Nov. 4, 1969 J. F. LA VAN 3,476,916

ELECTRICAL HEATER

Filed Dec. 11, 1967

Fig. 1.

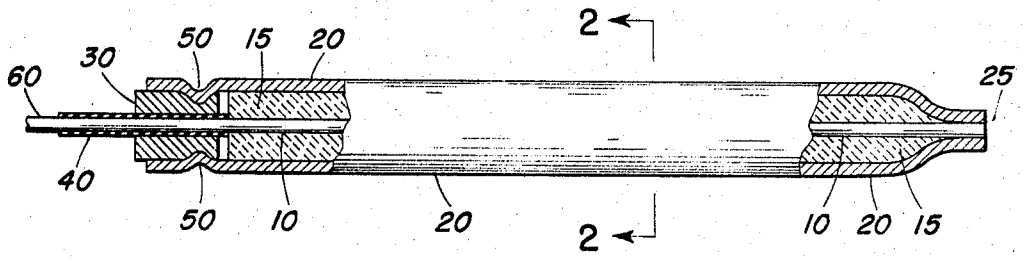


Fig. 2

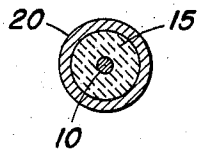


Fig. 3

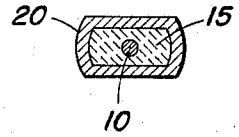
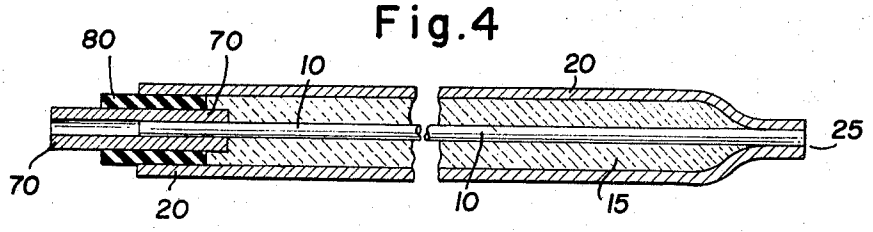


Fig. 4



INVENTOR.
John F. LaVan

BY Jefferson Ehrlich

ATTORNEY

United States Patent Office 3,476,916 Patented Nov. 4, 1969

3,476,916

ELECTRICAL HEATER

John F. La Van, Oak Park, Ill., assignor to American Standard Inc., New York, N.Y., a corporation of Delaware

Filed Dec. 11, 1967, Ser. No. 689,618
Int. Cl. H05b 3/10, 3/44, 3/50
U.S. Cl. 219—552 12 Claims

ABSTRACT OF THE DISCLOSURE

This invention relates to an electrical heater which employs: a linear resistive conductor; a linear outer sheath of metal; a swaged physical and electrical connection between the central conductor and the sheath at one end; a metallic plug between the central conductor and the sheath at the other end, with insulation between the plug and the central conductor or between the sheath and the plug; and powdered insulation within the sheath and around the central conductor. The sheath may be crimped or dented with sufficiently high pressure so as to crimp or dent the plug in order to retain the plug in place as well as to prevent its movement end-wise and, further, to seal the device against exposure to the weather, e.g., rain or snow.

This invention relates to an electrical heater and, more particularly, this invention relates to a heating unit or heater in which the heating element is a linear wire which is sheathed for protection against oxidation and other chemical reactions.

Heretofore, it has been the practice to utilize, for electrical heating purposes, a linear conductor of resistive material such as Nichrome of uniform cross-section throughout its length so that, when current is transmitted through the wire, it will assume a substantially uniform temperature throughout its length. When such a wire develops considerable heat due to its connection to a source of current, the prevailing hot condition quite often produces undesirable effects, such as oxidation of the wire, with a resulting drop in voltage across the wire and the embrittlement and deterioration of the wire due to such oxidation. The chemical changes in the wire due to the oxidation inherently result in a reduction in the mechanical strength of the wire and in resistance changes. Furthermore, due to the accompanying added drop in voltage as a result of increasing oxidation and embrittlement, more and more current may be required to produce a desired predetermined amount of heat, whereupon the supply of current must be increased to maintain the same initial heating effect within the unit. Obviously by raising the amount of current traversing the wire, the oxidation effect may be further increased and in due course the value of the unit as a heater will be lost or destroyed. The production of oxidation and embrittlement are especially severe and critical in cases in which the heating unit is directly exposed to the weather, e.g. rain or snow.

According to this invention, the heating unit comprises a single linear heating conductor of uniform cross-section made of highly resistive material, such as Nichrome, and the conductor is encased and sealed in a tubular sheath for the purpose of protecting the heating conductor against oxidation and other undesirable external effects, such as accompany variable weather conditions. Consequently, the heating unit will produce substantially the same heat dissipation over a considerable period of time without substantial adjustment of the applied voltage.

