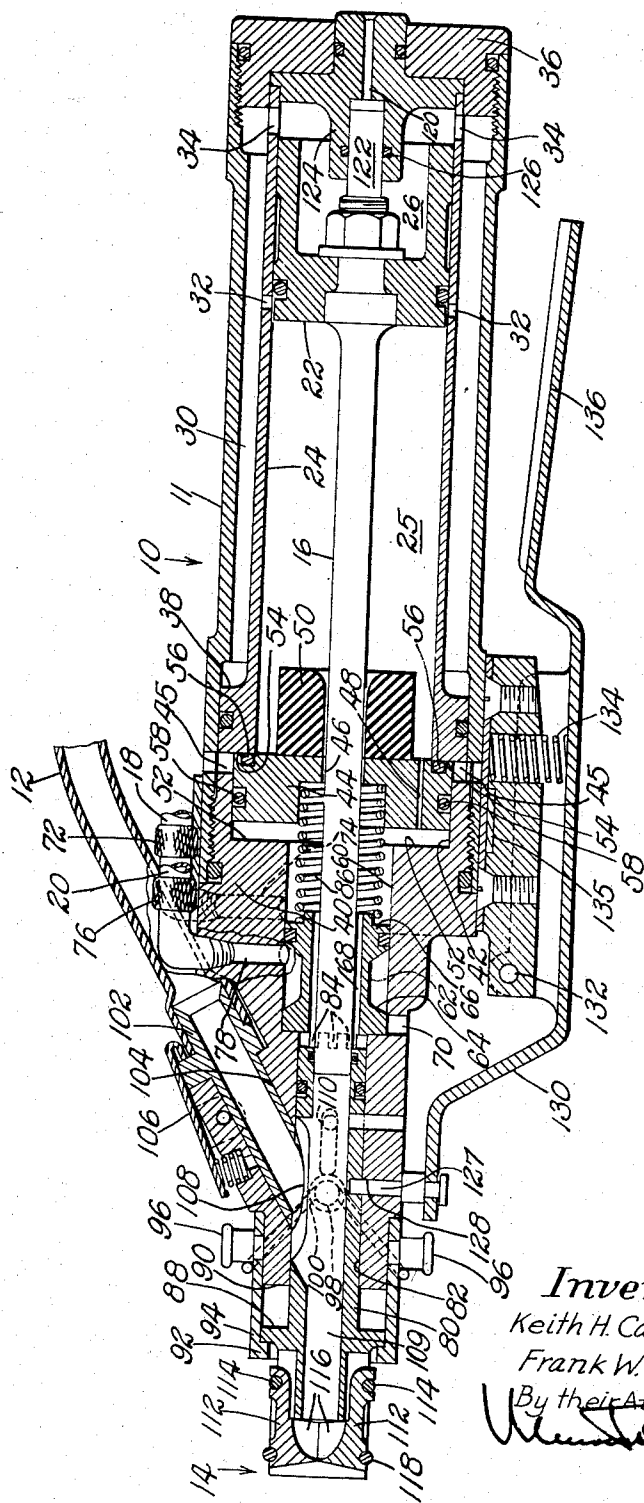


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K. H. CARPENTER ET AL
FASTENER INSERTING DEVICES

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FASTENER INSERTING DEVICES

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This invention relates to fastener inserting and particularly to portable pneumatic tools of the percussive type which are adapted for impact driving of fasteners, such as nails, sash pins, etc. However, in its broader aspects the tool of the present invention is not thus limited in its use.

