

Nov. 18, 1952

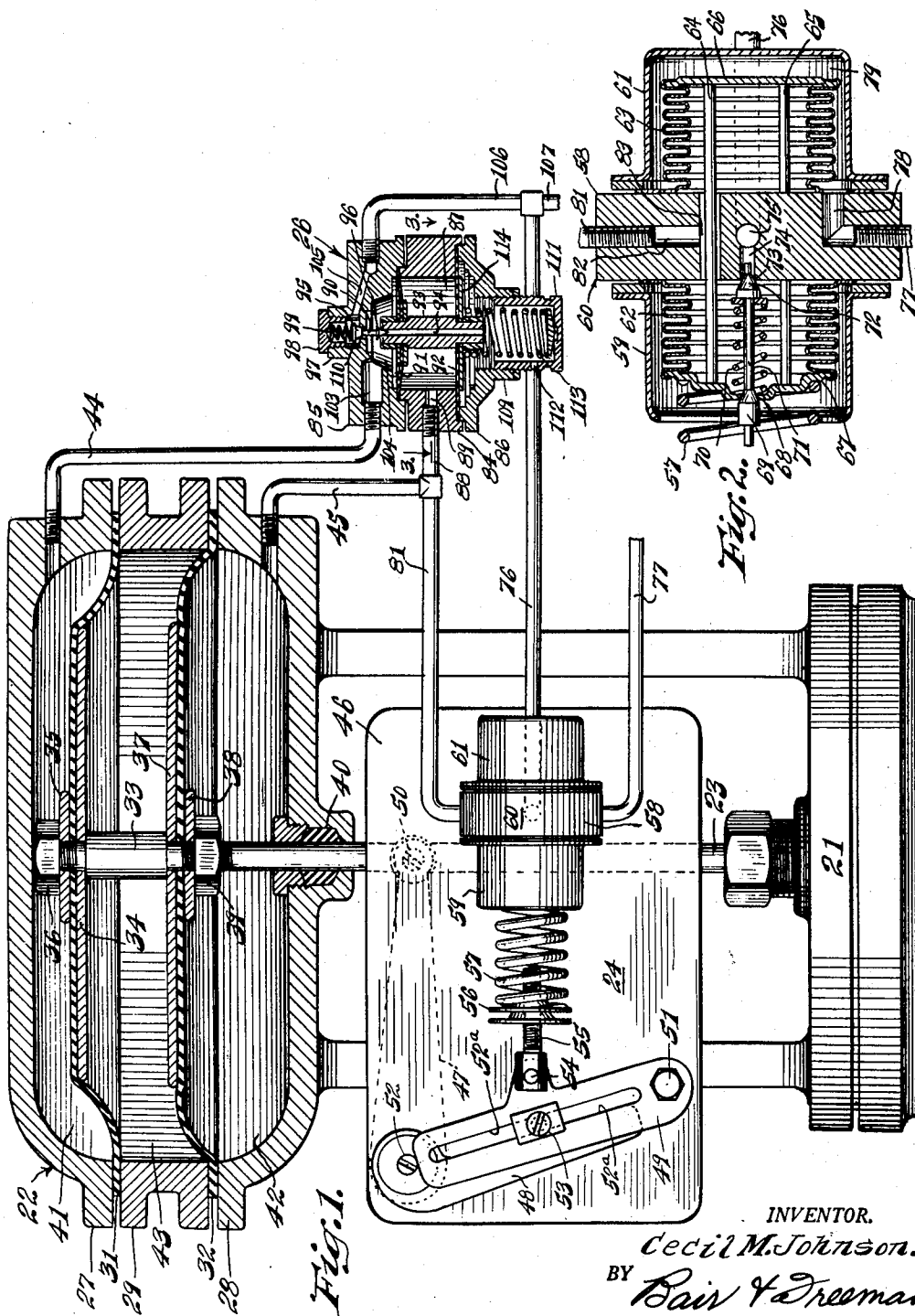
C. M. JOHNSON

2,618,286

PNEUMATIC REVERSE ACTING RELAY

Filed Aug. 17, 1948

3 Sheets-Sheet 1



INVENTOR.
Cecil M. Johnson.
 BY *Bair & Dreeman*
Atty's.

