

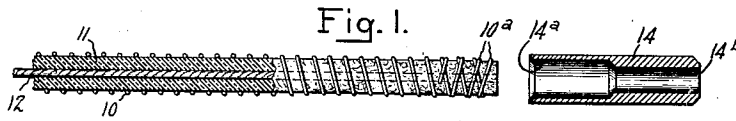
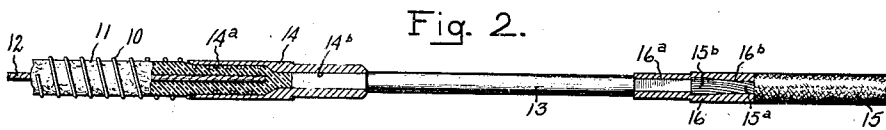
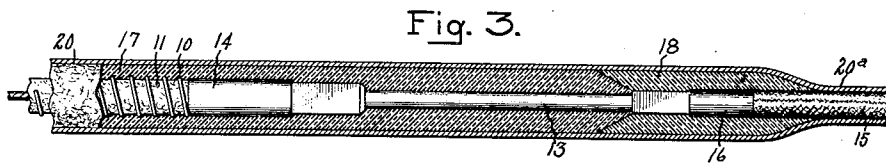
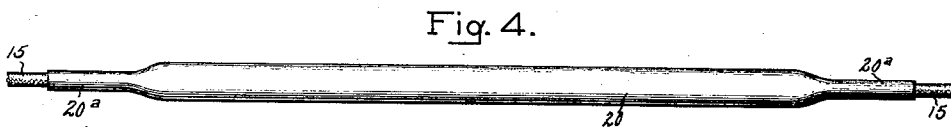
Sept. 8, 1936.

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2,053,933

ELECTRIC HEATER

Filed Aug. 12, 1933



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UNITED STATES PATENT OFFICE

2,053,933

ELECTRIC HEATER

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Application August 12, 1933, Serial No. 684,832

4 Claims. (Cl. 201-67)

My invention relates to electric heaters, and it has for its object the provision of a simple, efficient and inexpensive heater of this type and method of making it.

Although not limited thereto, my invention is particularly useful in connection with relatively low temperature electric heaters of the sheathed type wherein a resistance conductor is enclosed by a metallic sheath.

In carrying out my invention in one form thereof, a resistance conductor is wound upon an electrically insulating core, which preferably will be formed of a yielding fibrous insulating material, such as asbestos. This core is reinforced by means of a metallic wire or thread arranged centrally of the core. The core may be made by covering the wire with asbestos, roving in any suitable manner.

The resistance conductor and core are enclosed by an elongated metallic sheath, and preferably will be arranged substantially centrally of the sheath. Interposed between the resistance conductor and the sheath is a highly compacted layer of yielding, fibrous, electrically insulating material, such as asbestos. Suitable terminals are electrically connected with the ends of the resistance conductor and in one form of my invention, these terminals project from the sheath. In another form of my invention, the terminals are enclosed by the sheath and suitable external leads enter the ends of the sheath where they are electrically connected with the terminals. In this form, it is preferable to reduce the sheath materially at the ends so that the sheath fits tightly about the leads. The leads in this case are permanently attached to the terminals.

In making an electric heater in accordance with my invention, a suitable resistance conductor is wound upon a core formed as described above, and then suitable terminals are connected to the ends of the resistance conductor. This may be accomplished by compressing metallic tubular terminal members upon the end portions of the core in electrical contact with the end turns of the resistance conductor. These terminals may be compressed by swaging them upon the core.

Then suitable leads may be attached to the terminals, if it is desired to use permanently attached leads, and after this the resistance conductor and the core and also the terminals are covered with a layer of asbestos which may be in the form of a roving. Then the assembly is inserted in a metallic sheath which is subsequently reduced in diameter so as to highly compact the asbestos insulating material. The sheath may be reduced by swaging or rolling.

