April 30, 1968 G. H. MOREY 3,380,867

METHOD OF MAKING ELECTRICAL HEATING TAPE

Original Filed Aug. 26, 1963 2 Sheets-Sheet 1

FIG-1

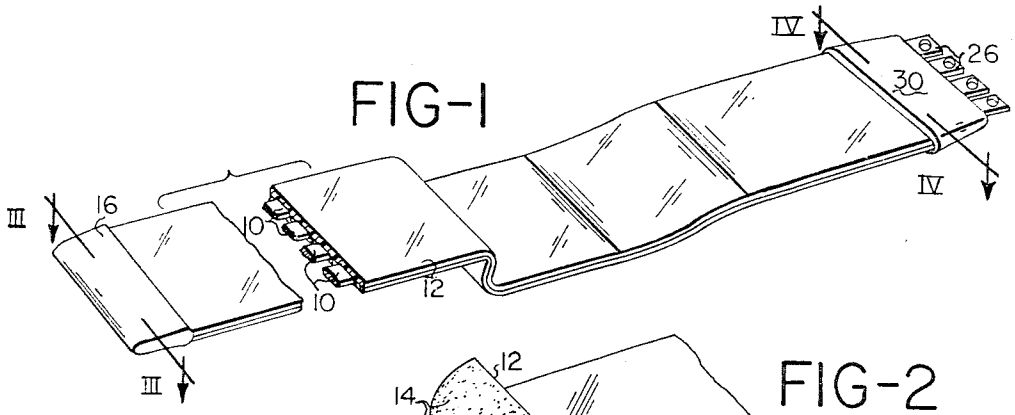
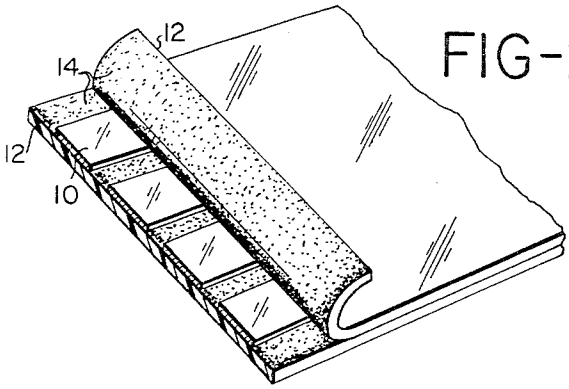


FIG-2



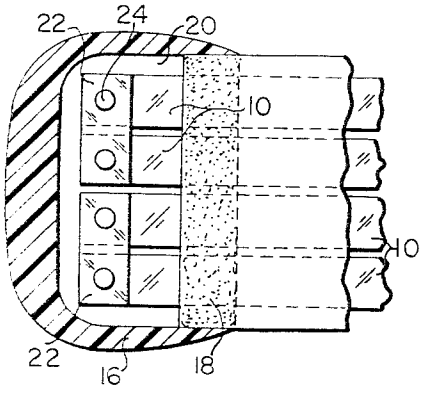


FIG-3

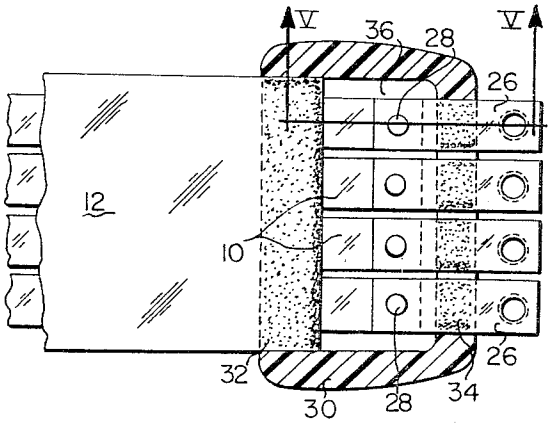


FIG-4

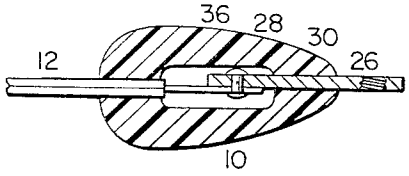


FIG-5

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METHOD OF MAKING ELECTRICAL HEATING TAPE

