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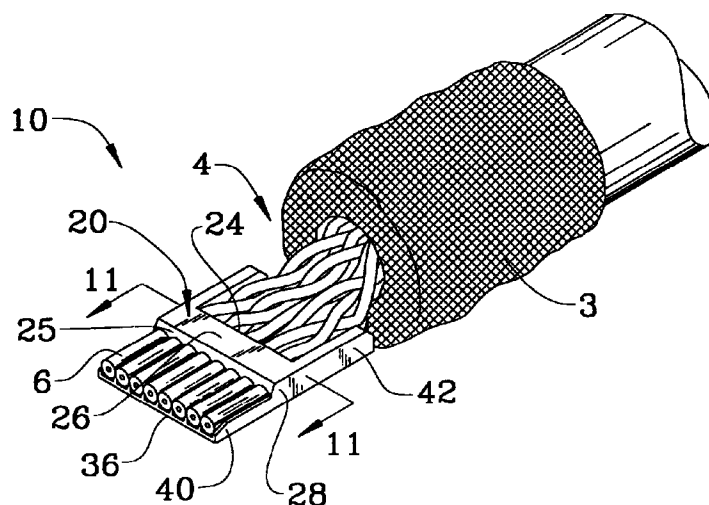
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(54) **Modular plug for high speed data transmission**

(57) Shielded modular plug (15) for category 5 applications comprises a plug housing (13) and a wire holder (10). The wire holder comprises a housing (20) with wire receiving cavities (22) extending therethrough, and a base wall extension (35) extending from the housing to a front end (36). The wire holder is assembled to the cable by inserting straightened wire ends into the cavities (22) of the holder and pulling the holder tightly against the twisted pairs of the cable. The wire ends (6) can then be trimmed with the front end (36) acting as the reference. The wire holder and cable ends are then inserted into the cavity (48) of the plug housing until a fully

inserted position where the plug contacts (18) are positioned above the wire ends (6), and can be depressed for piercing through the insulation to contact the inner conductors. Due to tightening of the wire holder against the twisted pairs, the length of straightened cable is as short as possible thereby reducing crosstalk interference and enabling higher data transmission speeds. Furthermore, tightening of the wire holder against the twisted pairs ensures that connections are made in a reliable manner with less sensitivity to variations in the assembly procedure.

FIG. 9



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Description

This invention relates to a modular plug cable assembly with reduced sensitivity to electromagnetic noise, such as crosstalk between adjacent lines, in particular for use with high speed data transmission for example in local area networks (LAN).

It is quite common to use shielded modular plugs for the transmission of data in local area networks. The shielding of these plugs reduces the transmission of noise and sensitivity to external noise, thereby allowing a higher data transmission speed than conventional non-shielded modular plugs (as used in telephone lines). The modular plug is compact and of relatively low cost in comparison to many other data connectors for transmission of high speed data, and it is therefore advantageous to use modular plugs in replacement of such connectors. Due to the ever increasing data transmission speeds, and the close spacing of juxtaposed conductors positioned in the modular plug, excessive crosstalk limits the data transmission speed capability of existing modular plugs.

The cables connected to modular plugs comprise twisted pairs of insulated conductors surrounded by a conductive shielding layer which is surrounded by insulation of the cable. The twisting of pairs of conductors reduces significantly their sensitivity to crosstalk and enables transmission of high speed data. The outer shielding reduces transmission and reception of electromagnetic noise. One of the problems is that assembly of twisted pairs cable to a modular plug means straightening end portions of the conductors which are then inserted into receiving cavities of the modular plug housing and terminated to insulation piercing contacts. Some modular plugs have a plastic wire holder having cavities therethrough for positioning the wire ends therein and subsequently, trimming the wire ends and inserting the wire holder into the modular plug. The adaptor makes it easier to arrange the wires in the correct order and ensures that when inserted into the modular plug for connection to the contacts, the correct order is maintained. Referring to Figures 1-7, the assembly of this Prior Art solution to a shielded twisted pairs cable is shown, and will be briefly described herebelow.

In Figure 1, a shielded twisted pairs cable 1 is shown with a strain relief rubber boot 2 mounted thereon which is for attachment to a modular plug 15' to protect the cable from overbending. First, a certain length of outer insulation of the cable is removed as shown in Figure 2, and outer conductive shielding 3 is then pulled over the cable to reveal the inner twisted pairs 4 of insulated conductor wires 6 as shown in Figure 3. A certain length of the wire 6 is then straightened and arranged in their final juxtaposed order as shown in Figure 3. A shielding cover 8 is then mounted over the cable with a rear end positioned over the shielding 3 as shown in Figure 5.

An adaptor 10' has conductor receiving cavities 12' within which the cable ends 6 are inserted as shown in Figure 5. A front face 14' of the adaptor 10' can be used

as a reference surface for trimming the wire ends such that they are all at the same length. The modular plug can then be inserted over the adaptor and pushed over the wires such that the adaptor is pushed away from the wire ends which are inserted into wire receiving cavities 16' of the modular plug 15' until the wire ends abut the end wall 17' as shown in Figure 6. Insulation piercing contacts are then pressed such that they pierce through the insulation to contact the conducting strands of the wires. The wire ends must be very close or abut the end wall 17' in order to ensure that all of the wire ends are pierced by the contacts 18 as shown in Figure 7 which shows a fully assembled shielded modular plug.

The wire ends 6 have to be straightened (untwisted) to allow for the rearward sliding movement of the adaptor with respect to the cable, where a certain amount of extra slack is required in order to ensure that none of the conducting wires, for example due to the twist, are drawn backwards during insertion into the modular plug cavities 16 which could lead to non-connection with one of the contacts 18.

One of the problems with this modular plug is that the required length of straightened cable ends 6 limits the data transmission rate below a certain standardised value (category 5) desired in many LAN applications.

