(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 687 037 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **94201656.9**

(51) Int. Cl.[6]: **H01R 13/658**

(22) Date of filing: **09.06.94**

(43) Date of publication of application:
13.12.95 Bulletin 95/50

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL PT SE

(71) Applicant: **Fokker Aircraft B.V.**
Schipholdijk 231
P.O. Box 7600
NL-1117 ZJ Schiphol (NL)

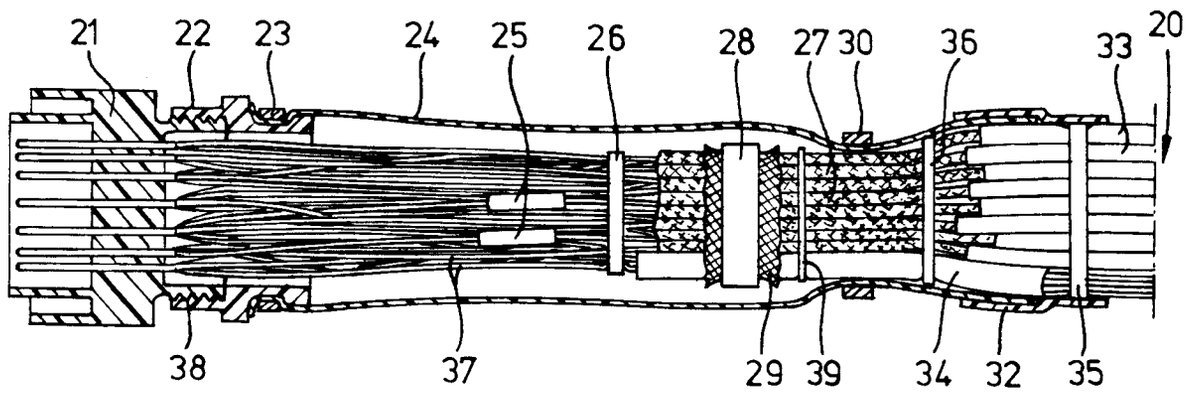
(72) Inventor: **Nagtegaal, Ronald**
Blauwe Zegge 74
NL-3648 JM Wilnis (NL)
Inventor: **Oskam, Pieter Hendrik**
Mijzijde 23
NL-3471 GN Kamerik (NL)

(74) Representative: **de Bruijn, Leendert C. et al**
Nederlandsch Octrooibureau
P.O. Box 29720
NL-2502 LS Den Haag (NL)

(54) Shielding arrangement between several shielding cables and a connector

(57) Shielding arrangement between several shielded cables (20) and a connector (21), each shielded cable (20) comprising at least one conductor within a shielding (27), the arrangement comprising flexible electrically conductive, hose shaped shielding means (24) comprising a first end and a second end, which first end is electrically conductively connected to a housing of the connector (21) having at least an electrically conductive outer surface, preferably by a first clip binding (30), and which second end is electrically conductively connected to each, partly stripped shielding (27) of each shielded cable (20), preferably by a second clip binding (30), a flexible, electrically conductive tape (29) being wound around the bundled shieldings (27) by second clamping means (28; 30) in order to establish good electrical contact between all stripped shieldings (27).

fig - 3a



EP 0 687 037 A1

The present invention relates to a shielding arrangement between several shielded cables and a connector, each shielded cable comprising at least one conductor within a shielding, the arrangement comprising electrically conductive, hose shaped shielding means comprising a first end and a second end, which first end is electrically conductively connected to an electrically conductive body of the connector and which second end is electrically conductively connected to each, partly stripped shielding of each shielded cable by first clamping means, each stripped shielding being inserted into said second end of the hose shaped shielding means.

Such a shielding arrangement between several shielded cables and a connector is known from "Tag Ring® Backshells; Glenair Assembly Instructions 40-1", 1988, Glenair, Inc. and is also disclosed in United States Patent 3,465,092, which will be discussed below.

The problem to be solved by the present invention will be explained by reference to Figures 1 and 2.

Figure 1 shows several cables 1 which may be or may not be kept together by an outer insulating jacket (not shown). Each of the cables 1 comprises at least one wire 6 each provided with an insulating jacket. All wires 6 within one cable 1 are shielded by a braid entirely enclosing the wires within the cable. Such braids are electrically conductive and known to persons skilled in the art.