In Letters Patent of the United States No. 2,807,021, granted September 24, 1957, on an application filed in the name of Fred F. Chellis there is disclosed a fluid motor which is effective in providing high impact energy for its size and weight. Such a motor is particularly useful when embodied in a hand-held or portable fastener inserting gun of the type disclosed therein. The Chellis gun includes a motor which comprises a driver piston slidable in a cylinder, the piston separating the cylinder into upper and lower chambers. A fastener driver in the form of a rod is attached to the piston and extends through the lower chamber and out of the cylinder. To "cock" the gun, pressurized fluid, preferably air, is introduced into the lower chamber moving the piston toward the upper chamber, making said upper chamber smaller as it moves. When the forces acting on opposite sides of the piston become equalized, due to the pressure of air admitted to or trapped in the upper chamber balancing that admitted to the lower chamber, the motion of the piston stops and it is ready to drive a fastener by means of the driver rod affixed thereto. To drive the fastener, the pressure in the lower chamber is reduced by permitting the air therein to vent rapidly from the gun, whereupon the pressurized air in the upper chamber expands, moving the piston and its driver rod in a percussive manner against a fastener positioned in the path of movement of the driver rod.

Present day standards necessitate that the operating cycle of pneumatic fastener inserting tools be extremely fast in order that a large number of fasteners may be driven in a relatively short time. Whereas the fastener driving stroke is extremely rapid and a major portion of the overall operating cycle is taken up by "cocking" the gun, i. e., retracting the driver piston by charging the lower chamber with compressed air, the time of the overall cycle may best be shortened by simplifying and reducing the sequence of operations needed to recharge the lower chamber.

It is a usual practice to trigger pneumatic tools of the above-described type by simply pressing a portion of the tool, frequently a nosepiece, against the work. It is possible to discharge the tool accidentally as, for example, by dropping or by inadvertent contact on the part of an operator which could result in injury. An advantage resides in providing this type of tool with mechanism whereby it cannot be fired accidentally but rather only under the intentional direction of an operator.

It is an object of this invention to provide an improved fastener inserting tool of the type having a fluid motor which operates on a differential air pressure prin-

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ciple and has a simpler and faster return or recharging rate.

Another object of this invention is to provide a fastener inserting gun of the type disclosed in the above-mentioned Chellis patent which is more economical to construct and operate.

In the above-mentioned Chellis gun the cocking and firing operations are brought about by an internal pilot valve, the position of which, relative to the gun as a whole, determining the flow of pressurized air toward and away from a control valve. The control valve in turn controls the admission and release of air within the driver cylinder by moving into positions alternately to seal and unseal said cylinder. The gun is fired by physically moving the pilot valve relative to the gun as a whole or vice versa, which is accomplished by either moving the nosepiece of the gun against the work or the work against the nosepiece, respectively. The gun is recharged or cocked after firing by disengaging the gun and the work piece (a physical movement), whereupon the pilot valve is returned to its original position by air pressure acting on a differential area obtained by constructing the pilot valve as a two-diameter spool.

The movement of the above-mentioned control valve into and out of its driver cylinder sealing position is also effected by air pressure being under the control of the pilot valve. Consequently, this movement cannot take place until after the pilot valve moves. Thus, in the recharging operation, the following sequence of events must take place before air is admitted to the driving cylinder to cock the piston. (1) The gun and work must be physically disengaged, (2) the pilot valve must be returned to its original position by air pressure and, (3) the control valve must be moved by air pressure under the control of the pilot valve to a position sealing the driver cylinder.

Applicants have found that the time required to complete the recharging cycle of the fluid motor may be substantially reduced by mechanically causing the control valve to reseal the driver cylinder immediately after the preceding fastener has been driven independently of and before the pilot valve is returned to its initial position. This eliminates the delay occasioned by the operator having to disengage the gun physically from the work before the control valve becomes reset as heretofore was required. Applicants have also found that by providing means to lock the pilot valve actuating member, which in the Chellis gun is the movable fastener positioning nosepiece, and separate means controlled by the operator to release the lock, the tool cannot be accidentally discharged.