For a more complete understanding of my invention, reference should be had to the accompanying drawing in which Fig. 1 is a fragmentary

view in elevation illustrating a resistance conductor wound upon a flexible supporting core arranged in accordance with my invention, and also showing a terminal connector member used with my electric heater, portions of the core and terminal being shown in section so as to illustrate certain structural details; Fig. 2 is a fragmentary view, partly in section, illustrating the manner in which the terminals are connected to the resistance conductor and also the manner in which leads are connected to the terminals, all arranged in accordance with my invention; Fig. 3 is a fragmentary view, mainly in section and taken on an enlarged scale, of a finished electric heater made in accordance with my invention; Fig. 4 is a complete elevation on a reduced scale of the finished electric heater of Fig. 3; and Fig. 5 is an elevation, partly in section, illustrating a finished electric heater embodying a modified form of my invention.

Referring to Figs. 1-4 inclusive, I have shown my invention in connection with an electric heater comprising a conductor 10 mounted upon a suitable supporting core 11. The resistance conductor 10 may be made of any suitable material, but preferably will be made of a nickel-chromium alloy. Preferably, the supporting core 11 will be made of a suitable electrically insulating, flexible and slightly yielding material, such as asbestos. And preferably, the asbestos will be reinforced by a fine metallic wire or thread 12 arranged centrally of the core. The core 11 may be conveniently formed by applying asbestos roving to the wire 12 so as to cover the wire with a substantially uniform layer of the asbestos. The thread 12, as shown, preferably will be formed by twisting together a plurality of relatively fine wires.

When a very large number of heating elements are to be made, it is convenient to wind the resistance conductor 10 continuously upon a relatively long length of the asbestos core 11, after which the core and the conductor wound upon it may be cut into portions of the required length for the various heating units.

The provision of the heat resistant, flexible core 11 is an important feature of my invention. It will be appreciated that in an electric heater adapted for low temperature work, it is desirable to use a very fine resistance conductor in order to secure the required resistance. In order to use satisfactorily a very fine resistance conductor, I have provided the conductor with the flexible heat resistant core 11 which serves both to support the turns of the resistance conductor and to retain the various turns in their proper spaced relation when wound. It will be observed that since the conductor is provided with a support which is slightly yielding, the conductor as it is being wound will slightly depress the outer surface of

the support so that each turn of the conductor will form its own recess or groove. By reason of this construction any displacement of the turns is prevented. It will be understood, however, that the asbestos supporting member 11 is sufficiently hard to provide a comparatively strong and firm support for the conductor 10, it being yielding merely to the extent of permitting the resistance conductor to slightly depress the outer surface. In other words, the supporting member 11 will be one possessing substantial mechanical strength.

After the conductor has been wound upon its core, suitable terminals 13 are connected to the end portions of the resistance conductor. The terminals 13 are connected to the resistance conductor by means of suitable terminal connector members 14. The connector members 14 are of tubular form and, as shown, are provided with a stepped bore; this bore has a relatively large portion 14a which serves to receive the end portion of the core with the resistance conductor wound upon it and a portion 14b of somewhat smaller diameter which receives the end of the terminal 13.

In assembling each terminal 13 with the heater, the end portion of the core with the resistance element wound upon it that is to be attached to the terminal is inserted in the bore 14a in a connector member 14. Then the connector member is reduced in diameter so that the conductor will be pressed into good mechanical and electrical contact with the end turns of the coiled resistance unit. This reducing step may be accomplished by rolling or swaging the connector. Preferably, before the core is attached to the terminal, the end of the conductor will be wound back in the opposite direction to form three or four turns 10a upon the end turns already wound, as shown in Fig. 1. It has been found that this insures a very good electrical contact between the resistance conductor and the connector after the connector has been applied, and furthermore, that this arrangement obviates danger of the connector pulling away from the core. It is also preferable to swage the end portion of the core somewhat before it is applied to the connector so as to size it to fit the bore portion 14a, it being understood that the portion 14a before it is swaged has a diameter somewhat smaller than the diameter of the core.

