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[54] **COMPOSITE LAYER MATERIAL HAVING AN
 OUTER LAYER OF COPPER AND SUCCESSIVE
 LAYER OF STAINLESS STEEL, LOW CARBON
 STEEL AND COPPER**
 1 Claim, 2 Drawing Figs.

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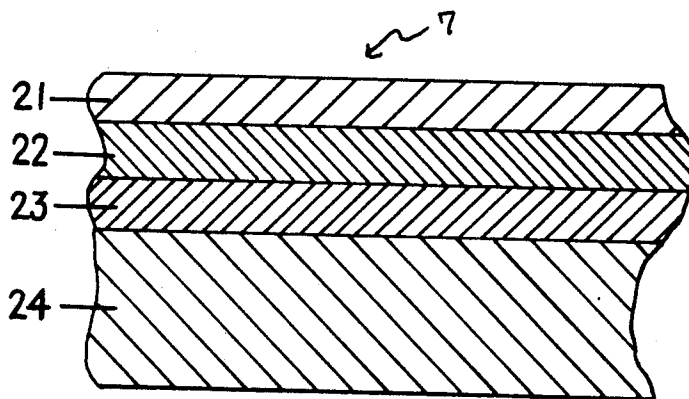
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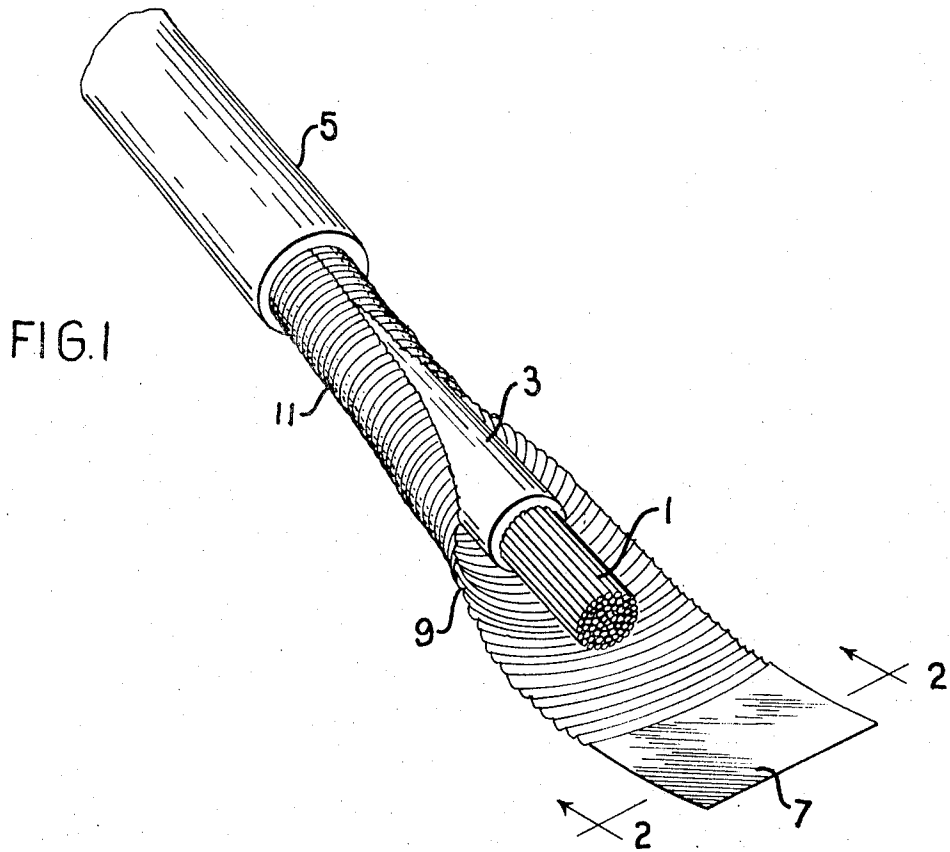
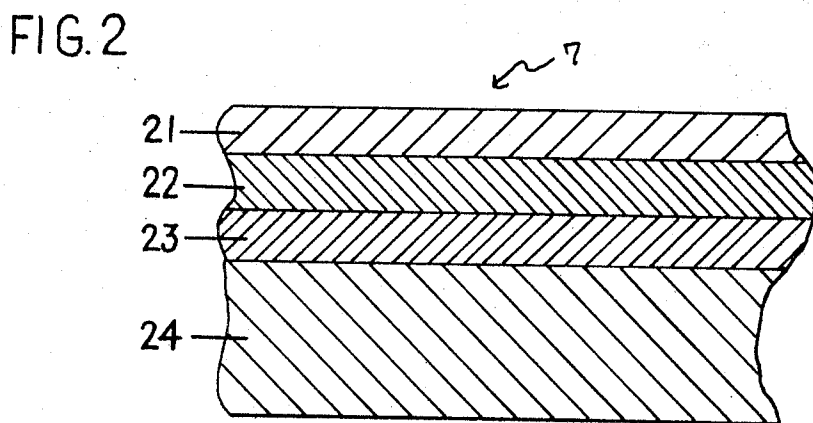
[50] Field of Search 29/196.3,
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ABSTRACT: A cable for the transmission of communication impulses or signals uses as a cable shielding material a highly conductive cable shield material which is of high strength and which is corrosion resistant. The material consists of a four-layered composite bonded together and comprised of a thin conductive layer of copper as the outer layer to prevent rust formation next to a layer of high strength, corrosion-resistant nickel and chromium containing steel (stainless steel) next to a layer of low carbon steel which provides greater ductility and a cost saving next to an innermost layer of copper which provides corrosion protection and which is relatively thick to provide overall conductivity.