In accordance with the various features of the invention, there is provided a fastener inserting tool having a driver operated by a fluid motor comprising a cylinder and a piston slidable therein and separating the cylinder into first and second chambers on either side thereof. Flow of pressurized fluid into and out of the first chamber effects the movement of the piston within the cylinder. A valve casing communicates with the first chamber and is provided with two exhaust ports. A control valve is mounted for sliding movement in the casing and controls the flow of pressurized fluid through one of the exhaust ports. A pilot valve, also slidably mounted in the valve casing, controls the flow of fluid into the casing and also out of the other exhaust port. By means of a restricted passage through the control valve the opposite sides of the valve are exposed to the pressure of the fluid in the first chamber when the two exhaust ports in the valve casing are closed. Spring pressure at all times urges the valves to their exhaust port closing positions. There are provided means for moving the pilot

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valve to a position where the second exhaust port is opened, and the pressurized fluid in the valve casing vents from the tool and the pressure of the fluid in the first chamber moves the control valve against the action of the spring pressure to permit rapid exhaust of the pressurized fluid therein. The means for moving the pilot valve comprise a sleeve slidably mounted relative to the inserting tool as a whole with jaws on the sleeve for releasably retaining a fastener in the path of movement of the driver.

The above and other features of the invention, including various novel details of construction and combinations of parts, will now be more particularly described with reference to the accompanying drawing and pointed out in the claims.

In the drawing, the figure is a sectional view of a preferred form of fastener inserting tool embodying the invention.

The gun comprises an air motor 19 having an outer casing 11 which may be gripped by an operator while inserting fasteners, such as nails, sash pins, tacks, etc., which are delivered one at a time through a flexible tube 12 to a nosepiece 14 wherein they are held until they are engaged by an impact delivering driver 16. Power is delivered to the driver by the air motor which is connected by a line 18 to a source of compressed air. When the gun is fired, in a manner hereinafter to be described, pressurized air flows from the gun through a signal line 20 to actuate a remotely located fastener feeding mechanism (not shown) which delivers another nail to the gun through the tube 12. The feeding mechanism forms no part of the present invention.

The air motor comprises a piston 22 which slides within a cylinder 24, dividing the cylinder into a first chamber 25 and a second chamber 26. The cylinder 24 is concentric with and spaced from the casing 11, the space between the cylinder and the casing forming an air accumulator 30. Communication between the accumulator and the cylinder 24 is provided by two sets of holes 32 and 34, the holes of each set being circumferentially spaced in the cylinder 24. One end of the accumulator is closed by a cap 36 which is threaded in the casing 11 and engages the outer wall of the cylinder 24. The opposite end of the accumulator is closed by a flange 38 on the cylinder 24 which forms an airtight seal with the casing 11.

Threaded in the casing 11 is a valve casing 40 in the form of an irregular shaped one-piece plug which extends from adjacent the flange 38 to the left-hand end of the gun adjacent the nosepiece 14. The valve casing 40 is provided with a valve chamber 42 in which a control valve 44 is slidably mounted. A plurality of passageways or exhaust ports 45 are circumferentially spaced in the casing 11 adjacent the flange 38. The driver 16 passes through a bore 46 in the control valve 44, the bore being large enough to permit passage of air around the driver. Spaced outwardly from the bore 46 is another passageway 48 in the control valve, permitting the passage of air past a shock absorber 50 surrounding the driver 16 on the side of the control valve facing the first chamber 25. The control valve 44 is movable within the valve chamber 42 between a shoulder 52 on the valve casing 40 wherein the passageways 45 are uncovered, and the left-hand face 54 of the flange 38 wherein the passageways 45 are sealed by the control valve. Fitted in the control valve 44 are O rings 56 and 58, forming airtight seals with the left-hand face 54 of the flange 38 and the valve chamber 42 respectively.

Adjoining the valve chamber 42 is a second valve chamber 60, also formed in the valve casing 40. Slidably in the valve chamber 60 is a pilot valve 62 in the form of a spool having flanges 64 and 66. The driver 16 passes axially through the pilot valve which is bored

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to provide a passageway 68 of greater diameter than the driver 16 to permit the flow of air from one end of the pilot valve to the other. A plurality of circumferentially spaced passageways or exhaust ports 70 in the valve casing 40, only one of which is seen in the drawing, communicate with the valve chamber 60.

