

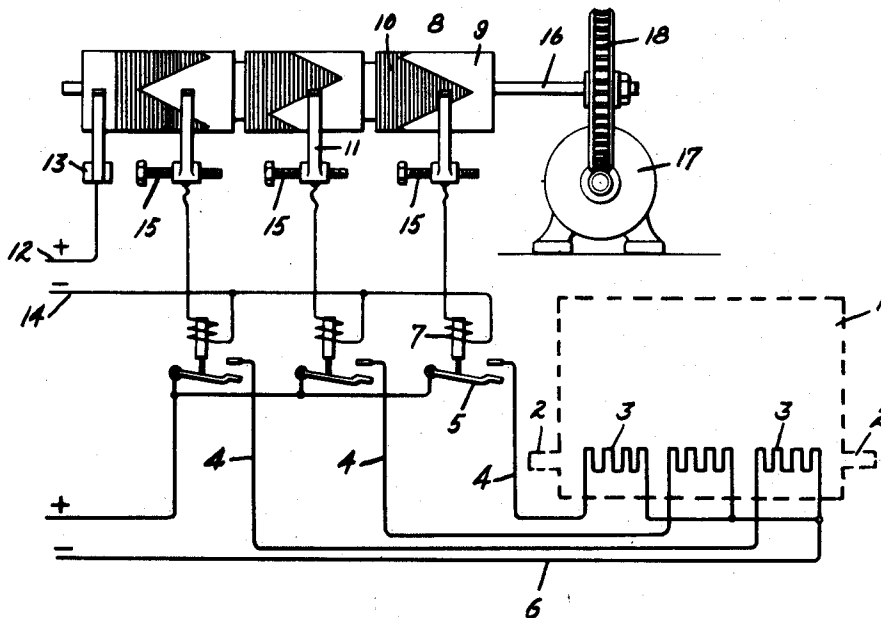
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C. STEENSTRUP

METHOD OF AND MEANS FOR OPERATING ELECTRIC FURNACES

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Inventor:
Christian Steenstrup,
by *Wm. S. Lunt*
His Attorney.

UNITED STATES PATENT OFFICE.

CHRISTIAN STEENSTRUP, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

METHOD OF AND MEANS FOR OPERATING ELECTRIC FURNACES.

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To all whom it may concern:

Be it known that I, CHRISTIAN STEENSTRUP, a citizen of the United States, residing in Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Methods of and Means for Operating Electric Furnaces, of which the following is a specification.

In the operation of electric furnaces of the resistor type, especially those of the closed type in which the heating operation is carried out in the presence of a selected gas, as hydrogen for example, it is necessary to vary the amount of current which passes through the resistors during the cycle of operation. For example, when the furnace and its contents are cold a greater amount of current is utilized than when the parts are heated to substantially the operating temperature. It has been the common practice to use resistance external to the furnace for cutting down or regulating the current supplied to the furnace which is of course highly wasteful of electric energy. Furthermore, these resistances which are costly to make and occupy considerable valuable space, are frequently burned out in practice which means a substantial loss in money and also a loss due to interruption of the furnace operations. This latter is particularly serious where the furnace is used in the commercial production of some product. It may be so serious as to necessitate shutting down a department which is dependent on the furnace while repairs are being made.

In the manufacture of resistors it is very difficult, if not impossible, to make the material used in the construction so uniform in cross-section and in resistance that the temperature at every point in the resistor is exactly the same as that at every other point. If the cross-section at one point is even very slightly smaller than that at the remainder, that point will get hotter than it should and is therefore a potential danger spot because of the liability to rupture. Furthermore, it is necessary to support the resistors at suitable points by insulators of some character which either partly or wholly enclose the resistor at the points of support. As a result of this, the radiation of heat from the resistor is impaired more or less at said points which means that

the resistors get hotter at said points than in regions between them.

As is well known, if a piece of metal is highly heated at one spot, as by a gas flame, when the flame is removed, the heat at the hot spot will be rapidly conducted by the metal itself to the cooler portions. This fact is utilized in the operation of the furnace as will appear more fully later on.

