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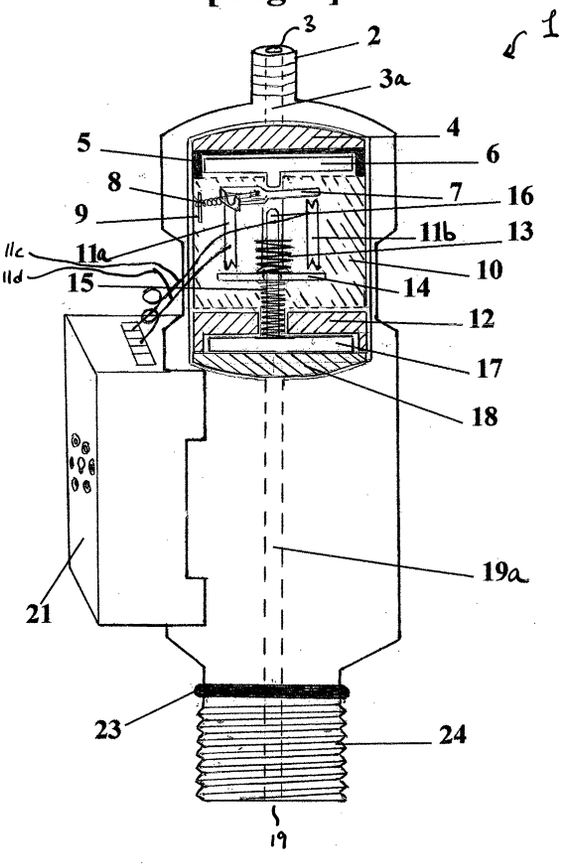
(54) A pressure-actuated switch

(57) A switch (1) comprises a first fluid inlet (3), a first set of electrical contacts (11a,7,11b) and means (4,6) responsive to the pressure at the first inlet (3) for switching the first set of electrical contacts from a first state to a second state when the fluid pressure at the first fluid inlet reaches a first predetermined level. The switch further comprises a second fluid inlet (19), a second set of electrical contacts (1 1a, 14,11b), and second means (17,18) responsive to the pressure at the second inlet for switching the second set of electrical contacts when the fluid pressure at the second fluid inlet reaches a second predetermined level.

[Fig 4]



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Description

[0001] This invention relates to a switch, in particular to a pressure-actuated switch which may be used, for example, for controlling a pump so as to control the level of liquid or gases inside a container.

[0002] There are many applications in which it is desired to control the level of liquid in a container. For example it may be desired to keep the level of liquid in a container below some pre-set value, and possibly to keep the level of liquid as low as possible. In such a case a pump for pumping liquid out of the vessel is provided. The pump is typically controlled by a switch that switches the pump on when the liquid level in the container has risen to a pre-determined value. In other cases it may be desired to keep the level of liquid in a container above a pre-set minimum value. In this case, a pump for pumping liquid into the container is provided, and this is typically controlled by a switch that switches the pump off when the liquid level in the container has risen to a pre-determined value.

[0003] Pumps for pumping liquids are normally controlled by float switches, or electronic or magnetic devices. These tend to close, or open, an electrical circuit, so switching on, or off, a pump, when a liquid level reaches a pre-set valve.

[0004] The disadvantage from having pump controlled by float switches or electronics devices are as follows.

[0005] They have electrical connections that are submerged or are in contact with the liquid, and so are prone to causing short circuit connections resulting in failure to operate.

[0006] They are vulnerable to fouling up or damage if used in contaminated or corrosive liquids.

[0007] They provide only limited control of fluid level before switching the pump on or off. In particular, they frequently tend to switch off a pump before the pump has completed emptying liquid from a vessel.

[0008] A first aspect of the invention provides a switch comprising: a first fluid inlet; a first set of electrical contacts; means responsive to the pressure at the first inlet for switching the first set of electrical contacts from a first state to a second state when the fluid pressure at the first fluid inlet reaches a first predetermined level; a second fluid inlet; a second set of electrical contacts; and second means responsive to the pressure at the second inlet for switching the second set of electrical contacts when the fluid pressure at the second fluid inlet reaches a second predetermined level.

[0009] A second aspect of the invention provides a switch comprising: a first fluid inlet; a first set of electrical contacts; means responsive to the pressure at the first inlet for switching the first set of electrical contacts from a first state to a second state when the fluid pressure at the first fluid inlet reaches a first predetermined level; and a second fluid inlet; and means responsive to the pressure at the second inlet for switching the first set of electrical contacts from the second state to the first state when the fluid pressure at the second fluid inlet reaches a second predetermined level.

[0010] A switch of the invention can control any type of electrical or magnetic device. All that is required is a standard relay, of voltage and amperage to suit the appliance that the unit is to control, plugged into a standard socket provided on the switch. Depending on how the electrical connections are made to the relay socket and to which inlet of the pressure switch a pressure signal from a sensor is connected, the switch unit can control an alarm system, the level of liquids in a vessel to within 10mm, or can be used to switch on a pump or an electrically controlled valve system to empty a vessel.

[0011] Alternatively, the switch may be used to control the input current to an electronic circuit, such as a power transistor circuit, and thereby control any desired electrical or magnetic device.

