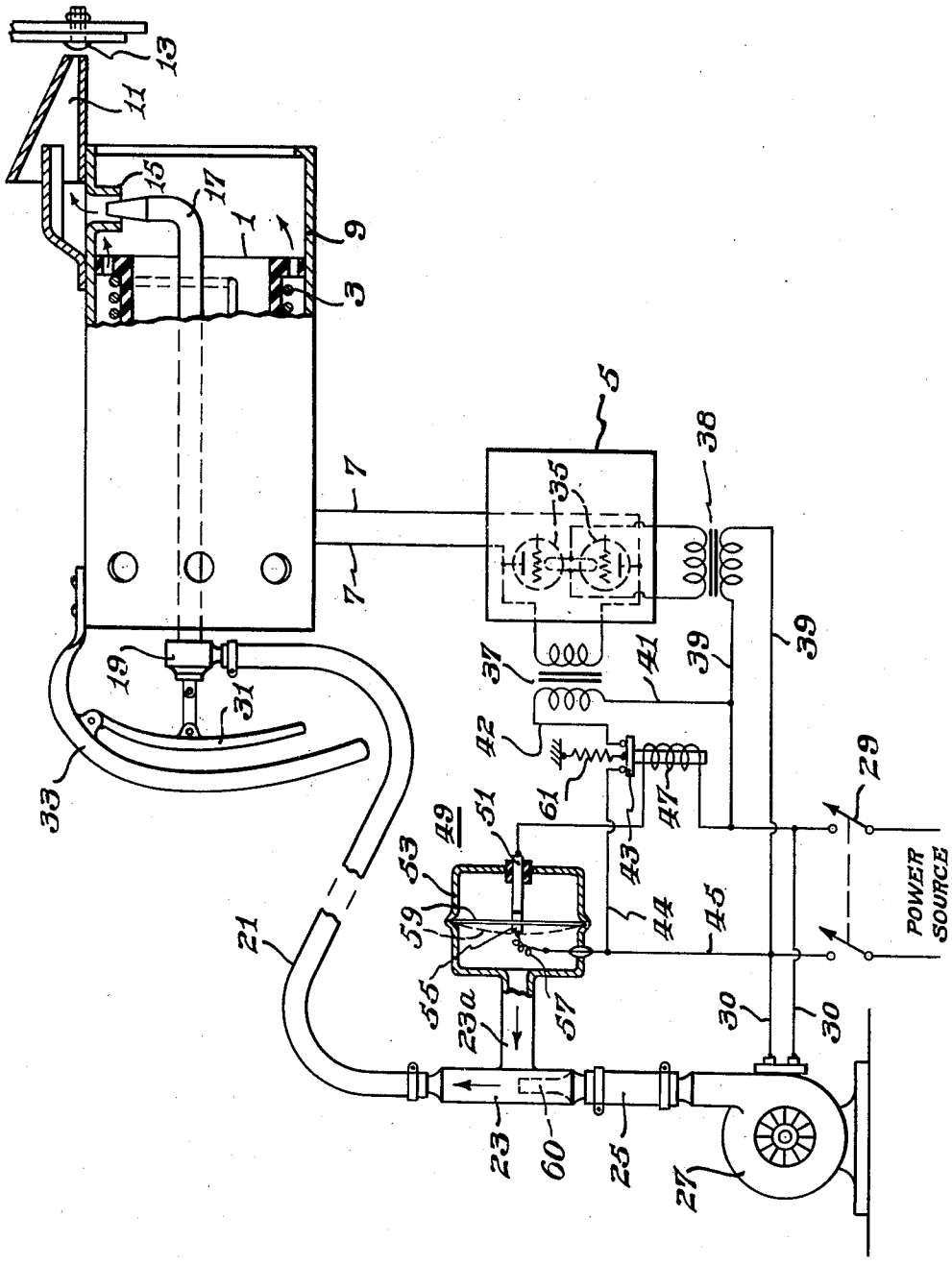
May 9, 1944. H. C. GILLESPIE 2,348,338

ELECTRICAL HEATING APPARATUS

Filed Feb. 2, 1942



Inventor
Henderson C. Gillespie

By C. A. Guska

Attorney

Patented May 9, 1944

2,348,338

UNITED STATES PATENT OFFICE

2,348,338

ELECTRICAL HEATING APPARATUS

Henderson C. Gillespie, Moorestown, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application February 2, 1942, Serial No. 429,276

