United States Patent [19]

Britz et al.

[11] **3,881,052**

[45] **Apr. 29, 1975**

[54] **CABLE FOR TRANSMISSION OF PCM SIGNALS WITH PLURAL INDEPENDENT SIGNAL PATHS**

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[22] Filed: **Mar. 20, 1974**

[21] Appl. No.: **452,941**

[30] **Foreign Application Priority Data**

Mar. 23, 1973 Germany 2314498

[52] **U.S. Cl.** **174/103**; 174/36;116

[51] **Int. Cl.** **H01b 11/06**

[58] **Field of Search** ..... 174/103, 36, 102 R, 27, 174/113 R, 105 R, 106 R, 116; 29/624; 156/53, 54, 56

[56] **References Cited**

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[57] **ABSTRACT**

The cable includes several bundles of conductors, each bundle having e.g. three quads. The quads of each bundle being shielded by a metal strip folded longitudinally around the conductors of the bundle with overlapping edges. In one example, a tab is formed, welded along the joint line and folded against the strip as enveloping the conductors of the bundle. In another example, at least one of the edges of the strip is provided with an adhesive, so that upon folding the strip, the edges overlap and are bonded together. The adhesive used here should be electrically conductive.

9 Claims, 4 Drawing Figures

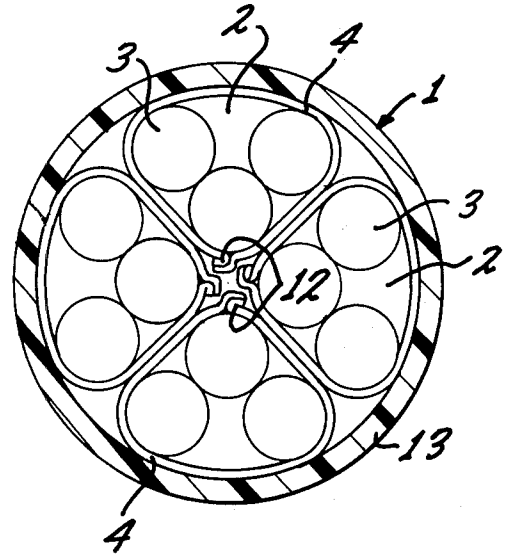


FIG. 1

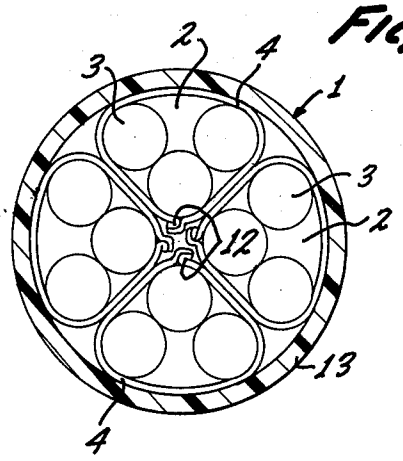
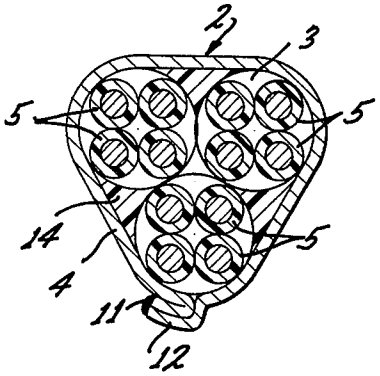


FIG. 2



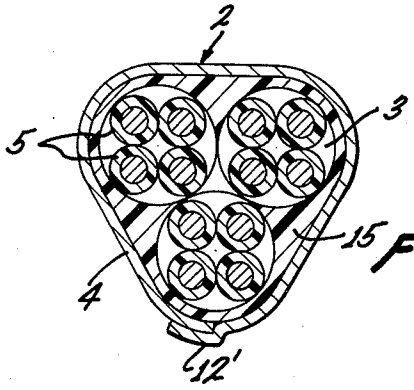
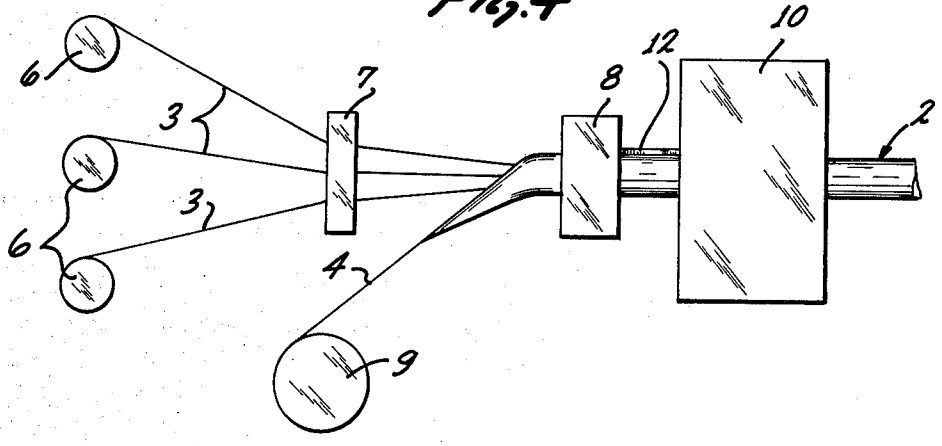