[0012] A switch of the invention may be made from any suitable materials. Most parts of the switch may be made of a plastics material, for example injection moulding.

[0013] Preferred embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 shows in perspective an air pressure switch of the invention connected to an air bell by a pipe;

Figure 2 shows one application of a switch of the invention;

Figure 3 shows an alternative application of a switch of the invention;

Figure 4 is a sectional view of a pressure switch of the invention:

Figure 5 is a partial enlarged view of the pressure switch of Figure 4: and

Figure 6 is an exploded exterior view of the switch of Figure 4.

[0014] In a preferred embodiment, a switch of the invention is provided with a primary contact 7 and a secondary contact 14. When closed, the primary contact 7 electrically connects a first terminal 11a to a second terminal 11b, and the secondary contact 14 also electrically connects, when closed, the first terminal 11a to the second terminal 11b. The primary contact 7 is controlled by fluid pressure at a first inlet 3, and is arranged to close when the fluid pressure at the first inlet reaches a first pre-set value. The secondary contact 14 is controlled by fluid pressure at a second inlet 19 and is arranged to close when the fluid pressure at the second inlet reaches a second pre-set value.

[0015] Figure 4 is cross sectional view of a switch 1 according to one embodiment of the invention. In the embodiment of Figure 4 the first inlet 3 is connected by a passage 3a to one side of a primary diaphragm 4 which is supported by a diaphragm ring 5, so that fluid pressure applied at the first inlet 3 is transmitted to one side (the upper side in Figure 4) of the primary diaphragm thereby deforming the primary diaphragm 4. A primary diaphragm button 6 is mounted movably in the switch, and is located so that when the fluid pressure at the first inlet increases to a first pre-set level the primary diaphragm 4 makes contact with the primary diaphragm button 6 thereby moving the primary diaphragm button (downwards in Figure 4). As the primary diaphragm button moves it comes in contact with the primary contact 7, and causes the primary contact 7 to move into its closed position and so electrically connect the first terminal 11a to the second terminal 11b. The terminals 11a, 11b are mounted on an electrically insulating housing block 10.

[0016] In the embodiment of Figure 4 the primary contact is pivotably mounted on the first terminal 11a. The primary contact is preferably provided with means for holding the contact in either the open or the closed state. In the embodiment of Figure 4 this means comprises a spring 8, one end which is connected to the primary contact 7 and the other end of which is connected to a mounting pin 9. The spring 8 may be any suitable spring including, but not limited to, a coil spring or a torsion spring.

[0017] In the embodiment of Figure 4 the second inlet 19 is connected by a passage 19a to one side of a secondary diaphragm 18 which is supported by a diaphragm support 12 so that fluid pressure applied at the second inlet 19 is transmitted to one side (the lower side in Figure 4) of the secondary diaphragm thereby deforming the secondary diaphragm 18. A secondary diaphragm button 17 is mounted movably in the switch, and is located so that when the fluid pressure at the second inlet increases to a pre-set level the secondary diaphragm 18 makes contact with the secondary diaphragm button 18 thereby moving the secondary diaphragm button (upwards in Figure 4). The secondary diaphragm button 18 is connected to the secondary contact 14 by a compression spring 15. As the secondary diaphragm button 18 moves upwards it applies pressure against the compression spring 15 and so moves the secondary contact 14 (upwards in Figure 4) until the secondary contact makes contact with the first and second terminals 11a, 11b so that the first and second terminals 11a, 11b are now electrically connected by the secondary contact 14 as well as by the primary contact 7.

[0018] As the secondary diaphragm button moves further (further upwards in Figure 4) the compression spring 15 is compressed further until the secondary diaphragm button 17 comes in contact with the primary disengage plunger 16. The plunger is then pushed up so as to come into contact with the bottom of the primary contact 7 so pushing the primary contact 7 into its open position. The primary contacts are then held in the open (off) position by the torsion spring 8.

[0019] Now, electrical connection between the first terminal 11a and the second terminal 11b is provided by the second contact 14. This electrical connection is maintained as long as the fluid pressure at the second inlet 19 provides sufficient deformation of the secondary diaphragm to keep the second contact 14 closed.

[0020] Bias means are preferably provided to bias the secondary contact 14 towards its open position. In the embodiment of Figure 4, a return spring 13 acts as this bias means, and the return spring 13 is compressed as the secondary diaphragm button moves as a result of deformation of the secondary diaphragm. When the fluid pressure at the second inlet 19 falls, the return spring 13 causes the secondary contact 14 to open, so breaking the electrical connection between the first terminal and the second terminal. If the switch is intended to be used in the orientation shown in Figure 4 it would in principle be possible to rely on gravity to open the second contact 14 when the pressure at the second inlet drops, in which case the bias means could be omitted.

[0021] The terminals 11a, 11b may be directly connected to a device that it is desired to control such as, for example, a pump, so that the device is controlled directly by the switch 1. In many cases, however, the level of the currents that must be switched make this undesirable, so it is therefore preferable if the device is not directly connected to the switch 1. Instead, the circuit via the terminals 11a, 11b is used to control the power supply to the device, for example by using a relay or an electronic circuit.