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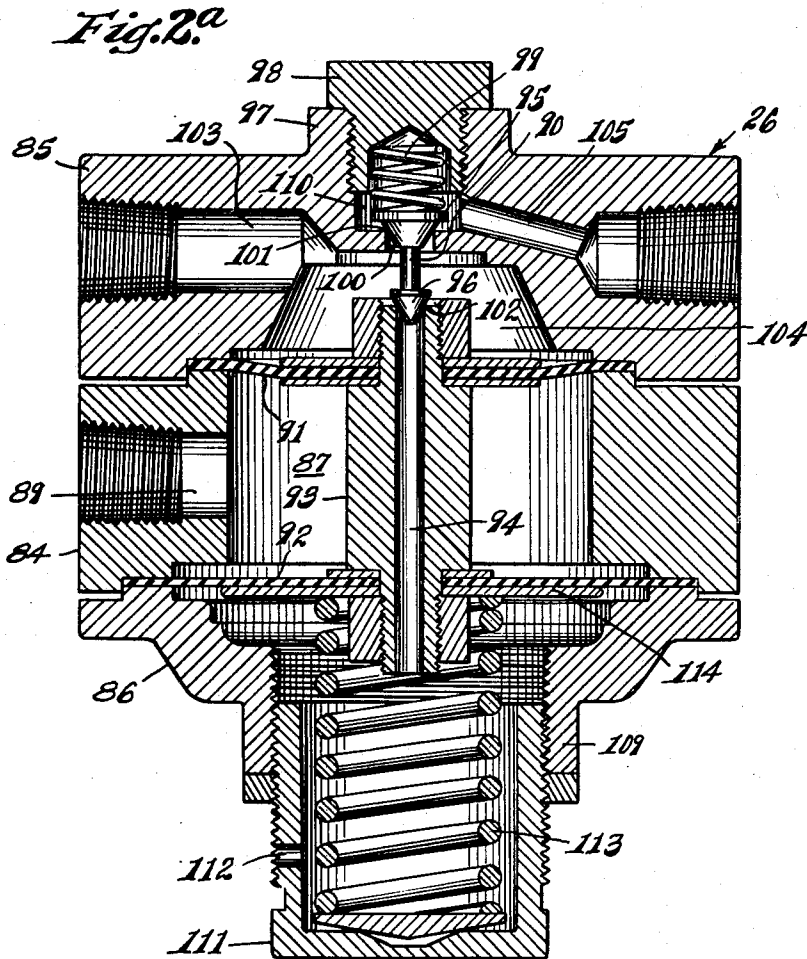
C. M. JOHNSON

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3 Sheets-Sheet 2



Inventor:
Cecil M. Johnson
By Baird Freeman
Atty's.

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C. M. JOHNSON

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PNEUMATIC REVERSE ACTING RELAY

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3 Sheets-Sheet 3

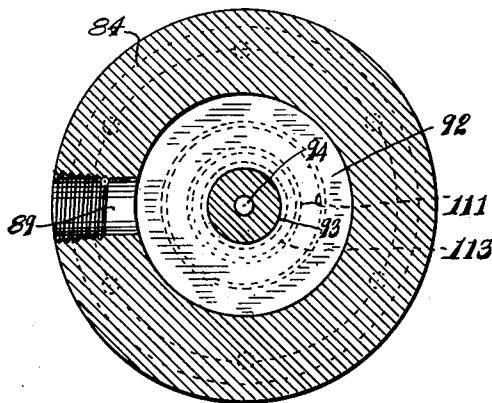
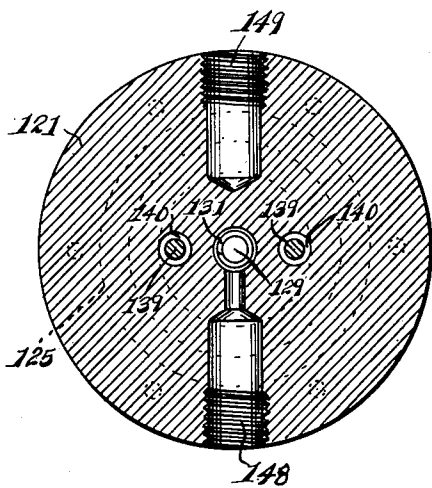
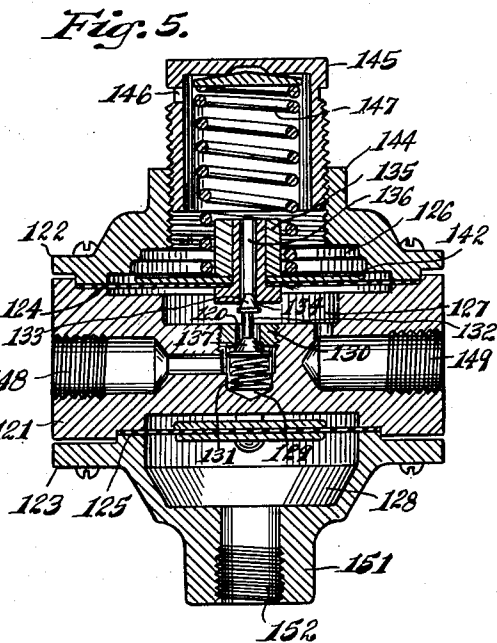
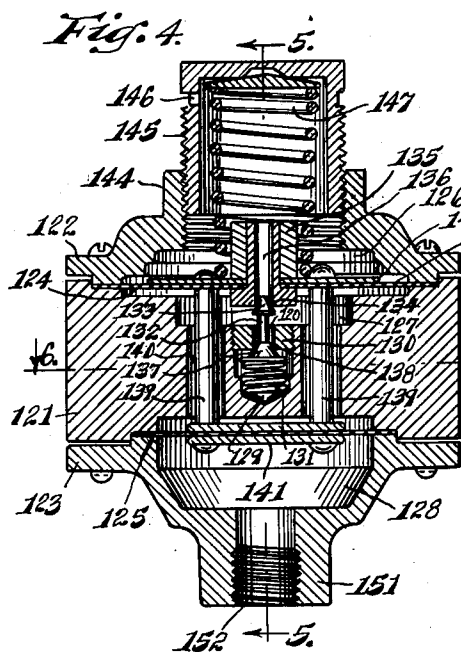


