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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : H01B 11/00	A1	(11) International Publication Number: WO 95/05668
		(43) International Publication Date: 23 February 1995 (23.02.95)

(21) International Application Number: PCT/US93/09361

(22) International Filing Date: 7 October 1993 (07.10.93)

(30) Priority Data:
08/108,012 16 August 1993 (16.08.93) US

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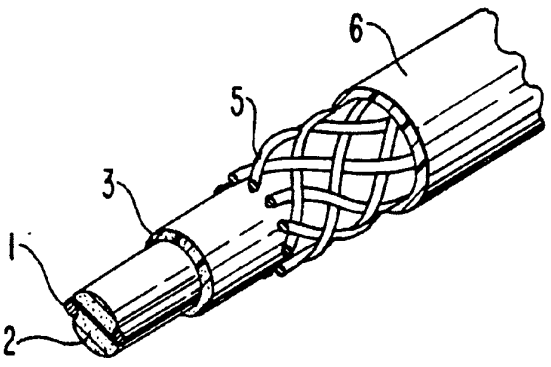
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(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: SIGNAL CABLE HAVING EQUAL FIELD CHARACTERISTICS FOR EACH SIGNAL CONDUCTOR



(57) Abstract

An insulated electrical signal cable is described in which the electrical field provided for each signal conductor by the insulation thereof is symmetrical, but not necessarily uniform across the cable cross section. The cable comprises a pair of electrical signal conductors arranged 180° apart on each side of a generally cylindrical core of insulation having means to hold conductors parallel 180° apart on the periphery of the core along its axis, and a layer of the same or different insulation as the insulation comprising the core surrounds the core and the pair of conductors.

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TITLE OF THE INVENTION

Signal Cable Having Equal Field Characteristics
For Each Signal Conductor

FIELD OF THE INVENTION

This invention relates to insulated electric signal cables having a pair of conductors.

BACKGROUND OF THE INVENTION

In the presently used methods for manufacturing insulated electric signal cables in the form of twisted pairs of the cables, or parallel pairs it is difficult to provide in each cable the same electrical characteristics in or background for each of the signal conductors. The insulation extruded or tape-wrapped on each center wire ordinarily has differing thickness, differing porosity (if porous), or void content if foamed, and different dielectric constant for each of the two conductors. These differences arise from the way the insulation is made or applied. These differences lead to problems of providing exact or near exact electrical signal transmission properties in the two signal conductors and to problems of matching closely enough the insulation of the two conductors so as to provide a high quality twisted pair cable or parallel pair, useful in modern electronic circuitry.

SUMMARY OF THE INVENTION

The invention provides a solution to the manufacturing problems outlined above by an insulated electrical signal cable in which the electrical field provided for each signal conductor by the insulation thereof are symmetrical, but not necessarily uniform across the cable cross section.

The cable of the invention comprises a pair of electrical signal conductors arranged 180° apart on each side of a generally

cylindrical core of insulation having means to hold conductors parallel 180° apart on the periphery of the core along its axis.

A layer of the same or different insulation as the insulation comprising the core surrounds the core and the pair of conductors. When that insulation is different than the core the electrical field for each signal conductor will be an identical mirror image of each other. An optional, but preferable, layer of electrically conducting shielding surrounds the core, conductors, and insulation layer surrounding them. An optional, but preferable, protective polymeric jacket surrounds the shielding.

The process of manufacture of the cable and the cables produced by that process also constitute a part of the invention.

The fact that the two signal wires share an inner core dielectric, and also share the dielectric that separates them them from the outer shield eliminates any differences in electrical signal transmission properties even if some down length dielectric variability exists.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional view of a cable of the invention.

Figure 2 is a cross-sectional view of a cable of the invention including a layer of conductive shielding and a polymeric jacket.

Figure 3 is a perspective cross-sectional view of a cable of the invention with layers partially removed.

Figure 4 is a perspective cross-sectional view of a cable of the invention with layers partially removed.

Figure 5 is a cross-sectional view of a cable of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The invention is now described with reference to the drawings.

Figure 1 is a cross-sectional view of a cable of the invention in which a pair of electrical conductors 1 is held in place 180° apart around the periphery of a generally cylindrical core of

insulation 2. The core insulation 2 can be formed by extruding a cylindrical shape or by helically-wrapping tape to form a cylinder or tube, depending on the nature of the insulation. The electrical conductors can be held in place by grooves formed by molding, cutting, burning or impressing the conductors into the core. A layer 3 of insulation is extruded or tape-wrapped around the core of insulation 3 and the pair of conductors.

The insulation 2 may be any insulation known in the art for the purpose of insulating electrical signal wires, but is preferably porous to provide a low dielectric constant and most preferably comprises expanded polytetrafluoroethylene (PTFE). The most preferred expanded PTFE is prepared according to U.S. Patents 3,953,566, 3,962,153, 4,096,227, 4,187,390, 4,478,665 and 4,902,423.

