United States Patent

[11] 3,634,606

[72] Inventor **Rama Iyengar**
Dorval, Quebec, Canada

[21] Appl. No. **45,980**
[22] Filed **June 15, 1970**
[45] Patented **Jan. 11, 1972**

[73] Assignee **Northern Electric Company Limited**
Montreal, Quebec, Canada

[54] **OUTER CONDUCTOR FOR COAXIAL CABLE**
7 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** ..... **174/106 D,** 174/28, 174/36, 174/102 D, 174/107
[51] **Int. Cl.** **H01b 7/18**
[50] **Field of Search** ..... 174/28, 29, 102 D, 105, 106, 107, 115, 126; 138/121, 128, 137, 142, 151, 156, 170

[56] **References Cited**

UNITED STATES PATENTS

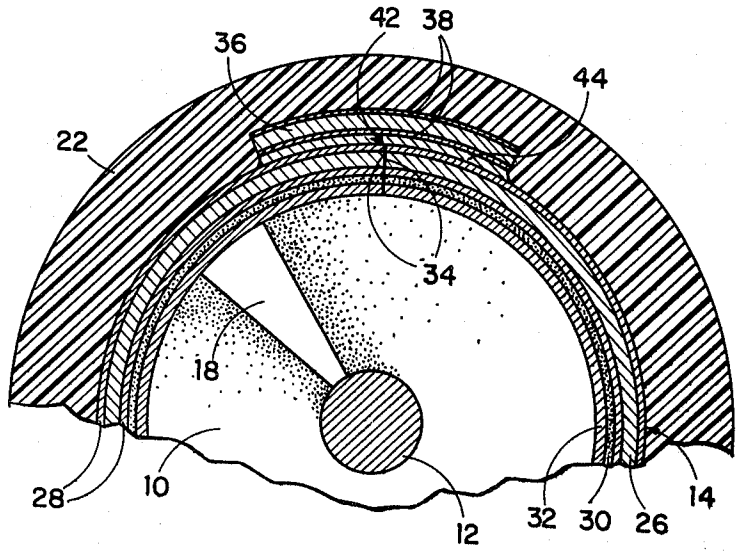
3,586,754	6/1971	Meskell, Jr.	174/106
3,183,300	5/1965	Jachimowicz et al.	174/106
2,589,700	3/1952	Johnstone	174/106
3,261,906	7/1966	Gee-Wah et al.	174/107
3,087,007	4/1963	Jachimowicz	174/110
2,697,772	12/1954	Kinghorn	174/102
3,504,102	3/1970	Polizzano	174/107
3,070,274	12/1962	Elam	138/156 UX

FOREIGN PATENTS

751,152	2/1953	Germany	174/106

Primary Examiner—Thomas J. Kozma
Assistant Examiner—A. T. Grimley
Attorney—Philip T. Erickson

ABSTRACT: The outer conductor of a coaxial cable is formed from a transversely corrugated metal strip comprising a laminate of steel and copper. The strip is applied longitudinally and folded about the cable with its edges in butting relation. A narrow transversely corrugated steel tape is placed over the abutting edges of the laminated strip and soldered thereto throughout the length of the cable.



