AU9352076

(12) PATENT ABRIDGMENT (11) Document No. AU-B-52076/93
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 654242

(54) Title
SEALED CABLE ASSEMBLY

International Patent Classification(s)
(51)[5] H01R 004/60 H01R 004/72 H01R 013/52

(21) Application No. : 52076/93 (22) Application Date : 30.11.93

(30) Priority Data

(31) Number (32) Date (33) Country
990478 14.12.92 US UNITED STATES OF AMERICA

(43) Publication Date : 30.06.94

(44) Publication Date of Accepted Application : 27.10.94

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(56) Prior Art Documents
US 3963295
US 4906202
US 4009924

(57) Claim

1. A sealed ignition cable assembly including a terminal including a cable attachment end attached to an end of an ignition cable, a cable seal and a tower seal for enclosing the terminal, the cable seal insulating a portion of the terminal, the tower seal including an elastomeric boot radially spaced from a contact of the terminal for engaging sealingly an insulation tower of a mating terminal, and a heat shrunk sleeve forming at least part of the cable seal and sealing in an air-tight manner the end of the cable and the cable attachment end of the terminal.

9. A method of making a sealed ignition cable assembly including the steps of providing a subassembly including an ignition cable and a terminal including a contact end and an attachment end attached to an end of the ignition cable, inserting the subassembly in an oversize heat shrinkable sleeve of electrically insulative material so that the end of the cable and the attachment end of the terminal are inside the sleeve, heat shrinking the sleeve so that it embraces the cable and forms at

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least part of a cable seal for sealing in an air-tight manner the end of the cable and the attachment end of the terminal, and attaching an elastomeric boot so as to surround the contact portion of the terminal in a radially spaced relationship for sealing engagement with a periphery of an insulating tower of a mating terminal.

AUSTRALIA

Patents Act

654242

COMPLETE SPECIFICATION
(ORIGINAL)

Class Int. Class

Application Number:
Lodged:

Complete Specification Lodged:
Accepted:
Published:

Priority

Related Art:

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Invention Title:

**SEALED CABLE ASSEMBLY**

Our Ref : 350021
POF Code: 1221/1695

**The following statement is a full description of this invention, including the best method of performing it known to applicant(s):**

# SEALED IGNITION CABLE ASSEMBLY

This invention relates to a sealed ignition cable assembly and to a method of making such an assembly.

One known method of extending the dielectric capability of an ignition cable assembly involves the use of a close fitting insulation sleeve. The sleeve is manufactured as a separate part of rigid, dielectric insulator material such as polyester, and inserted into the elastomeric boot. When inserted, this sleeve insulates a substantial portion of the terminal inside the elastomeric boot so that the dielectric arc over distance to ground is significantly increased when the ignition cable terminal is connected to a coil, distributor or spark plug, particularly when the mating terminal is located in a female insulating tower. The resulting increased dielectric capability increases long term reliability.

While this method does improve reliability, nevertheless, it has several drawbacks. The manufacture of a separate insert sleeve adds cost and complexity to the manufacturing process. Moreover, automated assembly is limited to straight cable assemblies having straight terminals and a straight cable dress. Furthermore, interior space limitations of the elastomeric boot require tight manufacturing tolerances for the plastic sleeve, which are difficult to maintain.

The present invention seeks to provide an improved sealed ignition cable assembly and method of making such as assembly.

According to an aspect of the present invention there is provided a sealed ignition cable assembly including a terminal including a cable attachment end attached to an end of an ignition cable, a cable seal and a tower seal for enclosing the terminal, the cable seal insulating a portion of the terminal, the tower seal including an elastomeric boot radially spaced from a contact of the terminal for engaging sealingly an insulation tower of a mating terminal, and a heat shrunk sleeve forming at least part of the cable seal and sealing in an air-tight manner the end of the cable and the cable attachment end of the terminal.

According to another aspect of the present invention, there is provided a method of making a sealed ignition cable assembly including the steps of providing a subassembly including an ignition cable and a terminal including a contact end and an attachment end attached to an end of the ignition cable, inserting the subassembly in an oversize heat shrinkable sleeve of electrically insulative material so that the end of the cable and the attachment end of the terminal are inside the sleeve, heat shrinking the sleeve so that it embraces the cable and forms at least part of a cable seal for sealing in an air-tight manner the end of the cable and the attachment end of the terminal, and attaching an elastomeric boot so as to surround the contact portion of the terminal in a radially spaced relationship for sealing engagement with a periphery of an insulating tower of a mating terminal.

The invention can provide in preferred embodiments, an ignition cable assembly which has a substantial portion of the terminal insulated by a close fitting sleeve to increase dielectric strength but which does not require insertion of a separate sleeve of precise manufacture into an elastomeric boot or tower seal. It is also possible to provide an ignition cable assembly of high dielectric strength which can be easily manufactured; an ignition cable assembly which is easily manufactured to accommodate an angled terminal; and an ignition cable assembly which is easily manufactured to provide an angled cable dress.

