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(54) Improvements in electrical switches.

(57) An electrical switch for protecting equipment from overheating has a bimetallic element (16) which breaks electrical contact at a threshold temperature and a resetting member (40) which restores it when depressed manually. A bistable, over-centre contact member (24) is arranged such that initial movement of the resetting member moves the contact member over-centre, but also displaces the contact member, leaving the electrical contacts disengaged. Electrical contact is only restored on release of the resetting member. In this way the risks of manual tampering with the switch are reduced.

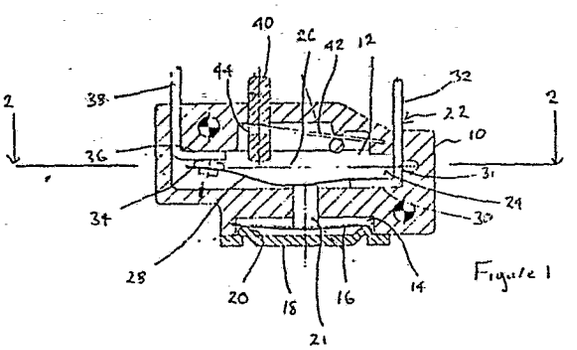

Figure 1

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IMPROVEMENTS IN ELECTRICAL SWITCHES

This invention relates to electrical switches and in one particular example to temperature sensitive switches for use in protecting electrical equipment from the damaging and possibly dangerous effects of over-heating.

Many such switches have been produced using a bimetallic disc which snaps over at a selected high temperature threshold. In order to prevent thermal cycling, it is usually arranged that the bimetallic disc does not return to the normal configuration at ambient temperatures and a separate resetting mechanism is provided. There remains a possibility, however, that if unusually low temperatures are encountered, the bimetallic disc will return automatically without manual intervention. It is therefore considered good practice - and it is a requirement under certain safety standards - to ensure that in the absence of manual resetting, the switch contacts remain open despite return movement of the bimetallic disc.

Thermostats satisfying this criterion have been produced and attention is drawn in this regard to GB 1 552 968 which suggests the use, alongside the bimetallic disc, of a second disc which is bistable but not responsive to temperature. At the high temperature threshold, the bimetallic disc snaps over, accompanied by the bistable disc. Should the bimetallic disc return at a low temperature to the normal configuration, the bistable disc will remain in the deflected state thus holding the switch contacts open. A reset plunger acts on both discs to enable them to be returned manually to the normal configuration.

In certain applications, there is a risk of a thermal protection device being tampered with. Electric cable drums, for example, are desirably provided with a thermal cut-out to avoid over-heating where too much cable is left wound on the drum. With a device having a reset plunger such as that shown in GB 1 552 968, there will be a temptation for the cable user to hold or secure the reset plunger in the depressed position to complete a particular operation without the trouble of unwinding more cable and waiting for the drum to cool down. Such tampering risks damage to the equipment and possible injury to the user. As a consequence, some safety standards now require that on over-heating, electrical continuity should be broken whatever the position of the resetting member.

Switches have been produced which satisfy this criterion but they are often complex in structure and expensive to manufacture. In GB 1 1551 999, for example, a mechanism is suggested in which movement of a reset button imparts sufficient kinetic energy to a steel ball to enable the ball to reset the thermostat. If the reset button is permanently depressed, the weight of the steel ball is not itself sufficient to reset the mechanism. An alternative approach is shown in GB 1 527 567 in which a reset mechanism is shown acting through a spring chosen to be "weaker" than the bimetallic disc at high temperatures. Only when temperatures have dropped is the power in the spring sufficient to restore the bimetallic disc to the normal configuration. This requires, however, that the spring forces are very accurately controlled in manufacture and this can increase production costs. In addition, the safety criterion is satisfied in a manner which is not directly visible and confirmable.

It is one object of this invention to provide an improved temperature sensitive electrical switch in which electrical continuity is re-established only on manual resetting and in which electrical continuity is broken at a temperature threshold irrespective of the orientation of the resetting member. It is a further object of this invention to provide such a switch which is reliable and of straightforward construction permitting inexpensive manufacture.

