

[54] "D." INTERNAL SHIELD IN TELEPHONE CABLES
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[22] Filed: Feb. 23, 1972
[21] Appl. No.: 228,540

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[52] U.S. Cl. 174/36, 174/105 B, 174/107
[51] Int. Cl. H01b 11/08
[58] Field of Search .. 174/36, 105 R, 105 B, 106 R, 174/103, 113 R, 112, 27, 107

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[57] ABSTRACT
A screen of D-shaped cross-section surrounds the conductor pairs of one half of the core of a communication cable to prevent cross-talk between different circuits; and this construction permits the core to be made with two sections, each of semi cylindrical cross-section. A semi circular portion of the D-shaped screen confronts the inside surface of an overall shield of the cable but avoids electrical continuity with this shield to keep lightning that strikes the shield from entering the core of the cable.

7 Claims, 7 Drawing Figures

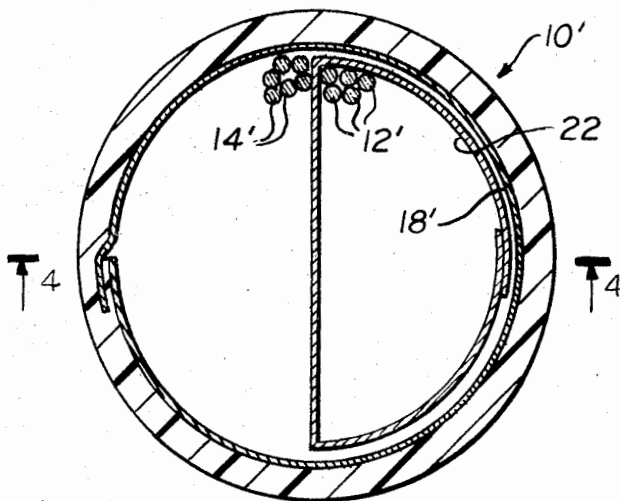


FIG. 1.

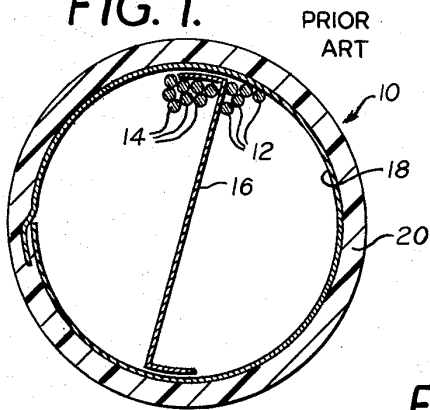


FIG. 3.

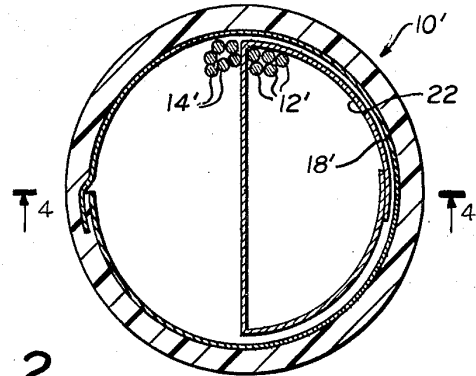


FIG. 2.

