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C. L. IPSEN

HEAT TREATMENT OF METALS

Filed July 10, 1925

Fig. 1.

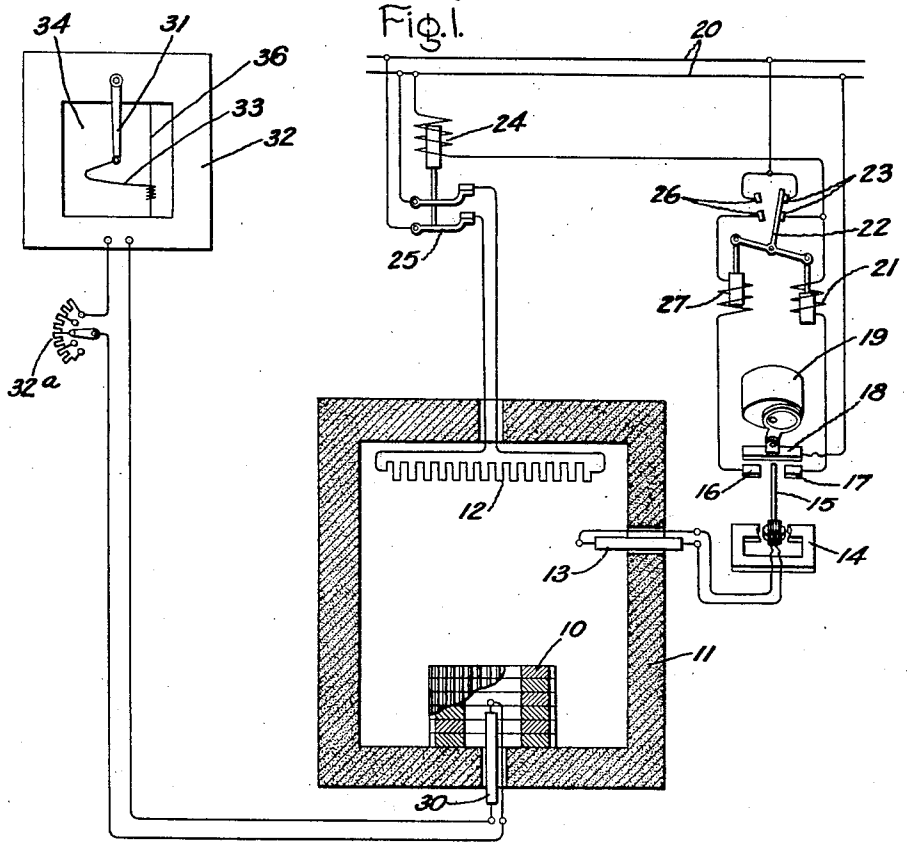


Fig. 2.

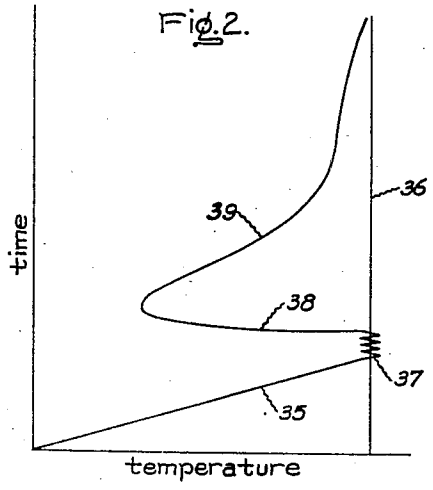
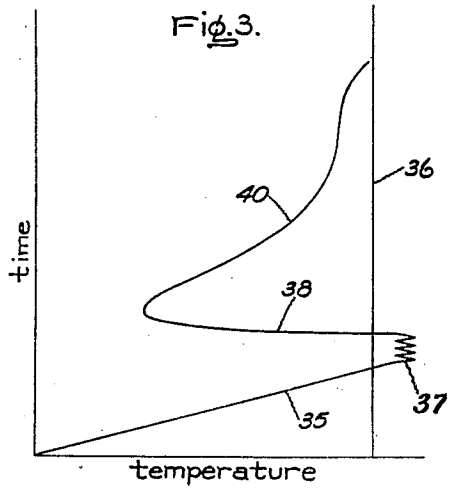


Fig. 3.



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UNITED STATES PATENT OFFICE.

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HEAT TREATMENT OF METALS.

Application filed July 10, 1925. Serial No. 42,779.

My invention relates to the heat treatment of metals for various purposes, such as hardening, refinement of grain, annealing, etc., and has for its object the provision of a method of and apparatus for heat treatment giving a high degree of excellence and uniformity of results.