Accordingly, the present invention consists in an electrical switch comprising fixed and movable contacts; a bistable contact member associated with said movable contact such that in a first stable configuration of the contact member the said contacts are in engagement whilst in a second stable configuration the said contacts are disengaged; actuating means serving to move the contact member from the first to the second configuration to disengage the contacts and a resetting member actuable manually to restore the contact member to the first configuration; characterised in that movement of the resetting member in one sense displaces the contact member from the second configuration to an unstable configuration in which the contacts remain disengaged, movement of the resetting member in an opposite sense then serving to restore the contact member from the unstable configuration to said first configuration.

Preferably, said bistable member takes the form of over-centre spring means.

Advantageously, said over-centre spring means is mounted for movement over centre between said first and second stable configurations and also for displacement, the resetting member being adapted on said movement in one sense to move the spring means over-centre and to displace the spring means, return movement of the

resetting member being accompanied by a return displacement of the contact member.

Suitably, said actuating means comprises temperature responsive means serving at a selected temperature to move the contact member to said second configuration.

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

Figure 1 is a section through a thermostat according to this invention;

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

Figures 3a), b) and c) are views similar to Figure 1 showing different stages in operation of the thermostat;

Figure 4 is a perspective view of an alternative contact arm for use in the thermostat of Figure 1; and

Figures 5a), b) and c) are sections at different stages in operation of a further thermostat according to this invention.

The thermostat shown in Figure 1 comprises an electrically insulating housing 10 defining an internal contact cavity 12. In the base of the housing there is provided a circular recess 14 in which is located a bimetallic disc 16. The disc is held in position by means of a metallic cap 18 serving also as a heat collector. The cap is formed with a circular ridge 20 which supports the disc close to its perimeter. At its centre, the disc cooperates with a transfer pin 21 which is slidable in a bore extending through the housing, between the recess 14 and the contact cavity 12.

Two terminals are provided and one terminal 22 is of L-shaped form with one limb 30 overlying the base of the contact cavity 12 and a second limb 32 projecting outwardly of the housing. The exact shape of the terminal outside the housing forms no part of the present invention. Inside the contact cavity, the first terminal carries on the limb 30 a contact member 24 formed of thin metal sheet. As seen in Figure 2, the contact member comprises a hollow rectangular frame 26 formed integrally with an inwardly directed tongue 28. The tongue 28 is secured at its free end to the limb 30 of the first terminal with the frame 26 passing behind the terminal and being located in a groove 31 formed in the second limb 32. At the end opposite the first terminal, the contact member carries a movable contact 34. As can be seen from Figure 1, the secured end of the tongue 28 lies beneath the plane of the frame 26 and the length of the tongue is such that in the normal position shown in Figure 1, the tongue is under significant stress.

A second L-shaped terminal 36 has an internal limb 38 positioned to form a fixed contact cooperable with the movable contact 34. Between the two terminals, a reset button 40 is mounted for sliding movement relative to the housing into and out of the contact cavity. The reset button is biased to the position shown in Figure 1 by means of a leaf spring 42 having one end passing through an aperture 44 in the reset button and the other end trapped in the housing.

The manner of operation of the described thermostat can now be understood and, for clarity, attention is directed additionally to

Figures 3a), b) and c) which are similar to Figure 1 but which show the thermostat at different stages of operation.

In the normal position shown in Figure 1, the bimetallic disc 16 is concave with respect to the transfer pin 21 which then engages - but exerts no significant force upon - the contact member. The movable contact 34 is urged into engagement with the fixed contact 36 by means of the resilient energy in the tongue 28. In this position, current may pass from the first terminal, through the contact member and movable contact to the second terminal. If the working temperature should exceed a predetermined safe threshold, the bimetallic disc will snap over from the concave position shown in Figure 1 to the convex position shown in Figure 3a). The consequent upward movement of the transfer pin 21 will push the tongue 28 over-centre to a position in which the bowed portion of the tongue is on the opposite side of the plane of frame 26. The movable contact is in this action forced downward and electrical continuity is broken.