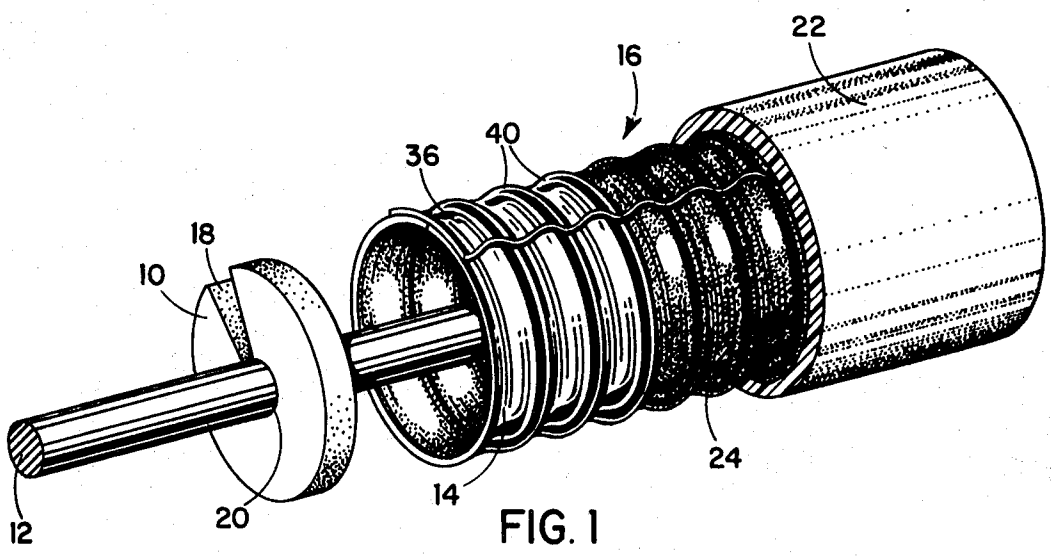


FIG. 1

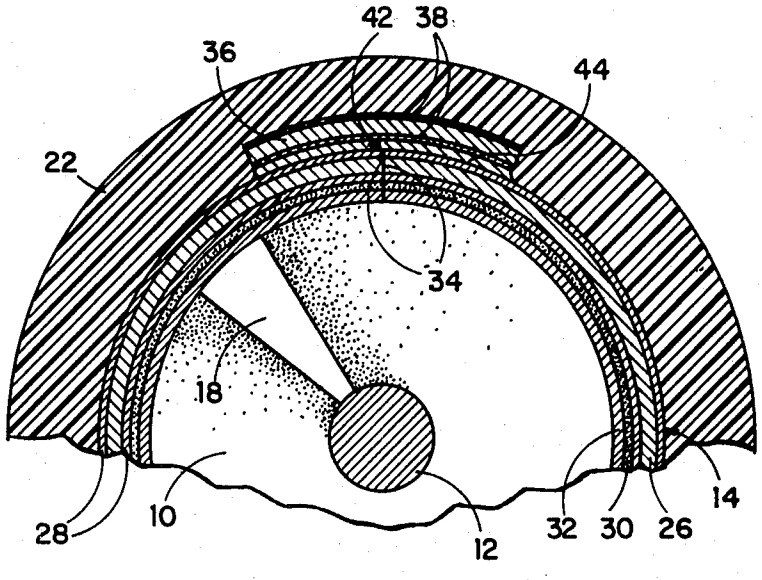


FIG. 2

INVENTOR
R. IYENGAR

AGENT

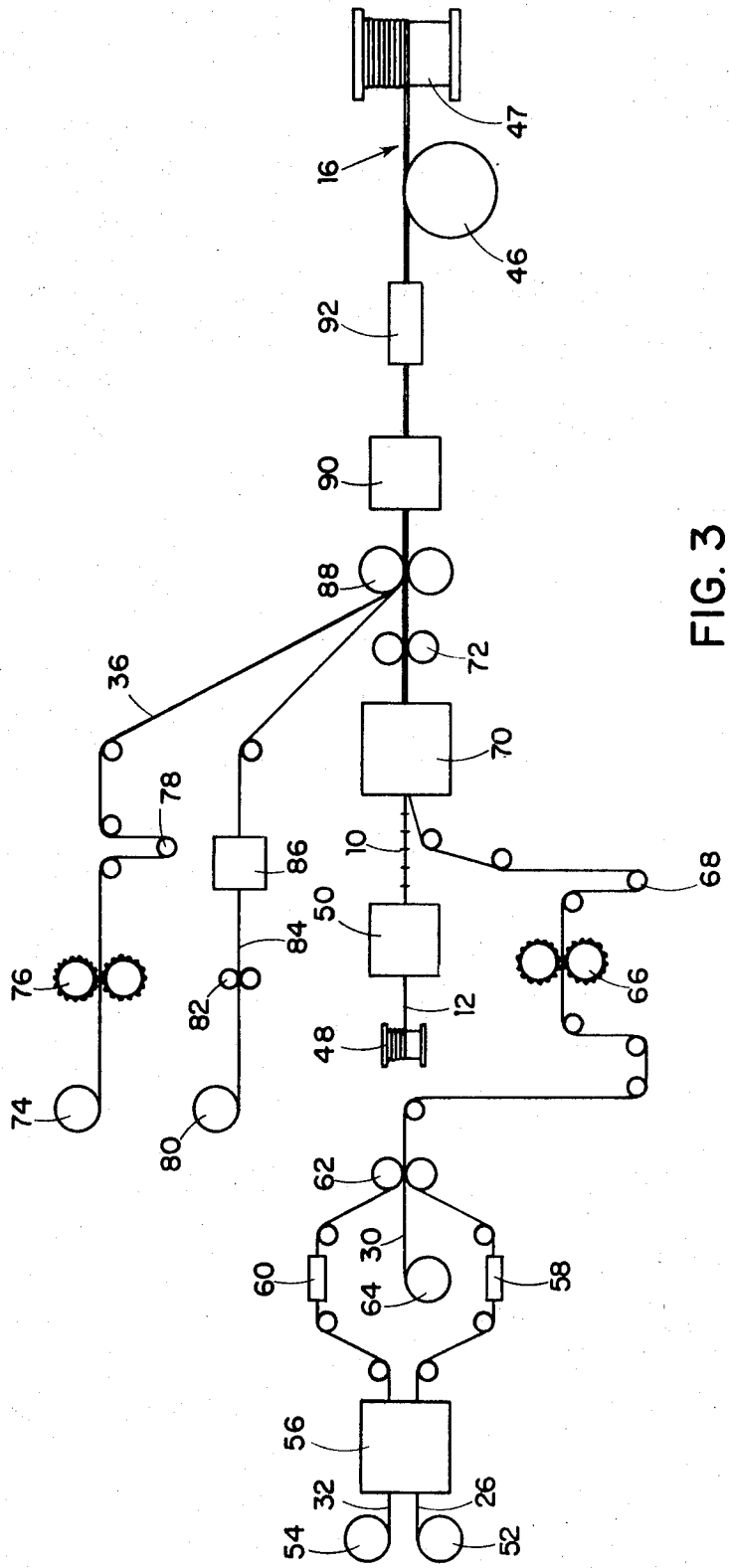


FIG. 3

INVENTOR
R. IYENGAR
AGENT

OUTER CONDUCTOR FOR COAXIAL CABLE

This invention relates to an outer conductor for coaxial cable.

A coaxial cable comprises a conductor centrally spaced within a tubular outer conductor by means of a suitable dielectric. The most suitable dielectric is air which has a low specific inductive capacitance and a low dissipation factor. Therefore, it is usual to space the outer conductor coaxially about the inner conductor by means of thin insulating discs at spaced intervals.

Suitable conductive materials for the outer conductor are very expensive, and for this reason, it is desirable to use as thin a material as possible and only as thick as is electrically necessary. When this relatively weak outer conductor is supported at intervals from within it is susceptable to being crushed when subjected to radial loads or bending stresses, and this will distort the electrical characteristics of the cable.

In disc-insulated coaxial cables, the outer conductor has consisted of a longitudinal copper tape having serrated edges abutting and interlocking to form a seam. Strength requirements have been obtained by the application of helical steel ribbons over the outer conductor.

A recent development, disclosed in an article in the Bell Laboratories Record of July 1969, describes an outer conductor formed from a laminated strip of copper and steel. The steel layer is wider to one side than the copper layer so that when the strip is applied longitudinally and formed about the cable, with the edges of the copper layer in the strip in butting relation, the projecting portion of the steel layer along the edge overlaps the other edge of the strip and is soldered to it throughout the length of the cable.

This design, however, has several disadvantages. The design of the overlap causes a ridge to be formed on the inner surface of the seam which results in distortion of electrical characteristics of the cable. Furthermore, the overlapping portion of the steel layer must be specially formed to allow intimate contact with the underlying portion of the outer conductor to permit proper soldering. Yet another disadvantage is the difficulty of producing the laminated strip with one of the laminae being wider than the other.

