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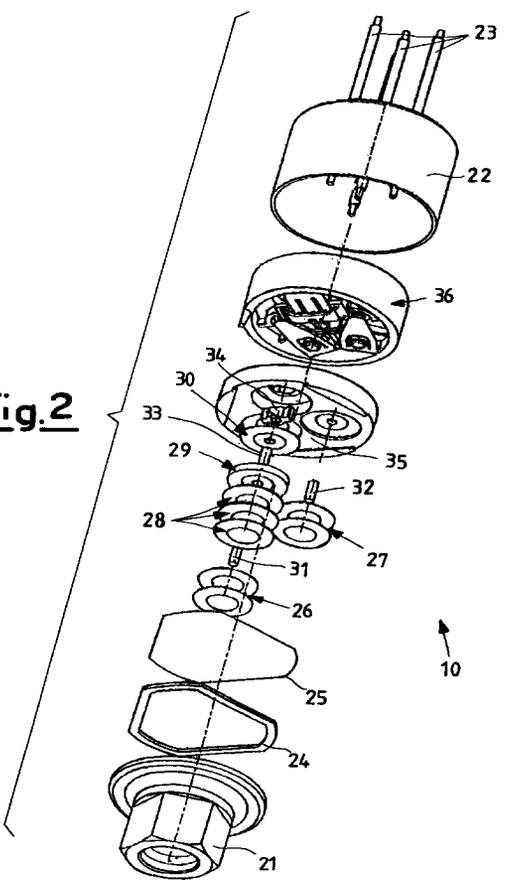
(54) Four-level regulator for fluid-operated air conditioning systems

(57) A four-level regulator for fluid-operated air conditioning systems, comprising a casing containing three electrical switches, said switches including respective fixed contacts and respective movable contacts, each of these including a slidable push-rod for causing a respective movable contact to move by the action of a respective substantially cap-shaped elastic member, said elastic members being definable between an inwardly-turned rest configuration and an outwardly-turned configuration, between the fluid and the switches there being provided an elastically deformable diaphragm, wherein one of said elastic members and the push-rod connected to it are holed, there being provided a further fourth switch including a push-rod inserted through the holed elastic member and through the holed push-rod, and operated by a respective fourth cap-shaped elastic member

Fig.2



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Description

This invention relates to a pressure switch for controlling air conditioning systems and the like.

In an air conditioning system, control means must be provided for activating and deactivating the compressor, operating the fan and effecting auxiliary actions.

All these actions are required to be effected when the conditioning fluid pressure reaches and/or exceeds predetermined values.

For example, Italian patent application MI93A000836 describes a pressure sensor device controlling an air conditioning system or the like on three levels.

In the device illustrated in this patent application, the functions required of the air conditioning system are implemented by the action of small stems acting on diaphragms which pass from a convex configuration to a concave configuration, hence interacting with a respective switch.

In this manner an electrical circuit is opened/closed, followed by the activation/deactivation of the apparatus connected to it. In this device three pressure levels, say low, medium and high, are concerned.

There is however a currently very strong requirement for the use of a fourth pressure level in operating and controlling the air conditioning system, for example for safety operations or for intermediate loading arrangements, etc.

However because of the development philosophy of traditional pressure switches, adding a further pressure level creates considerable problems. In this respect, if the inventive concept of the said patent application is followed, adding a new pressure level is equivalent to providing the three-level device with an arrangement of elements which is a simple repeat of arrangements which individually act on a single level.

This simple provision of new elements obviously results in increased overall dimensions, increased weight and a proportionally increased cost. In addition, as the number of mechanical elements increases, the pressure switch assembly becomes more articulated and difficult, whereas its reliability decreases (being inversely proportional to the number of said pieces).

An object of the present invention is to provide a pressure switch device which obviates said problems of the state of the art. A further object is to provide a device which is reliable, is of small overall size, and comprises the smallest possible number of mechanical elements or pieces.