In conformity with safety standards, the thermostat will remain in the open circuit position even if the bimetallic disc should thermally reset since, as shown in Figure 3b), downward movement of the transfer pin will leave the contact member in the over-centre position. In order to reset the thermostat, it is necessary for the reset button to be depressed against the action of leaf spring 42 to the position shown in Figure 3c) in which the tongue 28 has been forced, over-centre, through the plane of the frame 26. As the reset

button is released and moves upwardly under the action of the leaf spring, the movable contact will move upwardly into re-engagement with the fixed contact. It is important to note that the initial movement of the reset button causes the contact member to adopt an intermediate configuration in which the contacts remain disengaged. In this position, as shown in Figure 3c), the contact member has been moved over-centre but has also been displaced by bending about the cantilever support on the first terminal 22. It is only on release of the reset button that a return bending movement takes place and electrically continuity is re-established. An attempt to tamper with the device either by holding down the reset button after the cut-out has operated or by permanently securing the reset button in the depressed position will not result in the re-establishment of electrical continuity. A further point to be noted is that the initial downward movement of the reset button is limited through engagement of the button with the base of the contact cavity. In this way, the maximum force applied to the transfer pin through the tongue 28 can be regulated. It can therefore be ensured that resetting of the contact member is only possible after a predetermined drop in temperature leading to a calculated reduction in the thermal stress in the bimetallic disc.

Through the ingenious design of the contact member and the manner of cooperation with the reset button and the transfer pin respectively, the desired safety features are provided in a construction having a minimal number of parts. Reliability of the device can therefore be expected to be good and manufacturing costs will be relatively low.

An alternative form of contact member is shown in Figure 4. A mounting portion 50 is riveted to a support block 52 and includes oppositely directed wings 54 each formed with a deformable tab 56. Centrally of the wings, a tongue 58 extends from the mounting portion to a generally semi-circular end piece 60. Parallel tensioning members 62 extend from this end piece to the mounting portion 50 and have, at their ends, stirrups 64 which respectively engage the tabs 56. The end piece 60 carries a moving contact 66 cooperable with a fixed contact 68.

In a manner analogous with the previously described embodiment, a force is applied along line A, for example by a bimetallic disc acting on a tranfer pin, in order to force the tongue over-centre and displace the movable contact upwardly. With the tongue in the over-centre position shown in dotted outline, a resetting force applied along line B will return the tongue over-centre, removal of the force then permitting re-engagement of the contacts. The resetting force is preferably applied through a reciprocally mounted reset button but other arrangements are possible.

It will be appreciated that the frame 26 of the first described embodiment and the tensioning members 62 of the second described embodiment perform the similar function of tensioning the contact member tongue so defining two stable configurations. In another variation, this function can be performed not by elements of the contact member itself but through engagement of the free end of the contact member tongue with, for example, guide slots in the housing.

Reference is now directed to Figures 5a), b) and c), in which a further embodiment of this invention is illustrated. With the exception of the contact member, elements of this new embodiment correspond closely with Figure 1 and further description of those elements will be unnecessary. For convenience, the same reference numerals have been employed as in Figure 1.

The contact member 100 takes the form of a disc which can be snapped between stable convex and concave states. The disc is not bimetallic and does not respond to temperature. At one point on its periphery the disc carries an integral tab (not seen in the drawings) through which it is secured to the terminal 22. Diametrically opposite this tab, the disc carries on its upper surface a movable contact 102. In the position shown in Figure 5a), the bistable disc 100 is convex with respect to the transfer pin and biases the movable contact 102 into engagment with the fixed contact. It will be noted that the lines of action of the reset button 40 and transfer pin 21 are parallel and approximately equally spaced on opposite sides of the disc centre. As the temperature threshold is reached, the bimetallic disc snaps upwardly and the consequential movement of the tranfer pin causes the bistable disc to snap over to the concave position shown in Figure 5b). Electrically continuity is then broken and will not be restored on thermal relaxation of the bimetallic disc. In order to reset the thermostat, the reset button is depressed so returning the bistable disc to the convex configuration as shown in Figure 5c). At this point, however, the contacts are still disengaged. Only on release of the reset button is electrical continuity re-established.

