

June 23, 1959

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2,892,007

COAXIAL LINE

Original Filed June 17, 1955

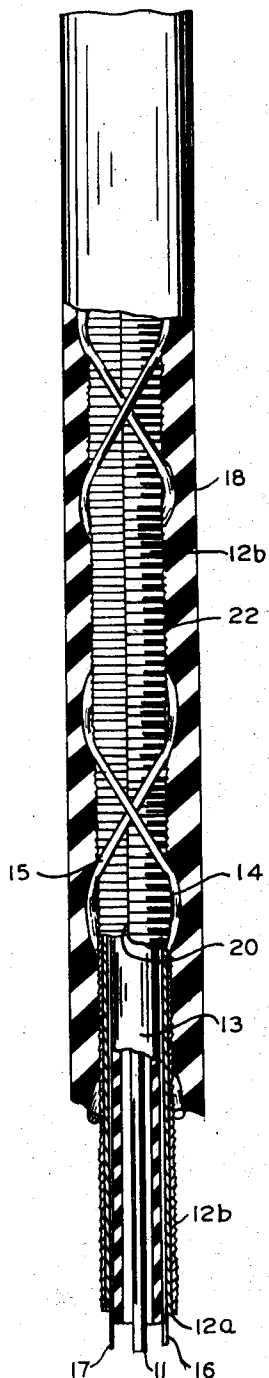


FIG. 1

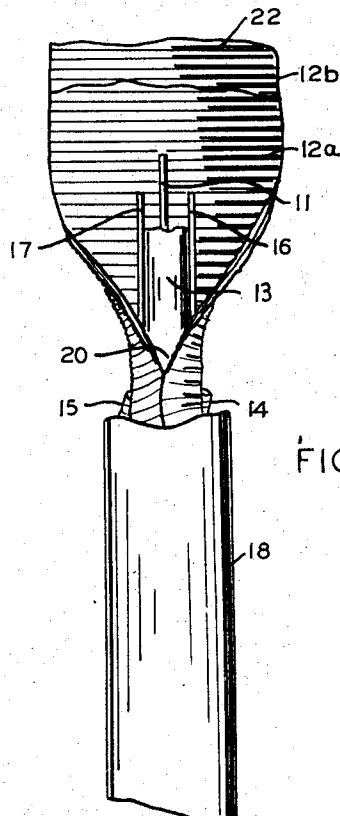


FIG. 2

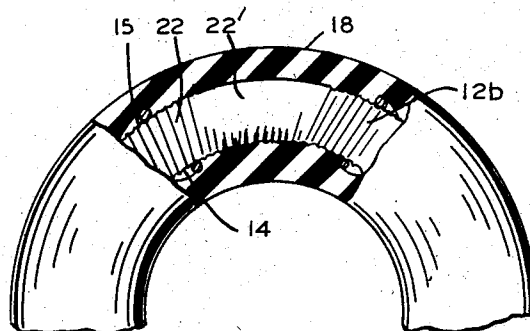


FIG. 3

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COAXIAL LINE

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Continuation of application Serial No. 516,072, June 17, 1955. This application June 15, 1956, Serial No. 591,577

10 Claims. (Cl. 174—28)

The present invention relates to coaxial lines, this application being a continuation of copending application, Serial No. 516,072, filed June 17, 1955, for Coaxial Cable.

As explained in the said application, conventional woven and braided-type coaxial-line shields may be replaced by a conductive foil member of particular construction that not only renders a coaxial line more economical to manufacture, but provides for more efficient shielding, particularly, though not exclusively, in the radio broadcast-frequency band. While the use of foil and related shields have heretofore been proposed in, for example, the audio-frequency cable field, the manner of application of the foil and the cable construction has not provided the advantages attendant upon the present invention, as later discussed.

An object of the present invention is to provide a new and improved coaxial line of the above-described type.

Other and further objects will be explained hereinafter and will be more particularly pointed out in the appended claims.