Figure 1 also shows a connector 4 to which the cables 1 are to be connected. The wires 6 extend into the connector 4 and their conductors (not shown) are connected to the contact members (not shown) e.g by soldering as is known to persons skilled in the art. The outer body of the connector 4 may be made of conducting metal to provide a shielding ground contact. However, the body of the connector 21 may also be made of an insulating material coated with a conductive coating as is known to persons skilled in the art.

Figure 1 shows that such a body of connector 4 is connected to all wire shieldings 2 by the "pigtail-method". All outer jackets of cables 1 are stripped. Each stripped shielding 2 is first flattened and then more or less pressed into a "pigtail" type of wire 2. Each of those pigtail wires 2 is put into one side of a conductive cable connection 5 which at its other end receives a grounding wire 7 connected to the electrically conductive body of the connector 4. The cable connection 5 is pressed together in order to make good electrical contact to both the pigtail wires 2 and to the grounding wire 7. A solder sleeve 3 may be used at the end of each stripped away outer jacket of each cable 1 to protect each cable from mechanical damage.

A disadvantage of the pigtail technique according to figure 1 is that all wires 6 are not protected against electromagnetic interference between the solder sleeves 3 and the connector 4.

This disadvantage is solved by the pigtail technique according to Figures 2a, 2b and 2c, which is known from "Tag Ring® Backshells; Glenair Assembly Instructions 40-1", 1988, Glenair, Inc. and also disclosed in United States Patent 3,465,092. In Figure 2 a connector 11 to be connected to a cable 16 is shown. The cable 16 comprises several wires 17 which are individually shielded by conductive braids or shielded by conductive braids in groups of two or more wires. The cable 16 is stripped in a known manner to strip an appropriate length of each wire 17. Each stripped length of wire is stripped to strip a predetermined length of each respective braid. Each stripped length of braid is flattened and pressed together to form a pigtail type of wire 14. Each pigtail wire 14 is bent away in a radial direction from the cable 16 after the stripped part of the cable 16 is fed through a tag ring nut 15. Then the stripped parts of the wires 17 are fed through a back shell 12, as shown in Figure 2a, until the body of the back shell 12 engages the bent away pigtail wires 14, as shown in Figure 2b. Lugs 13 are extending from the body of the back shell 12. There are as many lugs 13 as there are pigtail wires 14. Each pigtail wire 14 is guided into a slot between two adjacent lugs 13. Then, the back shell 12 is pushed further in the direction of the tag ring nut 15 in such a way that the lugs 13 are guided between lugs 18 extending inward from the tag ring nut 15. Thus, good electrical contact between the pigtail wires 14 and the engaging back shell 12 and tag ring nut 15 is established. Then, the conductor of each wire 17 may be connected to a corresponding contact member of the connector in a manner known to persons skilled in the art.

An advantage of the pigtail technique according to Figures 2a, 2b and 2c is that the terminals of the wires 17 from which the braids are stripped away are still shielded against electro magnetic interference by the conductive body comprising the tag ring nut 15, the back shell 12 and the connector 11 when these latter three parts are connected together. A disadvantage, however, is that the number of wires 17 that can be protected by the back shell 12 mainly depends on the size of the back shell 12 and the number of slots between the lugs 13. A further disadvantage of the pigtail technique according to Figures 2a, 2b and 2c is that the clamping action between the tag ring nut 15 and the back shell 12 to clamp the pigtail wires 14 is not very shock-resistant. Especially in airplanes in which electrical connections must be extremely reliable and extremely shock-resistant the application of the pigtail technique according to Figures

2a, 2b and 2c is not always satisfactory.

Therefore, the main object of the present invention is to provide a shielding arrangement between several shielded cables and a connector, which is very reliable both from a mechanical and an electrical point of view, and is very shock-resistant.

A further object is to provide a shielding arrangement between several shielded cables and a connector, which offers great flexibility in the number and dimensions of the cables to be connected to the connector and to be shielded by the shielding arrangement.