Preferably, the cable assembly has its dielectric strength increased by a close fitting insulation sleeve which does not require tight manufacturing tolerances to fit onto a terminal and/or to fit inside an elastomeric boot.

A heat shrinkable tube is preferably used to provide improved dielectric strength characteristics and/or manufacturing advantages particularly when an angled terminal or cable dress is desired.

An embodiment of the present invention is described below, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal section of a prior art ignition cable assembly connected to a mating terminal located in a female tower;

Figure 2 is a longitudinal section of an embodiment of ignition cable assembly positioned for connection to a mating terminal located in a female tower;

Figure 3 is a partially sectioned longitudinal view of the ignition cable assembly of Figure 2 in the process of being manufactured;

Figure 4 is a longitudinal sectional view of another embodiment of ignition cable assembly;

Figures 5 and 6 are partially sectioned longitudinal views of the ignition cable assembly of Figure 4 during various stages of manufacture;

Figure 7 is a partially sectioned view of another embodiment of ignition cable assembly during its process of manufacture;

Figure 8 is a partially sectioned longitudinal view of the ignition cable assembly of Figure 7 at a later stage of manufacture;

Figure 9 is a partially sectioned view of another embodiment of ignition cable assembly during its process of manufacture; and

Figure 10 is a partially sectioned longitudinal view of the ignition cable assembly of Figure 9 at a later stage of manufacture.

Referring to Figure 1, the prior art ignition cable assembly 10 shown comprises an ignition cable 12 which has a terminal 14 attached to one end thereof. The terminal 14 has a crimp barrel 16 at one end which is attached to the end of the ignition cable 12 and a contact 18 at the other end which is in the form of a two-piece resilient socket of the type generally shown in US-A-4,009,924.

The ignition cable assembly 10 has a close fitting insulation sleeve 20 and a flexible elastomeric boot 22 which provides the primary environmental seal and dielectric insulation for the terminal when it is connected to a mating terminal. The elastomeric boot 22 has a sleeve portion 24 at one end and a larger diameter socket portion 26 at the other end. The sleeve portion 24 fits tightly around the ignition cable 12 behind the terminal 14, which is housed in the socket portion 26. The interior of the socket portion 26 has a plurality of axially spaced, resilient sealing ribs 33 and a wedge shaped annular groove at its inner end.

The insulation sleeve 20 is a separate piece made of rigid dielectric material, such as polyester, which is inserted into the open end of the socket portion 26 and locked in place by lock nibs 28 which fit into the wedge shaped groove at the inner end of the socket portion 26. When inserted, the insulation sleeve 20 fits closely around the terminal 14 to insulate a substantial portion of the terminal 14 which is inside the socket portion 26 of the boot 22. In this case the entire crimp barrel 16 and nearly all of the transition between the crimp barrel 16 and the socket contact 18 are insulated by the sleeve 20.

The interior of the insulation sleeve 20 has an annular lock ramp 30 engaged by a latch finger 31, which is part of the socket contact 18, to prevent withdrawal of the terminal 14.

The ignition cable assembly 10 is plugged onto a stud terminal 32 located in the bottom of a female tower 34 of dielectric material. The stud terminal 32 and female tower 34 are representative of those found on ignition system components such as coils, distributors and spark plugs. In any event, when the ignition cable assembly 10 is fully engaged, the female tower 34 is inside the socket portion 26 of the elastomeric boot 22, where the resilient sealing lips 33 inside the socket portion 26 are biased into sealing engagement with the outer periphery of the female tower 34 to provide an environmental seal. In addition, the insulation sleeve 20 fits closely around most of the terminal 14 inside the female tower 34 leaving only the terminal contacts deep inside the female tower 34 exposed. Consequently, the insulation sleeve 20 increases the dielectric arc over distance to ground so as to increase significantly the dielectric capability and long term reliability of this prior art ignition cable assembly 10 as indicated above.

An embodiment of ignition terminal assembly 100 is shown in Figures 2 and 3. The ignition cable assembly 100 comprises an ignition cable 112 having a terminal 114 attached to one end thereof. The terminal 114 has a crimp barrel 116 at one end which is attached to the end of the ignition cable 112 and a contact 118 at the other end which is in the form of a resilient socket. The terminal 114 is an improved simplified design in that latch finger 31 of the prior art design shown in Figure 1 is eliminated.

The ignition cable assembly 100 has a two-piece seal comprising a cable seal 120 and a tower seal 122.

