Sept. 29, 1953 C. B. MOORE 2,653,578

POSITIONER FOR FLUID OPERATED MOTORS

Filed Sept. 8, 1949 2 Sheets-Sheet 1

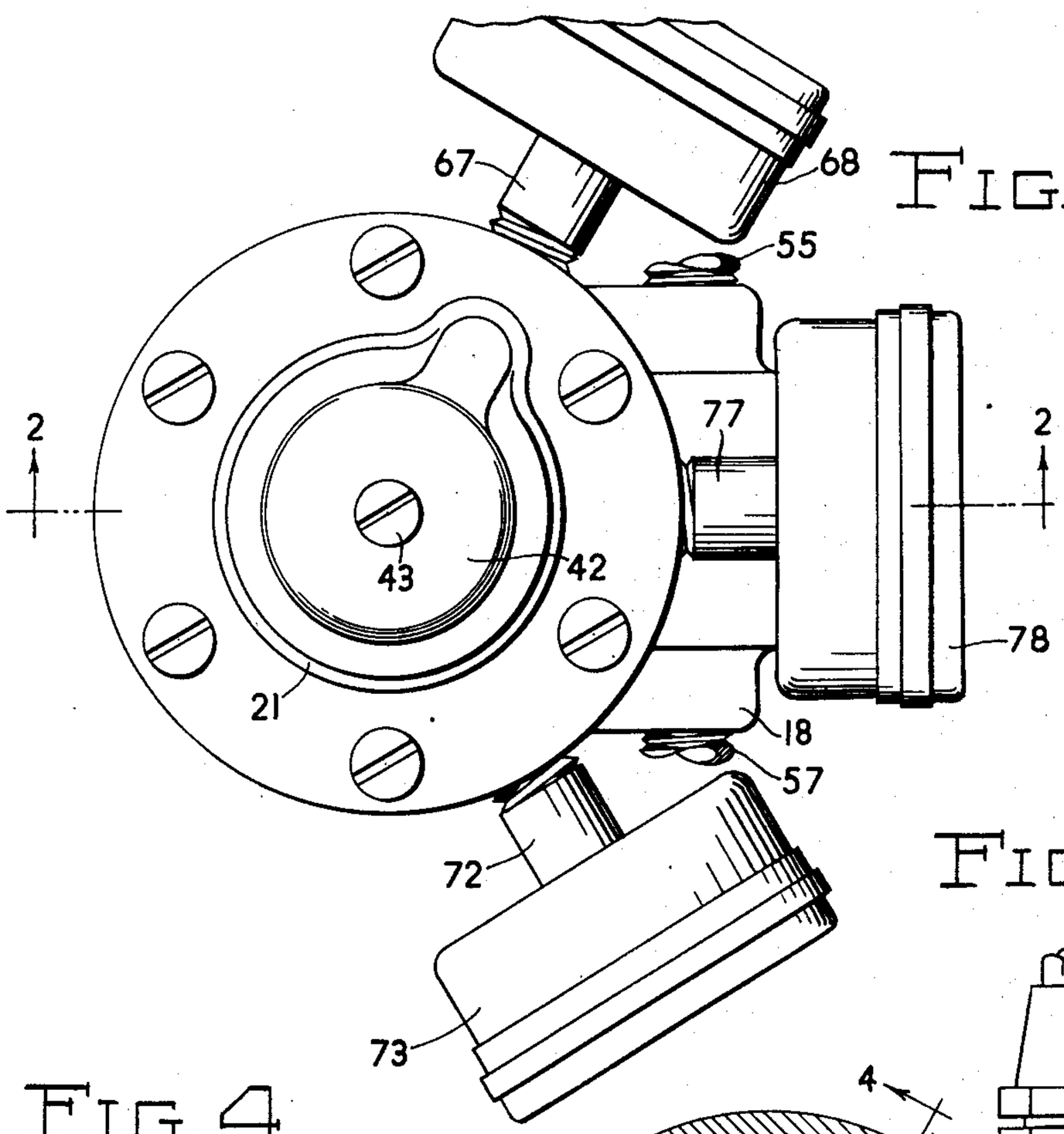
