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(54) Title: ELECTRICAL/SIGNAL CABLE HAVING IMPROVED COMPOSITE CABLE JACKET, SHIELD TERMINAL AND GROMMET

(57) Abstract

A cable management assembly for carrying electrical signals comprises a crod reel, a fixed length of cable extending from the reel and terminating in a cable connector, a retractable length of cable on the cord reel terminating in a grommet assembly that is adapted to be clamped into a terminal. The retractable cable comprises at least one conductor, an inner jacket, a fiber braid layer, and a pressure extruded elastomer outer layer. The outer elastomer layer passes through the fiber braid layer to bond to the inner jacket, thereby locking the braid in place. The conductor(s) within the inner jacket are allowed to move slightly, thereby retaining cable flexibility and focusing mechanical load on the fiber reinforced cover layers. The grommet assembly comprises a cable with an exposed shield layer, a supplemental conducting layer placed over the exposed shield layer, a conducting sleeve placed over the supplemental layer, and an elastomeric grommet molded over the sleeve and onto the cable jacket that is proximal to the sleeve. A distal end of the sleeve is exposed such that it may be received in a terminal having two clamp halves for 360° electrical contact with the exposed distal end of the sleeve. A cable connector is provided on the opposite end of the cable assembly, comprising a back shell having a plurality of passager, with a cable passing through each of the passages. A unitary conducting shield covers both cables, and is compressed to the back shell.

ELECTRICAL/SIGNAL CABLE HAVING IMPROVED COMPOSITE CABLE JACKET, SHIELD TERMINAL AND GROMMET

Cross Reference

This application claims the benefit of Provisional Application No. 60/094,936 filed July 31, 1998.

Field of the Invention

The present invention relates to cables for carrying electrical signals, grommets, terminals, and jacks. In particular, the present invention relates to a fatigue resistant shielded cable, grommet, terminal and connector assembly.

Background of the Invention

When connecting an electrical device to a source, a number of problems are encountered generally related to mechanical tension, flex, and torsion loading. As the cable is pulled or twisted, for instance, it is subject to stresses that may cause it to fail, or that may lead to eventual fatigue related failure. The repeated flexing of a cable, for instance, may lead to fatigue cracking of a conducting element and resultant failure. Repeated load strain on a cable, as another example, may lead to conductor elements or shielding separating from connection points and resultant failure. These cables may be subject to repeated and relatively severe flexing and bending, particularly in the area where a cable is connected to a source or device.

Cables for carrying an electrical signal commonly include central conductors and overlying protective layers. Some protective layers comprise insulation and jacket materials that are soft and flexible. As a result of this softness and flexibility, a significant portion of the mechanical load on such cables is carried by the conductors, thereby decreasing conductor service life.

Some prior art cables have insulation and/or jackets made from high performance polymers in an attempt to shift the mechanical load to the jacket and to thus prolong service life. These insulation and jackets, however, are often stiff and inflexible. Further, such jackets and insulators may in some cases be undesirably thick.

A cable protective layer covering that is flexible and yet is capable of carrying a mechanical load is a woven fabric covering of polymer such as Nylon. Such a covering allows conductor elements to shift, and thereby avoids placing a load on them. Such a woven cover, however, has disadvantages associated with it. For instance, it does not provide a barrier to moisture. If the primary insulation on the individual conductors is compromised, a fluid spill could result in a short. In addition, a woven cover is not easily cleaned of stains. Further, a woven cover may be difficult to use with cable cutting tools, as they may easily penetrate the woven fabric layer and pass into the conductors below or into the insulation layers around the individual conductors.

A proposed solution has been to combine a woven fabric covering with a liquid tight polymer protective layer. When the woven cover is placed over the polymer layer, however, the polymer layer may restrict movement of conductor elements, thereby potentially increasing the loads carried by the conductors and decreasing cable flexibility. Also, the woven fabric covering remains subject to staining. If the polymer layer is placed over the woven fabric, the polymer may restrict movement of the braid and thereby reduce flexibility. Further, regardless of which layer covers which, the presence of two layers may result in an unacceptable cable diameter.

To further reduce mechanical load and fatigue related failures of conducting cables, strain relief means may be used in connecting the cable to a device. Most often, cables are connected to a device by crimping the cable with a crimper. A crimped connection, however, tends to center the load on the conductors. Also, a crimp connection typically requires a flattening of an otherwise round cable, and thereby does not distribute the load evenly about the entire circumference of the cable. The load is instead focused on a small portion of the cable, which can lead to premature failure.

Cable EMI-RFI shielding may also be conductively attached to a device housing. Often, as in the case of an electrically connected handset, the interior of the device housing will have an EMI-RFI protective coating. In a conventional crimp connection, the shield makes contact with the interior protective coating through the shield being in contact with the conductive crimp connector, which may occur over an undesirably small area. Other prior art connection methods may include soldering a portion of the cable shielding to the device shielding. Such soldered connections, however, result only in point contact. While point contact may be adequate for most electrical contacts, it may be inadequate for EMI-RFI shielding and may result in EMI-RFI leakage.

Further, many existing devices connect EMI-RFI cable shielding to a device housing in an ineffective manner. As EMI-RFI cable shielding is brought into a device housing and connected to that housing's shielding, the distance between the entry point to the housing and the connection point to the shielding can be an entry portal for EMI-RFI interference into the housing.

Another set of problems relates generally to applications requiring plural shielded cables to be connected to a single commercially available connector. As an example, two cables may be connected to a single multiple pin connector. Past practice has included passing both cables through a single hole in the connector back shell. This practice, however, is troublesome for a variety of reasons. As the back shell hole is not intended to accommodate more than a single cable, the multiple cables may be cramped and thereby subject to excessive wear. Also, the separate individual cables each bring separate ground shields into the connector, which must then each be connected to the back shell. Further, passing two generally round cables through a single hole leaves gaps that may serve as EMI-RFI interference portals into the connector back shell or housing.

There is therefor an unresolved need for an electrical signal cable that is not prone to failure from fatigue, that provides effective strain relief at a device connection point, and that provides adequate EMI-RFI protection at a device connection point. Also, there is an unresolved need for a means and method for connecting a plurality of individual shielded cables using a single connector.

Objects of the Invention

It is an object of the invention to provide a flexible signal cable with improved durability.

It is a second object of the invention to provide a durable cable, grommet and terminal assembly for connecting a cable to a handset or device with improved EMI-RFI shielding.

It is a final object of the invention to provide an improved shielded jack for receiving a plurality of individual cables.

