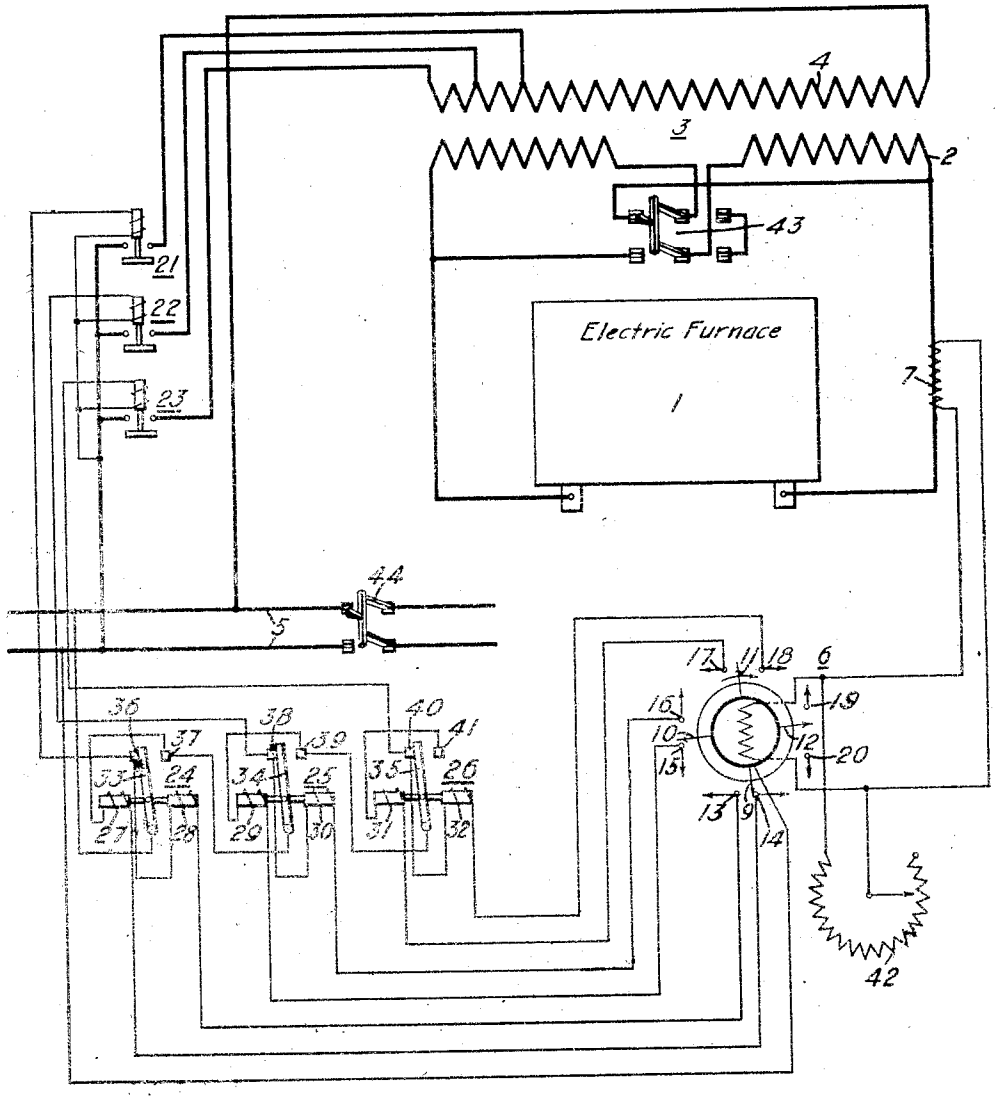
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CONTROL SYSTEM FOR ELECTRIC FURNACES.

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1,349,379. Patented Aug. 10, 1920.



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CONTROL SYSTEM FOR ELECTRIC FURNACES.

1,349,379. Specification of Letters Patent. Patented Aug. 10, 1920.

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To all whom it may concern:

Be it known that I, EDGAR A. HESTER, a citizen of the United States, and a resident of Edgewood Park, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Control Systems for Electric Furnaces, of which the following is a specification.