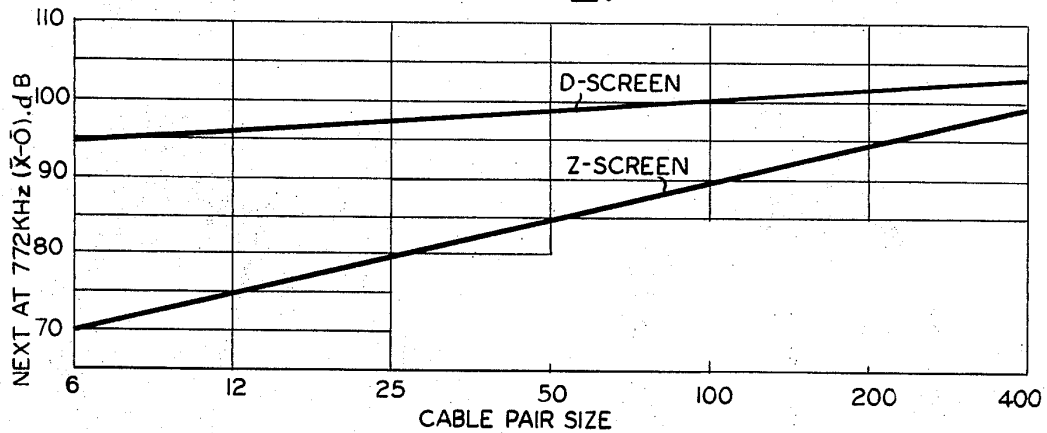


FIG. 5.

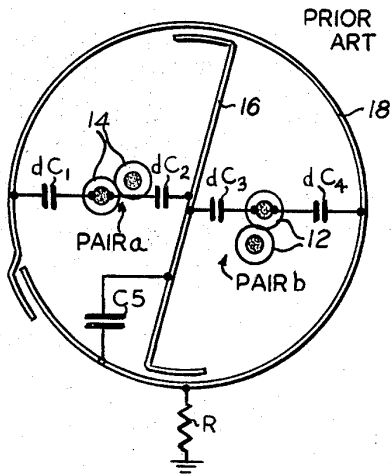


FIG. 4.

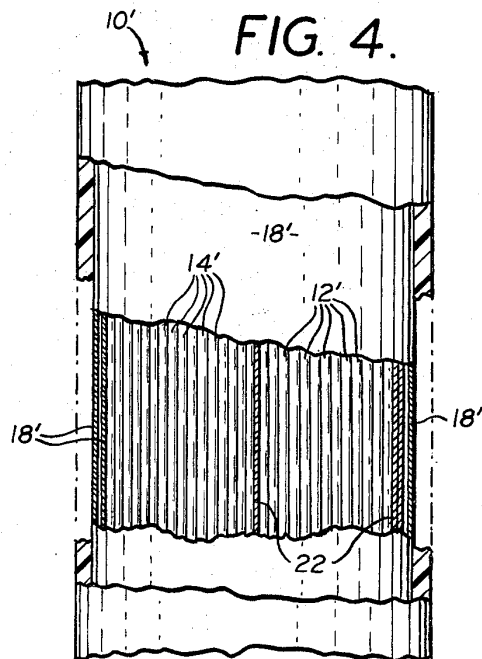


FIG. 6.

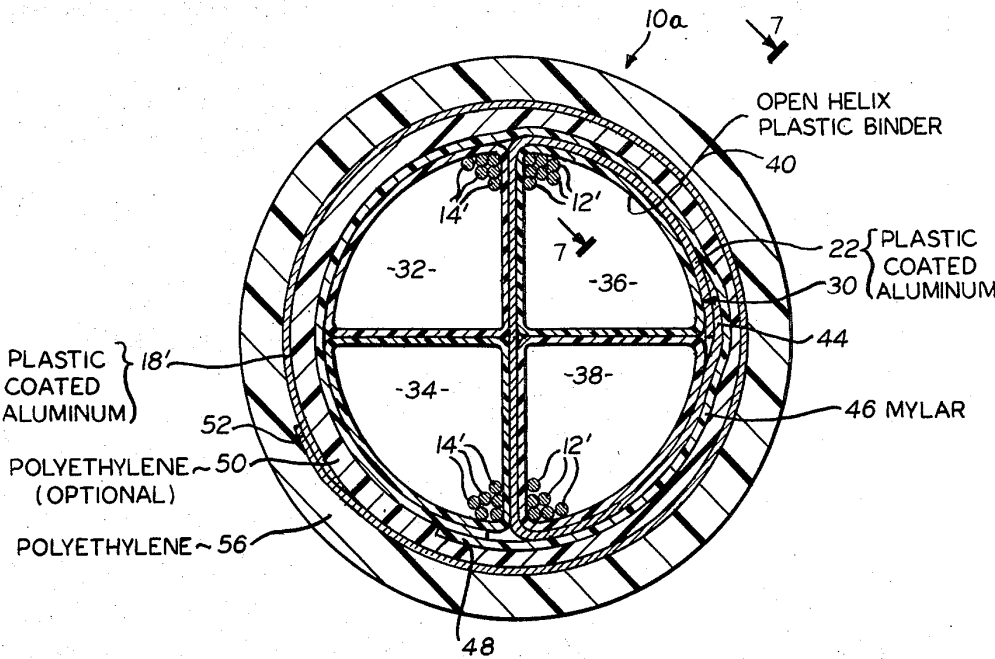
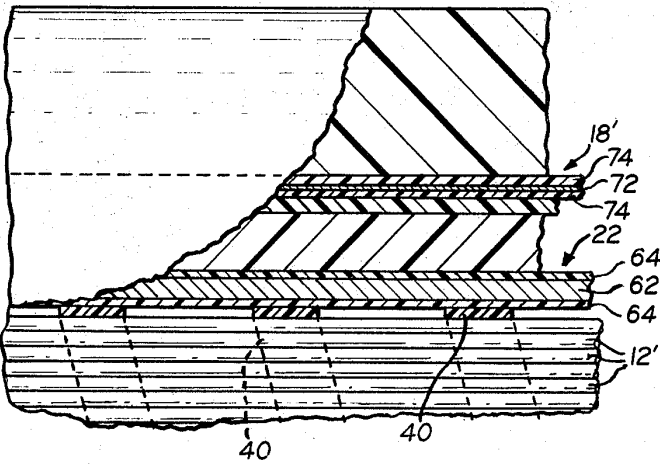


