Nov. 11, 1969 H. K. PRICE 3,477,126

METHOD OF MAKING STRIP CONDUCTOR MATERIAL

Filed Nov. 17, 1967 2 Sheets-Sheet 1

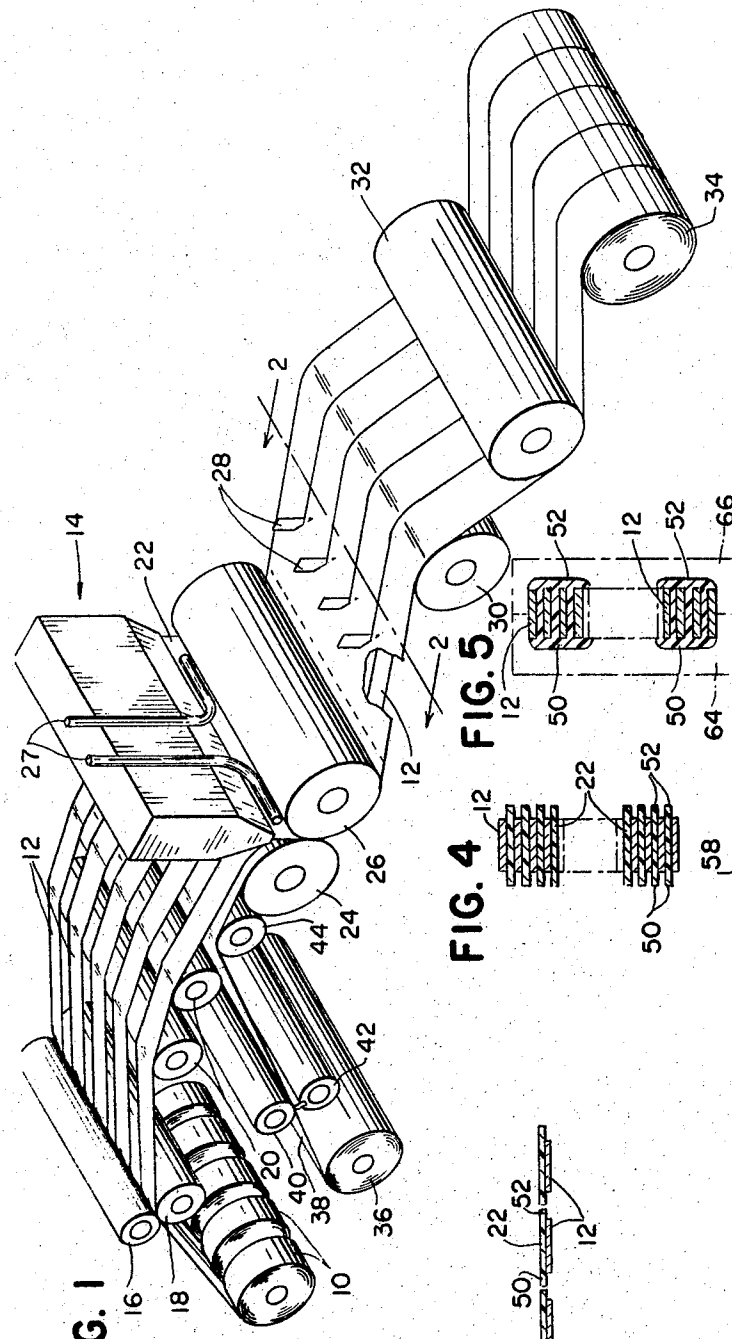

FIG. 1

FIG. 2

FIG. 5

FIG. 4

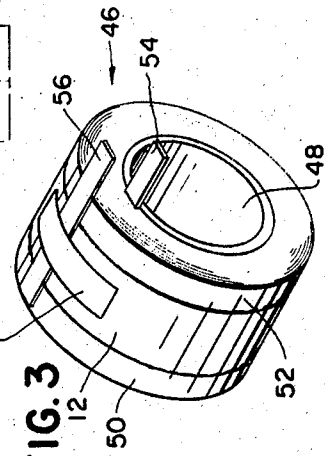

FIG. 3

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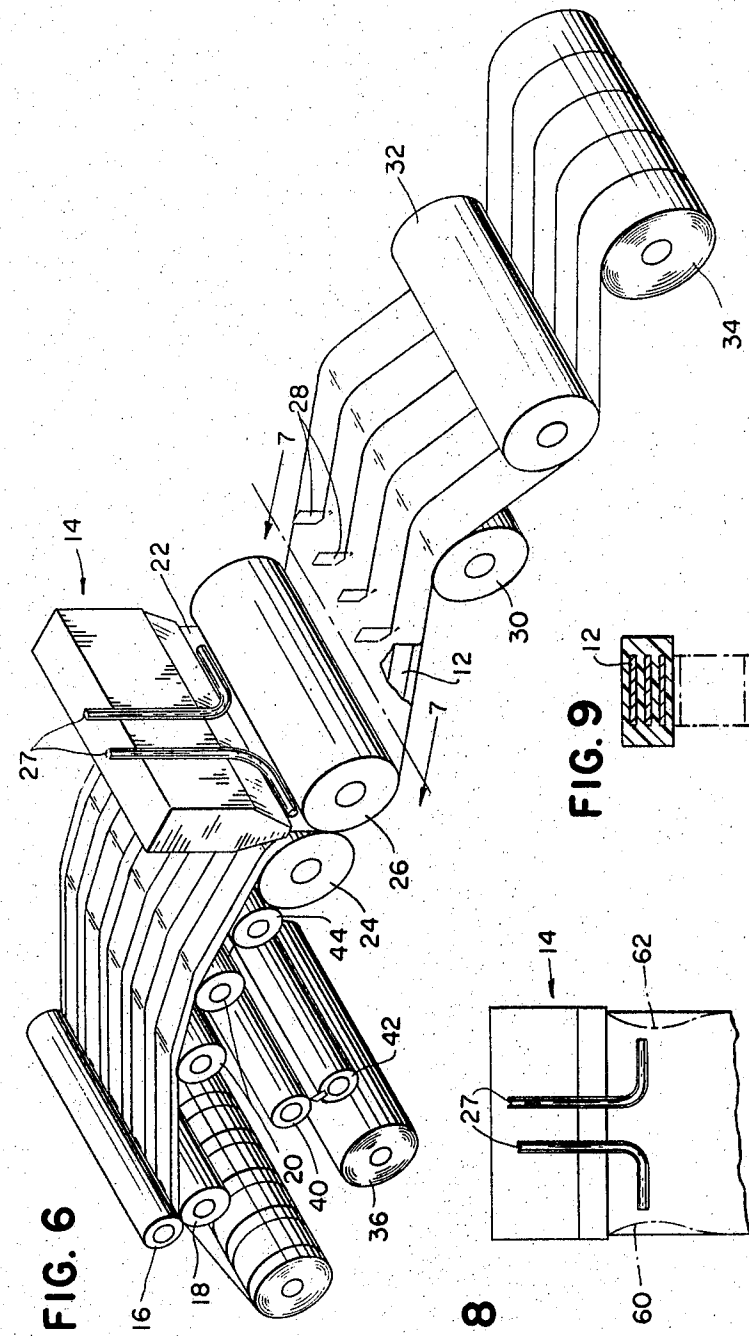

FIG. 6

FIG. 9

FIG. 8

FIG. 7

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METHOD OF MAKING STRIP CONDUCTOR MATERIAL

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ABSTRACT OF THE DISCLOSURE

An insulating coating is extruded onto a plurality of webs of electrical strip conductor material and slit to leave an overhang along each marginal edge sufficiently wide to prevent shorting of turns when the conductor is wound into coil form. In one embodiment, the insulating coating is extruded onto both sides of the conductor whereas in another form it is extruded only on one side. Initially, an auxiliary web is used to lead in the plurality of strips. Once the extrusion has commenced, the auxiliary web is severed.

BACKGROUND OF INVENTION

This invention pertains to an electrical strip conductor material and method of making same and more particularly to an electrical strip conductor material which is provided with an insulating coating so as to prevent shorting of turns when the strip conductor material is wound into a completed coil.

Heretofore it has been the practice to coat electrical strip conductor material with an epoxy film or the like by means of multiple coating passes in order to build up a sufficiently thick insulation which is free from pinholes. The metal is slit to the proper width and wound into coil form, after which the coils are placed in a caustic tank and the edges of the strip conductor material, frequently aluminum, are etched back approximately 5 mils beneath the epoxy film. It is then necessary to rinse the coil in water, neutralize it with sulphuric acid and then rinse again with water. This practice involves considerably more handling problems than is desirable and it is difficult to insure that the epoxy film is pinhole free to prevent inadvertent shorting of turns.