[0022] In the embodiment of Figure 4 the first and second terminals are connected by electrical connectors 11c, 11d to a socket 21, so that a relay 22 may be plugged into the socket. The socket 21 is preferably adapted to allow connection to any standard relay, so that a relay having appropriate current and voltage capability for the intended application can be easily fitted to the socket. The switch 1 is preferably provided with attachment means 20 to enable easy mechanical attachment of the socket 21 to the switch 1.

[0023] The inlets of the switch 1 are preferably provided with means for easy connection to pressure lines, pipes, etc. In Figure 4 the secondary inlet 19 is shown as having an external screw thread 24 and an O-ring seal 23 for making a screw connection to a pipe or pressure line, and the first inlet 3 is shown as having a force-fit or clamp-fit connector 2, but this is or illustration only and the invention is not limited to this. As shown in Figure 6 an adaptor cap 26 may be screwed onto the secondary inlet, for example using a reducer connector 25 if necessary.

[0024] Figure 2 shows one application of a switch of the present invention. This shows an arrangement in which a switch of the invention controls a pump for emp-

tying liquid from a container, or from a bilge of a boat. The second inlet 19 of the switch is connected into the outlet pipe 31 from a pump 33, which pump is arranged to pump liquid from a container 34. The pump 33 is connected to a suitable power supply (not shown) via a power line 35 and the relay 22.

[0025] An air bell 27 is mounted on a mounting bracket 29 by means of a suitable connector 28, and is fixed in a vertical position inside the container 34 using the mounting bracket 29, with the open end of the air bell directed downwards. The height of the air bell 27 can be set to any level that is required before pumping out needs to take place. One end of an air pipe 32 is connected to the air bell 27 by a connector 30, and the other end of the air pipe 32 is connected to the first inlet 2 of the switch unit.

[0026] It is assumed that the pump 33 is switched off, and that liquid is leaking into the container 34. When the level of liquid 36 in the vessel 34 rises above the bottom lip of the air bell 27 air trapped inside the air bell 27 and air pipe 32 is pressurised, and this raises the pressure at the first inlet 2. Once the pressure at the first inlet rises sufficiently the primary contact 7 will close, as described above, so connecting the first and second terminals 11a, 1b to one another. Closing the primary contact 7 completes an electrical circuit via the relay 22 and so starts the pump 33.

[0027] If a conventional switch were used in the arrangement of Figure 2, the pump 33 would cut out when the liquid level fell below the air-bell, so that the container 34 would never be emptied of liquid. Where a switch of the invention is used, however, as the pump starts to pump liquid from the container 33 it pressurises the outlet pipe 31 from the pump, which is connected to the second inlet. Thus, pressure at the second inlet 19 of the switch will rise, so closing the secondary contact 14 and opening the primary contact 7 in the manner described above. The pump will stay switched on, since electrical connection between the first terminal 11a and the second terminal 11b is maintained by the secondary contact, and the second contact will stay closed as long as the pump 33 can maintain pressure in the output pipe 31.

[0028] As soon as the container is emptied (or the liquid level falls below the height of the pump inlet) and the pump runs dry, the pressure in the output pipe 31 falls. The pressure against the secondary diaphragm 18 is lost, allowing the secondary set of contact points 14 to disengage returning to the open position, owing to the pressure from the return spring 13, thereby switching the pump off. The switch 1 is now ready for the next cycle.

[0029] In another embodiment, illustrated in Figure 3, a switch of the invention is used to control an alarm when the liquid level in a container reaches a pre-set level, or to control the level of liquid within a container. In this arrangement pump 33 draws liquid from a supply line 37 and pumps the liquid into the container 34.

[0030] In the embodiment of Figure 3 the air pipe 32 from the air bell 27 is connected directly to the second air inlet 19 of the switch 1. This may be done using a screw-on cap adapter 26, so that no change to the air pipe 32 is required. In this arrangement only the secondary contact 14 and 11 is used, and the switch 1 operates as a make and break switch controlled by the air pressure from the air bell 27. When the level of the liquid 36 rises above the bottom of the air bell so compressing the air trapped inside, this then applies pressure to the second inlet 19 via the connecting pipe 32. When the pressure at the second inlet 19 reaches a pre-set level the secondary contact 14 will close, as described above, so completing a circuit to the relay 22. This then can set off an alarm, or can disengage a pump that pumps liquid into the container if it is desired to fill the container to a level set by the position of the air bell 27. When the liquid level drops, the pressure in the air bell 27 also drops, in turn the pressure at the second inlet 19 also drops thereby allowing the secondary contact 14 to return to the open position, by way of pressure applied from the return spring 13. This then will switch off the alarm or, depending on how connections are made to the relay, can switch in a pump to pump more liquid into the container (until the level of liquid rises to reach the air bell 27 whereupon the switch 1 will again close). Where this arrangement is used to control a pump in this way, it is possible to control the level of liquid within the container 34 to within 1cm.

[0031] The air pipe 32 from the air bell 27 to the switch 1 can be several metres long, and this enables all electrical equipment to be kept well away from any moisture or liquid.