The invention will now be described in connection with the accompanying drawing, Fig. 1 of which is a side elevation of a coaxial line constructed in accordance with the present invention and partly cut away to illustrate details of construction;

Fig. 2 is a similar fragmentary view with parts shown opened up; and

Fig. 3 illustrates the flexing properties of the line.

While the transmission line of the present invention may be employed in many different frequency bands, ranging from audio to microwave frequencies, it will hereinafter be described as applied to the radio broadcast-frequency band where the need for flexible, inexpensive and highly shielded coaxial-line sections are required for such purposes as leads between automotive antennas and broadcast receivers.

As disclosed in the said copending application, the coaxial line comprises one or more longitudinally extending inner conductors 11 disposed within a preferably hollow insulating longitudinally extending cylindrical tube 13, as of polyethylene or other flexible insulating material. For purposes of simplicity and economy, particularly in the case of the use of the transmission line with radio broadcast frequencies, the inner conductor 11 may be a thin wire loosely strung along the hollow of the tubular insulator 13. If desired, spacers or solid dielectric filler material may be employed, though such construction mitigates against the simplicity and cost considerations with which the present invention is concerned.

A conductive foil member, comprising, preferably, a creped paper backing 12a secured to and carrying a creped or wrinkled foil layer 12b, as of aluminum, extends longitudinally along the tubular insulator 13 with the paper backing 12a adjacent the same, being transversely wrapped tightly completely around the insulator 13 in overlapping relationship, as more particularly shown at 20. This overlapped construction insures complete transverse shielding even when the line is flexed. The longitudinal edge portions of the foil member 12a, 12b are not, however, in direct electrical contact with one

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another since the paper 12a is interposed at the overlap region 20. A very narrow longitudinal slot 20 is thus formed, the overlap providing increased capacitance at the slot that serves to insure transverse current flow when the line is bent. Since this slot is parallel to the longitudinal lines of current, little radiation will escape there-through, as contrasted with the transverse slots of braided and woven shields and the like. In order to prevent the overlapped foil member 12a, 12b from opening up, as deliberately effected in the view of Fig. 2, spirally or helically wound conductor wires 14 and 15 are provided, as of copper, that, when wound in opposite directions serve not only to hold the overlapped foil member 12a, 12b closed on both sides of the slot 20, but transversely periodically intersect and short-circuit the slot 20 itself, assisting in the provision of transverse electrical conductivity around the foil 12b. The successive turns of the helical windings may be relatively widely spaced, as shown, since the windings are not themselves the shield, and any number of windings may be employed, as desired. In addition, since it is difficult to solder to aluminum, the conductive members 14 and 15 may serve to facilitate electrical connections at the ends of the line to the outer-conductor shield 12b. The line is protected by a flexible outer insulating sleeve, jacket or covering 18, as of polyvinyl plastic and the like, formed tightly over the foil 12b.

In order to prevent fracture or rupture of the foil 12b upon flexing or bending of the same, rayon or similar flexible spacer cords 16 and 17 are longitudinally disposed preferably between the tube 13 and the paper backing 12a; and, in addition, the creping or wrinkle corrugations or striations 22 of both the paper backing 12a and the foil 12b extend transversely to, and preferably at right angles to, the slot 20. When the transmission line is flexed, accordingly, the transverse corrugations or striations 22 expand, as shown at 22', Fig. 3, preventing fracture of the foil. The external wires 14 and 15, furthermore, aid in increasing the flexing life of the line. Satisfactory results have been obtained, for example, with transverse corrugations or striations spaced a sixteenth of an inch apart, more or less, permitting approximately eighteen to twenty percent elongation. The cords 16 and 17, moreover, tend to resist permanent elongation of the line which would otherwise result in view of the stretching properties of the polyethylene tube 13 and the vinyl covering 18 and would tend to rupture the foil. With the cords within the foil, moreover, coupling fittings can be secured to the foil at the ends of the line merely by removing a terminal section of the outer covering 18.