Fig. 6.

Fig. 3.

INVENTOR.

Cecil M. Johnson.

BY

Bain & Freeman

Attys.

UNITED STATES PATENT OFFICE

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PNEUMATIC REVERSE ACTING RELAY

Cecil M. Johnson, Marshalltown, Iowa, assignor
to Fisher Governor Company, Marshalltown,
Iowa, a corporation of Iowa

Application August 17, 1948, Serial No. 44,662

17 Claims. (Cl. 137—85)

1

This invention relates to pneumatic reversing relays also known as reverse acting relays, and particularly to such a relay which delivers a pressure that varies inversely as the instrument or control pressure in a valve operator or the like utilizing a pneumatic diaphragm motor.

An example of such a motor and motor and relay combination is described and claimed in the copending application of Donald J. Gaffney, Serial No. 44,780, filed August 17, 1948, now Patent No. 2,601,511, for Pneumatically Operated Diaphragm Motors. In such a system, the relay operates so that as the control air pressure increases, the delivery pressure from the relay decreases in the same proportion and vice-versa. This application relates to the relays per se.

It is an object of the invention to provide compact and reliable reversing relays of the pneumatic type which deliver output pressures inversely proportional to control pressures.

It is another object of the invention to provide pneumatic reversing relays which are readily adjustable.

It is also an object of the invention to provide a pneumatic reversing relay which operates in any position.

With these and other objects in view, the invention consists in the construction, arrangement and combination of the various parts of my device whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in the claims and illustrated in the accompanying drawings, wherein:

Figure 1 is an elevational view, partially in section, illustrating one embodiment of a reversing relay applied to a double diaphragm pneumatic motor, including a positioner, for moving the stem of a valve or governor;

Figure 2 is a sectional view of a bellows and valve assembly operated by the positioner;

Figure 2a is an enlarged sectional view of the relay shown in Figure 1;

Figure 3 is a sectional view of the relay taken on line 3—3 of Figure 1;

Figure 4 is a vertical sectional view of a reversing relay constructed in accordance with a second embodiment of the invention;

Figure 5 is a vertical sectional view taken on line 5—5 of Figure 4; and

Figure 6 is a horizontal sectional view taken on line 6—6 of Figure 4.

Referring specifically to the drawings, particularly Figures 1 and 2, for a detailed description of the first embodiment of the invention, a valve body is indicated generally at 21 and may be

2

any conventional control valve, butterfly valve, turbine governor control, or the like, well known in the art. A mechanism for operating the valve or governor includes a double diaphragm assembly generally indicated at 22, operating a reciprocating stem 23, a conventional valve positioner 24 and a reversing relay 26, all being connected to each other and to the double diaphragm assembly by suitable piping to be described.

The double diaphragm assembly 22 comprises an upper cup-shaped casing member 27, a lower cup-shaped casing member 28 and an intermediate annular or ring shaped member 29. An upper diaphragm, formed of rubber or synthetic rubber-like material, is clamped between the casing members 27 and 29, and a lower rubber or synthetic rubber diaphragm is clamped between the casing members 28 and 29. Bolts (not shown) are provided for retaining the casing members together.

The valve stem 23 is provided with an enlarged portion 33, which is disposed within the double diaphragm member 22. The enlarged portion 33 of stem 23 engages with a plate 34 disposed on the underside of the diaphragm 31. A plate 35 engages with the upper surface of the diaphragm 31 and is clamped to the plate 34 with the diaphragm 31 therebetween by a nut 36.

A plate 37 is disposed beneath the enlarged portion 33 in contact with the upper surface of the diaphragm 32. A plate 38 clamps the diaphragm 32 between itself and the plate 37 by means of a nut 39 secured to stem 23. Movement of either diaphragm is, therefore, transmitted to the other without slack. Atmospheric pressure is present between the diaphragms 31 and 32.

