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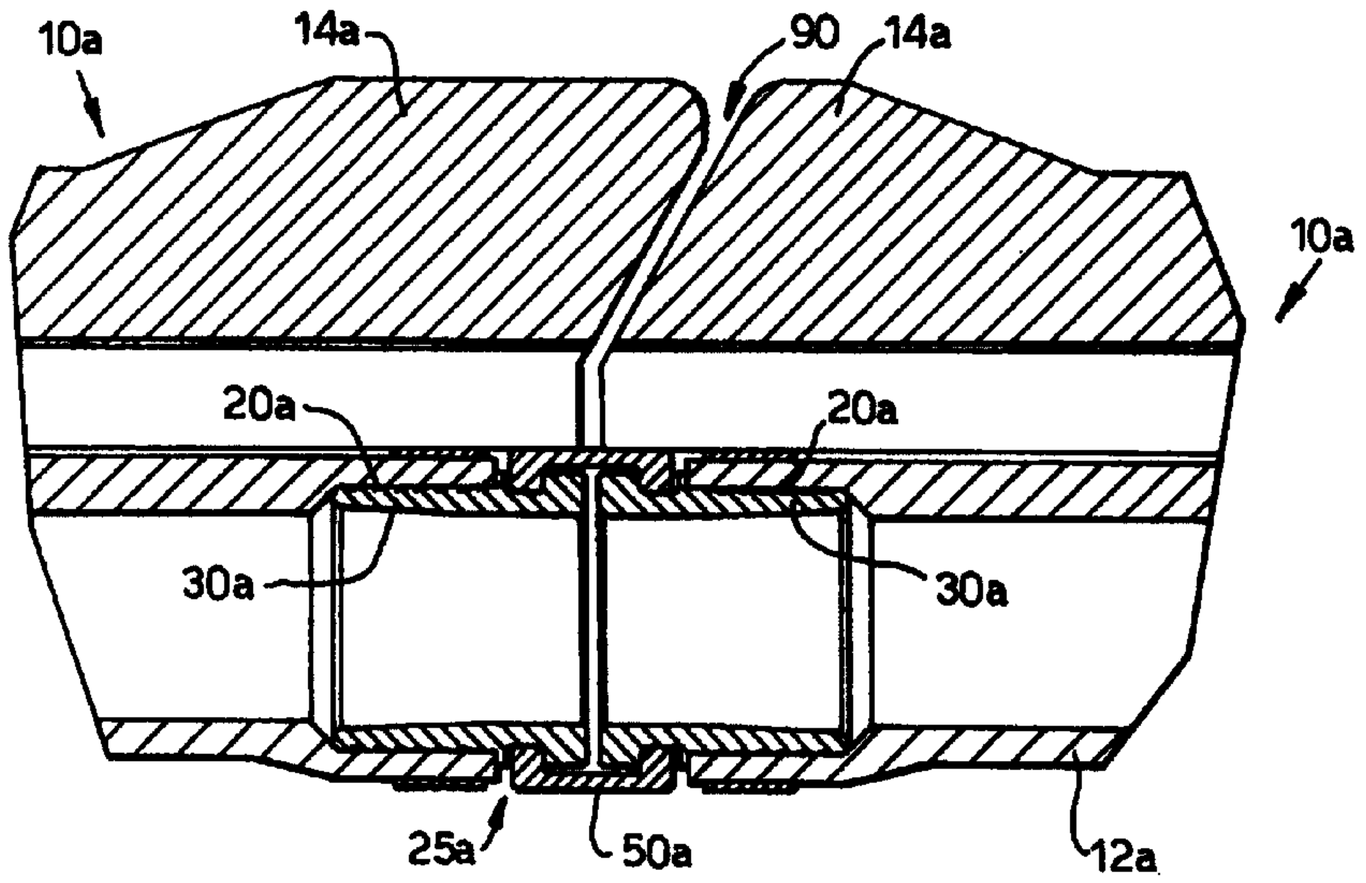
(54) **CARENAGES POUR CABLES**

(54) **FAIRINGS FOR CABLES**



(57) Carénage destiné à réduire la traînée produite par un câble de raccordement utilisé pour remorquer une ou plusieurs flûtes sismiques faisant partie d'un large groupe de flûtes. Ledit carénage possède une pluralité de parties dont chacune présente un trou central destiné à recevoir le câble de raccordement, ainsi qu'un profil fuselé. Lesdites parties sont couplées les unes aux autres bout à bout par des raccords pivotants qui permettent la rotation de ces parties les unes par rapport aux autres, si bien que chaque partie peut adopter l'orientation optimale en vue de la réduction de la traînée. La réduction de la traînée est en outre favorisée par le fait que les surfaces supérieure et inférieure du bord d'attaque de chaque partie de carénage sont dotées de séries respectives de rainures/nervures à extension longitudinale.

(57) A fairing for reducing the drag produced by a lead-in cable which is being used to tow one or more seismic streamers forming part of a wide streamer array comprises a plurality of fairing sections each having a central bore to receive the lead-in and a streamlined profile. The sections are coupled together end-to-end by swivel couplings which permit rotation of the sections relative to each other, so that each section can adopt the optimum orientation for drag reduction. Drag reduction is further enhanced by providing the upper and lower surfaces of the leading edge of each fairing section with respective sets of longitudinally extending ridges/grooves.