The main air line 18 is connected by means of a fitting 72 to a passageway 74 communicating with the valve chamber 60. Similarly, the signal line 20 is connected by means of a fitting 76 to a passageway 78 also communicating with the valve chamber 60. The fittings 72 and 76 are circumferentially spaced apart sufficiently to permit the fastener delivery tube 12 to be accommodated between them.

A sleeve 80 is slidable in a bore 82 adjoining the valve chamber 60 in the valve casing 40. The left-hand end of the sleeve 80 mounts the nosepiece 14 and the right-hand end engages the flange 64 of the pilot valve 62. In this area of engagement the sleeve 80 is provided with circumferentially spaced slots 84, the reason for which will become more apparent hereinafter. Compressed between the pilot valve 62 and the control valve 44 is a spring 86 urging the control valve 44 to the right and the pilot valve 62 and the sleeve 80 to the left, as seen in the drawing. The sleeve 80 has a flange 88 to limit its sliding movement between a shoulder 90 on the valve casing 40 and an annular shoulder 92 formed on a collar 94 slidably mounted on the valve casing 40. The collar 94 has a pair of ears 96 and the valve casing 40 is provided with a similar pair of ears 98, only one of which is seen in the drawing. Around the ears 96 and 98 is placed a spring 100 or other resilient means to hold the collar 94 on the valve casing 40.

The nail delivery tube 12, which passes between the fittings 72 and 76 on the outside of the gun, fits on the end of a tube 102 which is removably secured within a bore 104 in the valve casing 40 by a spring-biased pivotal clamp 106. The end of the tube 102 intersects a cut-away portion 108 of the sleeve 80 to permit the entry of fasteners to a fastener receiving chamber 109 which comprises a portion of the interior of the sleeve 80. To prevent rotation of the sleeve 80 relative to the valve casing 40, in order to assure that the cut-away portion 108 remains aligned with the tube 102, there is provided a conventional pin and slot connection 110 between the sleeve 80 and the valve casing 40.

The nosepiece 14 comprises a pair of jaws 112 which are pivotally secured by a ring 114 in slots formed in the end of the sleeve 80. The jaws have converging camming surfaces 116 which contact and retain a nail within the gun when it is delivered to the nail receiver 109. The jaws are yieldably held together by a garter spring 118 in order to retain the nail in position to be driven. The jaws are pivoted outwardly against the force of the spring 118 as the nail passes through the camming surfaces 116 on its way into a work piece.

Our air motor is provided with a temporary air relief mechanism of the type disclosed in Letters Patent of the United States No. 2,802,451, granted August 13, 1957, on an application filed in the names of Fred F. Chellis and Keith H. Carpenter. This temporary air relief mechanism, herein described only briefly, and forming no part of the present invention, is provided in order to facilitate the rapid return or cocking movement of the piston within the cylinder 24. The mechanism comprises a passageway 120 communicating with the chamber 26 through which air is free to escape as the piston begins its movement from left to right. When the piston nears the end of its stroke, a plunger 122, attached thereto, enters a sleeve 124 continuous with the passageway 120 and forms an airtight seal with an O ring 126 preventing the further escape of air from the passageway 120. A complete cycle of the gun in driving a fastener will

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now be described. Before the gun is fired there is no nail in the nail receiver 109; therefore, the gun must be either discharged once, in the manner now to be described, in order to have a nail delivered to the nail receiver or one may be inserted manually by removing the tube 102. The pilot valve 62 and the control valve 44 occupy the positions shown in the drawing, also referred to as their first positions, the spring 86 urging them in opposite directions. The air line 18, which is connected to a source of compressed air, admits air to the valve chamber 60 through the passageway 74. The air flows through the bore 46 and the passageway 48 in the control valve and into the first chamber 25 of the cylinder, causing the piston to move to the right whereby the first chamber 25 becomes larger and the second chamber 26 becomes smaller. During the initial movement of the piston some of the air which would otherwise be trapped in the chamber 26 and the accumulator 30 escapes through the passageway 120 permitting the piston to move more rapidly than would otherwise be possible. When the piston reaches the position shown in the drawing, which is called the inactive position, the plunger 122 has entered the sleeve 124 and pressurized air flows directly from the first chamber 25 through the then uncovered holes 32 into the accumulator 30 and the piston comes to rest. Since air is no longer free to vent from the passageway 120, the air in the second chamber 26 and in the air accumulator 30 is maintained under substantial pressure.