6 Claims. (Cl. 219—13)

This invention relates to a heating device, and more particularly to a device for heating conductive articles by induction from a source of electrical energy of high frequency, the present invention being directed to the type of heating device disclosed in my copending application Serial No. 420,956, filed November 29, 1941, now Patent No. 2,314,875, granted March 30, 1943, and being particularly directed to the control means for controlling the supply of energy from the high frequency energy source to the coupling coil.

In the aforesaid patent, there is disclosed a heating device adapted for local rapid heating in many industrial applications. This device comprises a single-turn coupling coil which is coupled to a high frequency oscillator through a step-down transformer, the coupling coil providing a high, concentrated magnetic field which induces eddy currents in a conductive article which is to be heated. Since the windings of the transformer and the coupling coil become quite hot, suitable aspirator means involving a stream of compressed air is employed to draw cooling air over the transformer windings, the compressed air stream being directed onto the coupling coil to cool that coil also. As arranged for use heretofore, the oscillator was coupled to the transformer of the heating unit independently of the cooling air stream. The disadvantage of such an arrangement is that, as long as energy is being supplied to the transformer and the coupling coil by the oscillator, heat will be developed therein and, unless removed, the heat developed may become excessive.

The primary object of my present invention is to provide an improved heating device of the type set forth above which will not be subject to the aforementioned disadvantage.

More particularly, it is the object of my present invention to provide an improved heating system of the type set forth wherein energy will be supplied to the coupling coil by the oscillator only when the air stream is flowing.

Another object of my present invention is to provide, in a heating system as above set forth, a single control device for both the oscillator and the compressed air source.

It is also an object of my present invention to provide, in a heating system of the type set forth, simplified control means for the oscillator.

A further object of my present invention is to provide an improved heating system as aforesaid wherein the supply of cooling air will be conserved.

Another object of my present invention is to provide an improved heating system of the type set forth which is simple in construction and highly efficient in use.

In accordance wth my present invention, I employ a vacuum tube oscillator having a plate transformer coupled to the plates or output electrodes of the vacuum tubes, a relay operated switch being provided in series with the primary winding of the transformer. The winding of this relay is connected in series with a switch which is responsive to changes in pressure and which is connected to the supply line of the compressed air stream in such a way that, when the compressed air is flowing toward the cooling coil, the last named switch will be open, and when the compressed air stream has stopped flowing, the last named switch will close. The system is arranged in such a manner that normally, when connected to a source of power, the relay is energized to open the switch in circuit with the primary winding of the plate transformer. When, however, a suitable valve device under control of the operator is opened to permit the flow of the cooling air, the pressure responsive switch opens, thereby de-energizing the relay and permitting the switch in circuit with the plate transformer to become closed. Immediately, therefore, energy is supplied by the oscillator to the heating unit. Upon release of the valve by the operator, the pressure responsive, control switch closes again as soon as the compressed air stops flowing, thereby once more energizing the relay which opens the transformer switch. Thus, the supply of energy from the oscillator to the heating unit is cut off.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention, itself, however, both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description of one embodiment thereof, when read in connection with the accompanying drawing in which the single figure is a partly structural and partly diagrammatic view illustrating one form of my invention.

Referring more particularly to the drawing, there is shown a supporting tube 1 of insulating material on which is wound the primary winding 3 of a transformer coupled to a suitable high frequency oscillator 5 by a suitable concentric

cable represented in the drawing by the leads 7. Surrounding the primary winding 3 and spaced therefrom is a single-turn secondary winding 9 to which is connected a frusto-conical coupling coil 11 constituting an inductor tip for heating the work, such as a rivet 13, as more fully described in my aforementioned patent.

