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RECIPROCATING VALVE AND PISTON

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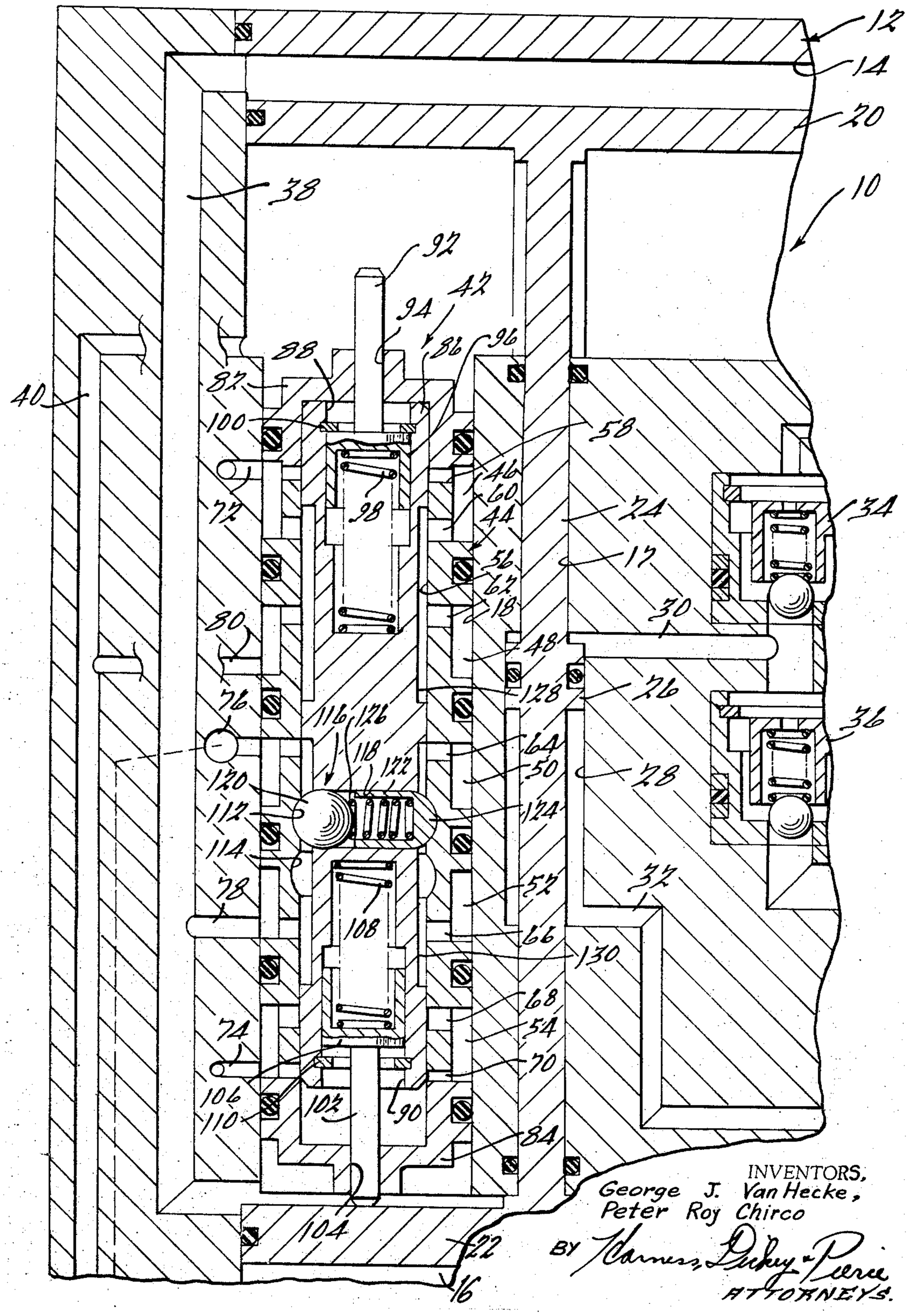

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RECIPROCATING VALVE AND PISTON

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ABSTRACT OF THE DISCLOSURE

A two position reciprocatable valve for causing automatic reciprocation of a piston.