The cable seal 120 is a sleeve of dielectric heat shrinkable material which is heat shrunk onto the crimp barrel 116 at the attachment end of the terminal 114 and the end of the ignition cable 112 with a substantially air tight fit as shown in Figure 2. In practice, the heat shrinkable sleeve 120 is applied as an oversized sleeve having a shape memory of a cylindrical tube smaller in diameter than the crimp barrel 116 of the terminal 114 and ignition cable 112. The terminal 114 and the end of the ignition cable 112 are inserted into this oversize sleeve until the socket contact 118 protrudes out the end, as shown in Figure 3. For example, a suitable proportion might be a sleeve having an inside diameter of about 12.7 mm for a 7.0 mm ignition cable. In any event the oversize sleeve is then heated by convection airflow or other suitable means so that it shrinks to be a tight fit around the end of the ignition cable 112, the terminal crimp barrel 116 and part of the terminal interface between the crimp barrel 116 and the socket contact 118, as shown in Figure 2. The heat shrunk sleeve 120 forms an air tight wrap so that air does not contact the covered surfaces of the terminal 114. The heat shrunk sleeve 120 also preferably covers as much of the terminal interface as practicable.

Suitable heat shrink sleeves of various materials having suitable dielectric insulating properties and thermal operating ranges are commercially available, one such sleeve being heat shrinkable Thermofit CRN tubing marketed by Raychem Corporation of Menlo Park, California. The tubing is described as a semirigid, flame retarded heat shrinkable tubing that is fabricated from radiation crosslinked polyolefin and which has a minimum shrink temperature of 135 degrees Centigrade and continuous operating temperature from -55 degrees Centigrade to 135 degrees Centigrade.

The heat shrunk sleeve 120 improves the dielectric strength of ignition cable assembly in comparison to the prior art ignition terminal assembly discussed above because it excludes air contact with a substantial portion of the terminal 114, thereby eliminating the potential for damaging ionisation of the air around the insulation material of the sleeve. Elimination of this ionised air and the simplified terminal design reduces electrical field stress at the termination and allows for a significant reduction in the wall thickness of the dielectric insulation material in the sleeve 120.

Another benefit is that the application of the heat shrunk sleeve 120 snugly around the end of the ignition cable 112 and terminal crimp barrel 116 provides good strain relief between the terminal 114 and cable 112 which reduces the potential for the terminal being pulled off during servicing.

The heat shrunk sleeve 120 can be flexible, semi-rigid or rigid depending on application requirements. For instance, an ignition cable assembly designed for use with engines having spark plugs disposed in deep wells could have a rigid heat shrunk sleeve of considerable length so that the terminal at the end of the ignition cable assembly can be readily plugged onto the spark plug terminal deep in the engine well.

The tower seal 122 is an elastomeric boot which has a sleeve portion 124 at one end and a larger diameter socket portion 126 at the other end. The sleeve portion 124 fits tightly around the heat shrunk sleeve 120 at the end of the ignition cable 112, as shown in Figure 2. The sleeve portion 124 may overlap the end of the crimp barrel 116 a small amount so long as the female tower 34 fits into the socket portion 126 which houses the terminal 114.

The interior of the socket portion 126 has a plurality of axially spaced, resilient sealing ribs 128 and an annular stop shoulder 130 at its inner end.

The ignition cable assembly 100 is plugged onto the stud terminal 32 located in the bottom of the female tower 34 of dielectric material. As indicated above, the stud terminal 32 and female tower 34 are representative of those found on ignition system components such as coils, distributors and spark plugs. When the ignition cable assembly 100 is fully engaged, the female tower 34 is inside the socket portion 126 of the tower seal 120 where the resilient sealing lips 128 are biased into sealing engagement with the outer periphery of the tower 34 to seal out the environment. Moreover the heat shrunk sleeve 120 which covers the crimp barrel 116 and terminal transition is inside the female tower 34 so that only the terminal contacts 114, 32 deep inside the female tower 34 are exposed. Consequently, the heat shrunk sleeve 120 also increases the dielectric arc over distance to ground significantly to increase the dielectric capability and long term reliability of the ignition cable assembly 100. Moreover it provides this capability without the need for a precisely sized plastics sleeve, which is difficult to insert in the elastomeric tower seal 126 as is the case with the prior art ignition cable assembly 10.

The embodiment of ignition cable assembly 200 shown in Figures 4, 5 and 6 comprises an ignition cable 112, a terminal 114 and a tower seal 122 which are the same as those of the straight ignition cable assembly 100 shown in Figures 2 and 3. The only component which is different is the heat shrunk sleeve 220, which has a shape memory which includes a right angle elbow. Consequently, the sleeve 220 provides a right angle dress for the ignition cable 112 when it is heat shrunk onto the end of the ignition cable 112 and attachment barrel of the terminal 114, as shown in Figure 4.

