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(54) **Condition responsive switch particularly with discrete pressure responsive unit.**

(57) A pressure responsive switch has a base and has a contact arm movable on the base between switch positions for opening and closing switch contacts. The switch has a spring biasing the arm to one of the switch positions and has a dished disc element mounted on the base to be movable with snap action between original and dished configurations during changes in pressure conditions. The dished disc element cooperates with the spring in moving the contact arm between switch positions on the occurrence of selected switch actuating or reset pressure conditions. The switch components permit overtravel of the disc during snap acting movement for closing switch contacts without substantially altering the pressure response characteristics of the switch. The disc element and a diaphragm are incorporated in a discrete separately testable pressure responsive unit.

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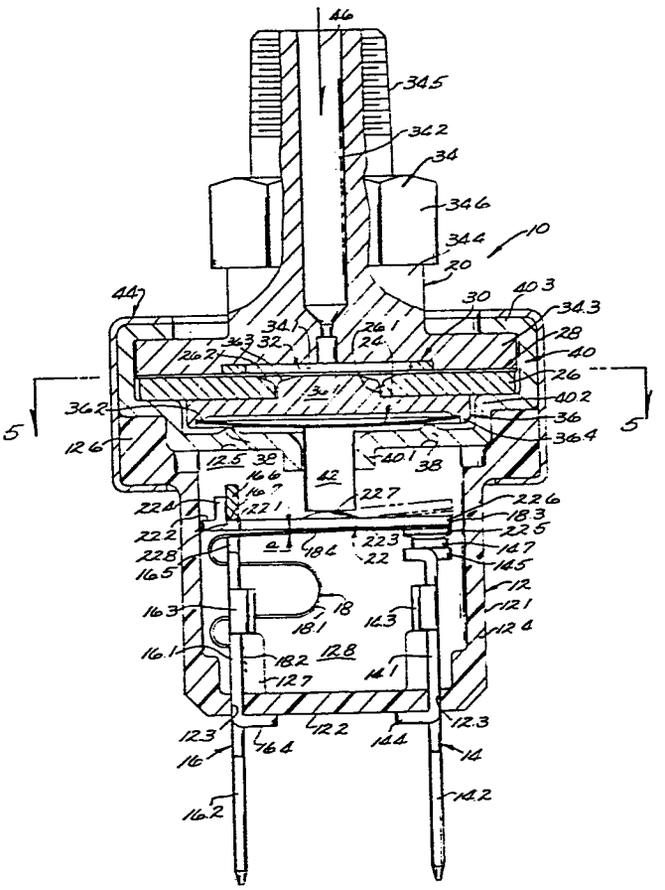
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Fig. 1.

CONDITION RESPONSIVE SWITCH PARTICULARLY WITH DISCRETE PRESSURE RESPONSIVE UNIT

Background of the Invention

The field of this invention is that of condition responsive switches and the invention relates more particularly to switches using dished disc elements which move between original and inverted dished configurations with snap action in response to the occurrence of selected pressure conditions.

Conventional condition responsive switches have a contact arm movable between first and second switch positions, have a spring biasing the arm to one switch position, and have a dished disc element movable between original and inverted dished configurations with snap action for moving the switch between switch positions in response to the occurrence of selected conditions. Such switches are intended to perform selected control functions but it is found that forces applied to the disc elements during assembly in the switches alter the response characteristics of the disc elements. Various switch structures have been proposed for limiting such variations in forces applied to the discs during switch manufacture, assembly, and use so that the switches will display consistently and reliably reproducible response characteristics. However, it is found that reaction forces applied to the discs due to overtravel of the discs during snap acting disc movement for closing switch contacts in known switch structures frequently result in undesirably large variations in the response characteristics of the switches.

In pressure responsive switches a diaphragm is conventionally exposed to fluid pressures in a zone to be monitored so that the diaphragm moves in response to applied fluid pressures. The diaphragm is typically arranged to actuate an electrical switch or the like when an applied fluid pressure reaches a selected level. In many applications, such switches primarily serve a safety function for discontinuing operation of a compressor motor or the like if fluid pressure in the zone exceeds a safe level. Accordingly, the switches have a long service life but are required to undergo only a limited number of operating cycles during that service life. In such conventional applications the pressure switches also tend to be subjected to relatively low operating pressure levels. Accordingly, the performance requirements for such switches are relatively easy to meet. More recently however, some pressure responsive switches have been used in applications where they are intended to perform repetitive control functions rather than protective functions and are therefore required to perform accurately over a very large number of operating cycles. In some of those new switch applications, the switches are subjected to very high operating pressures during normal operation of the switches and have to be capable of withstanding even greater pressures under certain over-pressure conditions without loss of accuracy or device function. Pressure switches adapted to meet these more stringent performance requirements have tended to be much more expensive to manufacture and it has typically been found that switches as manufactured are subjected to relatively high rejection rates when tested for meeting desired performance specifications.

Summary of the Invention

It is an object of this invention to provide a novel and improved condition responsive switch; to provide such a switch having components which are easily and inexpensively manufactured and assembled for providing the switches with consistent and reliable condition response characteristics; to provide such a switch utilizing a dished disc element which is movable between original and inverted dished configurations with snap action in response to the occurrence of selected pressure conditions wherein overtravel movement of the disc element in closing switch contacts during such snap action is accommodated without substantially altering the pressure response characteristics of the switch; to provide such a switch having a discrete, separately testable pressure responsive unit adapted to withstand repeated exposure to very high fluid pressures; and to provide such a novel and improved switch which is of simple, rugged and inexpensive construction.

Briefly described, the novel and improved condition responsive switch of this invention comprises a base and movable contact means which are mounted on the base to be movable between an open circuit position spaced from complementary stationary contacts mounted on the base and a closed circuit position engaged with the stationary contacts. The movable contact means comprise terminal

means mounted on the base having a first pivot surface disposed over the base in spaced, facing relation to the base. The movable contact means further includes a rigid contact arm having a complementary pivot surface formed at one end of the arm, the arm being disposed with its complementary pivot surface arranged in facing relation to the first pivot surface on the terminal means so that the two pivot surfaces are adapted to engage each other and so that the arm is adapted to pivot around the point of that engagement for moving the opposite end of the arm between the noted switch positions. A spring means, preferably comprising a flat spring having a relatively low spring rate and preferably having a bight formed intermediate the spring ends, is connected at one end to the terminal means and at its opposite end to the contact arm for biasing the complementary pivot surface on the arm into engagement with the first pivot surface on the terminal means. The spring means also biases the arm to pivot the arm to move the opposite end of the arm to one of said switch positions. Preferably the spring also serves to electrically connect the terminal means to the contact arm. A pressure responsive means including a dished disc element which is arranged to move between original and dished configurations with snap action in response to changes in pressure conditions is disposed for cooperating with the switch arm in moving the arm between the switch positions in response to the occurrence of selected pressure conditions.

