June 18, 1963 LE BORN HARDIE 3,094,008

SNAP ACTING MECHANISM

Filed Nov. 1, 1960 4 Sheets-Sheet 1

Fig. 1.

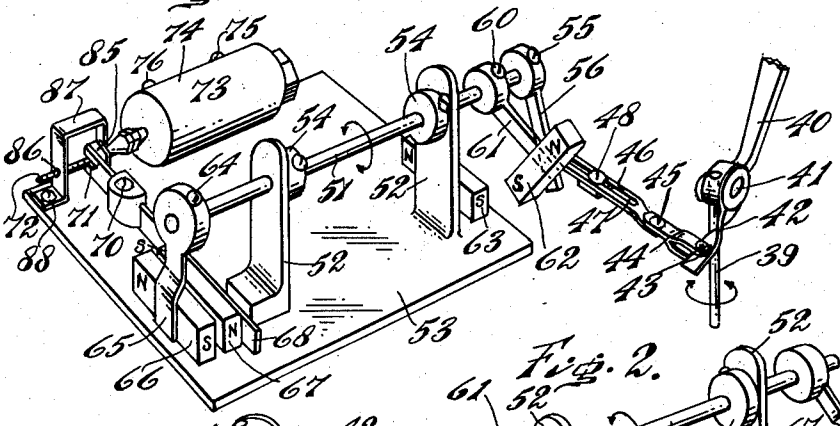


Fig. 2.

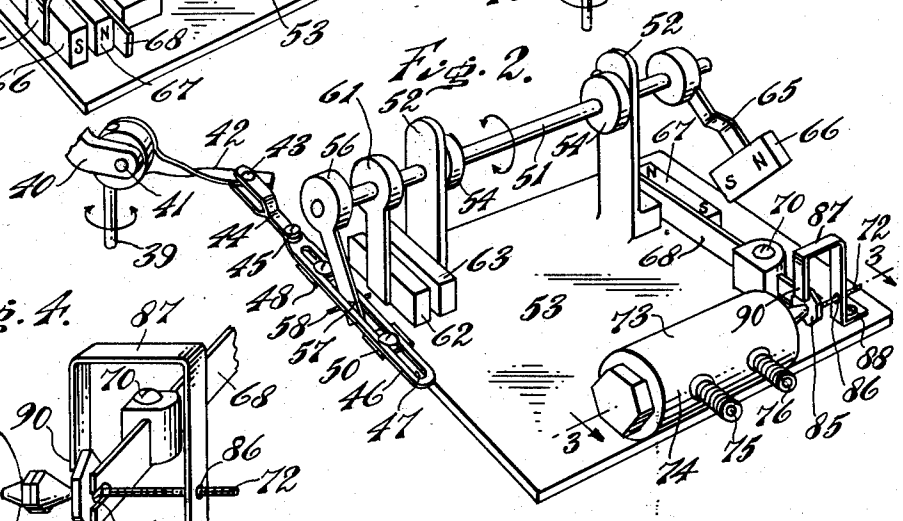


Fig. 4.

Fig. 3.

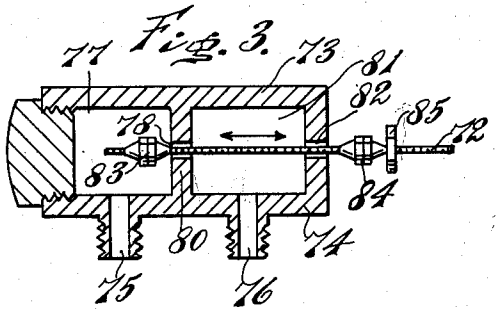
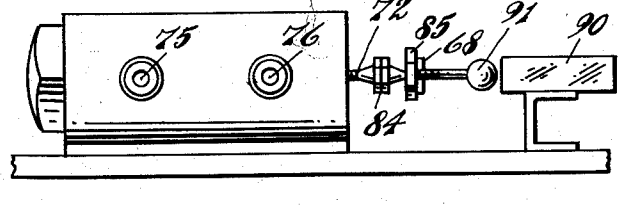


Fig. 8.



INVENTOR
LeBron Hardie
BY
ATTORNEYS

June 18, 1963 LE BORN HARDIE 3,094,008

SNAP ACTING MECHANISM

Filed Nov. 1, 1960 4 Sheets-Sheet 2

Fig. 5.

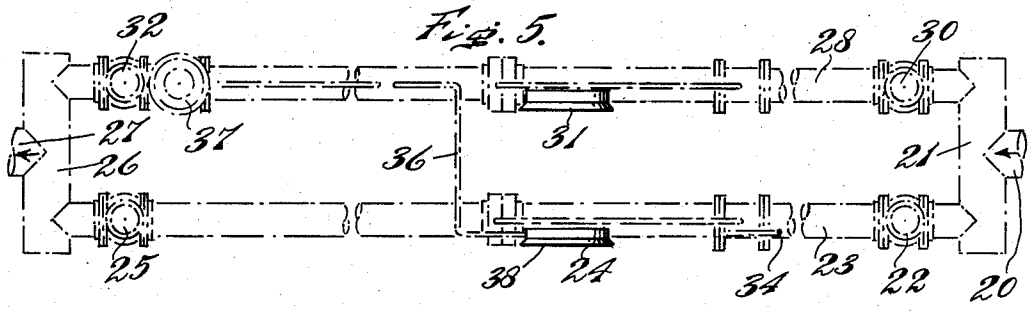


Fig. 6.