The stem 23 extends through the lower casing member 28 and into the casing 21, a packing gland 40 being provided in the lower casing portion 28 for the stem 23.

The diaphragms 31 and 32 divide the double diaphragm 22 into an upper chamber 41, a lower chamber 42 and an intermediate chamber 43. A conduit or pipe 44 communicates with the upper chamber 41, and a conduit 45 communicates with the lower chamber 42, for a purpose hereinafter described.

A valve positioner plate 46 supports levers 47, 48 and 49. The lever 47 is pivotally connected to valve stem 23 at 50. The levers 47 and 48 are connected together and are pivotally supported on the plate 46 at 52. The lever 49 is pivotally connected to the plate 46 at 51 and is provided with a longitudinal slot 52a. The lever

48 is also pivotally connected to a block 53 which slides in slot 52a, so that vertical movement of stem 23 rotates lever 49 about its pivot 51. A threaded member 55 is pivotally connected to the lever 49 at 54 and has a threaded abutment member 56 thereon which engages with a spring 57, and is adjustable to vary the compression thereof.

A combination bellows and valve member, generally indicated at 60, comprises a main body portion 58, having an open ended casing 59 secured to one side thereof adjacent spring 57, and a closed cup-shaped member 61 secured to the other side thereof. A bellows 62 is secured to the side of the main body portion 58 facing the spring 57, and a bellows 63 is secured to the other side of the main body portion 58 and is contained within the casing 61. Rods 64 extend through openings 83 in the body portion 58 and engage a plate 66 secured to bellows 63, and plate 67 secured to bellows 62. Spring 57 also engages the outside of plate 67 and tends to collapse bellows 62.

The plate 67 is provided with a central opening 68 therein, which provides a seat for a valve member 69, which is a part of a valve assembly 71, which in turn has a second valve member 72 on its inner extremity. A spring 70 engages the inner valve member 72, and the plate 67 tends to maintain the valve member 72 seated on its seat 73 formed in body member 58. A pair of passages 74 and 75 are also provided in body member 58 in communication with a conduit 76. The valve member 72 operates to open and close passages 74 and 75, which communicate with conduit 76, in a manner hereinafter described. A conduit 77, which communicates with a standard instrument or controller (not shown), also communicates with a passage 78 in body 58, which passage 78 opens into a chamber 79 formed between casing member 61 and bellows 63. Casing 79 is, obviously, hermetically sealed.

Another conduit 81, which communicates with conduit 45 and lower chamber 42 of the double diaphragm member 22, also communicates with a passage 82 in body 58, which in turn communicates with passages 83 in body 58 through which rods 64 extend. Conduit 81 is, therefore, in communication with the interior of the bellows 62 and 63.

The reversing relay 26 comprises a central body portion 84, to which is secured an upper body portion 85 and a lower body portion 86. A chamber 87 is formed in the central body portion 84 of reversing relay 26, and a conduit 88 communicates with the chamber 87 to a bore 89 at one end thereof and with conduits 45 and 81 at the other end thereof.

A diaphragm 91 formed of rubber or synthetic rubber is clamped between the upper portion 85 and the central portion 84 of the relay, and the diaphragm 92 is clamped between the lower portion 86 and the central portion 84 of the relay. Bolts may be utilized for retaining the parts together. The effective area of the lower diaphragm 92 is approximately twice that of the upper diaphragm 91. A stem 93 is secured to the upper and lower diaphragms 91 and 92, in any suitable manner, the stem 93 being provided with a central passage 94 extending therethrough. A valve assembly 90 has an upper valve member 95 and a lower valve member 96. The lower valve member 96 normally closes the upper end of passage 94. The upper body portion 85 of relay 26 is provided with a boss 97, which is internally screw

threaded to receive a plug 98. A spring 99 engages with the plug 98 and with the upper valve member 95 to normally bias the valve member 95 into engagement with its seat 101 surrounding a passage 100 in body portion 85. The spring 99 also biases the valve member 96 into engagement with its seat 102 on top of stem 93.

A passage 103 is provided in the upper body portion 85 of relay 26, and communicates at one end with pipe 44, which in turn is in communication with upper chamber 41 of the double diaphragm member 22. The other end of passage 103 communicates with a chamber 104, which is formed above diaphragm 91. A second passage 105 is provided in the upper body portion 85 of relay 26, which communicates at one end with a conduit 106 and at its other end with a chamber 110 above valve member 95. The conduit 106 also communicates with conduit 76 and with a conduit 107, which latter conduit connects with a regulated air supply.

The lower body portion 86 is provided with an internally threaded boss 109, into which is screwed a hollow plug 111 having a vent 112 in the side thereof. A spring 113 engages the closed end of the plug 111 and engages with a plate 114, which is secured to diaphragm 92, thus tending to bias stem 93 upwardly into engagement with valve member 96.