My invention relates to control systems for electric furnaces and it has special relation to those electric furnaces in which the resistance is comparatively high at the time of starting and which possess a negative temperature coefficient during the operation thereof.

Since the current in a furnace of the character above designated increases as the temperature of the furnace increases, it is necessary to associate with a furnace of such character a control system which will operate to decrease the voltage impressed upon the furnace as the temperature rises and, when the proper temperature has been reached, to so maintain the desired voltage that the conditions within the furnace will become stabilized.

It has heretofore been suggested that the desired control could be obtained by associating thermal relays with furnaces of this type. However, it is not possible, from an operating standpoint, to directly connect the switches necessary to vary the power supplied to a furnace with a thermal relay in such a manner that satisfactory conditions will be attained. This follows from the fact that the thermal relay, by reason of its delicate construction, can not carry sufficient current to operate the magnetic coils usually employed with switches of this type.

It is, therefore, necessary to interpose, between the main switching mechanism and the relay which controls this mechanism, such means as will transfer the energy from the relay to the switching means, and it is with this transfer apparatus that difficulty has been met. The apparatus in question must be of a compact and simple nature and not be liable to get out of order under the extremely severe operating conditions which pertain to electric furnaces of the type above-mentioned. Moreover, it is also necessary that such transfer means be reversible in character, that is, not only must the proper control be maintained when the temperature in the furnace is increasing but the control mechanism must also operate in such a manner that, should the furnace tend to become excessively hot, it could be removed from its source of power supply and, therefore, be allowed to cool for a predetermined time.

The objects of my invention are, therefore, to obtain the desired control of an electric furnace and to maintain the temperature in such furnace, in the manner above described, with a minimum amount of switching apparatus and with standard control apparatus, so far as possible.

For a better understanding of my invention, reference may be had to the accompanying drawing, the single figure of which illustrates diagrammatically a control system constructed in accordance with my invention. A furnace 1 is shown as supplied with power from the secondary 2 of a transformer 3. A primary winding 4 of the transformer 3 derives energy from a supply line 5. A thermal relay 6 is shown as operatively associated with the furnace 1 through a current transformer 7 which is inductively interlinked with one of the leads of the furnace. The energy induced in the secondary winding of the transformer 7 is translated into heat in a heating element which is disposed within the thermal relay 6.

Contact members 9, 10, 11, and 12 are disposed peripherally upon the relay 6. Associated with the respective members 9, 10, 11 and 12 are pairs of terminals 13—14, 15—16, 17—18, and 19—20, the contact members 9, 10, 11 and 12 oscillating between their associated pairs of terminals. For purpose of convenience, only three of the contact members, namely, members 9, 10, and 11 are used for control in the present invention. It will be understood, however, that any number of contact members and associated pairs of terminals may be used and, in this manner, any desired range of control obtained.

For a better understanding of the thermal relay as shown, reference may be had to a copending application, Serial No. 269,093, filed Dec. 31, 1918, by O. A. Colby, and assigned to the Westinghouse Elec. & Mfg. Company.

Magnetically operated switches 21, 22 and

23 serve to vary the number of effective turns of the primary member 4 of the transformer 3 and, by their successive closure therefore, also vary the amount of voltage impressed upon the furnace 1.

Transfer switches 24, 25 and 26 are interposed between the relay 6 and the switches 21, 22 and 23 and are adapted to be actuated by energy derived from the line 5. Actuating coils 27 and 28 are associated with the switch 24, coils 29 and 30 with the switch 25, and coils 31 and 32 with the switch 26. Furthermore, the movable member 33 of the switch 24 is adapted to be moved between terminals 36 and 37; the member 34 of switch 25 between terminals 38 and 39; and the member 35 of the switch 26 between terminals 40 and 41.

A regulating resistance 42 is shown as connected in the relay circuit and is used for purposes hereinafter to be described. The secondary winding 2 of the transformer 3 is divided into two portions, which are adapted for either series or parallel connection by a switch 43.

A line switch 44 is provided to energize the conductors 5 from a source of electrical energy (not shown).

Having described a system of connections as used with my improved system of control, the operation thereof is as follows: Assume that the furnace is started from a cold stand and that, therefore, its resistance is of maximum value. Also assume that the relay 6 has its contact member 9 engaging the terminal 14. Obviously, any of the other terminals and their associated contact members could be assumed as closed and the operation of the system varied in accordance therewith but, for the purposes of illustration, I have shown that pair of terminals which are placed closer together as the ones to be first engaged.