FIG. 7.



"D." INTERNAL SHIELD IN TELEPHONE CABLES**BACKGROUND AND SUMMARY OF THE INVENTION**

In the communication (telephone) cables there is always a certain degree of interference between circuits, unavoidable due to proximity of paired circuits. One form of interference called "crosstalk" is the induction of current in the "disturbed" pair by currents flowing in the "disturbing" pair. The "disturbed" pair therefore carries two currents. One, which is the information intended for transmission and the other unwanted induced by neighboring pairs, which superimpose themselves on the transmitted signal reducing the clarity and reliability of transmission.

Various methods were used in the past to reduce crosstalk. One method consists of transposition of conductors by varying lays of pair twist. When this is not sufficient, shielding or screening is employed.

An older and conventional method consisted of shielding, that is applying of metal screen (wrap) over single pairs or group of pairs and then cabling together into a cable core a number of round components each being a round bundle of pairs individually screened. Variation of this method when only one component is shielded, was to assemble a cable core by stranding together first the components to be shielded, applying metal screen (shield) over this group and stranding around this center portion of cable the remaining pairs or bunch of pairs and applying a shield and sheathing overall in concentric fashion.

The advent of pulse code modulation (PCM) in the field of transmission techniques on balanced pairs (potential symmetrical to ground) imposed a particular requirement on shielding. It became necessary to divide the number of pairs in the cable core into two groups of equal number, one group carrying signals in one direction and the other in the opposite direction.

The conventional method of stranding first of one-half of the cable pairs, applying shield and then stranding over it the second half of the cable pairs was not practical, since the present-day cables are made of prestranded units which could not be assembled in symmetrical concentric fashion. The earlier solution consisted therefore of S or Z shaped screen.

The shielding of the cable pairs of this invention includes a screen that separates different groups of pairs in the cable core, but that also extends around approximately one half of the circumference of the core with an outside surface confronting the inside surface of part of an outer metallic shield of the cable. This provides better shielding of the cable, and the construction prevents lighting currents in the outer shield that extends around all of the pairs from entering the core through the screen that surrounds some of the conductors and that separates the conductor into different groups, as will be explained in connection with the drawing which forms a part hereof. For purpose of this specification, the electrically-conducting "screen" that separates different groups of pairs is to be considered a part of the "core" of the cable. Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

BRIEF DESCRIPTION OF DRAWING

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views:

FIG. 1 is a diagrammatic cross-sectional view showing the prior art on which the present invention is an improvement;

