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C. L. RIRIE ET AL

3,234,792

DISPLACER OPERATED MECHANISM

Filed Feb. 20, 1961

2 Sheets-Sheet 1

Fig. 1

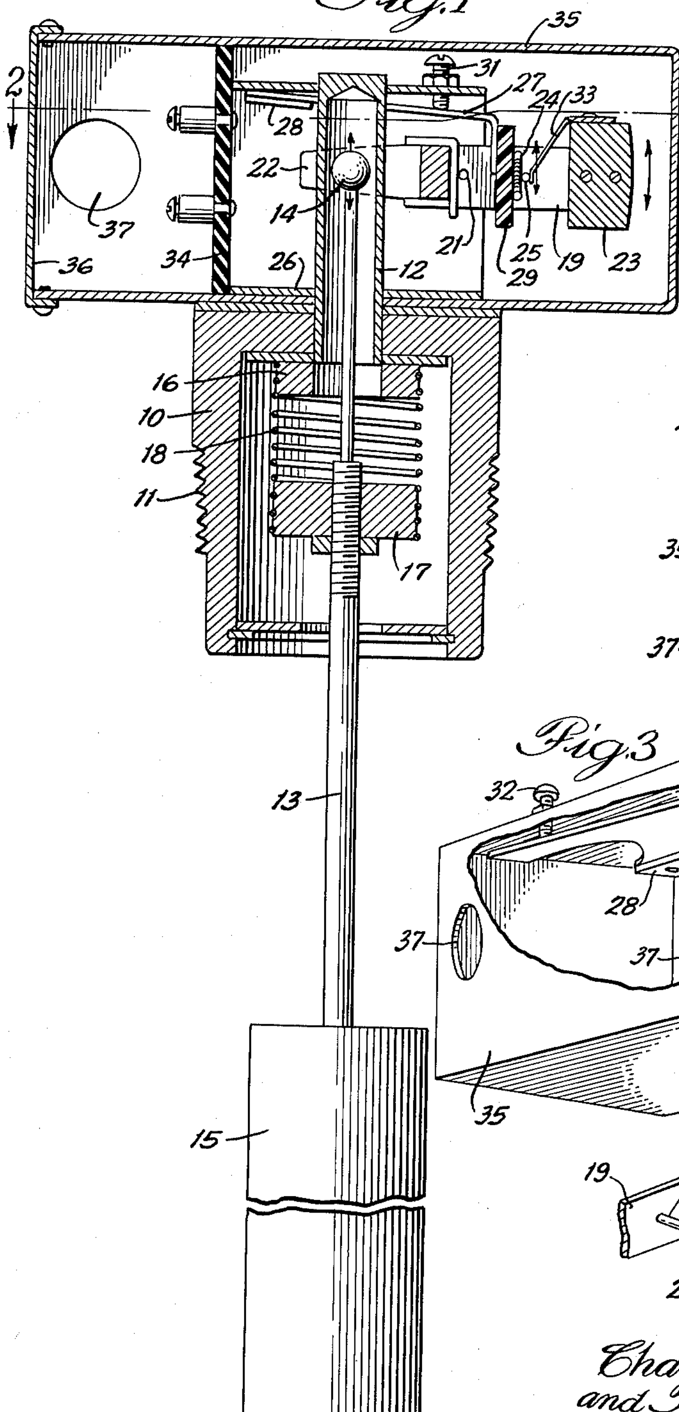

Fig. 2

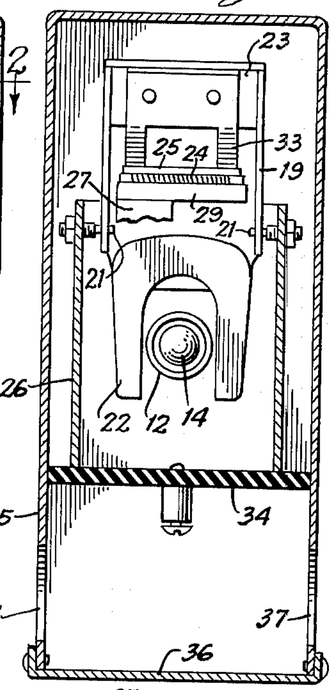

Fig. 3

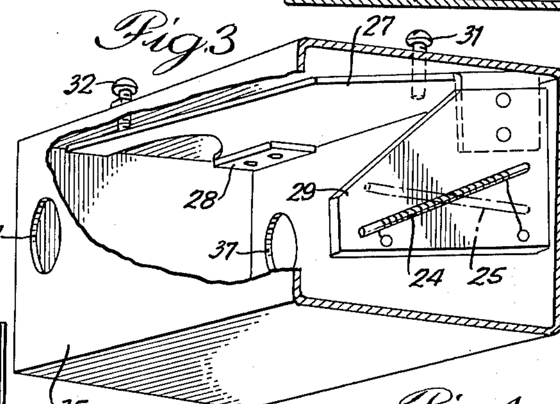

Fig. 4

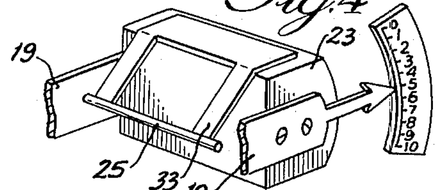

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Fig. 5

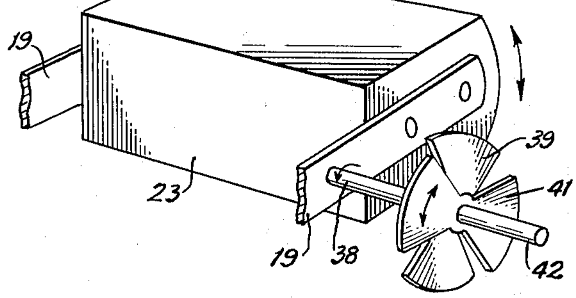


Fig. 6

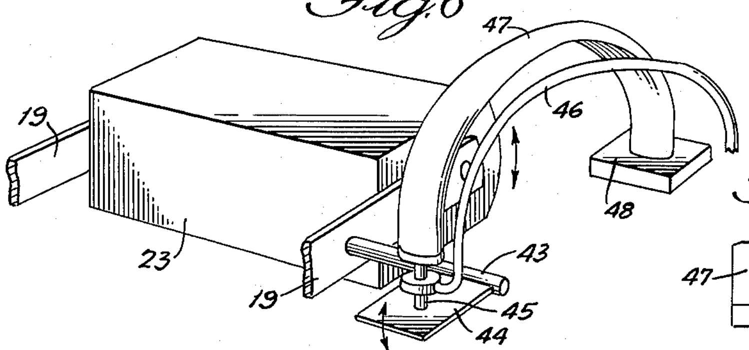