FIG. 3

FIG. 4



CABLE FOR TRANSMISSION OF PCM SIGNALS WITH PLURAL INDEPENDENT SIGNAL PATHS

BACKGROUND OF THE INVENTION

The present invention relates to the transmission of pulse code modulated signals via a cable, wherein plural transmission line elements, such as pairs or quads are bundled and encased in a common shield.

Since PCM signals are used for transmission of information to an increasing extent, cable must be provided to meet the increased demands for performance as well as requirements for greater economy. For example, such a cable should be constructed for transmission of signals in both directions. Accordingly, the several transmission paths in the cable transmitting in different directions must be completely decoupled from each other. Shielding for this purpose has been established in the past, for example, by wrapping metal strips or tape in helical fashion about a bundle of lines which transmits in the same direction. In order to provide for complete shielding the tape loops will overlap; that, however, results in the formation of air gaps in the shield, which reduce the crosstalk attenuation, and decoupling becomes incomplete. It has been suggested to provide an electrically conductive partition between the transmission lines for signals in different direction. However, the requirement exists here that the partition must envelope the two transmission paths without gaps.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide for a transmission cable, which can be easily manufactured and wherein the several transmission lines provide for adequate crosstalk attenuation.

In accordance with the preferred embodiments of the present invention, it is suggested to provide a shield by longitudinally folding an electrically conductive strip about the lines or conductors to be included in a bundle inside of the shield as formed in that manner, whereby the strip is sufficiently wide, so that the edges overlap. Several such shielded bundles are then included in the cable. It was found that a cable made in that manner has a low coupling impedance as to each shield, so that the crosstalk attenuation as between the several bundles is quite high. Each bundle is shielded completely in a separate process before several bundles are combined in a cable. It was found that even for very high frequencies, shielding is adequate and complete. Moreover, the shielding is not subject to deterioration upon ageing.

Without intending to exclude other possibilities, the shield can be longitudinally closed in two ways. In accordance with one suggestion, a tab is formed upon folding the strip into a tube, seam-welded and folded down. Alternatively, one or both edges are provided with an adhesive and upon folding the strip into a tube, the edges are merely made to overlap, so that the adhesive provides for the bond.

The conductor bundles with shield should have adequate mechanical strength. It is, therefore, advisable to reinforce the shield with plastic on the inside and to bond the plastic to the shield. The plastic may also fill some of the inside spaces of the bundle for positioning the conductors therein. This way, even strong bending of the cable will not lead to kinking of the shield. In the preferred form, three quads are arranged in a bundle, shielded and given a pie-shaped contour for combining several such bundles in a cable with circular cross-section. The overlapping edges of the shielding strips for the several bundles should all be located near the center of the cable to minimize any bending stress when the cable is being bent.

DESCRIPTION OF THE DRAWING

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter, which is regarded as the invention, it is believed that the invention, the objects and features of the invention and further objects, features and advantages thereof will be better understood from the following description taken in connection with the accompanying drawings, in which:

FIG. **1** is a cross-section of a cable in accordance with the preferred embodiment of the invention;

FIGS. **2** and **3** are cross-sections through bundles as they can be included in a cable of FIG. **1**, but shown on an enlarged scale; and

FIG. **4** is a schematic illustration of a facility for making such a cable.

Proceeding now to the detailed description of the drawings, the cable **1** in FIG. **1** is comprised of four bundles **2**, each of which being separately shielded. Each bundle **2** has three stranded quads, having four stranded conductors **5** accordingly. Each bundle **2** has its own shield **4**.

An individual bundle **2** is made in a manner best understood with reference to FIG. **4**. Several storage drums or spools **6** hold quads **3** in stranded configuration. These quads are withdrawn from the drums **6** and pass through individual openings in a plate **7**, quiding the quads for passage to a grouping head **8**. The head **8** positions the quads into a triangular disposition as shown in FIGS. **2** and **3**, with one apex up.

A metal tape or strip **4** is reeled from a drum **9** and runs longitudinally into the head **8** for folding and bending around the three quads. Strip **4** may be made of aluminum. The folded strip has its edges overlapping, for example, in form of a radially outwardly extending tab **12**. The device **10** provides for welding of the overlapping edges, so that the strip assumes the configuration of a completely closed tube.

