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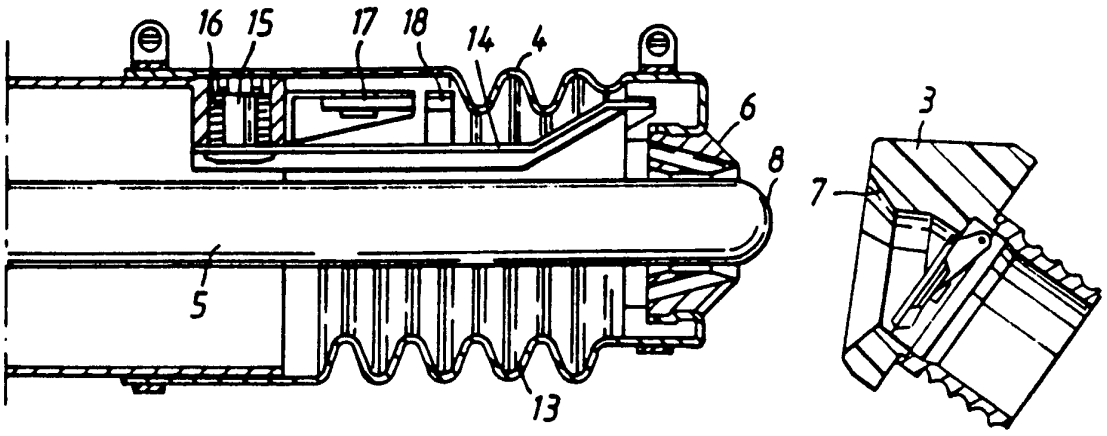
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(57) Abstract

Apparatus for the automatic refuelling of vehicles, primarily cars, comprising a robot which includes a robot head that is movable in relation to the robot so as to bring th robot head to a predetermined position in relation to the vehicle fuel tank pipe, this positioning of the robot head being effected by a positioning system which includes a first part located on the robot head and a second part placed in a predetermined position on the vehicle, wherein the robot head (1) includes an outer tube (4) and an inner tube (5) which can be moved within said outer tube and extended out of said tube, wherein the free, front end of the outer tube has a part in the shape of a truncated cone, said part being intended to be docked with a correspondingly conical part of an adapter (3), a truncated-conical part, during said positioning operation, said adapter being attached to the upper orifice of the fuel-tank pipe (2), and wherein subsequent to said docking operation, the free forward end of the inner tube is intended to project out to a position down in the fuel-tank pipe, whereafter fuel is delivered to the fuel tank through the inner tube.

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Apparatus for Automatic Refuelling of Vehicles

The present invention relates to apparatus for the automatic refuelling of vehicles.

Swedish Patent Specification No. 8901674-5 describes an apparatus for the automatic refuelling of vehicles, primarily cars, which comprises a robot which includes a robot head provided with a fuelling nozzle or like device and which is constructed to move the fuelling nozzle automatically from a rest position to a vehicle fuelling position in response to sensing and control means, subsequent to having placed the vehicle in a predetermined position relative to the robot.

According to this patent specification, the refuelling nozzle includes a rigid, first tubular element, preferably a metal tube, which is intended to be connected by the robot to an adapter which is provided with a hole and which is attached to the upper orifice of the vehicle fuel-tank pipe. A flexible, second tube, preferably of a plastic tube material, is arranged within the first, rigid tube for movement between a first end position in which the outer, free end of the second tube is located within the first tube, to a second end position in which the second tube projects out from the first tube. A tube connection is provided between said hole and the vehicle fuel-tank pipe. The robot is constructed to move the free end of the first tube into abutment with, or to a position in the immediate vicinity of the adapter in a first movement step and to move the free end of the second tube out of the first tube and down into said tube connection or down into the fuel-tank pipe of the vehicle in a second movement step, and to pump fuel through the second tube and down into the fuel tank of the vehicle in a third step.

