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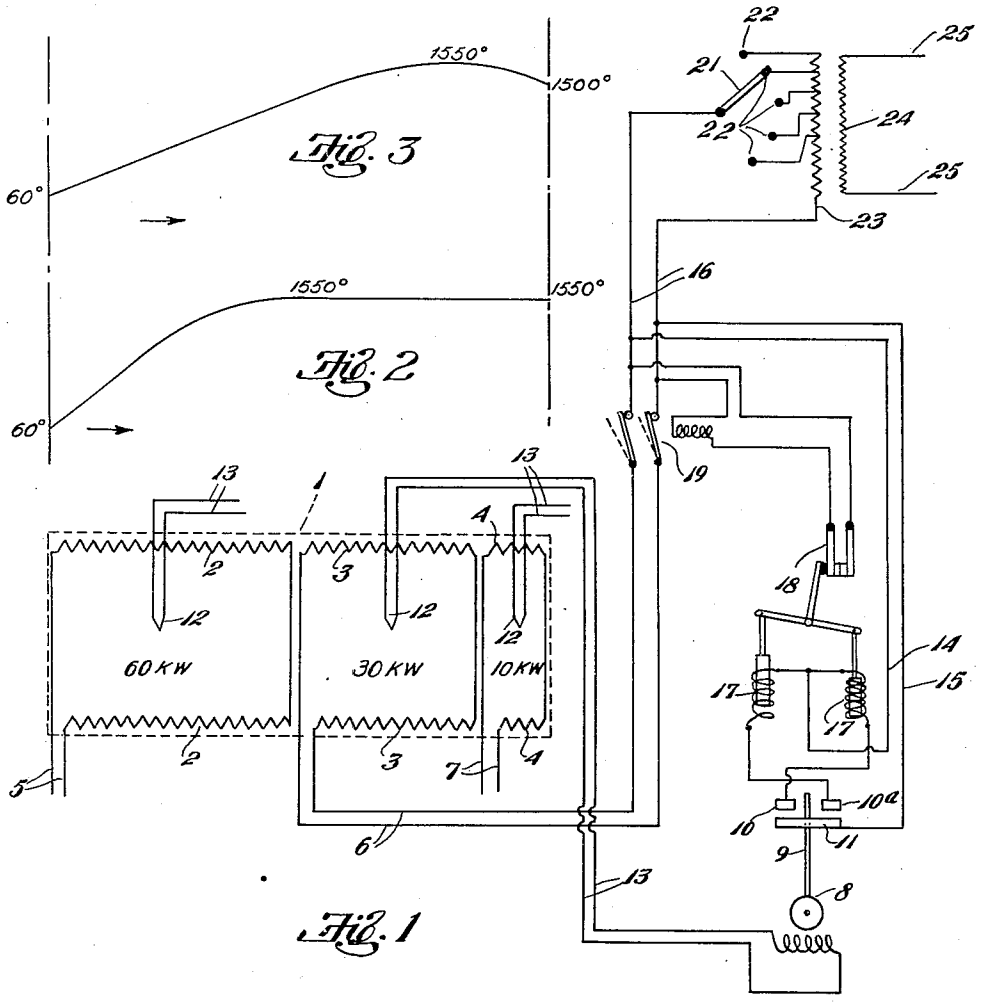


Fig. 3

Fig. 2

Fig. 1

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ZONED RESISTOR FOR ELECTRIC FURNACES.

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This invention relates to electric furnaces of the resistor type and more particularly to resistors of the grid type. The invention is especially applicable to furnaces of the continuous type and may also be carried out in other types of furnaces where it is necessary or desirable to compensate for an unequal cooling or overheating effect in certain portions of the furnace.

In continuous electric furnaces, in which the material is moved through the furnace in one direction, it is customary to provide resistor grids upon the walls of the furnace, extending from end to end of the heating chamber, a substantially uniform amount of energy being supplied to all parts of the resistor.

