ELECTRIC FURNACES.*

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The electric furnace is to-day no longer a laboratory device; it has taken a prominent place in the industries and has become a very important commercial apparatus, its importance growing daily Among the present uses of the electric furnace may be mentioned the refining of steel, the reduction of iron ores by means of water power, the production of aluminum, silicon, graphite, carborundum, alundum, calcium carbide, other carbides, bisulphide of carbon, ferro alloys, fused jewels, etc.

The electric furnace even promises to affect the wealth of nations. Sweden, one of whose national products for many generations was the famous Swedish iron, has for some time past been losing this important industry owing to the greatly increased cost of charcoal. But owing to the enormous water powers in that country, and the generous and wise aid of its parental government in developing them, Sweden will now be able to again recover that important national industry by means of the electric furnace, which requires only a fraction of the charcoal that the blast furnace does, and which enables the iron to be converted directly into refined steel of considerably higher money value.

Canada and the states along the Pacific coast, which abound in water powers and mines, but have no cheap coal, will no doubt also be greatly benefited by the electric furnace for reducing and refining the metals, provided nature's generous gift of water power will not be allowed to become monopolized by private interests, whose charges for power are governed only by the rule to charge "the highest price that the traffic can bear." The developments of the electric furnace industry will depend greatly on whether or not the governments can keep control of the water powers and regulate the charges.

In its general principle, the electric furnace is an extremely simple device, as it merely converts the most available form of energy, namely, electric energy, into the lowest and most degenerate form, heat.

The engineering skill required in the design and construction of electric furnaces lies not in the fundamental conversion of energy, but in building them well and efficiently, the latter being of far greater importance than in combustion furnaces in which the cost of a unit of heat is so much less that great economy is not of so much importance.

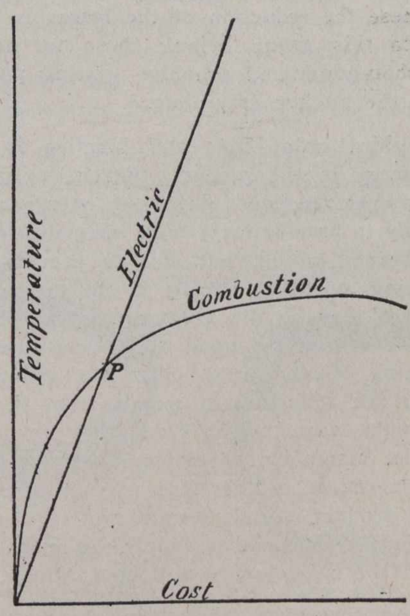
A comparison of the costs of electric and fuel heat depends so largely on local conditions, that a general comparison would not be of much value. But there are certain important characteristic differences between the two which can be compared in a general way, and a comparison of these is quite instructive.

In the accompanying diagram, Fig. 1, let the horizontal distances represent costs and the vertical ones temperatures, and let the curves represent the costs of heating a given body, say a ton of steel, to the various temperatures, neglecting such modifying factors as latent heats and variations in the specific heats. The general shapes of the curves for the combustion heat and the electric heat will be roughly about as shown. For the combustion heat the costs for the lower temperatures will be seen to be quite small, but as the temperatures become high the costs increase very much more rapidly, so much so that the curve finally becomes horizontal and even falls again, hence has a maximum point. Beyond this point the volume of gases in the blast becomes so great that they carry off the heat more rapidly than the fuel can supply it, hence they actually reduce the temperature by chilling the fuel or the gases.

The corresponding curve for electric heat is roughly a straight inclined line; in other words, the cost increases at an approximately constant rate, and there is no maximum point, as long as there exists a material to carry the current. The two curves therefore always intersect each other, and at this point P the costs are equal.

It will readily be seen therefore that low temperature heat is in general generated more cheaply by combustion, while for the high temperature heat it is cheaper to use electricity; also that for temperatures above the point P the cheapest way would be to combine the two, using combustion heat for the lower temperatures, below this point of intersection, that is, for melting or preheating cold charges, and electric heat for the higher temperatures, above the point P. This is what is now common practice in the electric steel industry, in which the melting is done by combustion heat, the hot metal being then run into the electric furnace for further treatment. If it were possible to so construct an electric furnace that both kinds of heat can be applied in the same furnace, then the advantage and the economy of this ideal combination could be fully realized. Such a furnace will be described below.

FIG. 1.



The relations of these two curves will, of course, vary with local conditions, and their shapes will also change somewhat; they should therefore be considered as showing only the general characteristics.

The maximum temperature for the combustion curve in commercial furnaces is in the neighborhood of those used in the iron industry, roughly between 1,500° to 1,900° C. (2,700° to 3,400° F.). The maximum for the electric arc furnace with carbon electrodes is their volatilization point, about 3,500° to 4,000° C. (6,000° to 7,000° F.), or just about double, hence far greater than necessary for most metallurgical purposes.

The chief advantages of electric furnaces over those of the combustion type are too well known to require more than mention here. They include the neutral atmosphere, that is, the heat is neither oxidizing nor reducing; the pos-

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