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ELECTRICAL SECURITY CABLE

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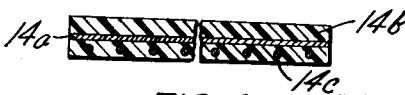
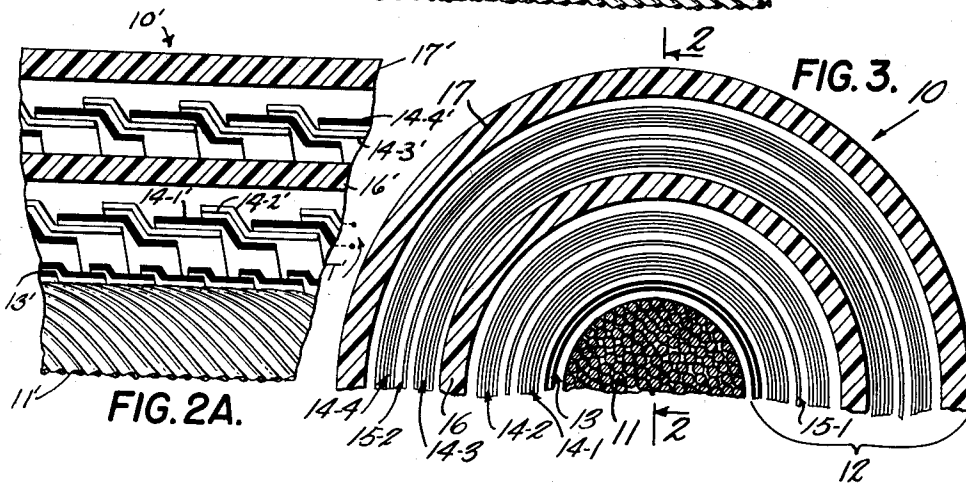
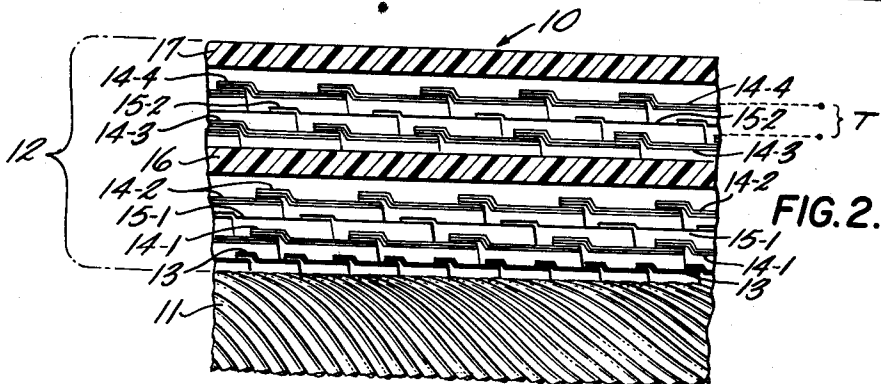
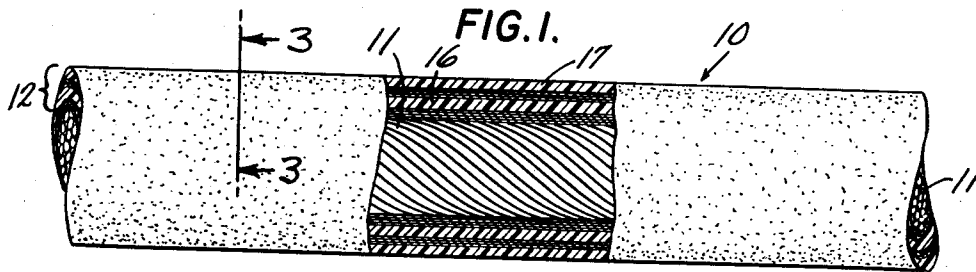


FIG. 4.



FIG. 5.



FIG. 6.

