United States Patent

[11] 3,611,220

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[45] Patented **Oct. 5, 1971**

[54] **CONDITION-RESPONSIVE MONITOR**
12 Claims, 12 Drawing Figs.

[52] **U.S. Cl.** ..... **335/207,** 200/82 R, 200/82 C
[51] **Int. Cl.** **H01h 5/02,** H01h 35/38
[50] **Field of Search** ..... 335/205, 207; 200/84 C, 81.9 M, 81.9 R, 82 R, 82 C

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Assistant Examiner—R. N. Envall, Jr.

ABSTRACT: A fluid pressure responsive device having two magnets with like poles facing each other. A first magnet is mounted with a piston to be movable in response to fluid pressure toward the other magnet to thus cause the other magnet to move due to repelling forces of the adjacent magnetic poles. A fixed armature, which may be adjustable, is located in the field of influence of said poles to control the repelling force which occurs between the magnets. The second magnet may used to actuate an indicating device.

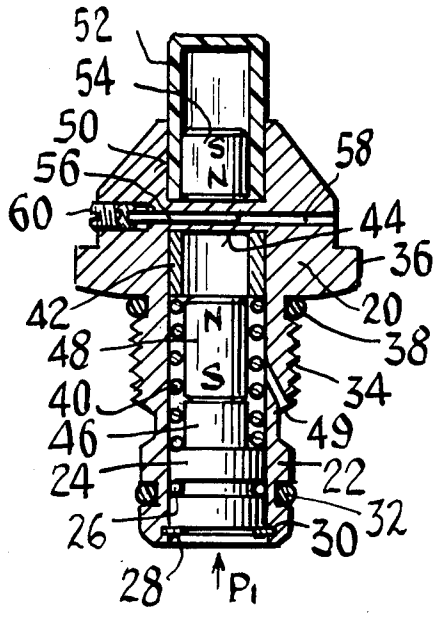


Fig. 1

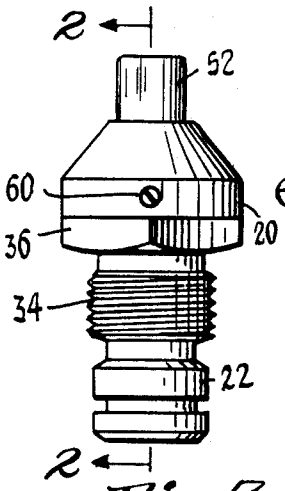


Fig. 2

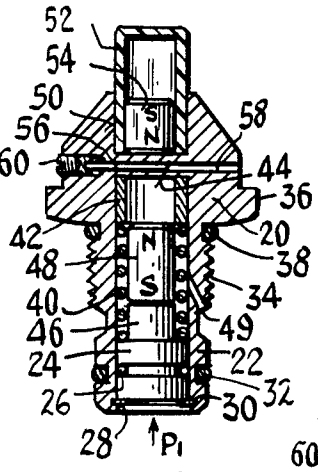


Fig. 3

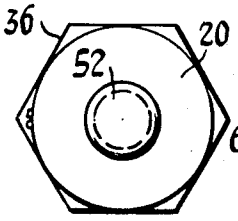


Fig. 5

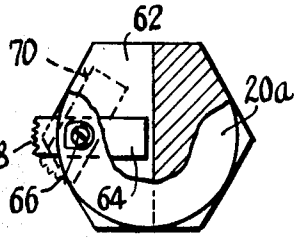


Fig. 6

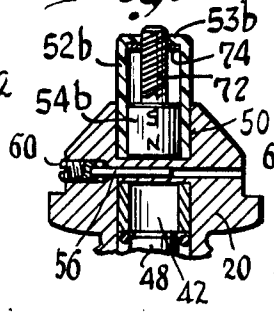


Fig. 4

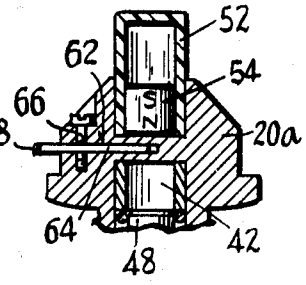


Fig. 7

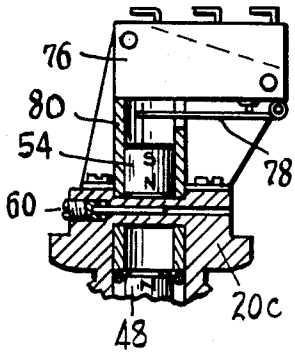


Fig. 8

