

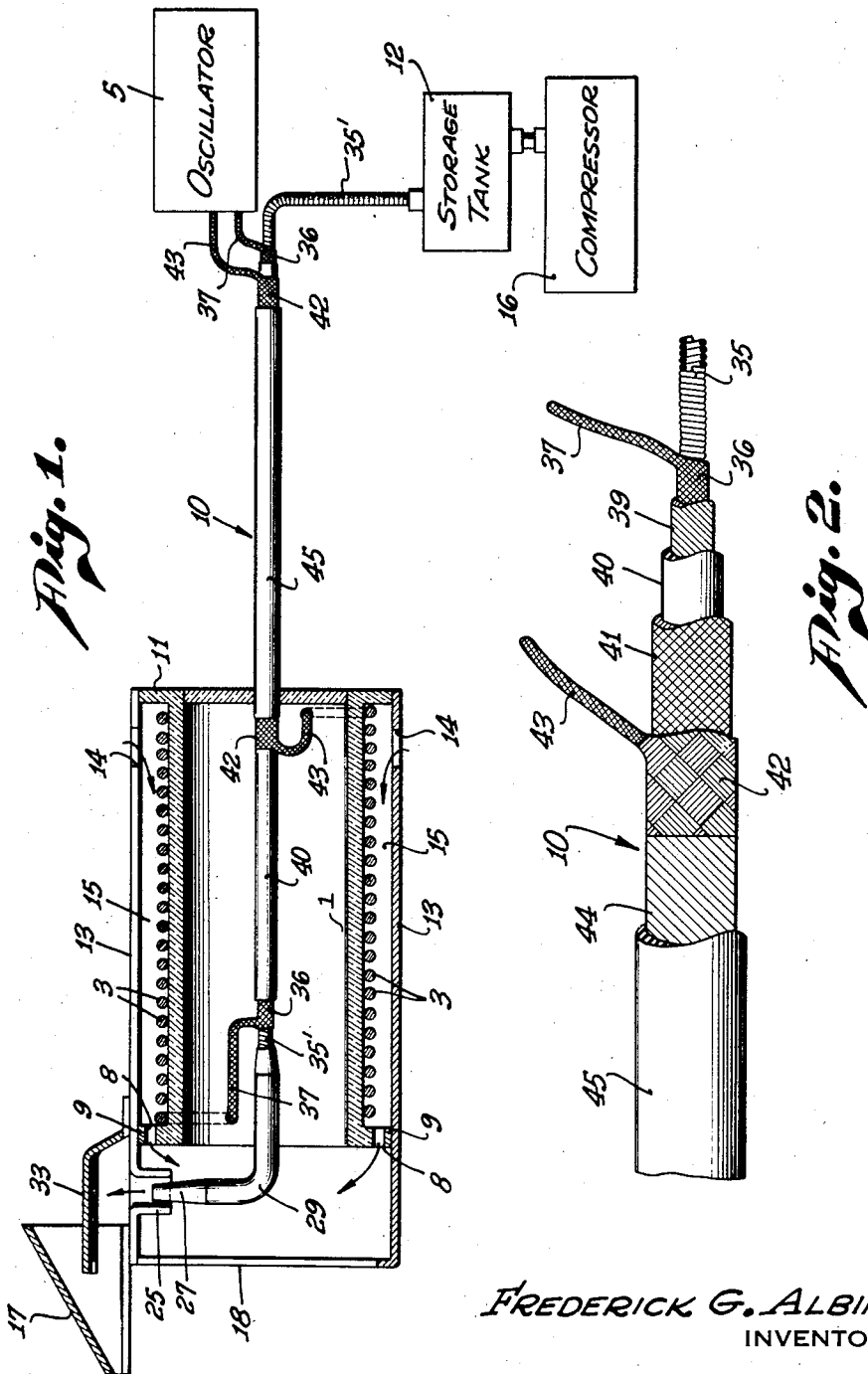
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COMBINATION ELECTRICAL AND FLUID CONDUCTING CABLE

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COMBINATION ELECTRICAL AND FLUID
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1 Claim. (Cl. 174—15)

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This invention relates to heating devices and particularly to a cable for simultaneously conducting high or radio frequency current and a fluid, such as air, for cooling purposes.

In R. A. Bierwirth Patent No. 2,314,865 of March 30, 1943, and H. C. Gillespie Patent No. 2,314,875 of March 30, 1943, devices for heating articles by induction from a source of electrical energy of high frequency, are disclosed and claimed. These devices comprise a single-turn coupling coil 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 air is caused to pass over the windings to cool them. This flow of air is the result of the Venturi action of a flow of compressed air supplied by a compressor.

In the above-mentioned patents, an electrical cable is employed for conducting the high frequency energy from the oscillator to the primary winding of the transformer, and a separate hose is used for connecting the air compressor storage tank with the transformer. The present invention is directed to a combination electrical conductor and air hose which is particularly efficient as an electrical conductor and an air hose, while being of small diameter, flexible, and light in weight.

The principal object of the present invention, therefore, is to facilitate the transmission of electrical energy between a source and a load while simultaneously conducting a cooling fluid such as air.

Another object of the invention is to provide an improved combined electrical and air conductor.

A further object of the invention is to provide an improved flexible electrical conductor for high frequency currents which simultaneously is adaptable to conduct air therethrough for cooling purposes.

Although the novel features which are believed to be characteristic of this invention will be pointed out with particularity in the appended claims, the manner of its organization and the mode of its operation will be better understood by referring to the following description read in conjunction with the accompanying drawings forming a part hereof, in which:

Fig. 1 is a diagrammatic view partly in section, illustrating the general heating device embodying the invention, and,

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Fig. 2 is an elevation view, partly cut away, showing the invention.