It would therefore be desirable to maintain the pairs of cables twisted and have the shortest possible straightened ends to minimize crosstalk.

It is therefore an object of this invention to provide a modular plug cable assembly for connection to twisted pairs cable that has reduced crosstalk.

It is a further object of this invention to provide a cost-effective and reliable connector assembly for connection to a twisted pairs cable for higher speed data transmission.

It is further object of this invention to provide a modular plug cable assembly for category 5 applications.

The objects of this invention have been achieved by providing an assembly comprising a modular plug having a separate wire holder having cavities extending therethrough for arranging and holding wires of twisted pairs cable in a predetermined order, the adaptor mountable within a receiving cavity of a housing of the modular plug for connection to contacts of the modular plug, wherein the wire holder has an extension extending from the wire receiving cavities to a position proximate ends of the wires, the length of wire between the ends of the wire and a forward end of the cavities forming a zone of contact where the plug contacts are connected to the wires, and wherein a rear face of the cavity housing is tightly abutable against the twist of the cable wire pairs.

The preferred embodiment of this invention will now be described in detail with reference to the figures, whereby;

Figure 8 is a cross-sectional view of a modular plug according to this invention for connection to a shielded twisted pairs cable;

Figure 9 is an isometric view of an assembly having the cable mounted to a wire holder of the modular plug;

Figure 10a is a cross-sectional view through the modular plug (without wire) in the wire receiving position;

Figure 10b is the same cross-section as Figure 10a but with the contact in the final connected position;

Figure 11 is a cross-sectional view through lines 11-11 of Figure 9 with the wires removed;

Figures 12a and 12b are other embodiments of the wire holder mountable to the modular plug of Figure 8;

Figure 13 is an isometric view of another embodiment of a wire holder mountable to a modular plug; Figure 14 is a top view of the wire holder of Figure 13 mounted in a modular plug housing partially shown in cross-section; and

Figure 15 is another embodiment of a modular plug with the wire holder of Figures 13 and 14, this embodiment shown in cross-section.

Referring to Figure 8, a modular plug 15 for connection to twisted pairs 4 of a twisted pair cable 1 comprising outer shielding 3, comprises a housing 13, insulation piercing contacts 18, wire holder 10 and conductive shielding 8 for connection to the shielding 3 of the cable. Outer dimensions of the modular plug 15 are similar to the prior art modular plug 15' for interconnection to standardized modular jacks. Mounting of the shielding 8 to the cable and to the housing 13, as well as mounting and design of the rubber boot 2 are similar to that of the prior art as shown in Figures 1-7. Construction of the contacts 18, and their assembly and piercing of the wire conductors 4 is similar to that described in the prior art. The modular plug is a relatively widely used conventional product and the prior art aspects as mentioned above will not be described in any great detail hereafter.

The invention principally relates to the wire holder and its cooperation with the housing 13 and twisted pairs cable 4, these aspects being discussed herebelow.

Referring to Figures 9-11, an embodiment of the wire holder 10 according to this invention is shown. The wire holder 10 comprises a wire receiving housing 20 having cavities 22 extending therethrough from a wire receiving end 24 to a contact end 25, the housing 20 comprising a top wall 26, side walls 28, and a base wall 30. Adjacent cavities 22 are interconnected, whereby wall portion 32,34 protruding towards each other from the top and base walls 26,30 respectively are separated by a gap. The wall protrusions 32,34 define the wire receiving cavities 22 for positioning and holding the wires in juxtaposed alignment for connection to insulation piercing contacts 18.

The base wall 30 has a forward extension 35 which extends from the contact end 25 of the housing 20 to a trimming end 36, the base wall having a further rearward extension 37 extending from the wire receiving end 24 of the housing 20 rearwardly to a cable end 38. There

are also side wall extensions 40 extending from the contact end 25 of the side walls 28 up to the trimming end 36. There are further side wall extensions 42 extending from the wire receiving end 24 of the side walls 28 rearwardly towards the cable end 38. The front base wall extension 35 comprises wall protrusions 44 that are extensions of the base wall protrusions 34 for defining wire receiving grooves 46.

The wire holder 10 is insertable into a wire holder receiving cavity 48 of the modular plug housing 13 whereby the base forward extension 35 is positionable below insulation piercing tips 50 of the contacts 18. In the fully inserted position as shown in Figures 10a and 10b, the top wall 26 of the housing 20 is positioned below a strain relief member 52 of the housing 13. The wire holder receiving cavity 48 extends from an open receiving end 49 to a closed front end 51 proximate the contacts 18. The contacts 18 are positioned in contact receiving cavities 53 that intersect the cavity 48 for insertion of the contacts 18 into the wire holder receiving cavity 48 proximate the front end 51.

Assembly of the modular plug 15 to the cable 1 will now be described with reference to Figures 1-4, 9, 10a and 10b. Firstly, the cable is prepared as previously described with reference to Figures 1-4, except for the procedure of straightening the twisted pairs wires extending from the end of the cable outer insulation. In the embodiment of this invention, the twisted pairs extending from the end of the cable insulation are maintained with a few twists and their ends straightened thereafter. The length of twisted wires extending from the cable end to the straightened and rearranged wire ends 6 should be slightly greater than the rear base wall extension 38 of the wire holder 10. The straightened wire ends 6 are then inserted into the corresponding cavities 22 of the wire holder, where the wire ends are sufficiently long to project beyond the front end 36 such that they can be grasped and the wire holder pulled towards the cable until all slack in the straightened cable ends is taken up and the rear end 24 of the wire holder housing 20 abuts the twisted pairs. Further pulling of the straightened cable ends through the cavities 22 tightens the twist of the twisted pairs extending from the cable outer insulation end against the holder housing rear end 24 formed by the top wall 26, side walls 28 and base wall 30.