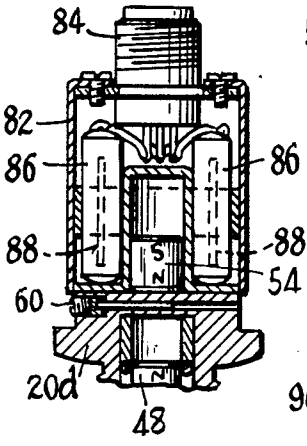


Fig. 9

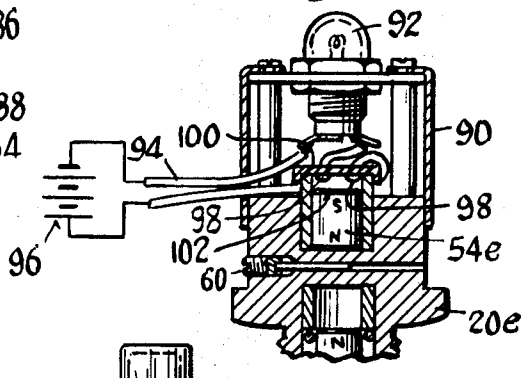


Fig. 10

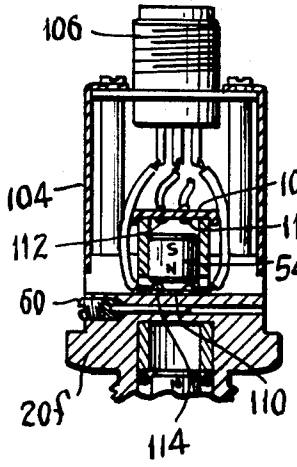


Fig. 12

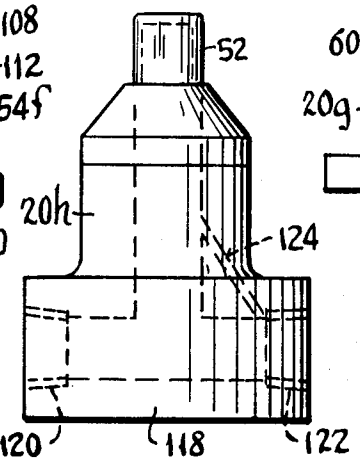
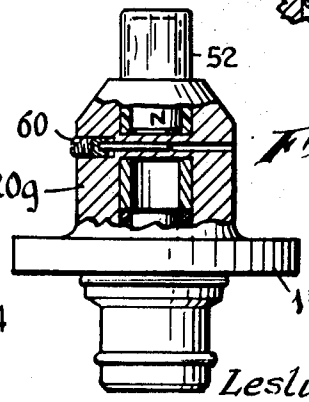


Fig. 11



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CONDITION-RESPONSIVE MONITOR

BACKGROUND

This invention relates to signalling or monitor devices, and more particularly to condition-responsive or fluid pressure responsive devices which employ magnetic members to effect a signal or control.

Several prior signal or indicator devices intended to respond to changes in fluid or liquid pressure utilized cylinder-and-piston arrangements wherein the piston shifted as changes in fluid pressure occurred on opposite sides of a filter. The piston was connected with a permanent magnet, or alternatively it was connected with a magnetic armature. In either case, an indicator device was provided in the form of a permanent magnet which was cooperable with the magnet or armature controlled by the piston. A strong attractive force existed which maintained the indicator device in a nonindicating condition, but if the piston and its magnet or armature was shifted away from the signal magnet, the latter being free for movement under the action of a biasing spring, shifted to a different position whereby it constituted an indication of the occurrence of a significant pressure change.

