United States Patent

Spade

[15] **3,688,016**

[45] **Aug. 29, 1972**

[54] **COAXIAL CABLE**

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[73] Assignee: **Belden Corporation,** Chicago, Ill.

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[52] **U.S. Cl.** .....**174/36,** 174/28, 174/107, 174/110 F, 174/110 SY

[51] **Int. Cl.**.....**H01b 11/18**

[58] **Field of Search**...174/28, 29, 110 F, 107, 102 R, 174/102 D, 27, 36, 115, 110 SY

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[57] **ABSTRACT**

A coaxial cable is described wherein a rigid expanded foam insulator fills the space between inner and outer conductors. Groove means are formed in the outer surface of the insulator to a depth sufficient to enable the insulator to flex with the inner and outer conductors.

8 Claims, 3 Drawing Figures

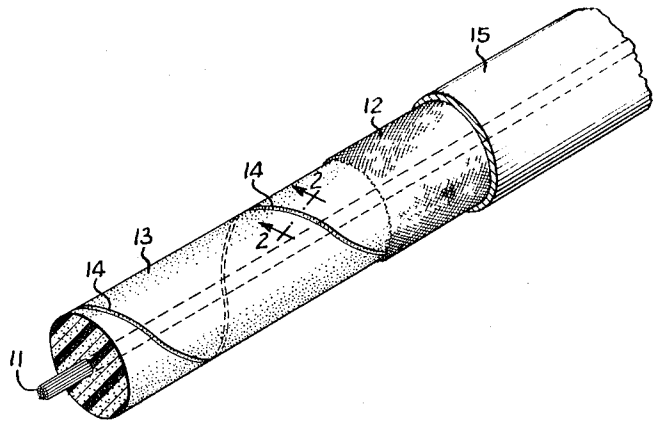


FIG. 1

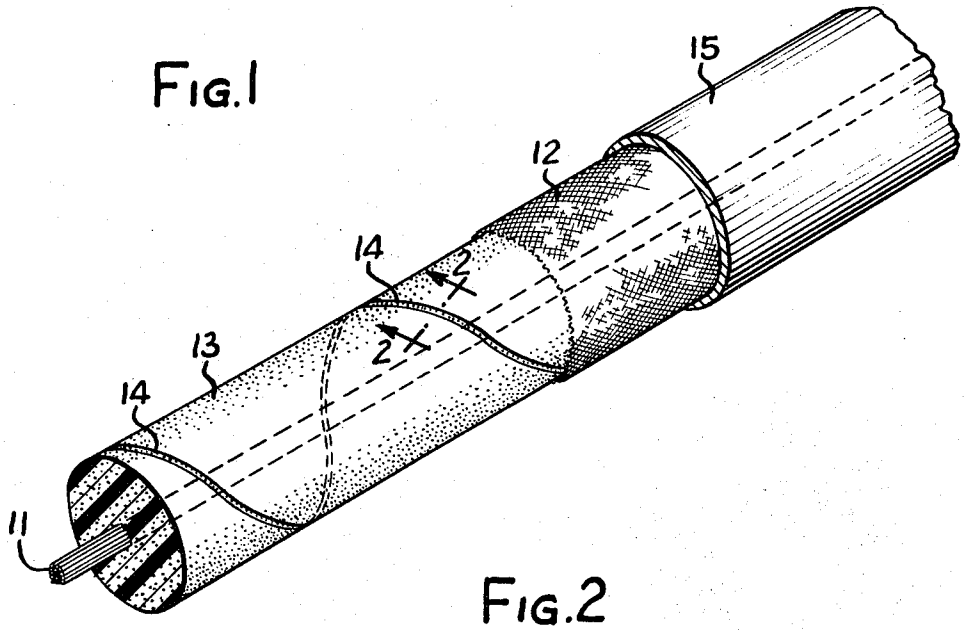


FIG. 2

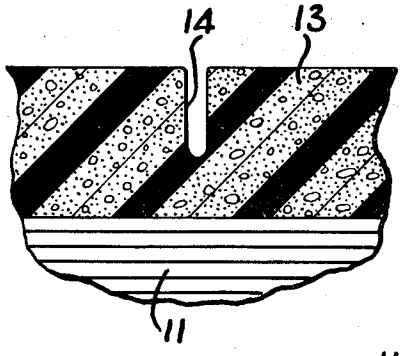
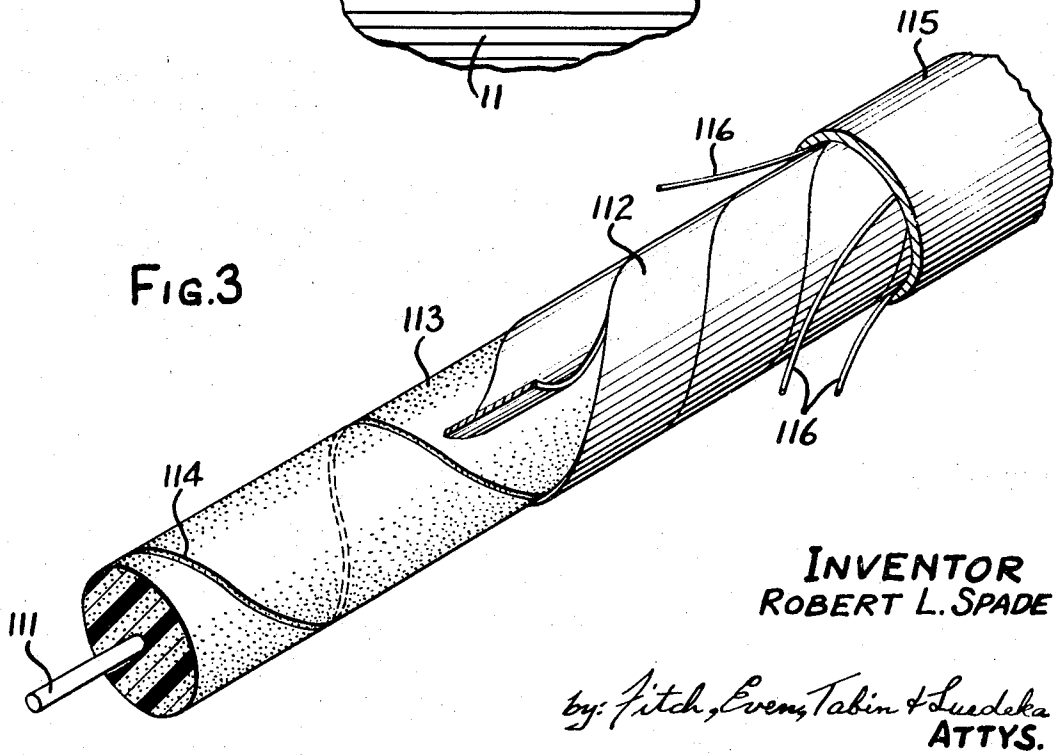


FIG. 3



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ATTYS.

COAXIAL CABLE

This invention relates to coaxial cables and, more particularly, to an improved coaxial cable which is easily manufactured and which has a low dielectric constant.

Coaxial cables are useful in many electrical applications, particularly for transmitting high frequencies. A coaxial cable typically comprises at least one flexible inner conductor and at least one flexible outer conductor surrounding and coaxial with the inner conductor. The two conductors are separated by a suitable insulator. The outer conductor is grounded and serves as a shield for the information being conducted on the inner conductor, to prevent noise interference from ambient signals.

In many instances, it is important to minimize the dielectric constant of a coaxial cable in order to reduce the capacitance of the cable. By minimizing the dielectric constant of the cable, that is, the dielectric constant of the insulating material separating the inner and outer conductors, the overall diameter of the cable may be reduced, because the inner and outer conductors need not be separated by as great a distance for a given capacitance tolerance, or the electrical efficiency of the cable may be improved.