The manufacture of the ignition cable assembly 200 is basically the same as the manufacture of the ignition cable assembly 100. The ignition cable 112 with the terminal 114 attached to the end of the ignition cable 112 is inserted into an oversize heat shrinkable sleeve 220 until the socket contact 118 of the terminal 114 projects out the end of the oversize sleeve, as shown in Figure 5. The oversize sleeve 220 is then heated until it shrinks onto the end of the ignition cable 112 and the attachment end of the terminal 114 with a tight fit. During the shrinking process, the sleeve 220 also bends the ignition cable 112 at a right angle due to its shape memory, as shown in Figure 6. The right angled subassembly of Figure 6 is then inserted into the tower seal 122 via the sleeve portion 124 to form the ignition cable assembly 200 shown in Figure 4. In this regard it should be noted that the portion of the right angled subassembly which is inserted into the tower seal 122 is linear. This insertion of one straight part into another straight part simplifies the assembly procedure significantly and makes automated assembly possible.

In the ignition cable assembly 200 and method of manufacture described above, the sleeve 220 itself bends the ignition cable 112 as it is heat shrunk. However it is also possible to use a shape memory insert, such as the spring 136 shown in phantom in Figure 4, to bend the ignition cable 112 or to assist the sleeve 220 in bending the ignition cable 112. In this event, a helical spring having a shape memory which includes an elbow portion is incorporated in a generally cylindrical heat shrinkable sleeve so that the ignition cable and terminal can be inserted into it easily before it is heat shrunk. The spring 136 or other suitable insert then takes its shaped memory configuration, as shown in Figure 4, as the sleeve is heated so that the spring or insert 136 bends or assists the sleeve 220 in bending the ignition cable as the sleeve shrinks. One type of insert is a metallic shape memory spring commercially available from Raychem Corporation and made with Tinel which Raychem Corporation describes as a nickel-titanium alloy.

Another embodiment of ignition cable assembly is shown in Figures 7 and 8. In this version the insulation sleeve for the terminal is part of the tower seal while the heat shrinkable sleeve is used primarily for providing a right angle dress for the ignition cable.

More specifically, the ignition cable assembly 300 comprises an ignition cable 112 having a terminal 114 attached to one end in the same manner as the above-described embodiments. In this instance, however, the tower seal 322 has a sleeve portion 324 which extends inside the socket portion 326. The ignition cable 112 and attached terminal 114 are inserted into this sleeve portion 324 in a linear fashion until the socket contact 118 of the terminal is properly positioned, as shown in Figure 7. During the manufacturing process, the ignition cable 112 and attached terminal 114 are disposed inside an enlarged heat shrinkable sleeve 320 (having a shape memory which includes a right angled elbow) so that nearly all the terminal 114 projects out the end of the heat shrinkable sleeve 320, as shown in Figure 7. The ignition cable 112 and attached terminal 114 are preferably inserted partially through the enlarged heat shrinkable sleeve 320 before the tower seal 322 is attached, however this is not necessary. In any event the enlarged heat shrinkable sleeve 320 is heated with the tower seal 322 attached and positioned as shown in Figure 7 so that the sleeve 320 shrinks to a tight fit around the ignition cable 112 and the exterior part of the sleeve portion 324 of the tower seal 322. During the shrinking process, the sleeve 320 bends the ignition cable 112 to provide a right angle dress, as shown in Figure 8. The heat shrunk sleeve 320 also squeezes the exterior part of the sleeve portion 324 to enhance the cable seal which the heat shrunk sleeve 320 in part provides.

The socket portion 326 is shown with a smooth interior but it may include internal seal lips as in the case of the tower seals 122.

Another embodiment of ignition cable assembly is shown in Figures 9 and 10. This version accommodates a right angle terminal for those applications where such a terminal is needed or desired. More specifically, the ignition cable assembly 400 has a right angle terminal 414 having a crimp barrel 416 at one end, a socket contact 418 at the other end and an interface which includes a right angled elbow 417. The terminal 414 is attached to the end of an ignition cable 112 in a conventional manner. This subassembly is then inserted into an oversize heat shrinkable sleeve 420 having a shape memory which includes a right angled elbow portion. The heat shrinkable sleeve 420 is generally cylindrical and large enough so that the subassembly can be inserted partially through the heat shrinkable sleeve 420 terminal end first to the position shown in Figure 9. The sleeve 420 is then heated until it fits tightly around the ignition cable 112, the terminal crimp barrel 416 and the elbow 417, as shown in Figure 10. The heat shrunk sleeve 420 provides a close fitting, air tight insulation sleeve for most of the terminal 414. It can also provide an excellent cable seal as well as an extremely strong strain relief.

The ignition cable assembly 400 is then completed by mounting a sleeve portion 424 of a tower seal 422 onto the straight portion at the end of the heat shrunk sleeve 420, which can also be readily incorporated in an automated procedure.

