Oct. 17, 1961 R. E. LEIBOLD ET AL 3,005,067

DIFFERENTIAL PRESSURE SWITCH

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FIG.2.

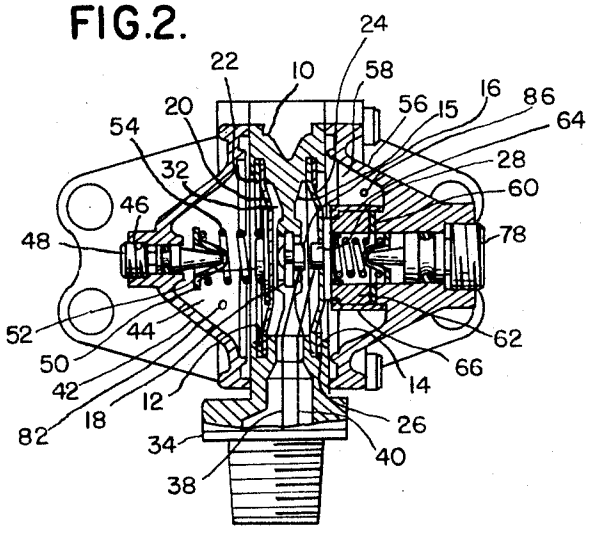


FIG.3.

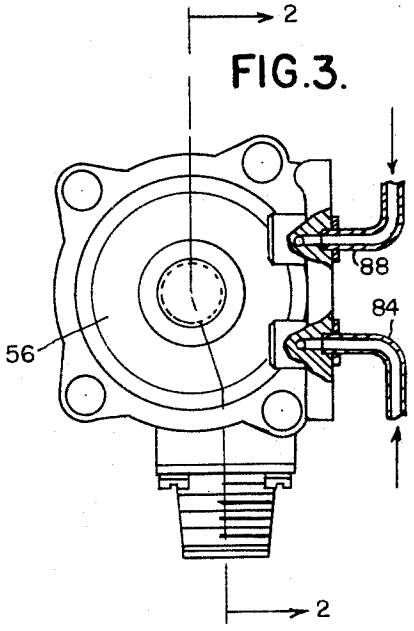
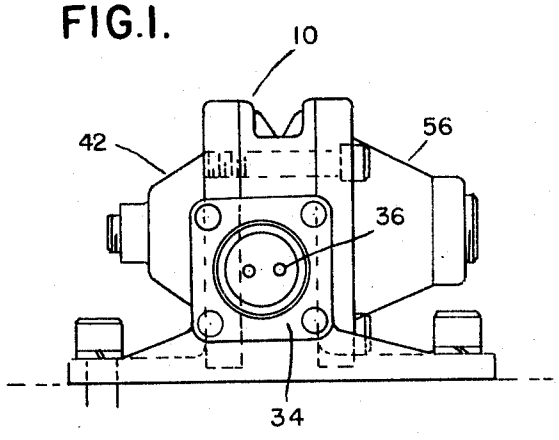


FIG.1.