Wires 1 may be of any conductive material, but usually comprise copper, metal plated copper, copper alloys, aluminum, or steel.

Insulation layer 3 may be any insulation known in the art to be useful for the same purpose as insulation 2, but in the preferred case is the same insulation as insulation 2. Insulation 3 is placed around insulation 2 and its accompanying conductors 1 by extrusion, if insulation 3 is thermoplastic, or by tape-wrapping in a helical or spiral pattern, which is especially useful for expanded PTFE which cannot be extruded in the manner of a thermoplastic.

Figure 2 is a cross-sectional view of a cable of the invention in which a core cable, corresponding to Figure 1, has been surrounded by metal foil shield 4 and a protective polymeric jacket 5. Shield 4 is usually spiralled or wound helically around an insulated core cable. Jacket 5 is usually an extruded thermoplastic polymer, such as polyvinyl chloride, a polyolefin, a polyurethane, a rubber, a polyester, or a thermoplastic fluorocarbon resin, or may be a tape-wrapped polymer such as PTFE.

Figure 3 is a perspective view of a cable of the invention in which the conductive metal foil shield 4 of Figure 2 comprises alternatively a conductive metal strand or wire braided shield 5. Metal strips may also be used and the wires, strands, or strips may be tightly braided or more loosely braided as shown for

illustrative purposes in Figure 3. A protective jacket 6 encloses braided shield 5.

Figure 4 is also a perspective view of a cable of the invention of similar structure to that shown in Figure 3, the braided strand shield of that figure being replaced by a shield 7 comprising served conductive metal wires, which may be of the same materials as braided shield 5.

Figure 5 is a cross-sectional view of a cable of the invention in which the shielding layer comprises a metal-coated or laminated polymer tape, the polymer being denoted as 8 and the metal coating as 9. Such a tape may comprise any customary polymer and metal ordinarily used for the purpose in the art, such as aluminized polyester tape, for example, which is usually spirally or helically applied to the cable core or may be applied longitudinally. The shielding layer may also comprise a conductive polymer material which may be tape-wrapped or extruded onto the cable core.

To prevent shorting on any collapse of the core, the conductors may, if desired, contain a thin layer of insulation around each individual conductor.

A preferred process for manufacturing a cable of the invention comprises the steps of:

(a) placing a pair of signal conductors having the same electrical properties configured 180° apart around the periphery of a generally cylindrical core of insulation along its axis; and

(b) surrounding the core and conductors with another layer of insulation.

The process alternatively includes surrounding the layer of insulation 3 with a conductive shield layer and alternatively surrounding the shield layer with a protective polymer jacket 5 or 6.

The method of applying the shield layer to the core may be by tape-wrapping a conductive foil or metallized polymer tape around the core or a conductive polymer shield may be extruded around the core. A conductive wire shielding may be braided or served around insulation 3. The protective jacket layer may be applied by extrusion or by tape-wrapping.

The insulation 3 surrounding the core and signal conductors may be extruded of the same material as core 2 if core 2 has been

extruded.

The signal conductors of the cable of the invention advantageously each share a common insulation system such that the insulation between signal and ground is essentially the same for each signal conductor. This structure and process of preparing it thus eliminates the effects of varying dielectric constants associated with the variations in thickness and densities of various porous dielectric systems.

The structure is substantially round and thus, rotary strippers can conveniently be used to strip the cable insulation.

A cable of the invention was made by wrapping a tape of expanded porous PTFE to form a cylindrical core shape about 1/3000 of an inch, and conductors of silver plated copper were placed 180° apart along the cylindrical core and impressed into the core by the force of a tape of expanded PTFE as it was helically-wrapped around the assembly.

Then an aluminized polyester shield wrap was placed over the construction followed by an FEP fluoropolymer jacket.

This assembly was tested for time delay skew (difference in time delay between the two wires in the pair). Typical delay skew values are about 2 percent for individually wrapped conductor pairs wrapped with expanded PTFE, but on the construction of this invention the skew as less than 0.1 percent and frequently less than 0.025 percent.