In accordance with the present invention the rather cumbersome handling problem and requirement for a multiple coating is obviated by passing a plurality of webs or strips of electrical strip conductor material to an extrusion nozzle wherein an extrusion coating is applied simultaneously to one side of a plurality of webs of electrical strip conductor material. The plastic coating is of a suitable thickness to insure against pinholes in the coating. The plurality of webs are then fed to a slitting means wherein the individual webs of strip conductor material and insulating coating are slit so as to leave a sufficient overhang along each marginal edge of the conductor material to insure against shorting of turns. It is preferred to space the webs laterally as they are fed to the extrusion nozzle so that a single slitting knife effects the desired amount of overhang on adjacent webs. It is then possible to use the individual webs of coated strip conductor material exactly as it exists in this form for winding into completed coils.

Alternatively, the electrical strip conductor material with an insulating coating thereon may be turned over and refed through the extrusion press prior to the slitting operation so as to insulate the second side of the strip conductor material and then perform the slitting operation. In this manner, the individual strips of electrical

strip conductor material are completely encapsulated by the insulating material.

Any suitable insulating material may be used. For example, polyethylenes, polyesters, polyurethanes, nylon 11, nylon 6, nylon 66, nylon 610, acrylic resins, polycarbonates and polyphenylene oxide may be used. The amount of overhang may vary from approximately 1/64 of an inch to ½ inch before the coated strip conductor material is wound into coil form.

Considerable improvement in speed is possible as a result of the present invention wherein extrusion speeds in excess of 600 feet a minute are not uncommon whereas previously it had been customary to deposit films at speeds in the order of 100 to 110 feet per minute.

The coated strip conductor material may be blocked, that is, put in an oven and heated to provide a solid form, if desired.

A still further alternate form is to coat one side only of the strip conductor material and to use a sufficiently large overhang so that the overhanging edges may be held against a hot plate and fused together. As has been noted, the amount of overhang is easily controlled simply by varying the lateral spacing of the webs being fed to the extrusion coater.

Another feature of the present invention is the use of hot air blasts adjacent the outlet end of the exrusion nozzle so as to blow the opposed edges of the web outwardly, thereby keeping them thin. This becomes important in providing a uniform product and prevent an uneven buildup on one side of a wound coil. A number of plastic materials including polyethylenes, nylons, polyesters, polyurethanes and polycarbonates all tend to neck in immediately upon leaving the extrusion nozzle.

The principal advantages and improvements of the present invention may be more readily understood by reference to the following detailed description thereof and reference to the accompanying drawings wherein:

FIG. 1 is a perspective view illustrating schematically the application of an insulating coating to one side of a plurality of webs of electrical strip conductors.

FIG. 2 is a cross sectional view taken along line 2—2 of FIG. 1 illustrating electrical strip conductor materials;

FIG. 3 is a perspective view of a wound coil made from strip conductor materials of the type shown in FIG. 2;

FIG. 4 is a cross sectional view, partially in phantom, of one strip conductor material wound into coil form;

FIG. 5 is a cross sectional view, partially in phantom, of a modified strip conductor material wound into coil form;

FIG. 6 is a perspective view similar to FIG. 1, illustrating the application of an insulating coating to a second side of a plurality of webs of electrical strip conductor materials;

FIG. 7 is a cross sectional view taken along line 7—7 of FIG. 6 illustrating electrical strip conductor materials;

FIG. 8 is a fragmentary end elevational view of the extrusion apparatus illustrated in FIGS. 1 and 6; and,

FIG. 9 is a cross sectional view, partially in phantom, of one strip conductor material of FIG. 7 wound into coil form.

Referring now to FIG. 1 there is illustrated a plurality of rolls of electrical strip conductor material **10**, such as aluminum foil, which has been preslit to a desired size to be wound onto a suitable core. Aluminum foil webs **12** are paid off from rolls **10** toward a plastic extruder, indicated generally at **14**. Suitable nip rolls **16**, **18** and idler rolls **20** facilitate feeding the webs **12** of electrical strip conductor material toward the plastic extruder in conventional fashion.

A curtain of extruded plastic material is illustrated at **22** which is fed by gravity toward the nip of a sup-

porting roll **24** and a chill roll **26**. The latter insures that the plastic material **22** will solidify. Hot air tubes terminating in outwardly directed nozzles are schematically represented at **27** for a purpose to be described in greater detail hereinafter.

The plastic film material solidifies and bonds itself to one side of the plurality of webs **12** of electrical strip conductor material and the composite web is then fed toward slitting knives **28** to sever individual strips of electrical strip conductor and plastic material thereon such as illustrated in FIG. 2.

After the composite web is slit, the individual webs appear substantially as illustrated in FIG. 2 and are fed over an idler roll **30**, under a tensioning roll **32** and then to a windup roll **34**. It is within the scope of the present invention to feed the composite webs as illustrated in FIG. 2 directly onto a core on a winding machine where the electrical strip conductor material coated at least on one side with a plastic material is wound into a completed coil form.