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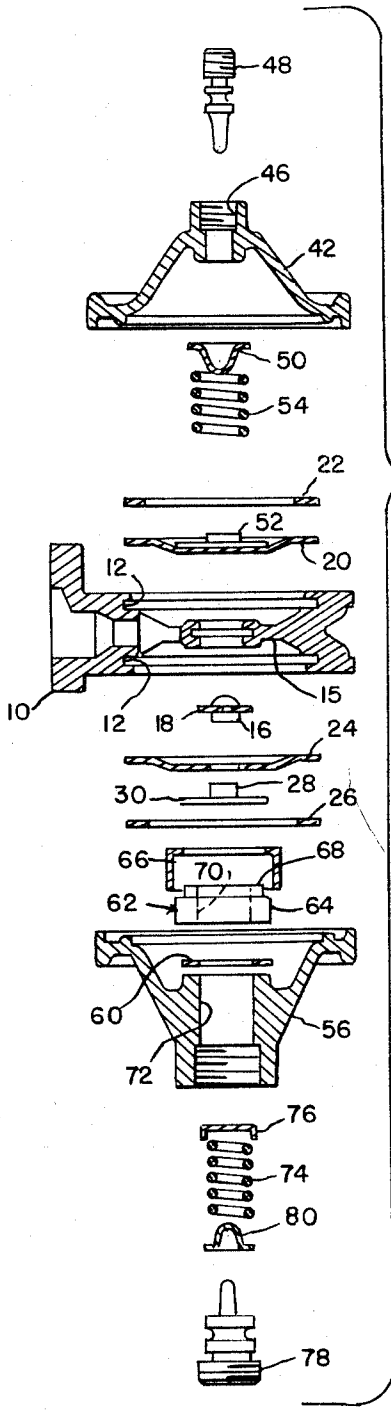
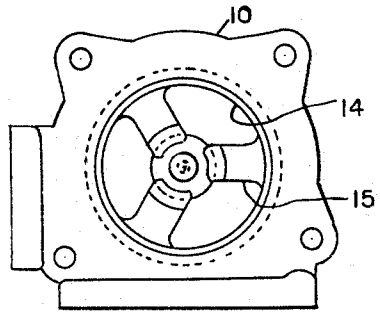


FIG.5.

FIG.4.



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DIFFERENTIAL PRESSURE SWITCH

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9 Claims. (Cl. 200—83)

The present invention relates to a differential pressure switch, and more particularly to a switch operable in accordance with the differential between two pressures and adapted to open and close at different pressure differentials.

It is an object of the present invention to provide a switch of the character described having switch contacts located in a switch chamber filled with electrically insulating oil.

It is a further object of the present invention to provide a pressure differential switch comprising a housing having two separated diaphragms therein defining a pair of separated pressure chambers and an intermediate switch chamber, said switch chamber having a stationary switch contact therein, a movable switch contact carried by one of said diaphragms, said switch chamber being filled with an electrically insulating oil, and means for connecting said pressure chambers to two different sources of pressure.

More specifically, it is an object of the present invention to provide a switch of the character described including pressure responsive means for effecting relative movement between a pair of switch contacts and magnetic hysteresis means effective to provide opening and closing movement of said contacts to occur at different pressure differentials.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawing, illustrating a preferred embodiment of the invention, wherein:

FIGURE 1 is an elevational view of the switch.

FIGURE 2 is a plan view sectioned on the line 2—2, FIGURE 3.

FIGURE 3 is a side elevational view with parts broken away.

FIGURE 4 is a fragmentary view of the contact supporting spider.

FIGURE 5 is an exploded view of the components of the differential switch.

The pressure differential switch disclosed herein comprises fluid pressure responsive means operable upon attainment of a predetermined pressure differential between two pressure sources to effect opening movement of the contacts of a switch and operable in response to attainment of a predeterminedly different pressure differential for effecting closing of the switch. In general terms this is accomplished by providing magnetic hysteresis means including a magnet and a magnetic member moved into engagement with the magnet upon a predetermined switch actuation so that a substantially different pressure differential is required to effect a reverse switch actuation.

In the embodiment of the invention illustrated herein, the magnetic hysteresis means is operable upon opening movement of the switch contacts so that the attraction between the magnet and the magnetic member must be overcome to initiate closing movement of the switch contacts.

Referring now to the drawings the differential switch comprises a support body **10** having a generally circular portion shaped to provide annular inwardly facing grooves **12** forming diaphragm seats at opposite sides thereof surrounding a central opening **14**. Extending into the central opening are a plurality of circumferentially separated arms **15** which together form a spider for supporting a stationary switch contact **16** mounted in an insulating disc **18**.

In the groove **12** at one side of the support body is a flexible diaphragm **20**, the peripheral portion of which is clamped and sealingly engaged in the groove by a backing ring **22**. At the opposite side of the body **10** the flexible diaphragm **24** has its peripheral portion received in the groove **12** and sealingly engaged therein by the backing ring **26**.

