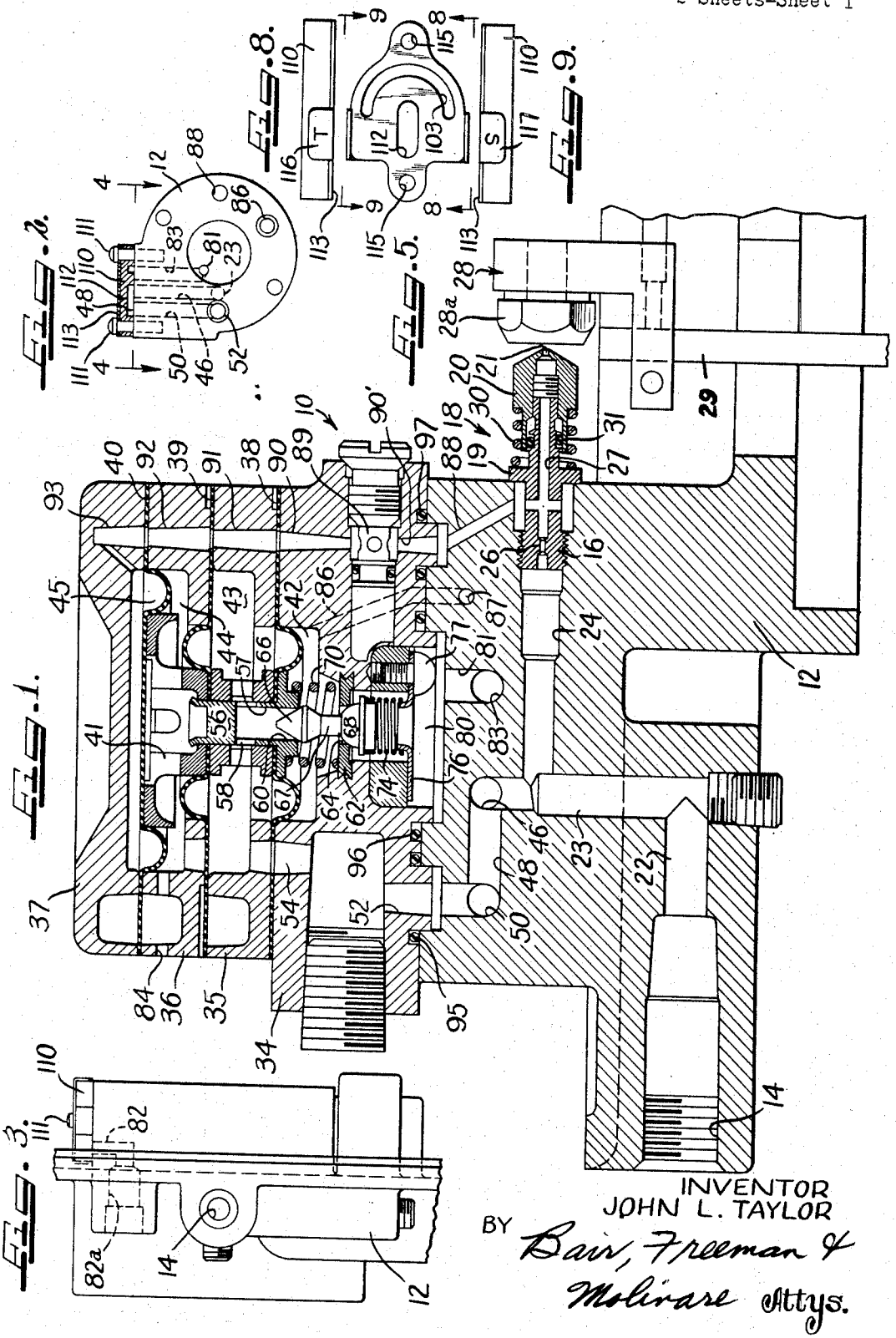
Dec. 3, 1968 J. L. TAYLOR 3,413,997

PNEUMATIC RELAY

Filed Dec. 20, 1965 2 Sheets-Sheet 1



INVENTOR
JOHN L. TAYLOR
BY Bair, Freeman & Molinare Attys.

