Aug. 16, 1927. 1,638,857

A. D. KEENE

ELECTRIC FURNACE

Filed Nov. 14, 1925

Fig. 2.

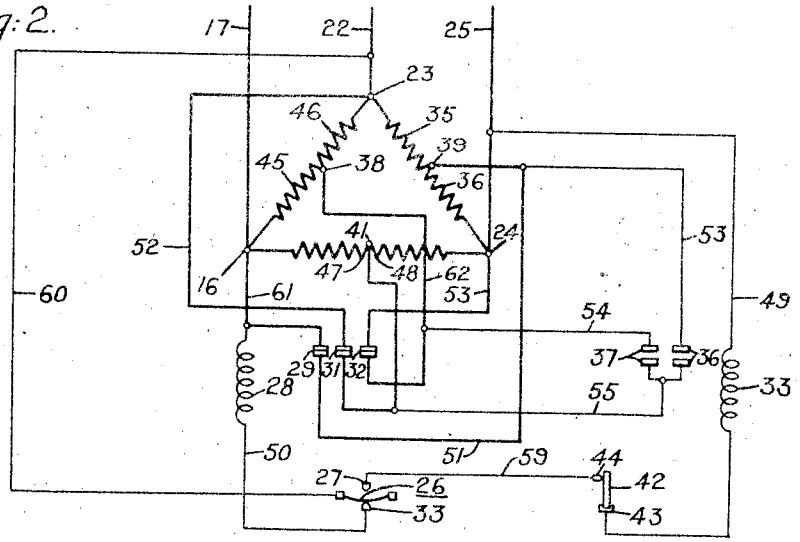


Fig. 1.

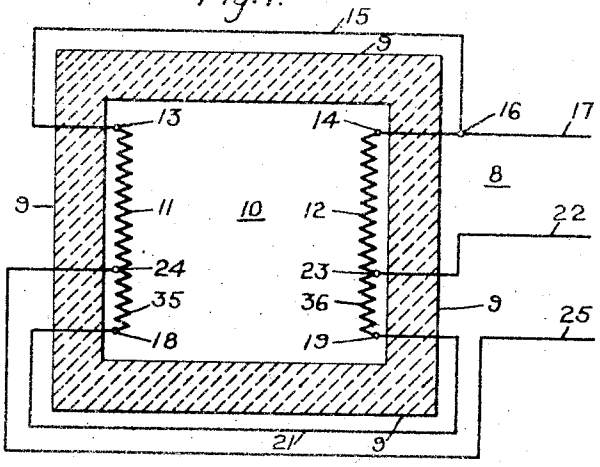


Fig. 3.

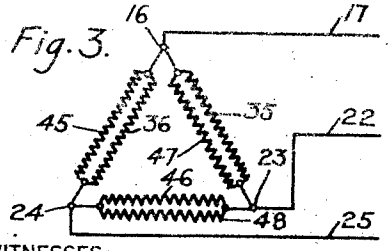
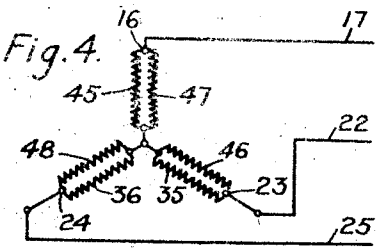


Fig. 4.



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UNITED STATES PATENT OFFICE.

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ELECTRIC FURNACE.

Application filed November 14, 1925. Serial No. 69,033.

My invention relates to electric furnaces and particularly to control systems for such furnaces.

An object of my invention is to provide means for controlling the power input to the resistors of an electric furnace whereby all of the resistors are operatively energized from the power supply at all times during normal operation of the furnace.

Another object of my invention is to provide means for controlling the temperature obtaining in an electric furnace by so selectively decreasing the power input into the resistors in accordance with the radiation losses of the furnace as to maintain the furnace at a predetermined temperature when that temperature is obtained.

Another object of my invention is to provide means for varying the voltage impressed upon the resistors of an electric furnace in accordance with the radiation losses of said furnace when a predetermined temperature obtains, whereby the heat energy obtained from the resistors is substantially identical at all voltages.

In operating industrial furnaces, and particularly electrically heated furnaces, it is desirable to control the power input to them so that the temperature desired will be maintained substantially at a constant predetermined value. It is also desirable that the heat energy generated in the resistors shall be uniformly distributed throughout the furnace and that all of the resistors shall be operatively energized from the power supply at all times during normal operation in order to obtain substantially identical heat distribution for all amounts of power supplied.

By my invention I have provided a means for controlling the voltage impressed on the resistor members of a furnace distributed within a furnace chamber in accordance with the degree of heat distribution desired. The resistor members are initially electrically connected in single delta and controlled by means whereby the resistors may be reconnected with respect to the power supply so that a large amount of heat energy may be obtained from the resistors during the heating up period of the furnace in order that a predetermined temperature may be obtained in a short time.

When the predetermined temperature has been obtained, the controlling means are operative to again change the connection of the resistors so that the voltage impressed on the various members is decreased, thereby decreasing the rate of heat energy generated within the furnace so that the thermal inertia of the resistors may be reduced to substantially prevent the temperature resulting therein from overtraveling or exceeding the predetermined value.