The present invention relates to a valve construction, and more particularly to a two-position reciprocable valve.

The present invention deals with an air directional valve which, in the specific form shown and described, can be used in the multiple stroke rivet installation tool, shown and described in the copending application of George J. Van Hecke et al., Ser. No. 408,828, filed Nov. 4, 1964. In that particular application the air directional valve is utilized to reciprocate rapidly between two positions to alternate the flow of air to opposite sides of a pair of tandem pistons. In such an application it is important that the air directional valve not stall between positions whereby the reciprocation of the tandem pistons is stopped; it is also important that the amount of wear, etc., on the air directional valve be minimized to insure a long life. Therefore, it is an object of the present invention to provide a novel valve.

It is another object of the present invention to provide a novel two-position reciprocable valve.

It is another object of the present invention to provide a novel air directional valve specifically for use in apparatus such as shown and described in the above-noted copending patent application.

It is still another object of the present invention to provide a novel valve adapted for rapid reciprocation between two positions.

Other objects, features, and advantages of the present invention will become apparent from the subsequent description and the appended claims, taken in conjunction with the accompanying drawing, in which:

The drawing is a fragmentary view of a combination schematic and sectional representation of a portion of a power supply including a preferred form of the valve of the present invention.

Looking now to the drawing, a portion of a power supply is generally indicated by the numeral **10** and is of the type shown in the above noted copending patent application. Since the specific details of the power supply **10** do not constitute a part of the present invention, and since all these details are not required for the understanding of the valve of the present invention, only those portions of the power supply **10** necessary to an understanding of the operation of the valve of the present invention have been shown for the purposes of simplicity. The power supply **10** includes a housing member **12** which includes a pair of cylinders **14** and **16**. Cylinders **14** and **16** are axially spaced and coaxially located and a through bore **17** extends between the cylinders **14** and **16** and along the axis thereof, and a second through bore **18** extends between the cylinders **14** and **16** and is axially offset from the central axis thereof. A pair of pistons **20** and **22** are located within the cylinders **14** and **16**, respectively, and are connected together by a common shaft assembly **24** which has an intensifier piston **26** located generally midway therealong. Intensifier piston **24**

is located in an enlarged portion **28** of the bore **17** to provide an output of intensified fluid pressure. A first passageway **30** connects the upper portion of the enlarged cylinder portion **28** and a second passageway **32** connects the lower end of the enlarged cylinder portion **28**. A pair of ball check valves **34** and **36** are connected to the passage **30** in a manner such that on the downward stroke of the intensifier piston **26**, fluid is drawn into the upper portion of the enlarged cylinder portion **28** through the check valve **36** to replenish that portion while intensified fluid is transmitted out through the passageway **32**. On the upward stroke of the intensifier piston **26**, the check valve **36** is closed and intensified fluid pressure is transmitted through the passageway **30** through the check valve **34**, a pair of check valves similar to the valves **34** and **36** can be provided to be operative with the passageway **32** whereby fluid pressure can be transmitted from the passageway **32** on a down stroke of the intensifier piston **26** and fluid can be transmitted to replenish the cylinder portion **28** upon an upward stroke of the intensifier piston **26**. The remaining details of such a power supply **10** are included in the copending patent application previously noted.