The gun is triggered to allow the pressurized air in the second chamber 26 and in the accumulator 30 to drive the piston to the left to a force delivering position by reducing the pressure in the first chamber 25. This is accomplished by causing relative movement between the nosepiece 14 and the valve casing 40 which may be obtained in two ways: (1) by moving the entire gun against a stationary work piece, whereupon the nosepiece 14, upon contact with the work piece, is prevented from further movement, while the outer casing 11 and the valve casing 40, which is secured thereto, move relative to the nosepiece, or (2) by maintaining the gun stationary as, for example, clamped in a frame or on a bench, and moving the work piece toward the gun to displace the nosepiece. The operation of the gun will be described, by way of illustration only, with reference to the outer casing 11, and thus the valve casing 40, maintained in a stationary position, the work piece being moved against the nosepiece 14. Movement of the nosepiece 14 to the right results in movement of the sleeve 80 which in turn moves the pilot valve 62 to the right until it occupies a position called the second position with its flange 66 to the right of the air inlet passageway 74. The flange 88 of the sleeve 80 will then have contacted the shoulder 90 on the valve casing 40.

Movement of the pilot valve 62 to the right causes the spring 86 to be further compressed and the exhaust ports 70 to be uncovered, whereupon pressurized air within the valve chambers 60 and 42 flows rapidly to atmosphere through the passageway 68 in the pilot valve, the slots 84 in the sleeve 80 and the ports 70. The passageway 78, which leads to the signal line 20, is then in communication with the passageway 74, thus pressurizing the signal line 20, which causes the above-mentioned fastener delivery means to be actuated to deliver a subsequent fastener to the gun in a known manner.

When the pressure on the left-hand face of the control valve 44 is reduced by venting air from the valve chambers 60 and 42, the valve is moved to the left, to a second position within the chamber 42 against the force of the spring 86 by the compressed fluid within the chamber 25. The exhaust ports 45 are thereby uncovered permitting the pressurized air in the chamber 25 to pass rapidly out of the gun. With the pressure within the first chamber 25 thus rapidly reduced, the pressurized air within the chamber 26 and the accumulator 30 causes the piston 22

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and the driver 16 to be propelled to the left in a percussive manner to the force delivering position wherein the nail then within the fastener receiver 109 is driven through the jaws 112 into the work piece. The piston continues toward the left in its force delivering stroke until it strikes the shock absorbing bumper 50, whereupon the nail will have been driven home.

During the nail driving stroke, the control valve 44 is, of course, under the influence of the force of the spring 86 which at all times is attempting to urge the valve toward the right to the first position wherein it seals the exhaust ports 45. The pressure within the chamber 25 approaches but never reaches atmospheric as long as the piston continues to move, since the air therein is under the compressive force of the moving piston and the control valve 44 exerts a back pressure due to the force of the spring 86. However, when the stroke of the piston terminates, the chamber 25 is no longer in the process of becoming smaller and the pressure of the air in the chamber falls off to a point where it exerts less force on the valve 44 than does the spring 86, whereupon the valve is returned to its right-hand or first position, sealing the exhaust ports 45.

The entire fastener driving stroke including the resealing of the exhaust ports 45 takes place in a matter of milliseconds which is a shorter period of time than the operator can remove the work piece from engagement with the gun or vice versa. Thus the control valve 44 is returned to its first position, sealing the exhaust ports 45 relay for the first chamber 25 of the cylinder 24 to be recharged before the operator disengages the work piece from the nosepiece 14 to allow the pilot valve 62 to be moved to its first position. When the operator does disengage the nosepiece 14 from the work, the spring 86, which also at all times is urging the pilot valve 62 to the left, moves the valve to its first position whereupon air then flows directly from the inlet passageway 74 through the bore 46 and the passageway 48 in the control valve to repeat the cycle.