The portions of the wire ends extending beyond the front end 36 can then be trimmed, the front end 36 of the base wall extension 35 serving as a reference for trimming the wire ends. The wire holder 10 and wire end 6 can thus be inserted into the cavity 48 of the modular plug until full insertion where the contact insulation piercing tips 50 are positioned above the wire ends 6 that extend between the housing contact end 25 and the base wall extension front end 36. The contacts 18 can then be depressed as shown in 10b into the cavity 48 such that they pierce through the insulation of the conducting wire 6 and make contact with the inner conducting strands (as shown in Figure 8).

The strain relief member 52 is then depressed against the top wall 26 of the wire holder, which is sufficiently flexible to clamp down on the wires in the cavities 22, thus gripping both the wire holder and wires in the housing 13.

Due to the tightening of the wire holder against the twisted pairs 4, the straightened portion of wire ends 6 are of a minimum length thereby leading to reduced crosstalk in comparison to the prior art. Furthermore, due to the trimming of the wire ends in their final position with respect to the wire holder, and non-movement of the wire holder with respect to the wire ends 6 when inserting into the plug housing 13, there is no risk of a wire being pushed or buckled backwards during insertion into the plug housing cavity 48, thereby ensuring that all wires will be reliably and correctly connected to their corresponding contacts 18. A further advantage is that once the wire holder is assembled to the wire ends 6, the wire ends 6 are in their final position and their disposition can be clearly visibly checked prior to insertion into the plug housing cavity 48, whereby the order cannot be changed due to the positioning of the wire ends into the cavities 22 and grooves 46 with no further movement being made during insertion and connection to the wires. Active tightening of the wire holder against the twists of the twisted pairs ensures that the straightened length of the wire ends is substantially the same and always a minimum, thus ensuring a reliable connection with small tolerances and improved data transmission speed capability.

Referring to Figures 12a and 12b, further variants of wire holders are shown where wire holders 110 and 210 have fewer wire receiving cavities for applications where less conductors are required. In the prior art, applications with less wires are often connected to the modular plug by moulding a plug housing with different wire receiving cavities. This however requires producing different moulding dies for different plug housings, which is more costly than moulding different wire holders. Furthermore, the wire holders make it very easy to see the order and position of the wire ends, whereby in the plug housing some confusion may arise due to difficulty of seeing the arrangement of the wire receiving cavities. Due to handling of only one type of plug housing, handling and transportation costs are also reduced with no risk of confusing the plug housings. In Figure 12a, the wire holder is for arranging wire pairs on outer lateral positions, whereby the central cavities are not provided. The rear end 124 of the housing 120 comprises tapered lead-in surfaces 125 for assisting guidance of the wires 6 into their respective cavities. In Figure 12b, wire pairs are arranged centrally, and the rear end 224 of the housing 220 is provided with tapered lead-in surfaces 225 to assist guidance of the wire into their respective cavities.

Referring to Figures 13-14, another embodiment of a modular plug according to this invention is shown. Most of the features of this embodiment are similar to those described for the embodiment of Figures 8-12, and these features will not be redescribed. Similar features will be denoted with the same numbering as that used for the

previously described embodiment. The features of this embodiment that differ from the previous will now be described.

In Figure 13 a wire holder 310 comprises a latching protrusion 54 positioned on the top wall 26, the protrusion being substantially centrally placed between the side walls 28 and having an inclined upper surface 56 extending rearwardly from proximate the contact end 25 of the wire receiving housing 20. In Figure 15, the modular plug 115 is shown comprising a cavity 58 extending through the strain relief member 52 of the housing 13, the cavity 58 forming a shoulder 60 for engagement with the latching protrusion 56 of the wire holder 310.

Referring to Figures 13 and 14, the wire holder 310 further comprises centering chamfers 62 at the trimming end 36 of the side walls 28 that cooperate with corresponding oblique surfaces 64 of the modular plug housing 13, the surfaces 62,64 abutting each other once the wire holder 310 has been fully inserted into the cavity 48 of the modular plug housing 13. Upon full insertion, the latch 56 engages with the housing shoulder 60 for retention of the wire holder therein.

The wire holder 310 further comprises arcuate protrusions 66 extending from the side walls 28 and positioned proximate a wire receiving end 24 of the wire receiving housing 20, these protrusions 66 extending further outwardly than the width of the wire holder receiving cavity 48 of the housing 13 such that there is an interference fit between the side wall protrusions 66 and side walls 68 of the cavity 48. The side walls 28 have a certain resiliency thus allowing elastic inward biasing of the protrusion 66 when the wire holder 310 is inserted into the modular plug housing cavity 48. Due to the positioning of the protrusion 66 proximate a wire receiving end of the wire holder 310, the trimming end 36 is able to pivot slightly, whereby the cooperation of the side wall tapered centering surfaces 62 and the oblique housing side wall surfaces 64 provide a means of centering the wire receiving grooves 36 accurately with respect to the modular plug housing, and therefore with respect to the contacts 18. Furthermore, cooperation of the latch protrusion 56 of the wire holder with the corresponding housing latching means 58 ensures that the wire holder is fully inserted into the modular plug housing 13 and securely held in that position prior to, and during connection of the contacts 18 to the wires. The inherent elasticity of the wire holder top wall 26 allows resilient biasing of the latch protrusion 56 for insertion into the wire holder receiving cavity 48.

Accurate positioning, and full insertion of the wire ends for connection to the contacts 18 is thus ensured, thereby enabling provision of the shortest possible straightened lengths of wire ends 6, and a reliable connection thereto.

Advantageously therefore, the invention provides a more reliable connection to twisted pairs cable, with higher data transmission speed capability.

