June 13, 1933. H. I. ALTSHULER ET AL 1,913,580

ELECTRIC FURNACE

Original Filed April 23, 1928 2 Sheets-Sheet 1

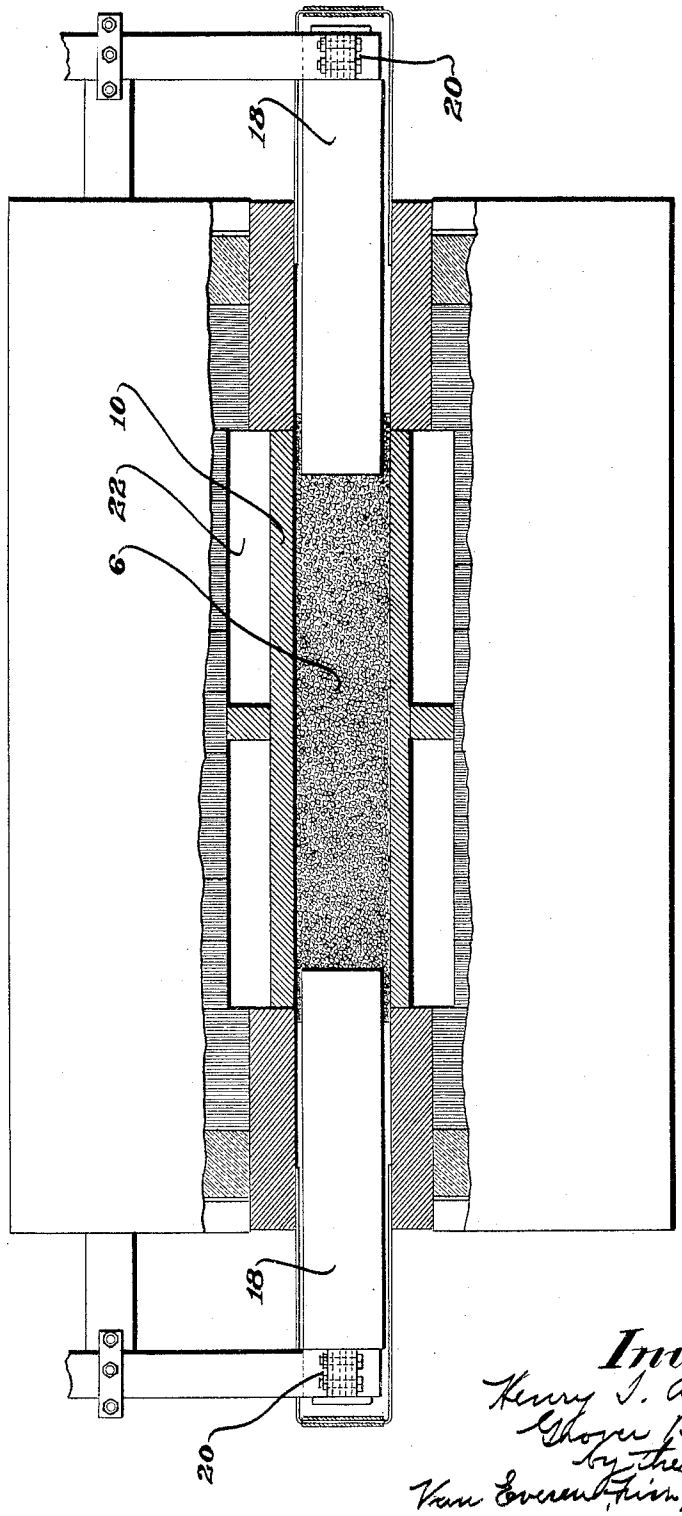


Fig. 1

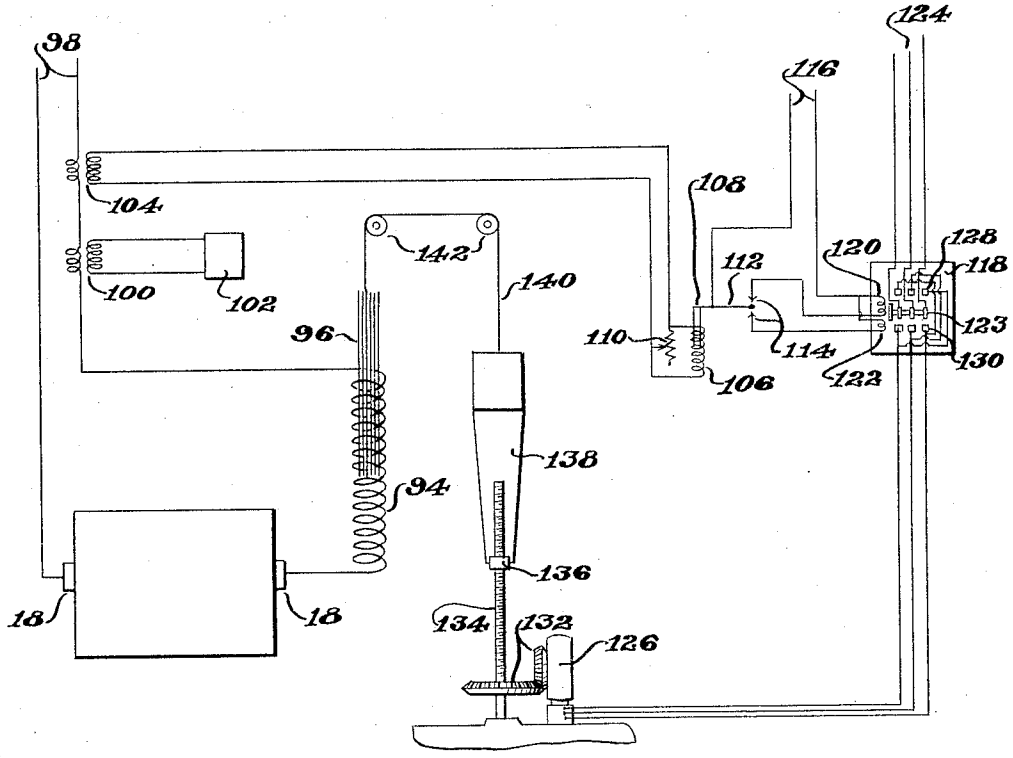
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Fig. 2



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UNITED STATES PATENT OFFICE

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ELECTRIC FURNACE

Original application filed April 23, 1928, Serial No. 272,122. Divided and this application filed March 24, 1931. Serial No. 524,844.

The present invention relates to electric furnaces and method of operating the same. This application is a division of our co-pending application, Serial No. 272,122, filed April 23, 1928.

One of the objects of the present invention is to provide an electric furnace and method of operating the same whereby the temperature may be accurately adjusted and maintained at a predetermined uniform value even under widely varying demands.

With this and other objects in view as will hereinafter appear, one feature of the invention comprises a resistor type furnace having a temperature control by which the temperature is maintained substantially constant over long periods and under varying demands. The method of control consists in maintaining the current through the resistor material substantially constant. Experiments have shown that the maintenance of constant current in a furnace of this type serves effectively to keep the heating temperature substantially uniform. The feature of temperature control by constant current is simpler than attempted control by automatic devices whose operations are functions of the furnace temperature. Temperature control by maintenance of constancy of current through the resistor material further offers the advantage that upon a variation in temperature following a change in the demand on the furnace the temperature is restored to its predetermined value in a minimum of time and without fluctuations or oscillations of temperature above and below the normal value.

Although other means for maintaining constant current in a circuit may be employed for effecting the above method of temperature control, this invention comprises a preferred apparatus by which the current is automatically held at the predetermined value necessary for maintenance of the desired value.