The object of the present invention is obtained by a shielding arrangement between several shielded cables and a connector of the type mentioned above, which is characterized in that the electrically conductive, hose shaped shielding means is made of flexible, electrically conductive material and that a flexible, electrically conductive tape is firmly wound around the bundled shieldings, that still enclose their respective conductors, by second clamping means in order to establish good electrical contact between all stripped shieldings.

Such an arrangement offers several advantages over the prior art pigtail technique. First of all, no pigtail wires need be made from the shieldings of the shielded cables, thereby saving time during manufacturing. Besides, estimating the length of the shieldings of the cables to be stripped from cable outer jackets is very uncritical which serves the ease of manufacturing. Because of the flexibility of the hose shaped shielding means the number of and dimensions of the cables to be connected to the connector is very uncritical: no predetermined number of or dimensions of the cables is required. Still a 360° shielding range is guaranteed. The application of a flexible, electrically conductive tape, which is firmly wound around the bundled shieldings by second clamping means provides for an excellent and cheap electrical contact between all stripped shieldings: all shieldings remain their state enclosing the inner conductors of the cables and are firmly pressed to one another by the electrically conductive tape, thereby providing an excellent ground contact for all shieldings.

Preferably, a first clip binding is provided to clamp the flexible shielding means to the connector. Such a metal clip binding provides an excellent electrical contact between the hose shaped flexible shielding means and the connector.

Preferably, the first clamping means is constituted by a second clip binding arranged around the second end of the shielding means receiving the stripped shieldings of the shielded cables. Such a clip binding exerts a predetermined pressing force on the hose shaped shielding means and, therefore, provides for an excellent electrical contact between the hose shaped shielding and the shieldings of the cables.

Preferably, also the second clamping means is constituted by a third clip binding.

In a preferred embodiment, the second clamping means, that clamps the flexible tape, is formed by the first clamping means. By this measure one clamping means may be omitted, thereby, saving costs and weight in each connection, which is an essential feature in especially airplanes.

The hose shaped shielding means may comprise a braided hose.

The flexible tape may comprise a braided, electrically conductive tape. The application of a braided tape has several advantages. First of all, the braided tape is able to fill up open spaces in the bundled shieldings of the cables with pieces of the braided tape, which is partly pressed into said shieldings by the second clamping means in order to establish as many points of electrical contact as possible between all shieldings. When the shieldings of the cables are bundled the shieldings at the outside of the bundle do not touch each other but leave open spaces: these spaces are filled with the braided, electrically conductive tape, thereby enhancing the shielding effectiveness. Moreover, the clamping force of a preferably applied second clip binding around the braided tape is spread as to establish a good mutual electrical contact between all shieldings and between the shieldings and the braided tape.

A connector adapter is may be provided between the connector and the hose shaped shielding means.

Moreover, the second end of the hose shaped shielding may be clamped to the shielded cables by an insulating shrink sleeve.

Besides the shielded cables at least one unshielded cable may be connected to the connector and may be received by the hose shaped shielding means.

The invention will be explained in greater detail below by reference to some drawings which show some embodiments of the invention which are not intended to limit the scope of the invention.

Figure 1 shows a shielding arrangement between several cables and a connector according to a prior art pigtail technique;

Figure 2 shows a further shielding arrangement between several cables and a connector according to another prior art pigtail technique;

Figure 3a shows a partly exploded view of a first shielding arrangement between several cables and a connector according to the invention;

Figure 3b shows a partly exploded view of an alternative shielding arrangement between several cables and a connector according to the invention;

Figure 4 shows a perspective outside view of a shielding arrangement between several cables and a connector according to the invention.

The shielding arrangement between several cables and a connector according to figure 3a comprises a braided, electrically conductive hose 24, a clip binding 23, a further clip binding 28, a still further clip binding 30 and a braided, electrically conductive tape 29.

In one embodiment of the invention the braided hose 24 may be of a type disclosed in United States Patent 4,896,402 assigned to Band-It-IDEX, Inc. Alternatively, the braided hose 24 may be substituted by any hose of any flexible, electrically conductive material. As a further alternative the braided hose 24 may be substituted by any hose of flexible, durable non-conductive material which is entirely coated with an electrically conductive coating in order to provide the desired shielding effect and to establish the required electrical connection to both the connector 21 and shieldings 27 of cables 20.