To effect proper cooling of the windings 3 and 9 and also the inductor tip 11, there is formed on the end of the secondary winding 9 adjacent to the inductor tip 11 a radially inwardly directed tubular member 15 through which extends, radially in an outward direction, the nozzle end of a hose 17, through which compressed air may be passed. This construction is also disclosed in greater detail in my aforementioned patent and it is not believed to require any further description at this point.

The hose 17 is connected through a valve 19, a second hose 21, a T connection 23, and a flexible coupling 25, to a compressed air pump or blower 27 having a motor connected to a suitable power source through a master switch 29 and leads 30. The valve 19 is controlled through a lever 31 carried by a handle 33 which is secured to the transformer winding 9. When the lever 31 is drawn toward the handle 33, the valve 19 is opened and the compressed air from the compressor 27 is directed to the inductor tip 11. When the lever 31 is released, the valve 19 is closed and the flow of the compressed air stream is cut off.

The oscillation generator 5 includes one or more vacuum tube oscillators 35 to the plates or output electrodes of which is connected a transformer 37. The filaments of the tubes 35 are connected to the supply means or power source through a transformer 38, a pair of leads 39 and the master switch 29, the transformer 37 being also connected to the supply means through the switch 29, a portion of one lead 39, a lead 41, a lead 42, a relay operated switch 43, a lead 44, and a lead 45. The coil or winding 47 of the relay which controls the switch 43 is connected in series with a control switch 49 having a fixed terminal 51 on a casing 53 which has air-tight connection with the T coupling 23 and a movable contact 55 connected by a flexible lead 57 to the lead 45. The movable contact 55 is carried by a flexible membrane or diaphragm 59 of insulating material and having an inherent bias such as to normally maintain the contact 55 in engagement with the contact 51. Within the vertical head of the T coupling 23 is a tube 60 so arranged that its mouth or open end is opposite the adjacent end of the horizontal arm 23a of the T coupling 23. Thus, as the air stream flows through the tube 60, there is created in the arm 23a and in the portion of the casing 53 to the left of the diaphragm 59 a suction (or decrease in pressure against the diaphragm 59) which causes the diaphragm to flex from the solid line position to the dotted line position, whereby to open the switch contacts 55 and 51. When, however, the valve 19 is closed, the diaphragm 59 is restored to the normal, solid line position and the switch 49 is closed again.

When the system is set up for operation, the master switch 29 is closed and energy is supplied to the filaments of the oscillator tubes 35 through the leads 39, the filaments thereafter being maintained constantly hot. Closing of the switch 29 also supplies energy to the blower motor through the leads 30. At the same time, since the control switch 49 is closed, the relay coil 47 is energized to open the switch 43. This breaks the circuit of the plate transformer 37 and therefore no current will flow in the output circuit of the oscillator to the primary winding 3 of the heating transformer. Thus, there is no danger of the heating transformer or the inductor tip being heated. It will be noted that, at this time, the valve 19 is closed and no compressed air is flowing to the inductor tip or coupling coil 11. Now, when the lever 31 is depressed to open the valve 19, compressed air from the compressor 27 immediately flows through the hose 17 to the inductor tip 11. The suction thus created to the left of the diaphragm 59 causes the diaphragm to flex to the dotted line position, thereby disconnecting the switch contacts 55 and 51 to open the control switch 49 and break the circuit through the relay coil 47. A spring 61 then pulls the armature of the relay into position to close the switch 43, whereby the transformer 37 becomes energized and the oscillator immediately supplies energy to the heating transformer and the coupling coil 11. As soon, however, as the lever 31 is released, the flow of compressed air is shut off and the change in velocity of the compressed air effects return of the diaphragm 59 to its solid line position to close the switch 49. The relay coil 47 is thus once again energized to open the switch 43 and the oscillator once more becomes inoperative to supply energy to the heating transformer.