The embodiments described above all have female terminals with socket contacts plugged onto a male stud terminal. However, they can be readily adapted to apply to ignition cable assemblies having male terminals which plug into female terminals of the ignition system components. Similarly the described embodiments can be adapted for ignition cable assemblies which are plugged onto male towers. Moreover, even though the examples show ignition cable terminal assemblies having a right angled ignition cable dress or a right angled terminal, they may also provide ignition cable assemblies having ignition cables dressed at other angles and terminals which incorporate other angles.

The disclosures in United States patent application no. 990,478, from which this application claims priority, and in the abstract accompanying this application are incorporated herein by reference.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A sealed ignition cable assembly including a terminal including a cable attachment end attached to an end of an ignition cable, a cable seal and a tower seal for enclosing the terminal, the cable seal insulating a portion of the terminal, the tower seal including an elastomeric boot radially spaced from a contact of the terminal for engaging sealingly an insulation tower of a mating terminal, and a heat shrunk sleeve forming at least part of the cable seal and sealing in an air-tight manner the end of the cable and the cable attachment end of the terminal.

2. A sealed ignition cable assembly according to claim 1, wherein the sleeve has a shape memory which is substantially straight and the terminal is substantially straight.

3. A sealed ignition cable assembly according to claim 1, wherein the heat shrunk sleeve has a curved portion which dresses the ignition cable at an angle.

4. A sealed ignition cable assembly according to claim 3, wherein the terminal is substantially straight.

5. A sealed ignition cable assembly according to claim 3, wherein the terminal has an angled portion between the attachment end and the contact end.

6. A sealed ignition cable assembly according to claim 3, 4 or 5, wherein the sleeve has a shape memory which includes a curved portion to dress the ignition cable at an angle when the sleeve is shrunk onto the cable.

7. A sealed ignition cable assembly according to any one of claims 3 to 6, wherein the sleeve includes a spring or insert having a shape

memory which is curved so that the ignition cable is dressed at an angle when the sleeve is shrunk onto the cable.

8. A sealed ignition cable assembly according to any preceding claim, wherein a portion of the heat shrunk sleeve tightly engages an outer surface of the elastomeric boot.

9. A method of making a sealed ignition cable assembly including the steps of providing a subassembly including an ignition cable and a terminal including a contact end and an attachment end attached to an end of the ignition cable, inserting the subassembly in an oversize heat shrinkable sleeve of electrically insulative material so that the end of the cable and the attachment end of the terminal are inside the sleeve, heat shrinking the sleeve so that it embraces the cable and forms at least part of a cable seal for sealing in an air-tight manner the end of the cable and the attachment end of the terminal, and attaching an elastomeric boot so as to surround the contact portion of the terminal in a radially spaced relationship for sealing engagement with a periphery of an insulating tower of a mating terminal.

10. A method according to claim 9, wherein the sleeve is shrunk onto the ignition cable before the elastomeric boot is attached and the elastomeric boot is mounted on the heat shrinkable sleeve.

11. A method according to claim 9, wherein the elastomeric boot is mounted on the ignition cable before the sleeve is shrunk onto the cable, the shrunk sleeve fitting tightly around an outer portion of the elastomeric boot.

12. A method according to claim 9, wherein the sleeve is shrunk so as to embrace the end of the

ignition cable and the attachment end of the terminal in a substantially air tight manner, the boot being attached to the sleeve.

13. A method according to any one of claims 9 to 12, wherein the sleeve has a shape memory which is substantially straight and the terminal is substantially straight.

14. A method according to any one of claims 9 to 12, wherein the heat shrunk sleeve has a curved portion which dresses the ignition cable at an angle.

15. A method according to claim 14, wherein the sleeve has a shape memory which includes a curved portion to dress the cable at an angle when the sleeve is shrunk onto the ignition cable.

16. A method according to claim 14 or 15, wherein the sleeve includes a spring or insert having a shape memory which is curved to dress the ignition cable at an angle when the sleeve is shrunk onto the ignition cable.

17. A method according to claim 14, 15 or 16, wherein the terminal is substantially straight.

18. A method according to claim 14, 15 or 16, wherein the terminal has an angled portion between the attachment end and the contact end.

19. A sealed ignition cable assembly substantially as hereinbefore described with reference to Figures 2 and 3; or 4, 5 and 6; or 7 and 8; or 9 and 10.

20. A method of making a sealed ignition cable assembly substantially as hereinbefore described with reference to Figures 2 and 3; or 4, 5 and 6; or 7 and 8; or 9 and 10.