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ELECTRICAL SECURITY CABLE

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3 Claims. (Cl. 174-105)

This invention relates to electrically conducting cables and more particularly to electrically conducting cables capable of use for transmitting intelligence in situations in which security against tapping is required.

There is an ever increasing need for providing communication channels which are secure against tapping by unauthorized persons. Wire tapping techniques have been perfected to a point at which the weakest of electromagnetic radiations from a conductor can be detected and amplified without physical contact with the body of the cable. Other techniques involve the piercing of cables which are otherwise adequately protected against inductive tapping by means of sharp extremely small probes having insulating surfaces to tap the intelligence-conducting wires, either conductively or inductively without perceptible damage to the cable and without triggering conventional cable-protecting alarm devices.

In accordance with the present invention, there is provided an electrically conducting cable protected against both inductive and conductive tapping. The cable core, which can comprise a bundle of individual electrical conductors for transmitting intelligence, is enveloped by a sheath of complex laminae including multiple layers of thin electrically conducting foil, preferably coated by an insulating film. Externally, the cable is jacketed in a heavy weather-proof and abrasion resistant casing. The thin foils can be applied in accordance with the invention in the form of a spirally wound tape laminae. Preferably, each tape comprises a foil sandwiched between flexible insulating coatings or films, at least one of which can be reinforced to facilitate handling of the foil in the construction of the cable as well as flexing of the finished cable. The tapes are spirally wound with a generous overlap and are preferably bonded at their areas of overlap. When wound separately, the several tapes form a corresponding number of generally cylindrical, concentric surfaces which become short circuited when pierced by a probe. Wound two tapes as one, a composite layer results which short circuits when pierced and which also short circuits when a probe is entered between overlapped surfaces.

A representative embodiment of the invention, from which the above and other features will be readily understood by those skilled in the art, is described in detail in the following specification having reference to the accompanying drawings in which:

Figure 1 is a view partly broken away in longitudinal section, of a portion of an electrically conducting cable protected against both inductive and probe tapping;

Figure 2 is an enlarged, radially exploded view in longitudinal section of a portion of the cable of Figure 1. Figure 2 also represents the section view taken on the line 2-2 of Figure 3, looking in the direction of the arrows;

Figure 2A is an enlarged, radially exploded view in longitudinal section of a portion of modified form of cable construction;

Figure 3 is an enlarged, radially exploded view of the upper half of the cable as viewed in transverse section taken on the line 3-3 of Figure 1;

Figure 4 is an enlarged view in transverse section of one spirally wound lamina in the sheath of the cables of Figures 2 and 2A;

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Figure 5 is an enlarged view in transverse section of another spirally wound lamina in the sheath of the cables of Figures 2 and 2A;

Figure 6 is an enlarged view in transverse section of still another spirally wound lamina in the sheath of the cable of Figure 1.

Referring to the drawing, the invention is illustrated as embodied in a cable indicated generally by the numeral 10 and comprising, working from the inside out, a core 11 in the form of a bundle of electrical conductors for carrying intelligence enveloped in a laminar sheath indicated generally by the numeral 12. The bundle of conductors making up the core 11 are preferably spirally wound or twisted to control electromagnetic effects.

Immediately surrounding the conducting core 11 is an insulating layer in the form of a spirally wound binder tape 13. The tape 13, as best seen in Figure 5, can take the form of a vinyl tape approximately one-half inch wide and 0.005 inch thick and reinforced by glass fiber filaments, and the spiral winding about the core can have an overlap preferably in the range of 20 to 25%.

Spirally wound about the binder tape 13 is a tape composite 14-1, which is the first of four tape composites 14-1, 14-2, 14-3 and 14-4 appearing in the completed cable. The structural details of each of these tape composites are shown in Figure 4 as including an aluminum sheet 14a in strip form approximately one inch wide and 0.00035 inch thick. The sheet 14a is covered on one side by an insulating film or coating 14b such, for example, as a vinyl film of 0.002 inch thickness and on its other side by an insulating film or coating 14c which can take the form of a vinyl sheet of 0.002 inch thickness preferably reinforced by longitudinally disposed glass fiber filaments. The films 14b and 14c are preferably intimately bonded to the foil to establish a union at least as strong as the foil itself so that the insulation cannot be stripped off without tearing the foil. The tape composite 14-1 can be wound with an overlap which is preferably in the range of 20 to 25%.