When fuelling of the vehicle is completed, the robot repeats the two first-mentioned steps, but in the reverse order.

A positioning system mentioned in the aforesaid patent application includes a transceiver unit mounted on the robot head which transceiver unit operates at microwave frequency, and a passive transponder is placed on the vehicle in a predetermined position relative to the fuel-tank pipe.

Although the robot head is positioned very accurately in relation to the fuel-tank flap or cover plate of the vehicle, and therewith in relation to the fuel-tank pipe, the load acting on the vehicle can change from the time at which the robot head is initially positioned to the time at which fuelling of the vehicle is commenced. This change in load may be caused by a person leaving the vehicle, for instance.

Furthermore, when positioning the robot head it is necessary to be able to accept within accepted tolerances deviations caused by measuring errors or by a wrongly positioned transponder on the vehicle.

It is thus desirable to be able to permit certain deviations between the ideal position of the robot head and the fuel-tank pipe when docking between the first, outer tube and the fuel-tank pipe, and the actual position occupied by the robot head immediately prior to docking.

Another problem is that docking must be monitored both prior to and during a fuelling operation, so that fuelling can be carried out in a safe manner.

These desiderata are fulfilled by the present invention.

The present invention thus relates to apparatus for the automatic refuelling of vehicles, preferably cars, comprising a robot which includes a robot head that is movable in relation to the robot so as to bring the robot head to a predetermined position in relation to the vehicle fuel tank pipe, this positioning of the robot head being effected by a positioning system which includes a first part located on the robot head and a second part placed in a predetermined position on the vehicle, wherein the robot head includes an outer tube and an inner tube which can be moved within said outer tube and out of said outer tube, wherein the free, front end of the outer tube has a part in the shape of a truncated cone, said part being intended to be docked with a correspondingly conical part of an adapter, a truncated-conical part, during said positioning operation, said adapter being attached to the upper orifice of the fuel-tank pipe, and wherein subsequent to said docking operation, the free forward end of the inner tube is intended to project out to a position down in the fuel-tank pipe, whereafter fuel is delivered to the fuel tank through the inner tube, said apparatus being characterized in that the forward end of the inner tube has an essentially conical shape; in that in said positioning operation, the inner tube has an axially displaced position relative to the outer tube such that the forward end of said inner tube will coact with the outer surface of the truncated cone of the outer tube to form a generally conical front part; and in that the outer tube is resilient or yieldable so that said docking procedure is able to take place provided that the tip of the inner tube is positioned radially inwards of the base of the conical part of the adapter.

The invention will now be described in more detail partially with reference to exemplifying embodiments thereof shown in the accompanying drawings in which

- Figure 1 is a side view of the front part of the robot head prior to final docking of the head with an adapter attached to a fuel-tank pipe;
- Figure 2 is a cut-away view of the front part of the robot head;
- Figure 3 illustrates a part of the forward part of the robot head and a part of the adapter;
- Figure 4 illustrates ongoing docking between the forward part of the robot head and the adapter, and shows a deviation between the actual and the ideal position;
- Figure 5 illustrates the position of the robot head upon termination of the docking procedure shown in Figure 4;
- Figure 6 illustrates conditions immediately prior to commencing a refuelling operation;
- Figure 7 illustrates the front part of the robot head seen from the right in Figure 1; and
- Figure 8 illustrates an alternative configuration of the forward end of an inner tube.

Figure 1 is a side view of the forward part of a robot head 1 and illustrates said part in a position prior to final docking of the robot head with an adapter 3 attached to the fuel-tank pipe 2 of the vehicle. The robot head belongs to a robot which is not shown in the Figure. The robot head 1 is movable in relation to the robot, so that the robot head can be brought to a predetermined position in relation to the fuel-tank pipe 2 of the vehicle, or more specifically in relation to the adapter 3.