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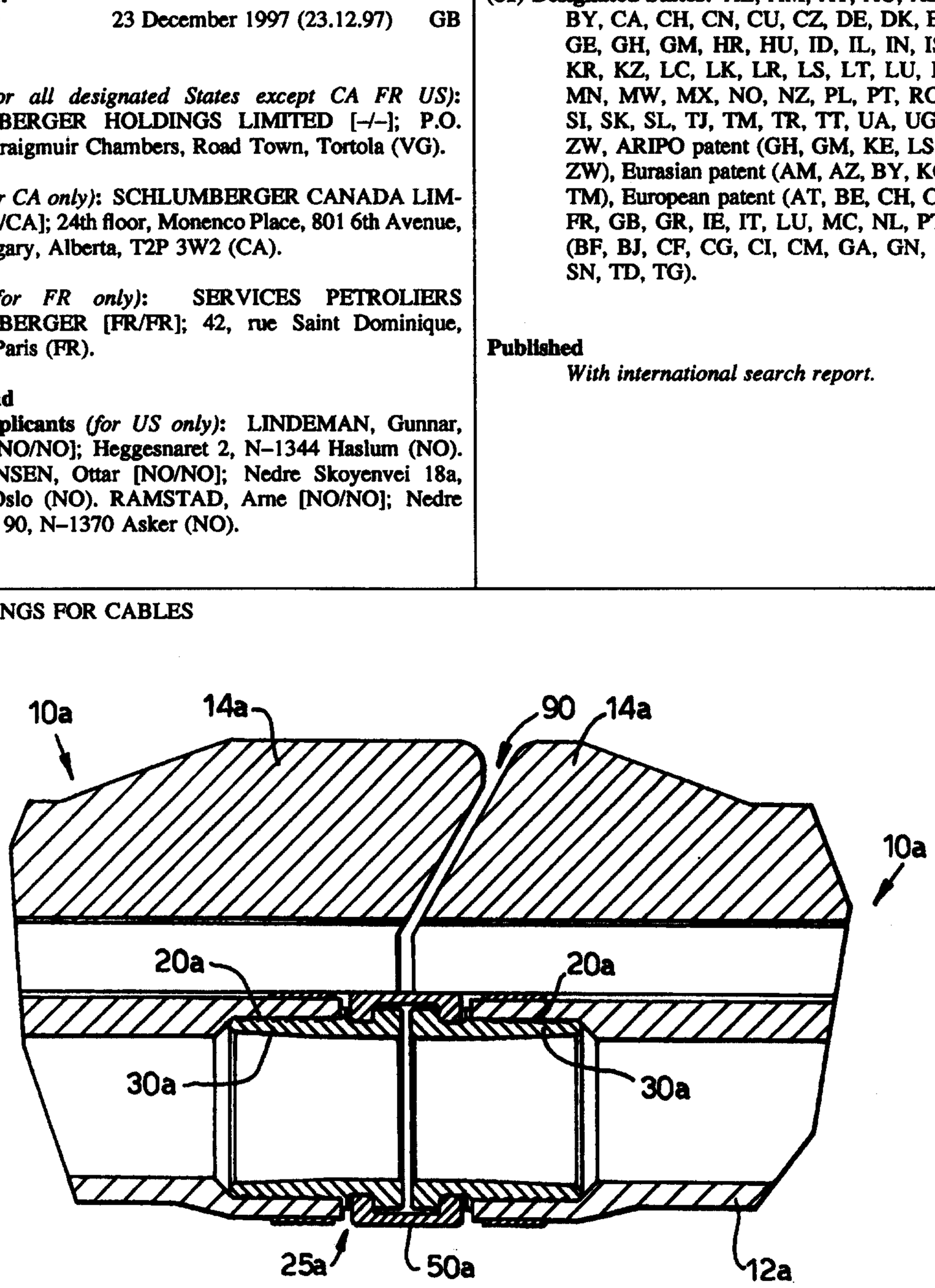
(54) Title: FAIRINGS FOR CABLES



(57) Abstract

A fairing for reducing the drag produced by a lead–in cable which is being used to tow one or more seismic streamers forming part of a wide streamer array comprises a plurality of fairing sections each having a central bore to receive the lead–in and a streamlined profile. The sections are coupled together end–to–end by swivel couplings which permit rotation of the sections relative to each other, so that each section can adopt the optimum orientation for drag reduction. Drag reduction is further enhanced by providing the upper and lower surfaces of the leading edge of each fairing section with respective sets of longitudinally extending ridges/grooves.

ten streamers, for example, would produce a drag of over 70 tonnes, which makes the use of such wider arrays containing more streamers unattractive.

It is an object of the present invention to alleviate this problem.

In accordance with one aspect of the invention there is provided a fairing for use on a cable, in particular a lead-in cable for a seismic streamer array, the fairing comprising: a plurality of fairing sections having a central opening in which the cable is received and a streamlined profile which acts to reduce drag when the cable is moved through water in a direction transverse to its length; and at least one coupling assembly for fastening together adjacent fairing sections in such a manner as to permit rotation of said adjacent fairing sections relative to one another.

In a preferred embodiment of the invention, the coupling assembly comprises a pair of end connectors each of which is secured to an end of one of a pair of adjacent fairing sections and has a radially outwardly projecting flange formed thereon, and an annular clamping ring which is made of a low friction material, and which secures together the flanges formed on the end connectors while permitting them to rotate relative to one another.

Advantageously, the annular clamping ring is made in two semi-circular parts which are secured together, and is of U-shaped cross-section so as to trap within the U-section the flanges of the end connectors.

In a further aspect, the invention provides a fairing for use on a cable, in particular a lead-in cable for a seismic streamer array, the fairing having a central opening in which the cable is received and a streamlined profile which acts to reduce drag when the cable is moved through water in a direction transverse to its length, wherein the fairing is provided with a plurality of longitudinally extending ridges formed on a part of the fairing which will, in use, be at or adjacent the leading edge thereof.

The invention will now be described in detail, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a part-elevational, part sectional view of a fairing section in accordance with one embodiment of the invention;

Figure 2 is a section taken on line II-II of Figure 1;

Figure 3 is a side elevational view of an end connector for use in joining together the fairing sections of Figure 1;

Figure 4 is a perspective view of a swivel bearing which forms part of a coupling for joining the fairing sections of Figure 1;

Figure 5 is a perspective view of a clamping ring which forms part of a coupling for joining the fairing sections of Figure 1;

Figure 6 is a section taken through an assembled coupling including the end connector of Figure 3, the swivel bearing of Figure 4 and the clamping ring of Figure 5;

Figure 7 is a part-sectional view of an anchoring assembly for securing a group of adjacent fairing sections to a lead-in cable, axially;

Figure 8 is a perspective view of an anchoring ring forming part of the anchoring assembly of Figure 7; and

Figure 9 is a section taken through an alternative form of the coupling of Figures 3 to 6, shown connecting two adjacent fairing sections in accordance with another embodiment of the invention.

The assembled fairing of the invention comprises a plurality of elongate generally tubular fairing sections 10, which are coupled together by means of suitable couplings 25 at their adjacent ends to form a continuous fairing around the lead-in cable.

A preferred form of fairing section 10 is shown in Figures 1 and 2. Each fairing section 10 comprises a generally cylindrical body portion 12 which is extended

at one side, to form a generally triangular-section tail portion 14. The cylindrical body portion 12 forms a sleeve around the lead-in cable (not shown). The triangular-section tail portion 14, which is generally hollow, extends in a radial direction from the cable, forming a trailing edge as the cable is dragged through the water. The tail portion 14 is made hollow to improve the weight balance of the profile of the fairing section 10 with respect to its pivoting centre (ie the axis of the lead-in cable) and to reduce storage volume. As can be seen in Figure 2, the overall profile of each fairing section 10 is 'teardrop' shaped, providing much less drag than a plain cylindrical cable.

A further drag reducing feature is formed on the cylindrical body portion 12 adjacent what is, in use, the leading edge of the fairing. Symmetrically disposed about the central radial axis of the tail portion 14 are two sets of longitudinally extending parallel ridges or ribs 18. The purpose of these ridges 18 is to 'roughen' the leading edge surface of the fairing section 10 and so trigger the creation of a thin turbulent boundary layer to control the laminar flow separation over the profile of the fairing section in accordance with known hydrodynamic principles. Substantially the same "roughening" effect is produced by grooves rather than ridges, and the term "ridges" as used herein is to be understood as encompassing both ridges and grooves.

