June 4, 1963 L. ARGENTO 3,092,685

FLEXIBLE ELECTRIC CONDUCTOR

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FIG. 3

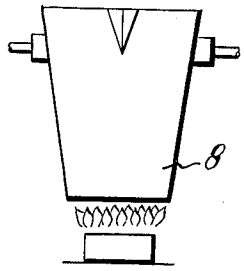


FIG. 4

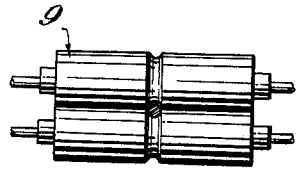


FIG. 1

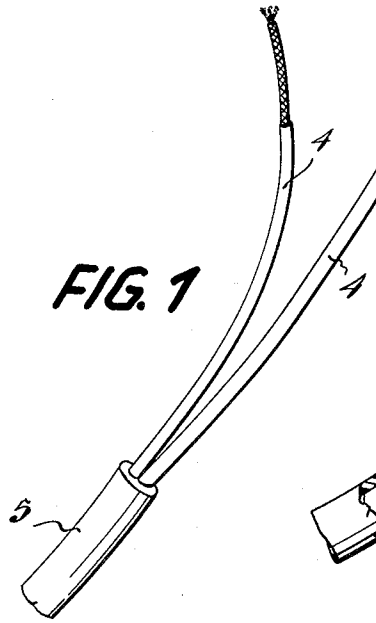
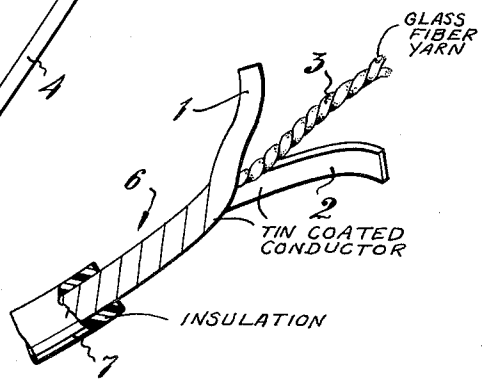


FIG. 2





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FIG. 5

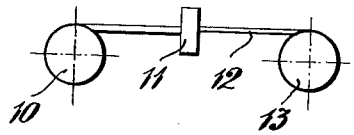


FIG. 6

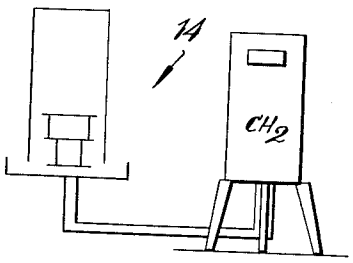
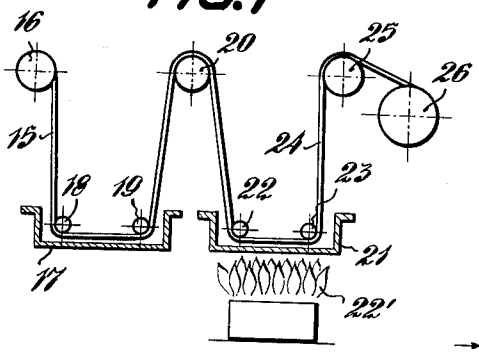


FIG. 7



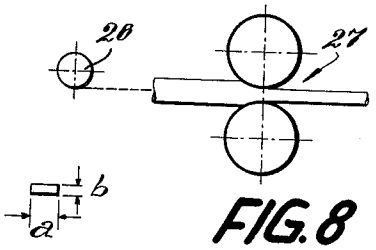


FIG. 8

FIG. 9

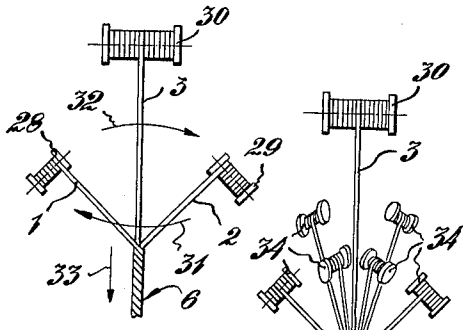


FIG. 8a

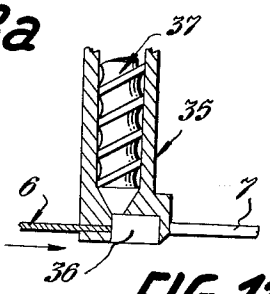
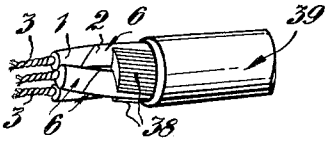


FIG. 11

FIG. 10

FIG. 12



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FLEXIBLE ELECTRIC CONDUCTOR

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14 Claims. (Cl. 174—116)

This invention relates to an electric conductor and more particularly to an extremely soft and flexible conductor which incorporates means for carrying out a soldering action. In addition the present invention refers to the method for manufacturing such an electric conductor.