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Filed Dec. 20, 1965 2 Sheets-Sheet 2

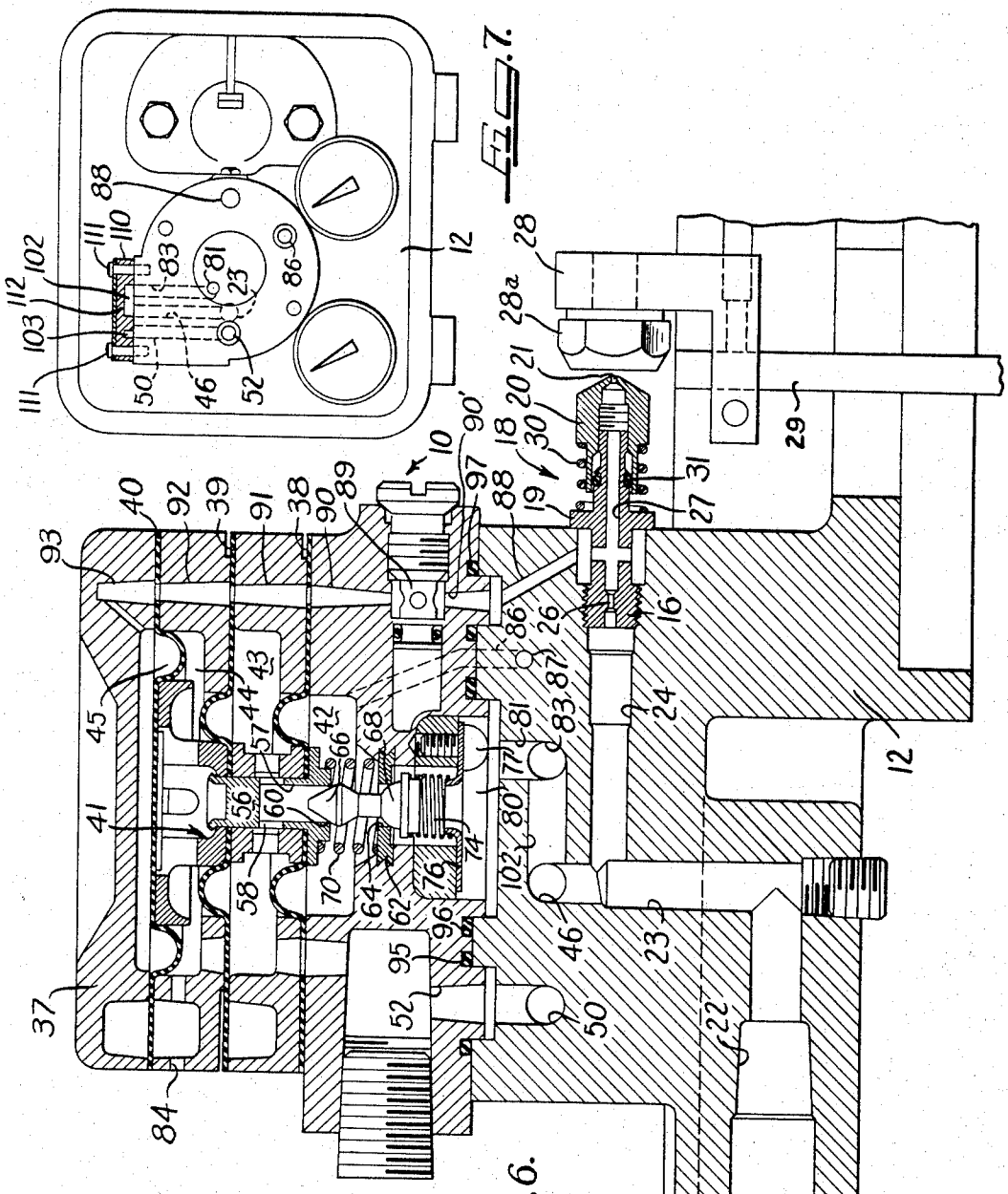

FIG. 7.

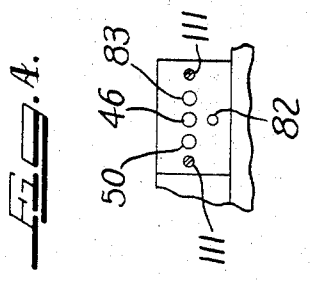

FIG. 4.