Fig. 7

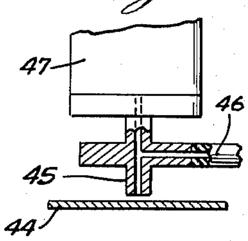


Fig. 8

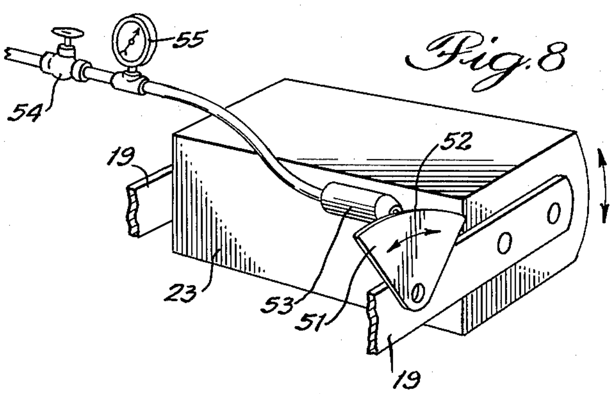
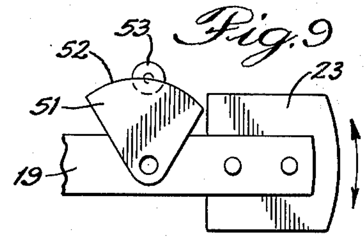


Fig. 9



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DISPLACER OPERATED MECHANISM

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This invention relates to displacer operated mechanism and more particularly to indicating or control devices operated magnetically by a displacer following variations in the level of a body of liquid.