In carrying out my invention, I dispense with all external resistance in the supply conductors and thereby obviate the troubles incident to their use. This is accomplished by using contactors or switches which directly make and break the main line or supply circuits to the resistors and by controlling the contactors through magnetic means which are responsive to suitable make and break devices. Instead of continuously supplying current to the resistors and varying the amount required to obtain the desired furnace temperature by the wasteful resistance method, the current is supplied intermittently, the periods when it is flowing depending on the temperature desired inside of the furnace. When the furnace and its contents are relatively cold the periods of admission are greater than when they are relatively hot. The nearer the furnace is to the operating temperature the shorter will be the periods of admission and the greater will be the care that must be exercised in its operation.

I have found from actual experience that a higher average amount of current can be admitted to the resistors by this method than where the flow of current is continuous. This is due to the fact that the hot spots in the metal are permitted to equalize with the cooler portions during the periods that the current is cut off.

In order to determine the temperature of the resistors within the furnace various means may be employed but by preference ordinary sight tubes are provided and arranged so that the operator can see the resistors and observe their appearance. By this means it can readily be determined if the resistors are too hot or too cold or if some point or points are showing signs of being overheated. My experience has further demonstrated that these observations and changes in current flow can be easily made by workmen of ordinary intelligence.

In the accompanying drawing is diagram-

matically illustrated suitable apparatus for practicing my invention.

1 indicates an electrical furnace of any suitable construction, and 2 the suitably placed sight tubes for observing the conditions inside thereof and specifically of the resistors. The resistors 3 may be made of any suitable material and can be arranged in any suitable way. In the present instance the resistors are made of iron. In practice the resistors are commonly located along the top and sides of the furnace and the work is placed in the center of the furnace chamber and supported by a suitable bed of heat insulation. In all, three resistors are shown, but a greater or lesser number may be provided. They are arranged to be connected in multiple directly across the supply conductors without the inclusion of any external resistance. Each resistor is so arranged that its supply of current can be separately regulated if desired or all the resistors may receive the same amount of current for the same periods of time. In the supply conductor 4 of each resistor is a contactor or switch 5 which comprises a movable and a stationary contact. I have not illustrated the specific construction of the contacts for these are well known in the art. All the resistors are connected to a common return conductor 6. The movable contact of the switch is actuated by an electromagnet 7 although other forms of relay mechanism to accomplish the same purpose may be employed if desired. Each magnet receives current from a suitable source of supply through a revolving contact drum 8. On each drum are one or more V-shaped contacts 9 and a body of insulation 10. Engaging with the drum is a contact finger or brush 11 which is connected to a solenoid or other magnet. The contacts 9 are connected to the supply wire 12 through the brush 13 and the opposite ends of the magnets to the return wire 14. The brushes are mounted so as to be movable along the drum in an axial direction whereby the portion of each revolution that the brush is on a V-shaped contact can be varied to energize the associated magnet for a greater or lesser period. For this purpose the brushes are mounted on adjustable lead screws 15. The drums are mounted on a spindle 16 which is driven by an electric motor 17 through worm or other gearing 18. The motor may run at constant speed or its speed may be changed by ordinary regulating means. In the present embodiment of the invention the drum revolves twice per minute.

Assuming that the furnace and its contents are cold or relatively so, the brushes 11 are so adjusted as to bear on the contact plates 9 throughout each revolution or at least a large portion thereof. This results in energizing the magnets for correspond-

ing periods of time during which the contacts 5 are closed thus controlling the amount of current admitted to the resistors. As the furnace temperature increases the period in each revolution of the drum that the contactors is closed is reduced by moving the brushes toward the left. The position of the brushes is adjusted right or left as the case may be until the desired amount of current is periodically admitted to and cut off from the resistors. To determine this the operator makes observations through the sight tubes from time to time. When the operating temperature of the furnace is attained, the brushes 11 will usually be in engagement with the contacts 9 for less than half of the time. The contacts 11 may make and break the relay circuit once for each revolution of the drum or two or more times per revolution. This will be governed by the operating conditions and by the revolutions per minute of the drum. If an inspection shows that one resistor is hotter or cooler than it should be the brush 11 controlling its contactor can be adjusted independently of the others to make the period of current flow longer or shorter as desired. It sometimes happens that it is desired to operate one resistor at a temperature different from the others which temperature may be higher or lower than the others. The independent adjustment of the brushes 11 readily permits of this.

