THE USE OF ELECTRICITY IN THE STEEL HARDENING ROOM.

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IN April 16th, 1914, issue of *The Canadian Engineer* the writer attempted to present in a general way the heat treatment operation of steel known as the process of hardening, and to explain its effect in relation to the varying composition which the material may have. The article referred to the critical temperatures which were associated with steels of different carbon content, and touched upon the theory governing the peculiar phenomena and characteristics one found in connection with the process. The necessity of accuracy for good results in the hardening of carbon steel was emphasized, and it is the purpose of this article to describe a practical means of determining the correct temperatures upon which these good results depend.

The necessary apparatus for the process which the writer has in mind consists of a small electric furnace in which to heat a specimen of the steel to be tested, a special thermo-couple pyrometer for indicating the temperature of this specimen throughout its range of heating, and a specimen itself, properly shaped for clamping to the thermo-couple. The apparatus for this purpose, as shown in Fig. 1, illustrating what is known as the Hoskins' recalescent outfit has a crucible chamber 2 1/16 in. in diameter and 2½ inches deep. Heat is produced by means of the resistance offered to the passage of an electric current through the "resistor" or heating element. This "resistor" is of a special metal in the form of wire which is wound in close contact with the chamber

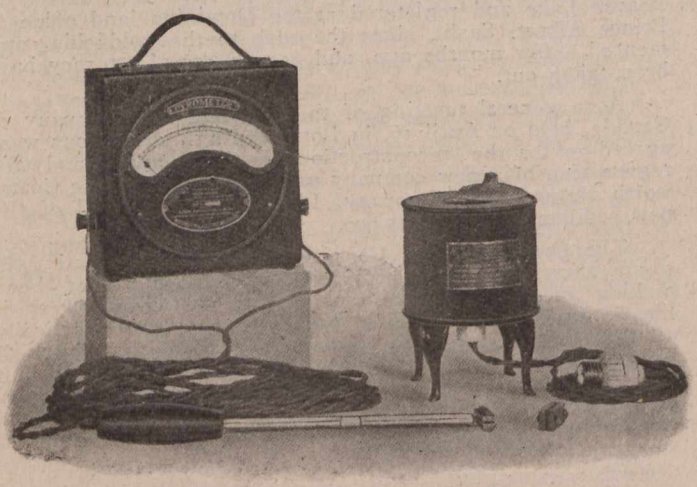

Fig. 1.—Recalescent Outfit. Note the two test specimens of steel, one fastened to couple.

lining. The furnace is designed so that it can be used on standard lighting circuits to which ready connection is made by means of a twin-conductor cord and lamp plug. In operation, it consumes 3½ amperes at 110 volts and is capable of producing a chamber temperature of 1,000° C. (1,832° F.) which is considerably higher than any required by a carbon steel.

The pyrometer of the outfit is of the thermo-electric type. This instrument embraces a thermo-couple, connecting leads and indicating meter. The thermo-couple is of small wire so as to respond quickly to any slight variation in temperature. The welded end of this couple is slightly flattened to enable the making of a good contact between it and the specimen of steel. The meter is portable and indicates temperatures up to 1,400° C. (2,552° F.).

The specimens of the steel to be tested should be small so as to heat quickly and uniformly. A well-formed specimen is made with two duplicate parts, each 1¼ inches long by ½ inch wide by ¼ inch thick. These pieces are clamped, by means of two ⅛ inch bolts, one on either side of the welded part or extreme end of the thermo-couple. Care is taken to form a tight contact,

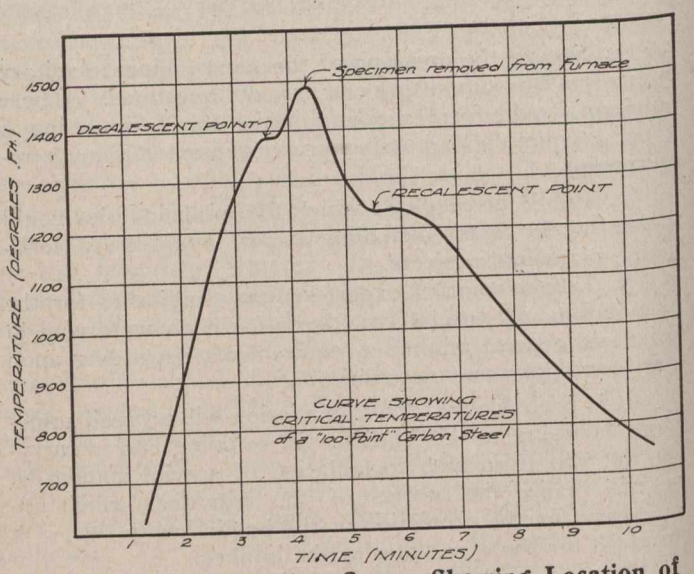

Fig. 2.—Heating-cooling Curve, Showing Location of "Critical Temperatures."

though not to cause an undue strain on the couple. The dimensions here given for the test specimen are not essential, though convenient; any pieces which will permit of tight contact with the thermo-couple and of ready heating in the furnace chamber, may be used.

Method.—With the specimen fastened to the couple, as just described, the furnace is connected in circuit and the cover placed over the chamber opening. The temperature within the chamber rises steadily. When it becomes 925° C. (1,700° F.) the end of the couple, with specimen attached, is inserted in the chamber.

The steel specimen rapidly heats up, its temperatures being constantly the same as that of the welded junction of the thermo-couple, due to the intimate contact between them. This temperature, indicated by the meter, will rise uniformly until the "decalescent" point of the steel which is being tested is reached. At this temperature the indicating needle of the meter becomes stationary, the added heat being consumed by internal changes instead of by increase of temperature. These changes completed the temperature again rises, the length of the elapsed period of time depending upon the speed of heating. With the furnace temperature kept constant at the initial point here given (925° C. or 1,700° F.), this "speed of heating" will be such as to allow of readily observing the pause in motion of the needle. The temperature at which this occurs should be carefully noted as it is the decalescent point.

To obtain the lower critical point, the temperature of the piece is first raised above the decalescent point by about 40° C. (104° F.). In this condition it is removed from the furnace and rested on top to cool. The decrease of temperature is at once noticeable by the fall of the meter needle. At a temperature somewhat below the