This object is achieved according to the present invention by a four-level regulator for fluid-operated air conditioning systems, comprising a casing containing a first, a second and a third electrical switch which are positioned in parallel within said casing and act on respective electrical circuits, said switches including respective fixed contacts and respective movable contacts, each of these including a push-rod slidable between a withdrawn rest position and an advanced position for causing the respective movable contact to move by the action of a respective substantially cap-shaped elastic member, said substantially cap-shaped elastic members being definable between an inwardly-turned rest configuration and an outwardly-turned configuration, the casing also containing auxiliary return elements for facilitating the snap return of said cap-shaped elastic members, between the fluid and the switches there being provided an elastically deformable sealed retention diaphragm, said regulator being characterised in that one of said elastic members and the push-rod connected to it are holed, said casing containing a further fourth switch with a respective fixed contact and movable contact acting on a relative electrical circuit, said fourth switch including a push-rod inserted through said one of said elastic members and through said push-rod connected to it, and operated by a fourth substantially cap-shaped elastic member definable between an inwardly-turned rest configuration and an outwardly-turned configuration.

Advantageously said cap-shaped elastic members consist of metal discs of different thicknesses, with a central part projecting from the remaining contour of the disc, they being stacked to offer different resistances to axial force.

A series of important advantages derive from the aforesaid characteristics, including the following:

- reduced axial and longitudinal dimension of the regulator;
- the form of the switches ensures minimum mounting tolerances, making it possible to dispense with additional final setting operations;
- the constituent elastic elements of the movable contacts, formed from superposed thin metal pieces, ensure considerable contact pressure with the switch closed and a considerable return force on opening;
- the shape of the casing provides considerable electric wiring flexibility by cable or connector exits of various types, without this involving alterations or structural modifications to the regulator.

Further characteristics and advantages of the present invention will be more apparent from the description thereof given hereinafter by way of non-limiting example with reference to the accompanying figures.

Figure 1 is a perspective view of a four-level pressure regulator according to the present invention;

Figure 2 is an exploded view of the regulator of Figure 1;

Figure 3 is an exploded view of a detail of the regulator of Figure 2;

Figure 4 is an exploded view of a second detail of Figure 2; and

Figure 5 is a detail of an elastic member inserted into a regulator according to the present invention.

In Figure 1 the reference numeral 10 indicates a four-level regulator according to the present invention. It consists of a threaded connector 21, a cap 22 and electric cables 23 leaving the cap 22 and connected to apparatus (for example a compressor or a fan), not shown.

Figure 2 shows the regulator 10 of Figure 1, in exploded view. At the bottom there is the threaded connector 21, which is mounted on a conditioning fluid line of the air conditioning system. The regulator is made to operate by the pressure in said line. In contact with said connector 21 there is a seal gasket 24 on which a diaphragm 25 of high-strength elastic material rests. This material is advantageously kapton, the flexibility, elasticity, mechanical strength and lightness of which make it excellent for use. On the diaphragm there rest three groups of discs 26, 27 and 28 respectively, acting as elastic members. Elastic members of different elasticity are obtained by varying the size, thickness and number of the relative discs. From the figure it can be seen that the two elastic members 26 and 27 are composed of two discs each, whereas the member 28 is composed of three discs. Above the group of three discs 28 there is a holed rigid spacer 29, on which there bears a holed disc 30 acting as the further fourth elastic member.

Each of the first three elastic members 26, 27 and 28 interacts with a respective push-rod 31, 32 and 33; the push-rod 33 is inserted through the hole in the spacer 29 and disc 30. On the disc 30 there acts a push-rod 34 of substantially different shape from that of the other stem-like push-rods. In this respect, it comprises two lateral flanges of lesser height but greater radial dimension than the other push-rods, and is holed in the centre to allow insertion of the underlying push-rod 33. The said push-rods act as operating elements for the movable contacts of the electrical circuits to be opened or closed. The said groups of discs are housed in suitable circular seats provided in a disc support 35. Above this latter there is a second support 36 containing the movable contacts (in the form of blades fixed at one end), which are made to close or open by the said push-rods.

The regulator is completed by a cap 22, which when assembly is complete covers and seals all the aforesaid elements.

Figure 3 is an exploded view showing the unit comprising two axially aligned elastic members already described with reference to Figure 2. In Figure 3 the movable contact on which the push-rods 33 and 34 act is shown in greater detail. Specifically, the contact is in the form of a thin blade 41 pivoted at one end 40 and caused to move by the push-rod 34, in order to open or close a first electrical circuit. Straddling the blade 41 there is a bridge 43. The blade 41 comprises a U-shaped cut defining a part 44 (positioned in correspondence with the bridge 43) which is moved by the push-rod 33. This interaction between the push-rod 33, the part 44 of the blade 41 and the bridge 43 results in the opening/closure of a second electrical circuit. The elements indicated by the reference numerals 40 to 44 are all contained in the support 36, which on the opposite side to these houses a cut-out circuit 37.