At each of its ends, each fairing section 10 is provided with a cylindrical socket 20 of larger diameter than the cylindrical opening through the main part of the body portion 12 of the fairing section 10.

The fairing sections can conveniently be formed of extruded EPDM rubber with reinforcing fibres made of Kevlar (registered trade mark) in the cylindrical wall of the body portion 12. The fairing sections 10 may be in the range 3m to 10 m in length and are of a size to give a clearance of 2 mm around the lead-in cable. This clearance is sufficient to allow the fairing to swivel freely about the cable but is a sufficiently close fit to avoid excessive movement of the lead-in cable within the fairing, which might cause damage.

It is desirable that the fairing section can swivel about the cable so that they can take up the most favourable position for reducing drag relative to the direction of

movement of the lead-in cable through the water, without the cable itself having to twist in the water to accommodate this streamlining. For this reason, it is also desirable that neighbouring fairing sections 10 are able to swivel freely relative to one another. To permit this, adjacent fairing sections 10 are joined by means of the swivel coupling 25 illustrated in Figures 3 to 6 of the drawings.

The coupling 25 shown in the drawings has four components, an end connector 30 shown in Figure 3, a swivel bearing 40 shown in Figure 4, and two clamping rings 50, one of which is shown in Figure 5.

The end connector 30 is made of, for example, stainless steel and consists of a spigot 32 provided with a plurality of circumferentially extending grooves 34. At one end, the end connector 30 is provided with an outwardly extending annular flange 36. The spigot 32 is inserted into the cylindrical socket 20formed at the end of the fairing section 10 and secured to it by crimping, using a suitable crimp ring of soft metal (not shown). The grooves 34 on the spigot 32 help to ensure that the crimping operation fastens the end connector 30 to the fairing section 10 securely. Each fairing section 10 is provided with an end connector 30 at both of its ends, if it is to be adjacent two other such sections. Alternative couplings arrangements may be appropriate at the ends of the lead-in cables, where the fairing sections 10 may be connected to other equipment, as will be described in more detail hereinafter, or may simply be left free.

Between each pair of end connectors 30 at the adjacent ends of neighbouring fairing sections 10 is positioned a swivel bearing 40. The swivel bearing 40 is a ring, typically made of aluminium bronze and of generally U-shaped cross-section, with two parallel annular flanges 42. In use, as can be seen most clearly in Figure 6, the swivel bearing is located between the end connectors 30 of two adjacent fairing sections 10. The annular end surfaces of the two parallel flanges 42 of the swivel bearing 40 abut the annular flanges 36 on the two end connectors 30, providing a bearing surface against which the end connectors 30 can rotate.

It will be appreciated that, in assembling the complete fairing, after each fairing section 10 is threaded on to the lead-in cable, two end connectors 30, properly

oriented relative to one another and to the fairing sections 10, must be threaded on to the lead-in cable, separated by a swivel bearing 40.

The coupling 25 between each pair of adjacent fairing sections is completed by means of clamping rings 50 shown in Figure 5.

Each clamping ring 50 is formed in two semi-circular parts which together form a ring having two inwardly directed flanges, thus giving the clamping ring a U-shaped cross section. Each coupling includes two clamping rings 50, each of which clamps together the annular flange 36 on one of the end connectors 30 and one of the two outwardly directed flanges 42 on the swivel bearing 40. The two halves of each clamping ring 50 can be secured together in a conventional fashion by means of suitable screws or bolts (not shown) which pass through holes 52 formed in the two halves of each clamping ring.

The completed clamping ring 50 traps the flange 36 on the end connector 30 and the flange 42 on the swivel bearing 40 in its U-shaped cross section, but in such a way that the two can rotate freely relative to one another.

As indicated earlier, the groups of adjacent fairing sections 10 are mechanically secured to the lead-in cable at, and only at, the two free ends of the groups of fairing sections. This is desirable to prevent stacking or telescoping of groups of adjacent sections 10.

Securing of the fairing sections to the lead-in cable is achieved using the arrangement shown in Figures 7 and 8. As shown in Figure 7, the lead-in cable has an armoured sheath 70 which is provided with reinforcing fibres 72. Loops 74 are formed in the reinforcing fibres 72. These loops 74, in use, lie and are held in four horseshoe-shaped grooves 82 formed in an anchoring bracket 80, shown in Figure 8. The anchoring bracket is provided at its end remote from the horseshoe-shaped grooves 82 with an outwardly extending flange 84 similar in configuration to the annular flanges 36 formed on the end connectors 30.

The flange 84 on the anchoring ring 80 is secured to the annular flange 36 of the end connector on the end-most fairing section 10 in exactly the same

manner as the annular flanges 36 of adjacent end connectors 30 are secured to one another.

The inter-engagement of the loops 74 formed on the armoured sheath 70 of the lead-in cable with the end-most fairing sections 10 through the anchoring ring 80 and adjacent end connector 30 serves to maintain the group of adjacent fairing sections 10 in a more-or-less fixed axial position relative to the lead-in cable.

Figure 9 shows a modified version of the fairing of Figures 1 to 6, in which corresponding elements are given the same references as were used in Figures 1 to 6, but with the suffix a. Thus the modified fairing of Figure 9 is made up of fairing sections 10a basically similar to the fairing sections 10, except that at their respective enlarged coupled-together ends, ie the enlarged regions of the cylindrical body portions 12a containing the sockets 20a, the tail portion 14a is also enlarged, to maintain the ratio between the diameter of the cylindrical body portion 12a to the length of the fairing from its leading to its trailing edge substantially constant. Additionally, the width of the gap 90 between adjacent fairing sections is much reduced, and inclined so that, in use, its length is more closely aligned with direction of movement of the fairing through the water.

The coupling 25a is much simplified, in that the swivel bearing 40 is omitted, and a single two-piece clamping ring 50a fits over and entraps the flanges 36a of adjacent end connectors 30a. The clamping ring 50a effectively performs the bearing function that was performed by the swivel bearing 40, and to this end is made from a hard low friction plastics material, preferably polyoxymethylene (POM).

The fairings described above significantly reduce drag arising from the laterally extending lead-in cables used in the towing of seismic streamer arrays, thus reducing operational costs, particularly fuel costs, and/or allowing economic use of larger arrays.

CLAIMS

1. A fairing for use on a cable, in particular a lead-in cable for a seismic streamer array, the fairing comprising: a plurality of fairing sections, each having a central opening in which the cable is received and a streamlined profile which acts to reduce drag when the cable is moved through water in a direction transverse to its length; and at least one coupling assembly for fastening together adjacent fairing sections in such a manner as to permit rotation of said adjacent fairing sections relative to one another.