Claims

1. An assembly comprising a modular plug (15,115) and a cable (1) having pairs of twisted wires (4) for connection thereto, the plug (15) comprising a housing (13), contacts (18) for connection to wire ends (6) of the wires (4), and a wire holder (10,110,210,310) receivable in a cavity (48) of the housing (13), the wire holder (10,110,210,310) comprising a housing (20,120,220) having a base wall (30), top wall (26), side walls (28) and wire receiving cavities (22) extending therethrough from a wire receiving face 24 to a contact end face 25, characterized in that the wire holder (10,110,210,310) comprises a base extension (35) positionable below the contacts (18) within the housing cavity (48), for positioning straightened wire ends (6) of the cable extending along the base extension (35) below the contacts (18) for connection thereto, wherein the pairs of twisted wires are in a twisted pair configuration up to the wire receiving face (24) of the holder. 5 10 15 20
2. The assembly of claim 1 characterized in that the base extension (35) extends from the base wall (30) and comprises grooves (40) for positioning the wire ends (6) thereon. 25
3. The assembly of claim 1 or 2 characterized in that the base extension (35) has a forward trimming end (36) that serves as a reference for trimming the wire ends (6) such that they are all positionable proximate a forward end face (51) of the plug housing cavity (48) 30
4. The assembly of any preceding claim characterized in that the wire holder (10,110,210,310) comprises a rearward base extension (37) extending from the holder housing (20,120,220) in an opposing direction to the forward extension (35). 35 40
5. The assembly of any preceding claim characterized in that the wire holder (110,210) has less wire receiving cavities than the number of contacts (18) of the plug, the wire holder comprising tapered lead-in surfaces (25,225) for guiding the wire ends (6) into their respective cavities. 45
6. The assembly of any preceding claim characterized in that the wire holder base extension (35) has wire receiving grooves (46) extending therealong for seating the wire ends (6) therein to laterally position and hold the wire ends (6). 50
7. The assembly of any preceding claim characterized in that the wire holder (310) has centering surfaces (62,66) cooperable with complementary centering surfaces of the plug housing (13), for accurate lateral positioning of the base extension (35) with respect to the housing (13). 55
8. The assembly of claim 7 characterized in that the centering surfaces comprise tapered surfaces (64) on the side walls (28) proximate the forward trimming end (36), cooperable with complementary oblique surfaces (64) in side walls (68) of a wire holder receiving cavity (48) of the plug housing (13).
9. The assembly of claim 7 or 8 characterized in that the centering surfaces comprise protrusions (66) extending outwards from the wire holder side walls (28), positioned proximate a wire receiving end thereof, and cooperable in an interference fit with side walls (68) of a wire holder receiving cavity (48) of the plug housing (13).
10. The assembly of any preceding claim characterized in that the wire holder (310) comprises a latch (56) engageable with a corresponding latch member (60) of the plug housing (13) when the wire holder is fully inserted into a wire holder receiving cavity (48) of the plug housing.
11. The assembly of claim 10 characterized in that the latch (56) is positioned on the wire holder top wall (26) which has a certain resiliency to allow resilient biasing of the latch (56).
12. A method of connecting a cable (1) with twisted wire pairs (4) to a modular plug (15), the method characterized by the steps of: providing a wire holder (10,110,210) having a housing (20,120,220) with cavities (22) extending therethrough; inserting straightened wire ends (6) of the cable (1) through the wire holder cavities (22) and pulling the wire holder against a twisted section of the twisted wire pairs (4); subsequently trimming the wire ends (6); inserting the wire holder with the wire ends thereon into a cavity (48) of a housing (13) of the modular plug (15) and making electrical connection between the wire ends (6) and plug contacts (18).
13. The method of claim 12 characterized in that the wire holder (10,110,210) comprises a base extension (35) positionable below the contacts (18) within the housing cavity (48), for positioning the straightened wire ends (6) extending along the base extension below the contacts (18).
14. The method of claim 13 characterized in that the base extension (35) extends from the base wall (30) and comprises grooves (40) for positioning the wire ends (6) thereon.
15. The method of claim 13 or 14 characterized in that the base extension (35) has a forward trimming end (36) that serves as a reference for trimming the wire ends (6) such that they are all positionable proximate a forward end face (51) of the plug housing cavity (48)