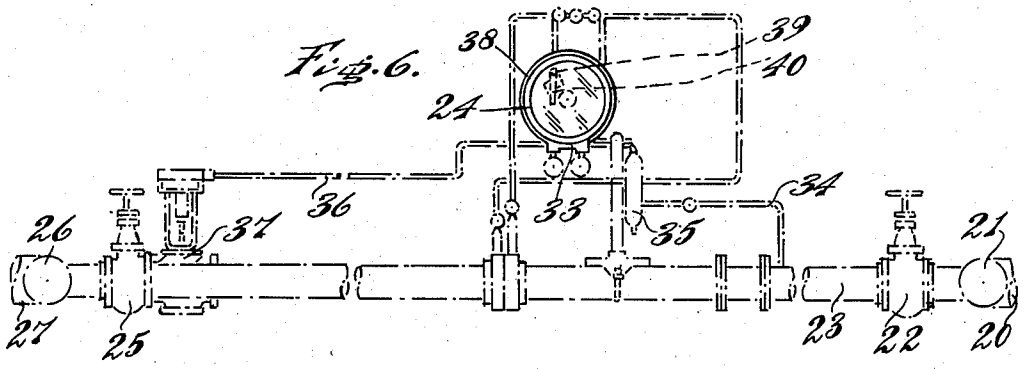
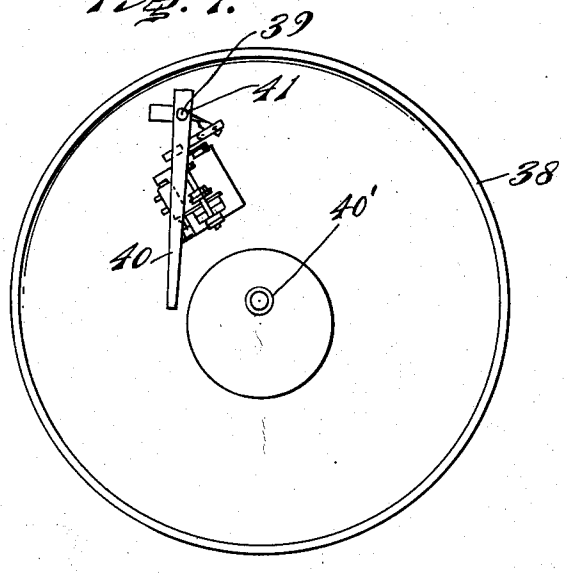


Fig. 7.



INVENTOR
LeBron Hardie
BY
ATTORNEYS

June 18, 1963 LE BORN HARDIE 3,094,008

SNAP ACTING MECHANISM

Filed Nov. 1, 1960 4 Sheets-Sheet 3

Fig. 9.

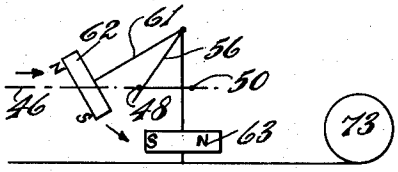


Fig. 9a.

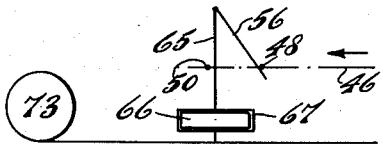


Fig. 10.

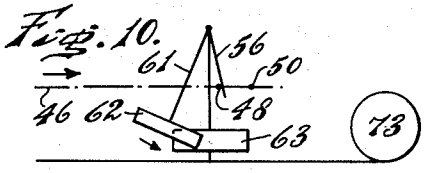


Fig. 10a.

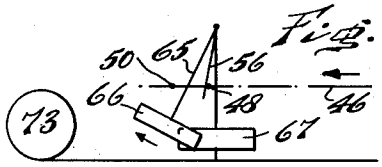


Fig. 11.

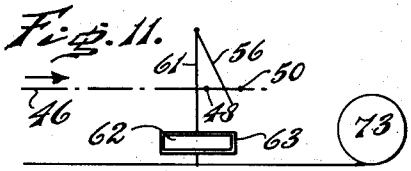


Fig. 11a.

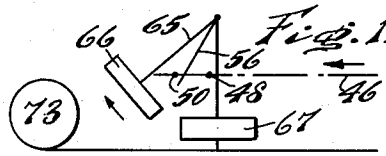


Fig. 12.

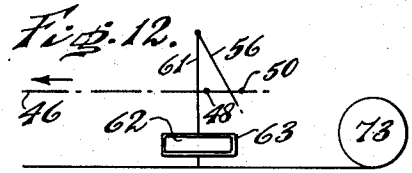


Fig. 12a.