The positioning is made by means of a positioning system which includes a first part located on the robot head and a second part which is placed in a predetermined position on the vehicle. The positioning system is preferably of the kind defined in the introduction, wherein the second part of the system is a passive transponder which is mounted on the vehicle

in the vicinity of or actually on the vehicle fuel-tank flap. The positioning system, however, is not significant to the present invention.

The robot head includes a fuelling nozzle which, in turn, includes an outer tube 4 and an inner tube 5 which is able to move within the outer tube and out of said tube, see Figure 2. The free, forward end of the outer tube 4 includes a part 6 in the form of a truncated cone, this part being intended to be docked with a corresponding conical part 7 in the form of a truncated cone on the adapter 3 attached to the upper orifice of the fuel-tank pipe during said positioning procedure. The free forward end 8 of the inner tube 5 is intended to be extended to a position further down in the fuel-tank pipe, see Figure 6, upon completion of the docking procedure, whereafter fuel is delivered through the inner tube.

According to the invention, the aforesaid foreward 8 of the inner tube 5 has a generally conical configuration. When positioning the robot head relative to the fuel-tank pipe, the axially displaced position of the inner tube 5 relative to the outer tube 1 is such that the forward part 8 of the inner tube will coact with the outer surface of the truncated cone 7 of the outer tube so as to form a generally conical forward part of the robot head.

As will be seen from Figure 2, among other things the forward part 8 of the inner tube 5 is smoothly rounded so as to provide a blunt point. This rounded forward part, however, coacts with the conical part 6 of the outer tube and a generally conical front part of the robot head. Figure 8 illustrates an alternative configuration of the forward part of the inner tube, namely a configuration in which the forward part 8 is much more pointed and in which a more accurate fit in the frusto-conical part 6 is achieved.

As shown only in Figures 8 and 7, the inner tube 5 of both of these embodiments is provided with openings 9 in its forward part, which allow fuel to pass through the inner tube and into the fuel-tank of the vehicle.

According to the invention, the outer tube 4 is sufficiently resilient or yielding to enable docking to take place provided that the tip of the inner tube is positioned radially within the base 10 of the conical part of the adapter. When docking is completed, see Figure 5, the conical surfaces 6, 7 of the robot head and the adapter respectively abut one another.

It is mentioned above that the outer tube 4 is sufficiently resilient or yielding to enable docking to take place provided that the tip 8 of the inner tube is positioned within the base 10 of the conical part 7 of the adapter 3, see Figure 1. Provided that the inner tube 5 meets the conical part of the adapter as the tube is projected out from the outer tube 4, the inner tube will be guided down into the adapter and therewith into the fuel-tank pipe 2. In that case when the forward end of the inner tube 5 does not come ideally into direct contact with the adapter opening 11 as the inner tube is extended from the outer tube, it is necessary for the outer tube 4 to be deformed in order to enable the inner tube to be guided down into the adapter.

Thus, the largest positional error of the robot head relative to the fuel-tank pipe that can be permitted is one in which the tip 8 of the inner tube is located within the base 10 of the conical part 7 of the adapter as the inner tube is forwardly extended. According to the invention, the outer tube shall be yieldable to an extent such as to allow effective docking to be achieved in the maximum permitted wrong positioning of the tube.

The base 10 of the conical part 7 of the adapter may have a relatively large diameter, for instance a diameter of from 5 to 10 centimeters.

Thus, the permitted positional error of the robot head relative to the fuel-tank pipe, or to the adapter, is much greater than the largest positional error that occurs as a result of measuring errors obtained in the positioning system. The difference in the height position of a car caused by a person leaving the vehicle is only one or more centimeters. The positioning problem mentioned in the introduction is therewith solved by means of the present invention.

Figures 4 to 6 illustrate a docking operation. In Figure 4 the broken line 12 illustrates the inner tube subsequent to having been extended from the outer tube, wherewith the tip of the inner tube lies against the conical part 7 of the adapter. When the inner tube is further extended from the outer tube, see Figure 5, the conical surface of the adapter will guide the inner tube down into the adapter opening 11. Simultaneously herewith, the whole of the robot head is moved forwards against the adapter, so that the conical part 6 of the outer tube will come into abutment with the conical part 7 of the adapter, see Figure 5, so as to deform the outer tube elastically. When docking has been completed, the inner tube is further extended outwardly and down into the vehicle fuel-tank pipe, see Figure 6.