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FIG-6

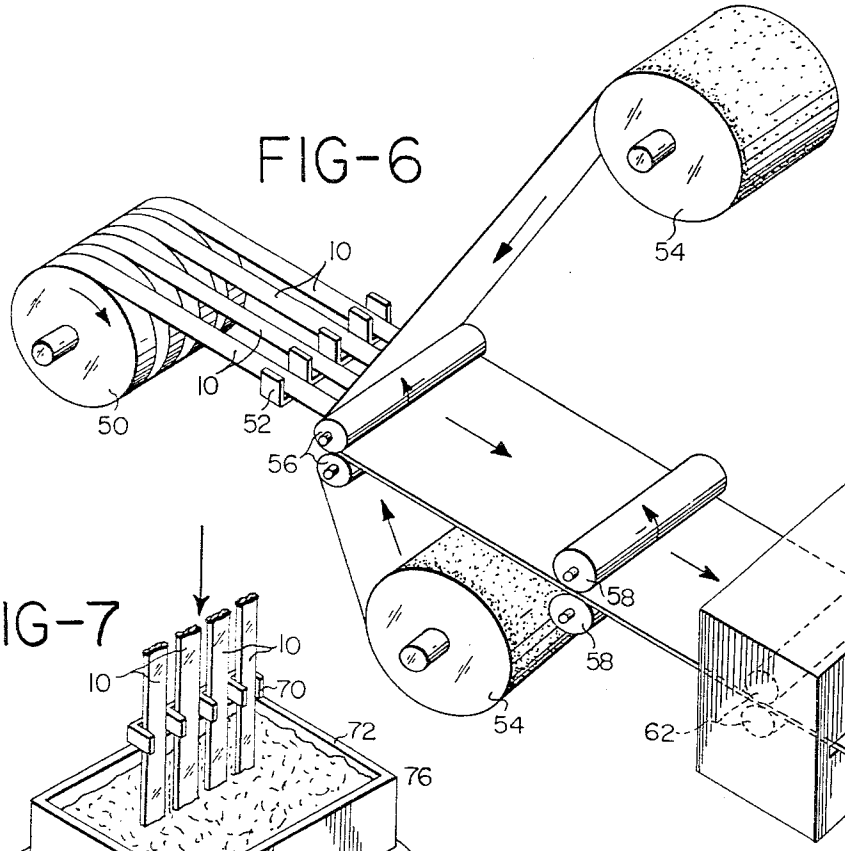
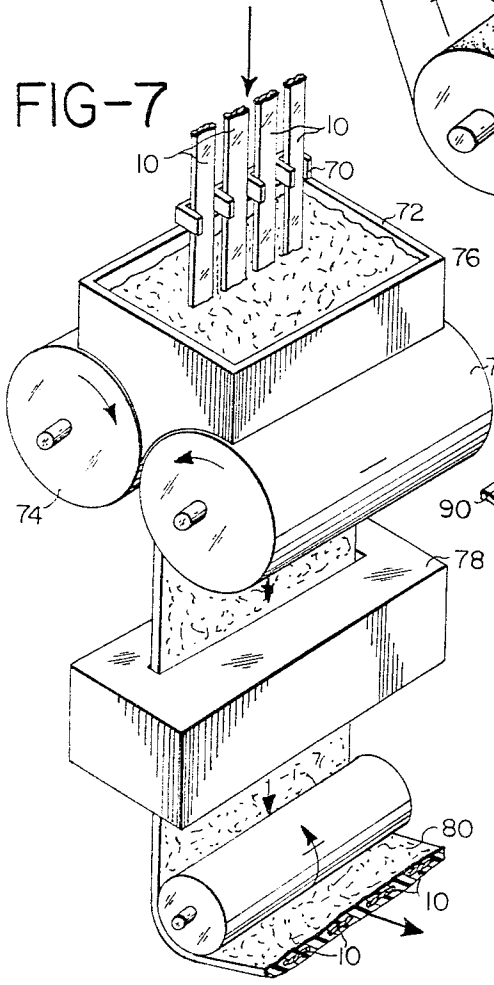


FIG-7



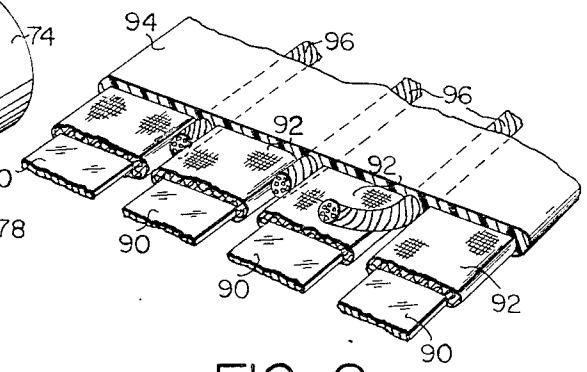


FIG-8

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United States Patent Office 3,380,867
Patented Apr. 30, 1968