2. A fairing according to claim 1, in which the coupling assembly comprises a pair of end connectors each of which is secured to an end of one of a pair of adjacent fairing sections and has a radially outwardly projecting flange formed thereon, and an annular clamping ring which is made of a low friction material and which secures together the flanges formed on the end connector while permitting them to rotate relative to one another.

3. A fairing according to claim 2, in which the end connectors are secured to the fairing sections by crimping.

4. A fairing according to claim 2 or claim 3, in which the annular clamping ring is made in two semi-circular parts which are secured together, and is of U-shaped cross-section so as to trap the flanges of the end connectors within the U-section.

5. A fairing according to any one of claims 2 to 4, in which the clamping ring is made of a plastics bearing material, such as polyoxymethylene (POM).

6. A fairing according to any preceding claim, in which at least one fairing section is provided with a plurality of longitudinally extending ridges formed on the part of the fairing section which will, in use, be at or adjacent a leading edge thereof.

7. A fairing for use on a cable, in particular a lead-in cable for a seismic streamer array, the fairing comprising a plurality of fairing sections having

a central opening in which the cable is received and a streamlined profile which acts to reduce drag when the cable is moved through water in a direction transverse to its length, wherein at least one fairing section is provided with a plurality of longitudinally extending ridges formed on a part of the fairing section which will, in use, be at or adjacent a leading edge thereof.

8. A fairing according to claim 6 or claim 7, in which said fairing section is provided with two groups of longitudinally extending ridges arranged generally symmetrically around the leading edge, in use, of the fairing section.

9. A fairing according to any preceding claim, in which at least one end of the fairing section is secured to the lead-in cable so as substantially to prevent axial movement of the said fairing section relative to the lead-in cable.

10. A fairing according to claim 9, in which the said end of the said fairing section is secured to the lead-in cable by means of an anchoring assembly which engages a sheath of the lead-in cable.

11. A fairing according to claim 10, in which the anchoring assembly includes an anchoring ring formed with at least one horseshoe-shaped groove for receiving a fibre incorporated in the said sheath.

Fig.1.

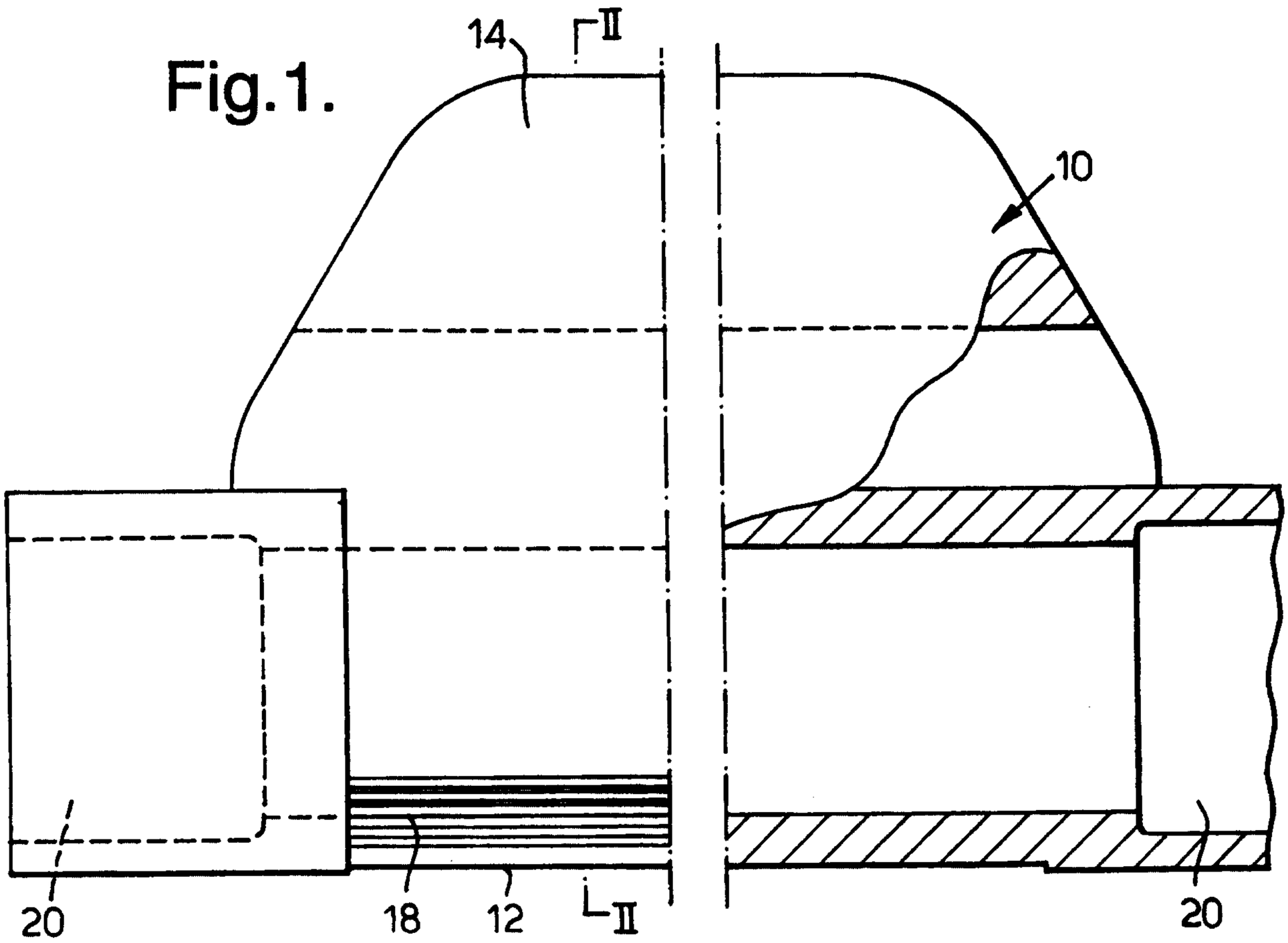


Fig.2.