From the foregoing description, it will be apparent to those skilled in the art that I have provided a novel and simple control of the oscillator in accordance with whether or not cooling air is being supplied to the inductor tip or coupling coil. Although I have shown and described but one embodiment of my invention, it will be apparent to those skilled in the art that many changes in the particular modification described, as well as other embodiments of the invention, are possible. I therefore desire that my invention shall not be limited except insofar as is made necessary by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In an electrical heating system for heating work by induction, the combination of a supporting device, a coupling coil adapted to be applied to the work for inducing heating current therein, said coil being carried by said supporting device, means for supplying electrical energy to said coil, means for directing a stream of cooling fluid to said coil, manually operable means also carried by said supporting device for controlling the flow of said stream, and means responsive to a change in flow of said stream for controlling the supply of energy to said coil by said first named means.

2. In an electrical heating system for heating work by induction, the combination of a supporting device, a coupling coil adapted to be applied to the work for inducing heating current therein, said coil being carried by said supporting device, means for supplying electrical energy to said coil, means for directing a stream of cooling fluid to said coil, manually operable means also carried by said supporting device for controlling the rate of flow of said fluid, and means responsive to a change in the rate of flow of said fluid for controlling the supply of energy to said coil by said first named means.

3. In an electrical heating system for heating work by induction, the combination of a supporting device, a coupling coil adapted to be applied to the work for inducing heating current therein,

said coil being carried by said supporting device, means for supplying electrical energy to said coil, means associated with said first named means for controlling the supply of energy to said coil, said second named means including a control member operable in response to change in pressure, means for directing a stream of cooling fluid to said coil, manually operable means also carried by said supporting device for controlling the velocity of said stream, and means associated with said member and said stream for converting changes in velocity of said stream into changes of pressure on said member whereby to operate said member to control the supply of energy to said coil.

4. In an electrical heating system for heating work by induction, the combination of a supporting device, a coupling coil adapted to be applied to the work for inducing heating current therein, said coil being carried by said supporting device, a high frequency oscillator coupled to said coil for supplying high frequency energy thereto, a control switch associated with said oscillator for controlling the output thereof, means for directing a stream of cooling fluid to said coil, manually operable means also carried by said supporting device for controlling the flow of said cooling fluid to said coil, and means responsive to a change in flow of said stream resulting from operation of said manually operable means for operating said control switch.

5. In an electrical heating system for heating work by induction, the combination of a supporting device, a coupling coil adapted to be applied to the work for inducing heating current therein, said coil being carried by said supporting device, a high frequency vacuum tube oscillator coupled to said coil for supplying high frequency energy thereto, a transformer connected to the output electrodes of said vacuum tubes, means for directing a stream of cooling fluid to said coil, manually operable means also carried by said supporting device for controlling the flow of said cooling fluid to said coil, and means responsive to a change in flow of said stream resulting from operation of said manually operable means for controlling the operativeness of said transformer.

6. In an electrical heating system for heating work by induction, the combination of a supporting device, a coupling coil adapted to be applied to the work for inducing heating current therein, said coil being carried by said supporting device, a high frequency vacuum tube oscillator coupled to said coil for supplying high frequency energy thereto, a transformer connected to the output electrodes of said vacuum tubes, a switch in circuit with said transformer, means for normally maintaining said switch open whereby said oscillator is normally incapable of supplying energy to said coil, means for directing a stream of cooling fluid to said coil, manually operable means also carried by said supporting device for controlling the flow of said cooling fluid to said coil, and control means responsive to the flow of said fluid resulting from operation of said manually operable means for controlling the closing and opening of said switch, said control means being constructed and arranged to effect closing of said switch when said fluid stream is flowing and to effect opening of said switch when said fluid stream has stopped flowing whereby energy will be supplied to said coil by said oscillator only when said cooling fluid is flowing to said coil.

HENDERSON C. GILLESPIE.