Spirally wound about the tape composite 14-1 is an insulating tape 15-1, the first of two in the cable, which can take the form, as best seen in Figure 6, of a vinyl tape one inch wide and 0.002 inch thick spirally wound with an overlap preferably in the range of 20 to 25%. Spirally wound about the insulating tape 15-1 is the second tape composite 14-2, which is constructed and wound similarly to the tape composite 14-1. It will be observed that the two closely spaced tape composites 14-1 and 14-2 can, as by terminals T, have potentials impressed thereacross, such for example, as a 100 to 150 volts D.C. to cause an alarm to act when a short or partial short is established between the layers. The close proximity of the two conducting layers and their physical characteristics make penetration as by a probe or unwinding of the tapes impossible without forcing metal from one layer into at least partial shorting engagement with the other layer or breaking the continuity. Also, the layers form a capacitor which can, if desired, be used in the security circuitry which protects the cable. A representative security system which can be used in conjunction with the cable is disclosed in the copending application Serial No. 615,106, filed October 10, 1956.

Surrounding the tape composite 14-2 is a jacket 16 of heavy insulating material such, for example, as vinyl affording a considerable degree of flexibility while at the same time protecting the layers disposed therein against moisture penetration, damage from abrasion, or the like.

Wrapped about the insulating jacket 16 is the third tape composite 14-3 wound, as are its corresponding composites 14-1 and 14-2 with an overlap of about 20 to 25%. Wound about the tape composite 14-3 is the

second insulating tape 15-2, which can be wound with an overlap in the range of about 20 to 25%. Wound about the tape 15-2 is the fourth tape composite 14-4 wound with an overlap of about 20 to 25%. The two tape composites 14-3 and 14-4 are separated by the insulating tape 15-2 to form a second pair of closely spaced layers also incapable of being penetrated without actuating alarm circuits to which the cable is connected. The entire cable assembly is sheathed in a heavy flexible insulating jacket 17 such, for example, as vinyl plastic affording both a weather-proof and abrasion resistant casing. A cable assembly formed in accordance with the present invention with an outside diameter of $\frac{1}{16}$ inch is capable of bending about a radius corresponding to roughly five diameters without damage to the several delicate foil layers 14a disposed in the sheath assembly 12.

In the finished cable, the overlapping laminae are preferably sealed together as by the use of chemical cement and heat so as to form an inseparable unit. In general, the degree of overlap should be selected so that an efficient bond can be established between the layers. When bonded, any attempt to penetrate the cable by peeling off layers will result in the tearing apart of several layers, causing to short circuit which can be readily detected to sound an alarm.

Referring to Figure 2A, a modified cable construction is shown, parts corresponding to those of the cable construction of Figure 2 being identified by like primed reference characters. The twisted bundle of intelligence conductors forming the core 11' are covered by a first layer of electrically insulating material 13' which can be in tape or ribbon form and wound thereabout in the manner of the layer 13 of Figure 2. The next layer is a composite layer made up of tape composites 14-1' and 14-2' each comprising an electrically conducting foil sandwiched between plastic films, at least one of which can be reinforced as shown in Figure 4. The two tape composites 14-1' and 14-2' are generously overlapped, preferably slightly more than 50% of their widths and wound as one about the insulating layer 13' using generally the same percentage overlap all along. Being wound as one, a composite foil layer is established in which the foil from one tape overlaps the next, as can be seen in the drawing. Thus, the foil of the tape 14-1' is overlapped by that of 14-2' which is in turn overlapped by that of 14-1', and so on along the length of the cable. It will be understood, however, that in certain cases the tapes 14-1' and 14-2' can be fully overlapped, i.e., 100% overlap, and wound as one in a spiral using an overlap of about 20-25%. Of course, one double foil tape can be used in place of two single foil tapes. Both this and the above arrangement afford protection against "axial" probing, as described below.