Preferably, the clip bindings 23, 28 are "Band-It" clamping bands disclosed in United States Patent 4,896,402 mentioned above. However, the clip bindings 23, 28 may be of any other type the only restriction being that they are electrically conductive and very durable and reliable in the assembled state.

As shown in Figures 3a and 4 one end of the braided hose 24 is fixed by the clip binding 23 to a connector adapter 22 which is preferably provided with a recess to receive that end of the braided hose 24 and to provide for a good immovable clamping action. The connector adapter 22 is mechanically and electrically connected to the connector 21, e.g., by threads 38. The adapter 22 is optional and may be omitted. In the latter case the connector may be provided with an appropriate recess to receive the end of the braided hose 24 and the clip binding 23. By means of the clip binding 23 an excellent electrical contact between the body of the connector 21 and the braided hose 24 may be established, as is known per se from United States Patent 4,896,402 mentioned above.

The other end of the braided hose 24 is clamped against the shieldings 27 of the shielded cables 20 by means of clamping means 30. Also clamping means 30 is, preferably, a "Band-It" clamping band like the clip bindings 23, 28. Such a clip binding exerts a very good pressing force. Each of the shieldings 27 enclose one or more insulated conductors 37. To strip the shieldings 27 insulating outer jackets 33 of the cables 20 are removed along a predetermined length by means known to persons skilled in the art. The stripped shieldings 27 are bundled and the braided tape 28 is wound around the shieldings 27. The clamping means 28 is installed and, then, the bundled shieldings 27 are inserted into the open end of the braided hose 24, deep enough to enclose part of the bundled shieldings 27. Then, the clamping means 30 is installed over the braided hose 24 and provided with the desired clamping pressure in order to press the shieldings 27 together to establish a firm electrical contact between all shieldings 27 and the braided hose 24.

An important object of providing the braided tape 29 between the clip binding 28 and the shieldings 27 is to fill up open spaces in the shieldings 27 with pieces of the braided tape 29, which is partly pressed into said shieldings 27 by the second clip binding 28, in order to establish as many points of electrical contact as possible between all shieldings 27. To that purpose, the braided tape 29 may be unraveled somewhat to provide for loose pieces which can be easily pressed into the shieldings 27.

The braided tape 29 may be of a type disclosed by European Patent Application 0,549,942. This Patent Application shows the application of a braided tape (14) wound around a stripped shielding of a medium voltage cable which is to be connected to another cable. Both of these cables comprise one conductor only. The purpose of the known braided tape is to establish an electrical intermediate between the stripped shielding of one cable and an intermediate flexible shielding plate to which the braided tape is fixed. This Patent Application does not suggest to use such a braided tape together with a clip binding and hose shaped shielding means. Moreover, this Patent Application does not suggest to use such a braided tape to enhance the inter-electrical contact between several shieldings by pressing such a braided tape wound around the bundled shieldings into the shieldings.

The braided tape 29 may be substituted by any other type of flexible, electrically conductive tape which is able to firmly press the bundled shieldings 27 to one another and to protect the shieldings 27 against the sharp edges of clip binding 28. However, a braided tape made of thin metal wires is very suitable for the intended purpose, especially when the braided is somewhat unravelled before installation.

Each cable 20 comprises at least one conductor 37 to be connected to a contact member (not shown in figures 3a, 3b or 4) of the connector 21. These contact members may be male, female or hermaphrodite. If there are several conductors within a cable they may be twisted. Several conductors 37 extending from the shieldings 27 may be connected together by a conductor connection 25 from which one or more conductors extend to respective, predetermined contact members (not shown)

in the connector 21.

Before inserting the bundled cables 20 with their shieldings 27 into the braided hose 24 they may be put together at appropriate locations by suitable tapes 26, 35, 36, 39 made of any suitable material.

Since the braided hose 24 is very flexible and does not restrict the diameter of the cables 20 to be connected to be within very strict ranges as in many prior art systems, also unshielded cables 34 may be easily connected to the same connector 21. They outer jacket of such unshielded cables 34 may extend into the braided hose 24 as far as the shieldings 27 of the shielded cables 20, as shown in Figures 3a and 3b.

To protect the joint between the braided hose 24 and the cables 20, 34 a shrink sleeve 32 enclosing both the end of the braided hose 24 and the outer jackets 33 of the cables 20 may be provided.