In order to facilitate the original conveyance of individual webs **12** of electrical strip conductor material toward the plastic extruder **14** a roll of paper stock **36** or other convenient auxiliary web may be employed. In the specific illustration shown, a strip material **38** is passed between nip rolls **40**, **42** and idler roll **44** to provide a support for individual webs **12** of electrical strip conductor material. It is desirable to use a strip material **38** which is readily severable and to which the strip conductor material may be adhesively secured. The strip material **38** constitutes an auxiliary feeding web and also facilitates proper lateral spacing of the individual webs **12**. The strip material **38** paid off from the roll of stock **36** is used only until such time as the adhesion of the curtain of plastic material from extruder **14** has been applied to the leading edge of the electrical strip conductor materials **12**, thereby providing a lead in for the composite webs. Thereafter, the auxiliary conveying by the strip material **38** may be discontinued. One convenient way for effecting this is to have a knife means **43** mounted on one of the feed rolls such as nip roll **42**. Alternatively, the strip material **38** may be cut by hand after the lead-in of the plurality of strips of electrical strip conductor **12** has been effected.

Reference to FIG. 3 illustrates a completed wound coil of electrical strip conductor material indicated generally at **46**. Thus an individual strip of aluminum foil or the like is wound on a core **48** which may be made from any suitable material such as paperboard. The individual strips of electrical strip conductor are shown in FIGS. 2 and 3 to have an overhang of the plastic material at **50** and **52**. In winding a completed core, it is customary to provide electrical terminal leads such as are represented at **54** and **56**. A suitable retainer means **58**, such as a pressure sensitive tape, is employed to prevent the completed wound coil from unraveling.

The use of hot air supplied through tubes **27** prevents necking in of the plastic material as it is fed from the mouth of plastic extruder **14**. This necking in is illustrated in phantom at **60** and **62** in FIG. 8. Not only does the hot air blow the edges of the web out to maintain a uniform distance across the web, but it also keeps the edges of the web thin. Thus polyethylene, various nylon materials, polyesters, polyurethanes and polycarbonates all tend to neck in. The amount of overhang can vary depending upon whether or not the plastic film is to be applied to either one or both sides of the electrical strip conductor material **12**. The overhang prevents shorting of adjacent layers of electrical strip conductor material when it is wound into completed rolls, as illustrated in FIG. 3. It is possible to employ heating dies such as is shown in phantom at **64** and **66** in FIG. 5 to take the overhanging plastic material such as is illustrated at **50** and **52** in FIG. 4 and seal or encapsulate the edges of the electrical strip conductor material **12** as illustrated in FIG. 5.

Alternatively, and in accordance with the preferred form of this invention, the slitting step illustrated in FIG. 1 is deleted and the composite web is wound on a take up roll. The composite web is then fed again to the extrusion coater but turned over so as to present the uncoated side of webs **12** to the extrusion nozzle **14**., This recoating step is illustrated in FIG. 6 of the drawings. In this instance, there is no need to rely upon an auxiliary feeding web to provide support for the electrical strip conductor material **12** since the plastic material already extruded across one face of each of the electrical strip conductor webs provides sufficient rigidity to feed the web to the extrusion apparatus **14** again. At this time a second layer of plastic material is extruded on each of the webs **12** on a side opposite from the side on which the plastic material was extruded in FIG. 1. Once again the electrical strip conductor material passes between supporting roll **24** and chill roll **26** so that when the composite web emerges from chill roll **26** it has an appearance in cross section such as is illustrated in FIG. 7. At this juncture the web is slit by knives **28** to electrical strip conductor material which may then be wound onto a core such as is illustrated in phantom in FIG. 9. It is within the scope of the present invention to feed the composite web immediately after it is slit onto a core on a winding machine where it is wound into completed coil form.

By virtue of the fact that the extrusion of plastic material is laid down in a curtain from the plastic extruder **14** it is relatively easy to effect or achieve sufficiently thick deposits of film on each side of the electrical strip conductor material.

A wide variey of plastic films may be employed in the practice of the present invention. For example, polyethylenes, polyesters, polyurethanes, various nylons such as nylon 6, nylon 66, nylon 610, acrylic resins polysolfones and polyphenylene oxide may be used. Typical melting temperature ranges for these plastic films are polyethylenes from about 480° F. to about 610° F.; polyester resins from about 375° F. to about 600° F., such as a product sold under the trademark "Vituff 1150" by Goodyear Chemicals which melts in the range of about 378° F. to about 400° F.; polyurethanes from about 350° F. to about 600° F.; such as a product sold under the trademark "Estane" by Goodrich Rubber Company having a melting range from about 360° F. to about 380° F.; nylon 11 having a melting range from about 425° F. to about 450° F.; nylon 6 having a melting range from about 410° F. to about 435° F.; nylon 66 having a melting range from about 480° F. to about 500° F.; nylon 610 having a melting range from about 525° F. to about 550° F.; acrylic resins having a melting range from about 250° F. to about 600° F.; polysulfones having a melting range from about 400° F. to about 450° F.; and polyphenolene oxide having a melting range from about 350° F. to about 450° F.