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COMPOSITE LAYER MATERIAL HAVING AN OUTER LAYER OF COPPER AND SUCCESSIVE LAYER OF STAINLESS STEEL, LOW CARBON STEEL AND COPPER

Among the several objects of the invention may be noted the provision of a strong, lightweight, easily formable and highly conductive cable sheath which is abrasion and impact resistant, which possesses superior mechanical strength and which has magnetic properties and is readily solderable and which is corrosion resistant, and the provision of a cable shielding material which provides a more economical structure.

Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the appended claims. In the accompanying drawings in which one of various possible embodiments of the invention are illustrated:

FIG. 1 is a view illustrating a typical application of our new multilayered shield material to form an improved cable, the material being shown diagrammatically by single lines;

FIG. 2 is an enlarged fragmentary cross-sectional view taken on a line 2-2 of FIG. 1 illustrating the four layered form of the material of the invention.

Similar reference characters indicate corresponding parts throughout the several views of the drawings. The drawings are illustrative and not to exact scale. The small thicknesses of the layers involved being exaggerated.

It has been known to shield electrical cable with a surrounding metallic sheath of copper because of its good corrosion resistance, its excellent conductivity of heat and electricity, its ready solderability and its ease of forming which thereby provides manufacturing economies. Compared with steel, however, copper has poor abrasion resistance and low tensile strength as well as low impact resistance. Where solid copper was employed it was highly expensive because of the thickness of copper required to provide adequate strength. Therefore, it has been a practice to provide a multilayered composite metal sheath including a layer of steel with copper bonded to both sides.

The instant invention is an improvement over these materials by means of a four layered composite material comprising a first layer of copper, a second layer of stainless steel, a third layer of low-carbon steel, and an inner fourth layer of copper.

Referring now to the drawing, particularly FIG. 1, there is shown at numeral 1 a typical conductive core of a communicating cable construction which is to be shielded. At numerals 3 and 5 are shown the usual inner and outer, nonmetallic, flexible insulating sleeves employed to provide a proper dielectric means for spacing the conductors relative to one another together with proper electrical insulation.

Typically these sleeves are extruded into place during cable manufacture. Between the sleeves, 3 and 5, is employed the novel composite shielding material or sheath of this invention as described below.

At numeral 7 is indicated a strip of such material made according to the invention. During the cable manufacture it is wrapped around the inner sleeves 3 in the usual manner as suggested at 9 in FIG. 1 with or without the transverse corrugation such as illustrated at 11. The corrugations improve flexibility but are not always necessary. In the alternative, strip 7 may be applied helically to the cable in a known manner (not shown). In FIG. 1 the composite, because of its thinness, is illustrated by single lines, that is, in schematic fashion.

Referring now to FIG. 2, the improved shield sheet material 7 is composed of a comparatively thick layer 24 of copper which is to form the inner layer of the shield when it is applied to the cable. A comparatively thin layer 21 of copper forms the exterior of the shield. At 22 and 23 are intermediate layers of steel of intermediate thickness. Layer 22 is composed of a corrosion resistant stainless steel while layer 23 is a low-carbon steel which is less expensive than the stainless steel and more ductile thereby providing easier working, a comparatively thick innermost layer 24 of copper provides conduction and

a degree of corrosion resistance. These four layers are interfacially bonded, preferably by a metallurgical solid phase bond such as those set forth, for example, in U.S. Pat. Nos. 2,691,815 and 2,753,623. Other bonding methods are not precluded however.