Figure 3b shows an alternative embodiment of the present invention. In this embodiment the braided tape 29 is still provided between the outer hose 24 and the shieldings 27 of the cables 20 but is clamped to the shieldings 27 by the clamping means 30 to guarantee a firm mechanical and electrical contact. The clamping means 30 is arranged outside the braided hose 24 as in the arrangement according to Figure 3a. Since the braided tape 29 is firmly wound around the bundled shieldings 27 this arrangement provides for a better electrical contact between the shieldings 27 and the hose 24 than the arrangement of Figure 3a, especially when the braided tape 29 is somewhat unravelled before installation as explained above. In the arrangement according to Figure 3b the clip binding 28 is omitted, thereby reducing costs and weight which is an essential feature in airplanes.

If desired the shieldings 27 may extend deeper into the braided hose 24 than shown in Figures 3a, 3b. Besides, as the case may be, only those parts of the shieldings 27 may be stripped by stripping away the outer jackets 33 that will be located directly under the braided tape 29. In the latter case still insulated parts of the shieldings 27 will extend into the braided hose 24 and the stripped parts of the shieldings 27 will only be intermediate parts between insulated parts.

Figures 3a, 3b and 4 diagrammatically show a cylindrical type of connector 21. However, the present invention is not restricted to cylindrical connectors only. The invention may be applied to connectors with a conductive body of any shape and any type.

Moreover, the bundled cables 20, 34 may have different dimensions, since there is no element of the shielding arrangement which limits the dimensions of the cables 20, 34 to strict predetermined ranges. The bundled cables 20, 34 may also have different numbers of conductors 37. Therefore, the shielding arrangement according to the invention provides for great flexibility in connecting different kinds of cables to different kinds of connectors, while still offering a very good shielding against electromagnetic interference.

The shielding arrangement according to Figures 3a and 4 was tested and exposed to severe mechanical vibrations in order to simulate worst case situations in airplanes. Test results show that the electrical resistance between the braided hose 24 and the shieldings 27 remained excellent, i.e. remains very low, after severe vibrations. In contrast, severe vibrations often resulted in bad electrical connections between the back shell 12 and the pigtail wires 14 in the pigtail construction of Figures 2a, 2b and 2c, thereby deteriorating the shielding effectiveness greatly.

Claims

1. Shielding arrangement between several shielded cables (20) and a connector (21), each shielded cable (20) comprising at least one conductor within a shielding (27), the arrangement comprising electrically conductive, hose shaped shielding means (24) comprising a first end and a second end, which first end is electrically conductively connected to a housing of the connector (21) having at least an electrically conductive outer surface and which second end is electrically conductively connected to each, partly stripped shielding (27) of each shielded cable (20) by first clamping means (30), each stripped shielding (27) being inserted into said second end of the hose shaped shielding means (24) characterized in that the electrically conductive, hose shaped shielding means (24) is made of flexible, electrically conductive material and that a flexible, electrically conductive tape (29) is wound around a bundle cables with stripped shieldings (27), that still enclose their respective conductors, by second clamping means (28; 30) in order to establish good electrical contact between all stripped shieldings (27).

2. Shielding arrangement according to claim 1 characterized in that a first clip binding (23) is provided to clamp the flexible shielding means (24) to the connector (21).

3. Shielding arrangement according to claim 1 or 2 characterized in that the first clamping means (30) is constituted by a second clip binding arranged around the second end of the shielding means (24) receiving the stripped shieldings (27) of the shielded cables (20).

4. Shielding arrangement according to any of the preceding claims characterized in that the second clamping means (28) is constituted by a third clip binding.

5. Shielding arrangement according to any of the claims 1, 2 or 3 characterized in that the second clamping means (28), that clamps the flexible tape (29), is formed by the first clamping means (30).

6. Shielding arrangement according to any of the preceding claims characterized in that the hose shaped shielding means comprises a braided hose (24).

7. Shielding arrangement according to any of the preceding claims characterized in that the flexible tape comprises a braided, electrically conductive tape (29).

8. Shielding arrangement according to claim 7 characterized in that the conductive tape (29) is somewhat unravelled before installation.