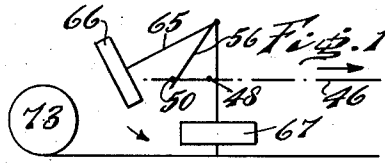


Fig. 13.

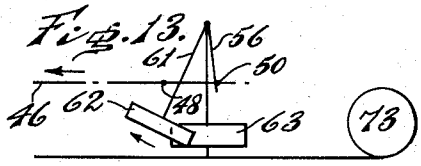


Fig. 13a.

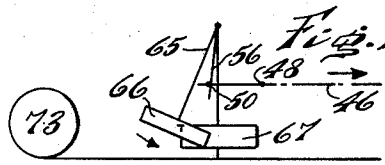


Fig. 14.

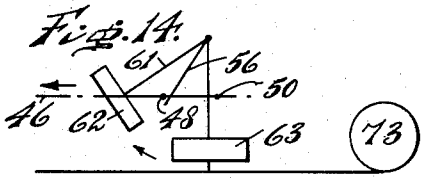
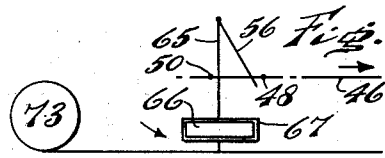


Fig. 14a.



INVENTOR
LeBron Hardie
BY
ATTORNEYS

June 18, 1963 LE BORN HARDIE 3,094,008

SNAP ACTING MECHANISM

Filed Nov. 1, 1960 4 Sheets-Sheet 4

Fig. 15.

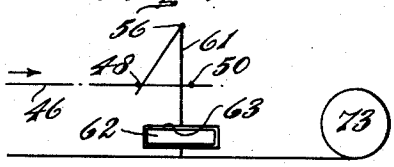


Fig. 15a.

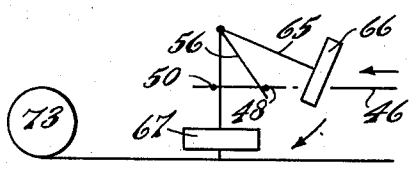


Fig. 16.

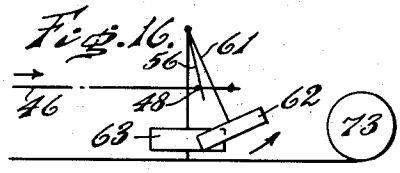


Fig. 16a.

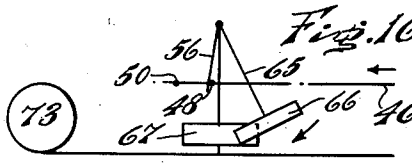


Fig. 17.

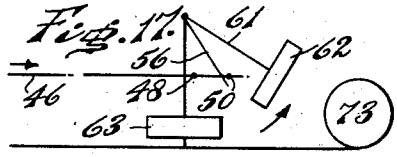


Fig. 17a.

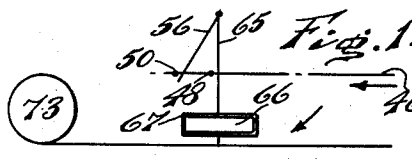


Fig. 18.

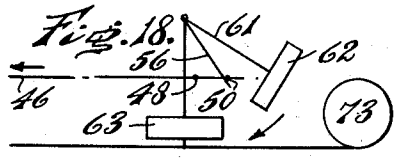


Fig. 18a.

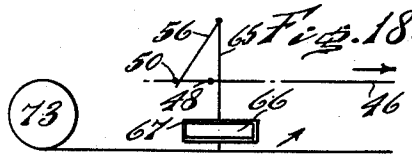


Fig. 19.

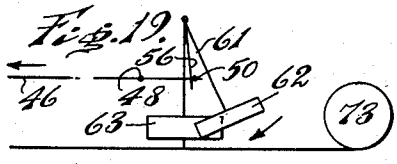


Fig. 19a.

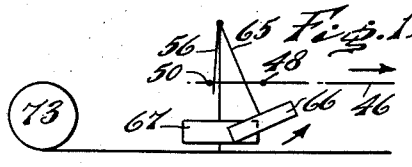


Fig. 20.

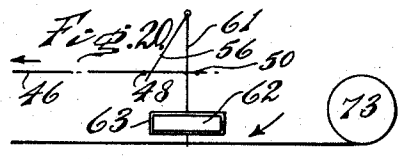
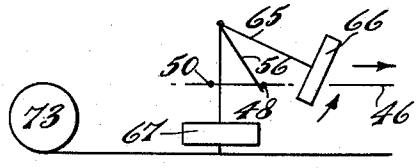


Fig. 20a.



INVENTOR
LeBron Haraie
BY
Dueber and Sons
ATTORNEYS

United States Patent Office 3,094,008 Patented June 18, 1963

3,094,008

SNAP ACTING MECHANISM

Le Bron Hardie, 3115 Aurora Ave., El Paso, Tex.