DATED: 31 August 1994

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David B Fitzpatrick

AUSTRALIAN PATENT OFFICE

# SEALED CABLE ASSEMBLY

Abstract:

An ignition cable assembly has a cable seal (120) and a tower seal (120) enclosing a terminal (114) and a heat shrunk sleeve (120). The cable seal (120) insulates a substantial portion of the terminal (114) to increase the dielectric strength of the assembly. The tower seal (122) includes an elastomeric boot (126) radially spaced from the contact (118) of the terminal (114) to engage sealingly an outer surface of a male or female tower (34). The heat shrunk sleeve (120) forms at least part of the cable seal and it may be used to provide an angled dress for the ignition cable (112) or to accommodate an angled terminal.

52076/93

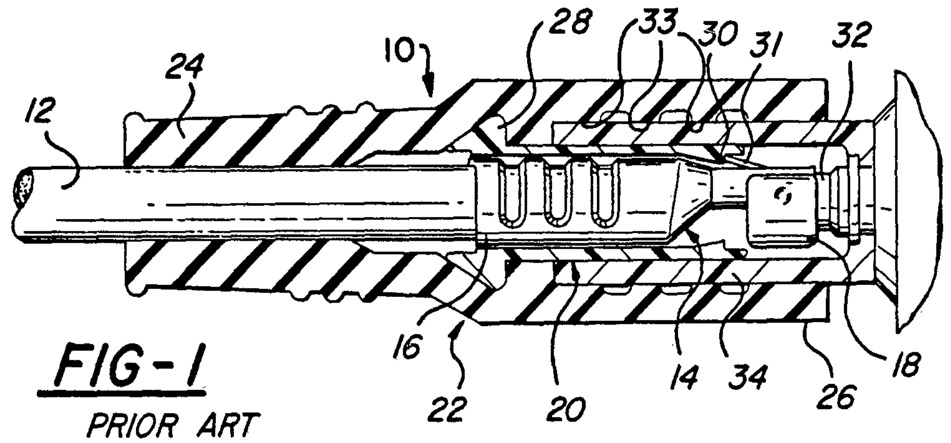



FIG-1

PRIOR ART