Carried by the flexible diaphragm **24** is an electrical switch contact **28** which as best seen in FIGURE 5 includes an integral or separate disc or armature portion **30** formed of magnetic material. The diaphragms **20** and **24** cooperate with the generally central portion of the support body **10** to define between the diaphragms a switch chamber **32**. A closure plate **34** is provided on the body **10** and has openings therethrough as indicated at **36** for receiving the electrical conductors **38** and **40** which are sealed in the openings and which are connected respectively to the switch contacts **16** and **28**.

The interior of the switch chamber **32** is completely filled with an electrically insulating oil. This oil serves two useful functions in the present switch. In the first place it completely surrounds the switch contacts **16** and **28** and effectively prevents arcing when the switch is operated. Secondly, since the switch chamber is completely filled with the oil, it serves as a means for mechanically connecting the diaphragms **20** and **24**.

At one side of the support body **10** is a hollow cap **42** which cooperates with the diaphragm **20** to form a first pressure chamber **44**. The cap **42** has a threaded opening **46** which receives an adjustable spring support **48** at the inner end of which is provided a spring seat **50**. Intermediate the spring seat **50** and a spring pilot **52** on the diaphragm **20** is a compression spring **54** which urges the diaphragm **20** to the right.

At the opposite side of the support body **10** is a similarly formed hollow cap **56** defining with the support body and the flexible diaphragm **24** a second pressure chamber **58**. Mounted on an insulating ring **60** in the cap **56** is a magnet **62** having a peripheral mounting portion **64** which may be formed of insulating material. The magnet is retained in assembled position by a cup-like retainer **66** having a central opening through which a polar end portion **68** of the magnet extends.

The magnet **62** is annular and has a central opening **70** therethrough. The cap **56** has an opening **72** in which is received a compression spring **74** the upper end of which engages a spring insulator **76** which in turn engages against the lower side of the disc portion **30** of the contact **28**. The lower portion of the opening **72** receives a spring adjusting screw **78** the inner end of which carries a spring seat **80** which engages the lower end of the compression spring **74**.

Means are provided for connecting the pressure chambers **44** and **58** to different sources of pressure. For example, the pressure chamber **44** has a port **82** adapted to be connected by an external conduit **84** to a source of low pressure. Similarly, the pressure chamber **58** is provided with a port **86** adapted to be connected by an external conduit **88** to a source of relatively high pressure. Thus, the conduits **84** and **88** may for example be connected to a fluid passage at different points having a flow restriction therebetween and thus make the switch responsive to flow through the passage.

With the foregoing construction it will be observed that the adjustable spring **54** acts to move the diaphragm **20** to the right as seen in FIGURE 2, whereas the spring **74** acts to move the diaphragm **24** to the left. Since the interior of the switch chamber **32** is completely filled with incompressible electrically insulating oil, the dia-

phragms move as a unit. Accordingly, the fluid pressure differential in the chambers 32 and 58 required to open the switch contacts 16 and 28 is determined by the adjustment of the springs 54 and 74. However, when the switch opens in response to an appropriate pressure differential, the movable armature portion 30 of the contact 28 moves into contact with the pole face of the magnet 62. Accordingly, initiation of switch closing movement requires that the attraction between the magnet and its armature be broken. Inasmuch as the attraction between the magnet and the armature, when they are in intimate contact, represents a substantial force and since this force drops to a negligible fraction as soon as contact is broken, it will be appreciated that closing movement of the switch takes place at a substantially greater pressure differential than is required to open the switch contacts. Moreover, the abrupt termination of the effectiveness of the magnet in preventing initiation of switch closing movement of the contact 28 results in a pressure differential of sufficient magnitude being built up to cause abrupt and complete closure of the switch contacts.