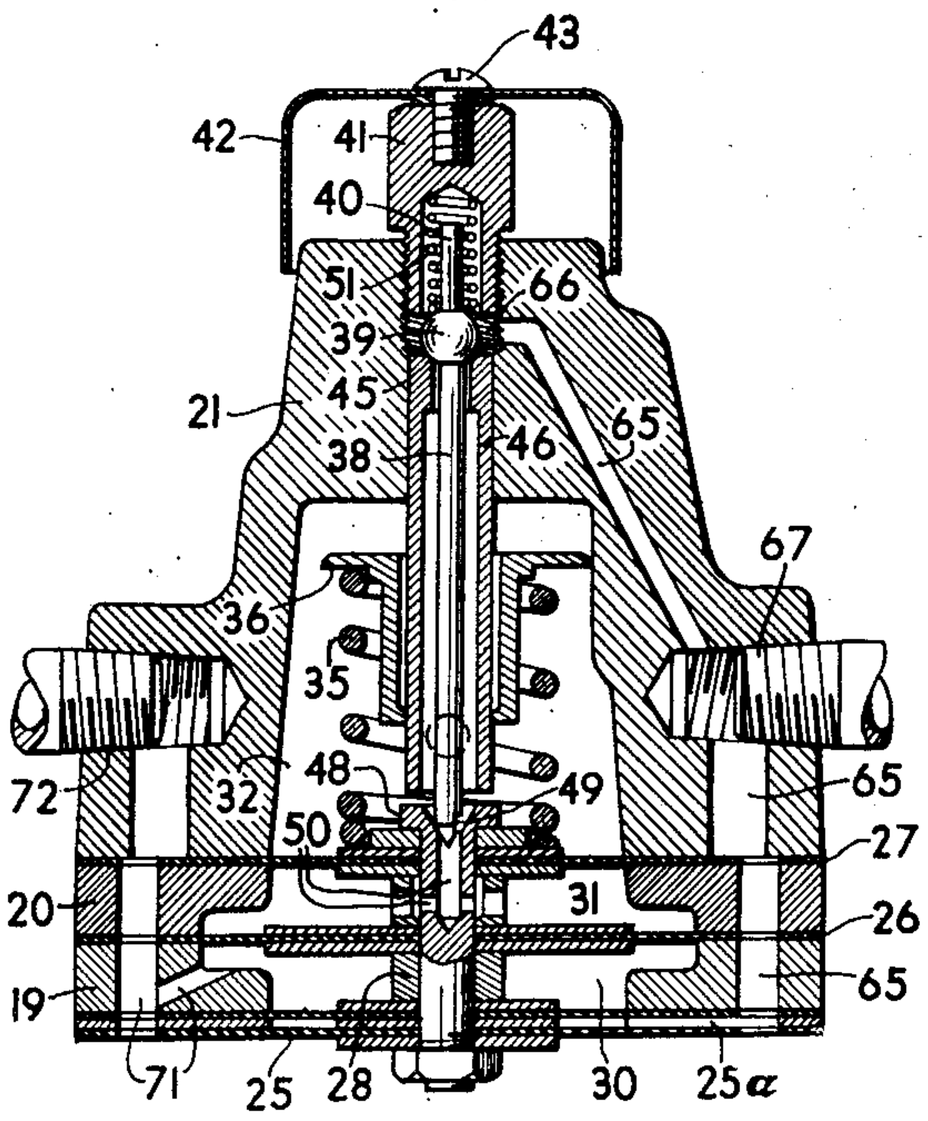
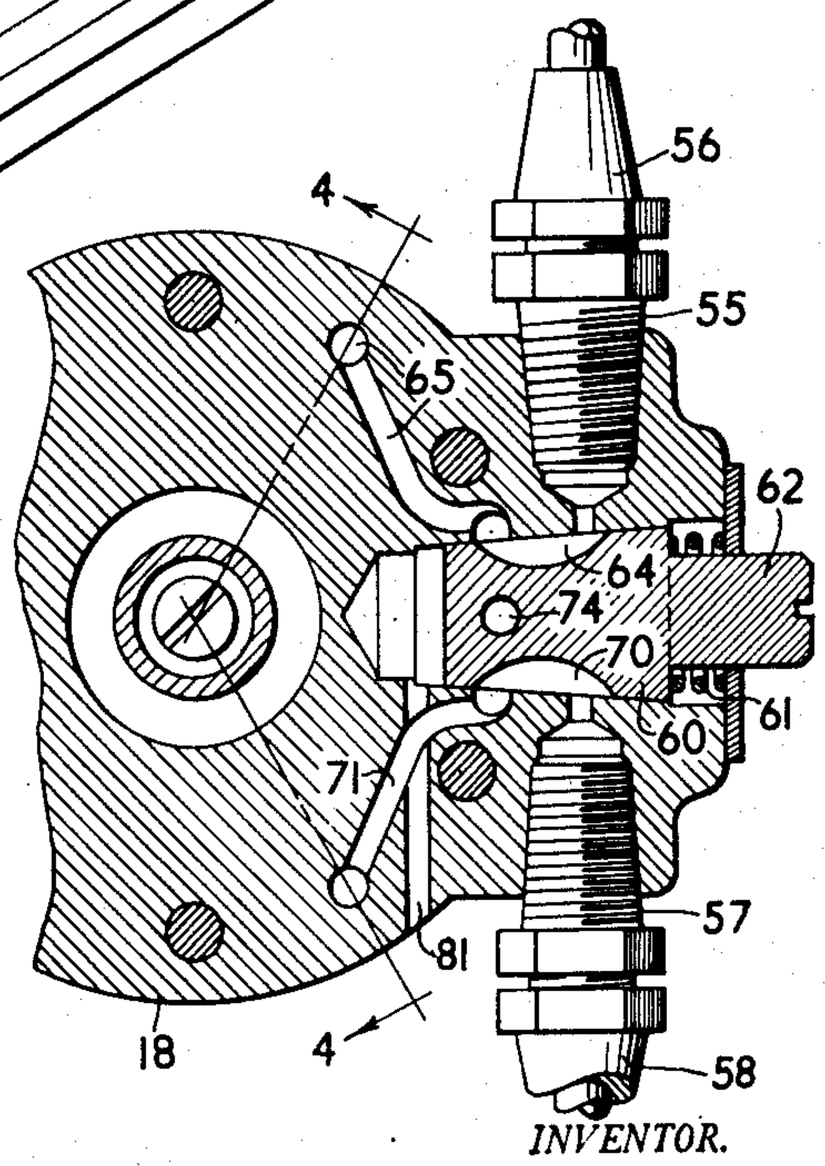