Referring now to Fig. 1, a spool-shaped supporting member 1 of insulating material has wound thereon a primary winding 3 of a transformer coupled to a suitable high frequency oscillator 5 by a concentric electric cable and air hose 10, to be described in detail hereinafter. Surrounding the primary winding 3 and spaced therefrom by annular flanges 9 and 11 formed on the ends of 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, and having one end 18 thereof extending beyond the primary winding 3 and the flange 9.

Mounted on the extending portion 18 of the secondary winding 13 is a frusto-conical coupling coil 17 constituting an inductor tip and having a relatively small diameter at its apex end. 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. In this manner, there is set up at the apex end of the coil 17 a highly concentrated magnetic field which, if brought into proximity with the article to be heated, such as the head of a rivet, the rivet will become heated by the eddy currents induced therein by the concentrated magnetic field.

To effect the proper cooling of the windings 3 and 13 and also the inductor tip 17, there is formed on the projection of the secondary winding 13, 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 8, the openings 14 permitting air to pass to the annular passage way 15 from which it passes through openings 8 into the portion 18 of the secondary winding 13. A nozzle 27 extends into the tubular member 25 and is of sufficiently small diameter to be spaced therefrom. The nozzle 27 facing

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radially outwardly of the secondary winding 13 and being connected by a hose 20 to the cable 10 which, in turn, is connected to a storage tank 12 of an air compressor 16. An air deflector plate 38 is secured to the secondary winding 13 in spaced relation to the tubular member 23, the deflector extending partly into the frusto-conical inductor tip 17.

For further detailed explanation of this transformer system, reference is made to the above-mentioned Gillespie Patent No. 2,314,875 in which is shown an electrical energy conducting cable connected between the primary winding 3 and the oscillator 5, and a separate air hose connected between the nozzle 27 and the storage tank 12. In the present invention, the electrical conducting cable and hose are combined into a single unit which is flexible, of light weight, and a particularly efficient electrical conductor.

This combination fluid and electrical conductor cable is shown in detail in Fig. 2 which will now be referred to. The cylindrical element which forms the core of the cable is a flexible metal hose 35 formed of spiral steel wire, the hose having an inside diameter of approximately $\frac{1}{8}$ of an inch and an outside diameter of approximately $\frac{1}{4}$ of an inch. This core prevents any crushing of the cable and maintains a clear air passage at all times. Over this core is a steel or bronze braid which is covered by a braided, tinned, copper conductor 36 having an extension 37 for making connections with the oscillator 5 at one end, and with the primary winding 3 at the other end. Although the copper conductor may be of any suitable construction, one form may be a braid of 256 strands of .005 inch copper wire. The tensile strength of the cable is primarily provided by these braids which are prevented from collapsing radially by the steel core, this internal construction providing the maximum of flexibility with a small diameter.

Over this tinned copper conductor, a cotton wrap 39 is placed followed by a thin sleeve 40 of rubber or other suitable dielectric material. The cotton wrap prevents the copper conductor from oxidizing from the sulphur in the rubber sleeve, while the rubber sleeve serves two purposes. First, it makes the cable air and liquid tight, and second, it prevents broken strands of the braided inner conductor 36 from projecting into a Celanese braided insulation layer 41 covering the rubber sleeve, the "Celanese" being a cellulosic plastic compound. Any projecting strands into the braid 41 would lower the breakdown potential. Although rubber is very satisfactory for this purpose, any homogeneous tough gum substance may be substituted. The Celanese braid 41 provides the principal insulation and the strength against internal pressure, and the rubber sleeve need not, therefore, be capable of withstanding this pressure. The dielectric properties of the insulation material should be such that the loss factor is low at high frequencies, and the dielectric strength is high. The loss factor varies with the dielectric constant. Thus, the braid is low in loss factor since it is low in

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dielectric constant because of the high percentage of air voids. Although the Celanese braid meets these requirements very satisfactorily, other satisfactory materials are glass, polystyrene, silk, wool, and the like.

Over the braid 41 is the second electrical conductor 42 of tinned copper braid having a terminal extension 43. This conductor has negligible loss compared with the inner conductor 36 because of its larger diameter. The second conductor is covered with a cotton wrap 44 over which an outer jacket or sleeve 45 of rubber is placed to make the entire cable of approximately one inch outside diameter, the outer rubber covering being sufficiently tough to wear well during use. To connect the inner core 35 to the hose 20 and to the storage tank 12, a rubber sleeve or hose is slipped over the steel core as shown at 35' by the stippling. This sleeve or hose may vary in thickness in accordance with the pressure of the air to be conducted.

This particular cable structure is not only a highly efficient conductor from the standpoint of transmission of high frequency current, but is also capable of transmitting a cooling fluid under considerable pressure. In combination with these necessary qualities, the cable is of small diameter and particularly flexible, which permits the heating device, shown at the left in Fig. 1, to be readily moved and efficiently manipulated about the work.

I claim as my invention:

A flexible electric cable for simultaneously conducting high frequency electric currents and compressed air comprising a flexible wire hose, a braided copper electric conductor about said hose, a layer of resilient air and water tight material surrounding said conductor, a textile wrapping interposed between the conductor and the layer of resilient material, a primary insulation of braided material having a low loss factor at high frequencies surrounding the resilient material, a second braided electrical conductor surrounding said insulating material and said resilient material, a textile wrapping on said second conductor and an outer insulating jacket about said wrapping.

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