Filed Nov. 1, 1960, Ser. No. 66,596
12 Claims. (Cl. 74—97)

The present invention relates to limit controller devices.

A purpose of the invention is to obtain snap action movement entirely from permanent magnets without the necessity of spring tension or other mechanical forces.

A further purpose is to obtain part of the force required to separate mutually attracting permanent magnets by simultaneous lateral motion of mutually repelling permanent magnets.

A further purpose is to minimize the force required to move a controlling element in a sensitive measuring instrument so as to increase the accuracy of the instrument.

A further purpose is to operate a control valve with complete elimination of any pneumatic system for control valve operation.

A further purpose is to operate a control device from a measuring device with very small driving force from the measuring device, such device being of small size and low cost.

A further purpose is to facilitate conversion of a limit controller from normally open to normally closed operation or vice versa.

A further purpose is to make the setting of the control points in a limit controller more readily adjustable.

Further purposes appear in the specification and in the claims.

In the drawings I have chosen to illustrate one only of the numerous embodiments in which my invention may appear, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

FIGURE 1 is a fragmentary diagrammatic perspective showing the limit controller device of the invention with one pair of permanent magnets widely separated and another pair of permanent magnets adjacent.

FIGURE 2 is a perspective of the device of the invention in a different position, one pair of permanent magnets being adjacent and the other pair of permanent magnets being widely separated.

FIGURE 3 is a section on the line 3—3 of FIGURE 2 taken through the control valve.

FIGURE 4 is an enlarged fragmentary diagrammatic perspective showing the interconnection with the control valve.

FIGURE 5 is a diagrammatic plan view of one installation embodying the device of the invention.

FIGURE 6 is a diagrammatic elevation of the device of FIGURE 5.

FIGURE 7 is an elevation of an indicator in which the device of the invention has been employed.

FIGURE 8 is an elevation of a modified form of control valve according to the invention.

FIGURES 9 to 14*a* are stepwise diagrams showing the operation of the device of the invention using a normally closed valve with a pressure closed motor valve.

FIGURES 15 to 20*a* are stepwise diagrams showing the operation of the device of the invention using a normally open valve with a pressure opened motor valve.

Describing in illustration but not in limitation and referring to the drawings:

There is extensive use in the art of limit controlling devices. A limit control device is provided with two control points. At one point operation of a control device such as a control valve occurs with increasing measurement, and at the other control point operation occurs with decreasing measurement. Normally in the case of such a device provided with a control valve, output pressure will not change until the measured variable has passed through both control points, either moving up or moving down.

For example, in order to understand the operation, if the low limit control point is set at 10% of the scale and the high limit control point is set at 90% of the scale, and the measured variable starts at 0, and increases to 90% plus, and then decreases to a value less than 10%, the following action will occur:

The control device such as the control valve will only operate to open or close when the measured variable reaches 90%. The control device will then remain at the same position until the measured variable moves back down the scale to a value below 10%, and at that point the control device such as the control valve will operate again to return to its original position. The limit controller has no change in output value such as output pressure from the controller within the set limits.

In order to further understand limit controller operation, reference is made to a specific example, as shown in FIGURES 5 and 6.

A limit controller device is used to provide a span or gap in on-off control in order to allow a predetermined change in the measured variable before the control device is repositioned. This prevents repetitive operation, opening or closing, through a single point.

A common use of a limit controller device is in a system where two lines, for example pipes, operate in parallel and it is required that some of the lines be open and closed as the flow changes over a wide range. For example, in a flow meter, one meter may measure flow in a primary line until full scale reading is approached, at which time the limit controller opens a secondary parallel line also equipped with a flow meter. The meter in the secondary line is not cut out until the flow measured by the limit controller in the primary line has decreased to a point indicating that the total of the two flows can be measured by the meter in the primary line alone.

The limit controller may operate a warning signal, an alarm, or a shutdown device when the measured value exceeds predetermined limits. In the flow meter arrangement of FIGURES 5 and 6 flow of gas or other fluid in a main pipe 20 is subdivided by a header 21 so that it can pass through a suitably open valve 22 into a main measuring line 23 equipped with a primary meter 24 and then passing through a normally open valve 25 and a header 26 to a main outlet pipe 27. Also connected to the inlet header 21 is secondary measuring line 28 having a normally open valve 30, a secondary flow meter 31 and a normally open valve 32. The primary meter 24 has a limit controller 33 which receives supply pressure from the line 23 through pipe 34 and regulator 35, and when the control device of the limit controller operates, it supplies fluid pressure through pipe 36 to diaphragm operated motor valve 37 in measuring pipe branch 28. Thus

when the limit controller so requires, the motor valve 37 opens, permitting both flow meters 24 and 31 to operate, whereas at other times motor valve 37 is closed and only the primary flow meter 24 operates.

It desired, manual interruption of the limit control device can be incorporated by installing a 3-position (output, automatic and no output) hand operated lever to override the automatic device in positioning the control valve.