[0032] Furthermore, in an application of the type shown in Figure 2, the second inlet 19 of the switch also acts as an air bell. While the pump 33 is switched off, the pump outlet pipe 31 and the inlet passage 19a extending from the second inlet 19 of the switch will contain air. When the pump is switched on and fluid pumped from the container 34 starts to flow through the pump outlet pipe 31, some air will be trapped within the passage 19a of the switch; as the pressure in the pump outlet pipe rises the air trapped in the passage 19a extending from the second inlet 19 will be compressed, thereby transmitting the increase in pressure in the pump outlet pipe 31 to the secondary diaphragm 17. Thus, the fluid passing through the pump outlet pipe 31 does not come into contact with the secondary diaphragm 17, so that condensation and corrosion of the switch is reduced.

[0033] In a preferred embodiment, shown in Figure 5, the first and second terminals 11a, 11b are provided with V-shaped ends 38, and the primary and secondary contacts are provided with cylindrical or dome-shaped protrusions 39. This allows the primary and secondary contacts to double contact with the terminals 11a, 11b, so increasing the reliability of the switch. Alternatively or additionally, the primary and secondary contacts and/or the terminals 11a, 11b may be gold-plated for reliability.

Claims

1. A switch (1) comprising: a first fluid inlet (3); a first set of electrical contacts (11a,7,11b); means (4,6) responsive to the pressure at the first inlet (3) for switching the first set of electrical contacts from a first state to a second state when the fluid pressure at the first fluid inlet reaches a first predetermined level; a second fluid inlet (19); a second set of electrical contacts (11a, 14,11b); and second means (17,18) responsive to the pressure at the second inlet for switching the second set of electrical contacts when the fluid pressure at the second fluid inlet reaches a second predetermined level.

2. A switch as claimed in claim 1 wherein the means responsive to the pressure at the second inlet are adapted to switch the first set of electrical contacts from the second state to the first state when the fluid pressure at the second fluid inlet reaches the second predetermined level.

3. A switch comprising: a first fluid inlet; a first set of electrical contacts; means responsive to the pressure at the first inlet for switching the first set of electrical contacts from a first state to a second state when the fluid pressure at the first fluid inlet reaches a first predetermined level; and a second fluid inlet; and means responsive to the pressure at the second inlet for switching the first set of electrical contacts from the second state to the first state when the fluid pressure at the second fluid inlet reaches a second predetermined level.

4. A switch as claimed in claim 3 and further comprising a second set of electrical contacts, the means responsive to the pressure at the second inlet being adapted to switch the second set of electrical contacts when the fluid pressure at the second fluid inlet reaches the second predetermined level.

5. A switch as claimed in claim 3 or 4 wherein the means responsive to the pressure at the second inlet comprises an actuating member mounted for movement in response to fluid pressure at the second inlet, wherein initial movement of the actuating member from its rest position switches the second set of electrical contacts and further movement of the actuating member switches the first set of electrical contacts from the second state to the first state,

6. A switch as claimed in claim 5 and further comprising bias means for biasing the actuating member towards its rest position.

7. A switch as claimed in claim 5 or 6 wherein the second set of contacts are connected to the actuating member by a resilient connector.

8. A switch as claimed in claim 6 wherein the resilient connector is a compression spring.

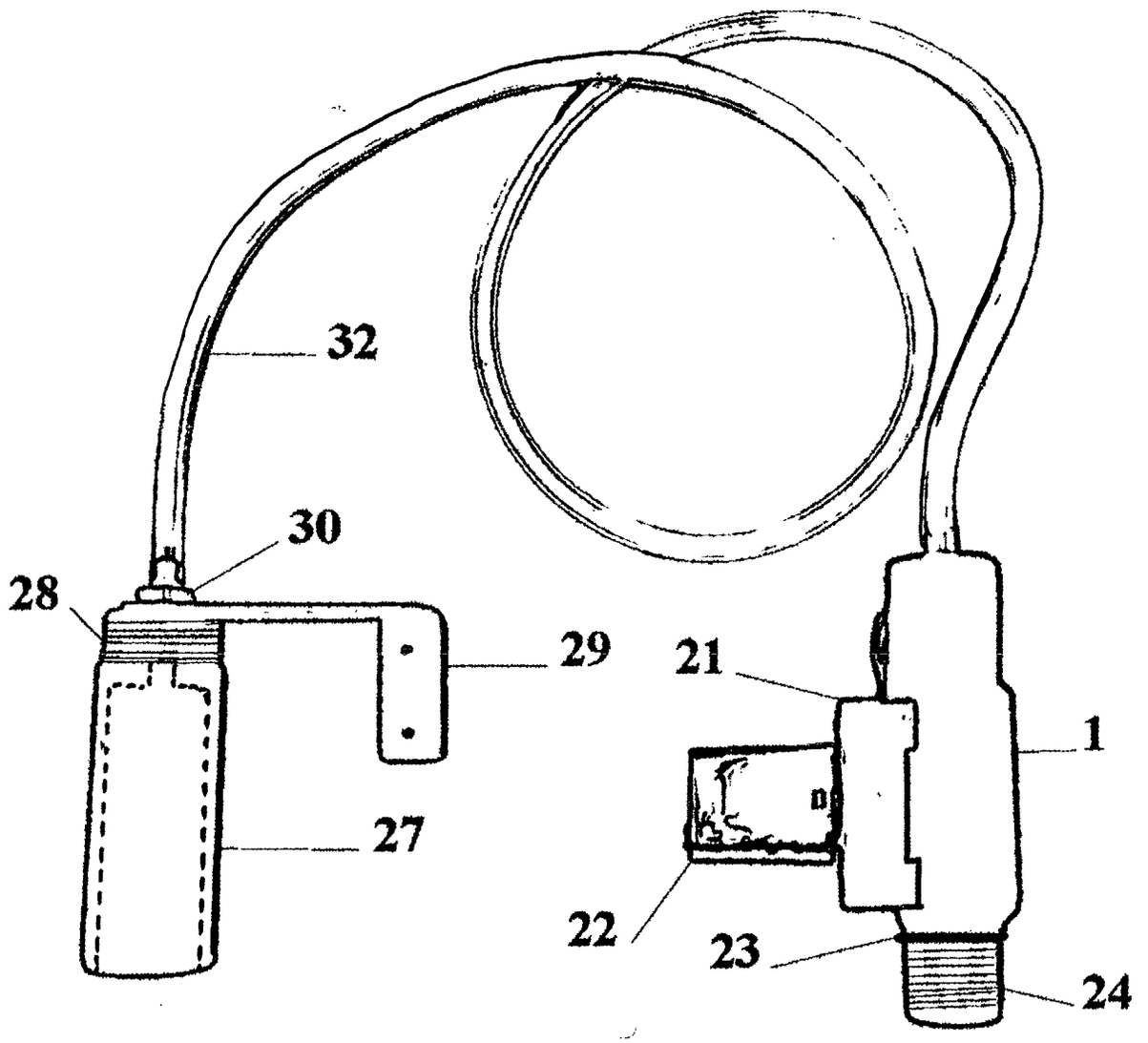
9. A switch substantially as described herein with reference to Figure 2 of the accompanying drawings.