Preferably the spring means is arranged to bias the contact arm to an open contacts switch position and the condition responsive means is arranged with the dished disc element thereof disposed in an original dished configuration holding the contact arm in a closed contacts position against the spring bias. The dished disc element is adapted to move to an inverted dished configuration with snap action for permitting sharp opening of the switch contacts on the occurrence of a selected actuating pressure condition or the like. On the occurrence of a subsequent reset pressure condition the dished element is adapted to return to its original configuration with snap action for moving the contact arm back into its closed contacts position against the spring bias. In that arrangement, that portion of the snap-acting movement of the disc element which moves the switch contacts to closed contacts position pivots the contact arm against a spring having a relatively low spring rate so that the reaction forces applied to the disc element during that portion of the snap-acting disc movement are relatively limited and do not substantially alter the subsequent condition response characteristics of the element. Additional snap-acting movement of the disc element then continues and builds a desired contact force between the switch contacts. Finally, additional overtravel type of snap-acting disc movement such as might be due to tolerances in switch assembly and variations in locating the disc element on the switch device or the like tends to move the contact arm to move the complementary pivot surface of the arm out of engagement with the first pivot surface on the terminals means against the bias of the noted spring. In that

way, the reaction forces applied to the disc element during build up of the desired contact engaging force tend to be very consistent and do not adversely effect manufacture of switches having consistently reproducible condition response characteristics. Further, the reaction forces applied to the disc element due to overtravel of the disc result primarily from movement of a spring having a relatively low spring rate and those reaction forces therefore have little effect in varying the subsequent condition response characteristics of the dished disc element.

The pressure responsive unit comprises a support plate having an opening with tapered edges and has a diaphragm preferably formed of a superimposed pair of polyimide films or the like arranged on the plate over the opening. An annular gasket is disposed over the diaphragm concentric with and closely surrounding the opening. A metal port body has a recess in one end and has a port communicating with the recess. The recess is fitted over and closely surrounds the gasket and the bottom of the recess bears against the gasket to form a sealed pressure chamber at one side of the diaphragm which communicates through the body port with a pressure zone to be monitored. A dished disc element of the type adapted to move from an original dished configuration to an inverted dished configuration with snap action when selected force is applied to the element is disposed at an opposite of the diaphragm and a force converter member is disposed between the dished element and the diaphragm.

A force receiving portion of the converter having tapered edges has a selected diameter and fits closely within the opening in the support plate to be movable with the diaphragm and a force applying portion of the converter of relatively larger diameter bears against one side of the dished element for transmitting diaphragm movement to the element. Reaction means are provided for bearing against an opposite side of the dished element so that the element snaps to its inverted dished configuration when sufficient force is applied to it by the converter in response to application of selected force to the diaphragm. Means mount the support plate, diaphragm, gasket, port body, converter and dished element in selected relation to each other to form a discrete, separately testable, pressure sensing unit. Preferably the mounting means comprises a deformed metal sleeve which encloses the dished element and force converter and which extends around the support plate and diaphragm and around a clamping ring portion of the port body, a reaction ring formed on the sleeve to bear against said opposite side of the dished element, and a central opening which slideably receives a motion transfer pin for transmitting snap-acting movement of the dished element to the movable contact means previously described. In that arrangement, the pressure responsive unit is of low cost, high performance construction and is easily and reliably assembled on the switch base to form a reliable pressure switch device. The pressure unit also cooperates with other switch components to provide long cycle life under high pressure operating conditions.

Description of the Drawings

Other objects, advantages and details of the novel and improved switch of this invention appear in the following detailed description of preferred embodiments of the invention, the description referring to the drawings in which:

Fig. 1 is a section view along the longitudinal axis of a preferred embodiment of the novel and improved pressure switch device of this invention;

Fig. 2 is a section view similar to Fig. 1 of another alternate preferred embodiment of this invention;

Fig. 3 is a graph illustrating response characteristics of the switch of this invention;

Fig. 4 is a section view similar to Fig. 1 of another alternate preferred embodiment of this invention; and

Fig. 5 is a section view along line 5-5 of Fig. 1.

Description of Preferred Embodiments

Referring to the drawings, 10 in Fig. 1 indicates the novel and improved condition responsive switch of this invention which is exemplified in Fig. 1 as a pressure switch device comprising a base means 12, stationary contact means 14 mounted on the base, movable contact means 16 mounted on the base for movement between alternate switch positions into and out of electrical engagement with the stationary contact means 14, spring means 18 biasing the movable contact means to one of the switch positions, and pressure responsive means 20 for cooperating with the spring means in moving the movable contact means between switch positions on the occurrence of selected pressure conditions or the like.

Preferably for example, the base means 12 comprises a generally cylindrical, cup-shaped housing or body 12.1 formed of a rigid, electrically insulating thermoplastic material or the like having a bottom 12.2 with openings 12.3 therein, having a side wall 12.4, having an open end 12.5, and having an integral mounting flange 12.6 extending around the open end of the housing. Preferably integral abutments 12.7 are formed inside the housing body chamber 12.8 adjacent to the opening 12.3. In that embodiment, the stationary contact means preferably comprises a first rigid terminal plate member 14.1 formed of a rigid, electrically conductive material

such as copper, brass, or bronze or the like which fits through one of the openings 12.3 in the housing bottom 12.2, a terminal post 14.2 extending outside of the housing for permitting electrical connection to be made to the first terminal member, a pair of wings 14.3 (only one being shown) on respective sides of the terminal member to engage respective abutments 12.7 inside the housing chamber, a pair of tabs 14.4 (only one being shown) on respective opposite sides of the terminal post engaging the outer side of the housing bottom 12.2 for securing the terminal member securely in the opening 12.3 against abutments 12.7, a contact seat 14.5 struck and bent out of the upstanding end 14.6 of the first terminal plate member, and an electrical contact 14.7 mounted on the seat by welding or soldering or the like, the contact preferably being formed of a precious metal or other material having desired contact wear and resistance characteristics in conventional manner.