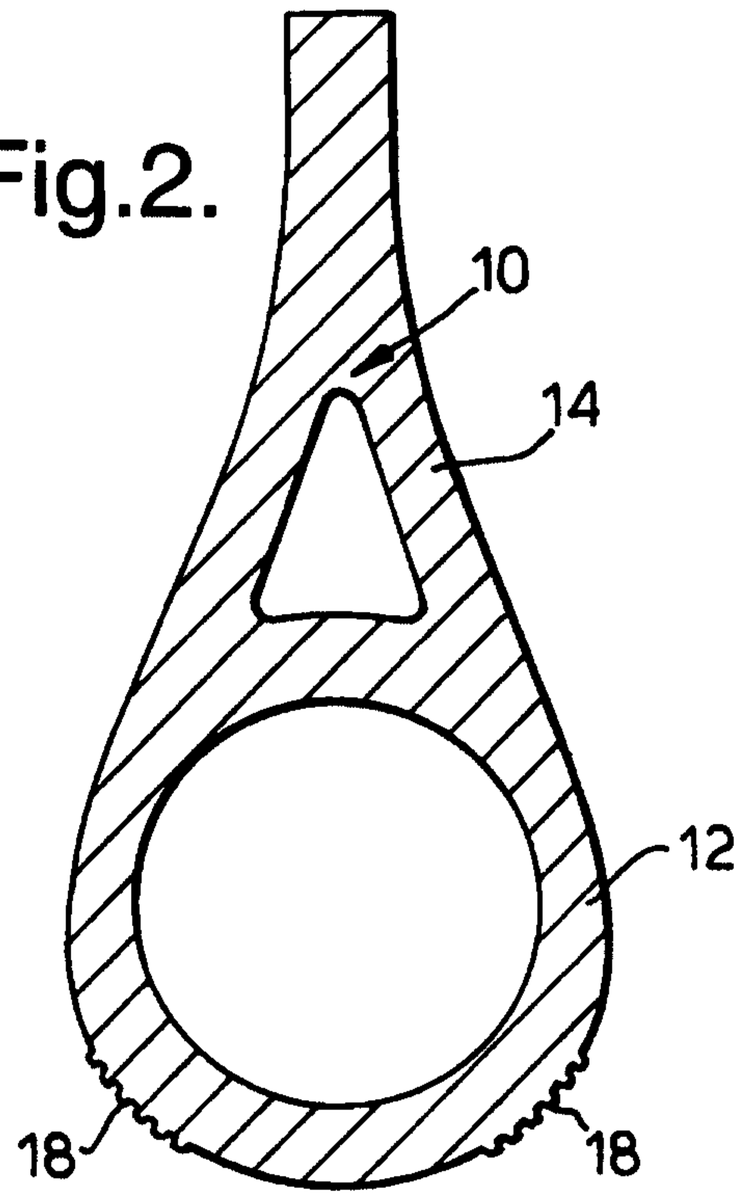


Fig.3.

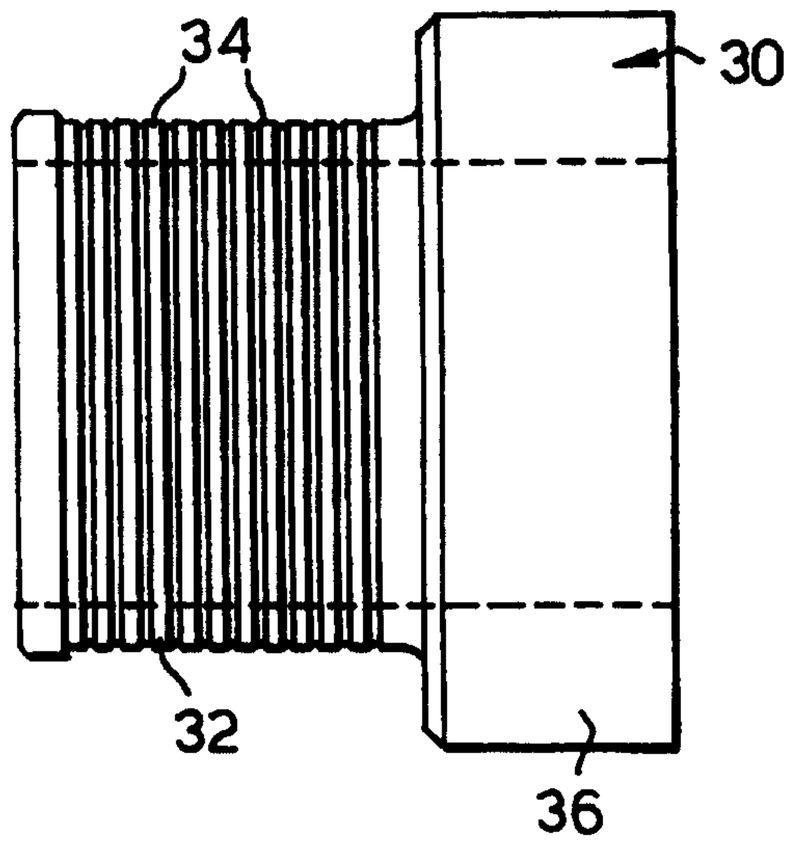


Fig.4.

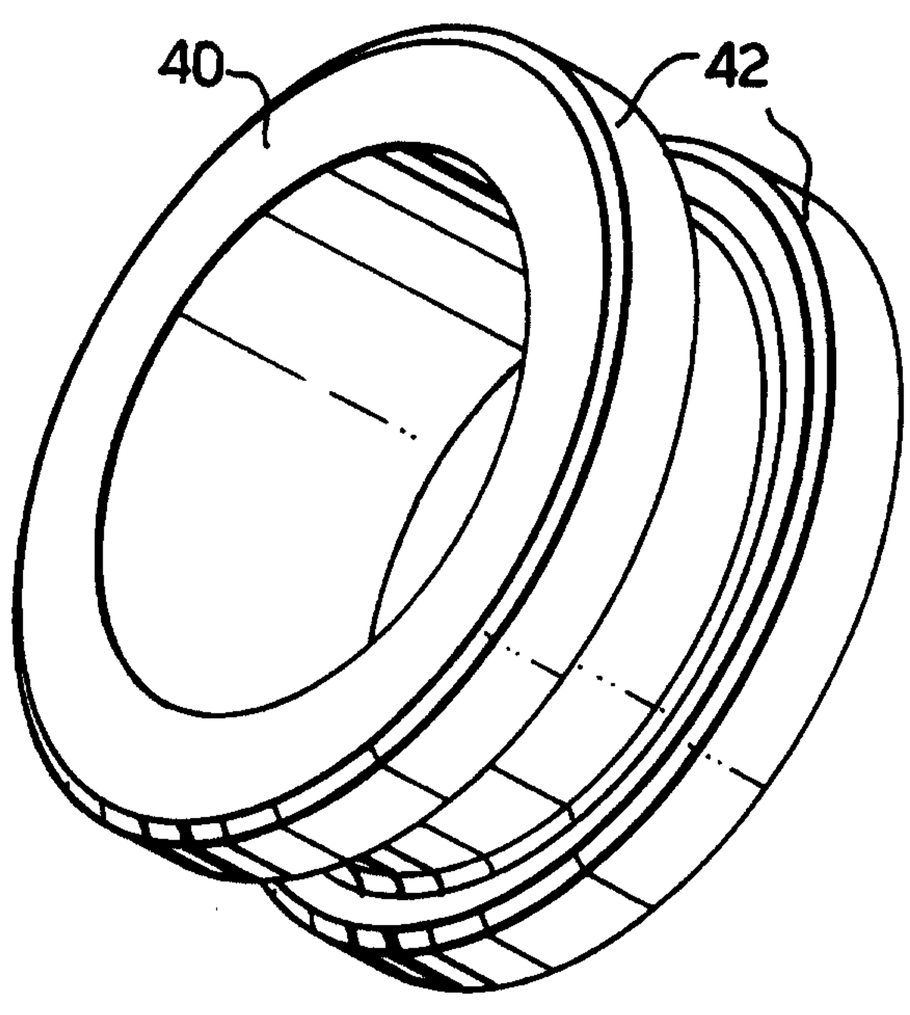


Fig.5.