10. An arrangement comprising: a container for a liquid; a sensor producing an output pressure signal dependent on the depth of liquid in the container; and a switch as defined in any preceding claim; wherein the output pressure signal from the sensor is input to the first fluid inlet of the switch.

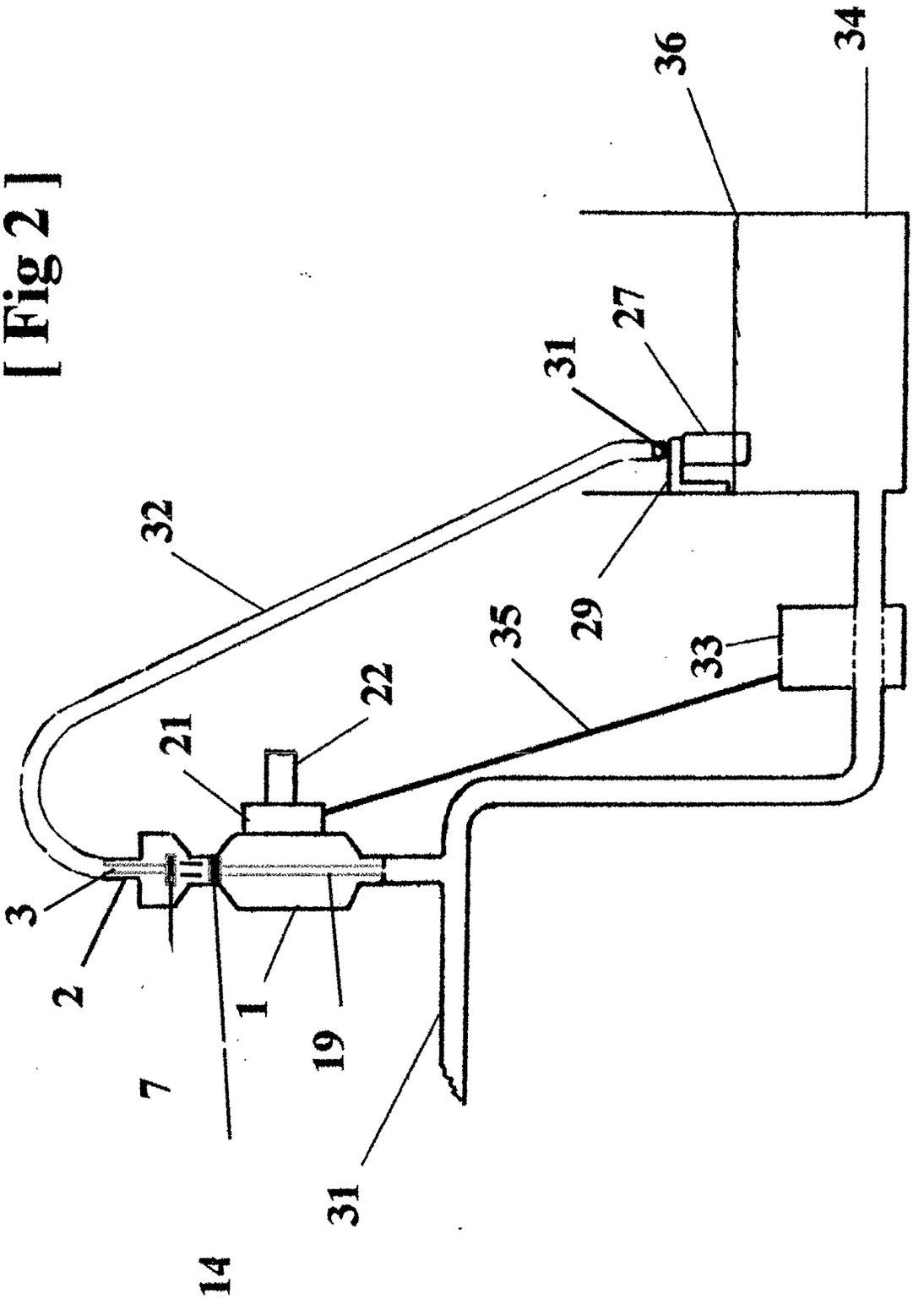
11. An arrangement as claimed in claim 10 and further comprising a pump for pumping liquid from the container, the second inlet of the switch being connected to the output from the pump.