In accordance with this invention, the movable contact means 16 includes a second, rigid terminal plate member 16.1 of an electrically conductive copper, brass or bronze material or the like having a terminal post 16.2, having wings 16.3, and having mounting tabs 16.4 similar to those of the first terminal member. The second terminal

member also has an opening 16.5 therein at an end 16.6 of the member upstanding from the base and has a first pivot surface 16.7 formed inside that opening at a margin of the opening where the surface is disposed over the bottom 12.2 of the base or housing in spaced, facing relation to the base bottom. Movable contact means also includes a contact arm 22 which is also preferably formed of a rigid, and typically conductive material such as steel, and is fitted into the opening 16.5 in the second terminal member as shown in Fig. 1. The contact arm has a second or complementary pivot surface 22.1 formed on the arm adjacent one end 22.2 of the arm. With the contact arm inserted in the terminal opening 16.5, that complementary pivot surface is disposed in facing relation to the first pivot 16.7 formed on the terminal member 16. Preferably the contact arm has a central portion 22.3 extending across the housing chamber 12.8 near the open end of the housing body, has a pair of lever tabs 22.4 (only one being shown) at opposite sides of the arm near the arm end 22.2 for engaging the terminal member 16 near the opening 16.5, and has an electrical contact 22.5 secured to the arm at the opposite end 22.6 of the arm to be pivoted into and out of electrically contacting engagement with the stationary contact 14.7. Preferably, the contact arm has a portion 22.7 formed therein intermediate the arm ends to be engaged for pivoting the arm, that deformed portion also typically serving to form a stiffening rib to add to the rigidity of the contact arm.

In accordance with this invention, the spring means 18 preferably comprises a flat spring formed of beryllium copper, phosphor bronze, stainless steel or other electrically conductive material having one or more bights 18.1 formed therein intermediate the ends of the spring, the spring preferably being secured at one end 18.2 by welding or riveting or the like in any conventional manner to the terminal plate member 16 and at its opposite end 18.3 in a similar manner to the contact arm 22. The spring is connected to the terminal member 16 and to the arm 22 for normally biasing the complementary pivot surface 22.1 of the arm into pivotal engagement with the first pivot surface 16.7 on the terminal member. The spring 18 also normally biases the contact arm to pivot (in a counterclockwise direction as viewed in Fig. 1) around the point 22.8 of that engagement so that the opposite end 22.6 of the arm moves the contact 22.5 away from the stationary contact 14.7. In accordance with this invention, the flat spring 18 has a relatively low spring rate as measured at the transfer pin 42 location, of 3.3 pounds per inch and preferably less than about 10 pounds per inch or less and in a preferred embodiment of the invention, the spring end 18.3 is connected to said opposite end 22.6 of the arm so that a length of the spring 18.4 extends along the arm between the arm and the base bottom 12.2 with a small angular separation a between the spring portion 18.4 and the arm.

In accordance with this invention, the condition responsive means 20 includes a dished disc spring element 24 formed of a metal spring material such as stainless steel or a thermostat bimetal or the like which is adapted to move between original and inverted dished configurations with snap action in response to the occurrence of selected pressure applied to the disc.

Preferably for example, the condition responsive means 20 comprises a discrete separately testable pressure responsive unit having the dished disc element 24 arranged for cooperating with the spring 18 in moving the switch device 10 between switch positions thereof in response to changes in pressure conditions in a pressure zone to be monitored. That is, as is shown in Fig. 1, the condition responsive means comprises a support plate 26 having an opening 26.1, a flexible diaphragm 28 disposed over the support opening, a ring gasket 30 arranged concentric with the support opening for forming a pressure chamber 32 at one side of the diaphragm, and a port body 34 having a recess 34.1 fitted over the gasket to seal the chamber, having a passage 34.2 communicating with the chamber, and having a clamping or mounting ring 34.3 formed around the recess. A force converter 36 is aligned with the support opening at the opposite side of the diaphragm to be movable in response to movement of the diaphragm as the diaphragm moves in response to variation in fluid pressures applied to the diaphragm in the chamber 32. That is, the

converter has a force receiving portion 36.1 of one diameter fitted into the support opening 26.1 and has a force transmitting portion 36.2 of a relatively greater diameter. The dished disc element 24 is positioned to be engaged on one side by force transmitting portion of the force converter, and reaction means 38 of a different diameter are arranged to engage an opposite side of the dished disc element. In that arrangement, the dished element is adapted to move from the dished configuration shown in Fig. 1 to an inverted dished configuration with snap action when a selected actuating force is applied to the disc element through the force converter in response to application of a selected actuating fluid pressure to the diaphragm 28. The disc is also adapted to return to the illustrated dished configuration with snap action when the fluid pressure applied to the diaphragm falls to a selected, relatively lower, reset fluid pressure level. Preferably, the reaction means 38 are integrally incorporated in a sleeve 40 which is swaged as shown in Fig. 1 for securing the various components of the condition responsive means 20 together in the illustrated manner. Preferably the sleeve 40 has a guide flange 40.1 slideably receiving a ceramic motion transfer pin 42 or the like for transmitting movement from the dished disc element spring 24 to the flat spring 18, the shoulder 40.2 of the sleeve locates the element 24 and the force converter 36 relative to the reaction means 38, and the flange 40.3 secures the support plate 26, the diaphragm 28, the gasket 30, and the clamping portion 34.3 of the port body together. Preferably the

condition responsive means 20 are pretestable to assure they display desired pressure response characteristics and are then mounted on the base 12 in any conventional manner such as by having a metal mounting sleeve 44 or the like swaged around the housing flange 12.6 and around a portion of the condition responsive means 20 as shown in Fig. 1.

Preferably edges 26.2 of the support opening are tapered and the force receiving portion 36.1 of the force converter fits closely within the opening and has similar tapered edges 36.3. Preferably the diaphragm 28 comprises a plurality of superimposed, thin films 28.1, 28.2 (see Fig. 5) of strong, pliable and stiffly flexible polyimide material about 0.005 inches thick which are preferably cut square as shown in Fig. 5. Preferably the gasket 30 is only slightly larger than the opening 26.1 and the recess 34.1 fits closely around the gasket so that the side wall of the recess restrains gasket expansion. Preferably the force converter has an annular stop 36.4 of relatively larger diameter than the dished element 24 which engages the portion of the sleeve 40 incorporating the reaction means 38 after the dished element snaps over and responds to fluid pressure on the diaphragm. Preferably the port body 34 is an extruded, one-piece body having an integral connector 34.4 threaded as at 34.5 and provided with hex means as at 34.6.