As contemplated in the copending patent application previously noted, hydraulic pressure is obtained out from the passageways **30** and **32** through reciprocation of the intensifier piston **26** in response to reciprocation of the tandem pistons **20** and **22** which are actuated by pneumatic pressure. The upper or head end of the cylinder **14** is connected to a passage **38** while the upper or rod end of the cylinder **16** is connected to the same passage **38**. Thus air under pressure can be transmitted to the passageway **38** to both the head end of the piston **20** and the rod end of the piston **22**, thereby causing the tandem piston structure to be moved downwardly. A second passageway **40** communicates with the lower or rod end of the cylinder **14** and with the lower or head end (not shown) of the cylinder **16** such that upon application of air pressure to the passageway **40** pressure will be exerted both on the rod end of the piston **20** and the head end of the piston **22**, causing the tandem piston structure to be moved upwardly. Air pressure is alternated between the passages **38** and **40** such that when the one passageway is pressurized the other is open to exhaust or atmosphere to thereby permit the reciprocation of the tandem pistons **20** and **22**. The connection of the passageways **38** and **40** alternately to pressure and exhaust is effected by the air directional valve assembly **42**, which is located matably within the bore **18** and includes a series of annular grooves **46**, **48**, **50**, **52** and **54** located in its outer surface. The grooves **46** and **54** are located at opposite extremities of the fixed body **44**. The groove **46** is connected in communication with the through bore **56** by means of a pair of diametrically extending ports **58** and **60**. The groove **48** communicates with the bore **56** by means of a diametrically extending port **62**. The groove **50** is in communication with the bore **56** by means of a diametrically extending port **64**. The groove **52** is in communication with the bore **56** by means of a diametrically extending port **66** and the groove **54** is in communication with the bore **56** by means of a pair of diametrically extending ports **68** and **70**. The annular groove **56** is connected to atmosphere by means of a passageway **72** in the housing member **12**. While the annular groove **54** is in communication with amosphere by means of a passageway **74** in the housing member **12**, the annular groove **50** is in communication with pressurized air by means of a passageway **76** in the housing member **12**. The passageway **38**, previously described, is in communication with the annular groove **52** by means of a passageway **78** in the housing member **12**, while the passageway **40**, previously described, is in communica-

tion with the groove **48** by means of the passageway **80** in the housing member **14**.

The passageway **58** at the upper end of the body member **44** is defined in part by an enclosing cap member **82**, which is located at the upper end of the bore **18** while the passageway **70** at the bottom end of the body member **44** is defined in part by a cap member **84** at the bottom or lower end of the bore **18**. The caps **82** and **84** serve a purpose to be described.

Caps **82** and **84** in general enclose the cavity defined by the through bore **56** in which is located a movable valve body member **86**. The valve body member **86** is provided with a pair of cavities **88** and **90** which extend inwardly from opposite ends. An actuating pin member **92** extends through a bore **94** in the cap **82** and has at its inner end and within the cavity **88** a cup portion **96** which receives a coil spring member **98**, which is precompressed to normally maintain the pin **92** in its outermost position against a retaining ring **100**. Similarly, at the opposite end within the cavity **90** is located a pin **102** which extends outwardly through a bore **104** at the end of the cap **84**. The pin **104** has a cup portion **106** located within the cavity **90** in which is housed a spring member **108** which is under a precompression to maintain the pin **102** in its outermost position against a retaining ring **110**. The bore **56** has a pair of annular grooves **112** and **114** which have a radial cross section defining a portion of a circle. The movable body member **86** is provided with a ball detent assembly **116** which is located in a diametrically through bore **118**. The ball detent assembly includes a ball bearing **120** and a cup member **122** which has an end portion **124** which defines a portion of a sphere of a diameter similar to that of the ball bearing **120**. A spring member **126** is located within the cup member **122** and is under precompression to exert a force against both the ball bearing **120** and a cup member **122** to maintain them separated. The movable body member **86** is provided with a pair of axially spaced, elongated annular grooves **128** and **130** in its outer surface. The groove **128** is located at the upper half of the movable body member **86** and is provided of a length to be constantly in communication with the port **62** and hence passageway **80** and hence the connecting passageway **40**. The annular groove **128** is provided to be of a length such that with the movable body member **86** in its uppermost position as shown in the drawing, the groove **128** will communicate with the through port **60** and hence with the annular groove **46**, thence with the passageway **72** to connect thereby the passageway **40** to exhaust. Thus in the position as shown, the rod end of the piston **20** and the head end of the piston **22** will be connected to exhaust. The annular groove **128** is of a sufficient length and is located such that with the valve body **86** moved downwardly in its lowermost position, the groove **128** will no longer communicate with the port **60** and hence will no longer communicate with the atmosphere through the passageway **72**, but will be in a position in which it is then in communication with pressurized air via the passageway **76**, the annular groove **50** and the port **64** whereby pressurized air is communicated to the passageway **40** and to the rod end of the piston **20** and the head end of the piston **22** to cause the tandem piston assembly to move upwardly. The annular groove **130** is constantly in communication with the passageway **38** via the passageway **78**, the annular groove **52** and the port **66**. With the valve body **86** in its upper position, as shown in the drawing, the annular groove **130** is in communication with the pressurized air from passageway **76** through the annular groove **50** and port **64** thereby applying pressure to the head end of the piston **20** and to the rod end of the piston **22**; note that as per the prior discussion of the annular groove **128**, at the same time, the rod end of the piston **20** and the head end of the piston **22** are connected to exhaust. With the valve body **86** in its lowermost position, the annular groove **130** is no longer in communication with the source of air pressure through