As a result of the above construction, in addition to its cost advantages, excellent shielding and electrical performance is obtained. The following table sets forth experimentally obtained attenuation characteristics over a particular important band of the radio broadcast-frequency spectrum, contrasting the same with the less efficient characteristics of present-day braided coaxial cables of the same length:

Frequency (in kilocycles)	Attenuation (in decibels)	
	Coaxial-Line of Present Invention	Conventional Braided-Shield Coaxial Line
580	83.5	82.9
700	89.5	88.0
800	94.3	89.5
900	98.4	89.5
1,000	104.4	94.0
1,100	110.4	95.8
1,300	105.2	103.7

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A transmission line constructed as shown in Fig. 1 with a polyethylene tube 13 about 0.2 inch in outer diameter, a copper-clad iron wire inner conductor 11 about 0.01 inch in diameter having a direct-current resistance of approximately 0.25 ohm per foot, was found to have the following advantageous characteristics:

Nominal characteristic impedance-----	150 ohms.
Nominal capacitance-----	7.8 $\mu\mu$ farads per foot.
Inductive shielding efficiency--	27 db at 555 kilocycles.
	33 db at 1020 kilocycles.
	36 db at 1610 kilocycles.
Capacitive shielding efficiency--	84 db at 580 kilocycles.
	110 db at 1100 kilocycles.
	97 db at 1600 kilocycles.
Velocity of propagation-----	87.5% of free space velocity.

While, as above stated, the line has been described in connection with its particular application to broadcast-band frequencies, tests have demonstrated that the present invention may also be applied to much lower audio frequencies and to much higher frequencies, even to the microwave range.

Further modifications will occur to those skilled in the art and all such are considered to fall within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A radio frequency coaxial cable comprising an insulative tube, a radio frequency lead-in conductor positioned within the tube, a tubular insulative-backed radio frequency conductive foil transversely wrapped around said tube in over-lapping relationship for completely shielding the lead-in conductor, said foil wrapped with the insulative backing on the inside, a plurality of conductive wires spirally wound along the length of said foil in opposite directions to secure said foil to said tube, a plurality of cords longitudinally interposed between said tube and said wires, and a protective insulative covering for insulating said foil and said wires.

2. The combination as defined in claim 1, wherein the insulative-backed radio frequency conductive foil is a crepe paper backed aluminum foil.

3. A coaxial transmission line comprising a longitudinally extending inner conductor, a longitudinally extending insulating member surrounding the conductor, a longitudinally extending insulation-sheet-backed foil transversely wrapped around the insulating member with the insulation backing on the inside in order to provide a longitudinally extending narrow slot between the longitudinal overlapped edges of the insulation-backed foil,

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a pair of conductive wires helically wound tightly along the foil in opposite directions with successive turns relatively widely spaced in order transversely to cross the said slot at relatively widely spaced points and to aid in the transverse electrical continuity of the foil, one or more flexible longitudinally extending cords interposed between the insulating member and the said conductive wires, and an insulative covering enclosing the foil.

4. A coaxial transmission line comprising a hollow flexible insulating longitudinally extending tube, a longitudinally extending inner conductor disposed within the tube, a longitudinally extending insulation-sheet-backed foil transversely wrapped around the tube with the insulation backing on the inside in order to provide a longitudinally extending narrow slot between the longitudinal overlapped edges of the insulation-backed foil, conductive wire means helically wound tightly along the foil in order transversely to cross the said slot to aid in the transverse electrical continuity of the foil and to aid in securing said foil around said tube, one or more flexible longitudinally extending cords interposed between the said insulating tube and the said conductive wire means, and an insulative covering enclosing the foil.

5. The transmission line of claim 3, wherein said insulating member is a polyethylene tube, and wherein said foil is formed of aluminum.

6. The transmission line of claim 4, wherein said foil is longitudinally stretchable to facilitate the flexing of said cable.

7. The transmission line of claim 4, wherein the insulation backing of said foil is crepe paper.

8. The transmission line of claim 7, wherein said foil is creped.

9. The transmission line of claim 8, wherein said crepe paper and said foil are transversely creped.

10. The transmission line of claim 3, wherein said foil is transversely creped.

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