Following the composite layer 14-1' and 14-2' is an insulating sheath or jacket 16' of flexible, insulating material such as plastic for example, followed by a second composite layer made up of the tape composites 14-4' and 14-3' overlapped and wound as one in the same fashion as the tape composites 14-1' and 14-2'. The modified cable construction can be completed by a heavy waterproof insulating sheath or jacket 17'. It will be understood that similarly to the arrangement of Figures 2 and 3, the cable construction of Figure 2A is preferably internally sealed as by the use of chemical solvents and heat so that the tape composites 14-1' and 14-2' are bonded to each other at their areas of overlap, as are the interwound tapes 14-3' and 14-4'.

In operation, it will be understood that D.C. voltage can be impressed across the tapes 14-3' and 14-4' as well as across the tapes 14-1' and 14-2' (through suitable terminals T') so that any attempt to penetrate either composite layer with a probe, radially of the cable will necessarily traverse two foils of opposite polarity to

cause a short circuit, this due to the nature of the foil constructions as described above. In addition, in the event an attempt is made to slip a probe instrument between two overlapped layers and in a direction which is more or less axial with respect to the cable, i.e., without penetrating either tape radially, will result in a short between bonded, overlapped foils, which, having voltages of opposite polarity impressed thereon, will result in a detectable short circuit. As in the arrangement of Figures 1-3, the tapes cannot, due to their bonding, be unwound in a peeling operation to expose the critical intelligence conductors without tearing the foils and triggering the alarm due to leakage, shorting or breaks in continuity.

When connected in a security circuit in accordance with the disclosure of the said copending U.S. application, Serial No. 615,106, filed October 10, 1956, cables formed in accordance with the present invention afford complete security against all known tapping techniques, either of the inductive or the conductive type. While the foil in the tape composites 14-1, 14-2, 14-3 and 14-4 (or their equivalents in Figure 2A) are so disposed in the cable, they form barriers to short circuiting, as described above, as well as a continuous shield about the conductors of the core conductors 11, they are also capable, particularly the outermost layers, of having impressed thereon jamming signals of white noise radiating externally of the cable with an intensity far exceeding any radiations which could possibly leak out from the conductors of the core 11 under normal operating conditions.

While preferred embodiments of the invention have been disclosed herein, having reference to the accompanying drawing, it will be understood that the invention can take other forms and embodiments within the scope of the invention, which should not, therefore, be regarded as limited except as defined in the following claims.

I claim:

1. In a security cable an electrically conducting core for carrying intelligence, a first layer enveloping said core and disposed substantially coaxially therewith, first insulation means separating said first layer from said core, a second layer enveloping said first layer and disposed substantially coaxially therewith, second insulation means separating said second layer from said first layer, a third layer enveloping said second layer and disposed substantially coaxially therewith, third insulation means separating said third layer from said second layer and being formed of a flexible, heavy, continuous, insulating material, a fourth layer enveloping said third layer and disposed substantially coaxially therewith, fourth insulation means separating said fourth layer from said third layer, each of said first, second, third and fourth layers being formed of electrically conducting material which is in the form of a ribbon of insulating plastic-backed metallic foil wound spirally with edges in overlapping relationship and the plastic of said edges being bonded to form a substantially closed cylindrical surface, and an insulating covering surrounding said fourth layer.

2. In a security cable as set forth in claim 1, each of said edges overlaps the adjacent edge by an amount approximately 50% of the width of said ribbon.

3. In a security cable as set forth in claim 1, each of said edges overlaps the adjacent edge by an amount approximately 25% of the width of said ribbon.

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