FIG. 2 is a diagram comparing results obtained with this invention and those obtained with the prior art;

FIG. 3 is a diagrammatic view, similar to FIG. 1, but showing the inner core shielding of this invention;

FIG. 4 is a fragmentary diagrammatic view, partly broken away and in section on a plane along the diameter of the cable shown in FIG. 3;

FIG. 5 is a diagrammatic sectional view, showing the electrical transmission paths of the prior art shielding of FIG. 1;

FIG. 6 is a sectional view showing a communication cable equipped with the "D" screen shielding shown diagrammatically in FIG. 3; and

FIG. 7 is a greatly enlarged, fragmentary sectional view taken on the line 7—7 of FIG. 6.

DESCRIPTION OF PREFERRED EMBODIMENT

FIG. 1 shows a communication cable 10 in which insulated conductors 12 on one side of the cable are separated from similar insulated conductors 14 on the other side of the cable by a Z-Screen 16 which divides the cable core in half. This screen is continuous in the direction of the length of the cable. All of the conductors 12 and 14 are surrounded by a cable shield 18.

When the cable shown in FIG. 1 is in use, pairs of the bunch of conductors 12 induce currents in the shield 18 and also in the Z-Screen 16. These potentials are picked up through unbalances by the pairs of conductors 14 resulting in cross talk currents in these circuits. The communication cable shown in FIG. 1 has a conventional outer jacket 20.

FIG. 3 shows a cable 10' which is similar to the cable shown in FIG. 1 except that the conductors 12' are completely surrounded by a screen 22 which has the configuration of a capital letter D. With this D-shaped screen 22, which encloses one half of the conductor pairs of the cable, there is not direct transfer of the cross talk energy from the bunch of conductor pairs 12' enclosed in the compartment provided by the shield 22 to the common shield 18' which surrounds all of the conductors 12' and 14'.

The objectionable results obtained with the prior art cable shown in FIG. 1 are illustrated diagrammatically in FIG. 5. For given unbalances of a pair "a," to cable shield 18 is dC_1 and to the shield 18 is dC_2 . A pair "b" in the second bunch of conductors 14 has respective unbalances dC_4 and dC_3 . The internal screen 16 is coupled to the overall shield 18 by capacitance C_3 . The shield has resistance to the remote ground R, which normally is low, on the order of a few ohms.

Pair "a" induces voltage in the overall shield 18 through unbalance dC_1 , this voltage is transferred to the pair "b" through unbalance dC_4 . However, since the shield 18 is grounded through low resistance R, the voltage acting on the unbalance is as reasonably low as it can be made by using cables with shields.

Another path of cross talk is through the screen 16 separating two halves of the cable. The unbalance dC_2 induces voltage in the screen 16 which in turn induces

voltage in the pair "b" through dC_3 . There is no direct grounding of the screen 16, there is only capacitance coupling of the screen 16 to the overall shield 18 through capacitance C_5 . Therefore, potential of the screen 16 is much higher than the potential of the cable shield.

With this invention the potential of the screen in the cable is collapsed to the level of the voltage of the shield as close as practical without providing metallic contact between the two. Such metallic contact would not be tolerable since lightning currents appearing in the shield should not be allowed to enter the cable core. There must be a high voltage barrier between the cable core and the cable shield to prevent lightning currents in the shield from entering the cable core.

The collapse of voltage between the screen 22 (FIG. 3) and the shield 18' is obtained by having the screen 22 D shaped with a large surface providing strong capacitive coupling between the D screen 22 and the shield 18'. In practice, this improved screening manifests itself very significantly, especially in the small pair count cables, as shown in FIG. 2. This graph shows that for a six pair cable the average minus standard deviation at 772 kHz near-end cross talk (NEXT) coupling loss across the screen was 70 dB (decibels) for a Z-shaped screen while in the D screen cable it was found to be 95 dB. The difference naturally decreases with increased pair count as the result of the shielding effects of other pairs. For 100 pairs, the difference drops from a 25dB improvement to 10 dB.