Summary of the Invention

The present invention comprises a shielded cable one end of which is intended to be attached to a movable device such as a hand set. The other end of the cable is intended to connect via a standard jack, such as serial jack, to a stationary source. Desirably, the majority of the cable is stored on a retractable cord reel. A shielded grommet adapted for connection to a terminal assembly are provided at the moveable end of the cable to provide effective EMI-RFI shielding and improved durability. A multi-cable, shielded jack is provided at the stationary end of the cable.

The cable of the invention generally comprises at least one conductor, an inner tube jacket over the conductor, a braided fabric layer over the inner jacket; and an outer elastomeric jacket extruded over and through the fabric layer to bond with the inner jacket. A shielding layer may be located between the conductor(s) and the inner tube jacket. The inner tube jacket over the conductor is thin and does not adhere to the conductors, thereby allowing conductor movement and preventing mechanical load transfer from the jacket to the conductors. The tube jacket is covered with a thin fabric braid to carry loads. The preferred fabric braid layer comprises braided polyester, and provides between 30% and 75% coverage, with 40% to 50% being preferred. The preferred outer elastomeric layer is a pressure extruded jacket that passes through the braided fabric cover and bonds to the inner jacket, thereby forming a laminated, fabric reinforced, moisture resistant jacket.

The combination of the inner and outer jackets bonded together through the fabric braid layer there between thus comprises a thin, fabric reinforced polymer jacket that is capable of carrying loads, that allows the inner conductors to shift or move slightly in response to loading, and that provides an effective barrier to moisture. The overall combined thickness of the three layers is substantially the same as a single prior art cover. Because the inner conductor(s), which preferably comprises plural insulated conductors, are shiftable as load is applied to the cover layers, the conductors avoid carrying load. This greatly reduces the frequency of fatigue related cable failures. In addition, the presence of the polymer jacket below the woven fabric layer makes the cable of the present invention easier to use with cutting tools reducing the risk of cutting into the conductors.

The present invention further comprises a jack for receiving a plurality of separate cables, as may be required when connecting a source to two or more devices, such a hand set and a kill switch. The connector comprises a back shell having plural openings for receiving plural cables. Each cable carries a braided metal shielding layer which is connected to the back shell. Desirably, the braided cable shield is continuous, extending from one cable to the other within the back shell of the jack. An individual opening for each cable allows for a more uniform fit around the circumference of each cable which provides improved EMI-RFI shielding.

The grommet assembly of the invention connects the cable to a movable remote device, such as a handset. The grommet comprises an elastomeric grommet molded around a conducting sleeve, with the inner conducting sleeve exposed at an outer or distal end. The sleeve carries a radially extending flange for better mechanical connection with the elastomeric grommet. The grommet is molded over and fused to the cable outer jacket proximal to the sleeve, thereby providing for transfer of load between the cable jacket and grommet. This reduces the load placed on the conductors, and significantly reduces fatigue related cable failure at the point of cable connection to the device, which may otherwise be subject to high rates of failure.

Preferably, the cable of the grommet assembly of the invention is shielded. One or more foil or braided metal shield layers are located between the inner conductors and outer cable jacket. A length of outer jacket is removed from the distal end of the cable exposing the shield layer(s). A length of the shield layer is pulled back and folded over the cable outer jacket. The conducting sleeve surrounds the folded over length of shield layer. The elastomeric grommet is molded around the sleeve, with a first end of the sleeve extending distally from the grommet. The exposed distal end of the sleeve provides for conducting linkage between device shielding and the cable shielding layer.

To further reduce fatigue related failure of the inner conductors a metallic braid supplemental shielding layer surrounds the folded over length of cable shield layer within the sleeve.

The grommet of the invention is adapted to be received in a terminal carried by the movable device for receiving the cable and grommet. The terminal comprises a clamp that is electrically connected to or is a part of the housing shielding for the remote device. The clamp has a first surface that clamps onto the exposed distal end the conducting sleeve. The clamp has a second surface that engages a recessed annular ring in the elastomeric grommet, which provides mechanical attachment between the grommet and device without placing significant load on the cable inner conductors.

Contact between the clamp first surface and the conducting sleeve is made over substantially 360° of the sleeve end to provide a continuous EMI-RFI shield. Further, as the clamp is preferably located at the connection point of the grommet and device, contact occurs almost immediately as the cable enters the device, thereby minimizing seepage of EMI-RFI signal to the housing.

The above brief description sets forth rather broadly the more important features of the present disclosure so that the detailed description that follows may be better understood, and so that the present contributions to the art may be better appreciated. There are, of course, additional features of the disclosure that will be described hereinafter which will form the subject matter of the claims appended hereto. In this respect, before explaining the several embodiments of the disclosure in detail, it is to be understood that the disclosure is not limited in its application to the details of the construction and the arrangements set forth in the following description or illustrated in the drawings. The present invention is capable of other embodiments and of being practiced and carried out in various ways, as will be appreciated by those skilled in the art. Also, it is to be understood that the phraseology and terminology employed herein are for description and not limitation.

The objects of the invention have been well satisfied. These advantages and others will become more fully apparent from the following detailed description when read in conjunction with the accompanying drawings.

Brief Description of the Drawings

Fig. 1 is a plan view of a preferred retractable cable assembly of the invention.

Fig. 2 is a cutaway view of an embodiment of the cable of the invention.

Fig. 3 is a transverse cross sectional view of the cable of the invention taken along line 3-3 of Fig. 2.

Fig. 4 is a longitudinal cross sectional view of an embodiment of the grommet assembly of the invention.

Fig. 5A to Fig. 5G are illustrations of the method steps for making the grommet assembly of the invention.

Fig. 6 is a cross sectional view of the grommet and cable attachment assembly of the invention.

Fig. 7 is a longitudinal cross sectional view of a preferred multi-cable connector of the invention.

Detailed Description

Turning now to the drawings, Fig. 1 is a plan view of the signal cable assembly 300 of the invention for connecting a source (not shown) to a remote, movable device such as a handheld controller (shown in dashed line). The signal cable assembly comprises a jack 200 for connection to the source, plural cables 206,207 extending from the jack, a cord reel 302, retractable cord 1, grommet 50, and terminal 150. Retractable cord reel 302 is generally known in the art and is described, for example, in U.S. Patent No. 5,094,396 to Burke, herein incorporated by reference. Cord reel 302 has a cable storage chamber, with cable 1 retractably stored therein. Cable 206 is fixed to reel 302 and is electrically connected to cable 1 as more fully described in the referenced Burke patent. Cable 207 may be connected to another device (not shown) such as a kill switch.