Other indicator or signal devices have members which experience a gradual change, these members being mounted directly on a piston which was shifted in response to changes in the fluid pressure. These gradual-movement-type indicators did not give as definite or distinct a signal as those in which an abrupt or snap action of the indicator member occurred, when considering a clogged condition of the filter element.

In other prior devices a pressure-actuated piston having a permanent magnet was associated with a magnetic follower which gradually shifted its position and which constituted the indication as to the difference in pressures caused by clogging of the filter. In still other devices a magnetic follower, which responded to a magnet carried by a float, was employed as a liquid level indicator, in connection with liquid containing vessels.

While these various prior devices have in general operated more or less satisfactorily, they all had the common drawback or limitation that the mode of operation was fixed and could not be altered to suit different requirements of the user. For example, those indicators which employed a snap action could not be readily changed to provide a gradual or analog type of indication, and the indicators which provided a gradual or analog type indication could not be readily converted to provide a snap or definite "on-off" type function. Moreover, the prior devices were in many instances relatively large and complicated, having a great many parts. In some cases the action of the parts was such that binding or malfunctioning could occur, resulting in the device becoming inoperative.

SUMMARY

The above drawbacks and disadvantages of prior condition-responsive monitors or controls are obviated by the present invention, which has for one object the provision of a novel and improved condition or fluid-pressure responsive monitor which is capable of either a snap action or else a gradual action of the indicator member, these constituting either a distinct "on-off" type response or else an analog or gradual type response, the arrangement being such that the device is easily and quickly converted from one to the other type of operation at the will of the user. This is accomplished by a piston and cylinder arrangement wherein the piston carries a small permanent magnet movable along a predetermined path of travel, and wherein there is an adjoining path of travel of a second or slave-type permanent magnet arranged to present a like pole to the nearest pole of the piston-carried magnet. As a consequence, magnetic repulsion exists between the magnets, tending to separate the same. Adjacent the normal, nonindicating position of the second or slave magnet is a fixed magnetic armature which is normally influenced or magnetized by the slave magnet whereby it tends to hold the latter in its

nonindicating position. When the piston-carried magnet is made to approach the armature and slave magnet, it gradually overcomes the magnetic influence of the latter on the fixed armature. Depending on the position of the armature, the change or reversal in its magnetism as the piston-carried magnet approaches, causes either a gradual shifting away of the slave magnet or else a sudden snaplike shifting away of the latter. The magnetic armature is adjustably mounted whereby it can be interposed in the space between the two magnets to effect the snap action of the slave magnet, or else removed somewhat from the space between the magnets whereby there ensues a gradual, responsive movement of the slave magnet as the piston-carried magnet is advanced on the latter.

Other features and advantages of the invention reside in the provision of a novel and improved, convertible monitor which responds to changes in a condition as above set forth, wherein relatively few parts are involved and wherein the construction is extremely simple, thereby reducing the fabricating cost; the provision of an improved convertible monitor of the kind indicated, which may be easily and quickly changed at the will of the user, from the gradual or analog type indication to the snap action type; the provision of an improved condition-responsive monitor which will readily actuate electrical switches such as microswitches, reed switches and the like to effect electrical controls, so as to illuminate a signal bulb for example; and the provision of an improved monitor as described above, wherein a reset type operation of the indicator may be readily had.

Still other features and advantages will hereinafter appear.

In the accompanying drawings illustrating several embodiments of the invention:

FIG. 1 is a side elevational view of the improved convertible condition-responsive monitor or control device as provided by the invention, shown without seals.

FIG. 2 is an axial sectional view taken on the line 2—2 of FIG. 1, but showing seals.

FIG. 3 is a top plan view of the device of FIGS. 1 and 2.