FIG. 6 is a sectional view through an example of a communications cable made with the D screen shown diagrammatically in FIG. 3. In FIG. 6 a cable 10a includes a core 30 made up of four segments 32, 34, 36 and 38. The quadrants 36 and 34 include the conductors 14'; and the quadrants 36 and 38 include the conductors 12'. The group of conductors 12' are shown surrounded by one or more lengths of colored plastic 40 wrapped loosely around the group of conductors 12' as open helices. The loose wrapping of plastic 40 provides color coding while still leaving the group of conductors free to assume a quadrant cross section or any other shape imposed by forming dies through which the different groups of conductors pass. This plastic 40 can be made of various materials and preferably is made of polypropylene of about 5 mils in thickness.

Although the cable shown in FIG. 6 has four quadrants, cables can be made with any number of groups of pairs bundled together for convenient assembly each shaped as necessary to form a cable core.

The core quadrants 36 and 38 are housed in the D screen 22 which is made of plastic coated aluminum or other suitable material. Copper can be used.

The D screen 22 is preferably made by folding a tape longitudinally around the core quadrants 36 and 38 with a lap seam 44 having an overlap of approximately one-fourth inch. The D screen 22 can also be made by wrapping core tape around the core quadrants 36 and 38 in a helix with the convolutions of the helix overlapping one another. When the D screen 22 is made of aluminum, the aluminum used is preferably 4 mils thick or less; and it is preferably coated with plastic partly to protect the aluminum from corrosion and partly to prevent the edges of the aluminum at the lap seam from damaging the insulation of adjacent conductors 12'.

The core quadrants 32 and 34 are made by binding their conductor pairs together with plastic binding tape

40, in the same way as the core quadrants 36 and 38. The entire core is then enclosed in a nonhygroscopic plastic such as polyethylene terephthalate (Mylar). This non hygroscopic shield 46 provides a heat barrier for protecting the insulated conductors of the core from heat during subsequent manufacturing steps of the cable. On small cables a thickness of 3 mils is sufficient for the shield 46, but on larger cables this thickness is increased, but such heat barriers are well known in the cable art.

Laminates of Mylar and GRS and other polyesters can be used for the shield 46. Thicknesses up to 16 mils have been used on large cables for better heat protection. The shield 46 is preferably formed by folding a tape longitudinally around the core and with a lap seam 48 which is usually not sealed.

An inner jacket 50, (optional) preferably of polyethylene, is applied over the shield 46 and the metal shield 18' is applied over the inner jacket 50 with a lap seam 52. This shield 18' can be made of aluminum, preferably coated with plastic as in the case of the D shield 22; and can also be made of copper or other suitable shielding material. The seam 52 is generally sealed, particularly if the metal of the shield is coated and the coating fuses at temperatures lower than the extrusion temperature to which the shield 18' is exposed when applying the outer jacket to the cable. For small cables the shield 18' is made from flat tape but for larger cables a corrugated shield is used to impart better flexibility to the cable.

An outer jacket 56 is extruded over the shield 18'. This outer jacket may be made of polyethylene; or if fire resistance is necessary, can be made of polyvinyl chloride.

FIG. 6 shows the application of the D screen 22 to a communications cable which is otherwise generally conventional in construction.

FIG. 7 shows the cable of FIG. 6 on a larger scale so that the plastic coatings on the screen 22 and shield 18' can be illustrated.

In FIG. 7 the D screen 22 is shown with a metal, preferably aluminum center lamination 62 and with plastic coating 64 on both the top and bottom surfaces of the metal 62. This coating 64 extends around the edges of the metal 62 or at least around the inner edge which faces pair circuit so as to prevent the metal from damaging insulation of the core, and cause low voltage rating between pair circuits and D screen as previously explained.

The shield 18' is shown with a metal lamination 72 covered on both its upper and lower surfaces by plastic coating 74. Such shielding tapes are of conventional construction.

With the new and unique configuration of the screen 22 of this invention, a superior communication cable is obtained with outstanding advantages in reducing cross talk.