FIG. 1

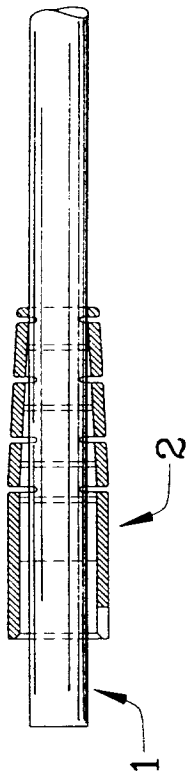


FIG. 2

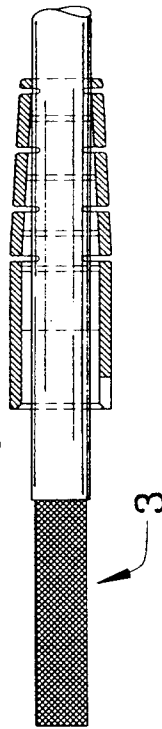


FIG. 3

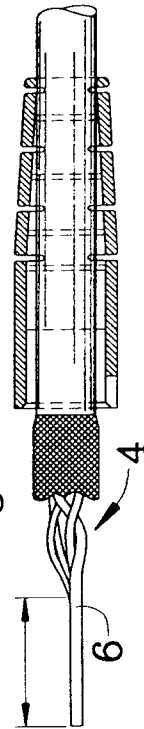


FIG. 4

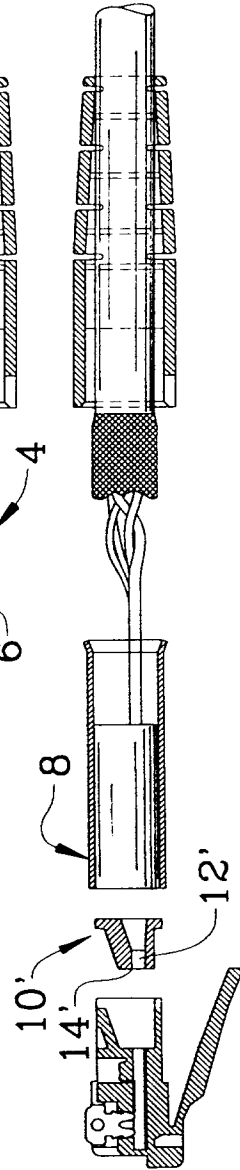


FIG. 5