With this form of furnace, the temperature within the heating chamber, at the charging end, is kept down considerably below the ruling temperature of the furnace, due to rapid absorption of heat by in-coming cold material, making it practically impossible to quickly bring the material to the desired temperature, since a high temperature differential cannot exist between the resistor and the cold in-coming stock without overheating the balance of the furnace.

The cooling effect of the discharge door also cools the discharge end of the heating chamber, making it impossible to hold the material at temperature until discharged from the furnace. This is objectionable in the heat treating of steel and the like as it is usually desirable to bring the material to a specified temperature in a reasonably short time, and hold the temperature until discharged from the furnace.

The objects of the present invention are to zone or segregate the resistors to overcome the cooling effect of the material and furnace doors in order that the material may be quickly brought to the desired temperature and held at such temperature until discharged from the furnace.

The above and other objects may be attained by providing a plurality of resistors throughout the furnace and directing different amounts of energy to different resistors, thus substantially zoning the temperature of the heating chamber.

An embodiment of the invention is illustrated in the accompanying drawing, in which—

Figure 1 is a diagrammatic view showing the furnace zoned by means of a plurality of resistor grids receiving different amounts of energy;

Fig. 2, a diagram showing the temperature gradient of a furnace such as shown in Fig. 1; and

Fig. 3, a similar view of the usual temperature gradient of a furnace where the same amount of energy is directed throughout the length of the resistor.

Similar numerals refer to similar parts throughout the drawing.

For the purpose of illustration, a continuous furnace which may be said to have an electrical capacity of 100 kw., is shown, the heating chamber being indicated at 1 and adapted to be heated by three sets of resistor grids as shown at 2, 3 and 4, substantially dividing the interior of the heating chamber into three zones extending from the charging end to the discharge end thereof.

The resistors 2, which extend from the charging end to a point near the center of the heating chamber, are connected to the wires 5 through which they are adapted to receive 60 kw. of electrical energy.

The resistors 3, in the central zone of the furnace, are connected to the wires 6, through which they are adapted to receive 30 kw. The short resistors 4 at the discharge end of the furnace may receive 10 kw. through the wires 7.

With this arrangement of resistor grids, the furnace is effectually zoned to produce a temperature gradient as shown in Fig. 2.

Assuming the cold material entering the charging end of the furnace to be substantially 60° F., the temperature curve will rise rapidly as shown, as the material passes through the first zone, the resistors 2 running at 60 kw., bringing the material to the desired temperature, indicated at 1550°, in a comparatively short time, due to the larger amount of energy being liberated in the first zone; whereas if a uniform amount of energy is delivered throughout the entire furnace, the heating time of the material will be considerably extended due to the lower amount of heat liberated at the charging end of the furnace.

The resistors 3, in the central zone, running at 30 kw., will liberate sufficient energy within the central zone of the furnace to hold the temperature at 1550°, and the cooling effect of the discharge door is overcome

by providing the short resistors 4 which receive 10 kw., liberating a greater amount of energy in a given space, due to the fact that they are operated at a higher current density, than the central resistors and maintaining the temperature at 1550° until it reaches the discharge door of the furnace.

In Fig. 3 is shown a typical temperature gradient of a furnace in which the resistor extends from one end of the furnace to the other and receives a uniform amount of energy throughout its length.

The cold in-coming material heats slowly, only reaching the desired temperature of 1550° as it nears the discharge end of the furnace and dropping to 1500° as it approaches the discharge door, due to the cooling effect thereof.

A control outfit is preferably provided for the resistors in each zone, but for the purpose of illustration, only one control outfit is shown, that of the central zone, it being, of course, understood that the control outfits of the first and last zones may be duplicates thereof and it may be desirable to control two or more zones by the same control outfit, it being of course understood that such an arrangement would not interfere with delivering different amounts of energy to the zones so controlled.

A control outfit includes a contact pyrometer 8, of standard type and provided with a needle 9 arranged to swing into contact with each of the plates 10 when depressed by the depressor bar 11, which may be clock or motor operated, depending upon the type of pyrometer used. Each pyrometer is controlled by a thermo-couple 12 extending into the corresponding zone of the furnace and connected to the pyrometer as by wires 13.