In accordance with the present invention, the outer conductor of a coaxial cable comprises a laminated strip of two dissimilar metals applied longitudinally to the cable and formed into a tube with the edges of the strip in butting relation to one another to form a seam. A narrow metal tape is applied over the mating edges of the strip and is soldered thereto on either side of the seam. The metal of the laminated strip on the inside of he tubular outer conductor is highly conductive and forms a layer substantially thinner than the outer metal layer of the laminate. The outer metal layer and the metal tape overlying the seam are of a metal or metals having substantially greater resistance to mechanical stress than the metal of the inner layer. In a preferred form, the invention contemplates an outer conductor of a coaxial cable formed from a transversely corrugated laminated strip of copper and steel, with the tape over the seam being of steel and having transverse corrugations nesting snugly in the corrugations of the underlying outer conductor.

A reinforced tubular conductor formed in accordance with this invention is perfectly circular and has no ridges on its inner surface to affect the electrical characteristics of the cable. Where the conductor is corrugated, the tape covering the seam can be formed with complementary corrugations so that it will fit closely to the conductor. The introduction of the solder ribbon is made simpler since it is applied in line with the overlying metal tape; it need not be wedged between the overlapping edges as is required with the overlap design. If this cable is stranded with others to form a multiunit cable, shearing stresses occuring at the soldered seam will not be borne by the soldered joint as would be the case with an overlap design. Should the solder creep in the conventional overlap configuration, the overlapping edges would slide one over the other causing dimensional deformation of the outer conductor. The

cost of producing the laminated strip in the present invention is kept to a minimum since both laminae are exactly the same width.