I CLAIM:

1. An insulated electric signal cable in which the electrical field characteristics provided for each signal conductor by the insulation thereof are substantially the same, comprising:
   (a) a pair of electrical signal conductor arranged 180° apart on each side of a generally cylindrical core of insulation having means to remain parallel along the axis of the core to hold said conductors in position 180° apart on the periphery thereof;
   (b) a layer of the insulation surrounding said core and said conductors;
   (c) an optional conductive shield surrounding said layer of insulation; and
   (d) an optional protective polymeric jacket surrounding said shield.
2. A cable of Claim 1 where the insulation in (b) is the same material as the core insulation.
3. A cable of Claim 2 wherein the insulation comprises a porous insulation.
4. A cable of Claim 3 wherein said insulation comprises expanded polytetrafluoroethylene.
5. A cable of Claim 4 wherein said shield is selected from the group consisting of metallized polymer tape, metal foil, braided metal strands, served metal strands, and braided or served metal wires.
6. A process for manufacture of an electric signal cable having the same field characteristics surrounding each signal wire therein, comprising the steps:
   (a) placing a pair of signal conductors having the same electrical properties 180° apart along the periphery of a generally cylindrical core of insulation; and
   (b) surrounding said core and said pair of signal conductors with a layer of insulation as that comprising said core.
7. The process of Claim 6 further comprising the step of surrounding the core and the conductors with a conductive shield.

8. The process of Claim 6 wherein said step b) comprises tape-wrapping said insulation around said core and said signal conductors.

FIG. 1

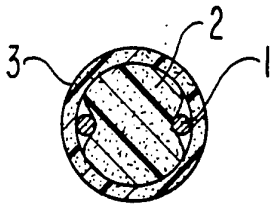


FIG. 2

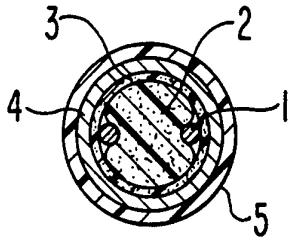


FIG. 3

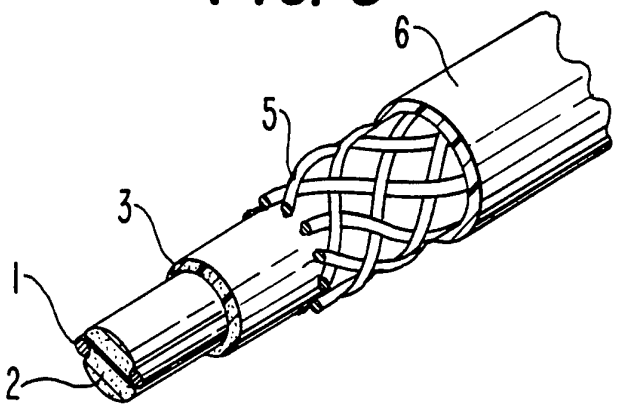


FIG. 4

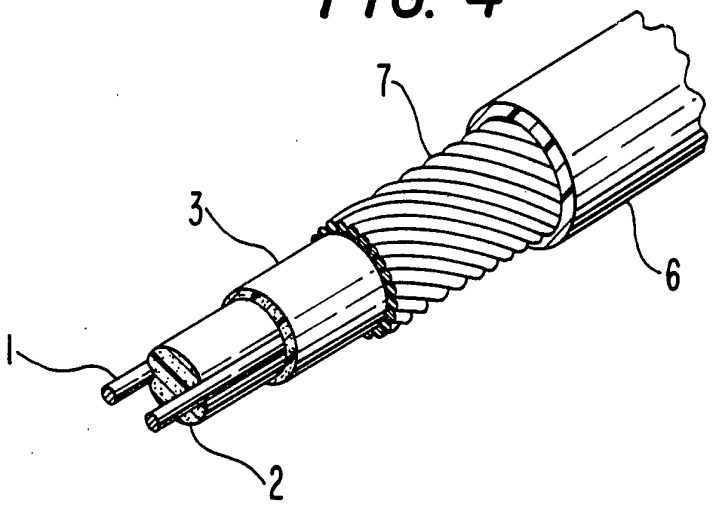
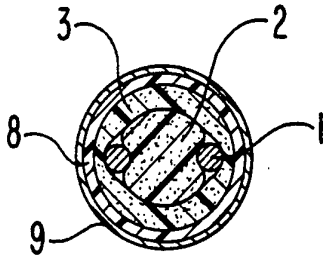


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 93/09361

A. CLASSIFICATION OF SUBJECT MATTER

H 01 B 11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H 01 B 11/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP, A2, 0 296 692 (W.L. GORE) 28 December 1988 (28.12.88), claims 1,2,5,6; fig. 1,2 and corresp. text. --	1-8
X	FR, A, 2 500 678 (LIGNES TELEGRAPHIQUES) 27 August 1982 (27.08.82), page 2, lines 7-25; page 4, lines 1-3; fig. 1. --	1,6
X	SU, A, 993 337 (ALFIMOV et al.) 30 January 1983 (30.01.83); & SOVIET INVENTIONS ILLUSTRATED, week 8346, issued 1984, January 04	1,6

☐ Further documents are listed in the continuation of box C.

☐ Patent family members are listed in annex.

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	DERWENT PUBLICATIONS LTD., London page SU-X-42 abstract no. 83-820 039/46 column 3, lines 6-20; fig. ----	