The tube forming process may, for example, be carried out in the following manner. The metal strip **4** is placed about the quads **3** and folded, so that a radially outwardly extending tab **12** is formed. The tab is established by portions along the edges, which abut each other in flat surface to surface contact with an outer exposed joint line. The radially outwardly facing edge faces are then welded along the joint line to obtain a welding seam **11** as shown in FIG. **2**. Next, the tab is folded down, flat against the tube as also shown in FIG. **2**. Station **10** in FIG. **4** provides for welding as well as folding of the tab.

A simpler form of forming the tube can be derived from FIG. **3**. The edges are made to overlap directly, upon forming of the tube, reference numeral **121** denoting the overlap joint. An electrically conductive adhesive is applied to a narrow portion of the strip along one or the other or both edges prior to folding, so that the strip edges are bonded together upon being folded in overlapping configuration.

The several bundles are not stranded in the cable; rather, they are combined, so that the overlapping portions **12'** or folded down tabs **12** are all located in or

near the center of the cable as shown in FIG. 1. This way, bending of the cable as a whole will influence the bond very little as the bonds are located near the center line.

In the preferred form as illustrated in FIG. 1, three quads are included in one bundle providing for a triangular configuration. Upon combining four such bundles, one will place them so that each of the bundles assumes position of a sector, whereby the outer side of each of them is curved. The shield material is sufficiently flexible to permit such configuration, so that the four outer sides together establish a circle. The four bundles may be encased in another field, which in turn is enclosed in an outer jacket 13 of a plastic material, which provides for protection of the cable.

It has to be observed, however, that the three quads per bundle are no longer arranged to approximate an equilateral triangle after having assumed pie-shaped configuration as per FIG. 1; the one side of the shield is even curved. Thus, one must provide the shield around a bundle in this case with less than the tight fit shown in FIGS. 2 and 3. Instead, some slack is needed to permit the displacement of the quads in each bundle from the close arrangement of FIGS. 2 and 3.

In order to reduce the danger of kinking for the shields 4 of bundles 2 further, it may be advisable to fill the gaps between the quads and the shield in each bundle with plastic material 14 of sufficient flexibility (FIG. 2). The filler of fillers 14 should be bonded to the shield. As a consequence, the mechanical stability of the shield is considerably improved. These fillers 14 may be individual strips laid into the assembly and fed through appropriate apertures of plate 7 for placement adjacent respective two quads. Either the surface of strip 4, which will become the interior of the tube to be formed, or the outer surface of these fillers (or both) are provided with an adhesive, so that upon folding the strip 4 into a tube, the fillers are bonded to the internal surface of that tube.

FIG. 3 shows an alternative way of mechanically stabilizing the strip 4. Accordingly, a plastic layer is e.g. extruded around the quads prior to folding strip 4 about the quads so as to establish a tubular, plastic carrier 15. The strip 4 is then folded onto and around carrier 15 and bonded thereto.

The carrier 15 may be comprised of polyethylene either in solid or in foamed configuration, but with solid outer skin. This particular carrier provides for additional advantageous features of the cable in that line attenuation is lower, while crosstalk attenuation is increased further. The invention is not limited to the embodiments described above, but all changes and modifications thereof not constituting departures from the spirit and scope of the invention are intended to be included.

We claim:

1. In a communication cable for the transmission of PCM signals, which includes a plurality of bundles of conductors, the bundles being arranged in a jacket, each bundle of the plurality being individually shielded with respect to the other bundles in the cable, the improvement comprising:

the shield of a bundle of the plurality being a longitudinally folded metal strip having its two longitudinal edges bonded in overlapping abutment, establishing a longitudinal joint of the shield of the bundle, there being but one such joint for each bundle and shield;

all bundles of the plurality being disposed in the jacket, so that the bonded edges of the joint of each bundle are located as near to the center of the cable as possible.

2. In a cable as in claim 1, wherein the edges are welded along their end-faces.

3. In a cable as in claim 1, wherein the edges are bonded together with an adhesive.

4. In a cable as in claim 1, wherein the edges abut in the form of a tab, and have been folded sideways against the strip, so that the edges overlap on the strip as folded about the conductors.

5. In a cable as in claim 4, wherein one of the edges overlap the other one with an electrically conductive adhesive in-between.

6. In a cable as in claim 5, wherein the tap has been seam-welded along a joint line between the two edges.

7. In a cable as in claim 1, wherein the several bundles have pie-shape and together establish a circular configuration.

8. In a cable as in claim 1, wherein gaps between the shield of each bundle and the conductor assemblies of the bundle are filled with a plastic material bonded to the shield.

9. In a cable as in claim 1, wherein the conductor assemblies of each bundle are included in a plastic carrier engaging the bundles over most of the periphery of each of them for holding them in position, the shield being bonded to the outer periphery of the carrier in contour matching relation.

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