Figs. 2 and 3 illustrate the cable of the invention. For clarity of illustration, the thickness of each layer has been exaggerated in Fig. 3. Cable 1 generally comprises a plurality of individual conductors 2, two conducting shield layers 4 surrounding conductors 2, inner jacket 6 over shield layers 4, fabric braid layer 8 over inner jacket 6, and outer pressure extruded jacket layer 10 over fabric braid layer 8. Conductors 2 each have individual insulation layers insulating them from each other and from conducting shield layers 4. Two shield layers are shown, but those skilled in the art will appreciate that one or more than two layers may be used.

Inner tube jacket 6 is impermeable to moisture, and preferably comprises a thin, flexible elastomer layer. It does not adhere to the shielding layers 4, thereby allowing for movement of shield layers 4 and conductors 2. Fabric braid layer 8 will bear the majority of mechanical load placed on cable 1. Pressure extruded jacket layer 10 flows through fabric braid layer 8 and adheres to inner tube jacket 6, thereby laminating layers 6, 8, and 10 together. A single, thin, fabric reinforced covering is thus effectively formed. The fabric reinforced cover allows for movement of the inner conductors and shield, thereby freeing them from carrying mechanical load and also retaining cable flexibility.

The laminated cable jacket provides significantly greater strength than an elastomer cover of the same thickness because of the presence of the fabric layer. For purposes of reference, it has been found that a preferable combined thickness range for a four conductor signal cable connected to a handpiece is in the range of 0.014 to 0.018 inches, thereby resulting in a thin, flexible and durable cable.

Fabric braid layer 8 may be comprised of any suitable fibrous material, including nylon, polyester, or Kevlar, with polyester preferred. Use of nylon requires an additional drying step as nylon absorbs water; if it is not dried prior to placement on the cable absorbed water will evaporate upon application of the extruded outer layer with resulting bubbling in the layer. While Kevlar does not absorb water, it is typically more expensive than polyester.

As the degree of fabric braid layer 8 coverage over the cable increases, strength of the braid likewise increases. Void space is also advantageous, however, for the outer pressure extruded jacket 10 to effectively flow through braid 8 and adhere to the inner jacket 4. It has been found that preferred braid layer 8 coverage of between about 30% to 75% is effective, with 40% to 50% preferred.

Fig. 4 is a cross sectional view of the grommet 50. Cable 1 is comprised of individual conductors 2 surrounded by a conducting shield layer 4, preferably comprising a metal braid or foil, and outer jacket 56. Outer jacket 56 may comprise a single layer, or may preferably comprise a plurality of layers, including an inner jacket, a fabric braid layer, and an outer extruded jacket (elements 6, 8, and 10, respectively, as shown in Figs. 2 and 3) laminated together as described above to form jacket 56. Likewise, shield layer 4 may comprise a single layer as shown in Fig. 4, or may comprise multiple layers as shown in Figs. 2 and 3. Referring again to Fig. 4, cable 1 has a distal end 58, which will be inserted in a device housing for electrical connection to the device. Outer jacket 56 is stripped away from a portion of the distal end 58, exposing shield layer 4. Exposed shield layer 4 is then pulled back and folded back over the end of outer jacket 56. An insulating tube 60 is slid over the exposed conductors at the distal end of the cable. Tube 60 is optional. Depending on the application, one may use a relatively long length of tube (6 cm), a short length (2.5 cm) or no tube 60.

A supplemental shielding layer 62, preferably copper metal braid, surrounds the folded over portion of shield layer 4 and extends over a portion of tube 60. A conducting sleeve 64, preferably comprised of metal, surrounds copper braid 62. Copper braid shield 62 insures good conductive contact between sleeve 64 and shield layer 4, while also preventing a binding mechanical linkage between the two. As sleeve 64, braid 62, and shield 4 are not mechanically attached to one another, shield layer 4 has sufficient freedom of movement so as to avoid carrying tensile load.

An insulating elastomer grommet 68 is molded over sleeve 64 and cable 1. Grommet 68 has a distal end 70, which terminates along sleeve 64 leaving exposed the distal end of the sleeve. Sleeve 64 carries a radially projecting annular flange 72 for good mechanical connection to grommet 68. Accordingly, grommet 68 is mechanically anchored to sleeve 64. However, because of the unique configuration of sleeve 64 and underlying shield layer 4, mechanical loads applied to grommet 68 will not be transferred to shield layer 4. This significantly reduces fatigue related cable failure in this traditionally high failure area.

Grommet 68 has a proximal end 74, as shown in Fig. 5G, which extends proximally beyond sleeve 64 and is molded to cable outer jacket 56. Grommet 68 tapers towards end 74 so as to provide a flexible support for cable 1 in this high flex and high fatigue region adjacent the device. During the molding process, grommet 68 is fused to the outer jacket 56. Load is thereby transferred between cable outer jacket 56 and grommet 68. As the inner conductors 2 may shift within jacket 56, the conductors and shield layer 4 do not carry load. Fusing of grommet 68 to outer jacket 56 around the entire circumference also provides for effective distribution of stress.

The method for making the grommet assembly generally comprises the steps illustrated in Figs. 5A-5G. As shown in Fig. 5A, outer jacket 56 of the cable is stripped away from cable end portion 102 exposing conducting shield layer 4. Outer jacket 56 may comprise a single layer, or may comprise a plurality of layers, including, for example, an inner jacket, a fabric braid layer, and an outer jacket (elements 6, 8, 10, respectively, of Fig. 2 and 3). Fig. 5B illustrates the next step of pulling back shield layer 4 from cable end portion 102, thereby exposing cable inner conductors 2. In Fig. 5C, pulled back shield layer 4 is folded over on top of outer jacket 56, and an optional length of supplemental insulator layer 60 is installed over exposed conductors 2. Preferred supplemental insulator layer 60 is shrink elastomer.

Fig. 5D illustrates installation of a length of second shield layer 62 over folded back shield layer 4. Shield layer 62 is preferably copper metal braid. Copper braid 62 may also extend over a portion of installed shrink 60. Desirably, the distal end 63 of the layer 62 is twisted to form a pigtail 63. Conducting sleeve 64 is then slid over copper braid conducting layer 62 as illustrated in Fig. 5E, until it completely covers copper braid 62, as shown in Fig. 5F. Sleeve 64 is preferably comprised of metal, and is held over copper braid 62 by a frictional fit that allows for some movement of shield layer 4 and inner conductors 2 relative to sleeve 64, but that insures good conductive contact. A short length of shrink tube 65 may be installed over the proximal end of sleeve 64, which prevents elastomeric material from penetrating under sleeve 64 in the grommet molding step.