9. Shielding arrangement according to any of the preceding claims characterized in that a connector adapter (22) is provided between the connector (21) and the hose shaped shielding means (24).

10. Shielding arrangement according to any of the preceding claims characterized in that the second end of the hose shaped shielding (24) is clamped to the shielded cables (20) by an insulating shrink sleeve (32).

11. Shielding arrangement according to any of the preceding claims characterized in that besides the shielded cables (20) at least one unshielded cable (34) is connected to the connector (21) and is received by the hose shaped shielding means (24).

12. Shielding arrangement according to any of the preceding claims characterized in that each shielded cable (20) is provided with an outer insulating jacket (33) which is only removed from the shieldings (27) at locations clamped by the flexible, electrically conductive tape (29).

13. Shielding arrangement according to any of the preceding claims characterized in that several conductors of the cables (20, 34) are interconnected by a conductor connection (25) which is located within the hose shaped shielding means (24) and is connected to one contact member of the connector (21) by one wire only.

fig-1

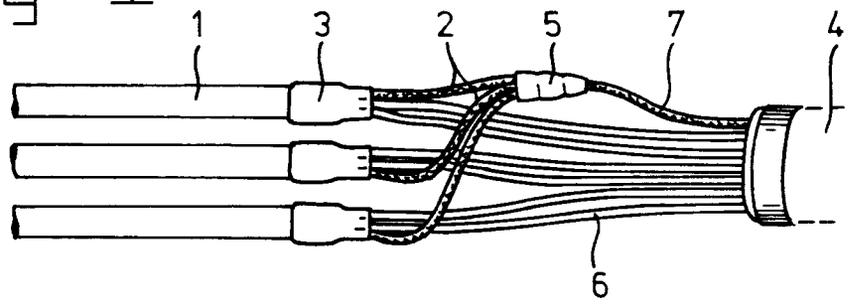


fig-2a

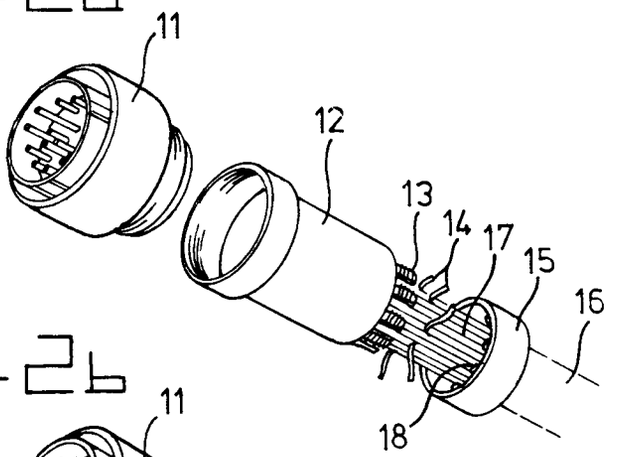


fig-2b

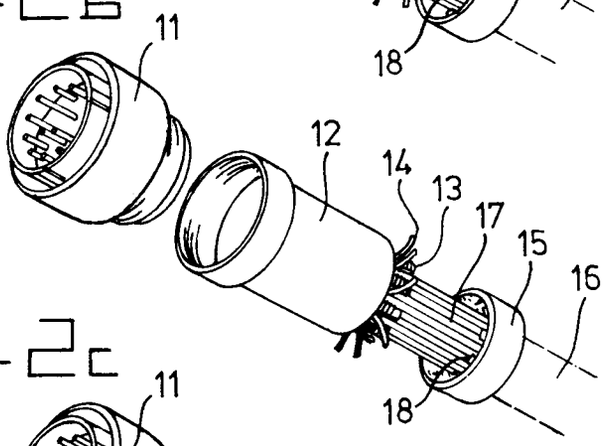


fig-2c

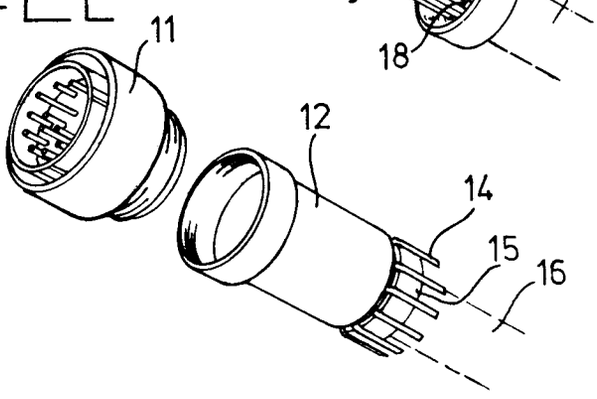


Fig - 3a

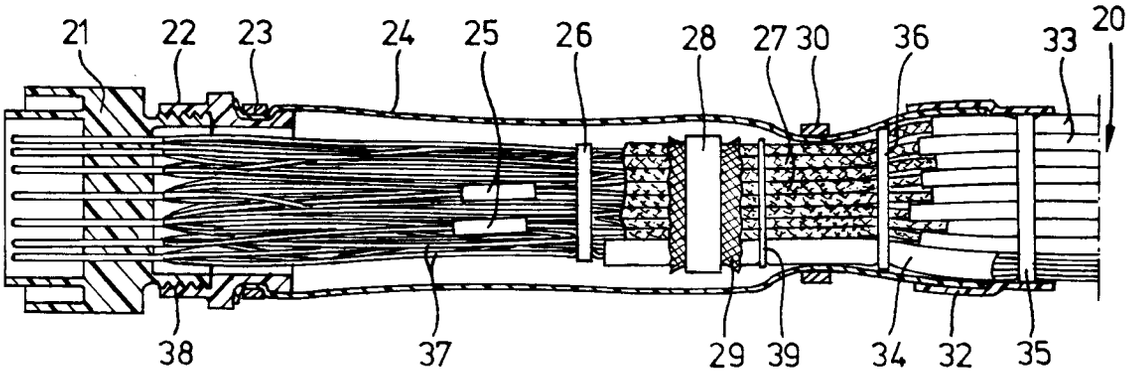


Fig - 3b

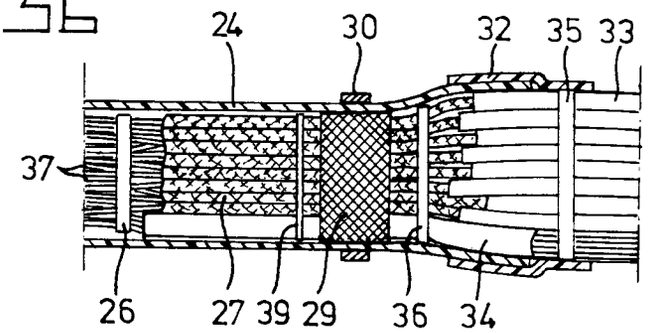
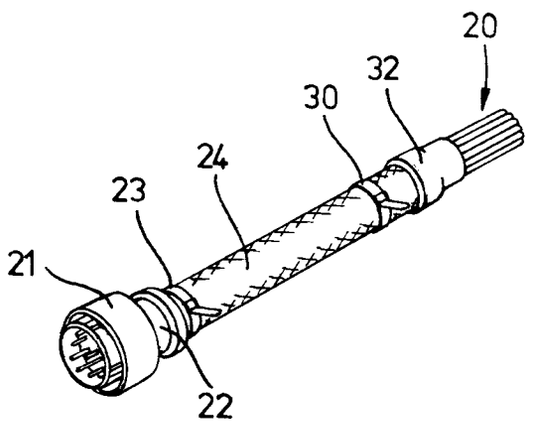


Fig - 4



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 20 1656

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	GB-A-2 199 198 (KERN ELECTRICAL COMPONENTS LIMITED) * page 10, line 31 - page 13, line 7 * * page 13, line 16 - line 18; figures 2,3,9 *	1,4,6,7, 9,10,12	H01R13/658
Y	WO-A-90 01225 (BOWTHORPE-HELLERMANN LIMITED) * page 2, line 29 - page 29, line 29; figures *	1,4,6,7, 9,10,12	
D,A	US-A-4 896 402 (JANSEN ET AL.) * column 8, line 39 - line 56; figure 8 *	1,2,6	
A	EP-A-0 160 465 (G & H TECHNOLOGY INC.) * page 5, line 7 - page 9, line 14; figure 1 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 November 1994	Kohler, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)