Single pole or phase electrical conductors manufactured of helical layers of metal ribbons, usually made of electrolytically pure copper, which are helically wound around a central core made of a cotton thread or the like, which is combustible and/or fusible, such as used for instance in telephone circuits, are well known in the art.

It is known that in this type of conductor it is almost impossible to solder two end pieces thereof together, or to solder one end piece to any type of post in view of the fact that the central core made of textile fiber would either be burned or fused during such a soldering action and the resulting residues would bar or at least render difficult the formation of a good electric contact, which is even more necessary when such a conductor is used for low voltage, such as in telephone circuits and the like. Until now, to overcome such a difficulty, it was necessary to link the end of such a conductor with the post or another conductor by means of a clamp terminal or the like, which of course is subject to a number of failures, so that these clamp terminals are the source of additional trouble.

To overcome these difficulties and drawbacks, according to the present invention a flexible electric conductor has been conceived of the type previously referred to which maintains its high flexibility, but which is perfectly solderable without altering the nature and structural conditions of the core.

More particularly, the present invention refers to a flexible electric conductor having a central non-conductive core and one or more helically, electricity conductive ribbons wound around, wherein said ribbons are coated at least on their outer faces with a layer of solderable material and said core is continuous and incombustible, the melting point of which is above the melting point of said layer.

In addition the present invention refers likewise to a method of manufacturing a flexible electric conductor, comprising the steps of forming a wire by hot rolling, drawing said wire, annealing it in an inert atmosphere to soften it and achieve a clean surface, pickling said wire, coating said wire with a layer of solderable material, cold rolling the coated wire to transform it into a ribbon and helically winding it on a continuous incombustible core, the melting point of which is above the melting point of said layer.

From the foregoing it will be apparent that the present invention overcomes the necessity of using a clamp terminal for the flexible electric conductor to connect it to another flexible conductor or any kind of terminal, as was necessary up to now and thus important savings in labour are achieved.

Furthermore, from a technical viewpoint it will be understood that the conductors of the present invention eliminate a source of technical failures due to the fact that it has now become possible to solder this type of electric conductor.

An electric conductor according to the present invention may be made of one or more metal ribbons which are helically wound around a core. Such a conductor is usually known as a single pole or a single phase conductor which may be sheathed with an insulating tape or

the like made of rubber, neoprene or other elastomers, polyvinyl chloride, plastics, and the like. As to the ribbon, usually electrolytically pure copper is used for the manufacture and the layer of solderable material preferably consists of a layer of tin.

The core is preferably made of a thread having a suitable twist and being of an incombustible material having a melting point which is above the melting point of tin. More particularly, the core may be made of glass fiber yarn preferably with a suitable twist. It would also be possible to use cotton yarn or any other combustible yarn provided that the latter is covered with an incombustible material such as sodium silicate and the like.

In order to solder one end of a flexible electric conductor according to the present invention, either to another similar flexible electric conductor or to any terminal, all that is necessary is to apply heat to the outer face of the ribbon so that the soldering material will fuse and establish a good electrical link connection to the other flexible electric conductor or terminal.

In order to facilitate the comprehension of the present invention reference will now be made to several preferred embodiments in relationship to the accompanying drawings, by way of example.

FIG. 1 is a perspective view of a flexible electric single pole conductor consisting of a plurality of basic conductors.

FIG. 2 is a detail, in perspective view of a basic conductor in accordance with the present invention.

FIGS. 3 to 11 schematically show the process for manufacturing such a conductor.

FIG. 12 is a perspective view, with parts cut away to show still another embodiment according to the present invention.

The expression "basic conductor" is to be interpreted as defining one flexible electric conductor according to the present invention which may form part of a plurality of such conductors defining a single pole conductor.

As may be best seen in FIG. 2, such a basic conductor consists for instance of a pair of helically wound ribbons **1**, **2** about a core **3**. The ribbons **1**, **2** are usually made of a good electricity conducting material, such as electrolytically pure copper coated with a soldering material, such as tin.

The core **3**, in the embodiment of FIG. 2 is made of a yarn which is incombustible and has a melting point above the melting point of the soldering material, for instance it may be made of glass fiber yarn.

The resulting basic conductor **6** may be fit into an insulating tubular member **7** or, as shown in FIG. 1 several basic conductors **6** may be fit into a single insulating tubular member **4** which in turn may define part of a conductor **5** having several multiple basic conductors sheathed in insulating tubular members **4**.

Obviously, the insulating sheath or tubular member should likewise be made of flexible material.

The process of manufacturing the flexible electric conductor according to the present invention is schematically shown in FIG. 3 and following.

Electrolytically pure copper is produced either by oxidation or de-oxidation in a suitable container **8** and formed into ingots or the like (not shown) which are then hot rolled in a rolling station **9** to obtain wires having preferably a diameter of 9 mm. The resulting wire is then wound on a drum **10** and drawn through an extrusion die **11** to obtain either in one or in several successive steps the wire **12** having a diameter of 0.10 to 0.07 mm., which is wound on a drum **13**.