Fig. 5G illustrates the final cable and grommet assembly. Elastomer grommet 68 is molded over sleeve 64 and cable outer jacket 56. Sleeve 64 has a distal end 66 that extends distally beyond grommet end 70 and is thereby exposed and useful as a contact point for providing a continuous shield with the cable underlying shield layer 4. Sleeve 64 has annular flange 72 for enhanced mechanical linkage to grommet 68.

The proximal end 74 of the grommet extends proximally well beyond sleeve 64 so that a substantial bond is made with cable outer jacket 56. During the molding process, grommet surface 76 is fused to outer jacket surface 56. The fused attachment between grommet 68 and outer jacket 56 results in a strong bond that transfers load between the whole circumference of jacket 56 and grommet 68 over a substantial length of jacket 56. Inner conductors 2 are thereby isolated from carrying mechanical loads. As a device to which the cable is connected may be twisted or pulled, grommet 68 will transfer load to outer jacket 56. The presence of copper braid 62 helps to partially isolate cable inner conductors from bearing associated mechanical loads. Thus inner conductors 2 are allowed to shift in relation to outer jacket 56 under cable twisting or pulling circumstances, with grommet 68 and jacket 56 absorbing such loads.

The grommet assembly of the invention is adapted to be received in a terminal carried by the device housing. Fig. 6 is a cross section of a terminal 150. Terminal assembly 150 generally comprises movable contact means, which are preferably two cooperating clamp halves 151. Each clamp half 151 has a first surface 152 for contacting the exposed sleeve end 66 of the grommet assembly, and a second surface 158 for mechanically engaging a recessed annular ring 160 in the grommet.

Clamp halves 151 are brought together with any conventional means, including, for example, screws. As clamp first surface 152 is in electrical contact with shielding carried by housing 156, such as a conductive coating. Thereby a continuous shield is thereby formed between grommet sleeve 64 and the shield layer for device 156. The large area of the outside of clamp halves 151 in contact with a conductive coating on the interior walls of housing 156 insures good contact. Also, as clamp half first surfaces 152 are substantially semi-circular, they make contact with sleeve end 66 over its entire circumference, providing for effective EMI-RFI shielding. Further, as this contact occurs close to the point of introduction of the cable to the device housing, opportunity for EMI-RFI interference to seep into the device housing is minimized.

Preferred clamp halves 151 further comprise second surfaces 158 for mechanically engaging grommet recessed annular ring 160. Because grommet 68 is comprised of a flexible elastomer, the mechanical engagement between semi-circular second surfaces 158 and recessed ring 160 around substantially 360° of the ring is firm and provides high strain relief. Rings 78 provide resistance to fluid penetration.

Fig. 7 is a cross sectional view of a preferred multi-cable connector assembly 200 of the invention. Connector 202 has two passages 204 for receiving two separate cables 206 and 207. Cables 206 and 207 each have a plurality of individual conductors 208, which carry an outer insulation layer. Conductors 208 are conductively connected to connector 202 through connector block 212 (shown in partial cross section in Fig. 7). Conductor insulation is stripped away from the end of conductor 208, leaving inner conductor 214. Inner conductor 214 then conductively contacts pin 216.

Cables 206 and 207 comprise elastomer jacket 217 surrounding conductors 208. Elastomer jacket 217 is overlaid with metallic braid sheath layer 218 for shielding of cable 206 and 207. Shield 218 is preferably continuous between cables 206 and 207 with a linkage at 220. Shield 218 is also in contact with connector back shell 222 by contact with back shell 222 as it passes through passages 204. Continuity between shield 218 on cables 206 and 207 advantageously provides for common shielding between cables 206 and 207.

Cables 206 and 207 further have outermost elastomeric cover layer 224 overlaying metal braid layer 218. Elastomer outer jacket 224 covers cables 206 and 207 only on the portions extending outside of back shell 222. Outer jacket 224 provides a moisture tight barrier, and also provides an added resiliency to reduce conductor 208 bending fatigue. Preferred outer jacket 224 comprises shrink tubing. Additional elastomeric cover layers may be provided.

It is also noted that elastomer jacket 217 surrounding conductors 208 and underneath shield 218 preferably comprises two elastomer layers. Two layers enhance the compressibility of the jacket, so that good electrical contact between the overlying shield 218 and back shell 222 can be made as the shell compresses the cable through passages 204. Elastomer jacket 217 has been illustrated for convenience as comprising a single layer in Fig. 7, but is preferably two elastomer layers. Preferred elastomer jackets 217 comprise shrink tubing. Although good electrical contact between the back shell 222 and shield 218 is made by compression, the shield may be soldered to back shell 222 for positive conductive connection.

Connector housing 222 is also preferably wrapped with elastomeric cover layer 226, preferably comprising shrink tubing. Use of such shrink tubing may leave a gap between layer 226 and cables 206 and 207, and between cables 206 and 207 themselves. This gap is preferably filled with epoxy 228. Epoxy layer 228 provides for moisture and electrical insulation, and further provides added bending support for cables 206 and 207 at the otherwise high fatigue location where cables 206 and 207 enter connector housing 222.

The advantages of the disclosed invention are thus attained in an economical, practical, and facile manner. While preferred embodiments and example configurations have been shown and described, it is to be understood that various further modifications and additional configurations will be apparent to those skilled in the art. It is intended that the specific embodiments and configurations herein disclosed are illustrative of the preferred and best modes for practicing the invention, and should not be interpreted as limitations on the scope of the invention as defined by the appended claims.

What is claimed is:

1. A cable, comprising:
   a) a conductor;
   b) an inner elastomeric jacket over said conductor, said conductor being shiftable within said inner jacket;
   c) an open fabric braid layer over said inner jacket; and
   d) an outer elastomeric layer over said fabric braid, said outer layer adhered to said inner jacket.

2. A cable as in claim 1, wherein said conductor comprises plural insulated conductors.

3. A cable as in claim 1, wherein said outer layer comprises a pressure extruded elastomer passing through said open braid and adhered to said inner jacket.

4. A cable as in claim 1, wherein said fabric braid provides between 30% and 75% coverage over said inner tube jacket.

5. A cable as in claim 1, wherein said fabric braid comprises between about 40% to 50% coverage over said inner tube jacket.

6. A cable as in claim 1, further comprising a grommet on an end of said cable, said grommet attached to said cable outer elastomeric layer.