This invention has been described by way of example only and numerous modifications are possible without departing from the scope of the invention. Thus, for example, other forms of thermally responsive means could be employed in place of the described bimetallic disc and axially displaced transfer pin. The movable contact could be associated with, but not directly carried on, the contact member which would then not necessarily form part of the electrical circuit. The movable contact might comprise a bridge establishing continuity between two fixed contacts.

Whilst this invention has been described with particular reference to temperature sensitive switches, it will have application to other switches where different forms of actuating means are employed. One example is a limit switch where the actuating movement is mechanical and the intention is to prevent - for instance - return movement of an over-travelled machine part without manual resetting of the limit switch. Similarly, a pressure transducer or an electrical or magnetic device could serve as the actuating means.

CLAIMS

1. An electrical switch comprising fixed and movable contacts; a bistable contact member associated with said movable contact such that in a first stable configuration of the contact member the said contacts are in engagement whilst in a second stable configuration the said contacts are disengaged; actuating means serving to move the contact member from the first to the second configuration to disengage the contacts and a resetting member actuable manually to restore the contact member to the first configuration; characterised in that movement of the resetting member (40) in one sense displaces the contact member (24) from the second configuration to an unstable configuration in which the contacts remain disengaged, movement of the resetting member in an opposite sense then serving to restore the contact member from the unstable configuration to said first configuration.

2. An electrical switch according to claim 1, wherein said bistable member takes the form of over-centre spring means (40).

3. An electrical switch according to claim 2, wherein said over-centre spring means is mounted for movement over centre between said first and second stable configurations and also for displacement, the resetting member (40) being adapted on said movement in one sense to move the spring means over-centre and to displace the spring means, return movement of the resetting member being accompanied by a return displacement of the contact member.

4. An electrical switch according to claim 3, wherein said spring means (40) is cantilevered and said displacement comprises bending movement of a free part of the spring means.

5. An electrical switch according to any one of the preceding claims wherein said bistable contact member comprises a spring member (28) mounted under stress in a supporting frame (26) for movement over-centre across the plane of the supporting frame.

6. An electrical switch according to any one of the preceding claims wherein the bistable contact member comprises a sprung disc (100) movable over centre between convex and concave configurations.

7. An electrical switch according to any one of the preceding claims wherein said actuating means comprises temperature responsive means (16, 21) serving at a selected temperature to move the contact member to said second configuration.

8. An electrical switch according to claim 7 wherein movement of the resetting member (40) in said one sense is limited to an extent which causes the contact member to move to said first configuration only if the temperature responsive means has returned to a low temperature state.

