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F. H. NICOLL ET AL
METHOD OF MAKING INSULATED WIRE

2,692,218

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FIG-1

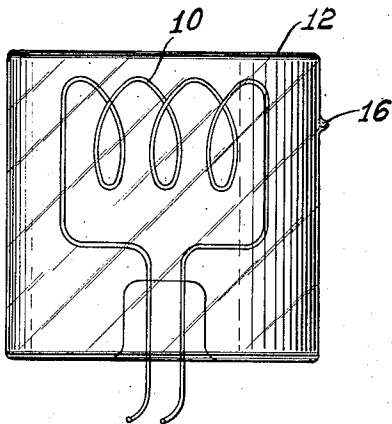


FIG-2

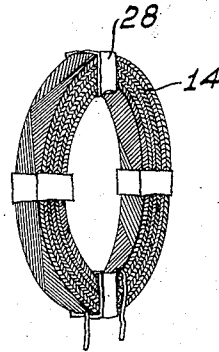


FIG-3

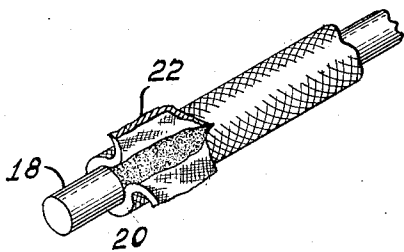


FIG-5

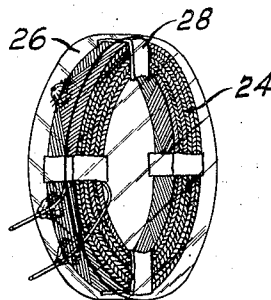
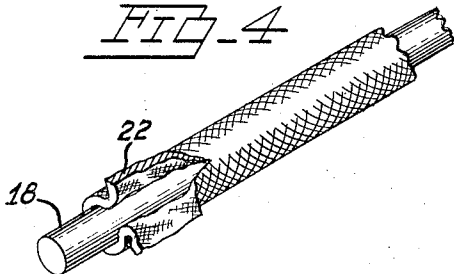


FIG-4



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METHOD OF MAKING INSULATED WIRE

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5 Claims. (Cl. 154—2.25)

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The present invention relates to improvements in methods of making insulated wire and more directly, although not necessarily limited thereto, to a method of making electrically insulated wire suitable for constructing close-wound coils of a type adapted for use at high temperatures.

More particularly, the present invention deals with improvements in the manufacture of close-wound electrical coils in which the individual turns of the coils are to be insulated from one another and in which there is to be included substantially no impurities capable of adversely affecting high vacuum systems under conditions of elevated temperatures.

The present invention is further concerned with the method of making electrical coils suitable for inclusion in the vacuum envelopes of electronic discharge devices such as described, for example, in a co-pending application by D. W. Epstein et al., Serial No. 105,924, filed July 21, 1949, now Patent Number 2,542,493.

The use of insulated electrical conductors in high vacuum systems is quite common in the electrical art. For instance, in the interconnection of various electrodes of complex electronic discharge tube structure, as found, for example, in image orthicon television pick-up tube, it is sometimes desirable to use insulated wire of one form or another. In such cases, the insulated wire generally takes the form of a simple electrical conductor covered by a ceramic or glass sheathing, either in woven or solid tubular form, which covering is inherently immune to the high temperatures employed in the manufacture of the electronic device.

As will be realized, the heat immunity of the insulated wire in electronic discharge tube vacuum systems is quite important since any component of the insulation, oxidizable or decomposable by extreme temperature, will tend to infect the desirably pure vacuum within the discharge tube envelope. More particularly, if such decomposed insulation components, formed during the well-known heating or degassing of the electron tube envelope, should find residence on the discharge tube cathode surface serious damage to the cathode emission characteristics could also result.