7. A cable as in claim 1, further comprising a conducting shield layer over said conductor and within said inner jacket.

8. A cable as in claim 7, further comprising a conducting sleeve over an end of said cable, said sleeve being in electrical contact with said shield layer, and an

elastomeric grommet partly over said outer elastomeric layer and partly over said sleeve, a distal end of said sleeve being exposed from said grommet.

9. A cable as in claim 8, wherein said sleeve is not mechanically anchored to said shield layer, thereby allowing for relative movement between said sleeve and shield layer.

10. A cable as in claim 8, further comprising a supplemental conductive layer between said shield layer and said sleeve.

11. A grommet assembly, comprising:

a) a cable having at least one conductor, a conducting shield layer surrounding said conductor, and an outer jacket surrounding said shield layer;

b) a conducting sleeve over an end of said cable and conductively connected to said shield; and

d) an elastomeric grommet partly over said outer jacket and partly over said conducting sleeve, a distal end of said sleeve being exposed from said grommet.

12. A grommet assembly as in claim 11, further comprising a supplemental conducting layer within said conducting sleeve and over said shield layer, said supplement layer not being anchored to either said sleeve or said shield, thereby allowing movement between said sleeve and shield while maintaining electrical contact.

13. A grommet assembly as in claim 11, wherein said conducting sleeve has an annular flange, said grommet molded over said flange.

14. A method of making a grommet assembly, comprising the steps of:

a) providing a cable having an end portion and at least one conductor, a shield layer surrounding said conductor, and an outer jacket surrounding the shield layer;
b) stripping the outer jacket from the cable end portion thereby exposing the shield layer;
c) sliding a conducting sleeve over the cable end portion, and making electrical connection between the conducting sleeve and the shield layer; and
d) molding an elastomeric grommet partly over the conducting sleeve and partly over the outer jacket, while leaving a distal end of the sleeve exposed from the grommet.

15. A method as in claim 14, further comprising after the stripping step, pulling back the shield layer from the cable end portion and folding the shield layer over the outer jacket.

16. A method as in claim 14, further comprising the step of covering the exposed end portion of the conductor with an insulating cover.

17. A method as in claim 14, wherein the conducting sleeve has an annular flange, the molding step includes molding the elastomeric grommet over the flange.

18. A method as in claim 14, further comprising the step of covering the exposed shield layer with a supplemental shield and sliding the sleeve over the supplemental shield layer.

19. A connector for connecting a plurality of the cables, comprising:
a) a back shell having a plurality of passages;
b) a plurality of the cables, each of said plurality of cables passing through a respective one of said plurality of passages in said back shell; and
c) each of said cables carrying an outer shielding layer, said shielding layer connected to said back shell at said passages.

20. A connector for connecting a plurality of cables as in claim 8, wherein said cables comprise an elastomeric layer under said shielding layer and said back shell is compressed onto said shielding layer compressing said elastomeric layer.