the passageway **76** and is moved in communication with the annular groove **54** via the port **68** and thence to communicate with the atmosphere via the passageway **74** thereby connecting the head end of the piston **20** and the rod end of the piston **22** to exhaust; note that as per the prior discussion of the groove **128**, at the same time, the rod end of the piston **20** and the head end of the piston **22** are connected to the source of air pressure thereby resulting in movement of the tandem piston assembly in an upward position. The passageways **72** and **74** can be either connected separately to atmosphere or together through a common passage.

Note that by reciprocation of the body **86** between the two positions shown and described, the result will be pressurization first on one side of the tandem pistons **20** and **22** to cause movement in one direction and then automatically to the other side to cause movement in an opposite direction. The two positions are definitely located by means of the detent assembly **116**. Thus, with the movable body **86** in its uppermost position, the detent assembly **116** will be in groove **112** and will maintain the movable body **86** in that position. With the body member **86** in its lowermost position, the detent assembly **116** will then be engaged in the annular groove **114** to thereby maintain the movable body **86** in that position. Movement between the two positions represented by the annular grooves **112** and **114** is caused by the contact of the piston heads **20** and **22** with the pins **92** and **102**, respectively. With the apparatus in the condition as shown in the drawing, pressurized air is communicated to the head end of the piston **20** and to the rod end of the piston **22** thereby causing movement of the tandem piston assembly in the downward direction. As the movement of the tandem piston assembly approaches its lowermost position, the bottom side of the piston **20** will engage the pin **92** moving it downwardly against the force of the spring **98**; the body member **86**, however, will not yet move. As the motion of the piston **20** continues downwardly, the force exerted upon the spring **98** increases until the pin **92** bottoms out in the cavity **88**, at which time the locking force of the detent assembly **116** within the groove **112** is overcome, whereby the stored energy in the spring **98** causes the body **86** to move downwardly; the movement of the body member **86** will be terminated as the detent assembly **116** engages the second annular groove **114**. This, then, changes, i.e., reverses, the pressure conditions of the passageways **38** and **40** such that pressurized air is then applied to the rod end of the piston **20** and to the head end of the piston **22** causing the tandem piston assembly to move upwardly. This motion will be continued until the piston **22** engages the pin **102** and the spring **108** is compressed; when pin **102** bottoms out in cavity **90** the detent assembly **116** will be unseated from the groove **114** and the movable body **86** will then be moved upperwardly until the detent assembly **116** seats within the annular groove **112** and the cycle is ready to be repeated. Note that by using the springs **98** and **108**, a positive, snapping action in the motion of the movable body **86** is assured, since the stored energy of the springs **98** and **108** as each is compressed, will assure that the valve body **86** will move to the next position. By this means the valve assembly **42** in conjunction with the operation of the pistons **20** and **22** will automatically cause reciprocation of the tandem piston assembly. The specific means for actuating and deactuating the valve assembly **42** and the tandem piston assembly is shown and described in the above-noted copending patent application.