In that construction, the pressure device 20 is of simple, low cost construction but is adapted to withstand very high operating pressures while moving the disc 24 to its inverted dished configuration to perform a control function over a long service life in response to the application of precisely predetermined fluid pressure to the diaphragm 28 in the chamber 32. That is, the chamber's size is restricted by the gasket diameter and by the recess fitting closely around the gasket to prevent lateral blowout of the gasket for reducing forces applied to the device components by the applied high fluid pressures; the diaphragm is substantially fully supported while under initially applied pressures, undergoes a precisely limited degree of flexing in response to increases in pressure to the actuating level of the device, and is thereafter substantially fully supported to prevent diaphragm rupture if substantial overpressures should occur. The multiple films used in forming the diaphragm permit flexing of the diaphragm over a long service life with improved strength and with reduced risk of fatigue cracking or the like and tapering of edges of the support and force converter while those components engage the diaphragm avoids risk of injury to the diaphragm. The square cutting of the film permits full use of film material without waste while achieving center locating of the films over the opening 26.1. The components of the pressure unit 20 are easily and accurately assembled by simply dropping the unit components into the sleeve 40 and by swaging the sleeve over the port clamping ring as shown. The unit is also adapted to be separately

tested for achieving desired performance characteristics before assembly with other switch components. Precise matching of the unit to the other components of the switch means 10 is easily and economically achieved by proper selection of the length of the pin and, when the pressure responsive unit provides snap-acting movement of the dished element 24, actuates the switch in a manner which is adapted to enhance the cycle life of the switch means used in the device 10.

In assembling the switch device 10, the contacts 14.7 and 22.5 are welded to the terminal 14 and arm 22, and the spring 18 is welded or riveted to the arm. The arm is slipped into place in the terminal opening 16.5 and the spring 18 has a selected shape so it is compressed to a known degree and is then welded or riveted to the terminal 16.1 to normally bias the complementary pivot surface 22.1 against the pivot surface 16.7. The terminal members 14 and 16 are mounted on the base 12 and the condition responsive means 20 is mounted on the base 12 by the swaged sleeve 44 with a motion transfer pin 42 of selected length disposed between the disc element 24 and the contact arm 22. As assembled, the arm is disposed in the switch in the position shown in Fig. 1 with the contact 22.5 engaged with the contact 14.7, with the complementary pivot surface 22.1 spaced from the pivot surface 14.7 as shown in Fig. 1, and with a selected angular separation a between the spring portion 18.4 and the arm 22. In that arrangement, the disc element 24 and

the spring 18 cooperate so that, while a first fluid pressure is applied to the diaphragm 28 as indicated by the arrow 46, the disc element 24 is normally disposed in the dished configuration illustrated in Fig. 1 and positions the pin 42 to hold the contact arm 22 in the position shown against the bias spring 18. When the applied fluid pressure 46 is then increased to the selected actuating pressure of the switch device 10, the disc element 24 moves with snap action to an inverted dished configuration as will be understood for permitting the contact arm 22 to move up away from the bottom 12.2 of the base to another switch position indicated by broken lines 22a in Fig. 1 in response to bias of the spring 18, thereby to engage the pivot surface 22.1 with the first pivot surface 14.7 at point 22.8 and to pivot the arm to disengage the contacts 22.5 and 14.7.

Subsequently, when the applied fluid pressure 46 is lowered to a selected reset pressure level for the switch device 10, movement of the diaphragm 28 allows the force converter 36 to reduce force on the dished element 24 so the element returns with snap action to the dished configuration shown in Fig. 1. As that snap-acting disc movement occurs, the initial movement of the disc moves the contact arm 22 to a closed contact position initially engaging contacts 22.5 and 14.7. That arm movement occurs against the bias of the spring 18 but, because the spring 18

has a relatively low spring rate and is arranged as discussed above, the reaction forces applied to the disc 24 during the contact closing movement is relatively limited as indicated by the portion 48a of the force/deformation curve for the spring 18 as shown in Fig. 3. Then, as snap-acting movement of the disc 24 continues in returning toward the original dished configuration of the disc, the force between the contacts 22.5 and 14.7 is increased without substantial increase in deformation of the spring 18 as is indicated by portion 48b of the spring curve. Finally, as snap-acting movement of the disc to its original dished configuration is completed and undergoes any intended or even excessive or undesired overtravel, the contact arm is pivoted oppositely so that the complementary pivot surface 22.1 of the arm is moved away from the pivot surface 16.7. That is, the arm then pivots around the point of engagement between the contacts 22.5 and 14.7 so that the first end 22.2 of the arm pivots (counterclockwise as viewed in Fig. 1) toward the bottom 12.2 of the switch base. Again, because the spring 18 has a relatively low spring rate, and is arranged as described, the reaction forces applied to the disc 24 by the spring 18 during such overtravel disc movement is relatively limited as is indicated by the portion 48c of the spring curve shown in Fig. 3. In that way, the switch device 10 is adapted to return to its closed contact position and to accommodate any overtravel type of snap-acting disc movement in closing the switch contacts without

substantially altering the condition response characteristics of the switch. Accordingly, manufacturing tolerances for switch components and for switch assembly can be relatively large without savings in cost while assuring manufacture of switches with consistently reproducible performance characteristics. In a preferred embodiment of the invention, the spring portion 18.4 is arranged to extend along the arm 22 and to have a selected angular separation a from the contact arm when in closed circuit position as shown in Fig. 1. However that spring portion has a relatively larger angular separation from the arm when the arm is in open circuit position. In that arrangement, the contact closing force of the spring 18 indicated by the curve portion 48a has an effective spring rate even lower than the spring rate of the spring during overtravel movement represented by the portion 48c of the curve of Fig. 3 as will be understood. Preferably also the contact arm 22 has lever tab means 22.4 thereon adapted to engage the terminal member 16 or the like during pivotal movement of the arm relative to the member 16. In that arrangement the lever means are located to engage the arm and move the arm laterally as the arm pivots so that the point 22.8 of pivotal engagement between the pivot surfaces 22.1 and 16.7 changes as pivoting of the arm continues and produces a wiping engagement between the switch contacts 22.5 and 14.7 for enhancing electrical engagement between the switch contacts.

It can be seen that the switch device 10 as above described is adapted to be easily and reliably manufactured and assembled but is adapted to be made with consistently reproducible pressure response characteristics. The switch device is particularly adapted to permit overtravel movement of the disc 24 during snap acting movement of the disc for closing switch contacts without substantially altering subsequent condition response characteristics of the switch. As a result, manufacture and assembly of the switch is adapted to be accomplished at low cost while achieving improved switch performance.

