March 30, 1943. H. C. GILLESPIE 2,314,875

HEATING DEVICE

Filed Nov. 29, 1941

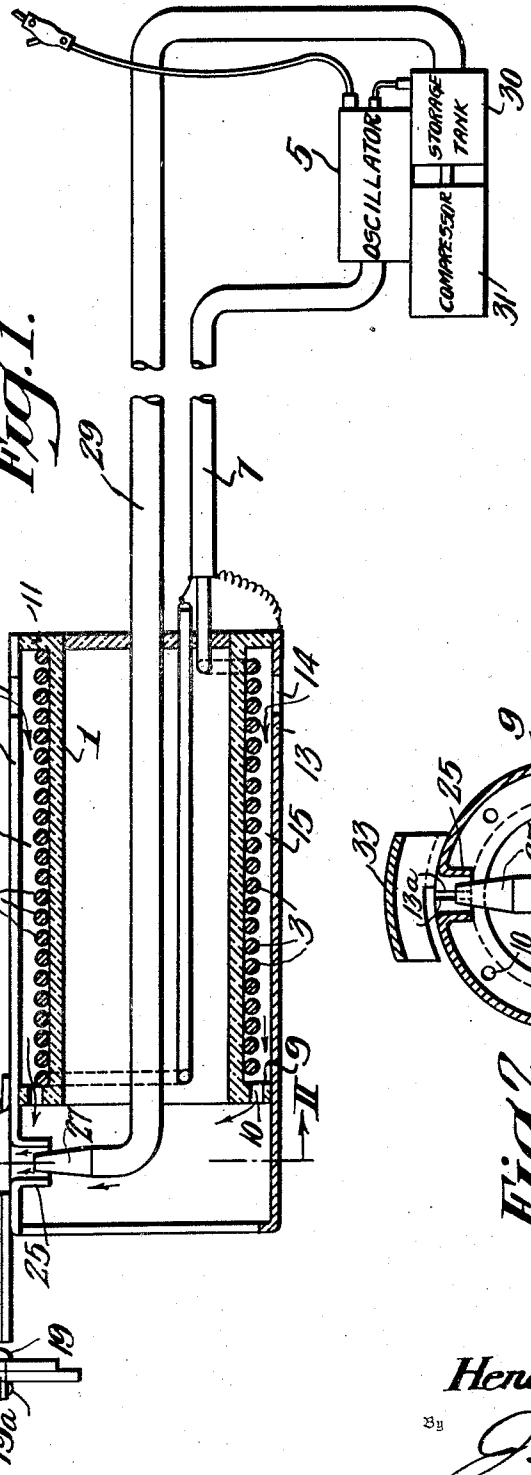

Fig. 1.

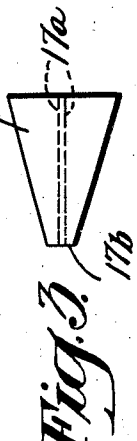

Fig. 3.

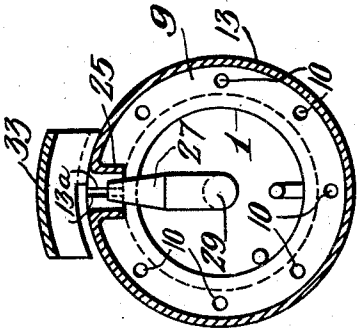

Fig. 2.

Inventor

Henderson C. Gillespie

By

Attorney

Patented Mar. 30, 1943 2,314,875

UNITED STATES PATENT OFFICE

2,314,875

HEATING DEVICE

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

Application November 29, 1941, Serial No. 420,956

7 Claims. (Cl. 219—13)

This invention relates to heating devices, 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 in the nature of an improvement over that forming the subject matter of the copending application of Rudolph A. Bierwirth, Serial No. 395,943, filed May 31, 1941, and assigned to Radio Corporation of America.

In the aforesaid application, there is disclosed a heating device adapted for local rapid heating in many industrial applications. As described in that application, the 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 become quite hot, a stream of compressed air is caused to pass over the windings to cool the same. The compressed air supplied by the compressor often contains moisture which, when it settles on the windings, produces arcing between the turns thereof with consequent corrosion.

The primary object of my present invention is to provide an improved heating device of this type which will not be subject to the foregoing disadvantage.

More particularly, it is an object of my present invention to provide an improved means for cooling the transformer windings and the coupling coil or inductor whereby efficient cooling will be obtained from an unfiltered air stream without damage to the windings of the transformer.

A further object of my present invention is to provide an improved heating unit and cooling system therefor as aforesaid which is simple in construction and highly efficient in use.