The ball bearing **120** and the spherical seat **124** of the spring retainer **122** provide a relatively large bearing surface area such that the wear thereupon is minimized whereby the life of the ball **120** and of the spherical seat portion **124** of the retainer **122** is enhanced. By providing the enlarged surfaces of contact between the ball **120**, the spherical seat **124** and the grooves **112** and **114**, the bearing loads required for effective locking action by the spring **126** can be readily provided with minimum wear. This is of importance since the movable body **86** will be

subjected to a substantial number of cycles and hence wear must be maintained at a minimum to provide adequate life.

A diametrical clearance is provided between the outer ends of the body member **86** and the inside diameters of the caps **82** and **84** such that in its uppermost position, the port **70** will be communicated with the volume at that end of the body member **86** enclosed by the cap **84**. Likewise, with the movable body **86** in its lowermost position, the volume at the end enclosed by the cap **82** will be communicated to the port **58**. This will prevent the air under the caps **82** and **84** from being trapped and pressurized; if air were permitted to be pressurized at these locations the forces required to cause shifting of the body member **86** can vary under different conditions and hence upset the reciprocating action of movable member **86** and hence of tandem pistons **20** and **22**.

While it will be apparent that the preferred embodiment of the invention disclosed is well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. A valve assembly adapted to be supported in a bore in a housing member for communicating a first pair of passages to a second pair of passages comprising: a fixed body member fixedly mounted in the bore and having a through bore, said fixed body member having a plurality of annular grooves each in communication with a different one of the first and second pair of passages in the housing member and a plurality of passageways each communicating a different one of said first plurality of annular grooves with said through bore, a movable body member reciprocably supported in said through bore for reciprocation between two positions, said movable body member having a pair of axially spaced communicating grooves in its outer surface, one of said communicating grooves connecting a first and second of said plurality of passageways together with said movable body member in one of said positions and said first and a third of said plurality of passageways together with said movable body member in the other of said positions, the other of said communicating grooves connecting said third and a fourth of said plurality of passageways together with said movable body member in said one of said positions and said second and fourth of said plurality of passageways together with said movable body member in said other of said positions, detent means for holding said movable body member in said one and said other of said positions, said detent means comprising a pair of axially spaced annular locking grooves located in said fixed body member and a detent assembly located in a radial bore through said movable body member and including a ball, a spring retainer and a spring in engagement with said spring retainer and engaging said ball for urging said ball and said spring retainer apart, said retainer terminating in a nose portion having a contour of a portion of a sphere, said nose portion and said ball being engageable in one of said locking grooves with said movable body member in said one of said positions and in the other of said locking grooves with said movable body member in said other of said positions, said movable body member having a retainer cavity at each of its opposite ends for receiving an actuating assembly, each said actuating assembly comprising a pin member having a pin portion extending outwardly from said retainer cavity with which it is associated, a spring member engaging said pin member for urging it outwardly, and a retainer for limiting the outward movement of said pin member, said spring member having a preselected compressive preload on said pin member and having a preselected spring rate relative to the spring rate of said spring of said detent means whereby movement of said movable body member from said one position to said other position and hence movement of said detent assembly from one of said retaining grooves to the other of said retaining grooves will occur only after said pin member has been moved into said retainer cavity a preselected distance with the energy of said spring member causing indexing of said detent assembly to said other of said retaining grooves after said detent assembly has moved from said one of said retaining grooves.

2. The valve assembly of claim **1** further including a pair of cap members enclosing the opposite ends of the bore in the housing member with each having an aperture for receiving said pin member of said actuating assembly at that end, and means for communicating the volumes enclosed by said caps to low pressure.