According to a preferred embodiment, the outer tube 4 is made of a relatively rigid plastic or rubber material, and the front part of the tube includes a bellows-like section 13 which facilitates said deformation.

According to another preferred embodiment, the bellows-like section 13 is carried by a spring-loaded tab

or plate 14 whose spring-loaded attachment point 15 is fixed in relation to the robot head, see Figure 2. The tab 14 is attached by means of a coil spring 16 of such strength as to support the outer tube in a generally horizontal and predetermined position in the idle state of said tube. When the outer tube is deformed in the aforesaid manner, the tab will rotate around its attachment point 15; compare Figures 4 and 5.

This latter embodiment obviates the need for the outer tube to be self-supporting, thereby enabling the tube to be made of a softer material, because the tube is supported by the tab 14.

The tab 14 is also rotatable about its attachment point in a direction perpendicular to the plane of the paper.

According to one preferred embodiment, a sensor 17, 18 is mounted at the tab attachment point 15, this sensor functioning to sense deviation of the tab from its rest position, in which position no load acts on the outer tube, i.e. the position shown in Figure 2. The reference numeral 18 identifies a permanent magnet and the reference numeral 17 identifies a magnet sensor which is connected to a data processor belonging to the robot and controlling robot movement.

Because the tab is bent down when the outer tube is bent down and is rotated relative to the tab attachment point when the outer tube is moved in the horizontal plane, i.e. in a direction perpendicular to the plane of the paper, the sensor 17,18 is able to register permitted and unpermitted outward flexures of the outer tube. When the magnet 18 is distanced from the sensor 17 to an extent which is slightly greater than that shown in Figure 6, the sensor will send to the processor a signal which indicates that bending of the outer tube is excessive.

Excessive bending of the outer tube indicates that the robot head has been positioned wrongly in relation to the adapter fitted to the fuel-tank pipe.

According to another preferred embodiment of the invention, there is provided on the forward end of the outer tube a further sensor 19 which is intended to coact with a sensor 20 in the adapter, see Figures 1 and 3. When docking is completed, the sensor 19 and the sensor 20 will be positioned opposite to one another, as shown in Figure 3. This sensor is also connected to the aforesaid processor and is intended to deliver a signal to the processor when docking is completed and during the duration of said docking.

The robot processor is constructed to permit fuel to be transported in the inner tube only when the last-mentioned sensors 19, 20 and the first sensors 17, 18 indicate that docking has been implemented and that outward bending of the outer tube lies within the range permitted. This means that docking must be sufficiently accurate for fuel to be delivered and that refuelling is immediately interrupted should, for instance, the vehicle be driven away while refuelling is in progress. The sensors thus enable refuelling to be effected more safely.

Although the invention has been described in the aforegoing with reference to different embodiments thereof, it will be understood that these embodiments can be modified in a number of ways, for instance with regard to the dimensions and construction of the robot head and adapter.

The present invention shall not therefore be considered limited to the aforedescribed and illustrated exemplifying embodiments thereof, since modifications and changes can be made within the scope of the following Claims.