In another alternate embodiment of this invention as shown in Fig. 2 (wherein comparable components are identified with corresponding reference numerals), an alternate switch device 50 is adapted to provide normally open switch contact operation. That is, in that device the contact 22.5 is located on an opposite side of the contact arm 22 and the terminal 14 has an opening 14.9 in which the stationary contact 14.7 is mounted to be engaged and disengaged by the movable contact 22.5. In that arrangement, the motion transfer pin 42 normally holds the arm 22 in a contacts open position as shown in Fig. 2 but when applied pressure 46 is increased to the selected actuating pressure of the switch, the disc 24 inverts and permits the spring 18 to move the switch sharply to closed contacts position.

In another alternate embodiment of this invention as shown at 52 in Fig. 4, another alternate embodiment the invention provides double throw switch operation. That is, an additional terminal member 54 is mounted on the base 12 and has an additional stationary contact 54.1 mounted on one end of that terminal member. The motion transfer pin 42 normally holds the contact arm 22 in a first, closed contact switch position so that one movable contact 22.5 carried on the arm is normally engaged with the stationary contact 54.1. However, when the applied fluid pressure 46 is increased to the actuating pressure level of the switch, the disc 24 inverts and permits the spring 18 to move the contact arm to a second, closed contacts switch position engaging a second movable contact 22.5 with the stationary contact 14.7 as will be understood.

It should be understood that although particular embodiments of the condition responsive switch of this invention have been described by way of illustrating the invention, the invention includes all modifications and equivalents of the disclosed embodiments falling within the scope of the appended claim.

CLAIMS:

1. A pressure responsive electrical switch having movable contact means mounted on a base to be movable between a first switch position engaging a stationary contact means and a second switch position spaced from the stationary contact means, the movable contact means being biased to one of said switch positions, and pressure responsive means including a dished disc element movable from an original to an inverted dished configuration with snap action in response to the occurrence of a selected pressure condition in a pressure zone to be monitored for moving the movable contact means to the other of said switch positions against said bias, characterized in that the movable contact means comprises terminal means mounted on the base having a first pivot surface disposed in spaced, facing relation to the base, a rigid contact arm having a complementary pivot surface adjacent one end thereof disposed in facing relation to the first pivot surface to be engaged therewith for pivoting the arm between said switch positions, and a flat, electrically conductive spring having a relatively low spring rate and having a bight formed therein disposed with one end of the spring secured in electrically conductive relation to the terminal means and with an opposite end secured in electrically connected relation to the contact arm with the spring bight compressed for biasing the arm away from the base to engage the complementary pivot surface with the first pivot surface and for biasing the arm to pivot away from the base into one

of said switch positions, and in that the dished disc element is coupled to the arm between said arm ends for pivoting the arm toward the base to the other of said switch positions against said bias in response to said snap acting movement of the disc element and for permitting movement of the complementary pivot surface away from the first pivot surface to allow overtravel of the disc element during such snap action without substantially altering the pressure response characteristics of the disc element in the switch device.

2. A pressure responsive switch as set forth in claim 1 further characterized in that the terminal means comprises a first plate member having one end mounted on the base in upstanding relation to the base, having an opening therein at an opposite end of the first plate member, and having said first pivot surface formed within the opening at one side of the opening, and the rigid arm has said one end fitted into said opening to dispose said complementary pivot surface in facing relation to the first pivot surface and to dispose one side of the arm in spaced, facing relation to the base, the spring having said one end thereof secured to said one end of the first plate member, having said spring bight accommodated in said plate opening, and having said opposite end of the spring secured to said one side of the contact arm to bias the arm to move away from the base.

3. A pressure responsive switch as set forth in claim 2 further characterized in that said opposite end of the spring is secured to said one side of the contact arm adjacent said opposite end of the arm and has a length of the spring extending along the contact arm with a selected angular separation from the arm such that movement of the arm for moving the complementary pivot surface of the arm away from said first pivot surface is adapted to engage the contact arm with said spring length along the length thereof for facilitating movement of the contact arm during said snap-acting overtravel movement of the disc element.

4. A pressure responsive switch as set forth in claim 2 further characterized in that lever means are provided on said contact arm for engaging said plate member during pivotal movement of the contact arm for laterally moving the point of engagement of said complementary pivot surface with said first pivot surface during pivotal movement of the arm to produce wiping engagement between the movable and stationary contacts of the switch for enhancing electrical engagement of said contacts.

5. A pressure switch device as set forth in claim 1 further characterized in that the pressure-responsive means is a discrete unit having separately testable pressure response characteristics, means mount the pressure-responsive unit on the base, and motion transmitting means are disposed between the pressure responsive unit and said movable contact means for moving the movable contact means between said switch positions in response to application of said selected fluid pressure to the pressure responsive unit, the pressure-responsive unit comprising a support having an opening therein, diaphragm means disposed on the support extending over the opening, gasket means having an opening larger than the support opening disposed on a first side of the diaphragm means opposite from the support in concentric relation to the support opening, port means mounted at said first side of the diaphragm means to bear against the gasket means and form a sealed chamber at said first side of the diaphragm means, the port means having a passage communicating with the chamber for exposing said first side of the diaphragm means to a fluid pressure to move the diaphragm means relative to the support opening in response to said pressure, a dished disc element disposed at an opposite side of the diaphragm means to be movable