After this, the terminal 13 is inserted in the bore 14b provided for it in the connector, and this portion of the connector is swaged by means of square dies so as to firmly connect the terminal to the connector. It will be understood that when the portion 14a was reduced upon the core, the diameter of the bore 14b will have been reduced somewhat at the same time. Because of this, the original diameter of the bore portion 14b will be chosen so that after the connector is applied to the core, the bore 14b will have a diameter approximately equal to the diameter of the terminal 13. Then the terminal may be inserted in the portion 14b which will be swaged upon the terminal, as described.

It will be understood, of course, that terminals 13 will be connected to both ends of the resistance heating element by connectors 14 in the manner just described.

It will be observed that when the connector 14 is reduced upon its end of the core 11, the asbestos forming the end portion of the core will be squeezed into the smaller bore 14b as clearly shown in Fig. 2. This is important because this

squeezed portion completely and effectively electrically insulates the connector 14 and terminal 13 from the metallic wire 12.

Suitable leads 15 are then connected to the free ends of the terminals 13. For this purpose, lead connector members 16 are provided. The connector members 16 are similar to the connector members 14. Thus, each member 16 is provided with a bore 16a of relatively small diameter and with a second bore 16b of relatively large diameter aligned with it. The diameters of these two bores before the connector is applied to the terminal and the lead are substantially uniform throughout their lengths, as are the bores 14a and 14b of the connector 14. The connector 16 is applied to the lead 15 by baring an end portion of the lead of its insulation, as clearly shown in Fig. 2, and then inserting the bared conductor 15a into the bore 16b. The connector is then reduced in diameter by swaging or rolling so as to compress it tightly upon the bared conductor. The effect of this operation is to leave a head 15b on the end of the conductor, as clearly shown in Fig. 2. During this reducing operation, the bore 16a is reduced somewhat, but its original diameter is chosen so that after the reducing process it will be approximately the same size as the terminal 13. The terminal 13 is then inserted in the bore 16a which is swaged by means of square dies so as to reduce its diameter sufficiently to effect a very good mechanical and electrical connection between the terminal and the connector.

It will be understood that the leads 15 for both ends of the heater will be connected in this same manner.

The resistance element 10 and the core 11 on which it is mounted are completely covered throughout their entire length by a layer of insulating material 17 which is preferably formed of a fibrous yieldable substance, such as asbestos. This asbestos may be conveniently applied in the form of a roving. It is also preferable to cover the terminal connectors 14 and the terminals 13 throughout substantially their entire lengths by means of the asbestos roving 17. The lead connectors 16 and the adjacent end portions of the leads are covered by an insulating layer 18, which may be formed of any suitable substance, but which preferably will be made of asbestos tape impregnated with a suitable electrically insulating compound, such as a resin of the alkyd type.

When a large number of heating elements are to be made, the resistance conductor and the terminals 13 may be conveniently covered with the insulating layer 17 in the following manner. After the resistance conductor 10 has been wound continuously upon a relatively long core 11 and has been cut apart to the desired lengths, as previously described, the separate resistance sections are connected together by means of terminal conductors having double the length of the terminals 13. These conductors will be secured to the ends of the resistance sections by means of the connectors 14, and are subsequently used to form the terminals 13. The desired number of the resistance sections are secured together in this manner so as to form a relatively long chain which may be wound upon a suitable collecting reel. It will be understood that the terminal conductors connecting the resistance sections are sufficiently flexible to permit the chain to be wound upon the reel. The resistance elements thus connected together may be run through a suitable insulating machine (not

shown) for applying the asbestos roving 17 to the chain so as to completely cover the resistance sections, the connectors and the terminal conductor lengths between the sections. The resistance sections are then separated by cutting through the terminal conductors midway between the connectors. This operation, of course, divides the chain into a number of separate resistance sections, to the ends of which are secured the several half sections of the terminal conductors that previously connected the sections together. These half sections form the terminals 13. After this, the insulation 17 on the free ends of the terminals 13 is stripped back to provide for connection of the terminals with the leads 15 by means of the connectors 16. After the leads have been attached, the insulating layers 18 will be applied to the connectors 16 and to the adjacent ends of the leads.