12. An arrangement comprising: a container for a liquid; a sensor producing an output pressure signal dependent on the depth of liquid in the container; and a switch as defined in any preceding claim; wherein the output pressure signal from the sensor is input to the second fluid inlet of the switch.

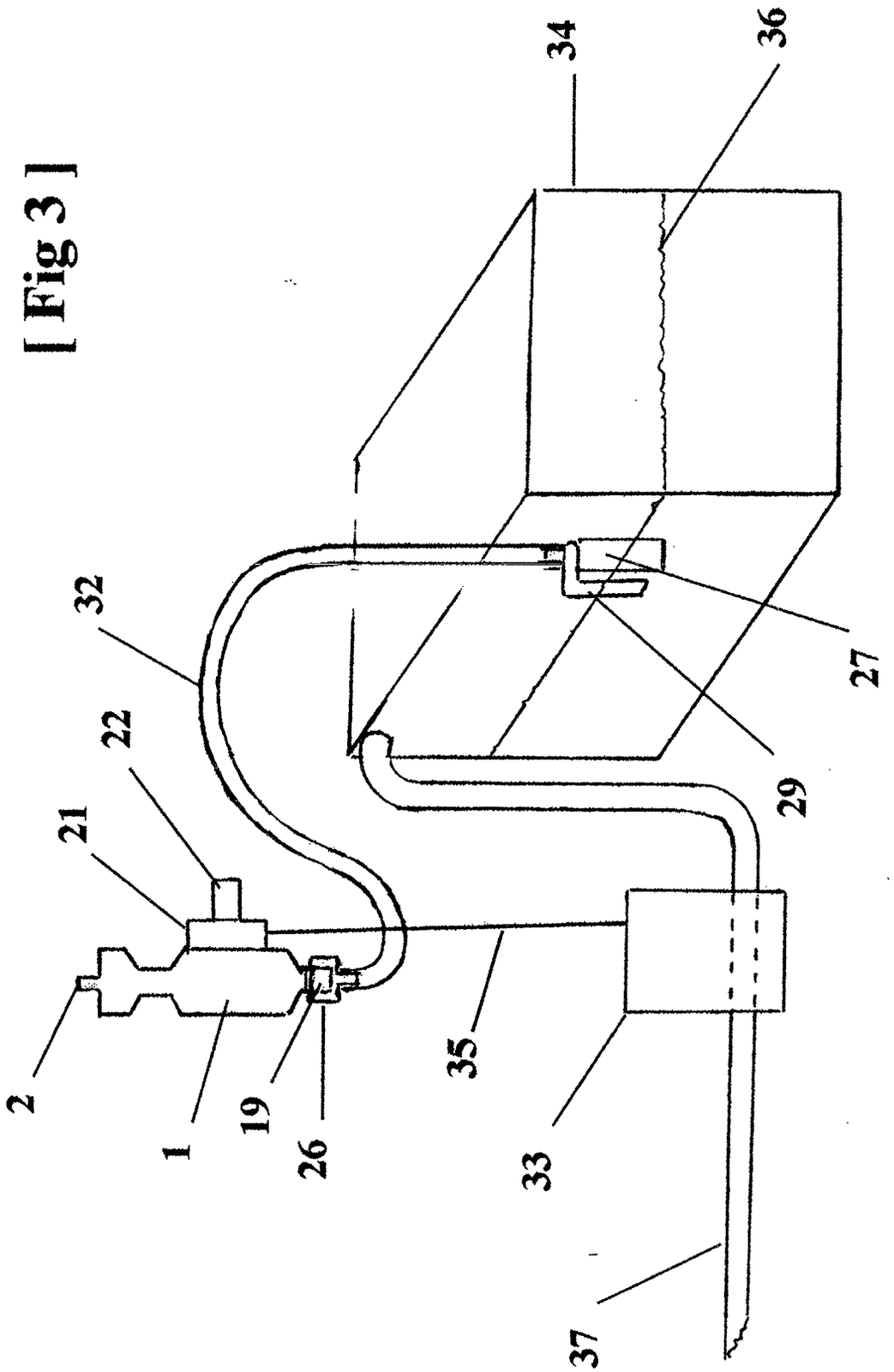
[Fig 1]