Operation of Figures 1 and 2

Referring first to the reversing relay 26, assuming a 20 p. s. i. air supply through conduit 106, then with no pressure at conduit 81, adjusting screw or plug 111 is screwed down to adjust the spring 113 until the diaphragm or delivery pressure in conduit 44 is 20 p. s. i. The effective area of diaphragm 92 is twice that of diaphragm 91, as stated hereinbefore. If the area of diaphragm 91 is equal to y , the area of diaphragm 92 is equal to $2y$. If the instrument or control pressure at 81 is increased 1 p. s. i., there will be an increase in force on diaphragm 92 equal to $2y$ and an increase in force on diaphragm 91 equal to y . This leaves a net unbalanced downward force on the diaphragm assembly equal to y and, consequently, the assembly will move, opening the bleed valve 96. This will allow air to escape from the chamber 104 until the pressure on the top of diaphragm 91 is reduced 1 p. s. i. The diaphragm assembly will again be in static balance, and the bleed valve 96 closed. Thus, it becomes apparent that with every pound increase at 81, one pound decrease will result at 44.

If there is a 1 p. s. i. decrease at 81, this will result in a 1 p. s. i. increase at 44, because the diaphragm assembly of the relay 26 will move upwardly, opening inlet valve 95 and permitting increase in pressure in chamber 104 and in conduit 44 until the pressures are again balanced, whereupon the inlet valve 95 is closed.

Referring now to the complete air circuit, starting with the air from the instrument or controller which enters through conduit 77, increasing air pressure will cause the bellows assembly 62, 63 to be moved to the left as viewed in Figure 2, which opens the air supply valve 72 allowing air supply pressure entering through conduits 107 and 76 to flow into the chamber formed by the two bellows 62, 63 and through conduit 81 into lower diaphragm chamber 42 of the motor valve 22. The same increase in pressure is also registered in chamber 87 of reversing relay 26 which, as explained above, causes an unbalance in the relay diaphragm assembly and causes

5

it to move downwardly allowing air to escape from chamber 104 through passage 94 and bleed outlet 112. This lowers the pressure in the chamber 41 of the motor 22 in an amount equivalent to the rise in pressure in the chamber 42 of motor 22. There is now an unbalanced force on the main diaphragm assembly 31, 32, which causes the valve stem 23 to move upwardly. This supplies compression to the spring 57 through the levers 47, 48 and 49, which balances the increase in pressure on bellows assembly 62, 63, causing supply valve 72 to again close. This places the system again in balance. If, due to hysteresis in the diaphragm assembly 31, 32, sticking in the stuffing box 40 or unbalanced pressure forces on the valve or governor being operated, the valve stem 23 does not move immediately, air will continue to bleed through the inlet valve 72, consequently increasing air pressure in the chamber 42 and decreasing pressure in the chamber 41 until the valve stem 23 moves or until the pressure in chamber 42 has increased to the equivalent of the air supply, that is 20 p. s. i., and the air pressure in chamber 41 has reached zero. This makes available for moving the valve stem 23 a force equivalent to the product of the diaphragm area 32, times the supply pressure. For example, if the diaphragm area is 100 square inches and the air supply is 20 p. s. i., there is 2000 p. s. i. force available to move the valve stem 23.

On decreasing pressure from the instrument or controller through conduit 77, the bellows assembly 62, 63 will move to the right as viewed in Figure 2. Since the inlet port 72 is closed, the inner valve 71 cannot move further to the right. Consequently, the left hand bellows head 67 breaks away from bleed valve 69, opening the bleed port 68 and allowing air to bleed from the chamber formed by the bellows 62, 63. This decreases the pressure in chamber 87 of reversing valve 26 and in chamber 42 of the motor 22. The decrease in pressure in chamber 87 causes an increase in pressure in chamber 41 of motor 22, as explained above. The unbalance on the diaphragm assembly 31, 32 will now cause the valve stem 23 to move downwardly, which through levers 47, 48 and 49, will decrease the loading on spring 57 until the spring load again balances the pressure load from the instrument or controller in the chamber formed by bellows 63 and cup shaped member 61, thus closing bleed valve 69 and placing the system again in balance.

Description of Figures 4, 5 and 6

Referring now to Figures 4, 5 and 6 for a detailed description of the reversing relay constituting the second embodiment of the invention, the principle is the same as that referred to with respect to Figures 1 and 2, although the force balance is slightly different. The reversing relay shown in Figures 4, 5 and 6 is intended to be used in the same system as shown in Figures 1 and 2, that is, with a pneumatic motor 22, a stem 23, a valve or governor 21, a positioner 24 and a bellows valve assembly 60. In the embodiment shown in Figures 4, 5 and 6, the reversing relay as shown in Figure 1 has been inverted, since the relay is capable of operating in any position and may have its outlet connected either to the upper chamber 41 of motor 22 or to the lower chamber 42 of motor 22, depending upon the desired direction of operation of the valve stem 23.