One of the problems encountered in magnetically operated devices is the friction due to engagement of the magnetic armature against the side of the non-magnetic tube in which it moves. Magnetic attraction between the armature and the follower magnet on the outside of the tube tends to pull the armature into contact with the tube wall even when magnetic poles are mounted on opposite sides of the tube, thereby interfering with the accuracy of operation of the mechanism.

The use of guides on the displacer or the displacer rod is not satisfactory since such guides themselves create friction interfering with the accuracy of operation. It has previously been attempted to support the displacer rod and displacer on a guiding spring, as for example in the construction shown in the copending application of Benjamin L. Binford, Serial No. 736,302, filed May 19, 1958. Such attempts, however, have resulted in a construction which is relatively complex and difficult to manufacture and to mount properly.

It is accordingly an object of the present invention to provide a displacer operated mechanism in which the displacer rod and displacer are accurately guided by a simple coiled spring which also serves partially to support the weight of the displacer and rod.

According to a feature of the invention, the spring acts in tension so that it is relatively stiff laterally and guides the displacer rod accurately to maintain the armature thereon centered in the tube with no friction.

Another problem in displacer operated mechanisms is to provide magnetically operated signal producing means which functions to produce a signal accurately proportional to movement of the displacer without creating resistance to movement. A further object of the invention is to provide a displacer operated mechanism including a freely movable and highly sensitive signal producing means.

According to a feature of the invention, the signal producing means may function to produce variations in a function of an electric current by moving two parts comprising a potentiometer or a variable condenser. Alternatively, the signal producing means may produce relative movements in the parts of a fluid nozzle and valve couple to produce variations in a fluid pressure.

The above and other objects, advantages and novel features of the invention will be more readily apparent from the following description when read in connection with the accompanying drawing in which:

FIG. 1 is a vertical sectional view of displacer operated mechanism embodying the invention;

FIG. 2 is a section on the line 2—2 of FIG. 1;

FIG. 3 is a partial perspective view with parts broken away illustrating mounting of the potentiometer resistor;

FIG. 4 is a partial perspective view of the follower;

FIG. 5 is a partial perspective view of the follower illustrating an alternative signal producing means;

FIG. 6 is a view similar to FIG. 5 showing a further alternative signal producing means;

FIG. 7 is a partial section of the signal producing means of FIG. 6;

FIG. 8 is a view similar to FIGS. 5 and 6 of still another signal producing means; and

FIG. 9 is a side elevation looking from the right in FIG. 8.

The complete displacer operated mechanism as shown in FIG. 1 comprises a tubular fitting **10** threaded on its outer surface as indicated at **11** for mounting in the top wall of a tank or the like containing a liquid whose level is to be measured. At its upper end the fitting supports a vertically elongated tube **12** of non-magnetic material, such as brass, which is closed at its upper end and is secured in fluid-tight relationship to the fitting at its lower end.

An actuating rod **13** extends vertically into the tube **12** and carries a magnetic armature **14** within the tube. The armature **14** may be a spherical ball of iron or the like of smaller diameter than the tube to be freely movable in the tube out of contact with the walls thereof. At its lower end the actuating rod **13** carries a displacer **15** which may be of slightly greater density than the liquid whose level is to be measured. A portion of the weight of the rod and displacer is supported by a spring as described hereinafter so that the displacer will follow changes in the level of the liquid as is well understood in the art. For supporting and guiding the actuating rod and displacer a mounting block **16** is rigidly secured in the upper part of the fitting **10** coaxial with the tube **12**. A similar mounting block **17** is rigidly and adjustably secured on the actuating rod **13** and a helical coiled spring **18** has its opposite ends threaded onto the mounting blocks as shown. With this construction the spring **18** is tensioned by the weight of the actuating rod and displacer and is so calibrated as to support only a portion of the weight so that when the displacer is partially immersed in the liquid the spring will balance the resulting weight and cause the displacer to follow the level of the liquid.