FIG. 6.

INVENTOR
JOHN L. TAYLOR

BY Bair, Freeman & Molinare Attys.

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3,413,997

# PNEUMATIC RELAY

John L. Taylor, Marshalltown, Iowa, assignor to Fisher Governor Company, a corporation of Iowa

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## ABSTRACT OF THE DISCLOSURE

A pneumatic relay convertible between snap-active service and throttling service by means of an adjustable switching block on the relay housing.

This invention relates to pneumatic relays and, more particularly, to an improved pneumatic relay capable of either snap-acting service or throttling service without modifying the internal components of the relay.

In some applications for pneumatic relays, the installer might not know whether to use a snap-acting device or a throttling device until he is on the job site. Thus, it might be necessary to carry both types. Further, in certain applications, for example oil well control, a different type relay may be required, dependent upon the fluid flow. At start up of the well, slime may flow and a snap-acting valve would be necessary. Later, when clear fluid flows, a throttling valve could be used. Heretofore, it was necessary to substitute a throttling relay for a snap-acting relay to accommodate varying flow conditions.

One object of the present invention is to provide an improved pneumatic relay that may be readily adapted for either snap-acting service or throttling service by controlling the supply of air to and from the relay and without internal structural change in the relay.

A second object of this invention is to provide an improved pneumatic relay that can be readily converted from snap-acting service to throttling service without additional parts and by means of a simple external adjustment.

Another object of the present invention is to provide an improved snap-acting pneumatic relay provided with a pair of diaphragms constructed and arranged to be acted upon by equal and opposite forces to neutralize the effect of supply pressure on the pair of diaphragms and a control diaphragm of larger effective area than either one of said pair of diaphragms, the diaphragms being interconnected by spacer means for movement together. Other objects and advantages of this invention will become more apparent hereafter.

The present invention will be more fully understood when the following specification is read in conjunction with the accompanying drawing, wherein:

FIG. 1 is an elevation in section of a pneumatic relay embodying the principles of the present invention, with such relay being adapted for snap-acting service;

FIG. 2 is a detail view of the relay case with part of the pneumatic relay being omitted to show the switching block for controlling the flow passages to adapt the relay for either throttling or snap-acting service, the switching block being shown in position for snap-acting service;

FIG. 3 is a side view of a part of the pneumatic relay rotated 90 degrees with respect to FIG. 1 and illustrating the location of the inlet opening and the exhaust passage from the case;

FIG. 4 is a view of the pneumatic relay block taken generally along line 4—4 of FIG. 2;

FIG. 5 is an enlarged rear view of the switching block illustrating the recesses therein;

FIG. 6 is an elevation in section of a pneumatic relay



embodying the principles of the present invention, with the relay being adapted for throttling service;

FIG. 7 is a plan view of the relay case with parts omitted, illustrating the position of the switching block for throttling service;

FIG. 8 is a side view of the switching block taken along line 8—8 of FIG. 5; and

FIG. 9 is a side view of the switching block taken along line 9—9 of FIG. 5.

Referring now to FIG. 1, there is illustrated the relay means of the present invention as adapted for snap-acting service, such relay means comprising a relay **10** carried in a conventional manner on the relay case **12**. Provided in the case or block **12** is an inlet port **14** adapted to be connected to a source of supply pressure.

Sealingly engaged with the opening or bore **16** in the case **12** is a nozzle assembly **18** comprising a tubular member **19** having a threaded end engaged with the opening **16** in the case **12** and a nozzle portion **20** threadedly engaged with the member **19** and having an opening **21** adjacent the outer end thereof. Supply air entering the inlet port **14** will flow through the passages **22, 23** and **24** to the nozzle assembly **18**. Such air will pass through the fixed restriction **26** in the member **19** and through the passage **27** in the nozzle assembly and exit from the nozzle assembly through the nozzle opening **21**.

Movably disposed adjacent to the nozzle assembly **18** is a shoe member **28**, which is movable toward and away from the nozzle opening **21** to control the bleed of air therethrough in response to a predetermined condition. For example, the shoe member **28** may be carried on a rod **29** suitably pivoted in response to the position of a float member in a liquid level control. The shoe may include an adjustable stop **28***a* adapted to cooperate with nozzle opening **21** for controlling the flow of air therethrough.