As the next step, wire **12** is annealed to an inert or a reducing atmosphere in the schematically shown equipment **14**, as such known, to achieve a flexible soft wire having a clean and shining surface.

The wire 15 is then mounted on a drum 16 and is passed through a container 17 containing a suitable acid solution to be pickled or scoured by passing along the guiding rollers 18 and 19 and then said wire is withdrawn from the container 17 by passing along the guiding roller 20 and into container 21 having a pair of guiding rollers 22 and 23. In container 21 a bath of soldering material (not shown) is arranged so that the wire 15 will be covered with a layer of such a soldering material for instance with the cooperation of heat 22'. Obviously, the coating could likewise be electrolytically achieved.

The resulting coated wire 24 is then rolled over a guiding roller 25 onto a drum 26. Drum 26 is then transported to a cold rolling station 27 which transforms the wire into a ribbon as shown in FIG. 8*a* having a rectangular crossed section of preferably $a=0.50$ to 0.20 mm. and $b=0.015$ to 0.4 mm.

The resulting ribbon is again wound onto a drum such as drum 28 shown in FIG. 9. A similar ribbon should be mounted on a second drum 29 and a third drum 30 should provide the core 3. The pair of drums 28 and 29 are then turned about a rectilineally moving core 3 as indicated by arrows 31 and 32 to define a resulting basic conductor 6 as will be obvious to those skilled in the art. The core 3 together with the helically wound around ribbons 1 and 2 is moved forward as indicated by arrows 33.

If it is desired to form a basic conductor having more than just a pair of ribbons 1 and 2, the embodiment of FIG. 10 may be used, wherein again drum 30 contains a single core 3 about which a plurality of drums 34 similar to drums 28 and 29 are moved around to define a helical path, whereby a basic conductor 6' is obtained.

The basic conductor 6 or 6' may then be passed to a sheathing device 35 as shown in FIG. 11 having a nozzle 36 and an endless screw 37 adapted to and press into the nozzle 36 the insulating material whilst the basic conductor 6 is inserted from another end likewise into the nozzle 36, so that a sheathed conductor 4 is achieved.

If it is desired to manufacture a conductor having an outer circular cross section but being formed of several basic conductors 6, as shown in FIG. 12, then the three basic conductors 6 may define a helical assembly having suitable fillers 38 to define a circular outer cross section to be sheathed by an insulating material 39 as shown in FIG. 12.

Although in practice the method as previously described seems to be the most adequate one, from a theoretical viewpoint it will be obvious to those skilled in the art that it will be sufficient if the ribbon or ribbons are merely coated with the layer of solderable material on the outer face.

As many embodiments may be made of this inventive concept, and as many modifications may be made in the embodiments, hereinabove shown and described it is to be understood that all matter herein is to be interpreted merely as illustrative and not in a limited sense.

I claim:

1. In a readily solderable, extremely flexible electric conductor, a central continuous and incombustible non-

conductive core and at least one electrically conductive relatively flat ribbon helically wound around said core, said wound around ribbon defining an outer surface, a layer of easily meltable solderable material coated on said outer surface, the melting point of said core being above the melting point of said layer whereby said conductor can be easily soldered without harming the conductor or core.

2. The flexible electric conductor as claimed in claim 1, wherein said layer of solderable material is tin.

3. A flexible electric conductor as claimed in claim 1, wherein said core comprises a yarn.

4. A flexible electric conductor as claimed in claim 3, wherein said yarn is a twisted yarn composed of glass fibers and said solderable material is tin.

5. The flexible electric conductor as claimed in claim 3, wherein said yarn is made of incombustible material.

6. The flexible electric conductor as claimed in claim 3, wherein said yarn is twisted.

7. The flexible electric conductor as claimed in claim 3, wherein said yarn is made of glass fiber.

8. The flexible electric conductor as claimed in claim 3, wherein said yarn is of combustible material and coated with an incombustible layer.

9. The flexible electric conductor as claimed in claim 8, wherein said incombustible layer is sodium silicate.

10. A flexible conductor as claimed in claim 1, wherein a plurality of ribbons are wound around said core.

11. The flexible electric conductor as claimed in claim 10, wherein said flexible electric conductor is sheathed with an insulating flexible tubular member.

12. The flexible electric conductor as claimed in claim 10, wherein said flexible electric conductor defines a basic conductor, a plurality of basic conductors being helically stranded together and sheathed by an insulating, flexible tubular member.

13. The flexible electric conductor as claimed in claim 12, wherein several of said flexible tubular members are in turn surrounded by a second single flexible tubular member of insulating material.

14. The flexible electric conductor as claimed in claim 13, wherein said several flexible electric conductors are helically wound together, filler means arranged around said wound together conductors to substantially define circular cross sections and said second tubular member surrounding said filler means and flexible electric conductors.

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