The chill roll at **26** assures solidification of the plastic material after in contacts the elertical strip conductor materials **12**. After the electrical strip conductor materials have been would into completed coils they may be blocked, that is put into an oven and heated to provide a solid form for the coiled material.

The difficulty encountered in the prior art of using caustic tanks and etching the edges of the electrical strip conductor material back from the edge of the plastic material with the concurrent necessity for rinsing, neutralization and further rinsing, is completetly obviated in the practice of the present invention. The electrical strip conductor material may be preslit to provide a cleanly slit edge which is precisely the desired width, and then spaced laterally to provide a desired amount of overhang of plastic material. When the material is turned over in order to pass it through the extruder a second

time, the previously extruded and solidified plastic material provides the desired spacing between individual strips of electrical strip conductor material.

Any convenient means may be used to heat seal the overhanging edges of plastic material when only a single layer of plastic material is extruded onto the electrical strip conductor materials. Thus it is possible to use a hot plate to heat seal the overhanging edges which for this embodiment are made relatively wide to provide the necessary overhang of plastic material,.

While presently preferred embodiments of the invention have been illustrated and described, it will be recognized that the invention may be otherwise variously embodied and practiced within the scope of the claims which follow.

What is claimed is:

1. A method of making an electrical strip conductor comprising the steps of

(a) feeding a plurality of webs of electrical strip conductor material to a plastic extrusion device,

(b) extruding a curtain of plastic material onto one side of said plurality of webs of electrical strip conductor material so as to form a composite web,

(c) and thereafter slitting said composite web so as to form a plurality of webs of electrical strip conductor material having a plastic overhang along each marginal edge thereof,

(d) whereby each web of electrical strip conductor material may be wound into a coil with the plastic overhang preventing electrical shorting of adjacent turns of said electrical strip conductor.

2. A method of making an electrical strip conductor as defined in claim 1 including the additional steps of

(e) turning said composite web over,

(f) feeding said composite web to a plastic extrusion device,

(g) and extruding a curtain of plastic material onto the other side of said plurality of webs of electrical strip conductor material prior to said slitting step.

3. A method of making an electrical strip conductor as defined in claim 1 including the additional step of preslitting the electrical strip conductor material from a web of foil stock to the desired width.

4. A method of making an electrical strip conductor as defined in claim 2 including the additional step of preslitting the electrical strip conductor material from a roll of foil stock to the desired width.

5. A method of making an electrical strip conductor as defined in claim 1 including the additional step of supporting said plurality of webs of electrical strip conductor material on an auxiliary web material until such time as the lead in ends of the webs of electrical strip conductor material have been fed to said plastic extrusion device and then cutting said auxiliary web.

6. A method of making an electrical strip conductor as defined in claim 5 including the additional step of spacing said plurality of webs laterally with respect to each other by attaching said webs to said auxiliary web material.

7. A method of making an electrical strip conductor as defined in claim 1 including the additional steps of winding an individual web of electrical strip conductor into coil form and thereafter heat sealing said plastic overhang along the marginal edges of said electrical strip conductor to insure against electrical shorting of the overlapping layers of said strip conductor.

8. A method of making an electrical strip conductor as defined in claim 2 including the additional step of supporting said plurality of webs of electrical strip conductor material on an auxiliary web of material until such time as the lead in ends of the webs of electrical strip conductor material have been fed to said plastic extrusion device and then cutting said auxiliary web.

9. A method of making an electrical strip conductor as defined in claim 8 including the additional step of spacing said plurality of webs laterally with respect to each other by attaching said webs to said auxiliary web material.

10. A method of making an electrical strip conductor as defined in claim 1 including the additional step of blowing air toward the lateral edge portions of said curtain of plastic material in order to prevent necking in of said curtain of plastic material adjacent the die outlet and to thin the longitudinal edges of said curtain.

11. A method of making an electrical strip conductor as defined in claim 2 including the additional step of blowing heated air toward the lateral edge portions of said curtain of plastic material in order to prevent necking in of said curtain of plastic material adjacent the die outlet and to thin the longitudinal edges of said curtain.

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