The line switch 44 is closed and the magnetically operated switch 21 is, therefore, also closed, and the highest possible voltage is impressed upon the furnace. At this point in the operation of the furnace, the double-pole, double-throw switch 43 is usually thrown into such position, that the two portions of the transformer secondary are in series relation. When working conditions have been reached, these portions of the transformer secondary are connected in parallel.

As the furnace heats up, the resistance gradually decreases and an increased current tends to flow in the current leads. This results in the thermal relay 6 rotating in a clockwise direction. Upon rotation in this direction, the member 9 engages the terminal 13, whereupon a circuit is completed through the coil 28 and the associated switch arm 33 is pulled into the position shown by the dotted lines, that is, the switch arm is disengaged from the terminal 36 and the terminal 37 is engaged by it. The circuit through the magnetically operated switch 21 is, by this action, broken, and, since the contact of the arm 33 with the terminal 37 establishes a closed circuit through the arm 34 and the terminal 38, the switch 22 is next closed and the next lower voltage is impressed upon the furnace.

Further rotation of the relay in the direction indicated will bring the contact member 10 into engagement with the terminal 16 whereupon the coil 30 will be energized and the arm 34 moved into contact with the terminal 39. This action will establish a closed-circuit which will allow the switch 23 to be closed while the disengagement of the lever 34 from the terminal 38 will result in the opening of switch 22. This last switching operation will result in the lowest possible voltage being impressed upon the furnace.

Should the current now further increase because of an exceptionally high temperature existing in the furnace, the member 11 would make contact with the terminal 18, whereupon, the coil 32 would be energized and the switch arm 35 be moved to engage the terminal 41. By such operation, the switch 23 would be opened and, consequently, no voltage would be impressed upon the furnace which would, therefore, start to cool.

The cooling operation will continue until the relay moves sufficiently in a counter-clockwise direction to cause the contact member 9 to engage the terminal 14. When this connection takes place, the coil 27 is energized, and the arm 33 moves back into its original position. The same sequence of events as above described then proceeds and, ultimately, the furnace temperature becomes stabilized. It will be noted that a considerable time interval will elapse before the relay moves sufficiently in a counter-clockwise direction to make the connections whereby the furnace is again supplied with power. This is a feature of considerable advantage, inasmuch as the furnace has time to cool sufficiently to a high resistance to be offered to the flow of current therethrough. In other words, a thermal relay automatically sets its own time limit and is particularly adapted for this type of apparatus. Moreover, as will be noted in following out the various steps, the transfer switches operate in such manner that, at no point, do the relay contact members break a circuit. That is, while the contact members always make a connection and thereafter cause current to flow, when the time arrives for that connection to be broken, the controller switches have operated in such a manner that there is no longer current passing at that point. The

resistor 42 may be used to vary the amount of the current flowing through the heating coil of the thermal relay 6. If the resistor 42 is so adjusted as to carry a larger amount of current than before, the current value in the furnace will be larger before the thermal relay will operate as described above, and, therefore, the furnace will be maintained at a higher temperature.

While I have described but one embodiment of my invention, it is obvious that many modifications may occur to those skilled in the art and, therefore, I wish only those restrictions to be placed upon my invention as are imposed by the prior art or are specifically set forth in the appended claims.

I claim as my invention:

1. The combination with an electric furnace and a source of power supply therefor, of a thermal relay operatively so associated therewith that a movement proportional to the change of current in said furnace is obtained, and switching means requiring an actuating current larger than can be used with said relay, for varying the amount of power taken by said furnace.

2. The combination with an electric furnace and a source of power supply therefor, of a thermal relay operatively associated therewith, switching means requiring an actuating current larger than can be used with said relay, for varying the amount of power taken by said furnace, and transfer means interposed between said relay and said switching means whereby they may be operatively connected.

3. The combination with an electric furnace and a source of power supply therefor, of thermally responsive means operatively so associated therewith that a movement proportional to the change of current in said furnace is obtained, and switching means connected to said relay to vary the power input of said furnace in accordance with the current therein.