FIG. 4 is a fragmentary axial sectional view illustrating a modified form of adjustable magnetic armature.

FIG. 5 is a view partly in top plan and partly in section, of the monitor device of FIG. 4.

FIG. 6 is a view partly in axial section of a reset type monitor device constituting another embodiment of the invention.

FIG. 7 is a partial axial sectional view of a convertible condition-responsive control device having incorporated in it a microswitch.

FIG. 8 is a partial axial sectional view of a convertible condition-responsive device in conjunction with reed switches, to actuate the latter.

FIG. 9 is a partial axial sectional view of a convertible device provided with a signal or pilot light and cooperable switch contacts, for providing an electrical control or electrically operated signal.

FIG. 10 is a partial axial sectional view of a convertible condition-responsive device having pairs of switch contacts, which are made operative and inoperative as the device responds to changing conditions.

FIG. 11 is a view partly in side elevation and partly in axial section, illustrating a flange-mounting type of housing for the device.

FIG. 12 is a side elevational view of a convertible monitor device incorporated in a line-mounting type of housing.

Referring first to FIGS. 1–3, the present improved convertible monitor device comprises a tubular housing 20 having a lower or cylinder portion 22 in which there is reciprocatively carried a piston 24 having a packing or rubber O-ring 26. At the outer end of the cylinder 22 there is provided a snap ring 28 constituting a stop for the piston, carried in an annular internal groove 30 in the cylinder wall. Around its exterior, the cylinder 22 has a packing or O-ring 32 adapted to constitute a seal when the piston is inserted in a close-fitting bore of a supporting fitting. The cylinder 22 has external screw threads 34 by which it can be threaded into such fitting, and the housing

20 has a hexagonal portion 36 adapted to accommodate a wrench, and also a packing or O-ring 38 to effect a seal with the mouth of the fitting into which the cylinder 22 is screwed.

Within the cylinder 22 there is a helical compression spring 40, engaged at one end with the adjoining end surface of the piston 24 and at its other end with an annular spacer sleeve 42. As seen in FIG. 2, the bore of the cylinder 22 constitutes in effect a blind hole, in that the spacer sleeve 42 bottoms against a transverse wall 44 of the housing 20.

The cylinder 24 has a shank portion 46 to which there is affixed a permanent magnet 48 having north and south poles as indicated. In a wall of the cylinder 22 there is provided a port 49 whereby fluid pressure can be brought to bear against the upper or inner end surface of the piston 24, to counteract fluid pressure bearing against the bottom or outer end surface of the piston.

With such arrangement, pressure differential can be made to exist with respect to the piston 24; when the pressure at the outer or bottom end of the piston increases it will overcome the biasing action of the coil spring 40, shifting the piston 24 upward in the cylinder and likewise shifting upward the permanent magnet 48 which is herein termed a "master magnet."

The housing 20 has a second bore 50 which is aligned with the bore of the cylinder 22 but has no communication therewith. A domelike or cup-shaped cover piece 52 of transparent material such as clear plastic is carried in the upper bore 50 of the housing 20 so as to enclose the bore, and a permanent slave magnet 54 is provided within the cover 52, to be readily movable therein between a nonindicating or lower position as illustrated in FIG. 2 and an indicating or raised position wherein it occupies the upper portion of the cover 52 and is clearly visible or in view.

In accordance with the present invention the slave magnet 54 has its north pole lowermost, whereby it opposes the uppermost north pole of the master magnet 48, thereby resulting in repulsion between the magnets 48 and 54.

Also, disposed in the field of influence of the like north poles of the magnets 48, 54 and adjacent the paths of travel of the same there is a stationary magnetic armature piece 56 in the form of a short length of magnetic or iron wire, said wire occupying a transverse bore 58 in the housing 20 and being at one end carried by an adjusting screw 60 which is threaded into the bore 58. As seen in FIG. 2, the magnetic armature 56 is interposed in the space between the north poles of the magnets 48, 54, and is located closely adjacent the latter (slave) magnet when it occupies its lowermost or nonindicating position. The master magnet 48 when in its lower position (indicating that a relatively low fluid pressure is being exerted at the bottom end of the piston 24) is relatively remote from the armature 56.