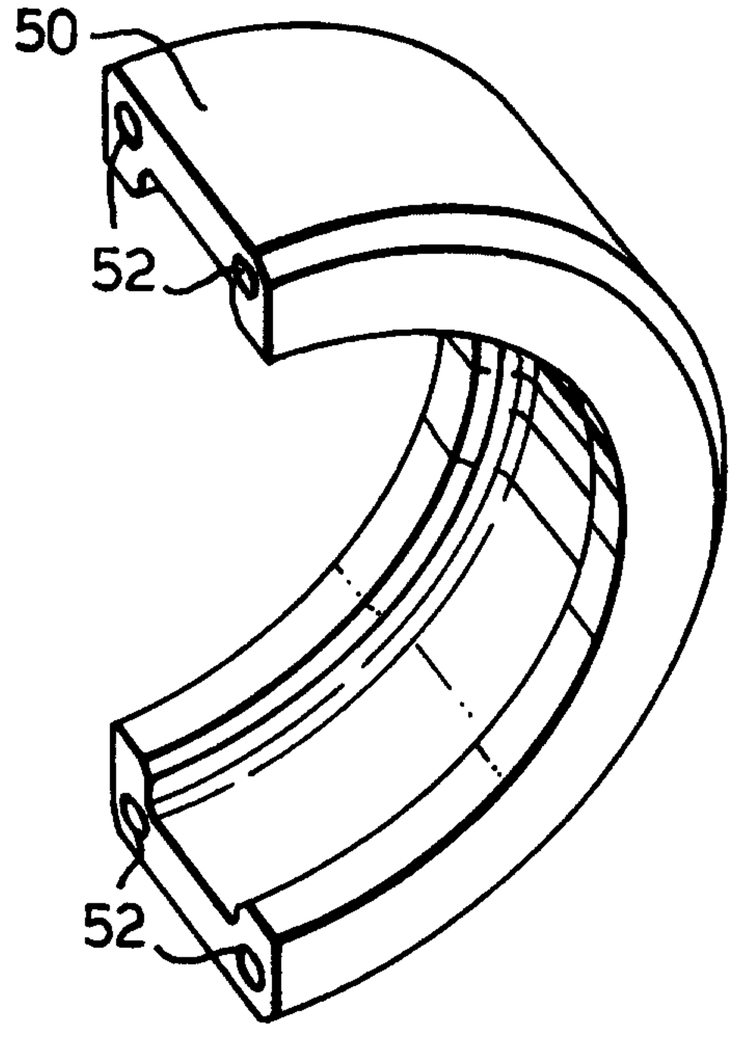


Fig.6.

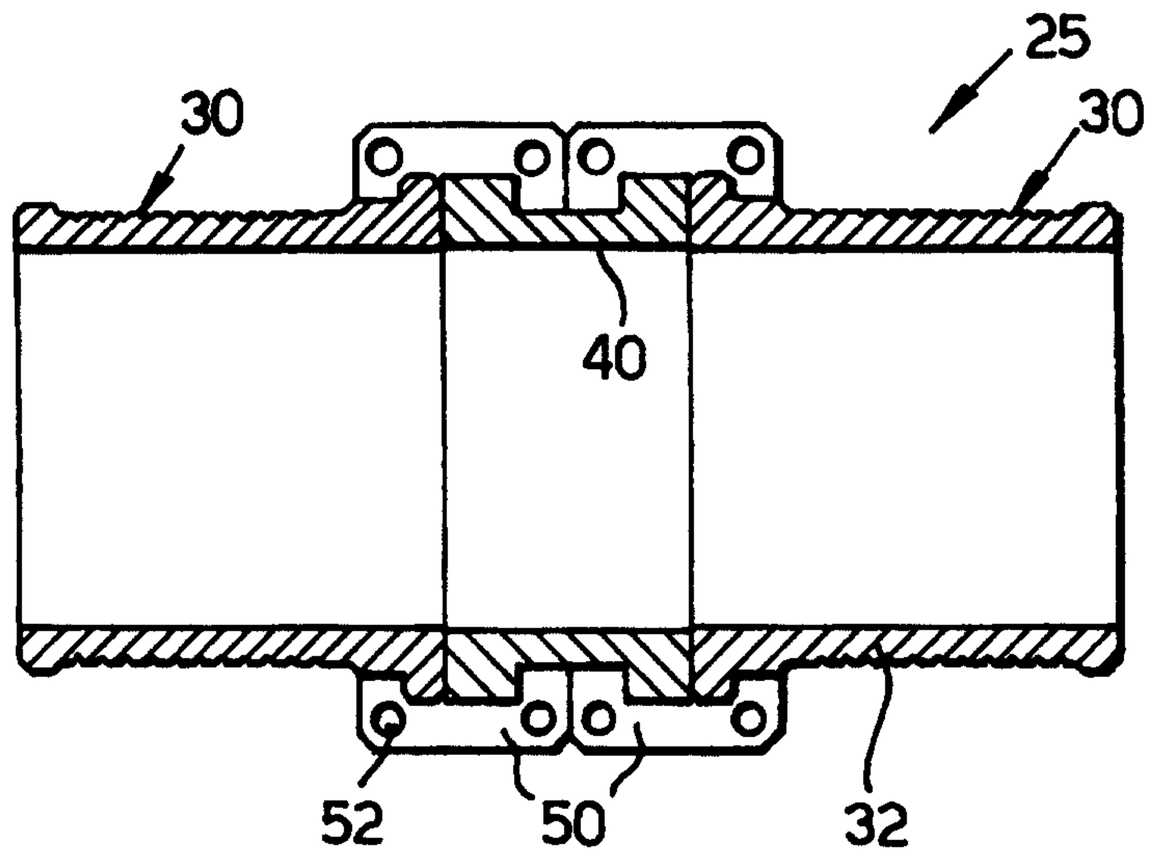


Fig.7.