Flexible expanded plastic foam insulators, such as explanded polyethylene foam, have been used in many instances as insulators in coaxial cables. Expanded polyethylene foam, however, is capable of being expanded only by an amount which results in a limited low dielectric constant. Accordingly, expanded foam polyethylene and similar flexible expanded foam insulators are unsatisfactory for many coaxial cable applications.

Some alternative forms of coaxial cable insulation which have been proposed are a series of ceramic or plastic washers as the insulating material separating the inner and outer conductors. By spacing the washers sufficiently, the cable is able to flex. Such washers are, however, very difficult to install, and substantially increase the manufacturing cost of coaxial cable.

It is an object of the present invention to provide an improved coaxial cable.

Another object of the invention is to provide a coaxial cable with a low dielectric constant which is capable of being manufactured easily.

Another object of the invention is to provide a flexible coaxial cable with a low dielectric constant and a relatively small diameter and/or improved signal efficiency.

Other objects of the invention will become apparent to those skilled in the art from the following description, taken in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view, with parts broken away, of a coaxial cable constructed in accordance with the invention;

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1; and

FIG. 3 is a perspective view, with parts broken away, of an alternative embodiment of the invention.

Very generally, the coaxial cable of the invention comprises at least one flexible inner conductor **11**. A flexible outer conductor **12** surrounds and is coaxial with the inner conductor. A rigid expanded foam insulator **13** fills the space between the inner and outer conductors. The insulator has groove means **14** formed in the outer surface thereof to a depth sufficient to enable the insulator to flex with the inner and outer conductors. The groove means extend the length of the insulator.

Referring now more particularly to FIG. **1**, the embodiment of the invention illustrated therein comprises a single flexible inner conductor **11**. The inner conductor **11** is comprised of a plurality of individual parallel wire strands as is known in the art. The strands of the inner conductor **11** may be copper or other suitable flexible conductive materials such as copper plus another material (e.g. aluminum).