FIG_1

FIG_3

FIG_4





INVENTOR.
COLEMAN B. MOORE
BY
Z. T. Wobensmith 2nd
ATTORNEY

Sept. 29, 1953 C. B. MOORE 2,653,578

POSITIONER FOR FLUID OPERATED MOTORS

Filed Sept. 8, 1949 2 Sheets-Sheet 2

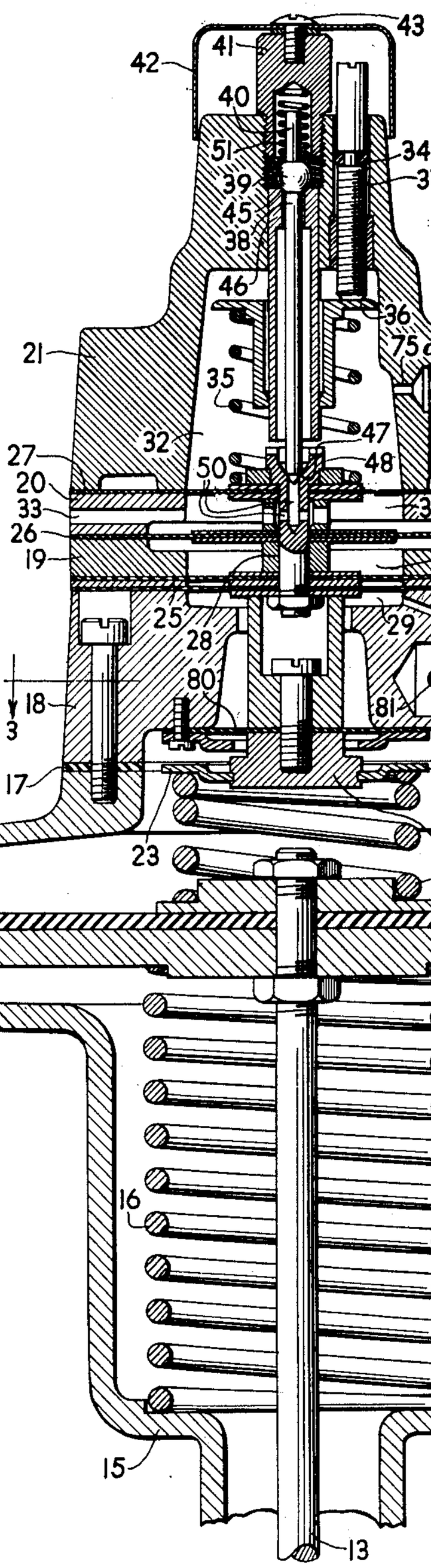


FIG. 2

FIG. 5

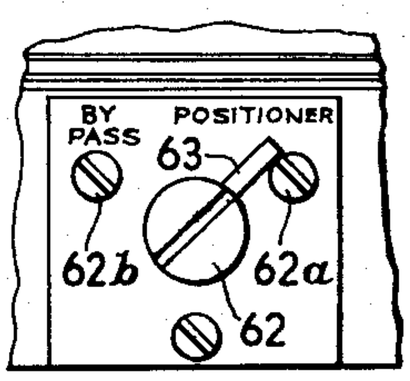
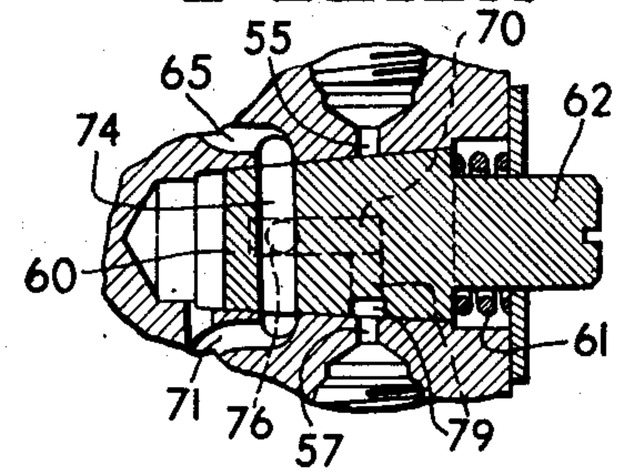


FIG. 3A



INVENTOR.
COLEMAN B. MOORE

BY
J. T. Wobensmith 2nd

ATTORNEY

Patented Sept. 29, 1953

2,653,578

UNITED STATES PATENT OFFICE

2,653,578

POSITIONER FOR FLUID OPERATED MOTORS

Coleman B. Moore, Carroll Park, Pa., assignor to Moore Products Co., Philadelphia, Pa., a co-partnership consisting of Coleman B. Moore, Charles H. Thompson, Walter G. Trumbower, and Robert Buhner

Application September 8, 1949, Serial No. 114,541

5 Claims. (Cl. 121—41)

1

This invention relates to positioners and more particularly to apparatus for providing accurate positioning of a fluid motor of the type employed with motor operated valves and in other applications.

It is the principal object of the present invention to provide a positioner which will be accurate in its operation with adequate sensitivity and speed.

It is a further object of the present invention to provide a positioner which may be directly built into the diaphragm chamber of a motor operated valve.

It is a further object of the present invention to provide a positioner having an improved arrangement of range spring, pressure responsive element, and pilot valve.

It is a further object of the present invention to provide a positioner having a range spring supported directly by the diaphragm of the pressure responsive motor.

It is a further object of the present invention to provide a positioner in which the control elements are mounted directly on the casing of the motor diaphragm of the fluid operated motor.

It is a further object of the present invention to provide a positioner having a controlling diaphragm and in which the pressure effective on the fluid operated motor is cancelled out.