Claims

1. Apparatus for the automatic refuelling of vehicles, primarily cars, comprising a robot which includes a robot head that is movable in relation to the robot so as to bring the robot head to a predetermined position in relation to the vehicle fuel tank pipe, this positioning of the robot head being effected by a positioning system which includes a first part located on the robot head and a second part placed in a predetermined position on the vehicle, wherein the robot head (1) includes an outer tube (4) and an inner tube (5) which can be moved within said outer tube and out of said tube, wherein the free, front end of the outer tube has a part in the shape of a truncated cone, said part being intended to be docked with a correspondingly conical part of an adapter (3), a truncated-conical part, during said positioning operation, said adapter being attached to the upper orifice of the fuel-tank pipe (2), and wherein subsequent to said docking operation, the free forward end of the inner tube is intended to project out to a position down in the fuel-tank pipe, whereafter fuel is delivered to the fuel tank through the inner tube, c h a r a c t e r i z e d in that the forward end (8) of the inner tube (5) has an essentially conical shape; in that in said positioning operation the inner tube (5) has an axially displaced position relative to the outer tube (4) such that the forward end (8) of said inner tube will coact with the outer surface of the truncated cone (6) of the outer tube to form a generally conical front part; and in that the outer tube (4) is resilient or yieldable so that said docking procedure is able to take place provided that the tip of the inner tube (5) is positioned radially inwards of the base (10) of the conical part (7) of the adapter (3).

2. Apparatus according to Claim 1, c h a r a c - t e r i z e d in that the forward part (8) of the inner tube (5) includes in its mantle surface openings (9) through which fuel is able to pass out from the inner tube.

3. Apparatus according to Claim 1 or 2, c h a r - a c t e r i z e d in that the outer tube (4) is made of a relatively rigid plastic or rubber material and has a bellows-like section (13) in its forward part.

4. Apparatus according to Claim 1, 2 or 3, c h a r a c t e r i z e d in that the bellows-like section (13) is supported by a spring-loaded tab or plate (14) whose spring-loaded attachment point (15) is fixed relative to the robot head (1).

5. Apparatus according to Claim 1, 2, 3 or 4, c h a r a c t e r i z e d by a sensor (17, 18) mounted at said attachment point (15), said sensor functioning to detect deviation of the tab (14) from its rest position, in which no load acts on the outer tube (4).

6. Apparatus according to Claim 1, 2, 3, 4 or 5, c h a r a c t e r i z e d in that the forward end of the outer tube (4) carries a sensor (19) which is intended to coact with a further sensor (20) in the adapter (3), said sensor (19) and said further sensor (20) being located opposite one another when docking is completed.