The entire assembly including the core 11, the resistance conductor 10, the terminals 13, the leads 15 and the insulating layers 17 and 18, is then threaded through a suitable metallic sheath 20. The sheath will have such a diameter that the assembly will have a sliding fit with the sheath.

Then the sheath 20 is reduced in diameter so as to highly compact the insulating layers 17 and 18 about the resistance element, its supporting core, the terminals and the connectors 14 and 16. The sheath may be reduced in diameter by swaging or rolling. The end portions 20a of the sheath are reduced to a smaller diameter than the intermediate portions of the sheath so that these end portions fit tightly on the leads. This arrangement prevents the entrance of moisture and like fluids into the sheath. The asbestos tape 18 impregnated with the alkyd resin assists greatly in rendering the heater moisture proof.

The sheath will be reduced considerably in diameter so as to thoroughly compact the insulating layers 17 and 18. Thus, for example, the sheath, if it had a diameter of

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inches before it is reduced, will have a diameter of approximately $\frac{1}{8}$ inch, after it has been reduced.

It will be observed that the heating element 10 is embedded in a compacted mass of asbestos which will readily conduct heat from the element to the metallic sheath 20.

It will also be observed that the turns of the conductor cannot become displaced and short circuit each other so that the finished heating element can be bent into suitable desired shapes.

In Fig. 5, an electric heater embodying a modified form of my invention is shown. In this heater, the resistance conductor 30 is wound upon a core 31 which is arranged substantially as is the core 11 of Figs. 1-4 inclusive. Thus, the core 31 is formed of asbestos reenforced by a metallic twisted wire or thread (not shown). The resistance conductor 30 is electrically connected at its ends with terminals 33 through the medium of connector members 34, and arranged as are the corresponding elements of Figs. 1 to 4.

The resistance conductor and the attached terminals are then completely covered with a suitable layer 35 of insulating material, which will be similar to the insulating material 17, that is, it will be formed of asbestos roving. The assembly

is inserted in a metallic sheath 36, which will have a diameter substantially equal to the diameter of the assembly and a length such that the ends of the terminals project from the sheath. Then the diameter of the sheath is reduced as by rolling or swaging so as to compress the asbestos insulation tightly about the resistance element, core and terminals.

While I have shown particular embodiments of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

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

1. An electric heater comprising a core formed of a yielding electrically insulating material, a resistance conductor wound upon said core, the ends of said conductor being wound back in a reverse direction on the end turns of the conductor on said core, and tubular terminal members compressed on said end turns and on said reversely wound ends so as to provide a good electrical and mechanical connection between said terminal members and said resistance conductor.

2. An electric heater comprising a metallic thread, a layer of fibrous yielding electrically insulating material covering said metallic thread, a resistance conductor wound upon said layer of insulating material, tubular terminals embracing the end turns of said resistance conductor, and compressing said electrically insulating material about the ends of said metallic thread so as to insulate said thread from said terminals, a second layer of fibrous yielding electrically insulating material covering said resistance conductor and a metallic sheath encasing said second layer of insulating material and compressed thereon so as to highly compact said layers of insulating material.

3. An electric heater comprising a yielding flexible core formed of electrically insulating material reenforced by a metallic thread arranged substantially centrally thereof, a resistance conductor wound upon said core, and tubular terminal members compressed upon the ends of said core in electrical contact with the end turns of said resistance conductor arranged to compress the ends of said insulating material of said core over and about the ends of said metallic thread.

4. The method of making an electric heater which comprises forming a core of flexible yielding electrically insulating material by covering a metallic thread with a layer of said material, winding a resistance conductor upon said core, compressing tubular terminal members on the end portions of said core so as to mechanically and electrically connect said members with said resistance conductor and to compress the end portions of said insulating material within said tubular members over the ends of said metallic thread to thereby electrically insulate said thread from said terminals, covering said resistance conductor and core with a layer of flexible yielding electrically insulating material, inserting said core with said layer of insulating material thereon into a metallic sheath and elongating and reducing said sheath so as to compact said layer and core of insulating material.

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