4. The combination with an electric furnace and a source of power supply therefor, of a thermally responsive relay operatively so associated therewith that a movement proportional to the change of current in said furnace is obtained, said relay having contact members being adapted to oscillate between two terminal points associated therewith, and switching means connected to said relay to vary the power input of said furnace in accordance with the current therein.

5. The combination with an electric furnace and a source of power supply therefor, of a thermally responsive relay operatively so associated therewith that a movement proportional to the change of current in said furnace is obtained, said relay having contact members peripherally disposed thereupon, switching means connected to said relay, terminals operatively associated with each of said relay contact members, and leads connecting said switching means to said terminals whereby the movement of said thermal relay controls the movement of said switches.

6. The combination with an electric furnace and a source of power supply therefor, of a thermally responsive relay operatively so associated therewith that a movement proportional to the change of current in said furnace is obtained, said relay having contact members peripherally disposed thereupon, switching means connected to said relay, terminals operatively associated with each of said relay contact members, and leads connecting said switching means to said terminals in such a manner that said relay does not, at any time, break the current at said terminals, whereby the movement of said thermal relay controls the movement of said switches.

7. The combination with an electric furnace and a source of power supply therefor, of switching means for varying the amount of power supplied to said furnace, a thermal relay operatively associated with said furnace, said relay being provided with a plurality of peripherally disposed contact members oscillating between terminals, each contact member being associated with a pair of terminals, and means connecting said terminals and said switching means.

8. The combination with an electric furnace and a source of power supply therefor, of switching means controlling said power supply, a thermal relay actuated in accordance with the current in said furnace, and transfer means connected between said switching members and said relay, said transfer means comprising a switching member adapted to be actuated by two coils.

9. The combination with an electric furnace and a source of power supply therefor, of switching means controlling said power supply, a thermal relay actuated in accordance with the current in said furnace, and transfer means connected between said switching and said relay, said transfer means comprising a switching member adapted to be actuated by two coils, one of said coils being energized when the current in said furnace is increasing and the other of said coils being energized when said current decreases.

10. The combination with an electric furnace and a source of power supply therefor, of switching means controlling said power supply, a thermal relay actuated in accordance with the current in said furnace, and transfer means connected between said switching means and said relay, said transfer means comprising a switching member adapted to be actuated by two coils, one of said coils being energized when the current

in said furnace is increasing and the other of said coils being energized when said current decreases.

11. The combination with an electric furnace and a source of power supply therefor, of switching means controlling said power supply, a thermal relay comprising a heating element, means for supplying to said heating element a current proportional to, and derived from, the current flowing through said furnace, and transfer means connected between said switching members and said relay, said transfer means comprising a switching member adapted to be actuated by two coils.

12. The combination with an electric furnace and a source of power supply therefor, of switching means controlling said power supply, a thermal relay comprising a heating element, means for supplying to said heating element a current proportional to, and derived from, the current flowing through said furnace, transfer means connected between said switching members and said relay, said transfer means comprising a switching member adapted to be actuated by two coils, and means for varying the ratio of the two currents.

13. The combination with an electric furnace and a source of power supply therefor, of a thermally responsive relay operatively so associated therewith that a movement proportional to the change of current in said furnace is obtained, said relay comprising contact members peripherally disposed thereon and a heating element, means for energizing said heating element by a current derived from, and proportional to, the current flowing through said furnace, switching means connected to said relay, terminals operatively associated with each of said relay contact members, and leads conecting said switching means to said terminals whereby the movement of said thermal relay controls the movement of said switches.

14. The combination with an electric furnace and a source of power supply therefor, of a thermally responsive relay operatively so associated therewith that a movement proportional to the change of current in said furnace is obtained, said relay comprising contact members peripherally disposed thereon and a heating element, means for energizing said heating element by a current derived from, and proportional to, the current flowing through said furnace, switching means connected to said relay, terminals operatively associated with each of said relay contact members, leads connecting said switching means to said terminals whereby the movement of said thermal relay controls the movement of said switches, and means for varying the ratio of the two currents.

In testimony whereof, I have hereunto subscribed my name this 26th day of Oct., 1918.

EDGAR A. HESTER.