April 21, 1964 R. C. MILDNER 3,130,256

CABLES FOR TRANSMITTING HIGH-FREQUENCY CURRENTS

Filed June 30, 1961

2 Sheets-Sheet 1

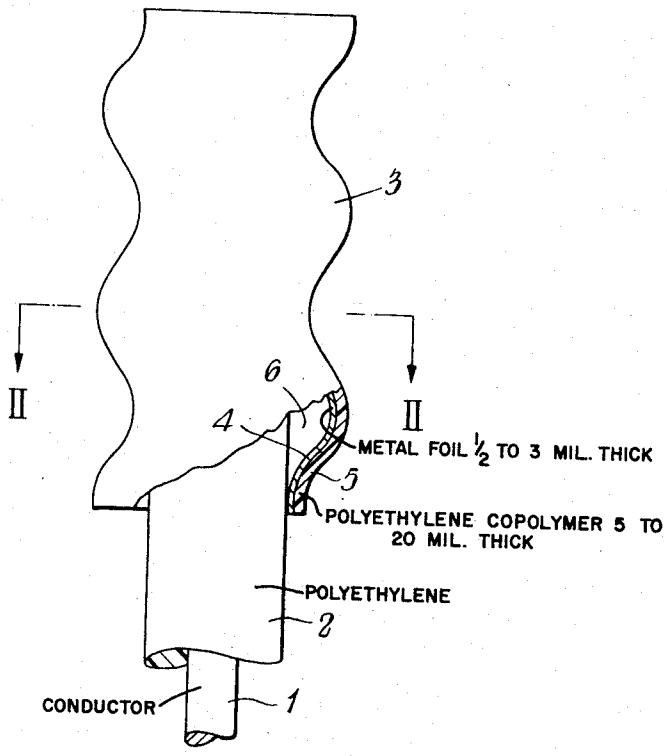


FIG.1

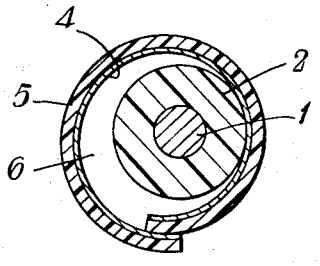


FIG.2

INVENTOR.
RAYMOND CHARLES MILDNER

BY Robert Adelmeier

ATTORNEY.