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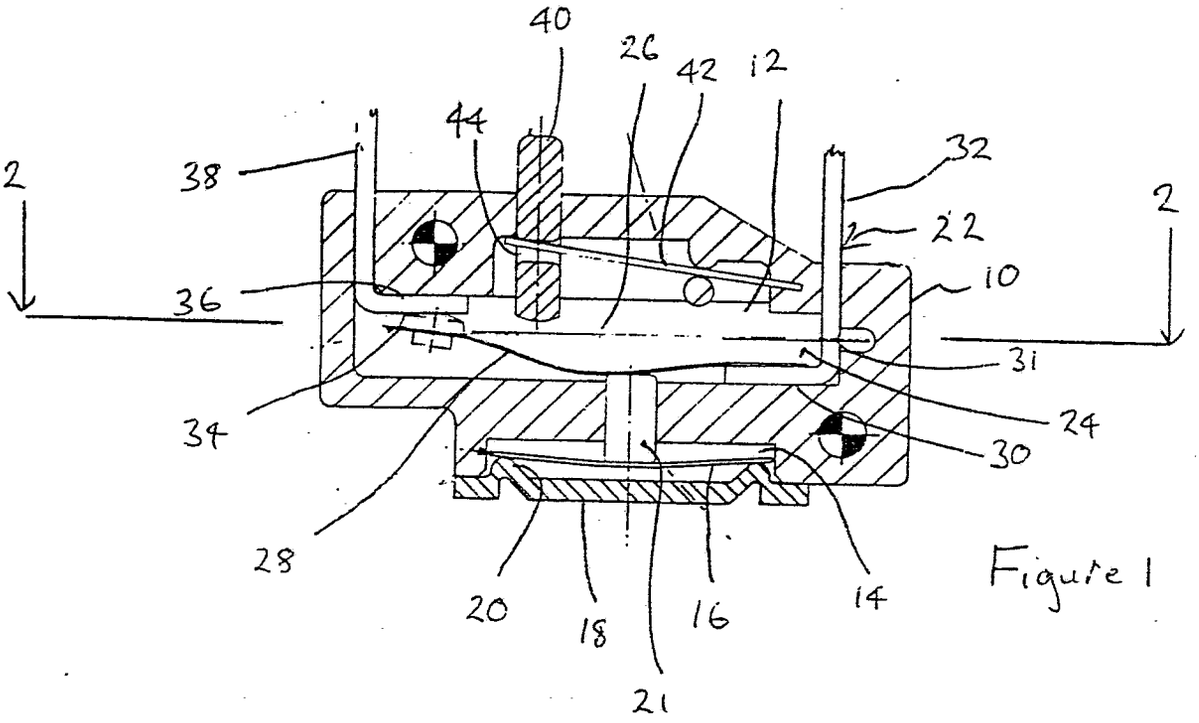

Figure 1

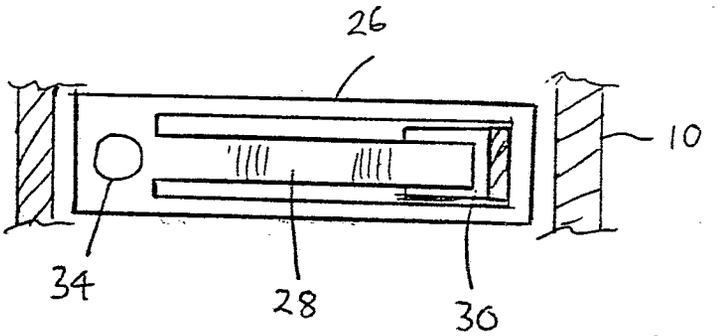

Figure 2

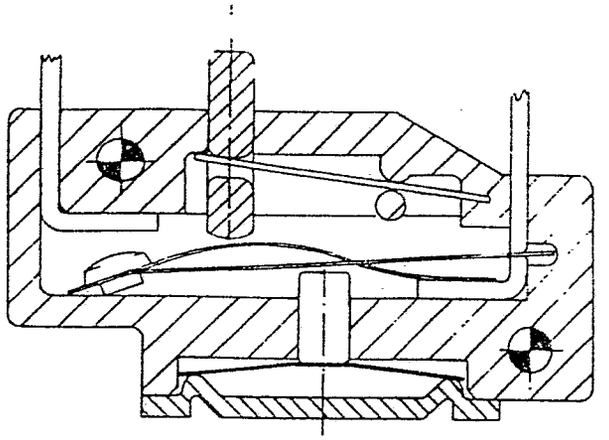

Figure 3a)

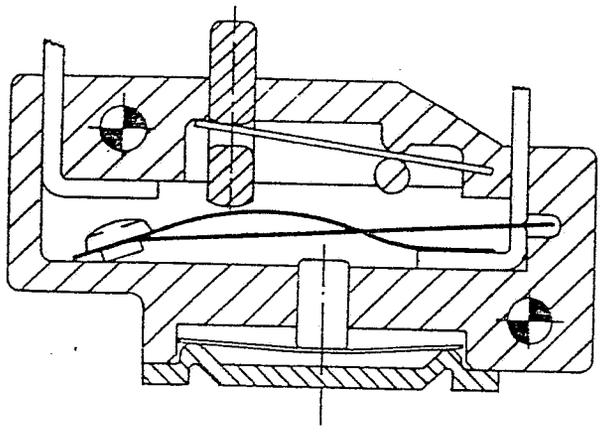

Figure 3b)