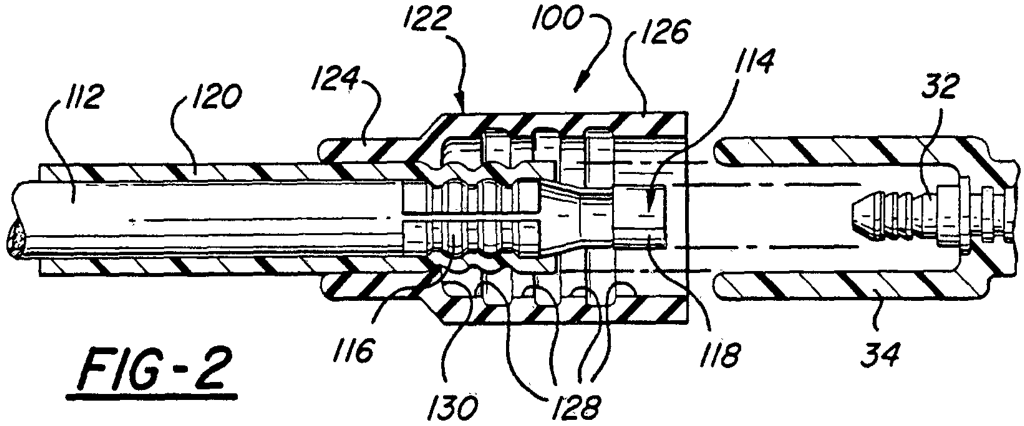



FIG-2

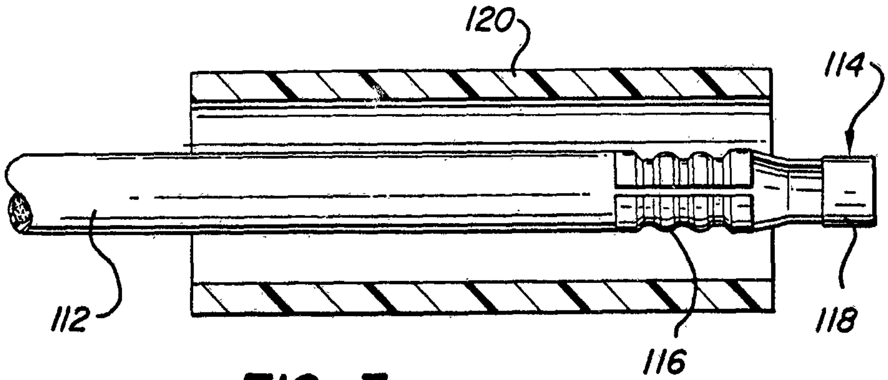



FIG-3

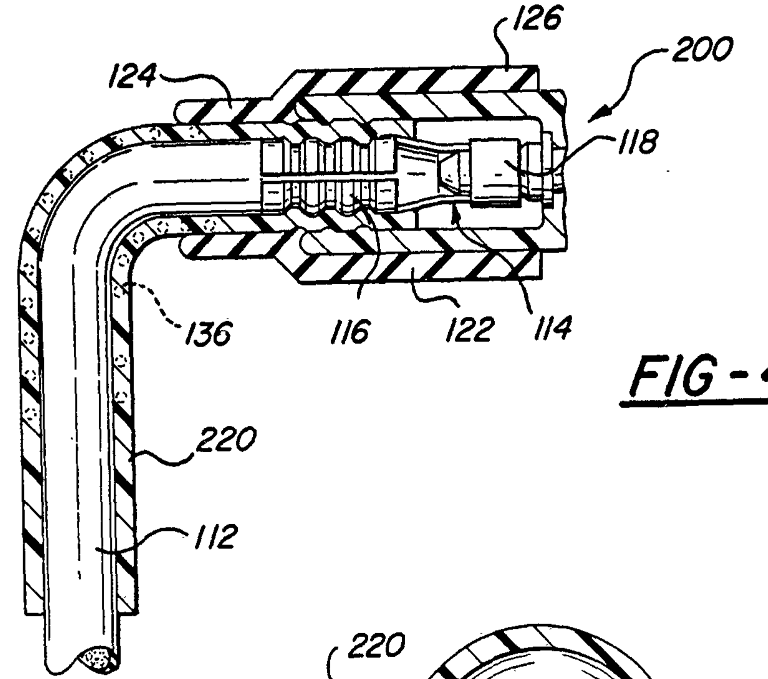



FIG-4

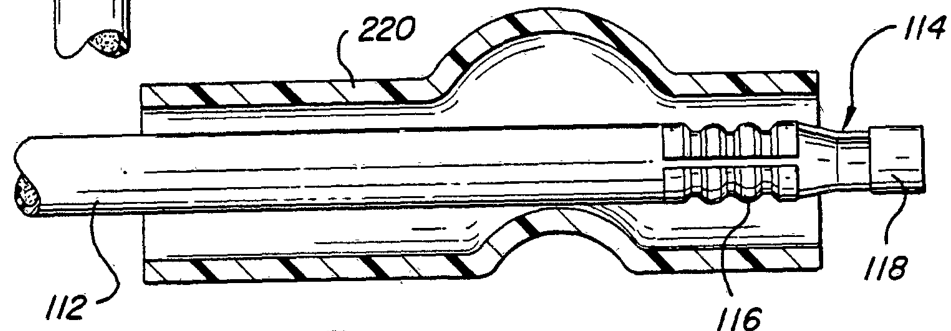



FIG-5

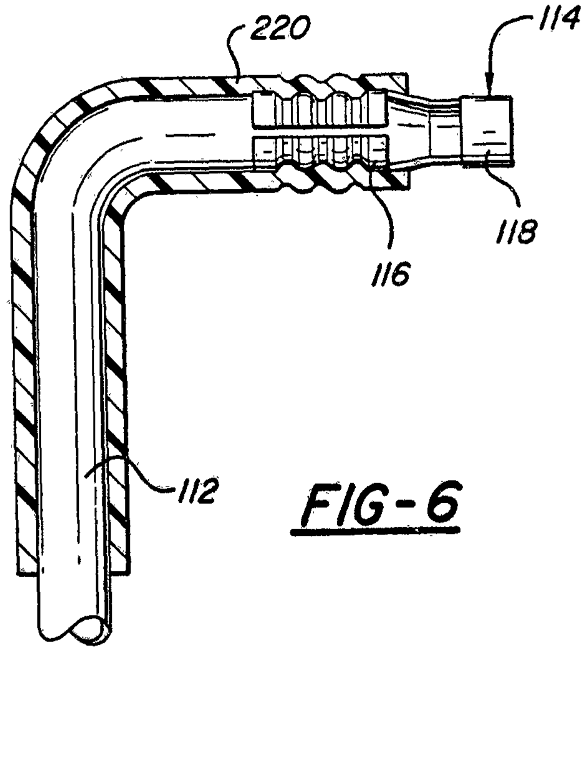



FIG-6

FIG-7

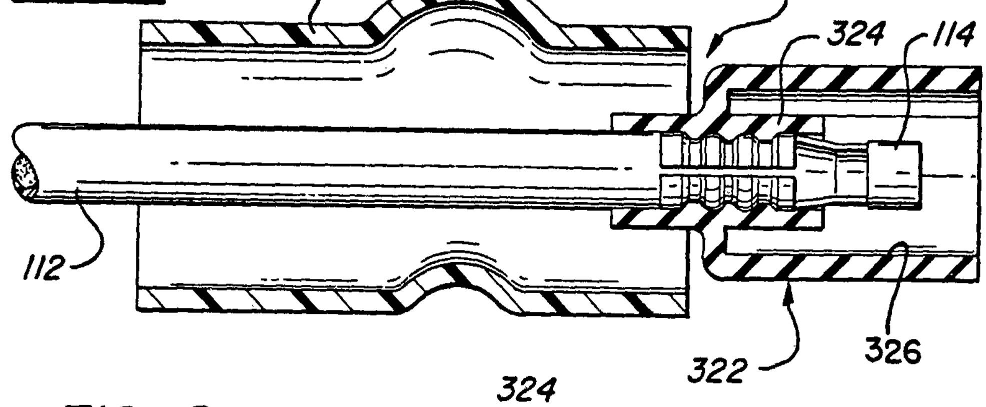
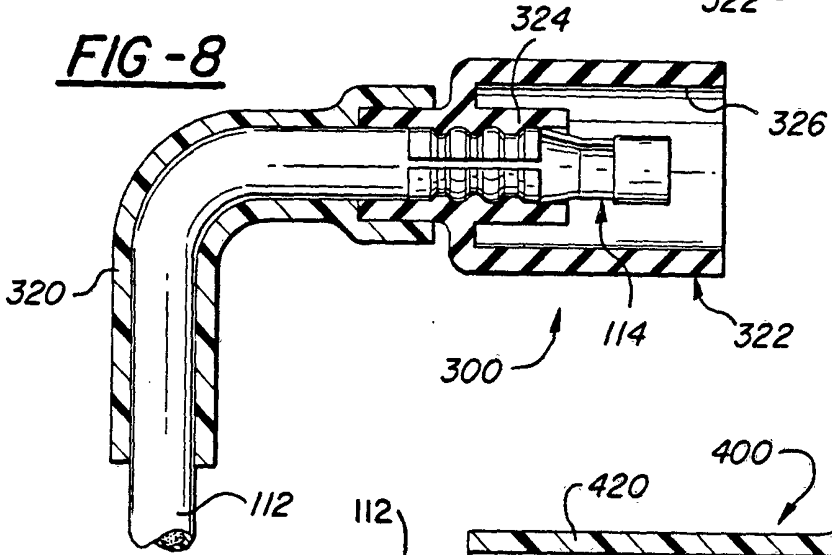



FIG-8



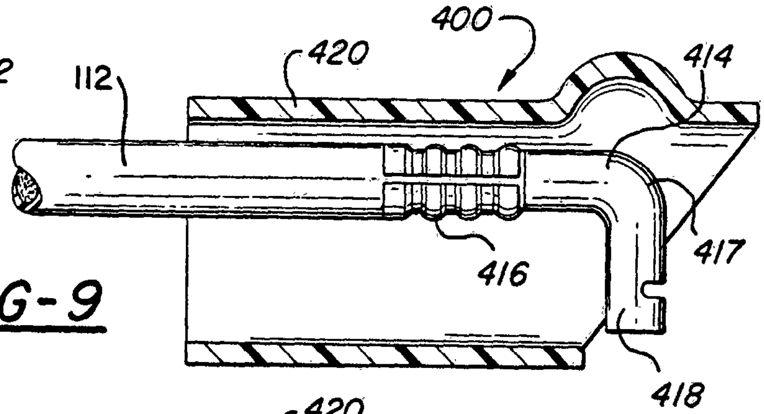




FIG-9

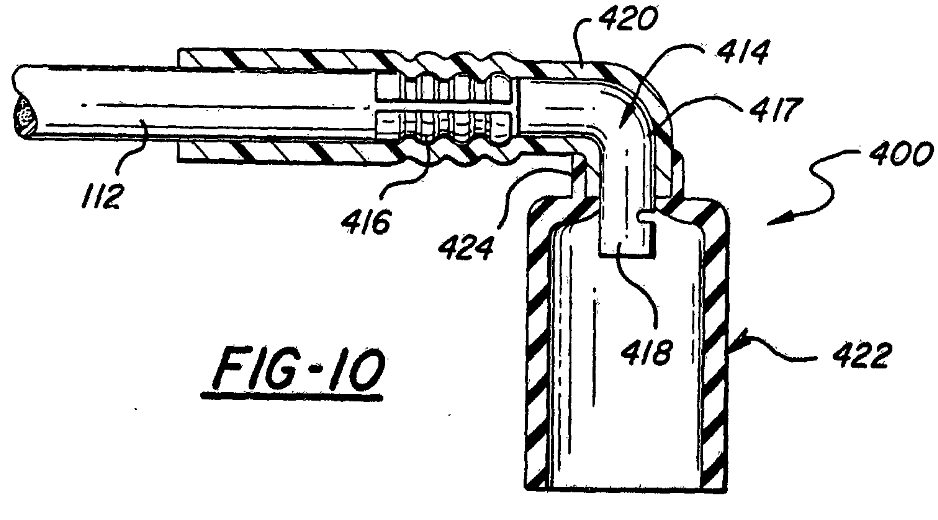



FIG-10