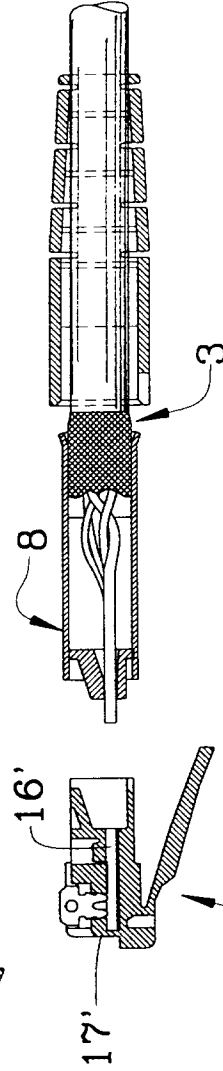


FIG. 6

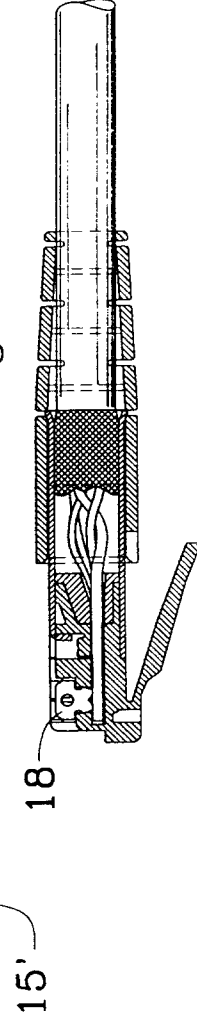


FIG. 7

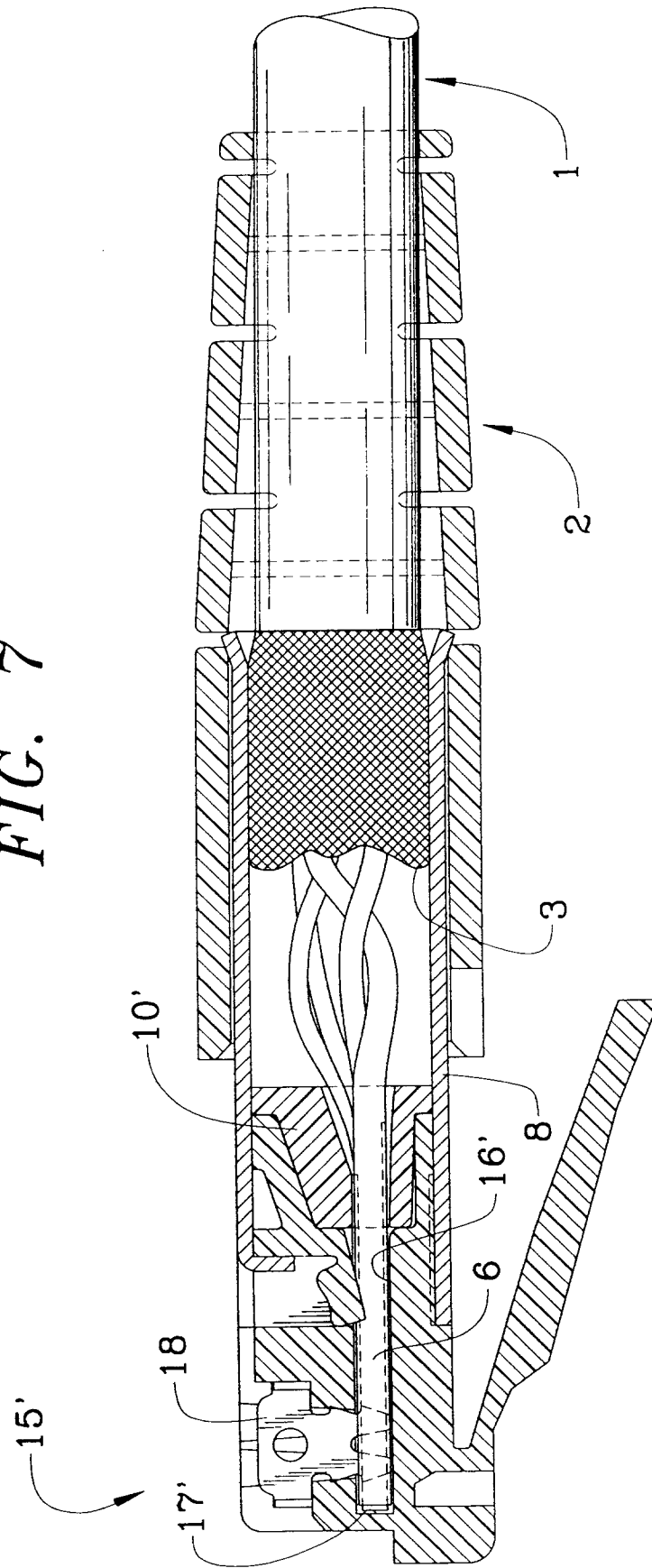


FIG. 8

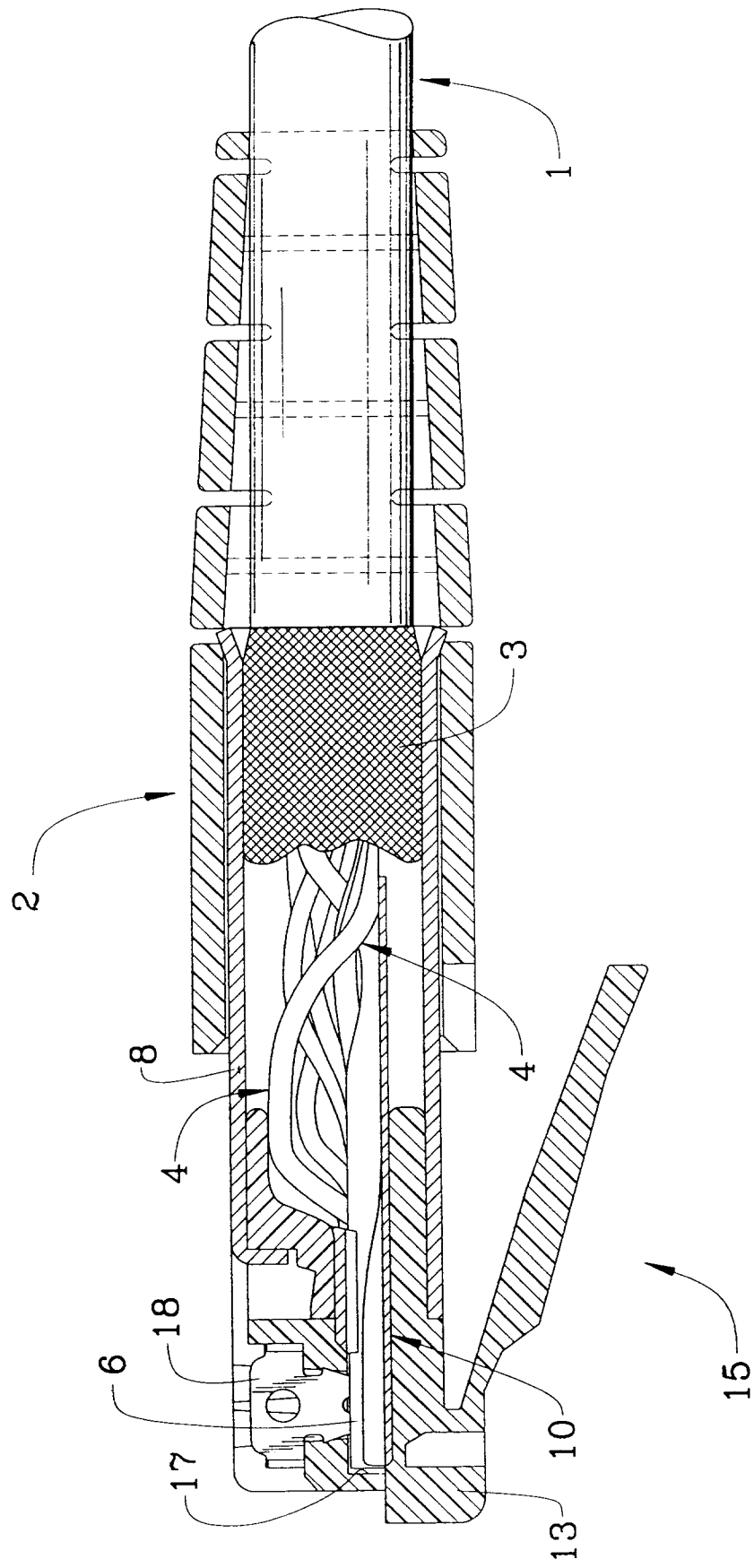


FIG. 9