My invention has especial application in the heat treatment of metals for the purpose of hardening them. Ordinarily such heat treating processes are dependent to a great degree on the skill of the operator in determining when the metal has been heated to the proper temperature.

In carrying out my invention, I maintain the temperature of the furnace at the desired temperature of the charge, or at a slightly higher temperature, and provide a pyrometer responsive to the charge temperature which actuates a pointer with reference to a reference mark representing the desired maximum temperature of the charge. The operator therefore has only to note the position of the pointer with reference to the reference mark and quench the charge when the pointer moves on this mark.

For a more complete understanding of my invention reference should be had to the accompanying drawing in which Fig. 1 is a view showing in diagrammatic form means for heat treating in accordance with my invention, while Figs. 2 and 3 are views showing typical temperature time curves produced by my method.

Referring to the drawing, I have shown my invention in one form as applied to the heat treatment of steel for hardening purposes. The articles to be heat treated consist of a stack of steel gears 10 which are placed in an electric furnace 11 provided with a heating resistor 12.

The temperature of the furnace is automatically maintained at the proper quenching temperature for the gears 10, this temperature having been previously determined for the particular material of the gears by means of suitable tests. For the purpose of automatically controlling the temperature of the furnace a pyrometer 13 is provided which is introduced into the furnace chamber through a suitable aperture in the furnace wall and which is shown in the form of a thermocouple having its terminals connected to a suitable galvanometer 14. The pointer 15 of the galvanometer is in a position to swing over two spaced contacts 16 and 17 in response to the temperature of the furnace. Cooperating with the contacts 16 and 17 is a reciprocating contact 18 which, during the operation of the furnace, is moved back and forth, toward and away from the stationary contacts, but without touching them, by means of an electric motor 19.

The adjustment of the contacts 16 and 17 is such that the galvanometer pointer 15 takes up a position midway between them when the furnace is at the proper quenching temperature, as shown in the drawing. If the furnace temperature rises above the quenching temperature a predetermined amount, for example two degrees C., the pointer 15 will move to the right over the contact 17 and will be squeezed between this contact and the reciprocating contact 18 upon the next downward movement of the latter. This closes a circuit from the supply source 20 through an operating coil 21 which thereupon throws a switch arm 22 to the left out of contact with the stationary contacts 23 whereby the circuit of the coil 21 and also an operating coil 24 is opened. The deenergization of coil 24 allows the contactor switch 25 to move to open position and thereby disconnect the resistor 12 from the supply circuit 20. The switch arm 22 when thrown to the left comes to rest in engagement with a pair of stationary contacts 26 which are in circuit with an operating coil 27.

As the temperature of the furnace now falls, due to deenergization of the resistor 12, the pointer 15 moves toward the left and upon the occurrence of a predetermined minimum temperature which may, for example, be five degrees below the desired quenching temperature, the pointer moves above the stationary contact 16. When in this position the pointer is squeezed between the stationary contact 16 and the reciprocating contact 18 and a circuit thereby closed through the coil 27 whereby the switch arm 22 is thrown back to the right into engagement with the contacts 23 and the circuit of the coil 24 thus completed, the circuit of the coil 27 being opened by the disengagement of contacts 27 by the arm 22. The energization of the coil 24 closes the contactor switch 25 and thus reconnects the resistor 12 to the supply source. The furnace temperature now rises and upon the reoccurrence of the

predetermined maximum temperature, the pointer 15 is again moved over the stationary contact 17, whereupon the control cycle is repeated as previously described. The furnace temperature is thus maintained automatically at the desired quenching temperature within predetermined minimum and maximum limits. Obviously any suitable system can be used for automatically regulating the temperature of the furnace.

A second pyrometer 30, shown as a thermocouple, is introduced through a suitable aperture in the furnace wall and placed in close proximity to the stack of gears 10 so as to be responsive to the temperature of the gears rather than to the temperature of the furnace interior. As shown, the pyrometer 30 is placed inside the stack of gears. This pyrometer is connected to a galvanometer, not shown, which is provided with a pointer 31 forming a part of a recording instrument 32 of any suitable form. The pointer 31 carries suitable means, such as ink, for inscribing a line 33 on a strip of paper or chart 34, which is moved beneath it at a uniform rate. The line 33 thus takes the form of a temperature time curve for the stack of gears.