My invention is useful in connection with electric furnaces intended for various purposes but is especially useful in connection with electric furnaces designed to unite various articles by the fusion of metal, as for example, fusing steel parts with copper. Such furnaces commonly operate at temperatures from 1200° C. to 1300° C. By adjusting the brushes 11 with respect to the drum contacts and driving the drums at suitable speeds the desired temperatures of the resistors can be maintained within close limits.

Another and very important advantage of my invention is that I am able to use cheap iron units for the resistors instead of the very expensive molybdenum units. This is due to the very close regulation obtainable when operating the furnace in accordance with the method herein described. An iron unit operates safely at about 1500° C. which while it is considerably lower than the operating temperature of a molybdenum unit is substantially above the operating temperature of the furnace. By making suitable observations of the conditions inside of the furnace from time to time and making proper adjustments of the regulating mechanism, the desired temperature of the furnace may be easily maintained which temperature is below the safe working temperature of the iron resistors. The saving

in the initial cost of iron units over molybdenum is very great. In a certain large furnace now operating in accordance with my invention the material in the molybdenum units which were formerly employed cost about \$1500, whereas the cost of the material for the iron units now employed is only about \$3.00.

In the operation of hydrogen furnaces the charge often comprises parts which differ greatly in mass; this is particularly true when it is composed of turbine parts such as a rotor having a massive center portion and relatively small buckets and a cover that are to be copper brazed to the periphery of the center part. In such cases it is important to control one or more of the heating units independently of the other or others. For example, the heating unit adjacent the small parts should not receive the same amount of current as the heater adjacent the more massive parts because they will be overheated. It has been proposed to employ temperature indicators at one or two places within the heating chamber and to automatically regulate the supply of current to the heating units as determined by the indicators. Such an arrangement is entirely satisfactory for many classes of work but for copper brazing operations I find that the automatic control is not satisfactory principally for the reason that the indicators only indicate the temperatures in relatively small regions of the heating chamber with the result that some parts of the charge are either over or under heated and hence the best results are not obtained. With my improved arrangement, however, the operator first observes the conditions within the furnace and then adjusts the relative positions of one or more brushes and their contact-controlling drums to the end that the average amount of current supplied to any given unit or units is exactly right to produce the desired heating effect. In some instances more than a single observation and adjustment may be desirable. In other words the heating effect of one unit can be increased or decreased with respect to another as experience indicates should be done and this without necessarily involving any appreciable change in the temperature of the heating chamber as a whole.

I have particularly referred to controlling the temperature of the furnace and its charge preparatory to the brazing operation, but it is also desirable in some cases, as for example where the center part is massive and the outer part thin, to control the tem-

perature of the parts during the cooling operation. That is to say, under the conditions specified, current may be admitted to the heating unit adjacent said thin outer part while the supply of current to the heating unit adjacent the massive part is cut off, so as to obtain a more uniform cooling of the charge as a whole.

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

1. The method of operating an electric furnace which comprises periodically admitting heating current to and cutting it off from the heating unit thereof and in varying said periods.

2. The method of operating an electric furnace which comprises connecting the heating unit directly across the supply conductors through a switch, opening and closing the switch to intermittently supply current to the unit, and varying the periods that said switch is opened and closed.

3. The method of operating an electric furnace having independent heating units which comprises directly connecting the heating units to supply conductors through independent relay actuated switches, and periodically operating said relays to open and close the switches.

4. In combination, an electric furnace, a heating unit therefor, supply conductors for the unit, a switch for connecting the unit directly across the conductors, relay mechanism for operating the switch, positively acting means for operating the mechanism periodically, and a device for changing the periods of operation of said means.

5. The method of operating a closed furnace in which a supply of selected gas is maintained and which is heated by a resistor which comprises directly connecting the resistor across the supply means and disconnecting it therefrom at regular and predetermined periods, and varying the relative periods that the resistor is in circuit.

6. The method of operating an electric furnace having independent heating units which comprises directly connecting the units across the supply conductors through independent switches, opening and closing the switches periodically, and varying the periodic action of said switches either independently or simultaneously, to suit the temperature conditions of the different parts of the charge within the furnace.

In witness whereof, I have hereunto set my hand this 10th day of May, 1923.

CHRISTIAN STEENSTRUP.