Movements of the armature **14** in the tube are detected and followed by a pivoted follower indicated generally at **19** which is pivoted on an axis **21** extending horizontally adjacent to the tube. At one end the follower carries a U-shaped magnet **22** whose legs straddle the tube **12** with one magnetic pole on each side thereof. At its opposite end the follower carries a counter weight **23** to balance the weight of the magnet.

With this construction and in spite of the fact that magnetic poles are positioned on diametrically opposite sides of the tube, there is a tendency for the armature **14** to be drawn into engagement with the tube to create friction which would interfere with the accuracy of the mechanism. Due to the construction of the spring **18**, however, with its diameter greater than its unstressed length the actuating rod is guided for accurate vertical movement so that the armature will be held centered in the tube out of contact with the walls thereof. It will be noted that by use of the coiled spring **18** positioned with its coils generally horizontal and in tension that the spring has a relatively high resistance to any lateral movement or twisting so that it tends to guide the actuating rod and armature accurately. This is quite different than the effect of a similar spring loaded in compression and which has a high tendency to tip. Actual experience with the mechanism as shown indicates that the coiled spring loaded in tension creates an extremely high resistance to lateral or tilting movements sufficient to guide the armature accurately in its vertical movements and without the creation of any friction. Therefore, due to this construction, the armature can move freely in the tube at all times and its movements will be accurately followed by the magnet which will tilt the follower to a position accurately corresponding to the existing liquid level.

For indicating or for producing a signal proportional to the liquid level means are provided which are actuated by movements of the follower. As shown in FIGS. 1 to 4, such means comprise an electric potentiometer including an elongated resistor element 24 and a wiper 25 movable over the resistor element. As best seen in FIGS. 1 and 2, a tubular rectangular sleeve 26 is mounted around the tube 12 and the pivot supports for the follower are carried by the sides thereof. A mounting plate 27 is supported beneath the top of the sleeve 26 by rivets or similar fastenings 28 at one corner of the plate. At its free end the plate 27 carries an angular downwardly extending insulating plate 29 on which the potentiometer resistor 24 is mounted. For setting the zero position of the potentiometer, an adjusting screw 31 is threaded through the top of the sleeve 26 and engages the plate 27 near its free end and near the side at which it is riveted to the top of the sleeve. By adjusting the screw 31, the free end of the plate may be moved vertically to move the potentiometer resistor vertically.

For calibrating the potentiometer a similar adjusting screw 32 is threaded through the top of the sleeve and engages the plate 27 adjacent to the edge thereof opposite to the rivets 28. By adjusting the screw 32 the plate may be tilted laterally more or less to change the angle of the potentiometer resistor 24 thereby to calibrate its characteristics.

The wiper bar 25 is carried by a bracket 33 secured to the counter weight 23 and extending forward from the counter weight to hold the wiper bar in a position to engage the resistor 24. The resistor and wiper bar lie at acute angles to each other so that when the follower is turned to move the wiper bar vertically relative to the resistor the effective point of engagement between the two will shift longitudinally of the resistor to vary the electrical characteristics thereof. In this way a signal is produced which is proportional to the level of the liquid and which can be transmitted to a desired remote point to effect an indicating or controlling operation.

The unit is completed by a terminal block 34 secured to one end of the sleeve 26 and carrying connectors for connecting electrical leads thereto and in turn to flexible leads leading to the potentiometer and wiper. The entire mechanism above the fitting 10 is preferably enclosed in a housing 35 having a removable cover 36 at one end and provided with one or more openings 37 through which the electrical leads can be taken out.

In the construction illustrated in FIG. 5 the potentiometer parts are replaced by variable condenser parts for producing a change in electrical capacitance upon movement of the follower 19. In this construction a shaft 38 coaxial with the pivotal axis of the follower is secured to the follower and carries one or more segmental condenser plates 39. Complementary segmental plates 41 are carried by a shaft 42 which may be adjustably journaled in the housing 35 to support the plates in spaced parallel relationship. In this case, as the follower turns the condenser plates will overlap to a greater or less degree to vary the capacitance between them, thereby changing their electrical characteristics. By adjusting the shaft 42 to turn the condenser plates 41 the zero position can be easily adjusted.