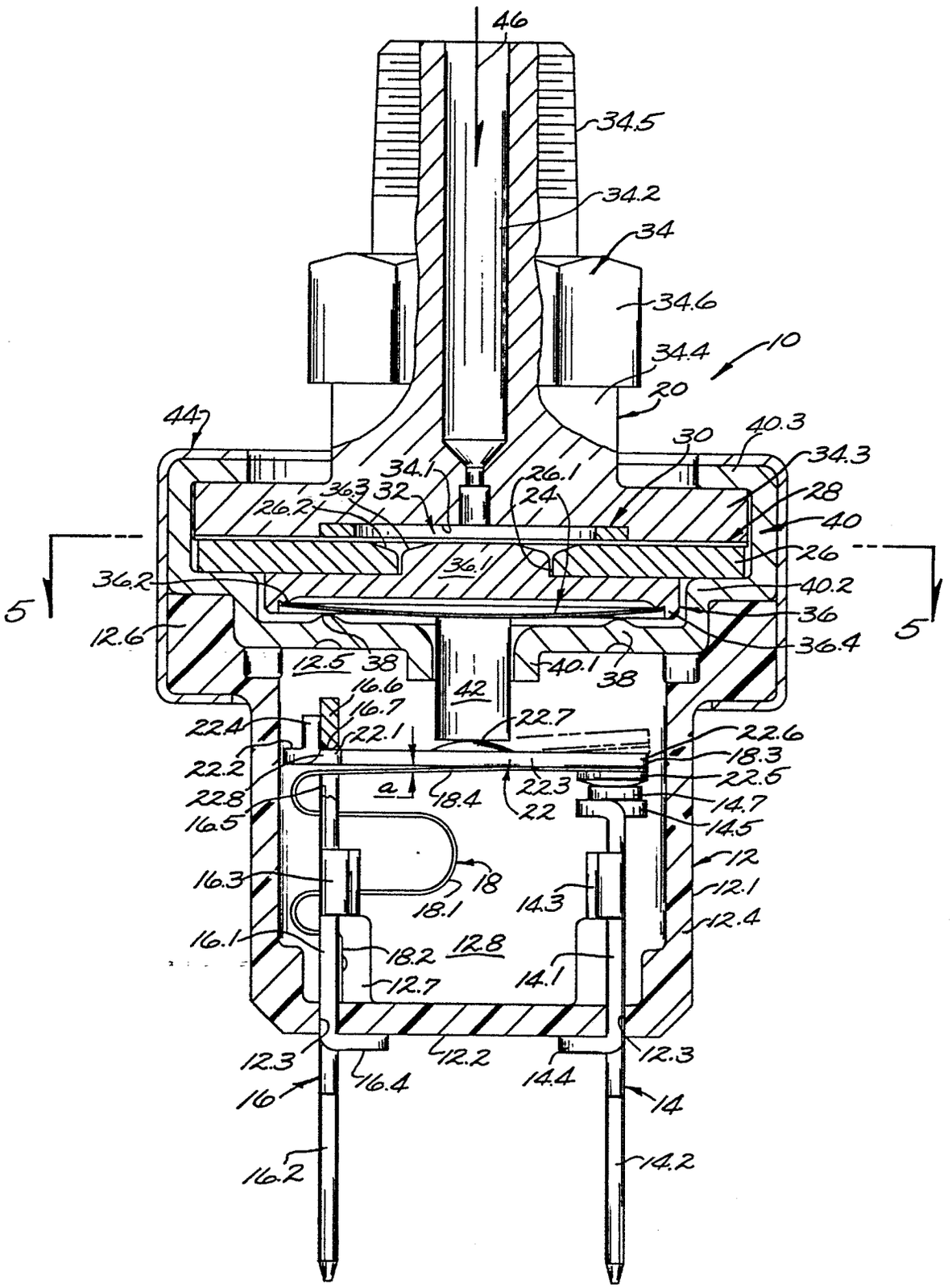
with snap action between original and inverted dished configurations for moving the switch means between said switch positions, force converter means disposed between the disc element and the diaphragm means having a force receiving portion of a first selected diameter disposed in the support opening to be responsive to movement of the diaphragm means and having an annular force applying portion of a second relatively larger diameter bearing against a corresponding diameter on one side of the disc element for transmitting said movement of the diaphragm means to the element, reaction means having a concentric annular reaction portion of a different diameter engaging such a corresponding diameter on an opposite side of the disc element permitting the element to move to said inverted dished configuration in response to application of said selected fluid pressure to the diaphragm means, and means mounting the support and disc element and the port, gasket, converter and reaction means in fixed relation to each other and to the diaphragm means to form said discrete, separately testable pressure-responsive unit.

6. A pressure-responsive switch as set forth in claim 5 further characterized in that the support opening has a selected diameter and the gasket means opening is limited to a diameter only slightly larger than the support opening for limiting the force applied to the support by said applied fluid pressure, and the port means comprises a metal body having a recess in one end fitted around the annular gasket member, the recess having a bottom bearing against the gasket member to form said sealed chamber, having a side wall engaging the outer diameter of the gasket member to restrict the outer gasket diameter for limiting the forces applied to the support means by fluid pressure in the chamber, and forming an integral body ring portion around the recess bearing against the diaphragm means for securing marginal portions of the diaphragm means in fixed location relative to the support, the body having an additional integral portion defining said passage for connection to a zone whose fluid pressure is to be monitored.

7. A pressure switch as set forth in claim 6 further characterized in that the diaphragm means comprises a plurality of flexible films of an organic material disposed in superimposed relation to each other on the support and clamped between the support and said integral ring portion of the port means for cooperating in withstanding relatively high applied fluid pressures without rupturing and for permitting flexing of the diaphragm over a long service life.

8. A pressure responsive switch as set forth in claim 7 further characterized in that the force converter means has stop means adapted to engage said reaction means after snap acting movement of the disc element to said inverted dished configuration in response to application of fluid pressure to the diaphragm means for protecting the disc element and positively supporting the diaphragm means in the support opening if excessive fluid pressure is applied to the diaphragm means.

9. A pressure responsive switch as set forth in claim 8 further characterized in that said mounting means comprises a metal sleeve integral with said reaction means, said sleeve having an integral inturned flange at one end forming said reaction means and having said annular reaction portion of the reaction means embossed therein, said sleeve enclosing said disc and force converter means and said integral flange portion of the body of the port means, and having an integral inturned flange at the opposite end of the sleeve engaging said flange portion of the port body means to form said discrete, separately testable pressure responsive unit.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36.2
40.2
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12.6
36.4
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40.1
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22.3
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14
16.2
14.2

Fig. 1.