An additional advantage of the D screen of this invention is that the D screen can be extended at cable terminations. With the Z-shaped screen, when the outer sheathing of the cable is removed for cable splicing, the Z-shaped screen is cut off also and the bunches of conductors in the compartments on opposite sides of the Z screen are brought to their respective repeater housings. Substantial cross talk occurs between those bunches which are not shielded from one another where they come to their repeater housings. With the

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D shaped screen of this invention, one bundle of wires does not have to be removed from the D shaped enveloping screen. The whole package, the bundle and the screen, can be conveniently brought to the repeater housing with the result that the bundle of conductors in the D screen is effectively shielded and cross talk is prevented from taking place between the two halves of the cable end from which the outside cable shielding has been removed for cable termination or splicing.

In actual practice, the cross segments about which the D shield is folded when making the cable are not as perfectly formed in cross section as indicated in the drawings of this specification. The cross section of the D screen is often distorted, therefore, so that it is not the outline of a D. There may be corresponding distortions in the shield 18' which is applied over the D screen, but if there are not, the differences in capacitance between the semi cylindrical portion of the D screen and the confronting inside face of the shield 18' do not affect the principle of operation of this invention.

The preferred embodiments of the invention have been illustrated and described, but changes and modifications can be made and some features can be used in different combinations without departing from the invention as defined in the claims.

What is claimed is:

1. A communication cable including a core containing a plurality of conductors divided into different groups along a generally diametrical plane through the core, an internal screen which is an electrical conductor and which surrounds one of the groups and constituting part of the core of the cable, an electrical conductive shield circumferentially surrounding the entire core and located entirely outside of said core including both groups of conductors and said internal screen, most of the outside of the internal screen confronting the inside surface of the shield and being adjacent thereto for increasing the capacitance between the internal screen and the shield with resulting reduction in cross talk between conductors in the different groups in the core, but the confronting surfaces of the screen and shield being spaced from one another throughout their entire extent so as to maintain a barrier between the cable core and the cable shield to prevent lightning currents in the shield from entering the core.

2. The communication cable described in claim 1 characterized by the cable core being of substantially circular cross section and the internal screen of substantially D shaped cross section with the curved part of the D shape generally semi circular and confronting a corresponding portion of the inside surface of the shield.

3. The communication cable described in claim 2

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characterized by the D screen extending around only the group of conductors that it encloses and being continuous around said group of conductors that it encloses, the shield being continuous around the core, and a circumferentially continuous outer plastic jacket that covers the shield.

4. The communication cable described in claim 2 characterized by the D screen being a longitudinally folded metal strip with a lap seam extending lengthwise thereof.

5. A communication cable including a core containing a plurality of conductors, an overall metal shield enclosing the core, said core including an internal metal screen for eliminating cross talk between groups of conductors of the core, said screen including a wall that extends generally diametrically of the core and between said groups of conductors and that reaches to the outside surface of the core at angularly spaced locations around said outside surface, the screen extending around said outside surface from both of said locations in converging directions and around the portion of the outside of the core which lies between said locations, the portion of the screen around the surface of the core confronting a corresponding portion of the overall shield and being close to but out of contact with the overall shield for increasing the capacitance between the inner screen and the overall shield without transmitting inductive currents to conductors on the other side of said wall in the region of the circumference of the core on said other side of the wall.

6. A shielded communication cable comprising a generally cylindrical core having a plurality of conductors divided diametrically into different bundles, a screen in the core dividing bundles of the core from one another, the screen completely enclosing one of the bundles and having a generally diametrical portion and a portion that forms a part of the circumference of the core, and a shield surrounding the entire core and having a portion of its circumference confronting the portion of the screen that forms a part of the circumference of the core to provide a capacitance effect that decreases the voltage induced in the screen by current flowing in conductors that are adjacent to the screen, the shield having space between it and the core around the entire circumference thereof, and plastic dielectric material in the space for insulating lightning currents in the shield from the core.

7. The communication cable described in claim 6 characterized by the different bundles being color coded by some of the plastic material wrapped around each bundle in a loosely applied helix with a fast lay so that successive convolutions of the helix are spaced from one another.

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