With the parts in the positions illustrated in FIG. 2 the slave magnet 54 dominates the magnetization of the armature piece 56, producing a flux therein which tends to oppose the flux from the north pole of the master magnet 48, Movement of the master magnet 48 a given distance upward toward the armature piece 56 will overcome the magnetic influence thereon by the slave magnet 54, eventually driving the latter away from the armature piece 56 and upward, into the upper portion of the cover piece 52. Such upward movement of the slave or indicator magnet 54 will be sudden, and will have a snap characteristic if the armature wire 56 is interposed in the space between the two magnets as shown in FIG. 2. As presently understood, the magnetism of the north pole of the master magnet 48 as the magnet is driven upward by the piston 24 in responding to pressure changes, will overcome the magnetic influence of the slave magnet 54 on the armature piece. Such magnetic influence, prior to upward movement of the master magnet 42, has held the slave magnet 54 in its lower, nonindicating position. However, the upward movement of the master magnet 48 in overcoming the magnetism in the armature piece 56 as effected by the slave magnet 54 will, in effect, reverse such magnetism whereby in place of the attractive force between the armature piece and the slave magnet 54 there will now abruptly be a repulsive force, causing the slave magnet 52 to snap upward to a raised position in the cover piece 52. At such time that the piston 24 is caused to shift downward under the action of the spring 48 (due to removal of the driving pressure from the bottom end of the piston 24) the magnetic influence of the master magnet 48 on the armature piece 56 will become weakened, whereupon the weight of the slave magnet 54 and its magnetic attraction for the armature piece 56 will be operative, resulting in the slave or indicator magnet 54 descending to the nonindicating position of FIG. 2.

If the armature piece 56 is removed somewhat from between the north poles of the magnets 48, 54, it will have a lesser effect in holding the slave magnet 54 against movement as the master magnet 48 is caused to shift upward due to pressure changes on the piston 24. In consequence, the upward gradual movement of the master magnet 48 will cause the slave magnet 54 to shift upward gradually due to the repulsive forces existing between the magnets, such repulsive forces being altered or effected to a much lesser extent by the partially withdrawn armature piece 56. Accordingly, instead of a snap action movement of the slave magnet 54 there will be a gradual or analog type movement of such slave magnet.

It will be seen that the type of response or movement of the slave magnet 54 can be easily converted by the user, in a simple manner, by merely turning the adjusting screw 60 inward or outward, to locate the armature piece 56 either closer to or further from the space between the north poles of the opposing magnets 48, 54.

Another embodiment of the invention is illustrated in FIGS. 4 and 5. In this embodiment, components which are similar to those already described have been given like numerals. In the embodiments of FIGS. 4 and 5, in place of the axially or longitudinally movable armature wire 56 there is provided a flat metal armature strip of magnetic material, which is pivotally movable into and out of the sphere of influence of the permanent magnets. As shown, the housing 20*a* has a horizontal slot or cut 62 in which there is disposed a flat strip of sheet metal 64 constituting a magnetic armature piece. The strip 64 has a pivot hole through which there extends a pivot screw 66 threaded into the housing 20*a*. The exterior end of the armature piece 64 has knurling or serrations 68 constituting a finger grip, by which the strip may be readily shifted from its fully operative, full line position illustrated in FIG. 5 to a relatively inoperative broken line position indicated at 70 in FIG. 5. For the full line position of the armature piece 64 a snap action of the slave magnet 54 will occur, whereas for the inoperative position of the armature piece 64 indicated at 70 in FIG. 5 a gradual or analog type movement of the slave magnet 54 will be had.