Fig. 1 is a diagrammatic view in vertical section of an electric furnace having a plurality of resistor members electrically connected in delta to a source of power supply.

Fig. 2 is a diagrammatic illustration of the control system embodying my invention.

Fig. 3 is a diagrammatic view of a double delta connection of the resistors when the maximum power is applied, and

Fig. 4 is a diagrammatic view of a double star connection of the resistors.

Referring more particularly to Fig. 1, a furnace structure 8 comprises a plurality of refractory heat insulating walls 9 enclosing a furnace chamber 10. Within the furnace chamber 10 are disposed a pair of resistor members 11 and 12 evenly distributed along opposite walls. Terminals 13 and 14 of the resistors 11 and 12 are connected by a conductor 15 to supply conductor 17. Terminals 18 and 19 of the resistors 11 and 12 are connected by a conductor 21. Supply conductor 22 is connected to a one-third point 23 of the resistor 12 and a one-third point 24 of the resistor 11 is connected to supply conductor 25. With these connections as illustrated in Fig. 1, we have a single delta arrangement as illustrated in Fig. 2, with the controlling means omitted.

In Fig. 2, I have shown the resistors of Fig. 1 connected in single delta in combination with a controlling means for changing the single delta of Fig. 1 to either a double delta or a double star connection.

In order to change from the single delta connection to the double delta connection, the movable member of a thermostat 26 engages a contact member 27 whereby coil 28 is energized by the voltage impressed thereon between conductors 17 and 22. After the coil 28 is energized, contractors 29, 31 and 32 are closed as illustrated in Fig. 2, where-

by the midpoints of the sides of the equi-lateral triangle of the resistor shown in Fig 2, are electrically connected to the opposite corners of the equi-lateral triangle of resistors. The resulting double delta connection is shown in Fig. 3.

The movable member of the thermostat 26 is preferably of bi-metal and is adapted to engage either the contact member 27 or the member 33. When the movable member of the thermostat 26 is in engagement with the contact member 33 as illustrated in Fig. 2, the power input to the resistor furnace as shown in Fig. 2 is four times the input for the single delta connection illustrated in Fig. 1. This connection will be useful in bringing the furnace up to temperature in a comparatively short period of time depending upon the value of the resistance in the resistors and the voltage impressed thereon.

The thermostat 26 is preferably adjusted to operate at a temperature slightly lower than the maximum predetermined temperature to be obtained. When the lower temperature has been obtained, the movable member of the thermostat 26 disengages the contact member 33 and the coil 28 is de-energized, thereby opening contactors 29, 31 and 32. The thermostat 26 engages contact member 27 and coil 33 is energized by the voltage between the conductors 22 and 25 to close contactors 36 and 37.

When the contactors 36 and 37 are closed, the midpoints 38, 39 and 41 of the resistors, as illustrated in Fig. 2, are electrically connected to form a double star connection, as shown in Fig. 4. The power input to the furnace by reason of the double star connection is reduced as compared with the double delta connection but is 33% more than for the single delta connection.

When the maximum temperature has been reached the thermostat 42, which is secured to the support 43, operates to disengage the contact member 44 whereby the coil 33 is de-energized to open the contactors 36 and 37 thereby leaving the resistors of the furnace chamber 10 of Fig. 1 connected in single delta.

The power input for the single delta is taken as unity and is therefore the connection having the lowest power consumption.

In Fig. 2, the resistor member between the power supply lines 17 and 22 is divided into sections 45 and 46 at the midpoint 38. Likewise the two opposite resistor members are divided into equal segments 47 and 48 having a midpoint 41 and two members 35 and 36 having a midpoint 39.

When the double delta connection is made by the closing of the contactors 29, 31 and 32 by reason of the energization of the coil 28, which is energized by the voltage between lines 17 and 22, each half of the resistors illustrated by the equi-lateral triangle in Fig. 2, is electrically connected in parallel with one half of another resistor member as illustrated in Fig 3. The members 35 and 47 are connected in parallel across the power supply lines 17 and 22. The members 46 and 48, are connected in parallel across the supply lines 22 and 25 and the resistor members 45 and 36 are electrically connected in parallel between the power supply lines 17 and 25. Obviously for this connection, the voltage impressed across each of the half members is double the value of the voltage impressed across the entire members of the single delta connection as shown in Fig. 1.

Likewise in Fig. 4, where a double star connection is shown, the midpoint of the sides of the equi-lateral triangle illustrated in Fig. 2, which are also the mid-points of the resistor members are electrically connected so as to form the double star illustrated in Fig. 4. In this double star connection, the half resistor members 36 and 48, 45 and 47, 35 and 46 are connected in parallel. The voltage impressed across the parallel resistor members illustrated in Fig. 4 is 16½% higher than the voltage impressed across the members when in the single delta connection, therefore, the power input to the double star connection will be 33% higher than the single delta. This connection is very useful when the predetermined operating temperature has been obtained because the value of the power input may be apportioned according to the resistor design so that substantially enough power will be supplied to compensate for the radiation losses thereby effecting a constant temperature within the furnace chamber as illustrated in Fig. 2.