Figure 4 further illustrates the structure of the support 36, and shows all the elements involved in achieving electrical contact by the movement of said push-rods. Specifically, the push-rods 31 and 32 act on the blades 43 and 45 respectively, which are fixed at one end by rivets 47 and 48. The mechanism of action of the push-rod 33 has already been described.

Auxiliary return means, not shown for simplicity, are provided for returning the elements from their working position to their rest position.

The principle of operation of the regulator is as follows.

The elastic members 26, 27, 28 and 30 are formed with different levels of elasticity, so that the devices to which they are connected are made to operate when different pressure thresholds or values are attained. In this respect, when in the rest state the constituent discs of the elastic members are in an inwardly-turned convex configuration with the convex part facing the kapton diaphragm 25 and in contact with it. The fluid enters the regulator through the threaded connector 21 and acts on the diaphragm 25. The fluid pressure deforms the diaphragm, which however on its opposite side encounters strong resistance by the series of discs of inwardly-turned convex configuration. On exceeding predetermined pressure thresholds the discs pass from an inwardly-turned convex configuration with that part emerging from the disc contour facing the diaphragm, to an outwardly-turned concave configuration in which the concavity faces the diaphragm. The pressure at which this configuration change occurs is determined essentially by the elasticity of the relative elastic member.

This configuration change results in an induced movement of the push-rods 31, 32, 33 and 34 connected to the elastic members, which by way of respective rivets then open or close electrical circuits. The relative electrical commands are then transferred via the cables 23 leaving the regulator.

It is of particular interest to describe the operation of the elastic members 28 and 30, which are aligned according to the invention. Of these the more elastic is the member 30 because it is composed of only one disc, having a lower resistance than the group of three discs forming the member 28.

As the fluid pressure increases, the diaphragm 25 exerts an increasing force on the member 28. This does not change its configuration from outwardly-turned to inwardly-turned because a pressure sufficient for this has not yet been attained. The force is hence transmitted practically unaltered to the spacer 29 which, being in intimate contact with the disc 30, causes the configuration of the disc 30 to snap from outwardly-turned to inwardly-turned when the fluid pressure reaches a first predetermined level. The disc 30 then urges the push-rod 34 to act on the blade 41 so that it makes contact with the relative rivet 42.

Only at a higher pressure level does the configuration of the elastic member 28 also snap-change, causing the push-rod 33 to move and hence act on the blade 41 at its cut part 44, which hence makes contact with the bridge 43.

The operation of the other two elastic members 26 and 27 is totally analogous. When the pressure reaches suitable levels, the diaphragm 25 transfers to the discs, which form said elastic members, a force sufficient to change their configuration from outwardly-turned convex to inwardly-turned concave. This change results in movement of the relative push-rods 31 and 32 and operation of the relative electrical contacts. This entire mechanism is clearly shown in Figure 5, from which the outwardly-turned convex configuration of the elastic member 26 can be seen. These movements are opposed by auxiliary return means which, when the fluid pressure again falls below the respective critical values, return the elastic members to their outwardly-turned convex rest configuration. These auxiliary return means, which in Figure 5 are shown for example as a thin plate 51, can generally consist of thin plate elements, flat springs acting on said movable contacts, helical springs, linear springs etc.

Claims

1. A four-level regulator for fluid-operated air conditioning systems, comprising a casing containing a first, a second and a third electrical switch which are positioned in parallel within said casing and act on respective electrical circuits, said switches including respective fixed contacts and respective movable contacts, each of these including a push-rod slidable between a withdrawn rest position and an advanced position for causing the respective movable contact to move by the action of a respective substantially cap-shaped elastic member, said substantially cap-shaped elastic members being definable between an inwardly-turned rest configuration and an outwardly-turned configuration, the casing also containing auxiliary return elements for facilitating the snap return of said cap-shaped elastic members, between the fluid and the switches there being provided an elastically deformable sealed retention diaphragm, said regulator being characterised in that one of said elastic members and the push-rod connected to it are holed, said casing containing a further fourth switch with a respective fixed contact and movable contact acting on a relative electrical circuit, said fourth switch including a push-rod inserted through said one of said elastic members and through said push-rod connected to it, and operated by a fourth substantially cap-shaped elastic member definable between an inwardly-turned rest configuration and an outwardly-turned configuration.