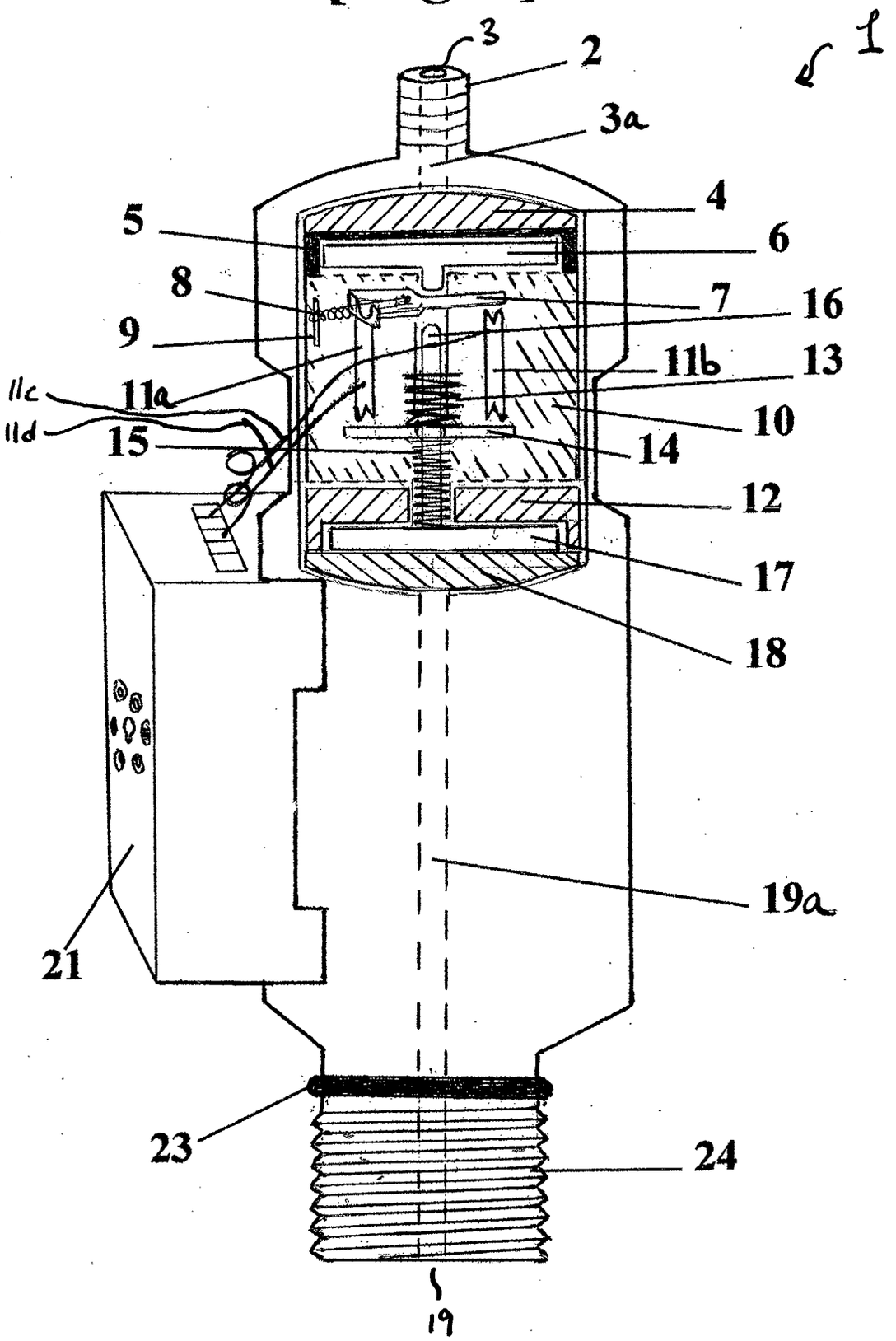
[Fig 2]



[Fig 3]