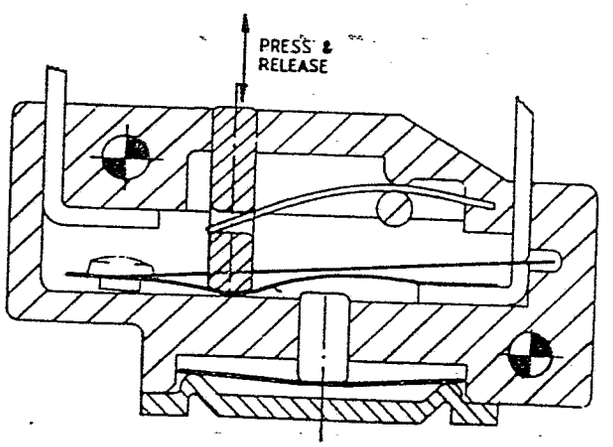

Figure 3c)

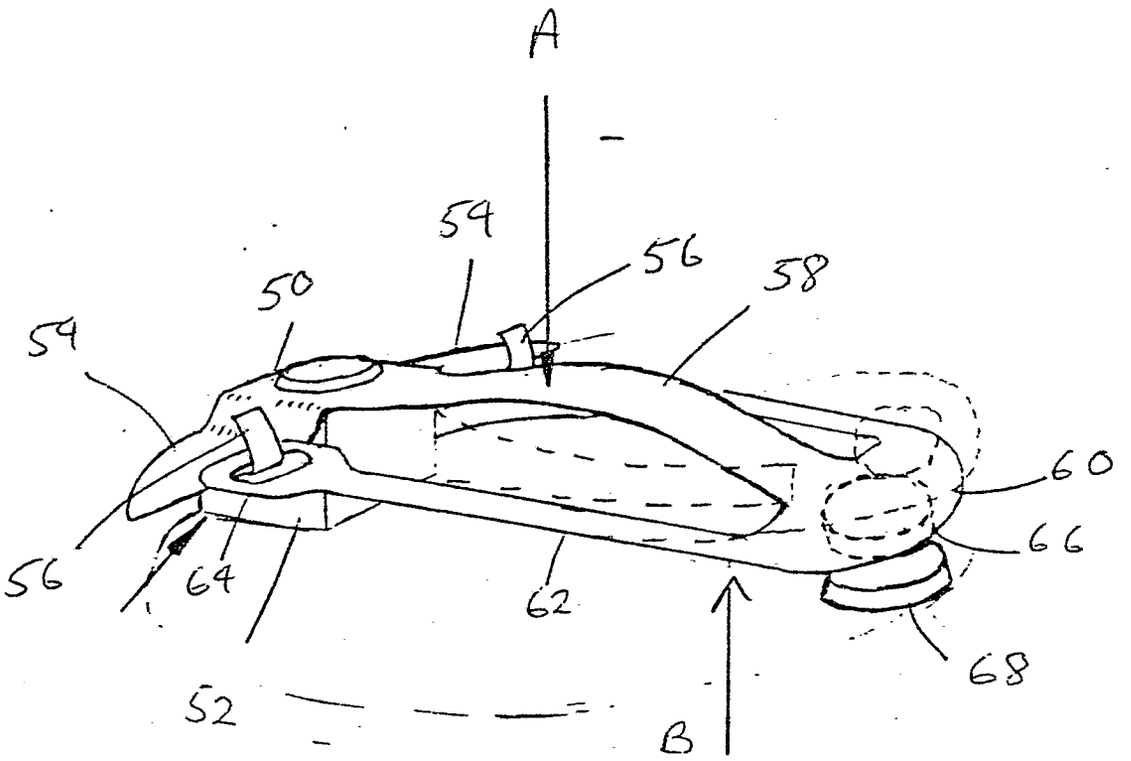

Figure 4

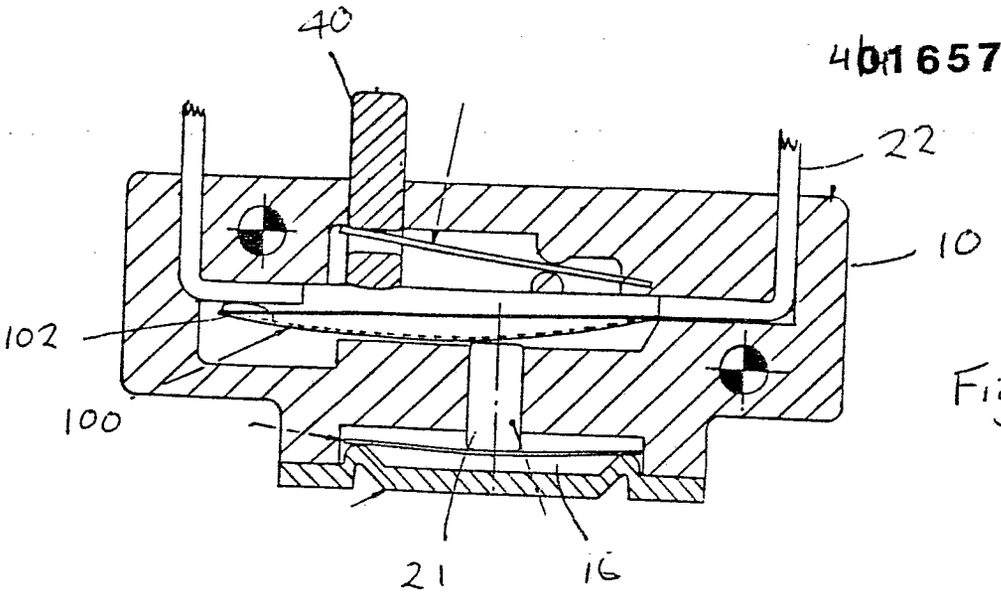