The invention will now be described with reference to a preferred embodiment thereof as shown in the accompanying drawings in which:

FIG. 1 is a perspective view of a coaxial cable having an outer conductor in accordance with this invention;

FIG. 2 is a partial transverse section of the coaxial cable in FIG. 1 illustrating the seam construction of the invention; and

FIG. 3 is a schematic diagram illustrating the steps in the manufacture of the coaxial cable of FIG. 1.

FIGS. 1 and 2 illustrate the general structure of a coaxial cable in accordance with the present invention. In FIG. 1, a number of dielectric discs **10** are disposed at spaced intervals upon a center conductor **12** to coaxially support a transversely corrugated outer conductor **14** to form the coaxial cable **16**. The discs **10** are slipped transversely onto the center conductor **12** by means of slot **18** and tightly fitting center opening **20**. Where required, a thermoplastic jacket **22** may be extruded over the coaxial cable **16**. For additional protection, a thermoplastic flooding compound **24** may be applied over the cable **16** prior to the application of jacket **22**.

As shown more clearly in FIG. 2, the outer conductor **14** is formed from a strip of laminated metal. The laminate comprises a steel strip **26**, having layers of tin **28** plated on its opposite faces, bonded by means of a plastic adhesive bonding strip **30** to a copper strip **32** of the same width. The outer conductor **14** is formed from the transversely corrugated laminate by forming it about and in close contact with the spaced dielectric discs **10** with the edges **34** of the laminate in butting contact.

A narrow steel tape or "buttstrap" **36**, having layers of tin **38** plated on its opposite faces, and having a pluralitY of adjacent transverse corrugations **40** (FIG. 1), is centered over the seam **42** formed from the abutting edges **34** of the outer conductor **14**. Corrugations **40** are complementary to the corrugations of the outer conductor **14** to ensure intimate contact between the buttstrap **36** and the outer conductor. A solder joint **44** is formed between the outer conductor and the buttstrap **36** as shown in FIG. 2.

The cable thus formed has an outer conductor comprising a small quantity of relatively expensive and conductive copper and a larger quantity of relatively inexpensive but much stronger steel. The total thickness is considerably less than would be required for an all copper outer conductor having comparable structural qualities. The tin plating makes the layer of steel **26** and the buttstrap **36** solderable at relatively high speeds while employing very small quantities of soldering flux.

The diameter of the coaxial cable **16** is approximately 0.430 inch over the outer conductor **14**. The outer conductor is formed from a laminate 1¼ inches wide. The copper strip is 4 mils thick, the steel strip is 10 mils thick and the adhesive between them is 2 mils thick. The adhesive is preferably a thermosetting polyester in strip form. The steel butt strap **36** is one-fourth inch wide and 6 mils thick. The jacket is preferably polyethylene about 50 mils thick.

The coaxial cable of FIGS. **1** and **2** is manufactured as shown in the schematic diagram of FIG. **3**.

In the process illustrated in FIG. **3**, the components of the coaxial cable **16** are drawn from their various supplies and through the processing steps by capstan **46** which draws the completed cable for winding on takeup reel **47**. The center conductor **12** is drawn from give-up reel **48** and passes through disc applicator **50** which puts the disc-shaped dielectric spacers **10** on the conductor **12** at intervals along its length. A suitable disc applicator **50** is disclosed in Canadian Pat. No. 494,928, issued on July 28, 1953 to A. C. Frankwich.

A tin-coated steel strip **26** is drawn from a roll **52** and a copper strip **32** is drawn from roll **54**. Both strips pass through a degreaser unit **56** then through heaters **58** and **60**. The heated strips are brought together at laminating rolls **62** with

an adhesive strip **30**, drawn from supply roll **64**, between them. The steel strip **26** and the copper strip **32** carry sufficient heat from heaters **58** and **60** to soften the adhesive **30** and causes the steel **26** and copper **32** to bond together into a laminated strip when the three layers are pressed together by laminating rolls **62**. The resulting laminated strip is air-cooled and passes through a set of corrugating rolls **66** which corrugates the laminate transversely to its longitudinal direction. To ensure proper tension in the corrugated strip, the laminate is drawn through a tension control loop **68**.