The nozzle member **20** is threadedly engaged with the member **19** to provide for adjustment of the nozzle opening **21** with respect to the shoe **28** in order to adjust the output range of the relay. The spring **30** functions to maintain the members **19** and **20** in desired adjusted relationship with respect to one another. Resilient O-ring seal means **31** are provided between the members **19** and **20** to prevent undesired loss of fluid pressure from the passage **27** to the atmosphere between the members **19** and **20**.

The relay housing is comprised of a base **34**, intermediate plates **35** and **36**, and end plate **37** secured together in a well known manner. The edge of flexible diaphragm **38** is sealed between the base portion **34** and the intermediate plate **35**. The diaphragm **39** is sealed between the intermediate plates **35** and **36**. Diaphragm **40** is sealed between the plate **36** and the end cap **37**. Spacer means **41** interconnect the diaphragms **38, 39** and **40** for simultaneous movement.

The diaphragms **38, 39** and **40** divide the interior of the relay housing into separate compartments **42, 43, 44** and **45**. The compartment **43** communicates with the inlet port **14** in the base or case **12** via passages **22, 23, 46, 48, 50, 52** and **54** and opening **38′** in diaphragm **38**. The spacer means **41** includes a central tubular member **56** having a passage **57** therethrough that communicates with the pressure in compartment **43** via openings **58** extending through the tubular portion **56**. The end of the tubular portion **56** defines an inlet port **60**.

Disposed within the base member **34** of the relay housing and forming one end of the chamber **42** is a partition plate **62** having an exhaust port **64** therein.

Reciprocably disposed within the chamber **42** is a valve assembly comprising an inlet valve **66** adapted to close the inlet port **60** and an exhaust valve **68** adapted to close

the exhaust port **64**. The valves are interconnected by valve stem **67** for simultaneous operation. The spring **70** provided concentrically about the valve means acts at one end upon the partition **62** and at the other end upon the spacer means **41** to move the spacer means away from the inlet valve **66** to open the inlet port **60**. Spring **74** acts between the support plate **76** affixed within the base portion by screw means **77** and the flange end portion of the exhaust valve **68** to bias the exhaust valve toward closed position.

Provided within the base portion **34** below the exhaust valve **68** is a chamber **80** which is adapted to be connected to the atmosphere via passages **81** and **83**, as will be more fully explained hereafter. The compartment **44** defined between the diaphragms **39** and **40** is vented to the atmosphere via a vent opening **84** in the plate member **36**.

Extending from the chamber **42** is an internal passage in the base portion **34**, which passage **86** is adapted to be connected via port **87** with a suitable pneumatic control element, as for example, a control valve.

Air is supplied to the chamber **45** defined between the diaphragm **40** and the end plate **37** from the inlet port **14** via passages **22**, **23**, **24**, restriction **26**, passage **88**, plug member **89**, passages **90'** and **90** in the base portion **34**, and passages **91**, **92** and **93** defined in the intermediate plates **35** and **36** and the end plate **37**, respectively. Plug member **89** carries an O-ring to seal passages **90**, **90'** from chamber **80**.

Resilient O-ring seal means are provided to seal the passages communicating between the base portion **34** and the case **12**. O-ring **95** is disposed about the passage **52**, O-ring **96** is disposed about the chamber **80** and O-ring **97** is disposed about the passage **90'**.

Referring to FIGS. 2, 3, 4 and 5, there is seen the orientation of the passages in case **12** to permit exhaust of fluid pressure from the case and also the means for converting the pneumatic relay between snap-acting service and throttling service. In FIG. 2, the relay has been omitted to show the case **12** more clearly. There is provided in the case **12** passages **52**, **23**, **81**, **88** and **86**. Extending from the passages **52**, **23** and **81** in the case **12** are transverse passages **50**, **46** and **83**. The transverse passages **50**, **46** and **83** open to a side of the case **12** (see FIG. 4). Cooperating with the side of the case **12** is a switching block **110** that is adapted to selectively connect either passages **46** and **50** or **46** and **83** to adapt the pneumatic relay for snap-acting service and throttling service, respectively. In FIG. 2, the switching block is positioned to adapt the relay for snap-acting use.