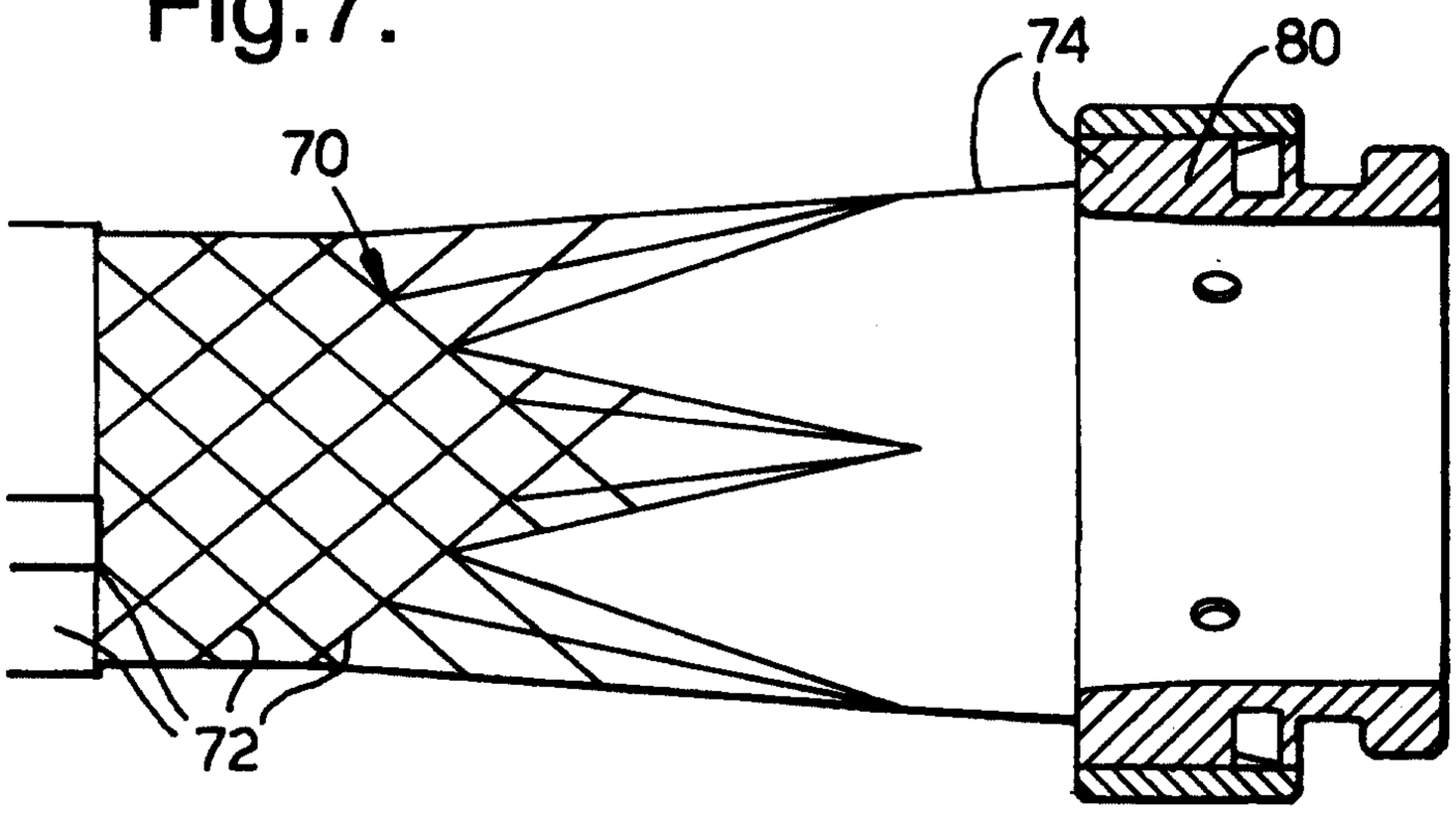


Fig.8.