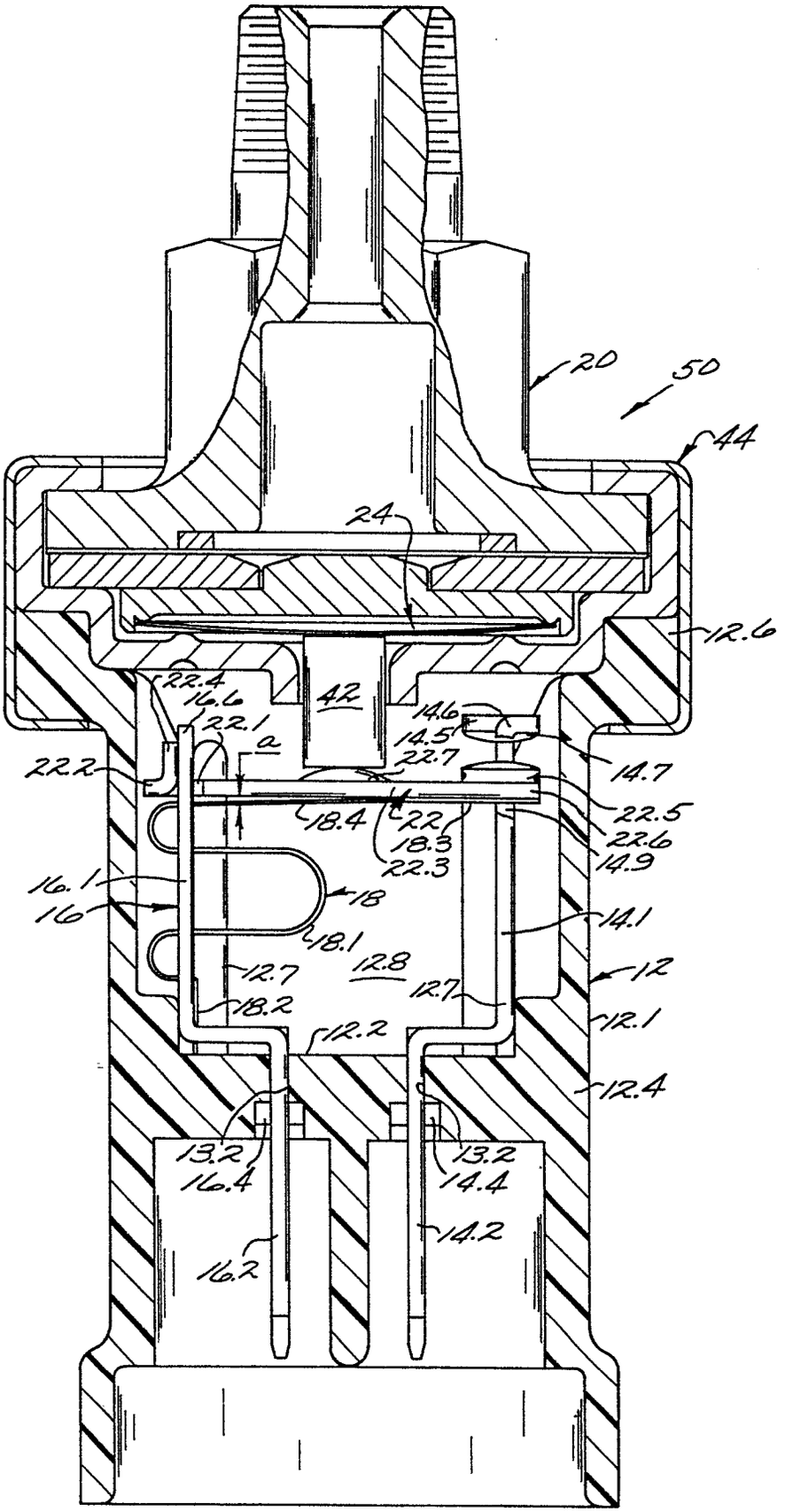
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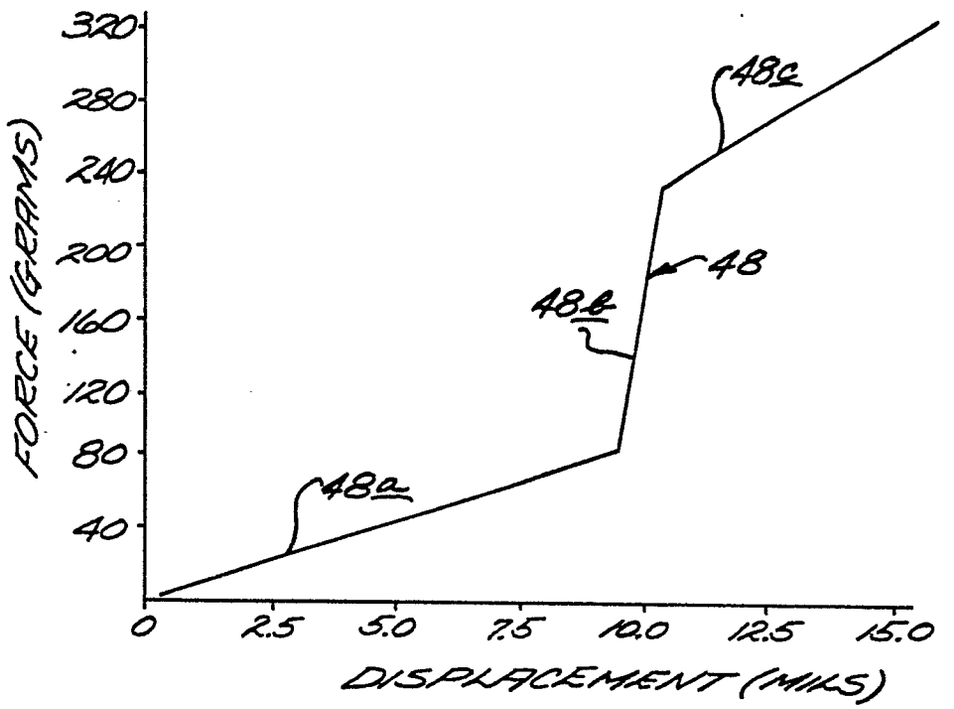
Fig. 2.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48c
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DISPLACEMENT (MILS)

Fig. 3.