In the accompanying drawings illustrating what is now considered to be the preferred form of the invention, Fig. 1 is a horizontal partly sectional view of an electric furnace, showing the resistor element and the electrodes, and Fig. 2 is a diagram of the circuit connections for the temperature adjusting and controlling means.

As illustrated and described herein, the invention comprises an electric resistance furnace for heating drill steels by radiation to desired temperatures. The heating element comprises a mass of granular carbon resistor material to which current is conducted by carbon electrodes. The granular material is contained in a box which extends longitudinally throughout the length of the furnace, the boxes being completely covered and closed to prevent access of air. The heating chambers into which the materials to be heated are introduced are formed by suitable vertical and horizontal partitions to facilitate introduction and withdrawal of the materials through ports in the furnace walls while avoiding unnecessary heat losses.

Referring to the drawings, the granular carbon resistor material 6 is enclosed in a box formed by the walls 10 and the adjoining walls at right angles thereto. Current is carried to the resistor by the electrodes 18. The electrodes are supported by any usual or preferred form of bracket 20 arranged externally of the furnace. Externally of the resistor box are a plurality of heating chambers 22, to which access is gained by suitable ports.

The construction of the furnace is described in detail in our co-pending application above referred to.

In operation, the furnace is energized by the flow of current between the electrodes 18 and through the granular resistor. The materials to be heated are inserted into the furnace through the ports in the walls and are heated by radiation.

As thus described, the furnace is subject to some fluctuation in temperature. Where a large number of drills are being heated, the demands on the furnace will increase and the temperature will tend to drop. The material has a negative temperature coefficient which results in a decreased resistance as the furnace warms up, and an increased resistance when the temperature drops. Control of temperature by the maintenance of constant

current has been found to yield a substantially uniform temperature even though the demands on the furnace may vary considerably. In its broader aspects, the invention contemplates the method of control by maintenance of constant current, however the conformity of the current may be obtained, and it is therefore within the scope of the invention to employ well known devices for this purpose, such for example as a constant current transformer. However, because of its simplicity and accuracy of control, the system shown in Fig. 2 is preferred.

This preferred control apparatus comprises an automatically variable impedance consisting of a reactor coil 94 which is in series with the furnace electrodes 18 and which has amovable core 96. The alternating current line 98 which serves to energize the furnace is connected through a current transformer 100 with an ammeter 102. A second current transformer 104 is connected with automatic devices for moving the core 96 with respect to the reactor winding 94.

The terminals of the secondary of the current transformer 104 are connected with a relay which comprises coil 106 and a movable core 108. The winding 106 is shunted by a rheostat 110, and the setting of the rheostat will determine the value of the current at which the relay 106 will operate, and consequently the temperatures which the furnace will constantly maintain.

The core 108 of the relay is connected with a movable switch member 112 which is adapted for engagement with one of the two opposed contacts 114. When the current is of the proper value, the switch arm 112 lies between the contacts 114 without making contact with either of them, but with increase of the current, the core 108 will be attracted into the relay coil 106 thereby closing the switch on the upper contact 114. Similarly, a decrease in current will close the switch on the lower contact. A line 116 connects through the switch arm 112 and its contacts 114 with a reversing switch relay 118. Upon closure of the switch on the upper contact, a coil 120 of the reversing switch relay is energized and similarly upon closure of the switch 112 on the lower contact, a coil 122 is energized. These two coils control a reversing switch 123 in a three-phase line 124 leading to a small induction motor 126.

As shown diagrammatically in Fig. 2, the coils 120 and 122 control an armature 125 which carries the movable switch contacts 123, all of which are insulated from each other. When the switch arm 112 is open, the contacts 123 are in neutral position with respect to two sets of fixed contacts 128 and 130, the latter being connected to the three phases of the motor. The movable contacts 123 are connected with the three-phase line 124 and the contacts 128 are connected with the contacts 130, as shown in Fig. 6, in such a manner that closure of the reversing switch on the contacts 130 reverses two of the phases, thereby reversing the direction of rotation of the motor.