As seen in FIGS. 3 and 4, there is provided in case **12** exhaust passage means comprising an exhaust passage **82** opening to the side of case **12** adjacent the outlets from passages **50**, **46** and **83** and a transverse exhaust passage **82***a* communicating at one end with passage **82** and at the other end with the atmosphere.

Considering FIG. 2, the switching block **110** is affixed to the case **12** by suitable fastening means, as for example, machine screws **111**, in such manner that the elongated recess **112** therein is adapted to communicate the passage **50** with the passage **46** so as to define connecting passage **48**. The semicircular exhaust recess **103** (FIG. 5) in the switching block **110** is adapted to communicate the passage **83** with the exhaust passage means so as to vent the passage **83** to atmosphere.

FIG. 5 is a rear view of switching block **110** showing the elongated recess **112** therein for communicating passage **46** with either passage **50** or passage **83** and illustrating the semi-circular exhaust recess **103** for selectively communicating either passage **83** or **50** to exhaust passage means **82**, **82***a*. Machine screws **111** pass through the openings **115** for securing the switching block to case **12**.

Considering now the operation of the relay in snap-acting service, supply pressure is supplied to the inlet port **14** and passes through the passages **22**, **23**, **46**, **48**, **50**, **52** and **54** to the chamber **43**. With supply pressure in chamber **43**, the forces across the diaphragms **38** and **39** are equal and opposite.

When the shoe **28** is away from the nozzle opening **21**, the relay spring **74** biases the exhaust valve **68** to the closed position and the relay spring **70** biases the spacer means **41** away from the conically shaped inlet valve **66** to open inlet port **60**. Thus, supply pressure will pass from the chamber **43** to the chamber **42** through ports **58** and **60** and through the passage **86** and port **87** to the control valve. With pressure in chamber **42**, the force from the diaphragm **38** is reduced, thus insuring that the supply port **60** will remain open to allow full supply pressure to build up in chamber **42**.

As the shoe **28** moves toward the nozzle assembly **18**, the nozzle opening **21** is restricted. Restriction of the nozzle opening will cause pressure build up between the nozzle opening **21** and the fixed restriction **26**. The closer the shoe **28** moves to the nozzle opening **21**, the higher the nozzle pressure will build up. The increased pressure will pass through the passageways **88**, **90**, **91**, **92** and **93** to the chamber **45**. When the force across the diaphragm **40** is greater than the force across the diaphragm **39** and the force from the relay spring **70**, the diaphragm assembly moves downward as viewed in FIG. 1, closing the inlet port **60**.

There will be no pressure change in the chamber **42** until the exhaust port **64** starts to open and then pressure in the chamber **42** will bleed through the exhaust port to the exhaust chamber **80**. The pressure bleeding through the exhaust port **64** will cause a force across the diaphragm **38** which increases the opening of the exhaust port **64**. Since this action is independent of any change in nozzle pressure and is self-perpetuating, it will continue until the exhaust port is wide open and the pressure in chamber **42** is atmospheric.

When the exhaust port **64** is open, the output pressure acting on the diaphragm of the control valve passes through the passage **86** to the chamber **42** through the exhaust port **64** to the chamber **80** and through the passages **81** and **83**, recess **103** and exhaust passages **82** and **82***a* to the atmosphere.

When the shoe **28** moves away from the nozzle opening **21**, the nozzle pressure in chamber **45** bleeds out through the passages **93**, **92**, **91**, **90** and **88** and the nozzle opening **21** faster than supply pressure can enter through the fixed orifice **26**. This will reduce the force across the diaphragm **40** until it is less than the force from the spring **70**. It is noted that the force across the diaphragm **39** is equal and opposite to the force across the diaphragm **38**. Thus, when the effective force acting upon the spacer means **41** urging it downwardly as viewed in FIG. 1 is less than the force from the relay spring **70**, the diaphragm assembly will move upwardly as viewed in FIG. 1 and permit closure of the exhaust port **64**. There will be no pressure in the chamber **42** until the inlet port **60** starts to open and bleeds pressure into chamber **42**. The pressure bleeding into chamber **42** reduces the force across the diaphragm **38** which increases the opening of the inlet port **60**. This action is independent of any change in nozzle pressure and is self-perpetuating. The action will continue until inlet port **60** is wide open and full supply pressure is in chamber **42**.