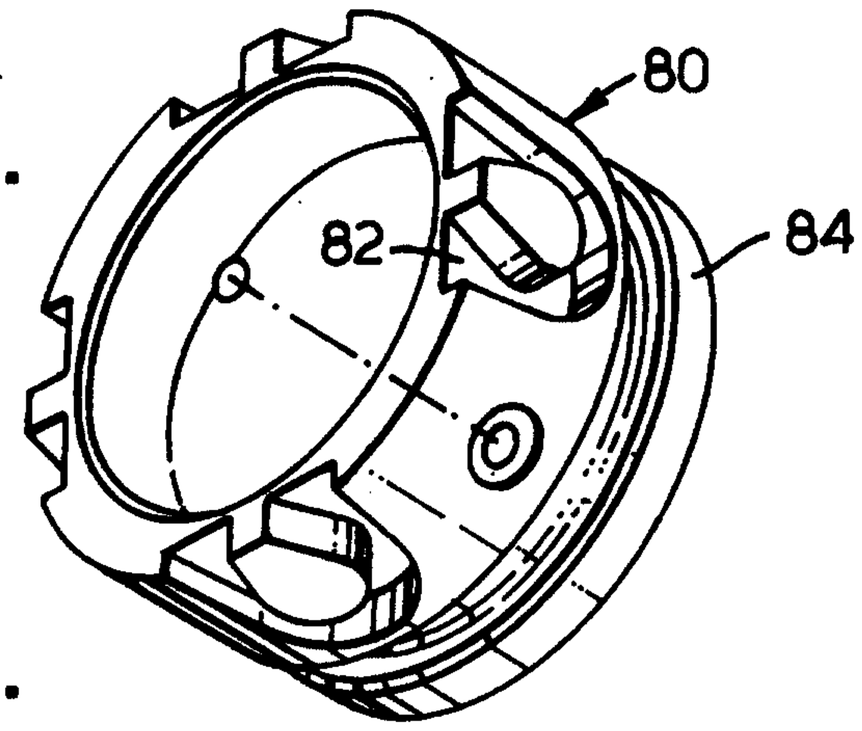
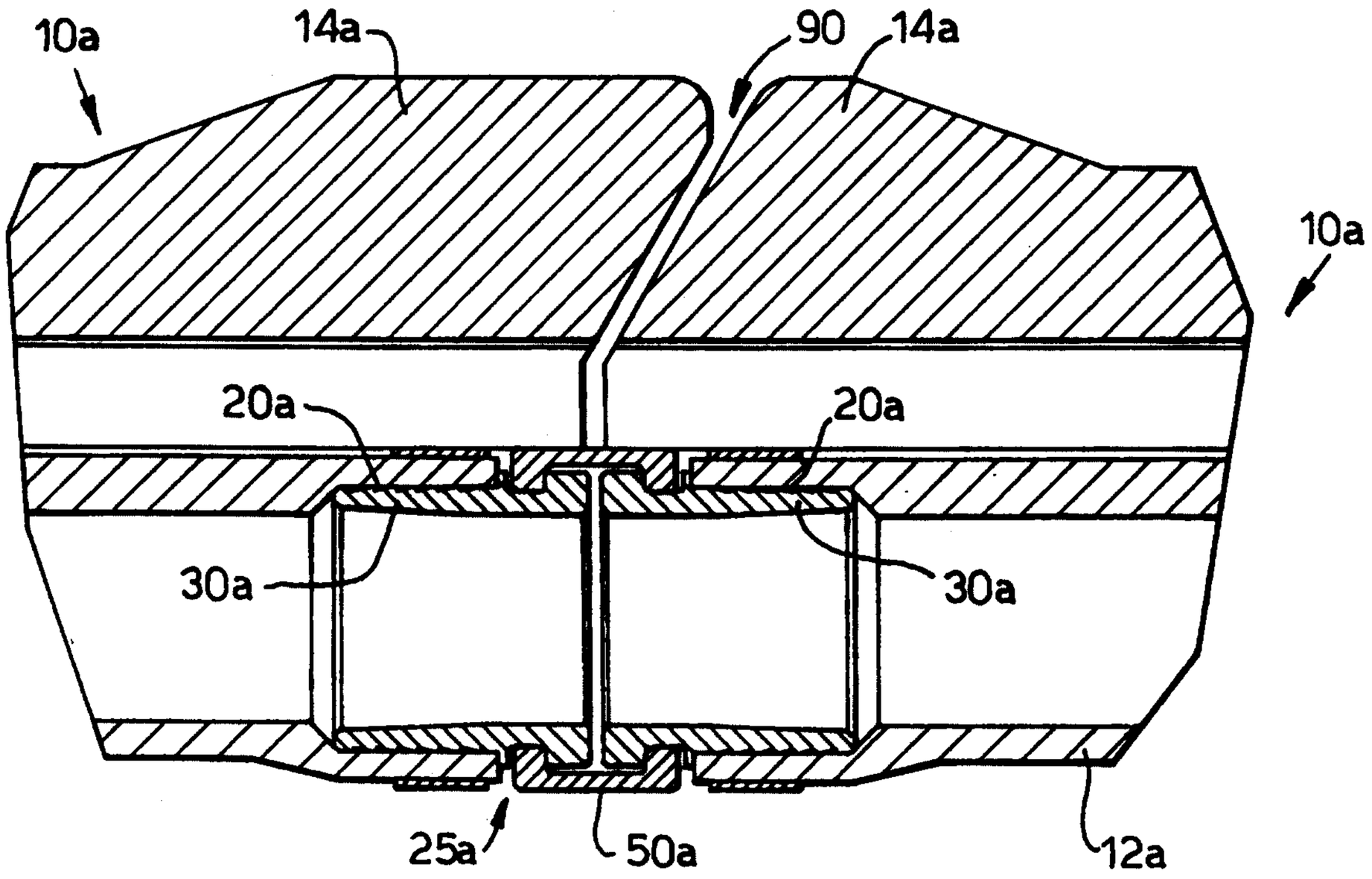
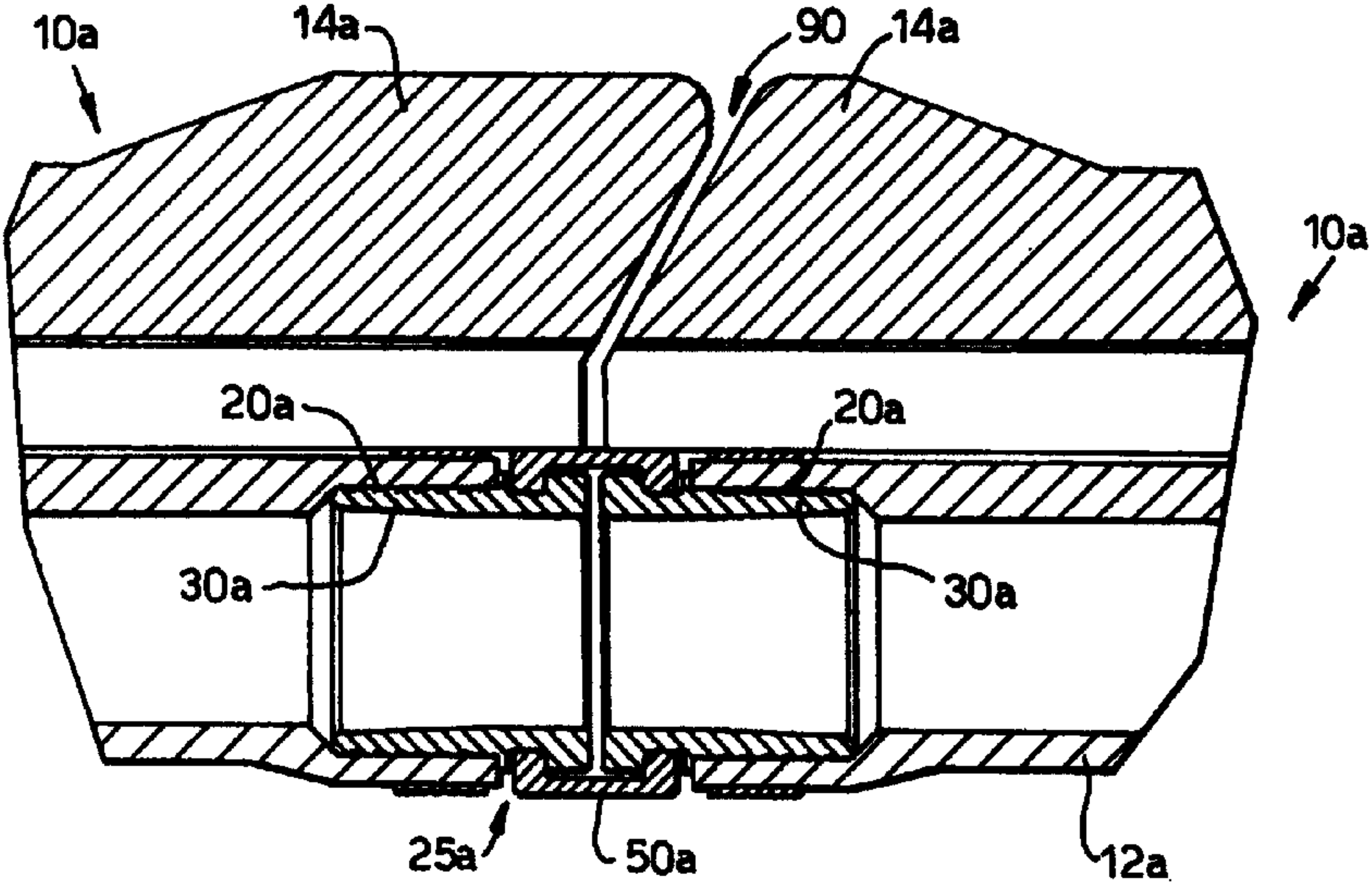


Fig.9.

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