Moreover, as described in the patent above referred to, it is sometimes desirable to include in a high vacuum electron discharge tube system a close-wound electrical coil used for the inductive pick up of electromagnetic energy later to be rectified and used as electrode polarizing potentials. Such a coil is made integral with the elec-

tron tube structure during its manufacture and is necessarily subjected to the high degassing temperature of the discharge tube during its latter phases of construction. The coil, being preferably as small as possible, yet utilized for the generation of rather high peak voltages, sets forth quite severe insulating requirements, which requirements must be met without introducing into the coil structure elements detrimental to the tube degassing process. Initial efforts in obtaining suitable coil arrangements led to the trial of numerous glass insulated wire types, the glass being chosen such as to be substantially immune to the necessary high temperature. However, it is found that in the manufacture of glass-covered wire, as well as many other types of wire characterized by their heat resistant insulation, an adhesive or binder is placed on the wire conductor to properly hold the heat resistant insulation material to the conductor. Accordingly, at the higher degassing temperatures encountered in electron tube manufacture, the adhesives used for such a purpose are volatilized or oxidized and contaminate the envelope.

It is therefore a purpose of the present invention to provide a novel method for making electrically insulated wire having a maximum insulation characteristic with minimum size requirements, yet embracing no constructional elements detrimental to the vacuum chamber of electronic discharge devices subject to high temperatures.

It is another purpose of the present invention to provide a new and improved method for making an electrical coil suitable for high vacuum use wherein the coil may be subject to high-operating temperatures and wherein the desired operating environment is to be kept free of contamination.

In realizing the above objects, the present invention contemplates the fabrication of an insulated wire by coating a wire conductor with an adhesive material suitable for conforming an insulating material to the outer surface of the conductor. The adhesive material, although being inherently adversely affected by higher temperature operation, does, at lower temperatures, permit effective application of the insulating material which is, according to the present invention, necessarily immune to high temperature conditions under which the wire is to be normally employed. The wire, with the adhesively-held insulation thereon, is then heated to oxidize or volatilize the adhesive binder, the products of such volatilization or oxidization being carried away by forced air or other suitable cleansing

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processes. The resulting wire then comprises nothing more than an electrical conductor surrounded by a very closely associated insulation having a high degree of heat immunity with no construction elements likely to contaminate high vacuum systems in which the wire may find use.

Various modes of carrying out the present invention, as well as numerous other objects and advantages thereof will become apparent to those skilled in the art through a perusal and understanding of the following specification, especially when considered in connection with the accompanying drawings in which:

Figure 1 illustrates a very common use of wire in a vacuum system in accordance with prior art technique;

Figure 2 illustrates a close-wound electrical coil of a type to which the present invention may be advantageously applied;

Figure 3 shows an electrical insulated conductor of the glass-insulated type before being fully treated in accordance with the present invention;

Figure 4 is the same glass-insulated conductor shown in Figure 3 after having been fully processed according to the present invention;

Figure 5 shows an electrical coil of the form illustrated in Figure 2 but constructed in accordance with the present invention thereby permitting its successful employment in the illustrated vacuum envelope.

Referring now to Figure 1 of the drawings, there is shown, only by way of illustration, a typical prior art arrangement employing an electrical conductor 10 in a vacuum chamber 12. Such an arrangement readily lends itself for use as an electric lamp or heating device and, as such, the conductor 10 may be coiled with such a low pitch that insulation between adjacent turns is not required.

However, should the coil 14 of Figure 2 be employed it is evident that suitable insulation around the wire would be necessary to prevent shorting of adjacent turns. As stated above, such insulation in prior art arrangements may conveniently take the form of glass spaghetti, plastic sheath or other easily formed insulating materials. However, should the coil 14 be designed for use in a vacuum envelope such as 12, in which other elements, such as electron discharge tube structure, are to be situated, the chamber 12 would have to undergo suitable degassing before the seal 16 of the chamber was closed. This degassing process generally requires heating of the envelope and the structure within the same, to temperatures in the neighborhood of 500° C. Obviously, insulation of the coil 14 must then be of a type which will withstand this higher temperature. This indicates the desirable use of a glass type of insulation.

As is well known, however, in the wire-making art, glass insulated wire, such as Vitro-tex, presently manufactured by the Anaconda Wire and Cable Corporation of New York city or Single Glass Enamel Wire manufactured by the Wheeler Wire Company of Bridgeport, Connecticut, necessarily employs around the surface of the conductor a binder or enamel on which to wind the glass insulated material. Such glass-covered wire so intimately associates the glass insulation with the outer surface of the conductor that a considerable saving in the space required by a coil of a given number of turns is made possible over and above the use of glass or other type of insulating sheathing. It has been found though

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that this adhesive binder material, on which the glass insulation is wound, tends to decompose by volatilization or oxidation during the degassing or heating process and upon sealing of the vacuum chamber 16 and cooling thereof, presents a very serious form of contamination in the chamber. Sometimes the volatilized adhesive material tends to condense upon cooling on portions of the structure within the vacuum chamber adversely affected thereby.