FIG. 1

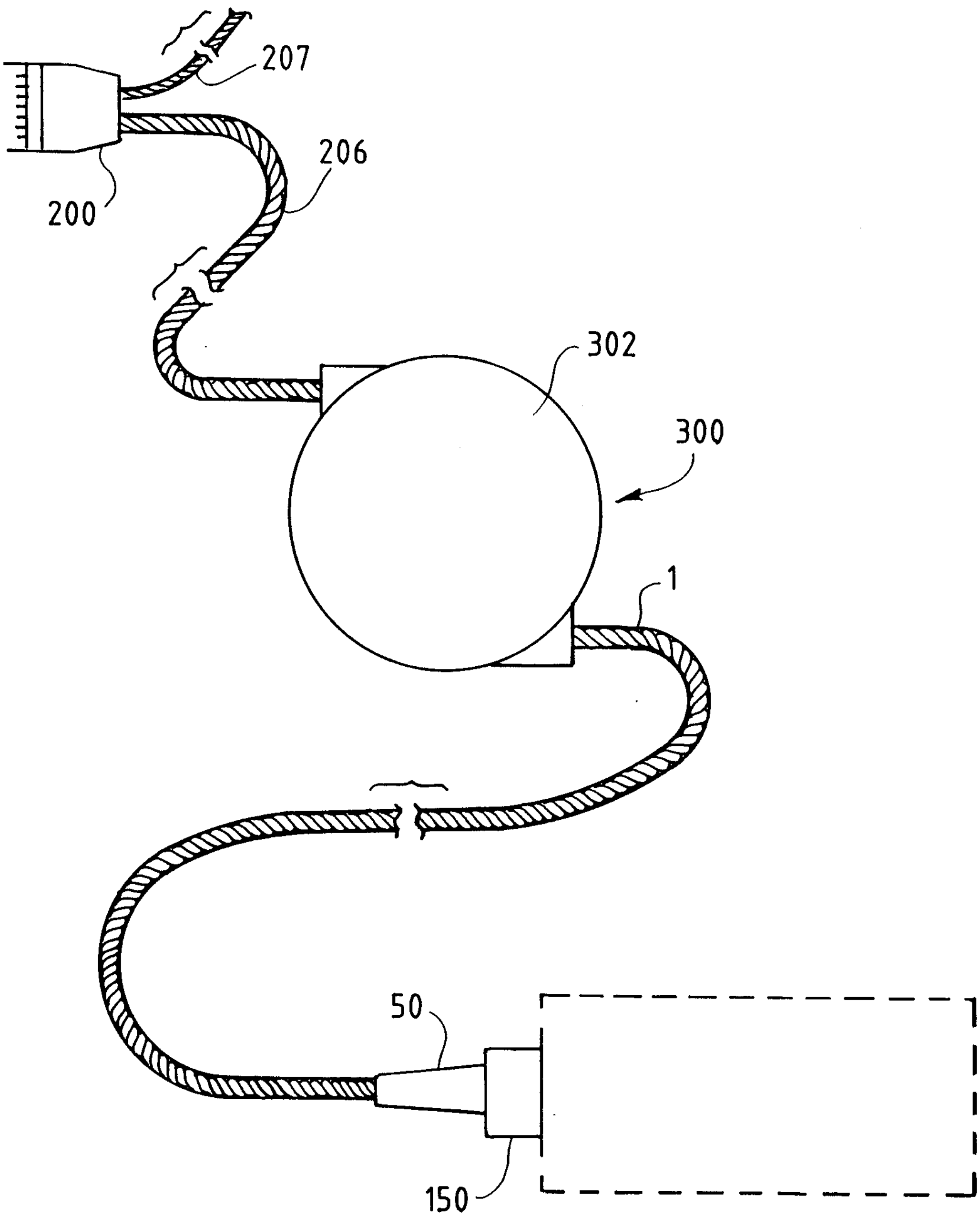

FIG. 2

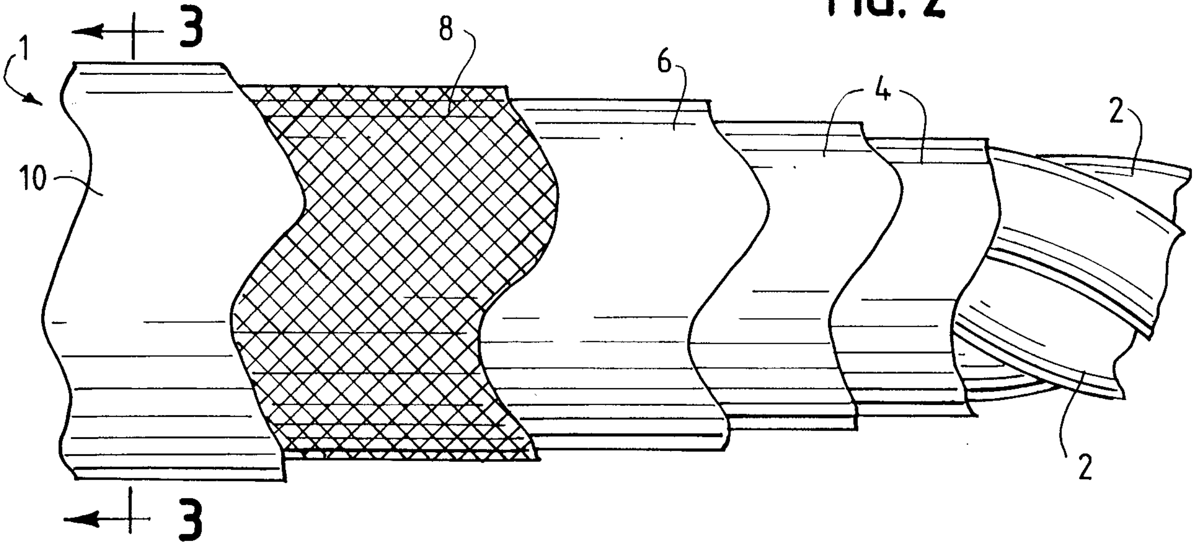

FIG. 3

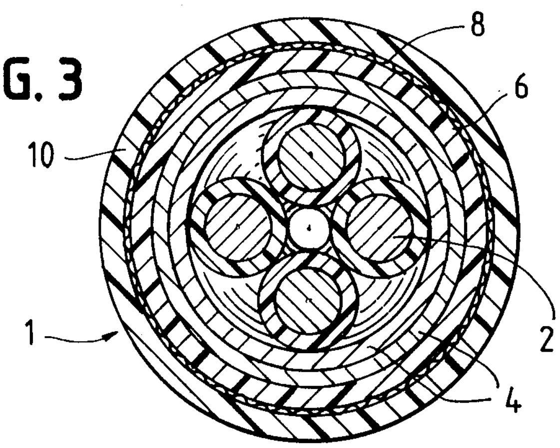

FIG. 4

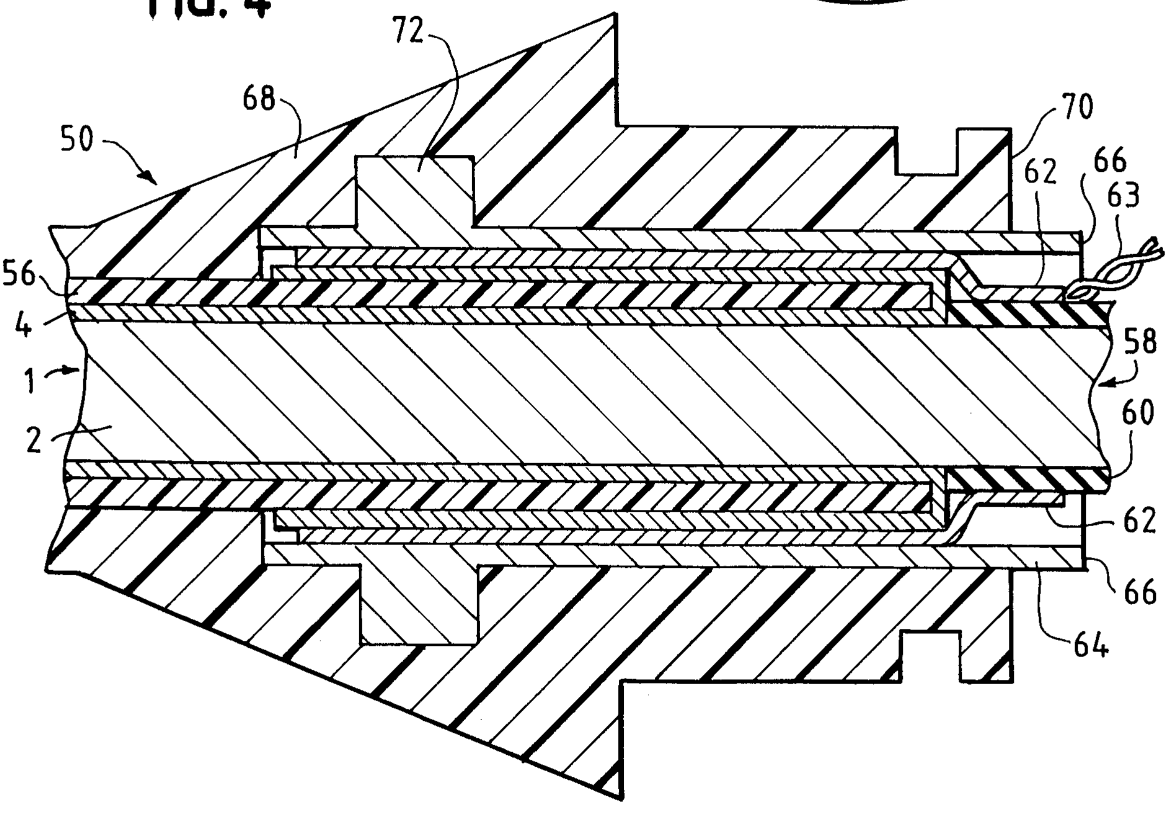

FIG. 5A

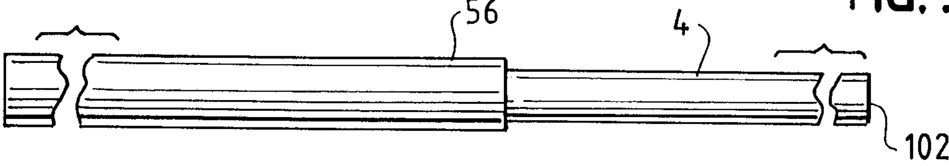

FIG. 5B

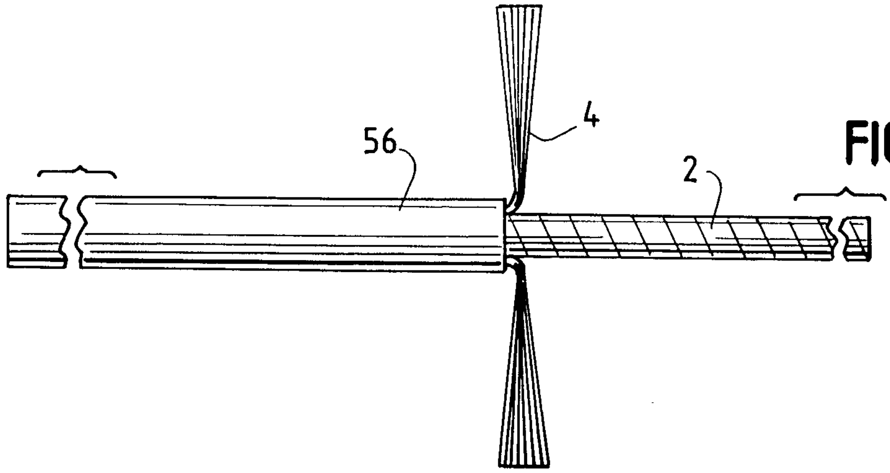

FIG. 5C