3. For controlling the reciprocation of a piston in a cylinder, a valve assembly adapted to be supported in a bore in a housing member for communicating a first pair of passages connected to the cylinder at opposite ends of the piston to a second pair of passages with one connected to a pressure source and the other to a low pressure outlet, said valve assembly comprising: a fixed body member fixedly mounted in the bore and having a through bore, said fixed body member having a first and second annular groove each in communication with one of the first pair of passages and a third and fourth annular groove each in communication with one of the second pair of passages in the housing member, said first, second, third and fourth passages each in communication with said through bore, a movable body member reciprocably supported in said through bore for reciprocation between two positions, said movable body member having a pair of axially spaced communicating grooves in its outer surface, one of said communicating grooves connecting said first and third of said annular grooves together with said movable body member in one of said positions and said first and said fourth of said annular grooves together with said movable body member in the other of said positions, the other of said communicating grooves connecting said second and said fourth of said annular grooves together with said movable body member in said one of said positions and said second and third of said annular grooves together with said movable body member in said other of said positions, detent means for holding said movable body member in said one and said other of said positions, said detent means comprising a pair of axially spaced annular locking grooves located in said fixed body member and a detent assembly located in a radial bore through said movable body member and including a ball, a spring retainer and a spring in engagement with said spring retainer and engaging said ball for urging said ball and said spring retainer apart, said retainer terminating in a nose portion having a contour of a portion of a sphere, said nose portion and said ball being engageable in one of said locking grooves with said movable body member in said one of said positions and in the other of said locking grooves with said movable body member in said other of said positions, said movable body member having a retainer cavity in one end for receiving an actuating assembly, said actuating assembly comprising a pin member having a pin portion extending outwardly from said retainer cavity with which it is associated and into the cylinder for engagement by the piston, a spring member engaging said pin member for urging it outwardly, and a retainer for limiting the outward movement of said pin member, said spring member having a preselected compressive preload on said pin member and having a preselected spring rate relative to the spring rate of said spring of said detent means whereby movement of said movable body member from said one position to said other position and hence movement of said detent assembly from one of said retaining grooves to the other of said retaining grooves will occur only after said pin member has been moved by the piston into said retainer cavity a preselected distance with the energy of said spring member causing indexing of said detent assembly to said other of said retaining grooves after said detent assembly has moved from said one of said retaining grooves.

4. For controlling the reciprocation of a piston in a

cylinder, a valve assembly for communicating a first pair of passages connected to the cylinder at opposite ends of the piston to a second pair of passages with one connected to a high pressure source and the other to a low pressure outlet, said valve assembly, comprising: a first body member having a bore and having a first passage means for communicating with one of the first pair of passages and said bore, second passage means for communicating with the other of the first pair of passages and said bore, a third passage means for communicating with one of the second pair of passages and said bore and a fourth passage means for communicating with the other of the second pair of passages and said bore, a movable body member reciprocably supported in said bore for reciprocation between two positions, said movable body member having a first and second communicating means, one of said communicating means connecting said first and third passage means together with said movable body member in one of said positions and said first and said fourth of said passage means together with said movable body member in the other of said positions, detent means for holding said movable body member in said one and said other of said positions, said detent means comprising a pair of axially spaced locking cavities, a detent assembly located in a different cavity and including a lock member and means for urging said lock member out of said different cavity, said lock member being engageable in one of said locking cavities with said movable body member in said one of said positions and in the other of said locking cavities with said movable body member in said other of said positions, sad movable body member having an actuating assembly means at one end for engaging the piston whereby movement of said movable body member from said one position to said other position and hence movement of said detent assembly from one of said retaining cavities to the other of said retaining cavities will occur only after said actuating assembly means has been engaged by the piston.

5. The valve assembly of claim **4** with said actuating assembly means comprising means engageable by the piston and resiliently resisting movement by the piston and for storing energy responsively to movement by the piston for moving said movable body member from one of said retaining cavities to the other of said retaining cavities.

6. The valve assembly of claim **4** with said lock member being a ball and with said actuating assembly means being located in an opening in the end of said movable body member.

7. A valve assembly adapted to be reciprocated in a bore in a housing member for communicating a pair of inlet passages to three passages for high and low pressure with two being for one pressure and one for the other pressure, a fixed body member fixedly mounted in the bore and having a through bore, said fixed body member having a first and a second groove each in communication with a different one of the inlet passages in the housing member, a third groove in communication with the passage for the other pressure, and a fourth and a fifth groove each in communication with a different one of the passages for the one pressure, a movable body member reciprocably supported in said through bore for reciprocation between two positions, said movable body member having a pair of axially spaced communicating grooves in its outer surface, one of said communicating grooves communicating said first and third grooves together with said movable body member in one of said positions and said first and fourth grooves together with said movable body member in the other of said positions, the other of said communicating grooves communicating said second and fifth grooves together with said movable body member in said one of said positions and said second and third grooves together with said movable body member in said other of said positions, detent means for holding said movable body member in said one and said other of said positions, said detent means comprising a pair of