According to the present invention, the contaminating effects on the adhesive binder employed to initially conform the heat-resistant insulation to the conductor may be eliminated. This is done by heating in air or other suitable atmospheres the wire at a temperature at least as high as the temperature to which it is to be subjected in the evacuated chamber. This heating is continued until all of the oxidizable or volatilizable and otherwise decomposable materials constituting the adhesive binder are driven off thereby leaving nothing but the glass insulation surrounding the wire conductor.

The effects of this process are illustrated more clearly by Figures 3 and 4 which respectively show a conductor, such as the glass enamel variety, before and after treatment according to the present invention. In Figure 3, the conductor 18 has an adhesive binder 20 to which the threaded glass insulation 22 adheres when woven onto the conductor. As noted, this binder 20 is considered by the wire-making industry as necessary in successfully applying an insulation of the woven glass variety. After prolonged heating and oxidation such as, for example, in open air at high temperatures, the binder 20 is driven off or decomposed to leave nothing but the woven glass insulation 22 surrounding the wire conductor 18, as shown in Figure 4.

After removing the binder 20, the wire or the coil, such as 24, into which the wire may be formed, as shown in Figure 5, is in suitable condition for placing in a vacuum chamber, such as 26, to be heated and degassed in accordance with conventional practice.

It is noted that, as shown in Figures 2 and 5, an appropriate type of cement or ceramic binder 28 may be applied to aid in holding the turns of the coil together, thereby making its manipulation somewhat easier. It will be realized that provided the porosity of the insulation 22 was sufficiently great, the binder 20 could be removed subsequent to the manufacture of the insulated wire by submerging the wire or coil in a solution containing a dissolving or decomposing agent for the binding material. In any event, it is generally found that, although the coil into which the wire is to be formed may be wound subsequent to the removal of the binder 20 by heating or otherwise, it is generally desirable to form the coil prior to the removal of the binder.

It is moreover manifest that a variety of insulating material may be employed for such application in heated vacuum systems provided the material itself will not be adversely affected by the higher degassing temperature. Mica or suitable forms of ceramics could conceivably be used for this purpose. As the art progresses, other insulating materials suitable for such high temperature work will undoubtedly become available and fall within the useful scope of the present invention.

Having thus described my invention, what I claim is:

1. The method of making an insulated elec-

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trical conductor suited for use in elevated temperature environments comprising the steps of: coating an electrical conductor with an adhesive binder inherently decomposable by the elevated temperatures to form readily mobile decomposition products adverse to the normal operating conditions of the conductor, covering the conductor, through the aid of the adhesive under lowered temperature conditions, with a glass-insulating material having a melting temperature below the predetermined elevated temperature environments, heating the so-formed insulated conductor to a temperature permitting decomposition of the adhesive, and removing the products of adhesive decomposition from between the conductor and insulating material.

2. The method according to claim 1 wherein the adhesive is readily volatilized and oxidized to form vaporous products of decomposition and wherein the removal of the adhesive decomposition products comprises the ventilization of the wire during heating in an atmosphere permitting ready oxidation and volatilization of the adhesive.

3. The method of making an insulated electrical conductor from a laminated assembly comprising an electrical conductor and a covering of refractory electrical insulating material bonded thereto by an adhesive material which decomposes at elevated temperatures, which comprises the step of heating such assembly to a tempera-

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ture sufficient to decompose said adhesive material but insufficient to affect said refractory material.

4. The method as defined by claim 3 wherein said insulating material comprises glass fibers.

5. The method of making an insulating electrical conductor from a laminated assembly comprising an electrical conductor, a coating thereon of adhesive material which decomposes under certain treatment and a covering of electrical insulating material secured to such conductor by said adhesive, said covering being relatively impervious to said certain treatment, which comprises the step of subjecting said assembly to said certain treatment whereby to decompose said adhesive material.

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