The midpoint 38 illustrated in Fig. 2 is electrically connected to the point 24 of the delta connection illustrated in Fig. 2, by reason of the conductor 62 and the contactor 32. The mid-point 39 is connected to the point 16 as illustrated in Fig. 2, by reason of the conductor 51, the contactor 29 and the conductor 61. The midpoint 41 is connected to the point 23 of the delta diagram shown in Fig. 2, by the conductor 52 and the contactor 31.

The midpoints 38, 39 and 41 are joined electrically to form the double star connection as shown in Fig. 4, by the reason of the conductors 53, 54, 62 and the contactors 36 and 37.

The coil 28 is energized when the movable member of the thermostat 26 engages the contact member 33 by reason of the connection across the power supply lines 17 and 22 through the conductors 50, 60 and 61. The coil 33 is energized by the voltage difference between the lines 22 and 25 when the movable member of the thermostat 26 engages the contact member 27 whereby an

electrical connection is made through the conductors 49, 59 and 60.

Further modification and changes may be made in my invention without departing from the scope thereof, I, therefore, desire that only such limitations shall be placed on my invention as are imposed by the prior art.

I claim as my invention:

1. In combination, in an electric furnace, a plurality of resistors uniformly distributed, initially connected in delta, and adapted for energization by a polyphase power supply, a thermally controlled means for changing said delta connection to double delta connection and for maintaining said double delta connection until a predetermined temperature has been attained within said furnace, a second thermally controlled means actuated by the first thermally controlled means for changing the double delta connection to double star connection, said second thermally controlled means being effective to maintain the double star connection until a second higher predetermined temperature has been attained and to change said double star connection to single delta connection and to maintain last named connection until the higher temperature has been lowered to the first predetermined temperature.

2. In combination, in an electric furnace, a plurality of resistor members uniformly distributed therein, said resistor members being initially connected in single delta and adapted for energization by a polyphase electric power supply, and a pair of thermally controlled switches for selectively connecting the resistor members in double delta, double star and single delta in accordance with the temperature obtaining within said furnace.

3. In combination, in an electric furnace, a plurality of resistor members uniformly distributed therein and adapted for energization by a polyphase power supply, and thermally controlled means for so varying the voltage impressed upon said resistors as to maintain the resistors in operative engagement with the polyphase power supply at all times.

4. In combination, an electric furnace structure having a plurality of walls inclosing a furnace chamber therewithin, a plurality of resistor members initially connected in single delta and adapted for energization by a polyphase power supply, and thermally controlled means for selectively changing said single delta connection to double delta or double star connection.

5. In combination, in an electric furnace, a plurality of resistor members, adapted for energization by a polyphase power supply, connected in double delta for the first operative connection, thermally actuable means for causing said connections to be maintained up to a predetermined temperature, said thermally actuable means being effective at said predetermined temperature to cause said double delta connection to be changed to double star connection.

6. In combination, in an electric furnace, a plurality of resistor members initially connected in double delta for the first operative connection and adapted for energization by a polyphase power supply, a plurality of thermally controlled contactors for causing said connections to be maintained up to a predetermined temperature, some of the thermally controlled contactors being effective at said predetermined temperatures to cause the double delta connection to be changed to double star a d to be maintained in said last named connection until a second higher predetermined temperature has been attained.

7. In combination, in an electric furnace, a plurality of resistor members connected in double delta in the first operative relation and adapted for energization by a polyphase power supply, a plurality of thermally controlled members for causing said connections to be maintained until a first predetermined temperature obtains within said furnace, said thermally controlled members being effective at the first predetermined temperature to cause the double delta connection to be changed to double star and to be maintained until a high predetermined temperature obtains, one of said thermally controlled members being effective to cause said resistor members to be changed from double star to single delta connection.

8. In an electric furnace, a plurality of resistor members, and a plurality of thermally controlled members for so changing the connected relations of said resistor members that the energy input into said resistor members is decreased in a plurality of predetermined steps in accordance with the increase in temperature effected thereby beyond a predetermined temperature so as to maintain a substantially constant temperature.

9. In an electric furnace, in combination, a plurality of resistor members normally connected in single delta and a plurality of thermally controlled members for changing the connected relations of said resistor members to double delta, double star and thence to single delta so that the energy input into said resistors is decreased in predetermined steps in accordance with the increase in temperature effected thereby, within said furnace, beyond a predetermined temperature so as to maintain a substantially constant temperature and a substantially identical heat distribution within said furnace.

10. In an electric furnace, in combination,

a plurality of thermally actuated members for varying the voltage impressed on said resistor members in predetermined steps in accordance with the temperature rise above a desired temperature so as to maintain all of said resistor members in connection with the power supply at all times and to effect substantially identical distribution of the power supplied for all voltages impressed on the resistor members.

In testimony whereof, I have hereunto subscribed my name this 12th day of November, 1925.

ALVIN D. KEENE.