April 21, 1964 R. C. MILDNER 3,130,256

CABLES FOR TRANSMITTING HIGH-FREQUENCY CURRENTS

Filed June 30, 1961 2 Sheets-Sheet 2

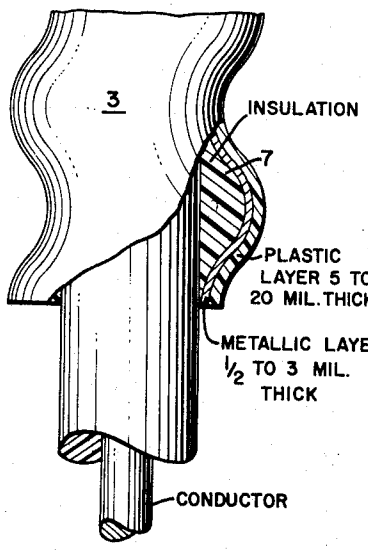


FIG. 3

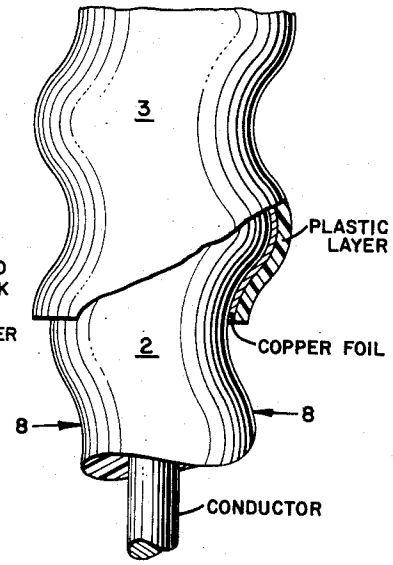


FIG. 4

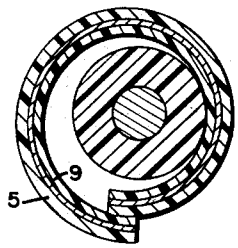


FIG. 5

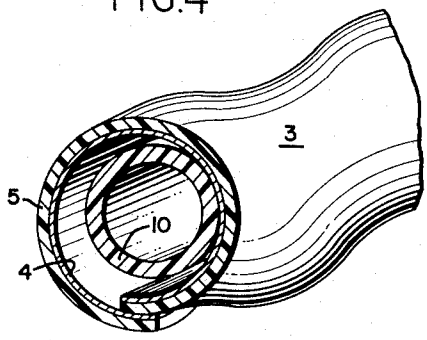


FIG. 6

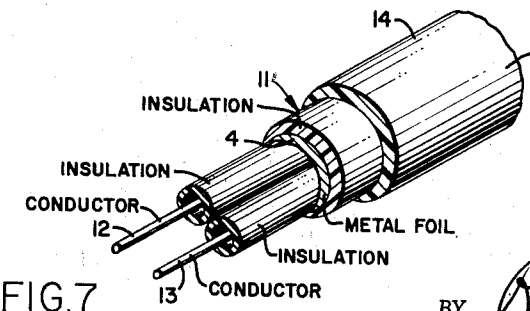


FIG. 7

INVENTOR
RAYMOND CHARLES MILDNER

BY Robert A. Clemens

ATTORNEY

United States Patent Office 3,130,256 Patented Apr. 21, 1964

3,130,256

CABLES FOR TRANSMITTING HIGH-FREQUENCY CURRENTS

Raymond Charles Mildner, 3703 Hillgrove Court, Midland, Mich.

Filed June 30, 1961, Ser. No. 121,128
Claims priority, application Great Britain July 4, 1960
10 Claims. (Cl. 174—28)

This invention relates to cables for transmitting high-frequency currents and is primarily concerned with but not limited to the return or outer conductor of a flexible co-axial cable designed to transmit currents of a frequency of about 1 megacycle per second or higher.

In flexible cables used for transmitting such high-frequency currents it is customary to use as the insulation, separating the go and return conductors, a substantially solid flexible insulating material. In other cases a semi-air-spaced insulation may be used, such as that provided by an extruded synthetic plastic material of cart-wheel cross-section, a helical thread of plastic surrounded by an extruded plastic tube or by extruded cellular plastic. The common feature of all of these constructions is that the insulation is sufficiently robust to support the return conductor or screen.

The return conductor is usually in the form of a co-axial cylindrical braid of copper wires, which may be plain, tinned or silver-plated. In cases where the requirements of flexibility are less stringent, this return conductor may be in the form of a thin-walled cylinder, provided with transverse corrugations to afford a measure of flexibility and to avoid kinking when the cable is bent. Since hermetic sealing is not essential with a substantially solid insulation, the cylindrical conductor is usually formed from a tape which is folded longitudinally to form a tube, the edges of the tape being either butted or overlapped. Corrugation of the conductor may be effected either before or after the tape has been formed into the tube.

This form of return conductor has the advantage over a braided conductor that it has a very much lower electrical resistance at high frequencies than an equivalent braided conductor, so that the signal which has to be transmitted by a cable with this form of return conductor is attenuated less than if the return conductor is a braided one. A return conductor formed of a corrugated tape will rarely have a resistance at high frequencies greater than 30% above that of a straight cylindrical conductor of similar material and of the same size, whereas a braided conductor will usually have an impedance of from 2 to 4 times that of a comparable straight cylindrical conductor.

The corrugated tape is also a much more effective screen against external electro-magnetic fields than is a braid, particularly at very high frequencies, so that it can often replace a double-braided cable. The corrugated tape construction is also attractive economically.

The weakness of the corrugated tape as a return conductor or screen lies in its mechanical properties. It is not possible to bend the cable round a very small radius without disastrous kinking of the tape. To avoid deformation due to crushing and to minimise kinking, it is necessary to use a fairly thick tape, usually of about 10 mils (1 mil=0.001 inch) in thickness, but sometimes a little thinner. This in turn makes the cable less easy to bend and increases the cost.