It is a further object of the present invention to provide a positioner in which the throttling range may be controlled by variation in diaphragm sizes in the control mechanism.

It is a further object of the present invention to provide a positioner with provisions for a stabilizing action.

It is a further object of the present invention to provide a positioner having an improved bypass valve arrangement.

It is a further object of the present invention to provide a positioner having a bypass which will permit of removing the indicating gages from the circuit without interference with the operation of the motor.

Other objects and advantageous features of the invention will be apparent from the specification and claims.

The nature and characteristic features of the invention will be more readily understood from the following description, taken in connection with the accompanying drawings forming part hereof, in which:

Figure 1 is a top plan view of a positioner in accordance with the present invention;

Fig. 2 is a vertical sectional view taken approximately on line 2—2 of Fig. 1;

2

Fig. 3 is a horiozntal sectional view, partly diagrammatic, taken approximately on the line 3—3 of Fig. 2 and showing the bypass valve in one position;

Fig. 3A is a fragmentary view similar to Fig. 3 showing the bypass valve in another position;

Fig. 4 is a vertical sectional view, partly diagrammatic, taken approximately on the line 4—4 of Fig. 3; and

Fig. 5 is a fragmentary vertical sectional view taken approximately on the line 5—5 of Fig. 2.

It should, of course, be understood that the description and drawings herein are illustrative merely, and that various modifications and changes may be made in the structure disclosed without departing from the spirit of the invention.

Like numerals refer to like parts throughout the several views.

Referring now more particularly to the drawings, in which a preferred embodiment of the invention is illustrated, upper and lower sections 10 and 11 of a diaphragm motor casing are shown with a motor diaphragm 12 interposed therebetween in the usual manner. The diaphragm 12 has a stem 13 connected thereto for movement therewith and the stem 13 is connected to a valve plug (not shown) or other controlling element to be positioned.

The lower casing section 11 has a downwardly extending portion 14 with a shoulder 15 at the lower end thereof for engagement by one end of a diaphragm return compression spring 16. The other end of the spring 16 is in engagement with the under side of the motor diaphragm 12.

The upper casing section 10 has an upper end wall 17 on which a bypass valve housing 18 is secured. Above the housing 18, diaphragm housing sections 19 and 20 and an upper housing 21 are secured.

Within the interior of the upper casing section 10 and the housing 18, diaphragm connectors are provided which include a range determining compression spring 22 in engagement with the motor diaphragm 12 and with a spring abutment 23 carried on a connector 24. The connector 24 is in turn in abutting relation to a diaphragm assembly hereinafter described. The connector 24 extends on opposite sides of a sealing diaphragm 80 which centers it and the seat or abutment 23 for the spring 22 and permits removal of the parts above the housing 18 without loss of fluid while the motor diaphragm 12 is in operation.

The diaphragm assembly preferably includes a

compound diaphragm **25** of the type shown in the prior application of Charles H. Thompson, for Pneumatic Control Apparatus, Serial No. 21,835, filed April 19, 1948, interposed between the bypass housing **18** and the housing section **19**, and having a supply connection **25***a* extending between the separated diaphragms. An intermediate diaphragm **26** is interposed between the housing section **19** and housing section **20**. The diaphragm **26** is of different and preferably larger effective area than the diaphragm **25**. An upper diaphragm **27** is interposed between the housing section **20** and the upper housing section **21**, and preferably has the same effective area as the diaphragm **25**. The diaphragms **25**, **26** and **27** are preferably connected together for simultaneous movement by a connector **28** and provide chambers **29**, **30**, **31** and **32** to which reference will be made. The chamber **31** is vented to the atmosphere through a port **33**.

The upper face of the diaphragm **27** has one end of a zero adjusting compression spring **35** in engagement therewith, the other end of the spring **35** being in engagement with a spring abutment **36**, the position of which is adjustable by means of an adjusting screw **37** sealed against fluid leakage by a packing ring **34**, carried in the upper housing **21**.

Within the upper housing **21** a pilot valve is provided which includes a valve rod **38** having a valve ball **39** carried thereon and an upper stem section **40**. A compression spring **51** mounted on the upper stem section **40** is in engagement with the ball **39** and with an interior abutment in a closure plug **41**.