2. A four-level regulator as claimed in claim 1, characterised in that said cap-shaped elastic members consist of metal discs.

3. A four-level regulator as claimed in claim 2, characterised in that said cap-shaped elastic members have different elasticities.

4. A four-level regulator as claimed in claim 1, characterised in that said auxiliary elastic return means consist of flat springs acting on said movable contacts.

Fig.1

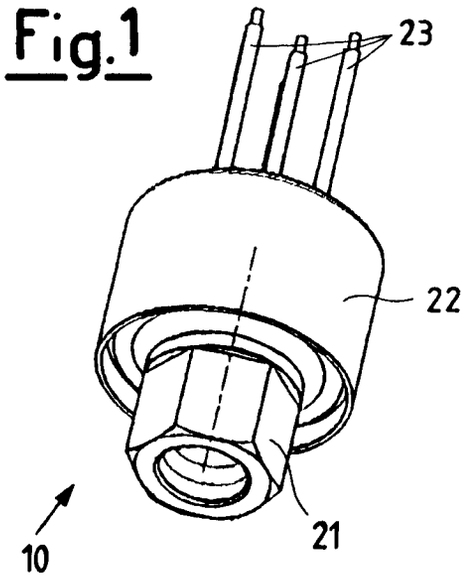
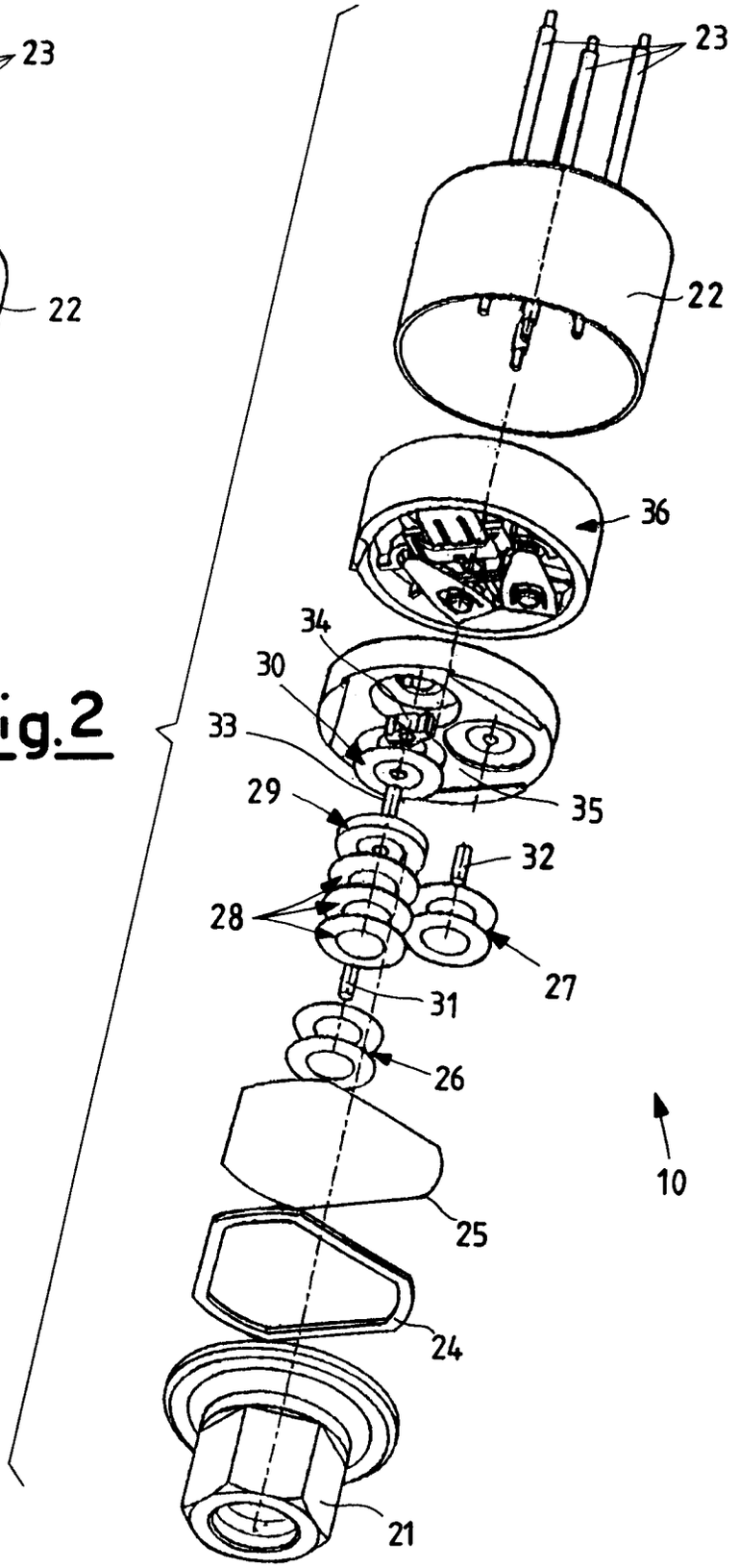