3,380,867

METHOD OF MAKING ELECTRICAL HEATING TAPE

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Original application Aug. 26, 1963, Ser. No. 304,412, now Patent No. 3,268,846, dated Aug. 23, 1966. Divided and this application May 13, 1965, Ser. No. 455,389
7 Claims. (Cl. 156—179)

ABSTRACT OF THE DISCLOSURE

Method of making an electrical resistance heating tape in which a plurality of thin, flat, ribbon-like resistance heating elements are arranged in parallel spaced coplanar arrangement and wherein flexible fluid impervious plastic electrical insulating material is applied to both sides of the group of heating elements and pressed thereagainst so as to enclose the heating elements on all sides with the insulating material, thereby to form a thin, flat, flexible and fluid-tight electrical resistance heating tape.

This invention relates to a method of manufacturing a heating tape having ribbon like resistance heating elements therein and is a division of my copending application Ser. No. 304,412, filed Aug. 26, 1963, now U.S. Patent Number 3,268,846.

Heating tapes of the type in which resistant heating elements are contained within an insulating sheath are well known and those with ribbon type heating elements of the general nature with which the present invention are concerned are illustrated in my issued U.S. Patents Nos. 2,939,099, 2,952,001, 2,966,648, 2,982,932, 2,985,-860. The present invention is particularly concerned with an improved heating tape of this general nature and to a method of making the same, which makes the tape more economical to manufacture and more adaptable to various situations in which it might be used.

Another object of this invention is the provision of a flexible electrical resistance heating tape and a method of manufacturing the same which requires the minimum in special material and equipment.

A still further object of this invention is the provision of an electric resistance heating tape and a method of manufacturing the same in which substantially commercial products are employed as the main components of the tape.

A still further object of this invention is the provision of an electric resistance heating tape having a plurality of resistance elements therein which can be selectively connected in various circuit arrangements to adapt a given tape to varying supply voltages.

Still a further object of this invention is the provision of an electric resistance heating tape which will be fluid impervious and which will not tend to absorb liquids in any way whatsoever.

A still further object is the provision of a flexible resistance heating tape in which the external surface of the tape can be made highly resistant to attack by chemicals and which will also be resistant to abrasion.

These and other objects and advantages of this invention will become more apparent upon reference to the following specification taken in connection with the accompanying drawings, in which:

FIGURE 1 is a somewhat diagrammatic perspective view showing a tape according to the present invention;

FIGURE 2 is a perspective sectional view showing details of construction of one form of the tape;

FIGURE 3 is a sectional view indicated by line 3—3 on FIGURE 1 taken through one end of the tape showing one manner in which the end of the tape can be finished;

FIGURE 4 is a view similar to FIGURE 3 and is indicated by line 4—4 in FIGURE 1 but is taken at the opposite end of the tape showing one manner of finishing the tape so that electrical connection can be made to the heating elements therein;

FIGURE 5 is a sectional view indicated by line 5—5 on FIGURE 4 showing how a connector member can be secured to a resistance heating element of the tape;

FIGURE 6 is a schematic perspective view showing one manner of manufacturing the tape according to the present invention;

FIGURE 7 is another schematic perspective view showing an alternate method of manufacturing the tape; and

FIGURE 8 is a perspective view showing a modified form which the invention can take.

Referring to the drawings somewhat more in detail, as will be seen in FIGURES 1 through 5, the heating tape comprises a plurality of ribbon like resistance heating elements **10** arranged in spaced parallel relation. The exact size of the ribbons of resistance material, of course, is variable within wide limits in accordance with the supply voltage which will be used to energize the tape and the length of the tape of the desired wattage. Calculation of these particular factors would be made according to conventional practices. As an example of a tape that could be manufactured according to this invention, the ribbons might be about three-eighths of an inch wide and be some two to four thousandths inch in thickness. The ribbons could be formed of Nichrome or some other suitable resistance material.

These ribbons are arranged in side by side relation as illustrated for example, four of the ribbons, and spaced about one-sixteenth inch apart.

The ribbons are sandwiched between two relatively thin plastic strips **12**. This material might, for example, be Teflon or silicone rubber or other plastic material available in thin films and capable of withstanding temperatures up to the range of about 500 degrees F. The Teflon and silicone rubber are merely representative examples of plastic materials of this nature.

Plastic strips of the nature referred to about two inches wide would be satisfactory for encasing a group of four resistance element strips each about three-sixteenths inch wide and spaced apart about one-sixteenth of an inch. The faces of the plastic strips toward each other are of such a nature as to adhere to one another and to the resistance elements, and this may be brought about by an adhesive coating on the plastic strips. Plastic of the nature referred to, which includes Teflon and silicone rubber, is resistant to chemical attack and abrasion and is extremely flexible.