Fig. 1

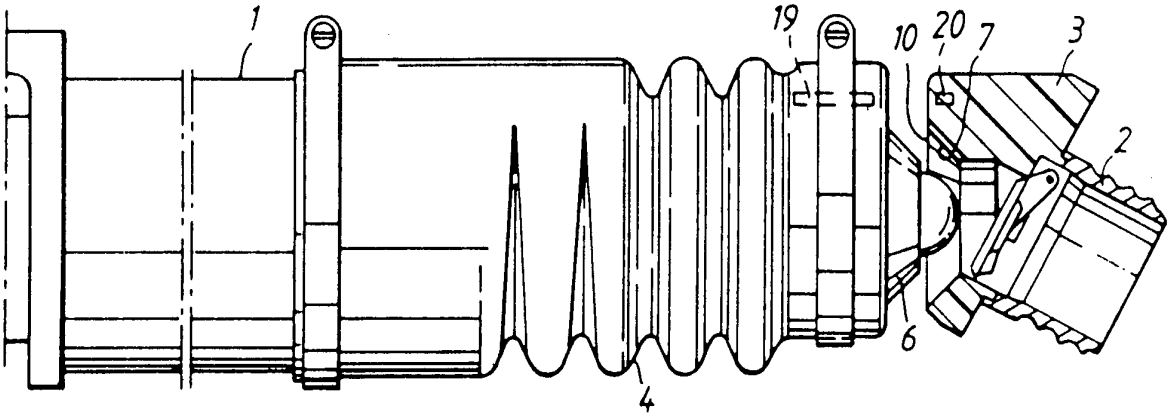


Fig. 2

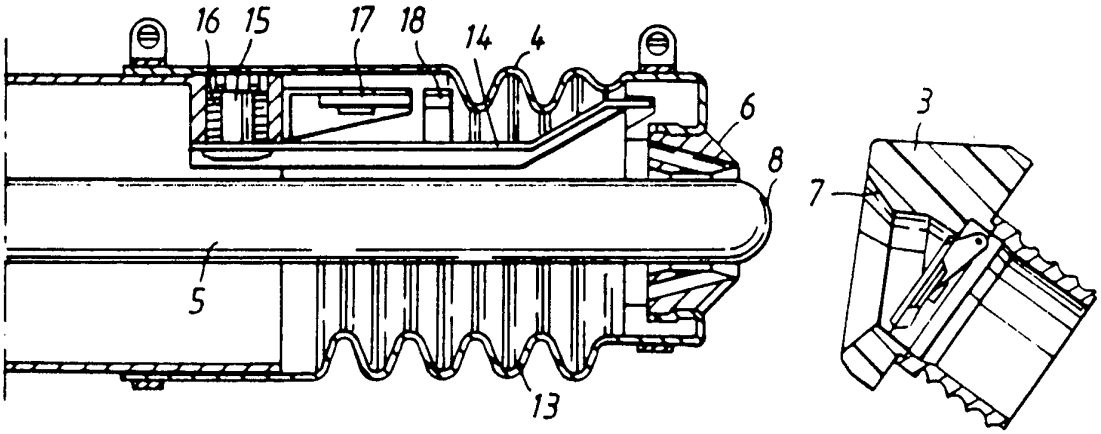


Fig. 3

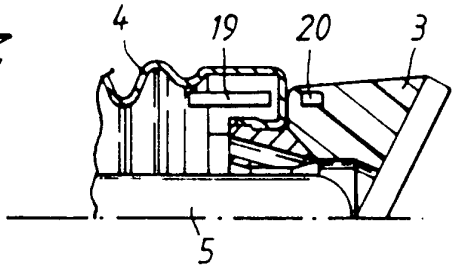


Fig. 4

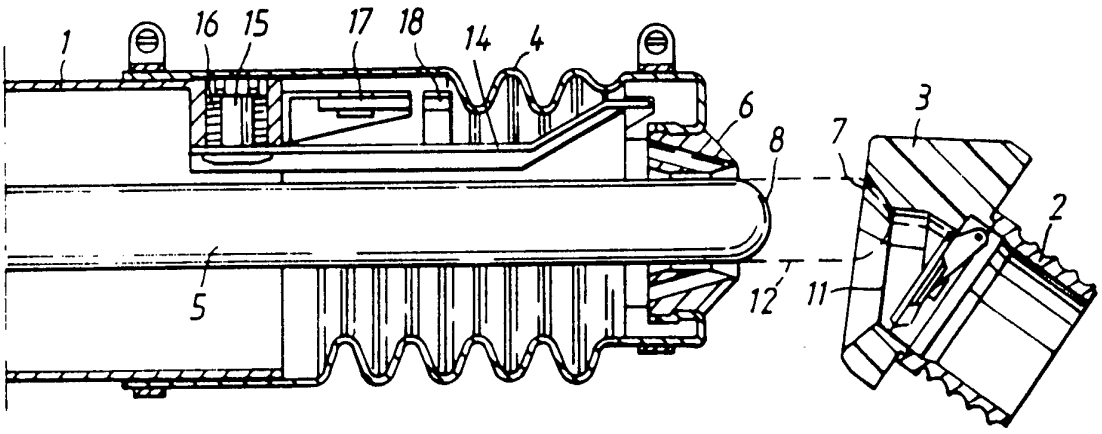


Fig. 5

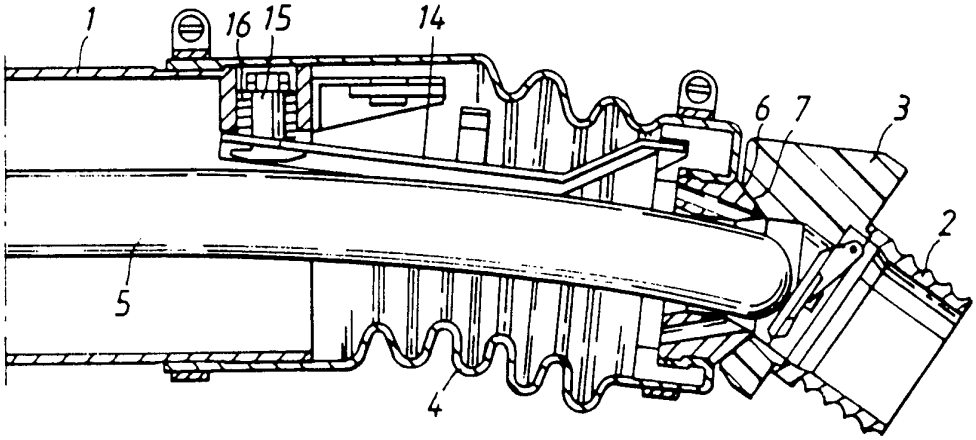


Fig. 6

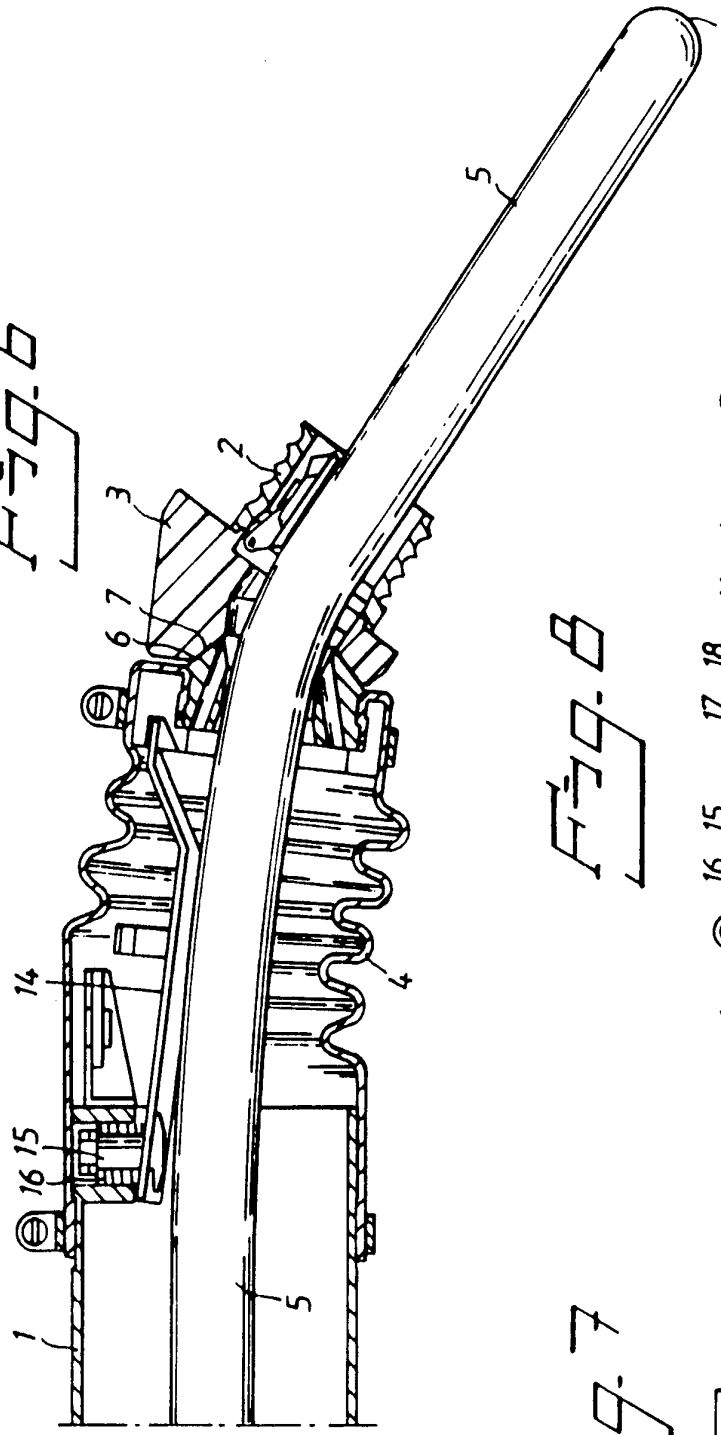


Fig. 8

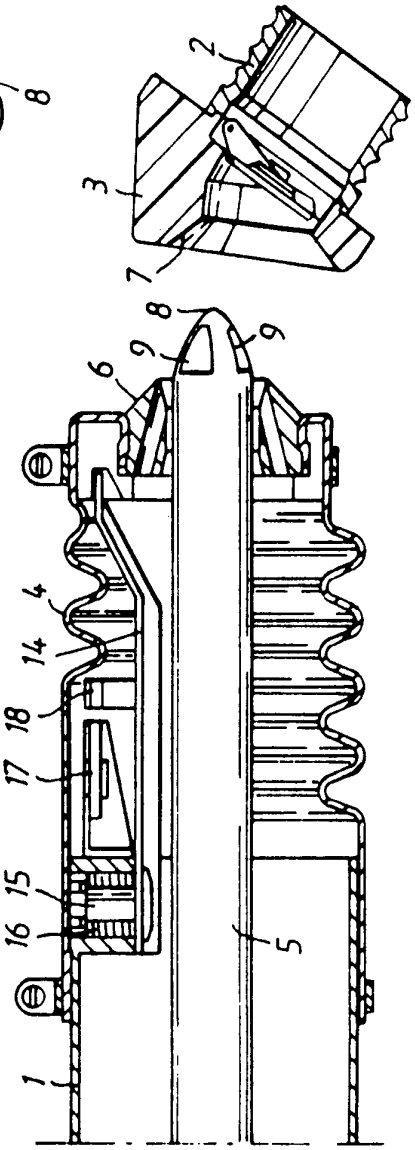
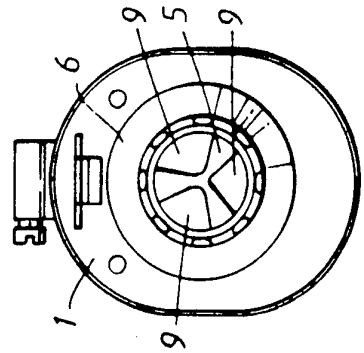


Fig. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 93/00717

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: B67D 5/08