The total thickness of the composite material 7 is in the range of from 0.005 to 0.0020 inch depending upon the conductivity and strength required. The interior copper layer 24 is preferably relatively thick in relation to the total thickness of the material since it is to act as the principle electrical conductor. However, the outer layer 21 is relatively thin and is to provide corrosion resistance together with ease of forming. The total thickness of layers 21 and 24 may be as little as 10 percent of the total thickness of the composite material depending on the conductivity required. Alternatively, layer 21 could also be formed of nickel. However, the copper is preferred as the exterior material because of its superior solderability. Copper also makes it easier to corrugate the cable shielding. Layer 21 thus could be in the range of from 0.0005 inch to 0.0015 inch. Composite inner layer 24 could be in the range of 0.002 inch to 0.010 inch. The copper employed in layers 21 and 24 is preferably of the deoxidized low phosphor (DLP) type, which has a nominal composition of 99.9 percent copper and 0.009 phosphorus. It is used because it is suitable for exposure to reducing atmospheres at elevated temperatures without damage thereto and has relatively high conductivity. Other high conductivity copper alloys could also be employed.

Layer 22 is a corrosion resistant steel of the stainless type and is preferably one of the martensitic or ferritic stainless steels which are highly corrosion resistant. The range of thickness for this layer is between 0.001 and 0.002 inch. This layer provides corrosion and abrasion and impact resistance since it backs the copper face 21.

Layer 23 is a layer of ductile steel such as one of the so-called low-carbon steels. This layer of steel provides strength while also providing ductility for manufacturing ease as in the corrugation process. Layer 23 is in the range of from 0.001 to 0.002 inch. If layers 22 and 23 were all stainless steel, the material would be more difficult to form because of the springiness of the material of the stainless steel. In addition, the use of a minimum amount of stainless steel with the remainder of low-carbon steel results in a substantial cost saving while not sacrificing corrosion resistance or strength. This is because the stainless steel layer is in the outer side of the composite strip and it is assumed that impact or abrading damages would be from the outer side. In addition, the low-carbon steel permits easier working because of its lack of a tendency towards work hardening. It will be understood that austenitic stainless steels could be used in layer 22 although generally more expensive. It will be understood that the thin copper layer also provides a lubrication of the stainless steel layer in the manufacturing process.

The innermost layer 24 is of a high conductivity copper alloy and is in the range of from 0.001 to 0.010 inch in thickness. In a typical example, a layer of 0.125 inch thick DLP copper, 0.40 inch 1006 low-carbon steel, a layer of 0.40 inch thick martensitic stainless steel No. 414 with a layer of 0.50 inch thick DLP copper were selected and bonded to one another as disclosed in the above-noted U.S. Pat. No. 2,691,815 in the solid phase without the use of a solder material which could deleteriously affect the performance of the cable wrap material. Thereafter this material was reduced by rolling to a material 0.006 inch in thickness in which the layer 24 was 0.003 inch while the other layers were each 0.001 inch thick.

It will thus be seen that the objects of the invention have been achieved and a substantial saving in expensive copper is accomplished by employing a composite of steel and copper in which the steel layer is in turn a composite of less expensive low-carbon steel and stainless steel. In addition, the copper outer layer provides solderability, corrosion resistance to certain media and manufacturing economy. Further, stainless steel provides strength and corrosion resistance together with

resistance against abrasion and impact. The inner layer of low-carbon steel provides ductility and being magnetic permits the location of underground cable by external magnetic detectors. Finally, the use of the low-carbon steel provides a stronger and more ductile composite.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changed changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. Composite cable shielding material comprising in combination:

- a. an outer layer of copper approximately 0.001 inch in thickness, the copper being of a high conductivity copper alloy;
- b. a layer of stainless steel of approximately 0.001 inch in thickness next to the outer layer of copper;
- c. a layer of low-carbon steel, approximately 0.001 inch in thickness next to the layer of stainless steel; and
- d. an inner layer of copper of approximately 0.003 inch in thickness, the copper being a high conductivity; the layers being interfacially metallurgically bonded to one another in a solid phase.

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