Both the center conductor **12**, carrying the discs **10**, and the corrugated laminate converge at a suitable roll former **70**. The roll former curves the laminated strip transversely and forms it into a tube about the discs **10** with the longitudinal edges of the laminated strip in butting relation. The resulting tube which forms the outer conductor **14** is then passed through a set of guide rolls **72** which prevent it from rotating about the axis of the cable and keep the seam in proper alignment for the application of the buttstrap **36**.

The buttstrap **36** is drawn from roll **74** and passes through a set of corrugating rolls **76** which forms transverse corrugations of such dimensions that the resulting corrugations will register with the corrugations of the outer conductor **14**. The tension of the buttstrap **36** is controlled by a tension control loop **78**.

A solder wire is simultaneously drawn from a coil **80** and passes through a set of flattening rolls **82**, which rolls it into a flat solder ribbon **84** having the same width as the buttstrap **36**. A suitable eutectic solder wire comprises 63 percent tin and 37 percent lead. Prior to rolling the solder wire is approximately 55 mils in diameter; it is rolled to form a ribbon one-quarter inch wide and 3 mils thick. The solder ribbon **84** passes through a flux bath **86** and converges on the outer conductor **14** under the buttstrap **36** at a set of registering rolls **88**. These rolls ensure that the corrugations of the buttstrap **36** register properly with the corrugations of the outer conductor **14** and also curve the buttstrap transversely to the contour of the outer conductor so that the buttstrap and outer conductor mate snugly together. The cable is advanced to a soldering station **90** where heat is applied in the area of the seam in the outer conductor to melt the solder and fuse the buttstrap **36** to the outer conductor **14**. Cable **16** passes through a cooling device **92** and is fed by the capstan **46** onto takeup reel **47**. A flooding compound **24** and a protective jacket **22** may subsequently be applied if required.

This process has been found to operate satisfactorily at speeds up to 150 feet per minute.

The process described hereinabove produces a coaxial cable having a much greater crush resistance than a disc-insulated coaxial cable having helical steel tapes applied over a thin copper outer conductor. Its bending qualities are such that is may be flexed over much smaller radii without significant deformation of the outer conductor. The soldered buttstrap design provides a smooth inner surface of the outer conductor at the seam and affords an effective seal against the ingress of moisture. Because the conductive portion of the outer conductor is completely covered by a steel layer which is sealed at the seam by soldering, radiation is effectively eliminated. Thus multicoaxial cable using adjacent coaxials suffer very little from crosstalk.

It will be obvious to those skilled in the art that aluminum can be substituted for the conductive copper layer without any deterioration of the above-mentioned characteristics. In that case, the aluminum would preferably be 6 mils thick.

Where sealing of the seam in the metal layer is not essential, the soldering or other joining technique need not be continuous throughout the length of the cable, subject to strength requirements of the construction. This may be of practical application where the metal layer and the buttstrap are coated with a suitable bonding material or other synthetic material.

What is claimed is:

1. An outer conductor for a coaxial cable comprising:

a metal strip folded transversely about an insulated center conductor to form a tube with the edges of the strip extending longitudinally of the cable in abutting relation to form a seam, said strip being a laminate of two layers of dissimilar metals, the one of said two layers on the inside of said tube being of a highly conductive metal and the other of said layers being substantially greater in thickness than said one layer and being of a metal having substantially greater resistance to mechanical stress than the metal of said one layer; and

a metal tape extending longitudinally of and overlying said seam and being soldered to the metal strip throughout its length on either side of the seam to seal the seam and prevent the edges of the strip from being displaced from the abutting position, said tape being of a metal having substantially greater resistance to mechanical stress than the metal of said one layer.

2. An outer conductor for a coaxial cable as defined in claim **1** wherein the metal tape is substantially thicker than said one layer.

3. An outer conductor for a coaxial cable as defined in claim **2** wherein the metal strip and the metal tape have transverse corrugations, the corrugations of the metal tape being complimentary to the corrugations of the metal strip to permit intimate engagement of the metal tape with the metal strip.

4. An outer conductor for a coaxial cable as defined in claim **3** wherein the metal of said other layer is steel.

5. An outer conductor for a coaxial cable as defined in claim **4** wherein the metal of said tape is steel.

6. An outer conductor for a coaxial cable as defined in claim **5** wherein the metal of said one layer is copper.

7. An outer conductor for a coaxial cable as defined in claim **6** further comprising a polymeric material disposed between and bonding together the two layers of the laminate.

* * * * *