Prior art limit controller devices have been rather complicated and correspondingly expensive.

Prior art devices are shown in Cowherd U.S. Patent No. 2,902,055, granted September 1, 1959, for Pneumatic Control; Kerr U.S. Patent No. 1,503,591, granted August 5, 1924, for Fluid Supply Systems; Hall U.S. Patent No. 2,158,785, granted May 16, 1939, for Liquid Level Indicator; and Lewis U.S. Patent No. Re. 20,473, granted August 17, 1937, for Cupola Operation.

The present invention overcomes many of the difficulties which have been encountered in the prior art.

It is not necessary with the present device to employ any pneumatic system. This is important where compressed air for the instrument is not available to use as a source of fluid pressure, and it is desired to operate by fluid from the fluid line such as natural gas or some other fluid which may be corrosive, toxic, explosive or otherwise objectionable either to the instrument or when bled to the atmosphere. Furthermore, the device of the invention does away with restricted orifices which have previously been very prone to clogging.

The device of the invention is extremely simple and inexpensive to manufacture and maintain.

The device of the invention makes it easy to convert a measuring device into a combination measuring device and controller. The driving force required of the measuring member to move the control element is so small that the accuracy of the measuring device is not seriously affected. This is particularly important in devices such as gas meters which measure a commodity which is sold on the basis of the measurement. The device of the invention is extremely small in size and compact. The device also is much less expensive and much more easy to maintain than two separate instruments, one a meter and the other a limit controller device.

It is very easy by the device of the invention to provide the desired span and gap for on and off control in the form of a lost motion device.

The device of the invention is readily reversible from normally open to normally closed or vice versa without requiring additional parts.

The device of the invention is readily adjusted for span width between control points and for position of the span in relation to the scale or range of the instrument.

The device of the invention makes it possible to obtain snap action entirely by permanent magnets without the need for spring tension or other mechanical force. The magnets may be so used that the force required to separate by lateral motion mutually attracting magnets can in part be obtained by simultaneous motion of mutually repelling magnets. Thus the force required of a sensitive measuring element to move a controlling element is minimized, preserving the accuracy of measurement.

In accordance with the present invention an improved limit controller device is provided interposed between a measuring element such as a measuring shaft and a control element such as a control valve. In accordance with the invention a measuring instrument, for example a flow meter 38 of FIGURE 7, is provided with a measuring shaft 39 which produces the measuring impulse as well known in the art on which is keyed or otherwise mounted an indicating arm bracket 40 which in the case of the usual recording instrument is a pen arm bracket as well known. The usual chart is omitted although the chart turning motor 40' is shown. The pen arm bracket is suitably pivoted on the shaft 39 by a pivot 41 so that it can move toward and away from the paper of the chart.

Also pivotally connected to the measuring shaft 39 so as to swing with the shaft, but free to pivot on an axis at right angles to it, is an arm 42 which at its outer end is pivotally connected at 43 on an axis parallel to the measuring shaft axis to a link 44, the opposite end of which is pivotally connected at 45 on an axis parallel to the measuring shaft axis to a pusher mechanism 46. The pusher mechanism has an elongated slot 47, and positioned in opposed relation in the slot are pusher abutments 48 and 50 adjustably held to the pusher mechanism by screws which can be loosened to move the pusher abutments in either direction and then tighten to anchor them in adjusted position.

On an axis suitably at right angles to the measuring shaft is a snap action shaft 51 journalled on brackets 52 from a base 53 and restrained against moving longitudinally by collars 54.

Secured in adjusted position by set screw 55 on snap action shaft 51 is a first arm 56 which extends through a slot 47 in the pusher mechanism 46 and beneath the pusher mechanism has an opening 57 which receives a pin 58 preventing the pusher mechanism from dropping away from the end of the arm 56.

The device provided by the pusher mechanism 46 and the arm 56 is in effect a lost motion device since the arm is free to move angularly after it ceases to engage one pusher abutment 48 or 50 until it encounters the other pusher abutment 50 or 48.

Also mounted on snap action shaft 51 as by set screw 60 is a second arm 61 which has secured thereto, at the end as by brazing, a permanent magnet 62 suitably of bar magnet type having its north and south poles positioned as shown on the drawing.

The angular position of the magnet 62 with respect to the shaft can be adjusted by loosening the set screw 60 and shifting the arm and then again tightening the set screw.

One of the brackets 52 has secured thereto, as by brazing, a second permanent magnet 63 which in one position of the arm 61 is right beside the permanent magnet 62 with minimum air gap, and with the poles opposite (that is, attracting, north to south and south to north), but which as the shaft 51 turns changes its relationship to the permanent magnet 62 until the permanent magnet 62 is angularly displaced with respect to the permanent magnet 63 as shown in FIGURE 1, and is repelling. The positions of the north and south poles on permanent magnet 63 are as shown in the drawing.

As later explained more in detail, the permanent magnets 62 and 63 contribute to impart a snap action to the device.