Referring now to FIGS. 6 and 7, there is illustrated the relay mechanism of the present invention adapted for throttling service. As aforenoted, one feature of the present invention is that the pneumatic relay may be adapted for either throttling service or snap-acting service without change of any of the internal components—only a simple external reorientation of a switching block **110**. Accordingly, the same elements in FIGS. 6 and 7 are identified by the same numeral as used in FIGS. 1 and 2. It is seen that the only difference between the relays in FIGS. 1 and 2 and FIGS. 6 and 7, respectively, is the arrangement of the passages in the case **12**.

With the pneumatic relay adapted for throttling serv-

ice, as shown in FIGS. 6 and 7, supply pressure enters through the supply port **14** and passes through internal passages **22** and **23** in case **12** and through passages **46** and **102** to the chamber **80**. The valve member **68** functions as an inlet valve to restrict the passage of fluid from the compartment **80** to the compartment **42** through the port **64** in the partition **62**. Fluid will also pass through the passage **24**, restriction **26**, and passage **27** to the nozzle opening **21**. When the shoe **28** moves toward the nozzle assembly **18**, the nozzle opening **21** is restricted. This allows nozzle pressure to build up within the nozzle assembly between the nozzle opening **21** and the fixed restriction or orifice **26**. The closer that the shoe **28** moves to nozzle opening **21**, the higher the nozzle pressure will build up. The nozzle pressure will pass through the passage **88** in block **12**, passage **90** in base **34**, and passages **91**, **92** and **93** to the chamber **45**. When the force across the diaphragm **40** is greater than the force across the valve **68** plus the force from the relay springs **70** and **74**, the diaphragm assembly will move downwardly as viewed in FIG. 6 to close the exhaust port **60** defined at the end of the tubular central portion **56** of the spacer means **41**.

At this point, the valve **68** is in a neutral position, that is, both the supply port **64** and the exhaust port **60** are closed.

As the diaphragm assembly continues to move downwardly, the supply port **64** is opened and supply pressure can enter the chamber **42** and pass through passage **86** and port **87** to the diaphragm of a control valve (not shown). With supply port **64** open, pressure builds up in chamber **42**. When the force across the diaphragm **38**, along with the combined force from the relay springs **70** and **74**, is greater than the force across diaphragm **40**, the diaphragm assembly moves upwardly, as viewed in FIG. 6, until valve member **68** abuts partition plate **62** to close the supply port **64**. Once again, the valve **68** is in a neutral position. For each nozzle pressure in chamber **45**, as determined by a given position of the shoe **28**, there is one and only one pressure in chamber **45** that will cause the valve **68** to stay in a neutral position. When either port **60** or port **64** is open, the forces across the diaphragms **40** and **38** are not in balance.

The chamber **44** is vented to the atmosphere through the vent passage **84**. The chamber **43** may be vented to the atmosphere through passages **54**, **52**, **50**, the recess **103** in switching block **110** and exhaust passage means **82**, **82***a* in case **12**. The atmospheric venting of the chambers **43** and **44** balances the fluid forces acting directly on diaphragm **39**.

When the shoe **28** moves away from the nozzle opening **21**, the nozzle pressure in the chamber **45** bleeds out through the passages defined by passages **93**, **92**, **91**, **90** and **88** and the nozzle opening **21** faster than supply pressure can enter through the fixed orifice **26**. This will reduce the force across the diaphragm **40** until it is less than the force across the diaphragm **38** plus the forces from the relay springs **70** and **74**. Thus, the diaphragm assembly will move upwardly, as viewed in FIG. 6. Upward movement of the diaphragm assembly will close the supply port **64** and open the exhaust port **60**. The output pressure acting on the diaphragm of the control valve will then pass through port **87** and passage **86** to chamber **42**. The output pressure will pass from the chamber **42** to the atmosphere through the exhaust port **60**, passage **58**, chamber **43**, passages **54**, **52**, **50**, recess **103** in switching block **110** and exhaust passage means **82**, **82***a*.

Referring now to FIG. 7, it is seen that the recess **112** in the switching block cooperates with the passages **46** and **83** to define the passage **102**. The transverse passage **50** communicates with the exhaust recess **103** provided in the switching block to vent the passage **50** to atmosphere through exhaust passage means **82**, **82***a*.