The tape, in being made of long ribbons of resistance material and long strips of plastic film, lends itself well to economic manufacture because these basic materials of the ribbon can be fed off continuous spools and the tape manufactured in continuous process and thereafter cut to length and finished.

The manner of finishing the tape, by which is meant the finishing of the opposite ends of a cut off section of the tape, can be accomplished in different manners, and one way of doing this is illustrated in FIGURES 3, 4 and 5.

FIGURE 3 shows that one end of the tape is provided with a Teflon or silicone rubber or plastic cap or fitting **16** cemented as by cement **18** to the plastic sheathing of the tape and confining with the end of the tape a space **20** into which the ends of the ribbons **10** extend. Within this space the ribbons can be interconnected in pairs by

connector strips **22** connected by rivets **24** with the ends of the resistance ribbons.

In the particular arrangement shown in FIGURE 3, each pair of interconnected ribbons would form a single heating element with two serially connected legs. Obviously, individual connection could be made to the resistance heating elements in which case they would all be in parallel, and could be energized singly or in multiple. Still further, it would be possible to connect the ribbons **10** so that they were all in series if so desired, and any of these circuit arrangements could be made to adapt the tape to the particular supply voltage available for any given tape. It will be understood that the connections illustrated in FIGURE 3 are therefore only representative of many circuit arrangements that could be made with a multiple ribbon tape according to the present invention.

FIGURE 4 shows one treatment of the end of the tape opposite the end shown in FIGURE 3. In FIGURE 4 each resistance ribbon **10** has a connector **26** secured thereto by a rivet **28** and there is provided an insulating plastic cap or fitting **30** cemented to the plastic sheath of the tape by adhesive **32**. This fitting is also sealed to connector members **26** by adhesive **34** and confines with the end of the tape a space **36** wherein the connector elements are attached to the ends of the heating ribbons. The connector elements **34** in FIGURE 4 as well as connector elements **22** in FIGURE 3 are preferably substantially thicker than the ribbons **10** as will be seen in FIGURE 5. These connector elements can be conveniently connected to the resistance elements by riveting, but could also be spot welded or brazed thereto.

FIGURE 6 shows somewhat diagrammatically the preferred manner of manufacturing a resistance heating tape according to the present invention. In FIGURE 6, **50** indicates the supply spools of the resistance ribbons and the individual ribbons will feed therefrom through a guiding comb **52** to predetermine and maintain the proper spacing between the ribbons. **54** indicates spools of the plastic material to be applied to opposite sides of the group of ribbons. These films are guided over guide rolls **56** and applied to opposite sides of the group of resistance ribbons. Pressure rolls **58** apply pressure to the outer faces of the plastic strips to cause them to adhere to each other and to the opposite sides of the resistance ribbons.

A pressure sensitive adhesive may be supplied to the faces of the plastic strips that engage each other, but it is possible also to employ heat sensitive adhesive material, and in this case, the rolls **58** could be heated in order to cause the plastic strips to adhere to each other and to the resistance ribbons. In still other cases the adhesive material on the plastic strips could be heat curable, and in this case, the tape would be passed through a heating station such as the oven **60**. Pressure rolls could also be included in this oven if so desired, as indicated at **62**.

The arrangement described above permits manufacturing of the tape in continuous lengths so that production is extremely rapid and economical, and so that tapes of any desired length could readily be manufactured.

FIGURE 7 shows schematically another method of manufacturing the tape in which the resistance ribbons **10** are fed through a spacing comb **70** and then downwardly through a hopper **72** and between calendering rolls **74**. Hopper **72** contains plastic material **76** which is calendered by rolls **74** and pressed and formed together and about the ribbons **10** whereby to form an integral body of plastic material completely enclosing the resistance ribbons. In most cases the plastic material would be cured by passing the tape through an oven **78** following calendering rollers **74**.

In the manufacture of a tape according to the present invention, simple plastic material for the films on opposite sides of the resistance ribbons would many times be adequate. However, it is also within the purview of this invention to utilize supported or reinforced films. Support for the films, for example, might comprise knitted or woven textile material imbedded therein or applied thereto and reinforcement of the films might take the form of textile or glass fibers or the like embedded in the plastic material. Fibrous material of this nature is indicated by the lines **80** in FIGURE 7. It will be understood that the fibrous material would be distributed through the plastic material according to any predetermined pattern or any random pattern.

In any case, the fibrous material would greatly reinforce a plastic material and give it considerably greater strength and greater resistance to abrasion and would in this manner, not only strengthen the entire tape and make it more wear resistant, but would also increase the protection of the individual resistance heating elements enclosed within the plastic sheath.