axially spaced annular locking grooves located in said fixed body member and a detent assembly located in a radial bore through said movable body member and including a ball, a spring retainer and a spring in engagement with said spring retainer and engaging said ball for urging said ball and said spring retainer apart; said retainer terminating in a nose portion having a contour of a portion of a sphere, said nose portion and said ball being engageable in one of said locking grooves with said movable body member in said one of said positions and in the other of said locking grooves with said movable body member in said other of said positions, said movable body member having a retainer cavity at each of its opposite ends for receiving an actuating assembly, each said actuating assembly comprising a pin member having a pin portion extending outwardly from said retainer cavity with which it is associated, a spring member engaging said pin member for urging it outwardly, and a retainer for limiting the outward movement of said pin member, said spring member having a preselected compressive preload on said pin member and having a preselected spring rate relative to the spring rate of said spring of said detent means whereby movement of said movable body member from said one position to said other position and hence movement of said detent assembly from one of said retaining grooves to the other of said retaining grooves will occur only after said pin member has been moved into said retainer cavity a preselected distance with the energy of said spring member causing indexing of said detent assembly to said other of said retaining grooves after said detent assembly has moved from said one of said retaining grooves.

8. A valve assembly for controlling the reciprocation of a pair of tandemly connected pistons each located in one of a pair of coaxially disposed cylinders in a housing member and adapted to be supported in a bore in a housing member with the bore interconnecting the cylinders and for communicating a pair of inlet passages to three passages for high and low pressures with two being for one pressure and one for the other pressure, a fixed body member fixedly mounted in the bore and having a through bore, said fixed body member having a first and a second groove each in communication with a different one of the inlet passages in the housing member, a third groove in communication with the passages for the other pressure and a fourth and a fifth groove each in communication with a different one of the passages for the one pressure, a movable body member reciprocably supported in said through bore for reciprocation between two positions, said movable body member having a pair of axially spaced communicating grooves in its outer surface, one of said communicating grooves communicating said first and third grooves together with said movable body member in one of said positions and said first and fourth grooves together with said movable body member in the other of said positions, the other of said communicating grooves communicating said second and fifth grooves together with said movable body member in said one of said positions and said second and third grooves together with said movable body member in said other of said positions, detent means for holding said movable body member in said one and said other of said positions located in said fixed body member and said detent means comprising a pair of axially spaced annular locking grooves, a detent assembly located in a radial bore through said movable body member and including a ball, a spring retainer and a spring in engagement with said spring retainer and engaging said ball for urging said ball and said spring retainer apart; said retainer terminating in a nose portion having a contour of a portion of a sphere, said nose portion and said ball being engageable in one of said locking grooves with said movable body member in said one of said positions and in the other of said locking grooves with said movable body member in said other of said positions, said movable body mem-

ber having a retainer cavity at each of its opposite ends for receiving an actuating assembly, each said actuating assembly comprising a pin member having a pin portion extending outwardly from said retainer cavity with which it is associated and into that one of the cylinders at that end, a spring member engaging said pin member for urging it outwardly, and a retainer for limiting the outward movement of said pin member, said spring member having a preselected compressive preload on said pin member and having a preselected spring rate relative to the spring rate of said spring of said detent means whereby movement of said movable body member from said one position to said other position and hence movement of said detent assembly from one of said retaining grooves to the other of said retaining grooves will occur only after said pin member has been moved by that one of the pistons with which it is associated into said retainer cavity a preselected distance with the energy of said spring member causing indexing of said detent assembly to said other of said retaining grooves after said detent assembly has moved from said one of said retaining grooves.