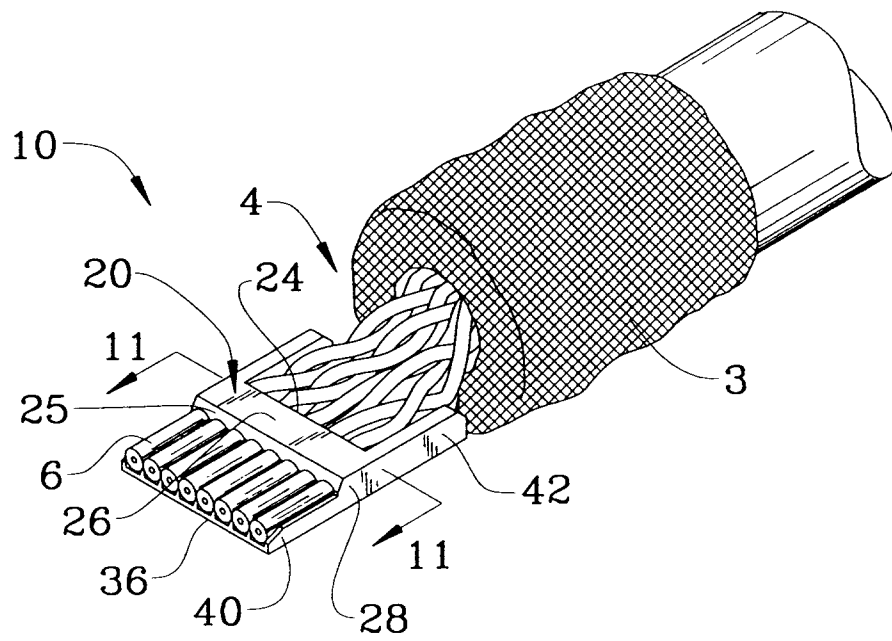


FIG. 15

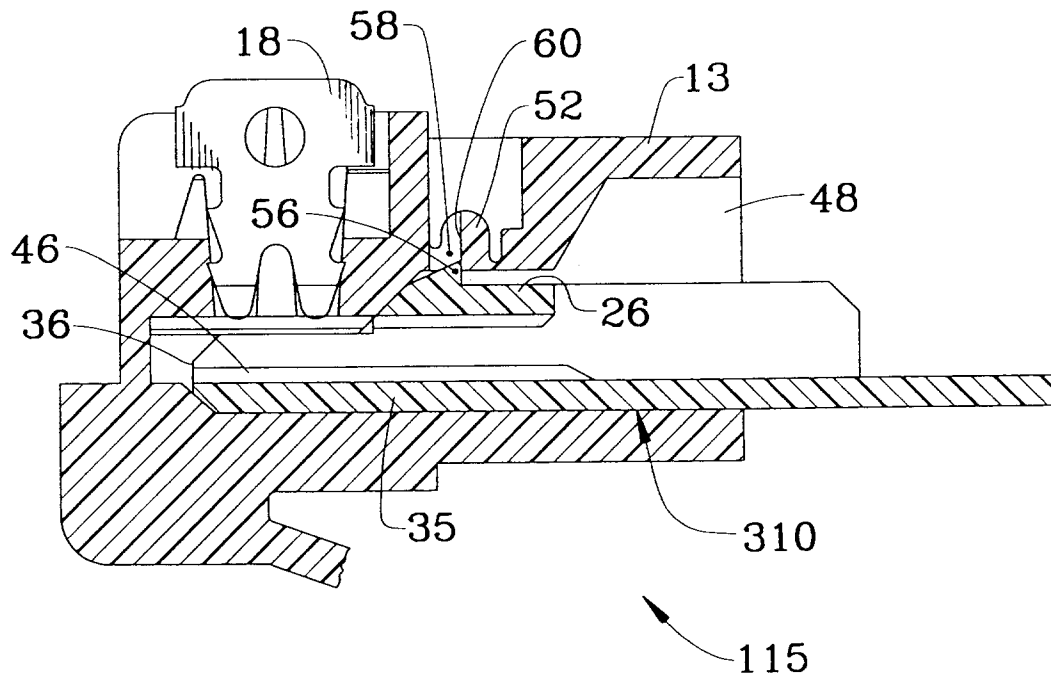


FIG. 10A

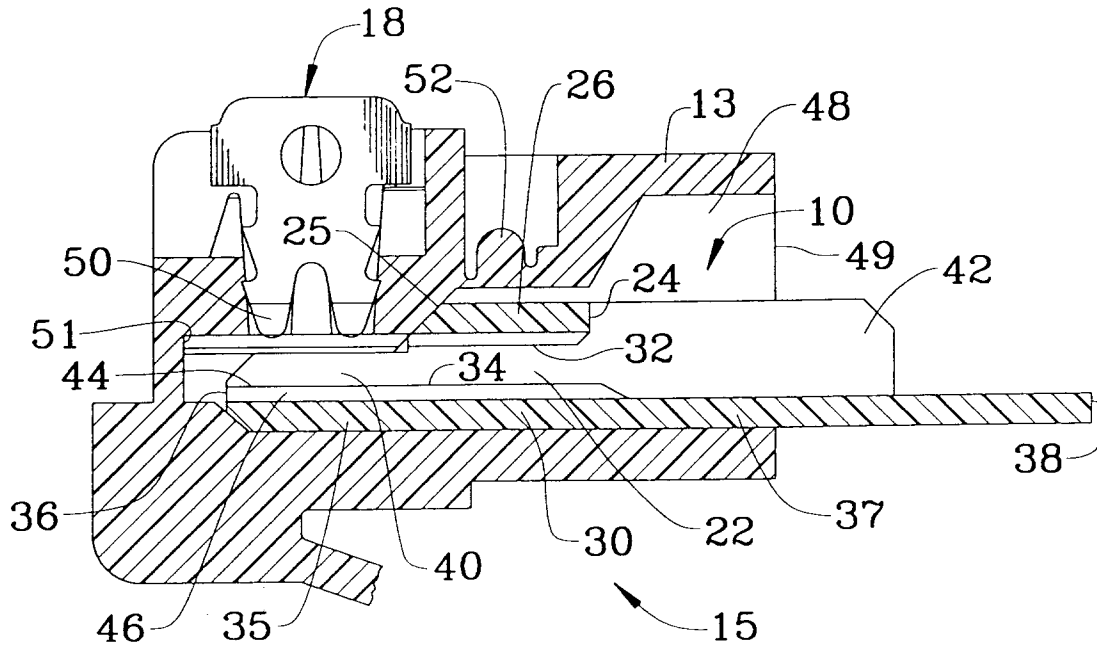


FIG. 10B

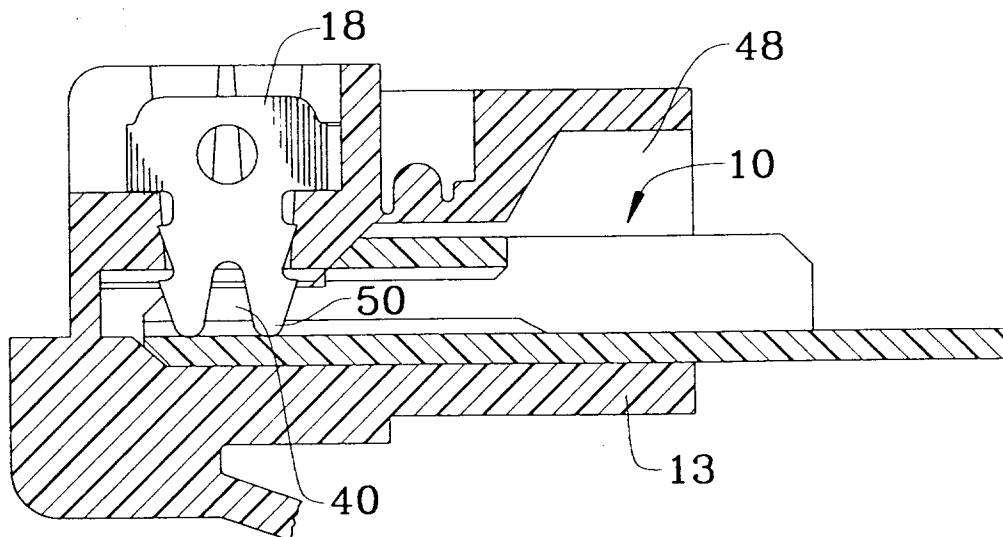


FIG. 11