Normally when the current in the line 98 is of the proper value, the reversing switch is open and the motor is stopped. The motor shaft connects through a pair of bevel gears 132 with a shaft 134 which is threaded through a nut 136 on a vertically movable member 138. The member 138 is connected by a cord 140 passing over pulleys 142 with the reactor core 96. Upon a change of current from its predetermined value, the reactor core is therefore automatically moved in or out of the reactor winding. Thus when the current increases, the core is permitted to move farther into the winding to increase the reactance and thereby to limit the current until the switch 112 again opens and stops the motor. Similarly, upon a decrease of current, the core 96 is retracted and the reactance is decreased until the current is brought to its original value.

Although it is generally assumed that constant temperature may be maintained by a constant power input, the advantages of constant current control may be made apparent by considering an example of a condition where the demands upon the furnace are subject to a considerable variation. Suppose the furnace to have been operating at a constant temperature to heat a moderate number of drills. If now it becomes necessary to increase the demands on the furnace by introducing an increased number of cold drills, a larger amount of heat will be required and the abstraction of this heat will cool the resistor. The carbon resistor has a negative temperature coefficient and upon cooling, its resistance increases, thereby tending to decrease the current through it. This decrease in current sets the automatic control devices in operation and the current is thereby restored to its original value. The power supplied to the furnace is thus increased under the control of the resistance of the resistor. This increased power results in an increased generation of heat which brings the furnace to its predetermined heating temperature in a minimum of time. As the furnace is being restored to its normal temperature, the resistance of the granular material gradually decreases and with it the power, the current being maintained substantially constant at its original value at all times. If it were attempted to adjust for constant power at all times, it will be seen that when the resistance of the granular material increases following an increase of load on the furnace, the current will be somewhat decreased and the power input will be lower than in the case of constant current control, thereby requiring a longer time to bring the

heating chambers to the proper temperature.

Similarly, if the load on the furnace is suddenly decreased by removal of a large number of drills, the furnace tends to heat up and the resistance decreases. The supply of constant current to the resistor, according to the present invention, results in a decreased power input which permits the furnace temperature to be restored quickly to its normal value under the decreased load; whereas if a constant amount of heat were dissipated in the resistor by maintenance of constant input, the furnace would require a considerable time to cool to the proper temperature for heating the drills.

The invention has been illustrated and described as embodied in a specific form of furnace utilized for heating drill steels, as its construction and control adapted it particularly for such or some analogous use when the work requires a uniform heating within close temperature limits. It is understood, however, that the invention is not limited to this particular use or to the specific arrangement of parts except as limited by the claims but may be employed for other and different kinds of work and may be constructed in different forms.

The invention having been thus described, what is claimed is:

1. An electric furnace comprising a body of resistor material having a negative temperature coefficient of resistance, means for conducting current to the resistor material, a continuously variable impedance in series with the resistor material, and means operated upon a variation in current through the resistor material to vary the impedance and thereby to restore the current to its original value.

2. An electric furnace comprising a body of resistor material, a continuously variable impedance in series with the resistor material, a relay, means for operating the relay upon a change of current from its normal value, and means acting upon operation of the relay for varying the variable impedance to restore the current to its normal value.

3. An electric furnace comprising a body of resistor material having a negative temperature coefficient of resistance, means for conducting current to the resistor material, a continuously variable impedance in series with the resistor, and means controlled by a variation in the resistance of the resistor to cause a compensating change in the variable impedance to restore the current to its original value.

4. An electric furnace comprising a body of resistor material having a negative temperature coefficient of resistance, means for conducting current to the resistor material, a continuously variable impedance in series with the resistor and having a movable core, and means controlled by a change in current due to a change in the resistance of the resistor to move the core and thereby to effect a compensating change in the impedance to restore the current to its original value.

In testimony whereof we have signed our names to this specification.

HENRY I. ALTSHULER.
GROVER B. LANTZ.