6

In the construction shown in Figures 4, 5 and 6, numeral 121 designates the main portion of the relay body, 122 an upper casing portion secured to the body 121 and numeral 123 a lower casing portion secured to body 121. A diaphragm 124, formed of rubber or synthetic rubber, is clamped between the members 121 and 122, and a similar diaphragm 125 is clamped between members 121 and 123. The upper diaphragm 124 has an effective area twice that of lower diaphragm 125. A chamber 126 is formed above the upper diaphragm 124, and a chamber 127 is formed below the upper diaphragm 124. A chamber 128 is formed below the lower diaphragm 125. A chamber 129 is formed in the body 121 and has a coil spring 131 positioned therein. A plug 130 closes the chamber 129 and has a passage 120 therethrough providing a seat for a lower valve member 137 of a valve 132. The valve 132 has an upper valve member 133 provided with a seat 134 in a hollow stem member 135 having a passage 136 therethrough.

A pair of rods 139 extend through vertical passages 140 in the body 121 and are riveted at their lower ends to a pair of plates 141, which clamp the diaphragm 125 therebetween. The rods 139 are riveted at their upper ends to a plate 142, which is secured to the stem 135 and clamps the diaphragm 124 thereto.

The upper casing portion 122 is provided with an internally threaded boss 144, into which is screwed a hollow plug 145 having a vent opening 146 therein. The plug 145 has a spring 147 therein, which is in contact with the top of the plug 145 and with the plate 142, thus tending to force the hollow stem member 135 and the diaphragm 124 downward. This maintains the valve 133 normally seated on seat 134, but the force of the spring 147 is not normally sufficient to unseat valve member 137 from its seat 138 against the force of spring 131 and the unbalanced force resulting from air pressure on diaphragm 124 and 125.

An internally threaded passage 148 connects with the chamber 129 in body 121 and is adapted to be connected to the air supply pressure conduit 107 of Figure 1. An internally threaded passage 149 communicates with chamber 127 in the body 121 and is adapted to be connected either to chamber 41 or chamber 42 of motor 22 in Figure 1, depending upon the direction of operation of stem 23 desired. An internally threaded passage 152 is provided in boss 151 of lower casing member 123 and communicates with chamber 128. The passage 152 is adapted to be connected to the instrument or control pressure through conduits 81, 88 of Figure 1.

Operation of Figures 4, 5 and 6

As stated above, the area of diaphragm 124 is twice that of diaphragm 125. If the area of diaphragm 125 is equal to y , the area of diaphragm 124 is equal to $2y$. With 20 p. s. i. air supply in passage 148 and chamber 129, the adjusting screw or plug 145 is set so that there is 20 p. s. i. in chamber 127 and, therefore, the same pressure in passage 149, which is connected to motor 22 with no pressure in passage 152, or chamber 128, which is connected to the instrument or control. If the instrument or control pressure is increased in passage 152 and chamber 128 to 1 p. s. i., there will be an increase in the upward force of diaphragm 125 equal to y . This will cause the diaphragm assembly to move upwardly to separate valve member 133 from its

seat 134 and bleed air out of chamber 127 through passage 136 and vent 146. Air will continue to bleed until the pressure has been reduced one pound in chamber 127. When this has occurred, the upward force in diaphragm 124 will have been decreased to $2y$ and the downward force on diaphragm 125 will have been decreased y . The net result of the change in pressure in chamber 127 will be a decrease in upward force equal to y . This decrease will be replaced by 1 p. s. i. increase in passage 152 and chamber 128, which will close valve member 123, and the relay will again be in equilibrium. Thus, an increase of 1 p. s. i. in passage 152 and chamber 128 causes a decrease of 1 p. s. i. in chamber 127 and passage 149.

In the reverse cycle, a decrease in pressure in passage 152 and chamber 128 will cause a like increase in chamber 127 and passage 149, because the diaphragm assembly 124, 125 moves downwardly, opening valve member 137 against the force of spring 131 and effecting an increase in pressure in chambers 127 and 149 until equilibrium is again reached, whereupon valve member 137 will be seated on its seat 138.

From the foregoing, it will be apparent that I have provided an improved pneumatic reversing relay which is capable of wide range application.

Some changes may be made in the construction and arrangement of the parts of my device without departing from the real spirit and purpose of my invention, and it is my intention to cover by my claims any modified forms of structure or use of mechanical equivalents which may be reasonably included within their scope without sacrificing any of the advantages thereof.

