the Plania Werke and Siemens. We are indebted to-day to the Plania Werke for the moulded screw, which enables electrodes to be joined together, thus doing away with the stub and machining of the electrode and the trouble of changing electrodes in the furnace. This screwed electrode applies mainly to furnaces for the manufacture and refining of steel. At the present time nearly all manufacturers are using anthracite coal as the carbon base, and while electrodes made by some manufacturers are superior to those made by others, this is mainly due to the different methods of moulding the electrodes and preparing the coal employed.

So much progress has been made in this industry in the last two or three years that perfectly satisfactory electrodes up to 24 inches (60 cm.) in diameter and 7 feet (2.1 m.) long are now being made, whilst only a few years ago nothing over 12 inches (30 cm.) square and five feet (1.5 m.) long was satisfactory. No doubt still larger electrodes can and will be built, as electric furnaces are still growing in size, and the time is not far distant when steel furnaces of 30 tons' capacity, and operating with electrodes three feet (0.9 m.) in diameter, will be as common as are our small 5-ton furnaces of to-day.

Before closing this paper, I would like to give a few hints as to the best manner of employing an electrode in order to ensure the best service and avoid the losses of which we have heard so much. Carbon, unlike metals, is a better conductor hot than cold, and the hotter it is, the better conductor it becomes. Carbon, however, even at a very high heat, is still a poor conductor, and it is impossible in actual practice to avoid some loss in the electrode itself. In all conductors, the longer the conductor, the greater the loss, but this loss can be lessened by increasing the size of the conductor. This same rule applies to electrodes, and in order to avoid all losses to the greatest extent possible the current should enter the electrode at a point as near as possible to the point where it will leave it. It is quite common practice to connect the metallic conductor to the head of the electrode, but this is a grave mistake, as the loss in volts in a long electrode will be from 4 to 6, depending on the current density employed, and in a furnace where the operating voltage is 50 volts, this loss would be equal to from 8 to 12 per cent. of the total energy consumed. Electrodes should be held in the same manner as one would hold a bar vertically in the hand, so that they can be taken at any point on their length, and in smelting furnaces the holder giving contact to the electrode should not be at any time more than 1 foot (30 cm.) above the charge. As the electrode wears away it is slipped through the holder, and the process goes on until it is finally taken by the head, but at no time should the part of the electrode carrying the current project more than 2 to 6 inches (5 to 15 cm.) from the holder itself. The losses, both of heat and energy, can be decreased by increasing the size of the electrode, but this can be carried too far. The writer would recommend a current density of from 30 to 35 amperes to the square inch of section (5 to 6 per sq. cm.) in order to keep the electrode as cool as possible and thereby prevent side oxidation and heat losses. With too large an electrode, quite a good percentage of the total energy supplied to the furnace would be required to keep the electrode warm.

An important point, the value of which is sometimes overlooked when considering the size of electrodes, is that it is often advisable to use electrodes of greater cross-section than electrical necessity demands, but for a totally different reason. In some processes, for instance, the electrode when working is surrounded to a certain depth by charge mixture. At the surface of such charge mixture, and therefore at some distance from the working end of the electrode, inflammable gases are given off, and these burning in air tend to attack and consume the electrode. Thus there is a tendency to reduce cross-section at this point with consequent increased current density, followed by rise of temperature, which further aggravates the condition described. It is, therefore, wise, for convenience sake, to use a larger cross-section so that the burning away does not result in eating the electrode through, letting a large piece of elecrode into the charge and disturbing conditions generally This is one of the exigencies imposed by practice.

FERRO-SILICON, FERRO-CHROME AND FERRO-PHOSPHORUS.

Ferro-silicon, ferro-chrome, ferro-phosphorus, etc., have been made in electric furnaces at Buckingham, Que., by the Electric Reduction Company, Limited. The furnaces were not in operation during 1910. Ferro-silicon has also been made in electric furnaces at Sault Ste. Marie, and at Welland, Ont. The electric furnaces operated by the Electric Metals Company were in operation during 1910. These furnaces, constructed some three years ago, consist of four furnaces of from 1,000 to 1,500 horse-power each, the daily production being from 5 to 8 tons.

The imports of ferro-silicon, manganese, etc., during 1910 were 18,900 tons valued at $464,741, or an average of $24.59 per ton. The imports during 1910 were 17,699 tons valued at $411,536, an average of $23.25 per ton.

Returns of steel production received direct from the producers showed a total production of ingots and castings for 1910 of 822,284 tons, as compared with 754,719 tons in 1909, and 588,763 tons in 1908. In 1910 the production of open-hearth ingots was reported as 580,932 tons, Bessemer ingots 222,668 tons, direct open-hearth castings 18,085 tons, and other steels 599 tons; compared with 1909 there was an increase in total production of 67,565 tons, or nearly 9 per cent.

Statistics showing the quantities of the principal materials used in steel furnaces have been obtained for the first time for the year 1910, and it may be of interest to refer to these here. The total quantity of pig iron used in steel furnaces during 1910 was 690,913 tons: of which 601,219 tons were produced by firms reporting, and 89,694 tons purchased. The quantity of ferro-alloys used was 8,143 tons purchased. Scrap, etc., was used to the extent of 211,453 tons, being 140,913 tons produced by the firms reporting, and 70,540 tons purchased. Ores used included 1,317 tons of manganese ore and 39,332 tons of iron ore, while 144,110 tons of limestone or dolomite flux were used 7,461 tons of fluorspar. In Ontario a little over 600 million cubic feet of natural gas were used, while in Nova Scotia, coke oven gas was used at Sydney, of which a record of quantity is not obtained.

Complete statistics of the production of rolled products and of manufactured steel have not been received. Returns from seven of the largest producers show a production of blooms, billets, slabs, etc., of 628,100 tons, of which 580,533 tons were used by the producer for further manufacture, and 47,567 tons sold to other rolling mills.

The production of rails was 399,762 tons, of rods 88,456 tons, of bars 125,778 tons, of other rolled products 31,516 tons. The production of steel rails in 1909 was returned as 377,642 tons, and in 1908, 300,935 tons.

CHEMISTRY IN SWEDEN.

Chemistry has played an important part in the industrial history of Sweden. No less than twenty of the known chemical elements have been discovered by Swedes.