According to the present invention there is provided a conductor for a cable, for transmitting high-frequency currents, comprising a corrugated tube formed from a laminate which comprises a layer of a synthetic plastic material having a thickness of from 5 to 20 mils, and an electrically conducting metallic layer having a thickness of from ½ to 3 mils, the tube being formed by longitudinally folding a tape of the laminate. The conductor of

the present invention is especially useful as either the outer or return conductor of a coaxial cable or the go or inner conductor of such a cable. Furthermore, the screen of a balanced cable for transmitting high frequency currents in which go and return conductors lie side-by-side may be a conductor of the present invention.

If desired, the conducting tape may be sandwiched between two tapes of synthetic plastic material, or, alternatively, the laminate may be further combined with a plain uncorrugated tube of synthetic plastic material so as to provide increased longitudinal strength and robustness.

In its application to a cable, the corrugated tape may be applied with the conducting element either on the outside or on the inside of the cable. In the former case the plastic tape forms part of the insulation and its electrical properties must be reasonably good. When the conducting element is placed on the inside, the plastic tape provides additional mechanical protection to the conducting element or may also serve as a separator or insulating barrier to a second conducting screen.

The preferred material for the conducting tape is copper, as it provides the best compromise in regard to electrical conductivity, mechanical properties, and cost. Other suitable materials are aluminium and silver. Plated or laminated conductors may be used to impart special properties to the conductor, such as corrosion resistance or resistance to high temperatures.

The synthetic plastic material of which the tape is made is preferably polyethylene, polypropylene or polystyrene, or laminates of these materials with re-inforcing elements such as glass-fibre weave or tape. Other materials may be used, the main requirements being high breaking strength, an elongation to break greater than 30% and a modulus of elasticity which is reasonably high but very low in comparison with that of the conducting element.

As indicated above, the conductor is formed from a tape comprising a laminate, the tape being longitudinally folded to form a tube, and the edges of the tape being either butted or overlapped. Corrugation of the conductor may be effected either before or after the tape has been formed into the tube. It has been found, however, that when the laminate is passed at room temperature through tube-forming rolls or corrugating rolls there is an excessive amount of elastic recovery of the deformed material. In order to reduce the elastic recovery, it is desirable to heat the laminate to a temperature just below the melting point of the synthetic plastic material since plastic deformation of the material will be great at this temperature. This heating operation is rendered possible because of the presence of the metal layer which supports the synthetic plastic material.

In order to enable the invention to be more readily understood, reference will now be made to the accompanying drawings which illustrate diagrammatically and by way of example some embodiments thereof, and in which:

FIGURE 1 is a cut-away view of part of a co-axial cable,

FIGURE 2 is a cross-section of the cable along the line II—II in FIGURE 1.

FIGURES 3 and 4 are views similar to FIGURE 1 showing modified embodiments of the cable of FIGURE 1.

FIGURE 5 is a view similar to FIGURE 2 of another embodiment of the cable of FIGURES 1 and 2,

FIGURE 6 is a perspective view of part of the outer conductor of a coaxial cable, the inner conductor not being shown, and

FIGURE 7 is a perspective view of a balanced cable.

Referring now to FIGURES 1 and 2 of the drawings,

there is shown a co-axial cable comprising a solid copper conductor 1 having a diameter of 0.048", and constituting the inner or go conductor of the cable. The conductor 1 is covered with solid polyethylene insulation 2 having a diameter of 0.240". The outer or return conductor 3 of the cable is formed from a laminate consisting of a layer of copper foil 4 having a thickness of 1 mil, and a layer of a polyethylene copolymer 5 having a thickness of 10 mil. The return conductor is corrugated with a pitch of 0.150" to a semi-amplitude of 0.020", and, as shown in FIGURE 2, the conductor is formed from a tape which is folded longitudinally to form a tube, the edges being overlapped.

The cable has an attenuation coefficient which is at least 15% lower than that of a copper-braided cable of the same overall size.

If desired, the cable may be provided with an overall sheath of polyvinyl chloride to provide mechanical protection and protection against corrosion.

In cases where, the air space 6 underneath the corrugated conductor 3 is undesirable, this space may be filled with a material 7 which is plastic but form-stable at the operating temperatures of the cable as shown in FIGURE 3. Alternatively, the surface of insulation 2 may be grooved as shown at 8 in FIGURE 4 so that the corrugated laminate constituting the outer conductor 3 conforms to the surface of the core. In this latter case, the outer conductor may be first formed into the cylindrical tube, and then pressed into the grooves of the insulating core.