FIGURE 8 shows an arrangement wherein the resistance ribbon-like elements **90** are encased in braided textile material **92** which may, for example, be glass fibers or quartz fibers or the like.

The tubular sheaths surrounding the ribbon-like resistance heating elements permit movement of the resistance heating elements due to contraction and expansion, and thus relieve them from stress which would otherwise be imposed upon them if they were confined between layers of plastic material adhering thereto. With the resistance heating elements encased within the sheaths **90** a plastic coating **94** is applied to the heating elements in the same manner as has been described above in connection with the previous modifications. This figure also shows how the individual resistance heating elements could be held in spaced relation by cords **96** between adjacent heating elements. These cords not only fix the spacing between the adjacent resistance heating elements but also reinforce the entire heating tape against longitudinal stresses imposed thereon.

It will be understood that the tape according to the present invention could have conventional plug-in type connector means at one or both ends, if so desired, as is shown in my Patents 2,982,932 and 2,985,860 for greater convenience in connecting and disconnecting the heating element to a source of electrical energy.

An advantageous tape construction can be arrived at by employing as the plastic material relatively thin ribbons of unsintered Teflon without the application of any adhesive. The Teflon ribbons are pressed on opposite sides of the resistance ribbons and are then heated up to about 600 degrees F. which will bring about sintering of the Teflon and the direct fusion of the Teflon ribbons with each other between the resistance elements. This heating can be done with the application of pressure in order to insure complete and continuous fusing of the Teflon ribbons with each other.

The net result of making the resistance ribbon in this manner is a flexible tape relatively inexpensive to construct and in which the encapsulating plastic material is fused into a homogeneous mass completely surrounding the resistance heating elements and absolutely fluid tight. A particular advantage of this last described method is that the Teflon material is relatively inexpensive and is easy to handle so that the resulting tape is quite inexpensive.

The tape according to the present invention is completely fluid tight and can be used in locations where heating tapes having fabric sheaths would be impractical or even inoperative.

On account of the extremely large area of the resistance heating elements high wattage per unit could be developed by a tape according to the present invention without the temperature of the resistance heating elements at the surface thereof becoming high enough to cause deterioration of the plastic sheath. This is a distinct advantage of the ribbon-like resistance heating element over the fine wire resistance heating elements of conventional tapes.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions; and accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

What is claimed:

1. The method of making a reinforced continuous tape for use in electrical heating tapes comprising; enveloping a plurality of continuous ribbon-like electrical resistance heating elements in respective textile insulating reinforcing members, positioning said heating elements in side-by-side relation in a common plane and moving the plurality of elements in the direction of the length thereof, positioning cords between the sides of adjacent heating elements of the previous step to maintain the spacing therebetween and to reinforce said tape against longitudinal stress and moving the cords with said elements, applying a heat curable flexible fluid impervious plastic electric insulator to both sides of said elements and cords to completely envelop said elements with their textile reinforcing members and said cords, applying pressure to said insulator to form a continuous flat fluid impervious tape, and heating the tape to cure said plastic insulator.

2. The method as claimed in claim 1, in which said step of applying a plastic insulator comprises disposing said heating elements, cords and textile reinforcing members between strips of the said plastic insulator.

3. The method as claimed in claim 1, in which said step of applying a plastic insulator comprises passing said elements, textile reinforcing members and cords through a hopper containing said plastic insulator in flowable form.

4. The method of making a continuous tape for use in making electrical resistance heating tapes comprising; maintaining spaced parallel coplanar relationship among a plurality of continuous ribbon-like strips of electrical resistance elements which are sheathed within close fitting tubular insulating sheaths of textile material and moving said sheathed elements in the direction of their length, applying a strip of flexible fluid impervious plastic electrical insulating material to each side of said plurality of sheathed elements, and calendering said plastic material around said sheathed elements thereby completely to surround the sheathed elements with the plastic material and to cause said strips to adhere to each other.

5. A method according to claim 4 in which said strips are in the form of at least partially uncured heat curable material, and heat is applied to the strips simultaneously with pressure during the said calendering to cure the strips while welding them together after they are applied to said sheathed elements.

6. A method according to claim 4 in which said strips of plastic electrical insulating material have pressure sensitive adhesive on the sides thereof that face each other.

7. A method according to claim 4 in which said strips of plastic electrical insulating material have heat curable adhesive on the sides thereof that face each other, and heat and pressure are applied to said strips during the said calendering to cure said adhesive after the strips have been applied to said sheathed elements.

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