The outer conductor or shield **12** surrounds and is coaxial with the inner conductor. In the illustrated embodiment, the outer conductor or shield **12** comprises a flexible braid of fine copper wires or other suitable flexible conductive materials. The outer conductor **12** provides shielding for the inner conductor **11** as is known in the art.

In order to maintain separation between the outer conductor **12** and the inner conductor **11**, the insulator **13** is provided filling the space between the inner and outer conductors. In accordance with the invention, the insulator **13** is comprised of a rigid expanded foam material, such as expanded polystyrene. Due to the strength or rigidity of rigid foamed material, rigid materials can provide larger cells so that the air or gas space volume of solid material is far greater than in softer flexible foamed material. Accordingly, the diameter of the outer conductor **12** may be substantially less for a given cable capacitance than in the case of flexible expanded foams.

Because rigid expanded foam is relatively inflexible, the insulator is provided with groove means **14** formed in the outer surface thereof to a depth sufficient to enable the insulator to flex along with the inner and outer conductors. The depth to which the groove means are formed is preferably approximately half-way between the inner conductor **11** and the outer conductor **12** but may be more or less in depth. In the illustrated embodiment, the groove means comprise a single helical groove which extends the full length of the insulator **13**. As may be seen in FIG. **2**, the groove extends about half-way through the insulator and may be formed with square or rounded corners. In the illustrated embodiment, rounded corners are shown both at the upper surface and at the bottom of the groove. Other configurations of the groove means are also possible, such as a plurality of annular grooves spaced axially along the insulator. In any case, the groove means extend the length of the cable so that the cable is sufficiently flexible.

The groove means **14** may be formed in the insulator **13** by any suitable means. For example, in the case of the helical groove illustrated, the groove may be formed as the insulator is extruded (by known extrusion techniques) by utilizing a rotating die or wire cutter as it is extruded. Preferably, the groove means are formed by a hot wire so that the plastic melts and fuses at the cut to produce a rounded bottom and corners.

In some cases, a final outer sheath **15** of insulation may be provided. The insulation **15**, however, is shown

in FIG. 1 only for the purposes of illustration, and is not a necessary requirement in a cable constructed in accordance with the invention.

Referring now to FIG. 3, an alternative embodiment of the invention is illustrated. Portions of the coaxial cable illustrated in FIG. 3 corresponding generally to portions of the coaxial cable of FIGS. 1 and 2 have been given identical reference numerals, preceded by a 1. Thus, the central conductor 111 (shown as a solid conductor in FIG. 3) is separated from an outer sheath or outer conductor 112 by an insulator 113. The insulator in FIG. 3 is identical with the insulator in FIG. 1, and is provided with a helical groove 114 therein for flexibility. The outer conductor in the embodiment of FIG. 3 comprises a helically wrapped metal foil rather than a braid. To assist in grounding the foil, up to four drain wires 116 are provided running the length of the cable is completed by an outer surrounding sheath 115 of a suitable insulating material.

The coaxial cable of the invention is readily manufactured, since the cable may be formed coincident with the extrusion of the expanded foam insulator. The helical groove means may be formed in the insulator at the time it is extruded. A very low dielectric constant is obtainable by utilizing rigid expanded foam insulation, and the cable of the invention is capable of flexing with the flexible inner and outer conductors due to the groove means formed in the outer surface of the insulator.

Various modifications of the invention in addition to those shown and described herein will become apparent to those skilled in the art from the foregoing description and accompanying drawings. Such modifications are intended to fall within the scope of the appended claims.

What is claimed is:

1. A coaxial cable comprising, at least one flexible inner conductor, at least one flexible outer conductor surrounding and coaxial with said inner conductor, and a rigid expanded foam insulator filling the space between said inner and outer conductors, said insulator having groove means formed in the outer surface thereof to a depth sufficient to enable said insulator to flex with said inner and outer conductors, said groove means extending the length of said insulator.

2. A coaxial cable according to claim 1 wherein said groove means comprise a single helical groove.

3. A coaxial cable according to claim 2 wherein the depth of said helical groove is over half the distance between said inner and outer conductors.

4. A coaxial cable according to claim 1 wherein the bottom of said groove means is rounded.

5. A coaxial cable according to claim 1 wherein said outer conductor comprises a flexible braid.

6. A coaxial cable according to claim 1 wherein said outer conductor comprises a flexible foil.

7. A coaxial cable according to claim 1 wherein said outer conductor is surrounded by an outer layer of flexible insulation.

8. A coaxial cable according to claim 1 wherein a plurality of drain wires are provided extending the length of the cable in contact with said outer conductor.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,688,016 Dated August 29, 1972

Inventor(s) Robert L. Spade

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 17 - after "cable" insert "on the outer surface of the outer conductor 112. The cable".

Signed and sealed this 13th day of February 1973.

(SEAL)
Attest:

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77

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.

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