9. A valve assembly for controlling the reciprocation of a pair of tandemly connected pistons each located in one of a pair of coaxially disposed cylinders in a housing member and adapted to communicate a first pair of passages connected to the cylinders at opposite ends of the pistons to a second pair of passages with one connected to a high pressure source and the other to a low pressure outlet, said valve assembly comprising: a first body member having a bore and having a first passage means for communicating with one of the first pair of passages and said bore, second passage means for communicating with the other of the first pair of passages and said bore, a third passage means for communicating with one of the second pair of passages and said bore and a fourth passage means for communicating with the other of the second pair of passages and said bore, a movable body member reciprocably supported in said bore for reciprocation between two positions, said movable body member having a first and second communicating means, one of said communicating means connecting said first and third passage means together with said movable body member in one of said positions and said first and said fourth of said passage means together with said movable body member in the other of said positions, the other of said communicating means connecting said second and said fourth of said passage means together with said movable body member in said one of said positions and said second and third of said passage means together with said movable body member in said other of said positions, detent means for holding said movable body member in said one and said other of said positions, said detent means comprising a pair of axially spaced cavities, a detent assembly located in a different cavity and including a lock member and means for urging said lock member out of said different cavity, said lock member being engageable in one of said locking cavities with said movable body member in said one of said positions and in the other of said locking cavities with said movable body member in said other of said positions, said movable body member having an actuating assembly means at each end for engaging that one of the pistons at that end whereby movement of said movable body member from said one position to said other position and hence movement of said detent assembly from one of said retaining cavities to the other of said retaining cavities will occur only after said actuating assembly means has been engaged by the piston with which it is associated.

10. The valve assembly of claim **9** with said actuating assembly means comprising means engageable by the piston with which it is associated and resiliently resisting movement by the piston with which it is associated and for storing energy responsively to movement by the piston with which it is associated for moving said movable body member from one of said retaining cavities to the other of said retaining cavities.

11. The valve assembly of claim **10** with said lock member being a ball and with each said actuating assembly means being located in one of a pair of openings at opposite ends of said movable body member.

12. A valve assembly comprising a fixed body member, a movable body member, detent means for holding said movable body member in one of a plurality of positions, said detent means comprising a locking cavity at each of said positions and a detent assembly located in a different cavity and including a ball, an elongated spring retainer, and a bias spring in engagement with said spring retainer and said ball for urging said ball and said spring retainer apart, said retainer terminating in a nose portion having a contour of a portion of a sphere, said nose portion and said ball being engageable in said locking cavity for locking said movable body member in the corresponding one of said positions, said movable body member having actuating assembly means for moving said movable body member to said each of said positions and including resisting means for resiliently resisting movement of said movable body member and for storing energy responsively to forces applied thereto for moving said movable body member and for releasing said energy for causing move ment of said movable body member to a next one of said positions when the magnitude of said forces overcomes the locking effect of said lock member.

13. The assembly of claim **12** in which said resilient means includes a spring and said resisting means includes a spring member with the spring rates of said spring and said spring member selected such that the locking effect of said lock member will be overcome at a preselected force having a magnitude sufficient to impart sufficient stored energy to said spring member whereby movement of said movable body member from one position to another will be effected.

14. In a valve assembly the improvement comprising: a fixed body member, a movable body member, detent means for holding said movable body member in one of a plurality of positions, said detent means comprising a locking cavity at each of said positions and a detent assembly located in a different cavity and including a ball, an elongated spring retainer, and a bias spring in engagement with said spring retainer and said ball for urging said ball and said spring retainer apart, said retainer terminating in a nose portion having a contour of a portion of a sphere, said nose portion and said ball being engageable in said locking cavity for locking said movable body member in the corresponding one of said positions, said movable body member having actuating assembly means for moving said movable body member to said each of said positions.

References Cited

UNITED STATES PATENTS

1,839,540	1/1932	Farr	91—329
2,555,018	5/1951	Von Seggern	91—329
3,261,265	7/1966	Weik	91—329
3,276,381	10/1966	Harklau	91—329
1,861,442	6/1932	Hammerstein	251—297

FOREIGN PATENTS

325,269	9/1920	Germany.

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