It will further be appreciated that adjustment of the spring 74 is affected primarily in determining the pressure differential required to initiate closing movement of the switch.

Switch opening and closing of this differential pressure switch occurs at separately adjustable pressure differentials. In other words, the switch may be regarded as comprising means incorporating an adjustable differential tripping or opening point and a separately adjustable hysteresis for the closing point.

The drawing and the foregoing specification constitute a description of the improved differential pressure switch in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What we claim as our invention is:

1. A differential pressure switch comprising a support body having an opening therethrough, a pair of laterally spaced seats at opposite sides of said opening, diaphragms on said seats defining therebetween and with the portion of said body surrounding the opening a central switch chamber, spider means on said body supporting a switch contact generally centrally of said switch chamber, electrically insulating oil filling said switch chamber, hollow caps overlying said diaphragms and sealed to said body to define pressure chambers therewith, means for connecting the interior of said pressure chambers with different sources of fluid pressure, an electrical contact carried by one of said diaphragms and movable thereby into and out of contact with said first mentioned contact, resilient means within one pressure chamber operatively engaging the diaphragm forming a part of said one pressure chamber and biasing said diaphragms in switch opening direction, a magnet fixed in said other pressure chamber, a magnetic member on said other diaphragm movable into engagement with a pole of said magnet when said diaphragms are in switch open position.

2. A differential pressure switch comprising a support body having an opening therethrough, a pair of laterally spaced seats at opposite sides of said opening, diaphragms on said seats defining therebetween and with the portion of said body surrounding the opening a central switch chamber, spider means on said body supporting a switch contact generally centrally of said switch chamber, electrically insulating oil filling said switch chamber, hollow caps overlying said diaphragms and sealed to said body to define pressure chambers therewith, means for connecting the interior of said pressure chambers with different sources of fluid pressure, an electrical contact carried by one of said diaphragms and movable thereby into and out of contact with said first mentioned contact, resilient means within one pressure chamber operatively engaging the diaphragm forming a part of said one pressure chamber and biasing said diaphragms in switch opening direction, a magnet fixed in said other pressure chamber, a magnetic member on said other diaphragm movable into engagement with a pole of said magnet when said diaphragms are in switch open position, and adjustable resilient means in said other pressure chamber operatively engaging a portion movable with said diaphragms to variably control the pressure differential required to separate said magnet and magnetic member to initiate switch closing movement of said diaphragms.

3. A differential pressure responsive contact switch effective to provide opening and closing movement of the contacts at different pressure differentials comprising a housing having a pair of spaced flexible diaphragms therein dividing the interior of said housing into a pair of separated pressure chambers and an intermediate switch chamber, a high pressure source connected to one of said chambers and a low pressure source connected to the other of said chambers, stationary and movable switch contacts in said switch chamber, said movable contact being carried by the diaphragm forming part of the high pressure chamber, a magnet and an armature positioned in the high pressure chamber, said armature being movable with respect to said diaphragms, an electrically insulating oil filling said switch chamber and effective to provide a force transmitting connection between said diaphragms, said switch being effective to open said contacts at a first pre-selected differential pressure between said pressure chambers whereby said armature is attracted to engage said magnet and said switch being effective to close said contacts at a second pre-selected differential pressure which overcomes the magnetic forces tending to hold the armature and magnet together.

4. A differential pressure responsive contact switch effective to provide opening and closing movement of the contacts at different pressure differentials comprising a housing having a pair of spaced flexible diaphragms therein dividing the interior of said housing into a pair of separated pressure chambers and intermediate switch chamber, a high pressure source connected to one of said chambers and a low pressure source connected to the other of said chambers, stationary and movable switch contacts in said switch chamber, said movable contact being carried by the diaphragm forming part of the high pressure chamber, a magnet and an armature positioned in the high pressure chamber, said armature being movable with respect to said diaphragms, an electrically insulating oil filling said switch chamber and effective to provide a force transmitting connection between said diaphragms, said switch being effective to open said contacts at a first pre-selected differential pressure between said pressure chambers whereby said armature is attracted to engage said magnet and said switch being effective to close said contacts at a second pre-selected differential pressure which overcomes the magnetic forces tending to hold the armature and magnet together and resilient means within said low pressure chamber operatively engaging the diaphragm forming a part of said low pressure chamber and biasing said diaphragms in switch opening direction.