Another embodiment of the invention is illustrated in FIG. 6, wherein like components already described have been given similar characters. In FIG. 6, a cover piece 52*b* is provided in the bore 50 of the housing 20, said cover piece having a central opening in its top wall 53*b*, through which there extends a stud 72 attached to an movable with the slave magnet 54*b*. When the magnet 54*b* moves upward in the cover piece 52*b*, the stud 72 will protrude from the top of the cover piece. Against the underside of the top wall 53*b* of the cover piece there is attached a magnetic keeper 74 in the form of a steel annulus. As the slave magnet 54*b* moves upward to its raised indicating position, the south pole thereof will attract the keeper 74 which is affixed to the cover piece 52*b*. Accordingly, the slave magnet 54*b* will be retained in its raised indicating position after having been shifted thereto in response to raising movement of the master magnet 48. This arrangement constitutes a manual reset, since it will be necessary for the user to depress the stud 72 so as to reset the slave magnet 54 to its lower, nonindicating position upon normal conditions being restored for the piston 24 and master magnet 48.

Yet another embodiment of the invention is illustrated in FIG. 7, wherein the monitor device constitutes a control. Mounted on the casing **20***c* is a microswitch **76** having an actuator arm **78** which is disposed in the path of travel of the slave magnet **54**. At the time that the slave magnet **54** is shifted to it raised position, it will actuate the arm **78** of the micro switch **76**, causing an actuation of the switch. The slave magnet **54** is shiftable in a vertical tubular guide **80** carried by the housing of the microswitch **76**.

Yet another embodiment of the invention is illustrated in FIG. **8**, wherein the housing **20***d* of the convertible monitor-control device carries an enclosure **82** provided with an electrical connector fitting **84**. Within the enclosure **82** are reed switches **86** having their lead wires connected to the connector fitting **84**. The reed switches **86** have magnetic elements **88** which are influenced by the slave magnet **54**. When the slave magnet is shifted to its raised position, it will actuate the magnetic elements **88** from the reed switches **86**, either closing or opening the same as the case may be.

Still another embodiment of the invention is illustrated in FIG. **9**, wherein the casing **20***e* is provided with an enclosure **90** on which there is mounted a pilot light **92**. An electrical circuit **94** including a battery **96** is provided for the pilot light, and included in such circuit are electrical contacts **98** carried by a circuit board **100**. The contacts **98** are engageable by the upper silvered surface **102** of the slave magnet **54***e*. When the magnet **54***e* is shifted to a raised position, the silvered end surface **102** thereof will bridge the contacts **98**, closing the circuit through the lamp **92** and effecting its energization, thereby indicating that the device has responded to a change in the conditions affecting it.

Yet another embodiment of the invention is illustrated in FIG. **10**, wherein a casing **20***f* has an enclosure **104** carrying a connector fitting **106**. Within the enclosure **104**, circuit boards **108** and **110** carry pairs of electrical contacts **112**, **114** respectively which are engageable respectively with the opposite silvered ends of a slave magnet **54***f*. With the slave magnet **54***f* in the lower position illustrated in FIG. **10**, the contacts **114** are bridged, whereas with the slave magnet in a raised position, the contacts **114** are not bridged but instead the contacts **112** are bridged, thereby effecting a circuit control for signalling or other equipment.

FIG. **11** indicates a flange mounting type housing **20***g* provided with an annular mounting flange **116** in place of the screw thread mounting **34** illustrated in FIGS. **1** and **2**.

In FIG. **12**, a housing **20***h* is illustrated, having a tubular fitting portion **118** provided with internal end threads **120**, **122** to receive pipe fittings. A port **124** connects with one end portion of the fitting section **118**.

It will now be understood from the foregoing that I have provided a novel and improved, readily convertible condition-responsive monitor or control device which is especially simple in construction, involving relatively few parts which may be economically fabricated and assembled. The monitor may be quickly converted from either a snap, on-off type of operation to a gradual or analog type operation, by merely shifting a magnetic armature piece between its operative and inoperative positions. The device is effective and reliable in use, not subject to leakage or malfunctioning, and is readily adaptable to monitor a variety of different conditions wherein changes occur.