The closure plug **41** may also have mounted thereon a cover **42** held in removable engagement by screw **43** for enclosing the upper end of the adjusting screw **37**.

The valve ball **39** is adapted to seat under certain conditions on a valve seat **45** formed in a sleeve **46** secured in the upper housing **21** and along which the abutment member **36** is guided in its adjustment. The lower end of the valve rod **38** is preferably provided with a seating portion **47** for seating engagement in a valve seating member **48** connected to and movable with the diaphragm connector **28**. The valve rod **38** preferably has a flattened face **49** on one side thereof (see Fig. 4) for providing a continuous flow of a limited quantity of fluid, for purposes to be explained. The valve seating member **48** is provided with passageways **50** in communication with the chamber **31** between the diaphragm **26** and the diaphragm **27**.

The bypass housing section **18** is provided with a fluid connection **55** which is adapted to be connected by a connector **56** to a suitable source of fluid under pressure, such as pressure regulated and filtered air. The housing section **18** is also provided with a fluid connection **57** which is adapted to be connected by a fluid connection **58** to the control or instrument pressure which is intended to determine the positioning of the motor diaphragm **12** and rod **13**.

Within a tapered bore in the housing section **18** a bypass valve plug **60** is provided, held in position by a spring **61** and with an externally disposed operating head **62** and indicating stop finger **63** (see Fig. 5). The valve plug **60** is movable between stops **62***a* and **62***b* from a position in which the diaphragm assembly is effective, indicated on Fig. 5 as "Positioner," to a position for bypassing the diaphragm assembly, indicated on Fig. 5 as "Bypass."

The valve plug **60** is provided with a passageway **64** for communication, at the "Positioner" setting, with the supply connection **55** and with passageways **65** extending through the housing sections **18**, **19**, **20** and **21** to a valve chamber **66** in which the valve ball **39** is located. The passageway **25***a* extends to and communicates with the passageway **65** for supplying fluid between the diaphragms of the compound diaphragm **25**.

A branch connection **67** in the upper housing **21** and in communication with the passageways **65** provides for the mounting in the housing **21** of an indicating pressure gage **68** for indicating the magnitude of the supply pressure.

The valve plug **60** is also provided with a passageway **70** for communication, at the "Positioner" setting, with the control or instrument pressure connection **57** and with passageways **71** which extend through the housing sections **18** and **19** to the chamber **30** wherein this control pressure is effective.

A branch connection **72** provides for the mounting in the housing **21** of an indicating pressure gage **73** for indicating the magnitude of the control pressure.

The valve plug **60** is also provided with a passageway **74** for establishing communication, at the "Positioner" setting, between the chamber **32** and the space above the motor diaphragm **12** through passageways **75** which extend through the housing sections **19**, **20** and **21** and passageways **76** which extend through the housing section **18**. The passageway **75** is preferably restricted and for this purpose a restricted section **75***a* may be employed. A branch **75***b* connects to the chamber **29**. A branch connection **77** in the housing **21** in communication with the passageways **76** provides for the mounting of an indicating pressure gage **78** for indicating the magnitude of the fluid pressure applied against the motor diaphragm **12**.

The valve plug **60** is also provided with a passageway **79** connected to the passageway **70** for establishing communication at the "Bypass" setting between the fluid connection **57** and the passageways **76**, the passageway **74** in this position connecting the passageways **65** and **71**.

The space at the inner end of the valve plug **60** is vented to the atmosphere through a vent passageway **81**.

The mode of operation will now be pointed out.

The conditions with the bypass valve plug **60** in the "Positioner" setting will be taken up first.

Fluid under pressure, such as air from a regulated source and at a predetermined pressure is supplied to the fluid supply connection **56** and is effective through the passageway **64** in the plug **60**, the passageways **65** and in the chamber **66**. The pressure of the fluid supplied is indicated on the gage **68**.

Fluid is admitted to the chamber **32** in accordance with the positioning of the valve ball **39** with respect to the seat **45**. The fluid in the chamber **32** is effective on the upper side of the diaphragm **27** and is further exhausted to the atmosphere through the action of the seating portion **47** on the stem **38** with respect to the seating member **48**. The discharge to the atmosphere takes place through the passageways **50**, the chamber **31** and the vent port **33**.