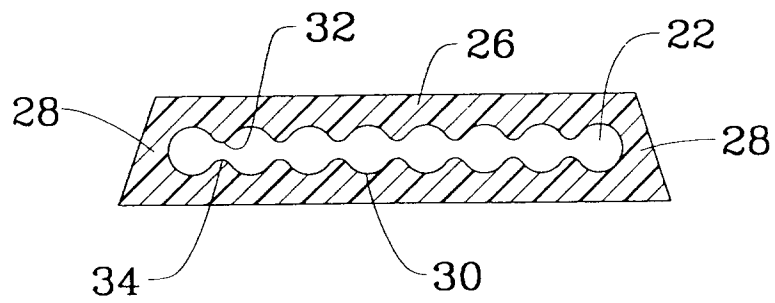


FIG. 12A

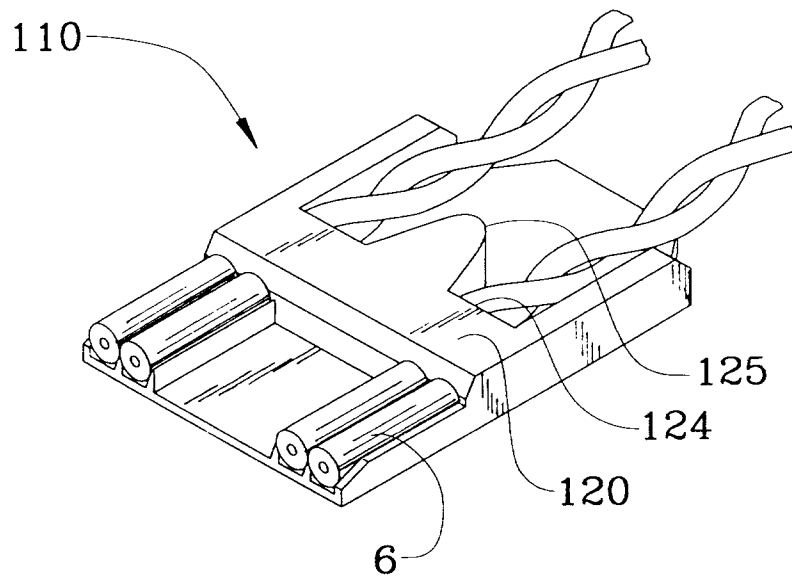


FIG. 12B

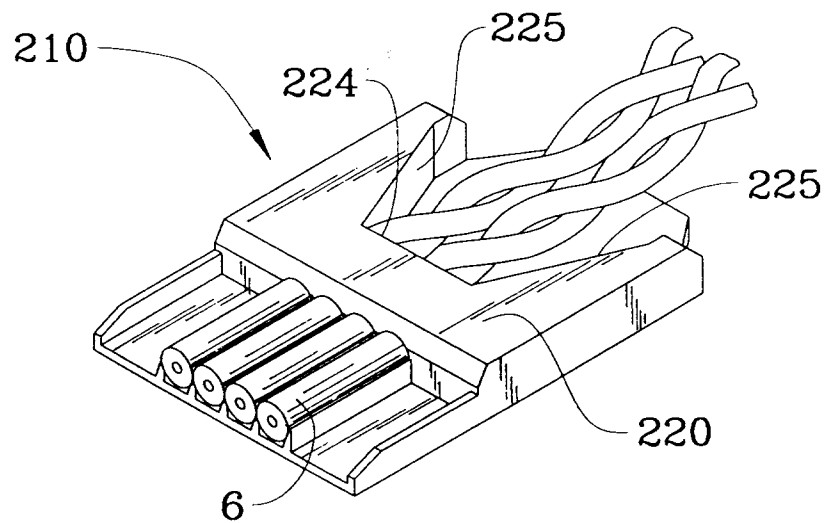


FIG. 13

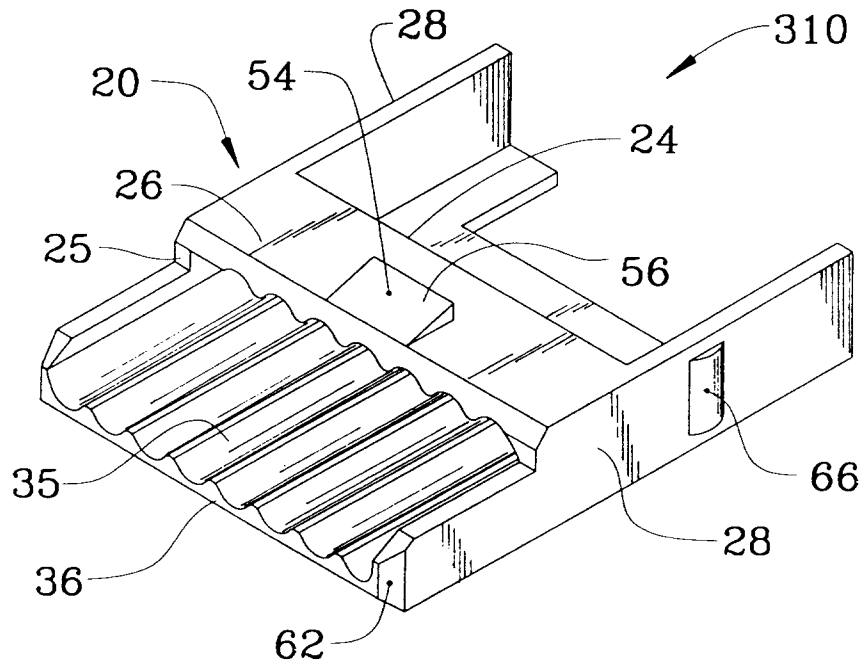


FIG. 14