I claim as my invention:

1. A pneumatic reverse acting relay comprising a first chamber communicating with a supply of pressure fluid, a port in said first chamber, a valve member having a first valve for opening and closing said port, means for normally biasing said first valve to closed position, a second chamber into which said port opens for admitting pressure fluid thereto, a passage for fluid communicating with said second chamber, one wall of said second chamber comprising a first flexible diaphragm, a movable member secured to said first diaphragm and having a passageway therethrough, said valve member including a second valve for opening and closing said passageway, said passageway communicating with said second chamber at one end thereof when said second valve is open and with atmosphere at the other end thereof, means for normally retaining said second valve in closed position, and a third chamber having an opening therein for fluid under pressure, two walls of said third chamber being formed by said first diaphragm and a second diaphragm, said second diaphragm also being secured to said movable member.

2. A pneumatic reverse acting relay comprising a first chamber communicating with a supply of pressure fluid, a port in said first chamber, a valve member having a first valve for opening and closing said port, means for normally biasing said first valve to closed position, a second chamber into which said port opens for admitting pressure fluid thereto, a passage for fluid communicating with said second chamber, one wall of said second chamber comprising a first flexible diaphragm, a movable member secured to said first diaphragm and having a passageway

therethrough, said valve member including a second valve for opening and closing said passageway, said passageway communicating with said second chamber at one end thereof when said second valve is open and with atmosphere at the other end thereof, means for normally retaining said second valve in closed position, and a third chamber having an opening therein for fluid under pressure, two walls of said third chamber being formed by said first diaphragm and a second diaphragm, said second diaphragm also being secured to said movable member, one of said diaphragms having a larger effective area than the other.

3. A pneumatic reverse acting relay comprising a first chamber communicating with a supply of pressure fluid, a port in said first chamber, a valve member having a first valve for opening and closing said port, means for normally biasing said first valve to closed position, a second chamber into which said port opens for admitting pressure fluid thereto, a passage for fluid communicating with said second chamber, one wall of said second chamber comprising a first flexible diaphragm, a movable member secured to said first diaphragm and having a passageway therethrough, said valve member including a second valve for opening and closing said passageway, said passageway communicating with said second chamber at one end thereof when said second valve is open and with atmosphere at the other end thereof, means for normally retaining said second valve in closed position, and a third chamber having an opening therein for fluid under pressure, two walls of said third chamber being formed by said first diaphragm and a second diaphragm, said second diaphragm also being secured to said movable member, one of said diaphragms having an effective area approximately twice that of the other.

4. A pneumatic reverse acting relay comprising a first chamber communicating with a supply of pressure fluid, a port in said first chamber, a valve member having a first valve for opening and closing said port, means for normally biasing said first valve to closed position, a second chamber into which said port opens for admitting pressure fluid thereto, a passage for fluid communicating with said second chamber, one wall of said second chamber comprising a first flexible diaphragm, a movable member secured to said first diaphragm and having a passageway therethrough, said first valve member including a second valve for opening and closing said passageway, said passageway communicating with said second chamber at one end thereof when said second valve is open and with atmosphere at the other end thereof, means for normally retaining said second valve in closed position, and a third chamber having an opening therein for fluid under pressure, two walls of said third chamber being formed by said first diaphragm and a second diaphragm.

5. A pneumatic reverse acting relay comprising a first chamber communicating with a supply of pressure fluid, a port in said first chamber, a valve member having a first valve for opening and closing said port, means for normally biasing said first valve to closed position, a second chamber into which said port opens for admitting pressure fluid thereto, a passage for fluid communicating with said second chamber, one wall of said second chamber comprising a first flexible diaphragm, a movable member secured to said first diaphragm and having a passageway there-

through, said valve member including a second valve for opening and closing said passageway, said passageway communicating with said second chamber at one end thereof when said second valve is open and with atmosphere at the other end thereof, means for normally retaining said second valve in closed position, a third chamber having an opening therein for fluid under pressure, two walls of said third chamber being formed by said first diaphragm and a second diaphragm, said second diaphragm also being secured to said movable member, spring means for biasing said diaphragms in one direction, and means for adjusting the bias produced by said spring means.

6. A pneumatic reverse acting relay comprising a casing, first, second, and third chambers in said casing, first, second, and third passages in said casing respectively in communication with said chambers, a first connecting passageway between the first and second chambers, a movable member having a second connecting passageway therethrough communicating at one end with said second chamber and at the other end with atmosphere, a valve member having a first valve for opening and closing said first connecting passageway, said valve member having a second valve for opening and closing said second connecting passageway, a first diaphragm between the second and third chambers, a second diaphragm bounding one of said latter two chambers, said diaphragms being rigidly connected together to move as a unit, said movable member being secured to at least one of said diaphragms, and said first diaphragm being of smaller area than said second diaphragm, whereby a change of pressure in said third chamber causes one of said valves to be opened to cause a reverse change in pressure in the second chamber.