In accordance with my invention, I employ an assembly comprising a multiple-turn primary winding, a single-turn secondary winding and a frusto-conical inductor tip connected to the latter, similar to the heating unit of the above-identified copending application. Instead of cooling the windings by a stream of compressed air, however, the required cooling air, according to my invention, is blown directly against the inductor tip through a nozzle arranged as an aspirator to draw, by suction, cooling air from the atmosphere and across the transformer windings. The air stream passing through the nozzle is arranged to be directed onto the coupling coil or inductor tip, and any water contained in this air stream is blown directly onto the tip where it can do no harm. On the other hand, the primary winding, which would be affected by water, is cooled by dry air drawn from the surrounding atmosphere.

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

Figure 1 is a view, partly in section, of a heating device formed according to my present invention and coupled to a suitable source of energy,

Figure 2 is a sectional view taken on the line II—II of Figure 1, and

Figure 3 is a top plan view of the frusto-conical inductor tip, or coupling coil, according to my invention.

Referring more particularly to the drawing, wherein similar reference characters designate corresponding parts throughout, there is shown a spool-shaped supporting member 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 concentric cable 7. Surrounding the primary winding 3 and spaced therefrom by the annular flanges 9 and 11 formed on the ends of the supporting member 1 is a single-turn secondary winding 13, the windings 3 and 13 being concentrically related and the flanges 9 and 11 providing an annular air space 15 between the two windings.

The primary winding 3 consists of a number of turns of wire of suitable diameter wound in a single layer on the supporting spool 1, and the secondary winding 13 may be made of a copper sheet of suitable thickness and length, being formed into a tube which surrounds the primary winding 3, as clearly shown in Figure 2, and having one end thereof (the left-hand end, Figure 1) extending beyond the adjacent end of the primary winding 3 and the flange 9.

The longitudinally extending terminals 13*a* of the secondary winding 13 are, of course, in slightly spaced relation, as clearly shown in Figure 2. Secured to the terminals 13*a* in any suitable manner are the corresponding terminal edges 17*a* of a frusto-conical coupling coil 17 constituting an inductor tip and having a relatively small diameter at its apex end 17*b*. When the system is set up for operation, the oscillator 5 supplies energy to the primary winding 3 whereby a high current

is induced in the secondary winding 13 and the coupling coil 17 connected thereto. Since the coil 17 is of small diameter, particularly at its apex end 17b, there is set up at the apex end of the coil 17 a highly concentrated magnetic field. If, now, the coil 17 is brought into proximity with the article to be heated, such as the head of a rivet 19 which is intended to unite a pair of sheets 21 and 23, for example, the rivet 19 will become heated because of the eddy currents induced therein by the aforementioned highly concentrated magnetic field. These eddy currents will be sufficient to explode a charge of explosive which has been placed in the hollow shank of the rivet 19, thereby causing the rivet shank to expand slightly, as shown at 19a in Figure 1, and thereby firmly uniting the sheets 21 and 23.

To effect the proper cooling of the windings 3 and 13 and also the inductor tip 17, there is formed on the end of the secondary winding 13 which projects beyond the flange 9, and adjacent to the inductor tip 17, a radially inwardly-directed tubular member 25. This member may be formed either by spinning, or by brazing or otherwise suitably connecting it to the secondary winding 13. The secondary winding 13 is also provided with one or more circumferentially distributed openings 14, and the flange 9 is provided with a plurality of circumferentially distributed openings 10, the openings 14 affording communication between the atmosphere and the passageway 15, and the openings 10 constituting additional passageways which afford communication between the passageway 15 and the tubular member 25. A nozzle 27 extends into the tubular member 25 and is of sufficiently small diameter to be spaced therefrom, the nozzle 27 facing radially outwardly of the secondary winding 13 and being connected by a hose 29 to a suitable source of compressed air, such as a storage tank 30 which is connected to a compressor 31. A deflector plate 33 is also secured to the secondary winding 13 in spaced relation to the tubular member 25, the deflector 33 extending partly into the frusto-conical inductor tip 17.

When compressed air from the tank 30 is forced through the nozzle 27, that air, in passing through the tubular member 25, produces a vacuum in the passageways 10 and 15 which sucks in atmospheric air through the openings 14, as shown by the arrows in Figure 1. The atmospheric air combines with the compressed air in the tubular member 25 and both are deflected by the deflecting plate 33 on to the hot inductor tip or coupling coil 17. Since the atmospheric air which passes along the primary winding 3 in the passageway 15 contains practically no moisture, it will be obvious that the winding 3 will not be deleteriously affected thereby. At the same time, although the compressed air supplied by the tank 30 contains some moisture, this will be driven off by the heat of the inductor tip 17, and there will be no harmful result.