Also positioned on snap action shaft 51 as by set screw 64 is an arm 65 which has secured to the outer end, as by brazing, a third permanent magnet 66 suitably of bar form as shown having the north and south poles suitably distributed as indicated. The position of the permanent magnet 66 angularly on the shaft with respect to the permanent magnet 62 can be changed as by adjusting the set screw 64 and then shifting the position and then tightening the set screw 64.

Arranged adjacent the path of the permanent magnet 66 and in line with it in the position of FIGURE 1 with minimum air gap is a fourth permanent magnet 67 which as shown in FIGURE 2 can be relatively angularly displaced by movement of the permanent magnet 66. Permanent magnets 66 and 67 when physically opposite have their poles opposite (that is, north to south and south to north so as to attract) and have another position (FIGURE 2) when the poles repel.

Permanent magnet 67 in the preferred embodiment is mounted as by brazing on a lever 68 near one end. The lever is pivotally mounted at 70 intermediate its ends and at this opposite end has a slot 71 which passes around stem 72 of a control device, suitably a valve 73. The

valve 73 has a casing 74 provided with a pressure inlet connection 75 as from pipe 34 and has an outlet connection 76 as for example to pipe 36. The inlet connection enters valve chamber 77 (FIGURE 3) which has a pressure valve port and seat 78 which in open position communicates through wall 80 to a chamber 81 communicating with outlet connection 76. Chamber 81 also has a valve port and seat 82 which communicates to exhaust. The valve stem 72 passes through the aligned ports and seats 78 and 82 and is threaded along its length to receive an adjustably positioned high pressure valve 83 which in one position is capable of closing valve port and seat 78 and cutting off high pressure from chamber 81. At the same time that the high pressure valve 83 is closed, an adjustable valve 84 to exhaust is opened at valve port and seat 82. A threaded nut 85 on the stem is engaged at the end remote from the housing by a forked end of lever 68.

The stem 72 is guided outside the housing by opening 86 in leaf spring 87 which is secured to the base at 88 and at the upper end 90 engages the side of nut 85 remote from lever 68.

In operation, the motion of the indicating pointer shaft 38 is transmitted through the lost motion device including the pusher 46 and the arm 56 to turn snap action shaft 51 and thus cause magnets 62 and 66 to revolve. When magnet 66 is opposite magnet 67 as in FIGURE 1, the opposite poles attract and lever 68 moves to open valve port and seat 78 and furnish air pressure into outlet line 76 while closing port and seat 82 against exhaust.

When snap action shaft 51 turns and magnet 66 moves away from its position opposite magnet 67, leaf spring 87 pushes the control valve to shut off high pressure by closing port and seat 78 and opening port and seat 82 to exhaust.

As well known, the opposite poles of the magnets are attracted to one another and the like poles are repelled. By positioning magnets 62 and 63 with the poles opposite when the magnets are adjacent and with magnet 62 angularly disposed with respect to magnet 66, a snap action within the lost motion area of slot 47 between opposed pusher abutments 48 and 50 occurs. Snap action shaft 51 is rotated to the snap position when arm 56 is pushed by either pusher abutment 48 or 50. At the snap point, continued rotation of shaft 51 is caused by one of the pairs of magnets attracting each other while the other pair of magnets repel each other.

When this snap action occurs, arm 56 moves away from the abutment 48 or 50 that has been moving it, but does not move enough to contact the other pusher abutment.

The free movement of the arm 56 and its forced movement from the point of contact with a pusher abutment 48 or 50 to the snap point permits lever 68 to remain motionless until a snap point is reached.

By adjusting the positions of the pusher abutments 48 and 50 along the pusher mechanism 46, the low and high points of the control band or span are set as well known.

The motor valve 37 which is operated by the fluid supplied through connection 76 and pipe 36 may be pressure opened or pressure closed. In order to obtain the proper action from either type of motor valve, for a given movement of the measuring component of the limit controller device, it is necessary to reverse the action of the controller device. This is done by changing the positions of the magnets 62 and 66 on the snap action shaft so that they approach and leave magnets 63 and 67 from opposite directions than was originally the case.

FIGURE 8 shows a modification of a control valve which employs the magnetic force of permanent magnet 90 acting on magnetically susceptible ball 91 on the end of valve stem 72 instead of spring 87. Since it is only necessary for the ball 91 to move about $\frac{1}{32}$ of an inch in a device of this kind, it always remains within the attraction of the magnet 90. The attraction force of the magnet 90 is sufficient to move the stem so as to close port 78 but is easily overcome by the force exerted in the opposite direction by the lever 68.

The operation of the snap actuating device will be better understood by reference to the diagrams. FIGURES 9 to 14*a* apply to a normally closed valve, using a pressure closed motor valve. FIGURES 9, 10, 11, 12, 13 and 14 show the condition at one end of the device having the permanent magnets 62 and 63 and FIGURES 9*a*, 10*a*, 11*a*, 12*a*, 13*a* and 14*a* show the condition of the device at the opposite end having the permanent magnets 66 and 67. The diagrams show the pusher mechanism 46 and indicate by arrows what the pusher mechanism is doing, and also indicate by arrows what the moving magnet is doing.