5. A differential pressure responsive contact switch effective to provide opening and closing movement of the contacts at different pressure differentials comprising a housing having a pair of spaced flexible diaphragms therein dividing the interior of said housing into a pair of separated pressure chambers and intermediate switch chamber, a high pressure source connected to one of said chambers and a low pressure source connected to the other of said chambers, stationary and movable switch contacts in said switch chamber, said movable contact being carried by the diaphragm forming part of the high pressure chamber, a magnet and an armature positioned

in the high pressure chamber, said armature being movable with respect to said diaphragms, an electrically insulating oil filling said switch chamber and effective to provide a force transmitting connection between said diaphragms, said switch being effective to open said contacts at a first pre-selected differential pressure between said pressure chambers whereby said armature is attracted to engage said magnet and said switch being effective to close said contacts at a second pre-selected differential pressure which overcomes the magnetic forces tending to hold the armature and magnet together, resilient means within said low pressure chamber operatively engaging the diaphragm forming a part of said low pressure chamber and biasing said diaphragms in switch opening direction and additional resilient means in said high pressure chamber connected to said diaphragms when said armature and magnet are engaged to apply a force to said diaphragms tending to separate said armature and magnet.

6. A differential pressure responsive contact switch effective to provide opening and closing movement of the contacts at different pressure differentials comprising a housing having a pair of spaced flexible diaphragms therein dividing the interior of said housing into a pair of separated pressure chambers and an intermediate switch chamber, a high pressure source connected to one of said chambers and a low pressure source connected to the other of said chambers, a stationary switch contact in said switch chamber, a movable switch contact and armature unit, said movable contact extending through the diaphragm forming part of the high pressure chamber into said switch chamber, said armature being located in the high pressure chamber and movable with respect to the movement of said diaphragms, a magnet positioned in the high pressure chamber, means retaining the magnet in an assembled position, an electrically insulating oil filling said switch chamber and effective to provide a force transmitting connection between said diaphragms, said switch being effective to open said contacts at a first pre-selected differential pressure between said pressure chambers whereby said armature is attracted to engage said magnet and said switch being effective to close said contacts at a second pre-selected differential pressure, which is larger than said first differential pressure, said second differential pressure overcoming the magnetic forces tending to hold the armature and magnet together.

7. A differential pressure responsive contact switch defined in claim 6 wherein adjustable spring means are located within the low pressure chamber operatively engaging the diaphragm forming a part of said low pressure chamber and biasing said diaphragms in switch opening direction.

8. A differential pressure responsive contact switch defined in claim 7 wherein additional adjustable spring means are provided in the high pressure chamber connected to said diaphragms when said armature and magnet are engaged to apply a force to said diaphragms tending to separate said armature and magnet.

9. A differential pressure switch comprising a support body having an opening therethrough, a pair of laterally spaced seats at opposite sides of said opening, movable walls on said seats defining therebetween and with the portion of said body surrounding the opening a central switch chamber, means on said body supporting a switch contact generally centrally of said switch chamber, electrically insulating oil filling said switch chamber, hollow caps overlying said movable walls to define pressure chambers therewith, means for connecting the interior of said pressure chambers with different sources of fluid pressure, an electrical contact carried by one of said walls and movable thereby into and out of contact with said first mentioned contact, resilient means within one pressure chamber operatively engaging the wall forming a part of said one pressure chamber and biasing said walls in switch opening direction, a magnet fixed in said other pressure chamber, a magnetic member on said other wall movable into engagement with a pole of said magnet when said walls are in switch open position.

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