In heat treating materials in accordance with my invention the furnace is started and heated while empty to the desired quenching temperature of the material. At this time the pyrometer 30 is exposed to the temperature of the interior of the furnace, and the pointer 31, therefore inscribes a straight line 35, as indicated in Fig. 2. When the furnace temperature has reached the predetermined quenching temperature for which the automatic regulating mechanism is set, the pointer 31 is adjusted, if necessary, to rest on a reference line or mark 36 on the chart, this reference line being in a direction to represent some predetermined temperature, i. e., in the direction of movement of the chart. This adjustment of the pointer can conveniently be made by varying the electrical resistance in circuit with the pyrometer 30 for example by adjusting a rheostat 32^a included in its circuit. When the pointer 31 is thus set on this line, the line becomes an indication of the quenching temperature for the charge. The pointer 31 will now make a zigzag line as indicated at 37 (Fig. 2) due to the small variations in temperature between the maximum and minimum limits occurring under the automatic regulator mechanism.

After the apparatus has been thus adjusted, the charge or stack of gears 10 to be treated is placed in the furnace in the location with respect to the pyrometer 30 previously described. The pointer 31 now describes the nearly straight portion 38 (Fig. 2) of the curve indicating a rapidly falling temperature due to the fact that the pyrometer 30 is now exposed to the cold gears 10. As the temperature of the gears begins to rise the pointer 31 moves back toward the reference line 36 inscribing the portion of the curve 39, the rate of temperature rise decreasing rapidly as indicated by the increasing curvature of this portion of the curve. When the temperature of the charge is near the quenching temperature, i. e., the temperature of the furnace, the curve 33 approaches parallelism with the reference line 36 indicating a slow increase in temperature. This period of slow temperature rise gives the charge an opportunity to become uniformly heated throughout.

Throughout the heating operation, the furnace operator simply watches the position of the pointer 31 with respect to the reference line 36, and when the pointer rests on the reference line the operator removes the charge and quenches it. It is not necessary for the operator to read temperatures or even to know the quenching temperature. He has simply to note when the pointer rests on the reference line. The success of the process is therefore not dependent to any great extent upon the degree of skill and care exercised by the operator.

If desired, in order to shorten the heating period and thereby increase the capacity of the furnace, the temperature in the furnace may be maintained somewhat higher than the desired final temperature of the charge. When this is done the furnace and recording instrument 32 are initially adjusted, as previously described, with the furnace empty and automatically maintained at the desired quenching temperature in such manner that the pointer 31 rests on the reference line at this temperature. Thereafter the automatic mechanism is set to maintain a higher furnace temperature. This adjustment may be made in the arrangement shown by moving the two contacts 16 and 17 together toward the right a predetermined amount. With the furnace maintained at this higher temperature the rate of heating of the charge will be more rapid as indicated by the more gradual curvature of the heating portion 40 of the curve shown in Fig. 2. For example, with a desired quenching temperature of 1500° F., the furnace control mechanism may be set to maintain a temperature of 1600° F. As before, the operator has simply to watch the pointer 31 of the recording instrument and quench the charge when the pointer rests on the reference line 36.

While I have described my invention as embodied in concrete form and as operating in a specific manner in accordance with the provisions of the patent statutes, it should be understood that I do not limit my invention thereto, since various modifications thereof will suggest themselves to those

skilled in the art without departing from the spirit of my invention, the scope of which is set forth in the annexed claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The method of hardening steel which consists in heating a furnace while empty to the proper quenching temperature of the steel, setting a charge temperature indicator on a definite reference mark at this temperature, placing a charge of said steel in said furnace whereupon the charge temperature indicator shows the temperature of said charge, maintaining the temperature of said furnace at least as high as said quenching temperature, noting the approach of said charge temperature indicator to said reference mark as the charge is heated, and then quenching the charge when said indicator is approximately on said reference mark.

2. In the heat treatment of metal, the method of heating the metal in a furnace provided with a temperature indicator closely associated with the charge so as to indicate the temperature of the charge, which consists in heating the furnace without a charge to the desired temperature for the metal, whereby said charge temperature indicator is subjected to said temperature, setting the charge temperature indicator on a definite fixed reference mark while maintaining the furnace at said desired temperature, inserting a cold charge in said furnace whereupon the charge temperature indicator shows the temperature of the charge, maintaining the furnace temperature at approximately said desired temperature of the charge as the charge is heated, noting the approach of the charge temperature indicator to the reference mark as the temperature of the charge approaches the temperature of the furnace, and then removing the charge when the indicator is approximately on said reference mark.

In witness whereof, I have hereunto set my hand this 9th day of July 1925.

CARL L. IPSEN.