By contacting with either of the contact points 10 and 10^a, the needle completes a circuit through the wires 14 and 15, from the line wires 16, to one or the other of the solenoids 17 operating the relay switch 18, which controls the solenoid operated switch 19, through which the circuit from the wires 16 to the resistors, is completed.

In the central circuit as shown, when the temperature of the corresponding zone is below the predetermined setting of the control pyrometer, contact will be established from the depressor bar 11 to contact point 10, closing the relay switch 18 which, in turn, closes the main line, magnet operated switch 19, thus connecting the resistor within that zone with the line 16.

The temperature within the zone controlled will immediately start to rise and will continue to rise until the needle 9 swings out of contact with point 10 and across the intervening space between the contacts 10 and 10^a, which distance, for the purpose of illustration, may be equivalent to 10° or 15° F.

As soon, however, as the needle contacts with the point 10^a a current flows through depressor bar 11, contact point 10^a to open the relay switch 18, in turn opening the main line switch 19 and cutting the current off of the particular zone. The needle 9 will again start to recede to again contact with point 10, which action it is seen will maintain the temperature of the controlled zone within a predetermined limit of 10° or 15° F.

For the purpose of varying the current density of the resistors, a manually operated multiple point switch is provided and comprises the switch blade 21, to which one of the wires 16 is connected, and the contact points 22, arranged to be selectively engaged by said blade and tapped at spaced intervals to the secondary coil 23, which is connected to the other wire 16. The primary coil 24 of the transformer is connected to the line wires 25.

This multiple point switch is arranged to be manually operated to independently control the current density of each resistor, while the duration of time during which current is delivered to each resistor is automatically controlled by the thermally controlled outfit.

It will, of course, be seen that each of the pyrometers may be set to maintain the corresponding zone of the furnace at the desired temperature for that particular zone in order to accomplish the results as above described.

Although the invention is illustrated and described as applied to a continuous furnace in which the material is constantly moved through the furnace in one direction, it should be understood that the invention is also applicable to other forms of furnaces where differential temperatures are desired.

It is known that furnaces have been constructed in which the resistors have been placed closer together or hung in parallel rows at certain points and it should be understood that no claim is made to such a construction as a uniform amount of energy is released throughout the entire length of the resistor, and the current density is not increased at these points; while in the present case differential amounts of energy are released from different portions of the resistor means, the current density being increased at the points where greater amounts of energy are released.

I claim:

1. An electric furnace including a plurality of zones, a resistor located in each zone of the furnace, means for liberating a different amount of heat from each resistor, and means controlled by the temperature in each zone for regulating the amount of energy delivered to the corresponding resistor.

2. An electric furnace including resistors

located in different zones of the furnace, each resistor having a different capacity for liberating energy, and means for varying the current density in certain of said resistors.

3. An electric furnace having segregated zones, electric resistors located within said zones, each resistor having a different capacity for liberating energy so that a predetermined temperature gradient is produced in the furnace, and controlled means for operating certain of the resistors at a higher current density than the other resistors.

4. An electric furnace including a plurality of zones, a resistor located in each zone of the furnace, each resistor having a different capacity for liberating energy, and means controlled by the temperatures in the different zones for delivering different amounts of energy to the several resistors.

5. An electric furnace including a plurality of zones, a resistor, located in each zone in the furnace, manually controlled means for varying the current density in the different resistors and pyrometer controlled means for controlling the duration of the current in each resistor.

6. A continuous electric furnace having segregated resistors, each resistor having a different capacity for liberating energy so as to zone the furnace to produce a predetermined temperature gradient, and pyrometer controlled means for controlling the length of time during which current is delivered to each resistor.

7. A continuous electric furnace having segregated resistors, each resistor having a different capacity for liberating energy so as to zone the furnace to produce a predetermined temperature gradient, manually controlled means for varying the current density in the different resistors and pyrometer controlled means for controlling the length of time during which current is delivered to each resistor.

In testimony that I claim the above, I have hereunto subscribed my name.

FRANK T. COPE.