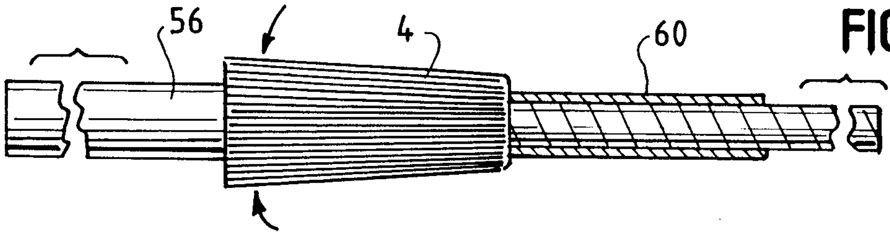

FIG. 5D

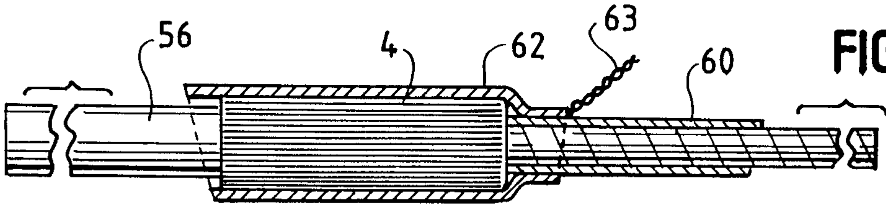

FIG. 5E

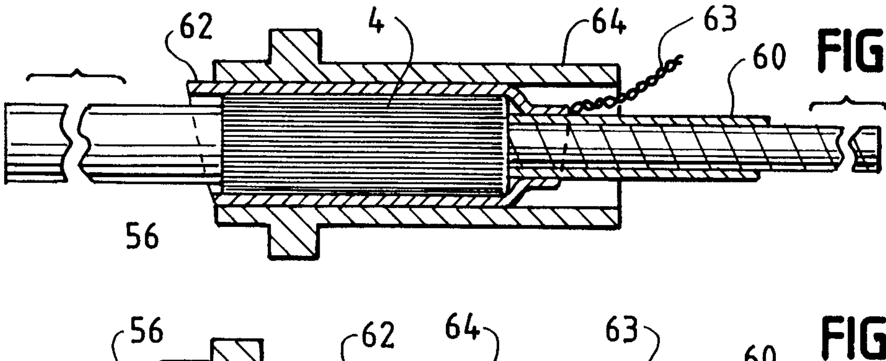

FIG. 5F

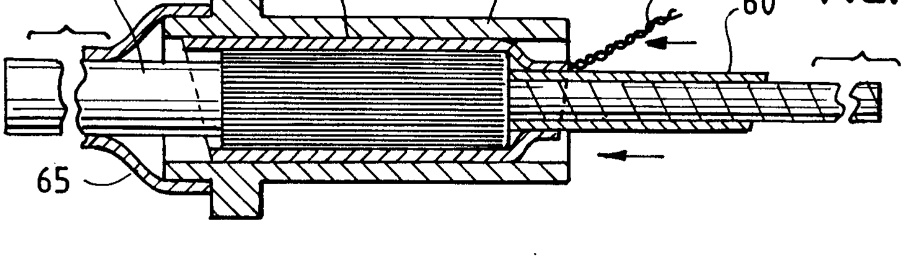

FIG. 5G

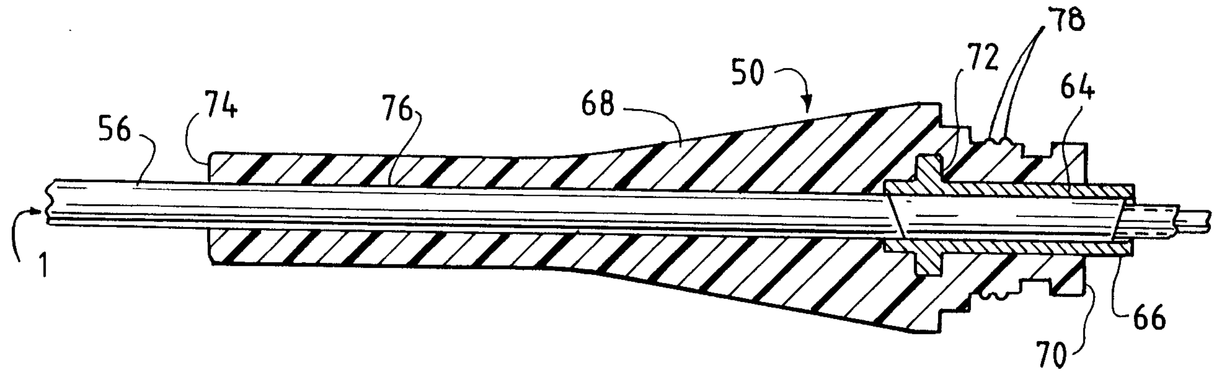
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FIG. 6