In FIGURE 9 the magnets 62 and 63 are remote and repelling one another as shown by the markings of the poles. The pusher is moving to the right and arm 56 is in contact with pusher abutment 48.

FIGURE 9*a* shows the condition at the opposite end of the device and the parts are of course turned around 180°. The magnets 66 and 67 here are adjacent and they are positioned with north pole to south pole and south pole to north pole so that they attract. Port 82 is closed and port 78 is opened, so output pressure is supplied at opening 76 causing the motor valve to be closed.

In FIGURE 10 the pusher has moved toward the right until permanent magnet 62 is partially opposite permanent magnet 63, and the parts are getting ready to snap as will be shown in the next views. Similarly in FIGURE 10*a* permanent magnet 66 has moved partially away from permanent magnet 67 and these magnets are getting ready to snap.

In FIGURE 11 the permanent magnet 62 has snapped to a position adjoining permanent magnet 63 (attracting) and arm 56 has snapped toward abutment 50 of the pusher mechanism 46. The force of the snap from the position of FIGURE 10 to the position of FIGURE 11 is supplied by permanent magnets 62 and 63 attracting each other while permanent magnets 66 and 67 in FIGURE 11*a* repel each other. The pusher position is the same in FIGURES 10, 10*a*, 11 and 11*a* but the snap has taken place. As the permanent magnets snap to the new positions, lever 56 in moving from pusher abutment 48 has moved toward pusher abutment 50 but not actually to it. Magnet 66 is now free from the attraction of magnet 67 so spring 87 pulls valve stem 72 to close port 78 and open port 82. Supply pressure is now shut off at 78, and output pressure is drained to atmosphere through port 82, allowing the motor valve to open.

In FIGURE 12 pusher mechanism 46 has moved to the left and pusher abutment 50 has encountered arm 56. Similar motion is shown in FIGURE 12*a*.

FIGURE 13 shows the pusher mechanism 46 moved to the left and pusher abutment 50 has moved arm 56 and therefore moved magnet 62 so that magnets 62 and 63 in FIGURE 13 and magnets 66 and 67 in FIGURE 13*a* are at the snap point.

FIGURES 14 and 14*a* show the respective magnets after snap has occurred and the condition of FIGURES 9 and 9*a* has been restored.

FIGURES 15 to 20*a* are similar to the diagrams just described except that they apply for a normally open valve using a pressure opened motor valve.

It will be evident that in FIGURES 15 and 15*a* the appropriate set screws have been adjusted and permanent magnets 62 and 66 and lever arm 56 have been repositioned on the shaft relative to one another as shown. In FIGURE 15 permanent magnets 62 and 63 are adjacent (attracting) but magnets 66 and 67 are remote (repelling). Spring 87 closes port 78 and opens port 82 so that no pressure is being supplied to the motor valve. The motor valve is held closed by its spring.

FIGURES 16 and 16*a* show the motion of the movable permanent magnets to the snap point.

FIGURES 17 and 17*a* show the completion of the snap action.

FIGURES 18 and 18*a* show the magnets in the same relative positions as FIGURES 17 and 17*a* but the pusher mechanism has begun to move to the left in FIGURE 18 until pusher abutment 59 encounters arm 56.

FIGURES 19 and 19*a* show the relative movement of the movable permanent magnets to the snap point and FIGURES 20 and 20*a* show the position of the permanent magnets after the snap action, and corresponds with FIGURES 15 and 15*a*. The lever 68 moves only at the time of snap action.

These principles are widely applicable to obtain snap action as required for other purposes.

It will be evident that the means of mounting and attaching the limit controller device with respect to the measuring shaft and the connections for supply and output pressure to the control device such as the control valve will vary with different types of equipment.

In view of my invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art to obtain all or part of the benefits of my invention without copying the structure shown, and I, therefore, claim all such insofar as they fall within the reasonable spirit and scope of my claims.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. In snap acting mechanism, a rotatable shaft, an arm mounted on the shaft, a first permanent magnet mounted on said arm and turning with said shaft, and a second permanent magnet adjoining the path of movement of the first permanent magnet, rotationally stationary with respect to the first permanent magnet and stationary with respect to the path of movement of the first permanent magnet, and having its poles oppositely disposed when the magnets are adjacent, said permanent magnets imparting snap action to said shaft.

2. In snap acting mechanism, a rotatable shaft, an arm mounted on the shaft, a first permanent magnet mounted on the arm and turning with the shaft, a second permanent magnet mounted relatively stationary rotationally with respect to the first permanent magnet, adjoining the path of movement of the first permanent magnet, the second permanent magnet having its poles oppositely disposed with respect to the first permanent magnet when the magnets are adjacent, and lost motion mechanism for turning said shaft, said mechanism providing snap action within the range of the lost motion.