If desired, the conducting tape 4 may be sandwiched between two tapes 5 and 9 of synthetic plastic material as shown in FIGURE 5, or alternatively the laminate may be combined with a plain uncorrugated tube 10 of synthetic plastic material so as to provide increased longitudinal strength and robustness.

While the invention has been described as being applicable to the outer or return conductor of a flexible coaxial cable, it is also applicable to the screen 11 of balanced cables, as shown in FIGURE 7, in which the go and return conductors indicated as 12 and 13 in FIGURE 7, lie side-by-side. It is also within the purview of this invention to provide the overall protective sheath 14 which may be of polyvinyl chloride.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A conductor for a cable for transmitting high frequency currents, comprising a corrugated tube formed from a laminate which comprises a layer of synthetic plastic material having a thickness of from 5 to 20 mil, and an electrically conducting metallic layer laminated to the plastic layer and having a thickness from ½ to 3 mil and an additional layer of synthetic plastic material, the metallic layer being sandwiched between the layers of synthetic plastic material, and the tube having a joint formed by the edges of the laminate extending longitudinally of the tube and parallel to the axis thereof.

2. The conductor of claim 1, wherein the synthetic plastic material is a thermoplastic material selected from the group consisting of polyethylene, polypropylene and polystyrene.

3. The conductor of claim 1, wherein the second mentioned synthetic plastic material is laminated to an exterior sheath of polyvinyl chloride.

4. A conductor for a cable for transmitting high frequency currents, comprising a corrugated tube formed from laminate which comprises a layer of synthetic plastic material having a thickness of 5 to 20 mil laminated to an electrically conducting metallic layer having a thickness of from ½ to 3 mil and a plain uncorrugated tube positioned within the corrugated tube with the outer surface of said plain tube engaging the crests of the corrugations of the corrugated tube, the conductor having a joint extending longitudinally of the conductor parallel to the axis thereof.

5. A coaxial cable for transmitting high frequency currents comprising an inner conductor, an outer conductor, and insulation material separating the two conductors, at least one of said conductors comprising a corrugated tube formed from a laminate which comprises a layer of synthetic plastic material selected from the group consisting of polyethylene, polypropylene and polystyrene and having a thickness of from 5 to 20 mil, said layer being laminated to an electrically conducting metallic layer selected from the group consisting of the electrically conducting copper, aluminium and silver, and having a thickness of from ½ to 3 mil, the conductor tube having a joint extending longitudinally of the tube parallel to the axis thereof.

6. The cable of claim 5, wherein said joint is a lap joint.

7. The cable of claim 5, wherein the corrugated tube conductor is arranged so that the electrically conducting metallic layer is inside the synthetic plastic layer.

8. The cable of claim 5, wherein said corrugated tube constitutes the outer conductor, and wherein the insulation material fills the space between the outer conductor and the inner conductor.

9. The cable of claim 5, wherein the layer of insulating material is grooved and wherein the corrugated tube constituting the outer conductor conforms to the surface of the insulating material.

10. A balanced cable for transmitting high frequency currents, comprising a go conductor and a return conductor lying side-by-side, and a screen for the conductors comprising a corrugated tube formed from a laminate which comprises a layer of synthetic plastic material having a thickness of from 5 to 20 mil and an electrically conducting metallic layer laminated to the plastic layer and having a thickness of from ½ to 3 mil, the tube having a joint extending longitudinally thereof parallel to the axis thereof.

References Cited in the file of this patent

UNITED STATES PATENTS

2,172,978	Kirch	Sept. 12, 1939
2,348,752	Quayle	May 16, 1944
2,436,421	Cork	Feb. 24, 1948
2,447,168	Dean et al.	Aug. 17, 1948
2,614,172	Greenfield et al.	Oct. 14, 1952
2,808,450	Peters	Oct. 1, 1957
2,939,905	Canfield	June 7, 1960
2,960,561	Plummer	Nov. 15, 1960

FOREIGN PATENTS

752,006	France	July 3, 1933
932,619	Germany	Sept. 5, 1955
955,331	Germany	Jan. 3, 1957