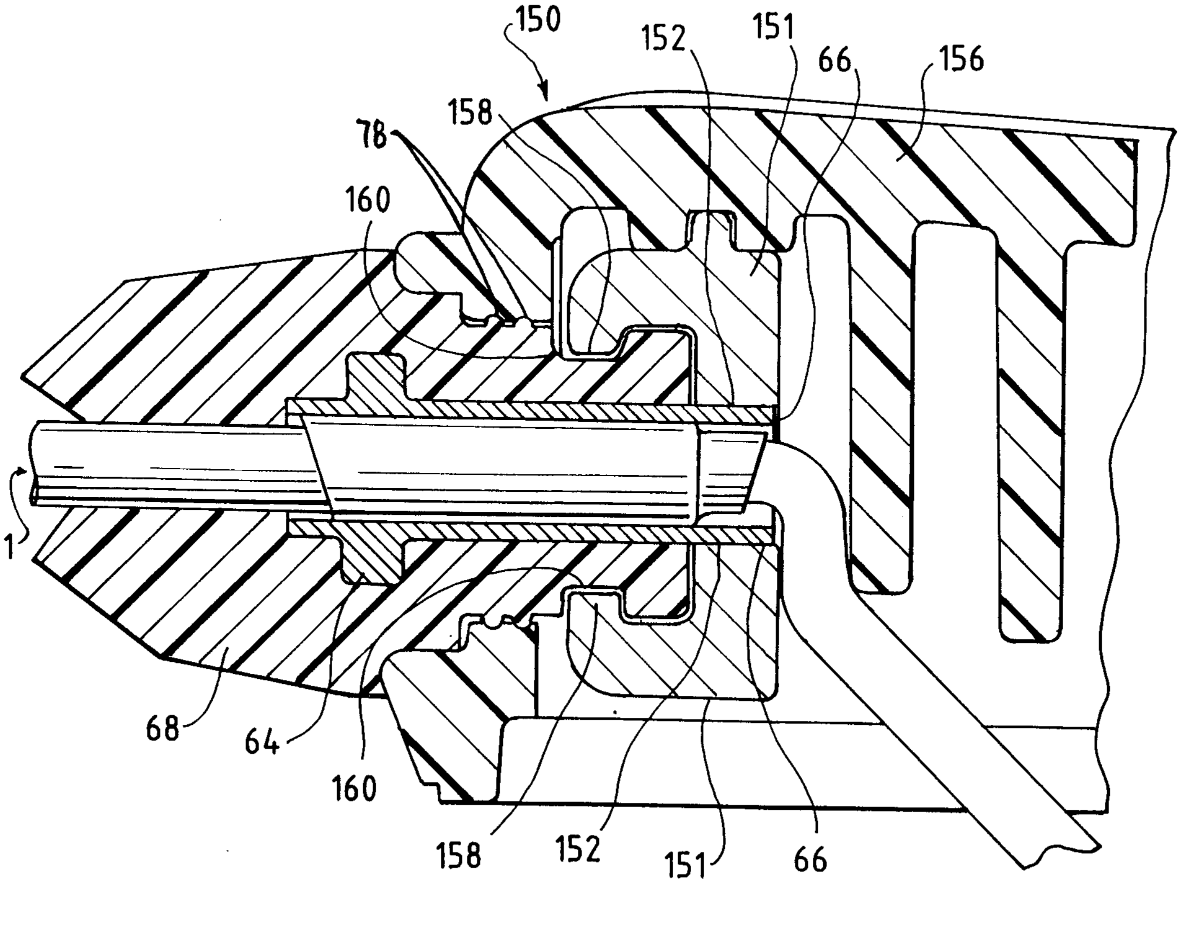
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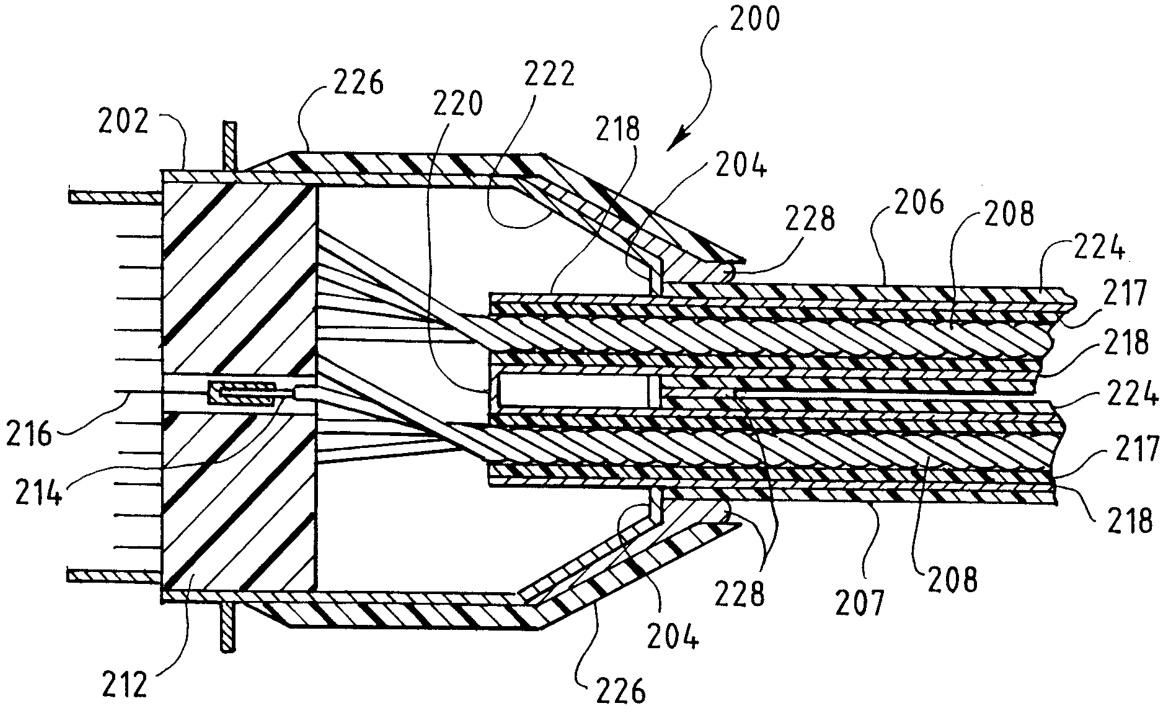
FIG. 7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