7. A pneumatic reverse acting relay as set forth in claim 6 wherein said second diaphragm has an effective area approximately twice that of the first diaphragm.

8. A reverse acting relay as set forth in claim 6 including spring means for biasing said diaphragms in one direction, and means for adjusting the bias produced by said spring means.

9. A pneumatic reverse acting relay comprising a casing, first, second, and third chambers in said casing, first, second, and third passages in said casing respectively in communication with said chambers, a first connecting passageway between the first and second chambers, a movable member having a second connecting passageway therethrough communicating at one end with said second chamber and at the other end with atmosphere, a valve member having a first valve for opening and closing said first connecting passageway, said valve member having a second valve for opening and closing said second connecting passageway, a first diaphragm between the second and third chambers, a second diaphragm bounding one of said latter two chambers, said diaphragms being rigidly connected together to move as a unit, said movable member being secured to at least one of said diaphragms, said first diaphragm being of smaller area than said second diaphragm, whereby a change of pressure in said third chamber causes one of said valves to be opened to cause a reverse change in pressure in the second chamber, said diaphragms and movable member having a balanced position wherein both valves are closed, the displacement from said balanced position of said diaphragms and movable member in one direc-

tion affording opening of said second valve, and the displacement from said balanced position of said diaphragms and movable member in the other direction affording closing of said second valve and opening of said first valve.

10. A pneumatic reverse acting relay comprising a casing, first, second, and third chambers in said casing, first, second, and third passages in said casing respectively in communication with said chambers, a first connecting passageway between the first and second chambers, a movable member having a second connecting passageway therethrough communicating at one end with said second chamber and at the other end with atmosphere, a valve member having a first valve for opening and closing said first connecting passageway, said valve member having a second valve for opening and closing said second connecting passageway, a first diaphragm between the second and third chambers, a second diaphragm bounding one of said latter two chambers, said diaphragms being rigidly connected together to move as a unit, said movable member being secured to at least one of said diaphragms, means for normally biasing said first valve to a closed position, means for normally retaining said movable member against said second valve to close said second connecting passageway and said first diaphragm being of smaller area than said second diaphragm, whereby a change of pressure in said third chamber causes one of said valves to be opened to cause a reverse change in pressure in the second chamber.

11. A pneumatic reverse acting relay comprising a casing, first, second, and third chambers in said casing, first, second, and third passages in said casing respectively in communication with said chambers and adapted for connection to sources of fluid under pressure located exteriorly of said casing, a first connecting passageway between the first and second chambers, a movable member having a second connecting passageway therethrough communicating at one end with said second chamber and at the other end with atmosphere, a valve member having a first valve for opening and closing said first connecting passageway, said valve member having a second valve for opening and closing said second connecting passageway, a first diaphragm between the second and third chambers, a second diaphragm bounding one of said latter two chambers, said diaphragms being rigidly connected together to move as a unit, and said movable member being secured to at least one of said diaphragms.

12. A pneumatic reverse acting relay as set forth in claim 11 wherein said second diaphragm serves as one of the walls of the third chamber.

13. A pneumatic reverse acting relay as set forth in claim 11 wherein said movable member is secured to said second diaphragm.

14. A pneumatic reverse acting relay comprising a casing, first, second, and third chambers in said casing, first, second, and third passages in said casing respectively in communication with said chambers and adapted for connection to sources of fluid under pressure located exteriorly of said casing, a first connecting passageway between the first and second chambers, a movable member having a second connecting passageway therethrough communicating at one end with said second chamber and at the other end with atmosphere, a valve member having a first valve for opening and closing said first connecting passageway, said valve member having a second

11

valve for opening and closing said second connecting passageway, a first diaphragm between the second and third chambers, two of the walls of said second chamber comprising said first diaphragm and a second diaphragm, said diaphragms being rigidly connected together to move as a unit, and said movable member being secured to said first diaphragm.

15. A reverse acting relay as set forth in claim 14 wherein one of said diaphragms has a larger effective area than the other.

16. A reverse acting relay as set forth in claim 14 wherein one of said diaphragms has an effective area approximately twice that of the other.

17. A reverse acting relay as set forth in claim 14 including spring means biasing said dia-

12

phragms in one direction, and means for adjusting the bias produced by said spring means.

CECIL M. JOHNSON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,762,260	DeMotte	June 10, 1930
2,073,838	Hammond	Mar. 16, 1937
2,193,295	Otto	Mar. 12, 1940
2,226,865	Kirchhoff	Dec. 31, 1940
2,286,282	Joesting	June 16, 1942
2,299,884	Edwards	Oct. 27, 1942