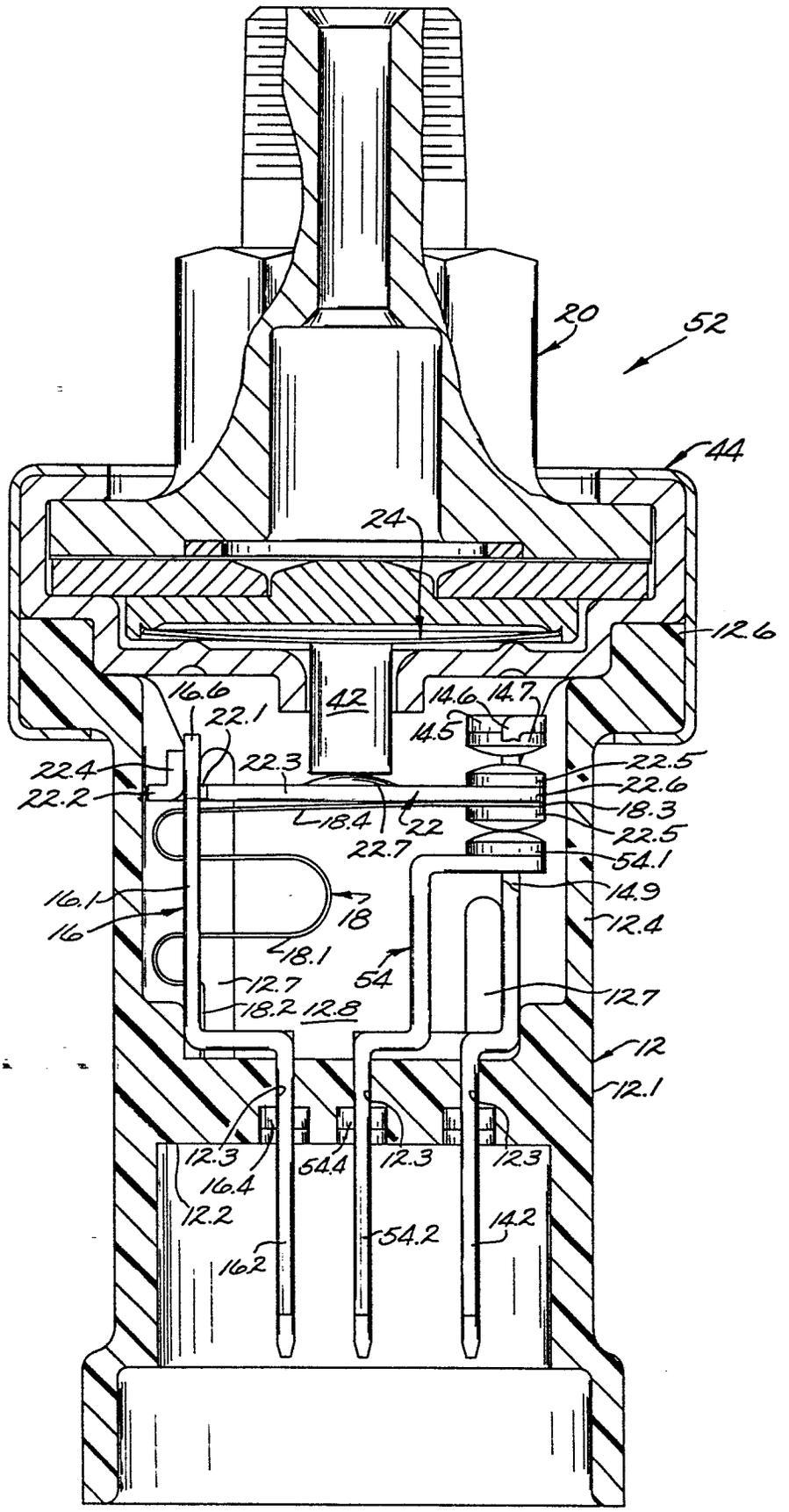
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Fig. 4.

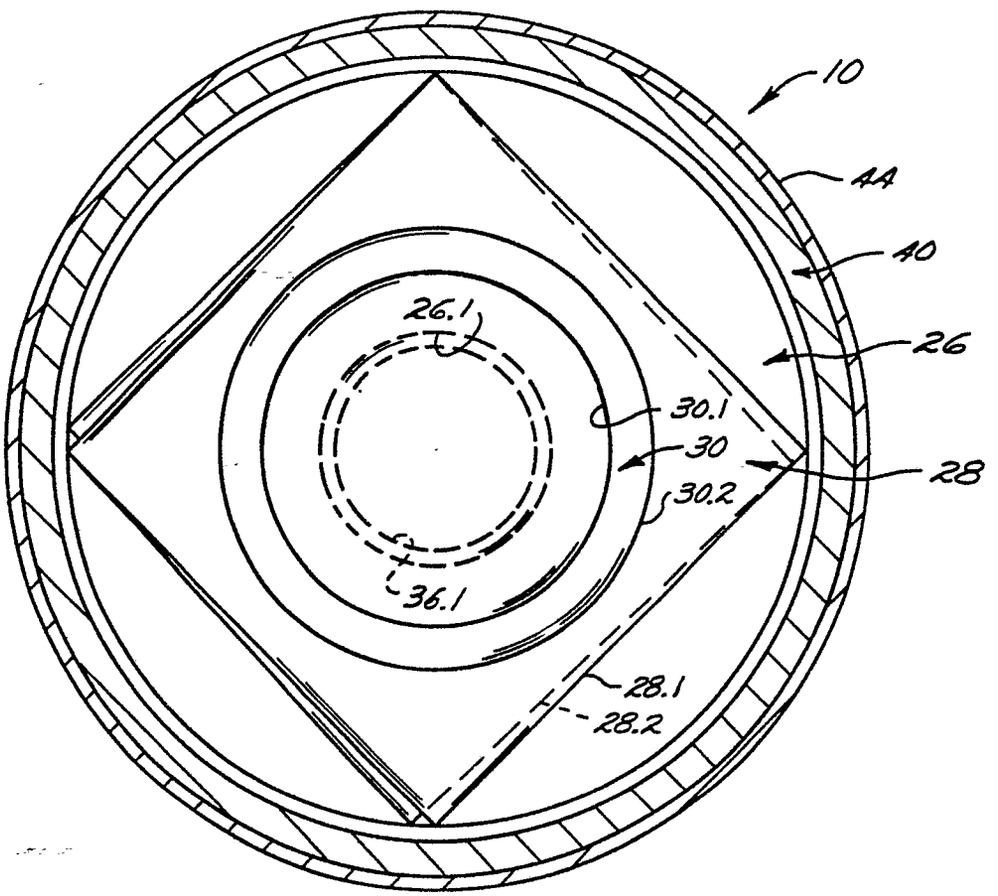

Fig. 5.

European Patent Office

EUROPEAN SEARCH REPORT

0113544
Application number

EP 83 30 7436

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. ³)
A	US-A-2 550 623 (A. TERUSSI) * Claim 1 *	1,2	H 01 H 1/24 H 01 H 35/34
A	DE-B-2 261 761 (R. SCHEUFFELE) * Column 3, lines 37-41; column 4, lines 7-40 *	1	
A	US-A-3 876 845 (D.L. GRIFFITH) * Column 2, lines 1-30 *	1	
A	DE-A-1 941 598 (SIMPLIFIX) * Page 4, paragraphs 1,2 *	5,6,8, 9	
A	US-A-4 342 887 (TEXAS) * Column 4, lines 12-29 *	5,6,8	

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

H 01 H 35/00
H 01 H 13/00
H 01 H 37/00
H 01 H 1/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27-03-1984	LIBBERECHT L.A.

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