In order to insulate a resistive conductor of the kind above referred to from its sheath enclosure, some suitable refractory material, e.g. powdered magnesium oxide or any other suitable insulating material, may be inserted

between the linear heating element and the external sheath. The refractory material will provide a dense uniform mass between the heating conductor and the sheath. This same arrangement may also be applied, if desired, to a plurality of like heating conductors, which are physically disposed parallel to each other, all enclosed within a common external sheath, and the insulation above-noted would be inserted to insulate the several heating elements from each other and from the external sheath. In accordance with this invention, the outer sheath is preferably made of a metallic substance, such as Inconel or any other appropriate corrosive resistive steel material. The shape of the sheath may have any configuration, e.g., circular, elliptical, flat-sided oval, etc. and at the same time maintain the heating conductor uniformly spaced from the sheath.

A feature of this invention resides in a heating unit having a linear heating conductor within a metallic sheath, and having suitable insulating material, as above-noted, inserted between the two elements, and one terminus of the unit may be swaged to bind the heating conductor to the sheath so as to provide good electrical and physical connections between the two elements. Such a swaged arrangement obviates the use of electrical terminals for the heating unit. This, therefore, reduces the number of parts required in manufacture and assembly, and minimizes the time necessary to maintain the heating unit in good working condition continually.

Another feature of this invention resides in the use of a metallic plug and appropriate insulation interposed at the other end of the heating unit, between the central conductor and the sheath, so as to maintain the heating element and the sheath completely separated and insulated from each other.

This invention will be better understood from the more detailed description hereinafter following when read in connection with the accompanying drawing, in which FIGURE 1 represents a side elevational view of one form of an assembly, shown partially in section, of a heating unit in accordance with this invention; FIGURE 2 represents a cross-sectional view taken at or near the center of the unit when it has a circular cross-section; FIGURE 3 represents another sectional view taken at or near the center of the unit when it is arranged to have a flat-sided oval configuration throughout its length; and FIGURE 4 represents another side elevational view, in cross-section, of a somewhat different form of the heating unit of this invention.

For convenience and clarity of exposition, the invention will be described and illustrated with reference to an elongated heating unit comprising a single linear conductor **10** made of resistive material which is enclosed within a cylindrical sheath **20** which may be, for example, circular in cross-section. The arrangement of FIGURE 1 includes the central heating wire or conductor **10** which is uniform in cross-section throughout its length and is made of a resistive material such as Nichrome, Chromel, Tophet, or any other suitable resistive metallic element, preferably one which may be non-corrosive in weather. This central conductor **10** is arranged concentrically within the sheath or outer housing **20** which may be any non-corrosive resistant steel element, such as Inconel, or any other like material. Between the conductor **10** and the outer sheath **20**, there is inserted an insulating material **15** which may be, for example, magnesium oxide or other suitable ceramic or plastic insulating material, preferably a powdered insulating material.

At the right end of the heating unit of FIGURE 1, the sheath **20** is swaged to the central conductor **10** at **25** so as to form what may be termed a "hot junction." The swaging operation is performed by well-known mechani-

cal tools and processes and need not be further described. The central conductor **10** is electrically connected to the outer sheath **20** at this terminus **25** so that current may freely flow in either direction, or in both directions, between the two elements **10** and **20**. The swaging connection **25** eliminates any use whatever of auxiliary terminals or other hardware which are separate and distinct from the combined components **10** and **20**. Furthermore, the swaged elements may be so tightly sealed to each other as to prevent any appreciable leakage of water or air into the unit.

At the left hand end of the FIGURE 1 arrangement, there is interposed, between the sheath **20** and the central conductor **10**, a plug **30** which may be made of a soft metallic conducting material, such as brass, copper, aluminum or any other suitable material which may be readily crimped. The central conductor **10** is provided with an annular electric insulator **40**, as shown, which electrically insulates the plug element **30** from the central conductor **10**, thereby avoiding any short circuit therebetween. The sheath **20** embodies a crimp or annular ring **50** which is formed as a circular depression over the surface of sheath **20**, in the region of plug **30**, thereby providing ringed depression **50** to which an electrical terminal may be physically and electrically connected as desired. Naturally, if the shape of the sheath **20** is not circular but is, for example, flat-sided oval-shaped, as shown in FIGURE 3, the crimp **50** will necessarily be formed of a similar shape about sheath **20**.