Figure 5a)

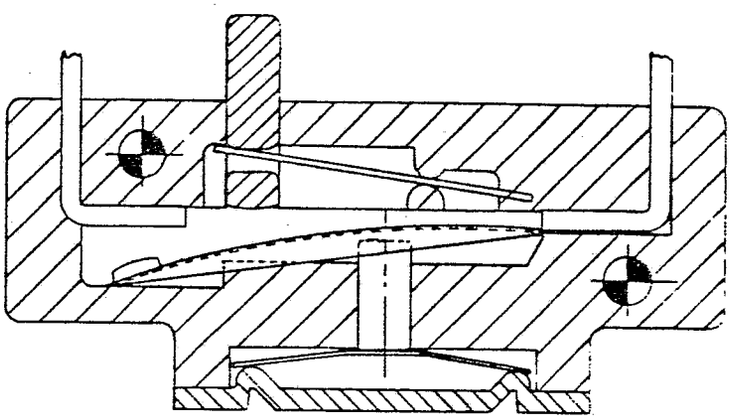

Figure 5 b)

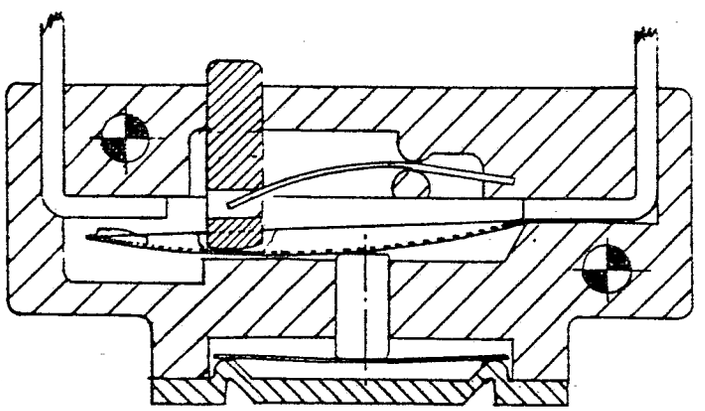

Figure 5 c)