a partial oxidation of the bath makes possible the prevention of chromium oxidation. Therefore, on oxidation of the bath with oxygen (instead of ore) the amount of chromium oxides in the bath is reduced. The partial oxidation of the bath with gaseous oxygen, in heats treated by the method of alloy waste remelting, makes it possible to use ordinary carbon-containing scrap instead of soft iron in the charge for the heats. The cost of steelmaking is thus considerably lowered.

The modernization and the enlargement of the electric furnaces carried out during 1955 and 1956 was of great significance for the increase of electosteel output; the 10-ton capacity furnace was completely redesigned: charging boxes were replaced with bucket charging and the weight of charge was increased.

Simultaneously, with the rebuilding of furnaces, steps were taken to eliminate bottle-necks in the adjoining sections of steelmaking plants.

The modernization of furnaces made possible an increase in electosteel output of tens of thousands of tons annually.

The use of chrome iron ore for fettling the furnaces producing stainless steel increases the life of furnace linings considerably, reduces the time loss on stoppages for fettling and markedly lowers the consumption of magnesite powder. The fettling of furnaces with a mixture of 35—40% chrome iron ore and 65—60% magnesite powder gave satisfactory results. Such a mixture sinters quickly and adheres well.