The arrangement of FIGURE 1 may be connected to any source of voltage, such as a six or twelve volt battery or any other source of power, whether AC or DC, for supplying current for heating purposes to the central core heating element **10**. One terminal of the source of power will be connected at the terminus **60** of the central conductor **10** in any well known manner and the other terminal of the power source will be connected to the crimped sheath **50**. The flow of current will be over the central conductor **10** to the swaged junction **25** at the right hand end of the unit, then back over the sheath **20** to the crimped end **50** thereof. The cross-section of the wire **10** is so small as to produce the required amount of heat when related to the voltage of the applied source. The generated heat is sufficiently high so as to travel outwardly, i.e. radially, in the direction of the sheath **20**, more or less by convection. The heat generated by the wire **10** will reach the metal sheath **20** where it will be dissipated and radiated in all directions. A cover or reflector (not shown) may be positioned over the sheath **20** as to direct the heat in one or another direction if directivity is required.

By so enclosing the central conductor **10** within the insulation **15** and the outer sheath **20**, the central conductor will be substantially free of oxidation or other chemical reaction. The swaged terminal **15** at the right hand end and the suitable plugged unit **30** at the left-hand end will serve as additional protection to further insure the heating element **10** against chemical action. The unit would then be readily adaptable for continuous use even in rain or snow or other external environments and it would maintain a high constancy in its electrical parameters. The unit may be manufactured in any length and in any cross-sectional shape and with any resistive wire **10** and sheath **20** to meet any desired conditions. The ringed depression **50**, if it is circular as above-indicated, enables the heating unit to be readily turned about the axis of the central conductor **10**, through one or more revolutions or through part of a revolution without breaking the continuity of the electrical circuit during such rotation.

Although the invention has been described above with particular reference to a heating unit which is of circular cross-section, that is, a unit having a configuration in cross-section such as is shown in FIGURE 2, any other configuration, such as a flat-sided oval configuration, as shown in FIGURE 3, may be employed. If the FIGURE 3 arrangement is selected, there would necessarily be greater flexibility, that is, bendability, in the direction perpendicular to the flat side. Such an arrangement would be especially suitable for a unit which is intended to be flexed in one or another direction or which is to be formed into any desired configuration or pattern. It will be understood that the sheath **20** and the plug **30** preferably should have matching, similar cross-sectional shapes so that they fit tightly together. If desired, for example, both may be flat sided oval configurations.

FIGURE 4 illustrates a variant of the form of heating unit shown in FIG. 1. Here the central resistive conductor **10**, the outer sheath **20** and the insulation **15** therebetween are, respectively, similar to the corresponding elemens of FIG. 1. However, a metallic pipe or tubing **70** is positioned adjacent to the central resistive conductor **10** of FIG. 4 as to be in intimate and direct physical and electrical contact therewith. Also, the pipe or tubing **70** is spaced from the outer sheath **20** by the coaxial insulator **80**. Thus, the pipe or tubing **70** effectively increases the metallic conductive material associated with the resistive conductor **10** and therefrom allows the resistive conductor **10** to operate considerably cooler at its terminus.

If desired, appropriate sealants of well known types may be applied at the swaged terminal **25** of the heating units of FIGS. 1 and 4, that is, between the central conductor **10** and the sheath **20**; and at the terminal at the left of FIG. 1, that is, between the plug **30** and sheath **20** and between plug **30** and insulation **40**; and at the terminal at the left of FIG. 4, that is, between the pipe or tubing **70** and the central conductor **10** and between the tubing **70** and the insulating sleeve **80** and between the sleeve **80** and the sheath **20**. Such sealants will further insure against the leakage of air or water or other fluid into the cavity of the heating unit and maintain it substantially dry and unaffected by weather or other external conditions and contaminants. Furthermore, the left terminal of the FIG. 4 arrangement may incorporate a coaxial depression, such as **50** of FIG. 1, whereby partial or complete rotation of the heating unit will not precipitate a breakage of the continuity of the electrical circuit and whereby the parts at the left terminal of the heaing unit will be held against end-wise movement away from or out of the sheath **20**.

It will be obvious that the same general physical and electrical arrangement may be employed for a plurality of parallel conductors which are linear. In such an arrangement, all the conductors may be inserted within a common sheath and current would be transmitted separately or jointly over the various linear conductors within the sheath enclosures. Swaging might be employed at one end of the unit, as shown at **25** at the right-hand side of FIGURE 1, and a plug element **30** having one or more openings depending upon the number of linear conductors, would be employed at the left-hand end of the unit. Whether the central conductors are circular in cross-section or of any other shape, they will be protected by the insulation and the sheath which encases the insulation.

It will be observed, as a feature, that the unit per se does not employ any binding post or other mechanical structures for tying the central conductor **10** to the sheath **20**. However, the central conductor may have a binding post if this is desired, by this is optional.