The pressure effective in the chamber **32** is also effective on the under side of compound diaphragm **25** in the chamber **29** through re-

stricted passageway 75*a*, passageways 75 and branch passageway 75*b*, and is also effective in the space above the motor diaphragm 12, from the passageways 75 through the passageway 74 in the valve plug 60 and passageways 76.

The pressure applied in the space above the motor diaphragm 12 is also available at the indicating gage 78.

The instrument or control pressure is effective through the connections 58 and 57, and passageway 71 to the chamber 30 and is available at the indicating gage 73. Since the diaphragm 26 has a larger effective area than the diaphragm 25 the net effective of pressure applied in the chamber 30 is in an upward direction. Upon an increase in the control pressure the diaphragm assembly because of the upward force exerted thereon will be moved upwardly, thereby moving the seating member 48 closer to the seating portion 47 and reducing the discharge and moving the valve ball 39 further from its seat 45 thus increasing the pressure effective in the chamber 32 and therefrom in the space above the motor diaphragm 12.

The increase in pressure on the motor diaphragm 12 moves the same downwardly and decreases the force exerted in the spring 22 so that the upward force exerted by the spring 22 on the diaphragm assembly is also reduced. The action will be terminated when the decrease in force from the spring 22 equals the increase in force caused by the change in the control or instrument pressure.

The action upon a decrease in the instrument or control pressure will be the reverse of that just described with the fluid being exhausted past the valve member 47.

The condition with the bypass valve plug 60 in the "Bypass" setting will now be described.

The instrument or control pressure is effective through the connections 58 and 57 and through the passageways 79 and 74 and down through passageways 76 to the space above the motor diaphragm 12. The air supply will be cut off by the positioning of the passageway 64, and by the positioning of the passageways 70 and 74 access of fluid to the passageways 71 and 65 will also be cut off. The passageways 65 and 71 are then connected together by the passageway 74 so that any air trapped in the chamber 30 will be bled off through the passageway 33. The three indicating gages 68, 73 and 78 will be disconnected from their sources of pressure and may be removed for checking and cleaning and in this position there will be no pressure supplied above the casing 13, so that the entire superstructure may be removed for cleaning and servicing.

The flat portion 49 of the tapered end 47 prevents complete closing of the exhaust port at this location at any time. When the positioner is in equilibrium the valve seating portion 49 will be in engagement with the seat above the passageways 50 but a bleed will occur at the flat portion 49 and the valve ball 39 will be a short distance from its seat to make up the fluid discharged past the flat portion 49. The positioner will move to equilibrium rapidly without any detent or dead spot which might occur if the supply port and exhaust port were sealed.

It is preferred to provide a restricted passageway, such as the section 75*a*, between the chamber 32 and the chamber 29 below the diaphragm 25. The diaphragms 25 and 27 have the same effective areas so that when there is fluid flow in

a direction to increase the valve pressure there will be a differential in the pressure applied on the diaphragms 25 and 27 in a direction to force the diaphragm assembly downward. This force opposes that effective in the chamber 30 but diminishes to zero at equilibrium and provides a stabilizing action which keeps the motor diaphragm 12 from overshooting. Upon a decrease of fluid flow the converse will occur.

If the upper diaphragm 27 were larger than the diaphragm 25 then at equilibrium, after flow through the restricted passageway 75*a* has ceased and the pressures on these diaphragms had become equal, the forces on the diaphragm assembly would be unequal because of the difference in effective areas. The direction of the resultant force would oppose the direction of the force exerted by the instrument or control air in the chamber 30 and therefore a larger pressure change in the chamber 30 would be required to produce the same net change in position as compared with that required when the areas are equal.

It will be noted that a frictionless coupling is provided between the diaphragm assembly and the motor diaphragm 12, the range spring 22 engaging respectively with the diaphragm 12 and the connector 24 which is in engagament with the diaphragm 25. The pressure in the space above the motor diaphragm 12, with which the chamber 29 is in communication, is effective upwardly on the diaphragm assembly but at equilibrium is cancelled out by the pressure effective on the same area and in the opposite direction in the chamber 32 against the diaphragm 27.