From the foregoing description, it will be apparent to those skilled in the art that I have provided an improved heating device which is capable of applying heat locally and with great efficiency to an article to be heated, while itself being adequately cooled without damage thereto. 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 modifications, 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 electric heating device, the combination of a transformer including a primary winding adapted to be connected to a source of electrical energy and an elongated single-turn, secondary winding surrounding said primary winding in spaced relation thereto whereby to provide a passageway therebetween for passage of air, said secondary winding extending beyond said primary winding and including an inwardly-directed tubular member on its extension, means affording communication between said tubular member and said passageway, a coupling coil of relatively small diameter connected to said secondary winding, and a nozzle adapted to be connected to a source of compressed air extending into said tubular member and facing outwardly therein, the compressed air passing through said nozzle and said tubular member serving to produce a vacuum in said passageway whereby to draw atmospheric air therethrough to effect cooling of said windings.

2. In an electric heating device, the combination of a transformer including a primary winding adapted to be connected to a source of electrical energy and an elongated, single-turn, secondary winding surrounding said primary winding in spaced relation thereto whereby to provide a passageway therebetween for passage of air, said secondary winding extending beyond said primary winding and including an inwardly radially extending tubular member on its extension, means providing a communicating passageway between said first-named passageway and said tubular member, a coupling coil of relatively small diameter connected to said secondary winding, and a nozzle adapted to be connected to a source of compressed air extending into said tubular member in spaced relation thereto and facing radially outwardly of said secondary winding, the compressed air emitted through said tubular member by said nozzle serving to create a vacuum in said passageways whereby to draw atmospheric air therethrough to effect cooling of said windings.

3. The invention set forth in claim 2 characterized in that said coupling coil comprises a frusto-conical member secured to said secondary winding adjacent said tubular member and extending beyond said secondary winding extension with the smaller end thereof located beyond the extremity of said extension, said frusto-conical member being adapted to receive the compressed air and the atmospheric air passed through said tubular member.

4. The invention set forth in claim 2 characterized in that said coupling coil comprises a frusto-conical member secured to said secondary winding adjacent said tubular member and extending beyond said secondary winding extension with the smaller end thereof located beyond the extremity of said extension, said frusto-conical member being adapted to receive the compressed air and the atmospheric air passed through said tubular member, and characterized further by the addition of a deflector associated with said tubular member and arranged to direct the air passed therethrough onto said frusto-conical coupling coil whereby to effect cooling of said coil.

5. The invention set forth in claim 2 char-

acterized in that said coupling coil comprises a frusto-conical member secured to said secondary winding adjacent said tubular member and extending beyond said secondary winding extension with the smaller end thereof located beyond the extremity of said extension, said frusto-conical member being adapted to receive the compressed air and the atmospheric air passed through said tubular member, and characterized further by the addition of a deflector on said secondary winding constructed and arranged relative to said tubular member to direct the air passed therethrough onto said frusto-conical coil whereby to effect cooling of said coil.

6. In an electric heating device, the combination of an insulated tubular support, a winding thereon constituting the primary winding of a transformer adapted to be connected to a source of electrical energy, a single-turn, elongated conductive member surrounding said primary winding and constituting the secondary winding of said transformer, said secondary winding extending beyond said primary winding at one end, means maintaining said windings in concentric and spaced relation to each other whereby to provide a passageway therebetween, said secondary winding being provided with at least one opening adjacent its other end whereby atmospheric air may enter into said passageway, a radially inwardly extending tubular member on said secondary winding adjacent its first-named end, means providing a communicating passageway between said tubular member and said first-named passageway, a nozzle adapted to be connected to a source of compressed air extending into said tubular member in spaced relation thereto and facing radially outwardly of said secondary winding, the compressed air emitted through said tubular member by said nozzle serving to create a vacuum in said passageways whereby to draw atmospheric air therethrough to effect cooling of said windings, a frusto-conical coupling coil secured to said secondary winding adjacent said tubular member with the smaller end thereof located beyond the extremity of said first-named secondary winding end, and a deflecting plate secured to said secondary winding, said deflecting plate having a portion spaced from said tubular member and extending into said frusto-conical coupling coil whereby the air passed through said tubular member is directed onto said coupling coil to also effect cooling of said coil.

7. In combination, a transformer including a primary winding adapted to be connected to a source of electrical energy and a secondary winding inductively coupled to and spaced from said primary winding whereby to provide a passageway therebetween for the passage of air, one of said windings extending beyond the other of said windings, a radially extending tubular member on the extension of said first named winding, means affording communication between said tubular member and said passageway, and a nozzle adapted to be connected to a source of compressed air extending into said tubular member and facing in a direction such that the compressed air passing therethrough and thence through said tubular member will produce a vacuum in said passageway whereby to draw atmospheric air therethrough to effect cooling of said windings.

HENDERSON C. GILLESPIE.