Variations and modifications are possible without departing from the spirit of the invention.

I claim:

1. A condition-responsive monitor comprising, in combination:

a. a permanent master magnet,

b. means mounting the master magnet for movement in either of opposite directions along a predetermined path of travel,

c. a drive device responsive to changes in a condition, for shifting said permanent magnet in said path,

d. a permanent slave magnet,

e. means mounting the slave magnet for movement in either of opposite directions along a predetermined path of travel adjoining and noncoincidental with said first-mentioned path of travel,

f. said magnets being arranged with a pair of like poles directed toward each other, thereby causing opposing forces to exist between the magnets, which tend to separate the same,

g. a stationary magnetic armature piece disposed in the field of influence of said like poles of the magnets, adjacent the paths of travel of the same,

h. means biasing said master magnet to a position away from said armature piece whereby it is movable toward the piece and against said biasing means in response to changes in said condition,

i. said slave magnet being normally close to the armature piece, dominating the magnetization thereof, and producing a flux therein according to a given polarity, movement of the master magnet a given distance toward the armature piece overcoming the magnetic influence thereon by the slave magnet and driving the latter away from the armature piece to a position relatively remote therefrom.

2. A condition-responsive monitor as in claim **1**, wherein:

a. said armature piece is disposed between said like poles of the magnets,

b. said slave magnet being driven away from the armature piece with a snap action when the master magnet overcomes the slave magnetization of said piece as it moves toward the latter.

3. A condition-responsive monitor as in claim **1**, wherein:

a. said armature piece is disposed adjacent the space between said like poles of the magnets,

b. said slave magnet shifting slowly away from the armature piece when the master magnet overcomes the slave magnetization of said piece as it slowly moves toward the latter.

4. A condition-responsive monitor as in claim **1**, wherein:

a. said drive device comprises a piston and cylinder,

b. said master magnet being connected to said piston to be shifted thereby,

c. said cylinder having passages at opposite ends of the piston to admit pressurized fluid.

5. A condition-responsive monitor as in claim **1**, wherein:

a. said armature piece comprises a magnetic wire, and

b. means for adjustably positioning said wire, said means comprising a screw carrying said wire in alignment with its axis whereby turning of the screw either advances the wire into the space between said like magnet poles or retracts the wire from said space.

6. A condition-responsive monitor as in claim **1**, wherein:

a. said armature piece comprises a strip of magnetic sheet metal, and

b. means for adjustably positioning said strip, said means comprising pivot means for enabling the strip to be swung into or out of the space between said like magnet poles.

7. A condition-responsive monitor as in claim **1**, and further including:

a. a magnetic keeper disposed in the path of travel of the slave magnet, for yieldably holding the latter in shifted position as effected by the master magnet.

8. A condition-responsive monitor as in claim **1**, and further including:

a. a microswitch, and

b. means for actuating said switch in response to shifting of the slave magnet by said master magnet.

9. A condition-responsive monitor as in claim **1**, and further including:

a. a reed switch having a magnetic actuator member,

b. said reed switch being disposed in the field of influence of the slave magnet to be actuated thereby when the magnet is shifted by the master magnet.

10. A condition-responsive monitor as in claim **1**, and further including:

a. a pilot light,

b. an energizing circuit for the pilot light, and

c. cooperable contacts controlling said energizing circuit and actuated by said slave magnet when the latter is shifted by said master magnet.

11. A condition-responsive monitor as in claim 1, and further including:

a. pairs of electrical contacts respectively bridged by the slave magnet when the latter is either close to said armature piece or else shifted away therefrom.

12. A condition-responsive monitor as in claim 4, and further including:

a. a tubular housing comprising said cylinder,

b. said master and slave magnets being axially shiftable in the bore of the housing,

c. said biasing means comprising a coil spring in the housing bore and encircling the master magnet.