Means are provided on the switching block to indicate to the user whether the relay is adapted for throttling service or for snap-acting service. As seen in FIGS. 2, 5, 8 and 9, such means comprise indicia plate **113** having indicia tabs **116** and **117** that are offset perpendicularly from the plane of the plate **113**. The plate conforms generally to the configuration of the block **110**. Tab **116** has the indicia T, or similar indicia, thereon and tab **117** has the indicia S, or similiar indicia, thereon. When the block **110** is positioned for snap-acting service, with the plate **113** in position on block **110**, tab **117** and the indicia S will be visible. When the block **110** is positioned for throttling service, tab **116** and the indicia T will be visible.

There has been provided by this invention a novel switching arrangement to permit conversion of a pneumatic relay between throttling service and snap-acting service without change of internal parts and without removing the relay from the line. By the improved construction of the present invention, the inventory of components and devices may be materially reduced, for a single relay can be readily adapted for either snap-acting service of throttling service. The pneumatic relay of the present invention will function in a reliable manner whether used as a snap-acting device or as a throttling device.

While there has been shown and described a particular embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and, therefore, it is intended in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new, and desire to secure by Letters Patent of the United States, is:

**1.** A pneumatic relay capable of conversion for both snap-acting service and for throttling service comprising housing means, said housing means having an inlet adapted to communicate with a source of fluid operating pressure, a diaphragm assembly including three diaphragms defining first, second, third and fourth spaced chambers within said housing means, said diaphragms being operatively connected by spacer means for conjoint operation, a bleed nozzle assembly on said housing means, supply passage means in said housing for supplying said operating pressure from said inlet to said bleed nozzle assembly, a passageway communicating said first chamber with said bleed nozzle assembly, said bleed nozzle assembly controlling pressure in said first chamber, a passageway in the spacer means communicating said third and fourth chambers, first, second and third passages opening to the exterior of the housing means adjacent one another and said first and third passages being adapted to communicate with said second passage, said second passage communicating with supply passage means, exhaust passage means in said housing means having an opening at the exterior of the housing means adjacent said openings from the said first, second and third passages and communicating to the atmosphere, the fourth chamber being provided with an inlet port and exhaust port, the inlet port communicating with said third chamber, cooperating valve means responsive to movement of said diaphragm assembly for controlling flow through said inlet port and said exhaust port, said first passage communicating with said third chamber, said second passage communicating with said supply passage means and said third passage communicating with said fourth chamber, an outlet passage in the housing means for communicating the fourth chamber at a location remote from the inlet and exhaust port between the inlet and exhaust ports with a device to be operated, and switching means mounted externally on said housing means having a first position for selectively communicating the first and second of said three passages to one another for the snap-acting mode of relay operation, with the third passage being communicated to said exhaust passage means, and having a second position for selectively communicating the second

and third passages to one another for the throttling mode of relay operation, with the first passage being communicated to said exhaust passage means, said switching means movable between first and second positions without interfering with the components within the housing means, said switching means comprising a switching block affixed externally to the housing means, said switching block having a first recess therein for selectively communicating only the first and second, or the second and third passages and a second recess for communicating the third or first passage respectively to the exhaust passage means, and means for detachably joining the switching block to the housing means, the first and second recesses being in the same side of the switching block.

2. A pneumatic relay as in claim 1 wherein said first, second, and third passage openings are aligned with one another and said exhaust passage opening adjacent said first, second, and third openings is offset from a line extending through the axes of said first, second and third



openings, said second recess in said switching block being semicircular, whereby the relay may be changed between snap-acting service and throttling service by moving the switching block from said first position to said second position.

3. A pneumatic relay as in claim 1 wherein indicia tabs extend from the switching block, the tabs bearing different indicia to clearly indicate to the user whether the relay is adapted for snap-acting service or throttling service.

**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,335,923 | 12/1943 | Dube | 137—270 |
| 2,737,973 | 3/1956 | Kimmell | 137—85 X |
| 2,927,593 | 3/1960 | Hall | 137—85 |
| 2,966,168 | 12/1960 | Hunt | 137—270 |


ALAN COHAN, *Primary Examiner.*