Fig.2



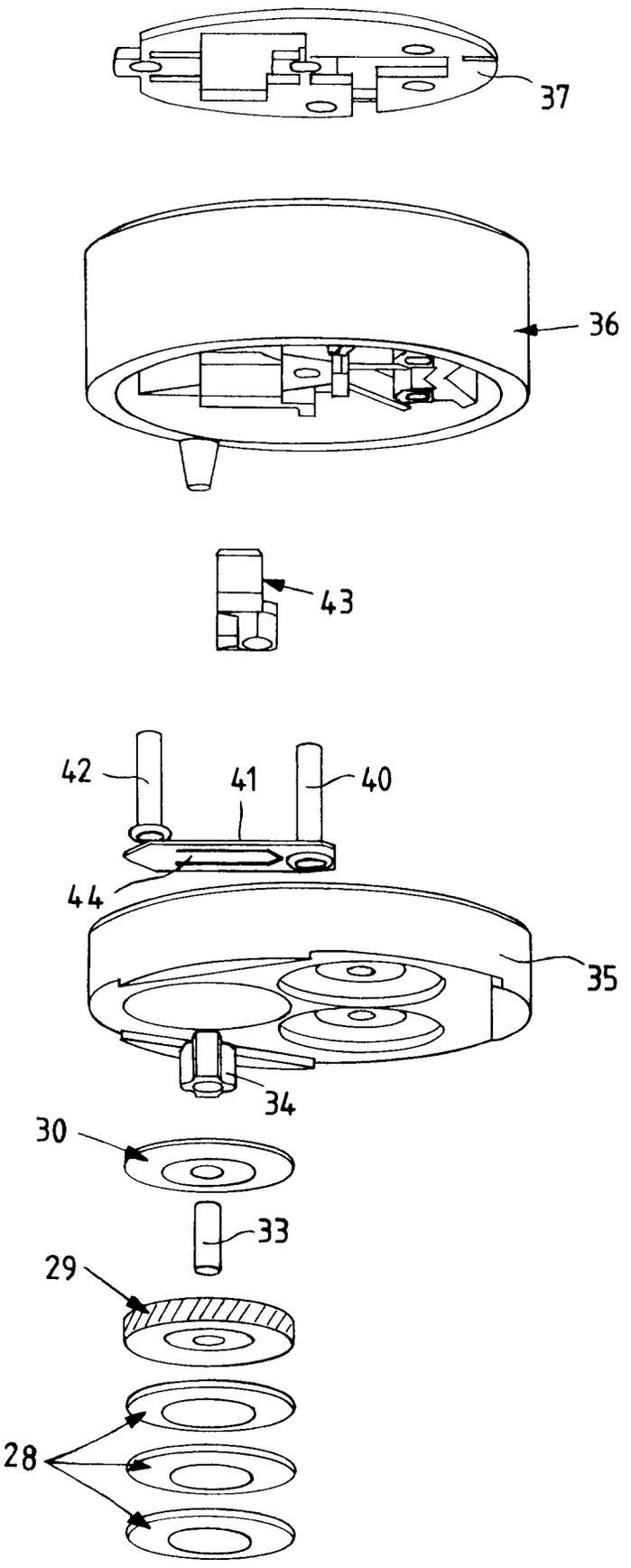


Fig.3

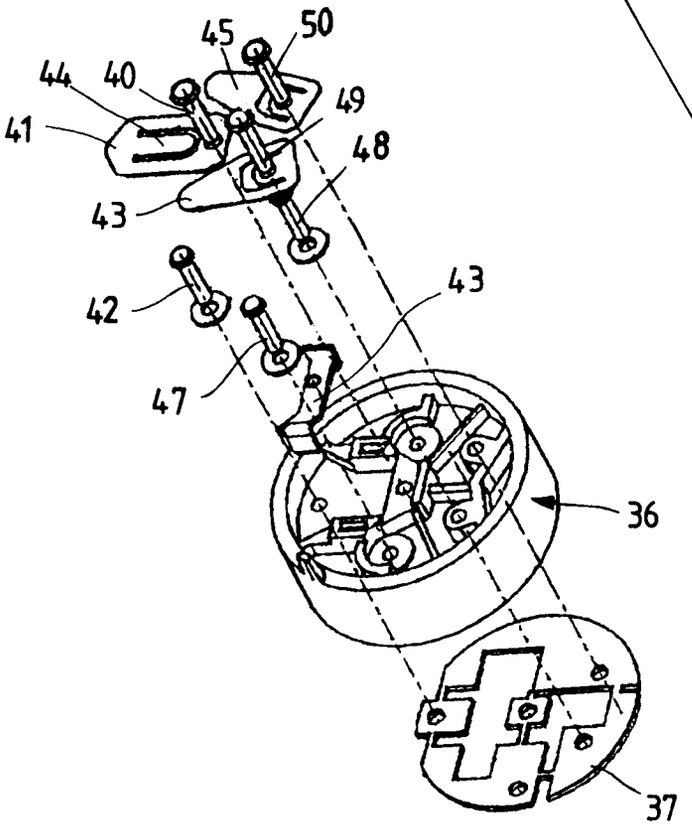
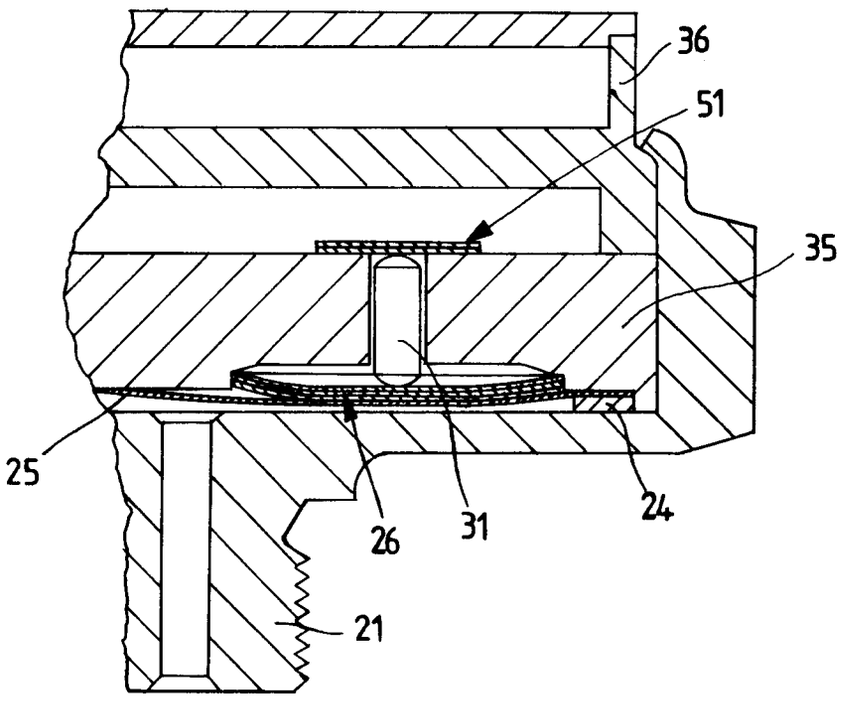


Fig. 4

Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 95 20 1865

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	EP-A-0 265 391 (SICEB SPA) 27 April 1988 * the whole document * ---	1-4	H01H35/26
Y	US-A-4 827 094 (TANAKA HAZIME ET AL) 2 May 1989 * column 10, line 23 - column 11, line 59 * ---	1-4	
Y	GB-A-2 185 857 (HADEN D H LTD) 29 July 1987 * abstract * -----	1-4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) H01H B60H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 October 1995	Libberecht, L

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