3. In snap acting mechanism, a movable carrier, a first permanent magnet on said carrier having a path of motion as said carrier moves, a second permanent magnet rotationally stationary with respect to the first permanent magnet, disposed along the path of movement of the first permanent magnet, the first and second permanent magnets having a position physically opposite one another, the poles of the first and second permanent magnets being magnetically opposite (attracting) when the first and second permanent magnets are physically opposite, a third permanent magnet on said carrier having a path of motion as said carrier moves, a fourth permanent magnet rotationally stationary with respect to said third permanent magnet, disposed along the path of movement of said third permanent magnet, the third and fourth permanent magnets having a position physically opposite one another, the poles of the third and fourth permanent magnets being magnetically opposite (attracting) when the third and fourth permanent magnets are physically opposite, the first and second permanent magnets being physically opposite one another (attracting) when the third and fourth permanent magnets are physically removed from one another (repelling), and vice versa.

4. In snap acting mechanism, a rotatable shaft, an arm mounted on said shaft, a first permanent magnet mounted on said arm and turning with said shaft, a second permanent magnet rotationally stationary with respect to said first permanent magnet and mounted adjoining the path of said first permanent magnet, a second arm mounted on said shaft, a third permanent magnet mounted on said second arm and turning with said shaft, and a fourth permanent magnet mounted rotationally stationary with respect to the third permanent magnet adjoining the path of the third permanent magnet, said pairs of permanent magnets being in opposed pole relation, and one pair of permanent magnets being physically opposite one another when the other pair of permanent magnets is physically remote from one another.

5. A mechanism of claim 4, in combination with means for mounting said fourth permanent magnet in position to move relatively toward and away from said third permanent magnet depending upon the relative positions of the poles of said third and fourth permanent magnets.

6. A mechanism of claim 5, in combination with lost motion mechanism for turning the shaft, the magnets imparting snap action to the shaft within the range of the lost motion.

7. A mechanism of claim 6, in combination with a control device operated by the movement of the fourth permanent magnet toward or away from the third permanent magnet.

8. In snap acting mechanism, operating mechanism, a shaft, lost motion mechanism operatively connected between the shaft and the operating mechanism for turning the shaft in one direction after an interval by motion of the operating mechanism in one direction and for turning the shaft in the opposite direction after an interval by motion of the operating mechanism in the opposite direction, a first permanent magnet mounted on the shaft and turning with the shaft, and a second permanent magnet rotationally stationary with respect to the first permanent magnet and positioned along the path of the first permanent magnet, the first permanent magnet in certain positions coming close to the second permanent magnet and the first and second permanent magnets having their magnetic poles opposite to one another, and the first permanent magnet in other positions moving beyond the second permanent magnet and imparting snap action to the motion of the shaft by the relative position of the poles of the first and second permanent magnets.

9. A mechanism of claim 8, in combination with a third permanent magnet mounted on and turning with the shaft, an operating lever, and a fourth permanent magnet mounted on the operating lever and positioned relatively stationary with respect to the rotational movement of the third permanent magnet but free to move toward and away from the third permanent magnet as the pole relations of the third and fourth permanent magnets may determine, the poles of the third and fourth permanent magnets being opposed when said permanent magnets are physically adjacent, the first and second permanent magnets attracting when the third and fourth permanent magnets repel, and vice versa.

10. In a snap acting mechanism, opposed pusher abutments in spaced relation, means for supporting said pusher abutments and moving them along a path, a shaft, means for rotatably mounting the shaft, an arm on the shaft extending into a position between the opposed pusher abutments, said opposed pusher abutments being in spaced relation with respect to the arm to provide lost motion, a second arm on the shaft, a first permanent magnet mounted on the second arm, and a second permanent magnet mounted rotationally stationary with respect to the first permanent magnet and adjoining the path of the first permanent magnet in the range of influence of its poles, the first and second permanent magnets cooperating to provide snap action of the shaft.

11. A mechanism of claim 10, in combination with a third arm on the shaft, a third permanent magnet mounted on the third arm and turning with the shaft, and a fourth permanent magnet mounted rotationally

stationary with respect to the third permanent magnet, positioned adjoining the path of turning of the third permanent magnet and having poles opposed (attracting) when the magnets are physically opposite, the first and second permanent magnets repelling when the third and fourth permanent magnets are attracting, and vice versa.

12. A mechanism of claim 10, in combination with a third arm mounted on the shaft, a third permanent magnet mounted on the third arm and turning with the shaft, a lever pivoted intermediate its ends and extending to a position adjoining the rotational path of the third permanent magnet, and a fourth permanent magnet on said

lever adapted to move toward and away from said third permanent magnet depending upon the relative position of the poles of the third and fourth permanent magnets, one pair of permanent magnets magnetically repelling when the other pair of permanent magnets are magnetically attracting, and vice versa.

References Cited in the file of this patent

UNITED STATES PATENTS

2,626,527	Meyers	Jan. 27, 1953
2,853,576	Tigerschiold	Sept. 23, 1958
2,960,971	Tear	Nov. 22, 1960