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: B67D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DIALOG; WPI, CLAIMS, QUESTEL; EDOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO, A1, 9013512 (CORFITSEN, STEN), 15 November 1990 (15.11.90), page 10, line 6 - line 12, figure 3, detail 27; figure 9, details 23, 80, 81 --	1-4
Y	EP, A2, 0418744 (ETS ELEKTRONIK GMBH BERATUNG + VERTRIEB), 27 March 1991 (27.03.91), figure 6, detail 46 --	1-4
A	EP, A2, 0239193 (EMCO WHEATON, INC.), 30 Sept 1987 (30.09.87), page 10, line 17 - line 24, figure 1 --	3-5

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4681144 (RONALD F. HORVATH ET AL), 21 July 1987 (21.07.87), column 7, line 64 - column 8, line 5, figure 4 -- --------	1-6

INTERNATIONAL SEARCH REPORT

Information on patent family members

16/10/93

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A1- 9013512	15/11/90	AU-A- 5660690	29/11/90
		CA-A- 2064216	11/11/90
		EP-A- 0471773	26/02/92
EP-A2- 0418744	27/03/91	DE-A- 3930981	28/03/91
EP-A2- 0239193	30/09/87	AU-B- 580944	02/02/89
		AU-A- 6802587	30/07/87
		JP-A- 62220497	28/09/87
		US-A- 4697624	06/10/87
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