The coaxial arrangement of pilot valve, diaphragm assembly and range spring permits of a compact arrangement for mounting axially with the motor diaphragm although other and non-coaxial mountings could be employed.

I claim:

1. In a positioner for a movable member in an expansible chamber, a plurality of spaced pressure responsive members separated to provide a plurality of chambers and connected together for simultaneous movement, a resilient connector between said spaced members and said movable member, a connection to a source of pressure fluid, a pilot valve coaxially mounted with respect to said spaced members, said pilot valve having an upper seat in communication with said connection and a lower exhaust seat, a plunger member movable with respect to said seats and positioned by said pressure responsive members, means for continuously delivering fluid from one side of one of said seats to the other side thereof when said plunger member is in closing relation to said seat, a fluid connection for applying the pressure fluid from said pilot valve against said movable member, and a connection from a source of variable control pressure to one of the chambers for applying a pressure therein for positioning said plunger.

2. In a positioner for a movable member in an expansible chamber, a connection to a variable control pressure fluid, a connection to a regulated supply of pressure fluid, means including a pilot valve for delivering actuating pressure fluid to said movable member, indicating means for indicating the pressure of at least one of said fluids, and a bypass valve having members including passageways for establishing communication between said expansible chamber and said pilot valve in one position, said members cutting off the pressure fluids to said

indicating means in another position and said bypass valve having passageways for delivery of the control pressure fluid to said movable member in said other position.

3. In a positioner for movable member in an expansible chamber, a connection to a variable control pressure fluid, a connection to a regulated supply of pressure fluid, means including a pilot valve for delivering actuating pressure fluid to said movable member, indicating means for indicating the pressure of said control pressure fluid, said supply pressure fluid and said actuating pressure fluid, and a bypass valve having members including passageways for establishing communication between said expansible chamber and said pilot valve in one position, said members cutting off the pressure fluids to a plurality of said indicating means in another position and said bypass valve having passageways for delivery of the control pressure fluid to said movable member in said other position.

4. In a positioner for a movable member in an expansible chamber, a plurality of spaced pressure responsive members separated to provide a plurality of pressure fluid chambers and connected together for simultaneous movement, said chambers including balancing and compensating chambers effective in opposed directions to each other, and a control pressure chamber, a resilient connector between said spaced members and said movable member, a connection to a source of pressure fluid, a pilot valve coaxially mounted with respect to said spaced members and controlled by the positioning of said spaced members, a fluid connection for applying the pressure fluid from said pilot valve in said balancing chamber, a connection from a source of variable control pressure to the control pressure chamber for applying a pressure therein for actuating said valve, and fluid connections from

the expansible chamber to the balancing chamber and to the compensating chamber, the connection to the compensating chamber including a predetermined restricted passageway.

5. In a positioner for a movable member in an expansible chamber, a plurality of spaced pressure responsive members separated to provide a plurality of pressure fluid chambers and connected together for simultaneous movement, a resilient connector between said spaced members and said movable member, a connection to a source of pressure fluid, a pilot valve coaxially mounted with respect to said spaced members, said pilot valve having an upper seat in communication with said connection and a lower exhaust seat, a plunger member movable with respect to said seats and positioned by said pressure responsive members, means for continuously delivering fluid from one side of one of said seats to the other side thereof when said plunger is in closing relation to said seat, fluid connections for applying the pressure fluid from said pilot valve against opposing face portions of said movable member and in said expansible chamber, one of said last mentioned connections including a restricted passageway, and a connection from a source of variable control pressure to one of the chambers for applying a pressure therein for positioning said plunger.

COLEMAN B. MOORE.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,264,262	Erbguth	Nov. 25, 1941
2,285,540	Stein et al.	June 9, 1942
2,382,941	Moore	Aug. 14, 1945
2,411,748	Kelley	Nov. 26, 1946
2,432,705	Williams	Dec. 16, 1947
2,543,120	McLeod, Jr. et al.	Feb. 27, 1951