By encasing the central conductor as indicated herein above, the temperature at which the central conductor will operate may be kept relatively low if desired and hence problems incident to oxidation and embrittlement will be virtually non-existent. If desired, the central conductor **10** may assume a zig-zag or helical shape within the outer sheath **20**.

In commercial practice, the central conductor **10** and the outer sheath **20** may be made and sold or stocked in a continuous length with the appropriate insulation between these elements. The material may be cut to any

desired length, then swaged at one end as shown at **25**, then plugged at **30** as shown at the left-hand end of FIGURE 1, for example, then crimped as shown at **50**, so as to complete the heating unit. It will be obvious that the arrangement is relatively simple, economical and highly efficient.

While this invention has been shown and described in certain particular arrangements merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. An electrical heater unit comprising an elongated rod-shaped substantially linear conductor of resistive material, an outer substantially linear sheath of non-corrosive metal, heat conductive and electrically non-conductive material interposed between and physically separating the linear conductor and the outer sheath, said sheath and said conductor being swaged to each other at one end of the unit to form an electrically conducting junction so that current may flow serially along said conductor and serially along said sheath, said swaged junction substantially preventing leakage therethrough, and sealing means at the other end of said unit substantially sealing said sheath to said conductor, whereupon the sheath may also dissipate heat generated by the flow of current through the conductor.

2. An electrical heater unit in accordance with claim **1** having, in addition, a metallic plug inserted between said sheath and said conductor at the other end of said unit, and additional insulation interposed between said conductor and said plug.

3. An electrical heater unit in accordance with claim **1** having, in addition, a metallic tube inserted between said sheath and said conductor at the other end of said unit, and additional insulation interposed between said sheath and said metallic tube so that said metallic tube will increase the area of the conductive path at said other end of said unit.

4. An electrical heater unit in accordance with claim **2** in which a crimp is formed in the sheath and in said plug for retaining said plug in position within the sheath.

5. An electrical heater unit in accordance with claim **2** in which the sheath and said plug have non-circular but similar cross-sectional shapes.

6. An electrical heater unit comprising an elongated cylindrical sheath made of non-corrosive metal, a rod-shaped electrical resistive conductor substantially linearly disposed substantially at the geometric axis of said sheath, one end of said sheath and the corresponding end of said conductor being swaged to each other so as to form a good electrical conducting junction between said sheath and said conductor so that current may flow freely therebetween, a plug inserted between said sheath and said conductor at the other end thereof, means for retaining said plug within said sheath, said retaining means being provided by a crimp which is uniformly indented into said sheath and also into said plug, said plug being insulated from the central conductor, and heat conductive and electrically non-conductive material interposed between the electrical resistive conductor and the cylindrical sheath to substantially fill the space therebetween.

7. An electrical heater unit in accordance with claim **6** in which the plug is made of a soft metal which can be crimped by pressure applied through the sheath.

8. An electrical heat unit in accordance with claim **7** in which the linear conductor is made of Nichrome and the sheath is made of Inconel metal.

9. An electrical heater unit in accordance with claim **5** in which said plug is insulated from said sheath and is conductively connected to the central conductor.

10. An electrical heater unit comprising an elongated rod-shaped substantially linear continuous resistive conductor, a substantially linear continuous metallic sheath coaxially arranged with respect to said conductor, said sheath being swaged to said conductor at one end of said unit, a coaxial plug inserted between said conductor and said sheath at the other end of said unit, the space between said sheath, said plug and said conductor being filled with heat conductive and electrically non-conductive material whereby current may freely flow serially over said conductor and serially over said sheath in a continuous circuit through the swaged end of the unit for generating heat in said conductor which is passed on radially to said sheath to enable said sheath to heat the adjacent medium surrounding the outer surface of said sheath, said swaged junction substantially preventing leakage therethrough.

11. An electrical heater unit in accordance with claim **10** in which a sealant is applied to the ends of the unit to substantially bar the entrance of fluid into said unit.

12. An electrical heater unit in accordance with claim **10** in which said sheath is crimped circumferentially to correspondingly crimp said plug.

References Cited

UNITED STATES PATENTS

2,178,659	11/1939	White	123—145
2,736,784	2/1956	Gore	338—274 X
2,272,282	2/1942	Wiegand	174—77
2,480,903	9/1949	Charbonneau	174—77
2,767,288	10/1956	Lennox	174—77 X
2,884,920	5/1959	Moule et al.	123—145
3,252,122	5/1966	Baxter	338—238 X
3,067,311	12/1962	Lacy-Hulbert	219—552

FOREIGN PATENTS

1,086,489	8/1960	Germany.

VOLODYMYR Y. MAYEWSKY, Primary Examiner

U.S. Cl. X.R.

174—77; 219—534, 544; 338—242, 274