paratus, amongst which has to be mentioned an integrating wattmeter, which enables us to read at any moment the power consumed and also the power used for each operation of the process. The pressure in the primary does not exceed 300 volts and the intensity varies from 1,200 to 1,400 amperes.

Some Interesting Particulars During Reduction Operations.—The furnace under review treats 1.2 tons of steel. The chemical analysis during treatment can be made with perfect ease as compared with the old combustion furnace. The whole process, which can be started at a moment's notice. lasts two or three hours, and the energy consumed varies from 300 to 500 kw. hours per ton according to the metal treated.

Efficiency of Electric Furnaces.—It is most important to ascertain the efficiency of the electric furnace as compared with the coal or coke combustion furnace and to find the relative cost of electrical and fuel heat. In order to do so, we must consider in one way or another the amount of heat each type of furnace will generate, and what amount of electric energy will be required to be transformed into heat to produce as much as, say, one pound of coal would yield when being burnt. It is well-known that one kilowatt hour is equal to 3,415 British thermal units, and if we admit that one pound of best Transvaal or Natal coal on burning will give 12,000 to 14,000 British thermal units, we find that one pound of coal will be equal in calorific value to about 4 kw. hours. The first comparison seems not in favor of electric power, as we have to pay over a half-penny per unit, but in localities where water power can be developed cheaply, and also where the cost for transport of coal is high, electric power will be at once cheaper than coal. But the above comparison is superficial, incomplete and misleading, if we neglect consideration of the utilization of the heat generated. It should be borne in mind that the utilization of heat differs in an electric from that in a combustion furnace. The largest part of the heat generated in an electric furnace is actually utilized in heating the materials in the furnace, whereas in the combustion furnace this is not the case, particularly in one which requires a high temperature, the greatest portion of the heat being simply wasted and but a very small part actually utilized.

Before going into details I shall explain what I understand by the *efficiency* of a heating apparatus, such as a furnace. The efficiency is the ratio of heat units actually utilized in heating the contents, to the total heat units supplied either in the form of coal or electricity. In this connection the following table, prepared by Prof. Richards, will be of great interest, as it shows the typical efficiencies of the different furnaces:—

Crucible steel furnace	2 to 3%
Reverberatory furnace	10 to 15%
Regenerative furnace	20 to 30%
Shaft furnace	30 to 50%
Electric furnace	60 to 85%

These figures apply both for melting or smelting. A few words of comment will explain the above-mentioned table. In the crucible and reverberatory furnaces the greater part of the heat is carried away in the hot escaping gases. In the shaft furnace the heat is largely absorbed by the solid materials, mostly in the upper portions of the furnace. The furnace gases which are produced in electric smelting are very much less in volume than in combustion furnaces. Another point to be considered is the amount of atmospheric air that passes through the combustion furnaces in excess of that actually required to burn the fuel, which increases the already great loss of heat; and lastly, there is a serious loss due to incomplete combustion of fuel. All shut-downs, which are mostly inevitable, tend to lessen the efficiency of combustion furnaces, but the same does not apply to electric furnaces, as the supply of electrical energy is simply cut off. Thus, comparing the relative costs of electric and fuel combustion from the point of efficiency or useful work done, the electric furnace proves to be cheaper.

Experiments have been made, and it was established by actual measurements, that a much larger proportion of the heat generated electrically is transferred to the furnace charge than it is possible in a combustion furnace, in which the carrier of heat consists of a larger volume of gas, and in spite of all regenerative (Siemens) methods for smelting work, the method of heat transference by the individual hot gas molecules to the metal baths is a faulty one indeed. In the electric furnace, however, the main portion of heat is generated in the space intervening between the electrode and the slag, which space is less than an inch in width. The bottom surface of the electrode is at the volatilization temperature of the carbon, and thus a considerable portion of heat passes to the smelting charge by radiation, by means of carbon vapor. The carbon vapor, which starts from the electrode, is impinging continually on the surface of the slag, and is consumed by the slag oxides. In this way both fused materials, metal and slab, themselves form additional producers of heat. They further serve as resistance in the path of the current, and the layer of slag converts a very large amount of electricity into heat. The distribution of heat in the electric furnace is a long way the more economical. A most energetic reaction takes place in the space between the overheated particles of the slag, the electrodes and the constituents of the metal bath, which is the reason of the immense success of the operation. The rapidity of the work is due to the high current density, the enormous heat production in a narrow space, and the very great rapidity of the chemical reactions. All this produces an energetic mechanical flow of the liquid particles in the slag and the metal, which has a most favorable influence upon the desired change of constitution.

There will probably be many sceptics as to whether the electric furnace will supplant the different combustion furnaces mainly for smelting now in use on the Rand, but to those I would point out that at the end of 1910, France had only one electric furnace, and hardly twelve months later the number grew to thirty-five. Electricity has won the day everywhere, in spite of conservative opposition, and ere long war will be declared on the old combustion furnace, and I would recommend everyone to be on the side of the electric furnace.

The development of the natural gas areas in New Brunswick is proving a boon to the Intercolonial Railways. In the shops at Moncton it is used exclusively for the generation of power. The steady and reliable heat makes it an ideal fuel for the blacksmiths' forges, furnaces and gas engines. Being immediately ready for use there is no time wasted in "firing-up." Over 30,000,000 cubic feet of gas were used in September, and in the winter months 50,000,000 feet per month will be necessary to meet the railway's requirements, and results show considerable saving in expenditure. It is not generally known that this gas is used for the lighting of the railway's passenger cars all over the line.