[Fig 4]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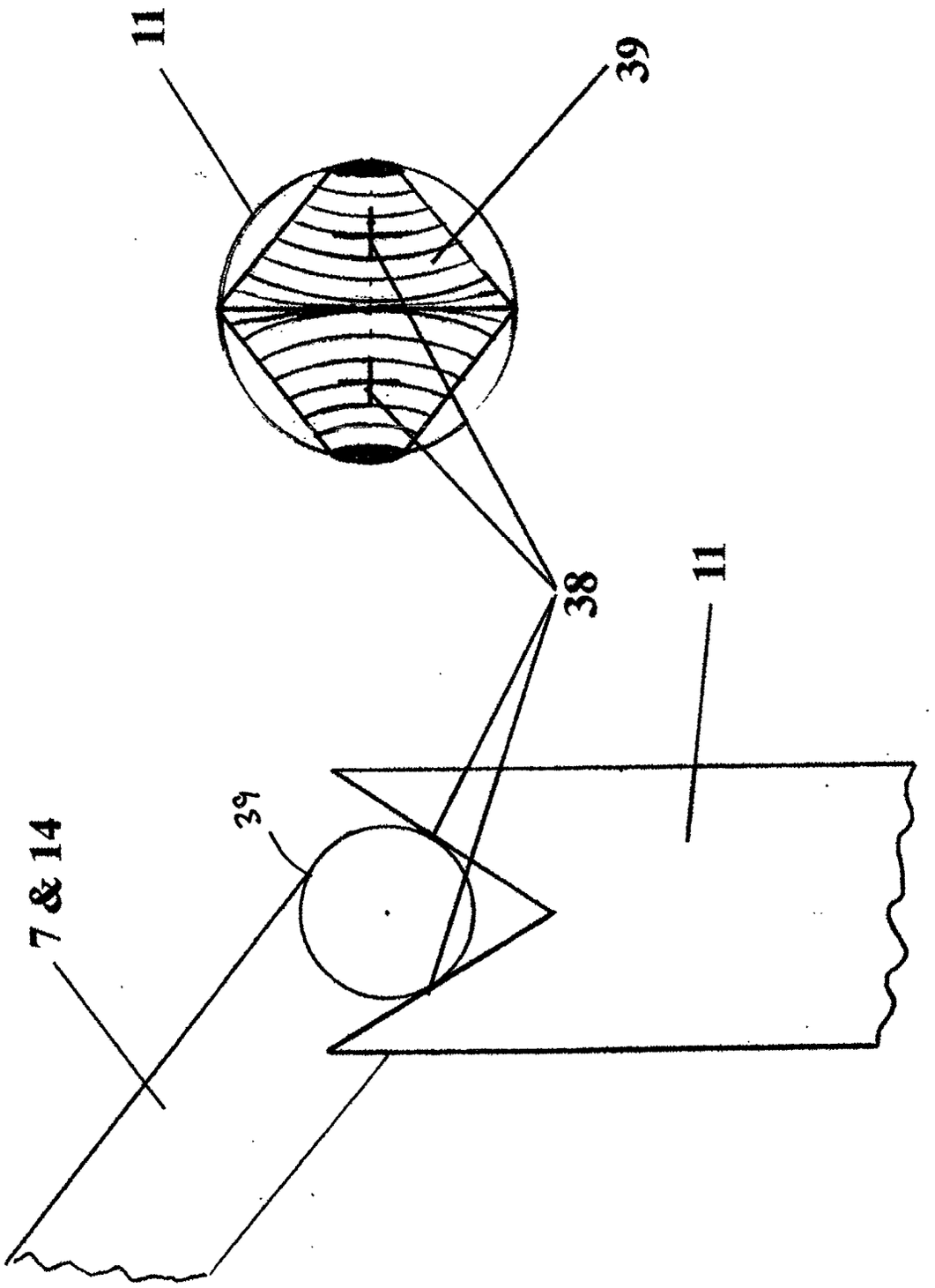
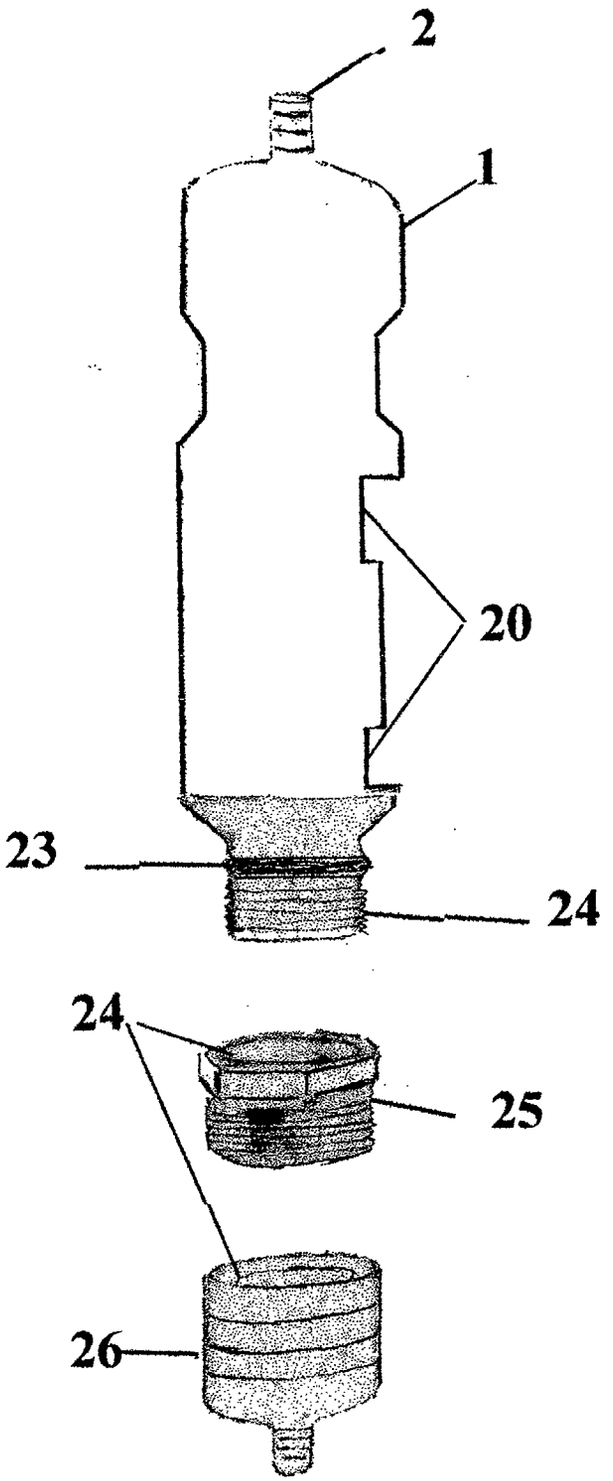
[Fig 5]



[Fig 6]



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EUROPEAN SEARCH REPORT

Application Number
EP 01 30 7378

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	25 January 2002	Socher, G

CATEGORY OF CITED DOCUMENTS

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