FIGS. 6 and 7 illustrates a further signal producing means in which the signal is produced by varying a fluid pressure such as air pressure. In this construction the follower carries a shaft 43 coaxial with its pivotal axis and on which a flapper valve 44 is rigidly secured to turn as the follower turns. The flapper valve is moved toward or away from a nozzle 45 receiving a fluid such as air through a supply conduit 46 and preferably including a restriction, not shown, which may be remote from the nozzle 45. As the flapper valve moves toward the nozzle 45 it increases the resistance to discharge of fluid and increases the pressure behind the nozzle corresponding to changes in the liquid level.

In order to increase the range of effective movement of the flapper valve, the nozzle is arranged to follow movements of the flapper valve. For this purpose the nozzle is mounted on one end of a curved Bourdon tube 47 which is rigidly mounted at its opposite end on a support 48. As seen in FIG. 7 the interior of the Bourdon tube communicates with the nozzle so that the pressure therein will correspond to the signal pressure. With this construction, when the flapper valve moves toward the nozzle to increase the pressure therein, it will also increase the pressure in the Bourdon tube which will act to move the nozzle away from the flapper valve. The degree of movement will be proportional to the pressure which will in turn be controlled by movement of the flapper valve so that the pressure back of the nozzle will at all times correspond closely to the level of the liquid.

FIGS. 8 and 9 show an alternative construction for producing variations in a fluid pressure. In this structure a plate valve 51 is mounted on the follower coaxial with the pivotal axis thereof and has its outer edge 52 non-circular in shape, as best seen in FIG. 9. A fluid nozzle 53 is fixed mounted adjacent to the edge of the plate so that the plate will more or less overlap the discharge orifice therein. The nozzle is supplied with a fluid such as air past a restriction 54 and the pressure between the restriction and the nozzle may be indicated by a gauge 55.

As the follower tips clockwise, as seen in FIG. 9, the edge portion of the plate 51 will overlap the discharge orifice of the nozzle 53 to a greater extent and will produce an increased pressure therein, which is indicated by the gauge 55. By properly shaping the edge of the plate relative to the nozzle pressure changes so produced can be made to correspond accurately to changes in the liquid level.

While several embodiments of the invention have been shown and described in detail, it will be understood that these are illustrative only and are not to be taken as a definition of the scope of the invention, reference being had for this purpose to the appended claims.

What is claimed is:

1. Displacer operated mechanism comprising a vertically elongated tube of non-magnetic material, a vertical actuating rod movable vertically in the tube and extending from the bottom thereof, a magnetic element carried by the upper end of the rod within the tube and of smaller diameter than the interior diameter of the tube, a magnetic element outside of the tube to be moved by the first named magnetic element as it moves, a displacer connected to the lower end of the rod to be moved vertically in response to changes in the level of a body of liquid to be measured, and a coiled tension spring fixedly secured at its upper end concentrically with the tube at its lower end and secured at its lower end to the rod concentrically therewith, the spring partially supporting the weight of the rod and displacer and having a coil diameter greater than the diameter of the tube and large relative to its length to guide the first named magnetic element for movement centrally in the tube spaced from the wall thereof.

2. Displacer operated mechanism comprising a vertically elongated tube of non-magnetic material, an actuating rod movable vertically in the tube, a magnetic armature carried by the rod in the tube, a displacer connected to the rod to move it and the armature, a follower pivoted on a horizontal axis adjacent to the tube and including a magnet adjacent to the tube to follow movement of the armature therein, an elongated resistor element and an elongated wiper element crossing and contacting each other at an angle and both lying at an angle to vertical, means connecting one of the elements to the follower to be moved thereby relative to said one element, a generally horizontal plate fixedly mounted at one end adjacent to one side and on which the other of the elements is mounted, adjustable means engaging the plate adjacent to its other side and said one end to tilt the plate thereby to change the angle of the element mounted thereon, and second adjustable means engaging the plate adjacent its

other end to move the other end thereof vertically, said other element being carried by said other end of the plate to be moved vertically therewith.

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ISAAC LISANN, *Primary Examiner.*