Heretofore, air motors of the above-mentioned Chellis type relied on the pilot valve being returned to its left-hand or first position and the control valve being returned to its sealing or first position by means of air pressure only which was found to be substantially slower and less reliable than by the use of the spring 86.

To prevent the gun from accidentally being fired, a safety locking mechanism is provided comprising a pin 127 slidable in the valve casing 40 and engageable within a bore 128 in the sleeve 80 to prevent movement of the sleeve relative to the valve casing 40 which, as explained above, initiates firing of the gun. The pin 127 is mounted on a lever 130 which is urged in a clockwise direction, as seen in the drawings, about a fulcrum 132 by a spring 134. The lever 130, the fulcrum 132 and the spring 134 are secured to the outer casing 11 in any convenient manner, as for example, by a clamping bracket 135. On the end of the lever 130 remote from the pin 127 is a handle 136, which, when pressed toward the outer casing 11, causes the pin 127 to be withdrawn from the sleeve 80 permitting the sleeve to be moved relative to the valve casing 40.

The above described safety mechanism forms no part of the present invention but is claimed in our copending divisional application Serial No. 739,222, filed June 2, 1958, in our names.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a chamber arranged to contain pressurized fluid, a valve casing communicating with said chamber, said casing having two exhaust ports, a control valve movable in said casing and controlling the flow of pressurized fluid from said chamber through one of said exhaust ports, said control valve having a restricted passage therethrough providing communication between op-

posite sides thereof whereby both of said sides are exposed to the pressure of the fluid in said chamber when the two exhaust ports in the valve casing are closed, a pilot valve movable in said casing and controlling the flow of pressurized fluid from said casing through the other exhaust port, a spring at all times urging said valves to their exhaust port closing positions, and means for moving the pilot valve to open said other exhaust port permitting rapid release of the pressure in the valve casing whereby the pressure of the fluid in the chamber moves the control valve against the action of the spring to permit rapid exhaust of the pressurized fluid from said chamber.

2. In combination, a chamber arranged to contain pressurized fluid, a valve casing communicating with said chamber, said casing having two exhaust ports, a control valve movable in said casing and controlling the flow of pressurized fluid from said chamber through one of said exhaust ports, said control valve having a restricted passage therethrough providing communication between opposite sides thereof whereby both of said sides are exposed to the pressure of fluid in said chamber when the two exhaust ports in the valve casing are closed, a pilot valve movable in said casing and controlling the flow of pressurized fluid from said casing through the other exhaust port, a spring at all times urging said valves to their exhaust port closing positions, means for moving the pilot valve to open said other exhaust port permitting rapid release of the pressure in the valve casing whereby the pressure of the fluid in the chamber moves the control valve against the action of the spring to permit rapid exhaust of the pressurized fluid from said chamber, releasable locking means normally rendering said pilot valve moving means inoperative to prevent the displacement of the pilot valve to its exhaust port opening position, and means to release said locking means.

3. In combination, a chamber arranged to contain pressurized fluid, a control valve movable into one position to seal said chamber and movable into a second position to permit exhaust of fluid from said chamber, said valve being subjected to the pressure of the fluid in said chamber tending to move the valve into the second position, a pilot valve, a valve casing containing said pilot valve and said control valve, said control valve having a restricted passage therethrough connecting said chamber with said casing, said casing having an exhaust port covered by said control valve with said valve in said first position and arranged when uncovered by movement of said control valve to permit rapid release of pressure from said chamber, said casing having a second exhaust port covered by said pilot valve when in a first position and arranged to be uncovered when the pilot valve is moved into a second position, a spring between said valves and at all times urging said valves toward their first positions, and means for moving said pilot valve into its second position.

4. In combination, a cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side thereof, flow of pressurized fluid into and out of said first chamber controlling the movement of the piston within the cylinder, a passageway for venting fluid from said first chamber, a valve member having one side facing said first chamber and a second side facing away therefrom, said valve member being movable between a position adjacent said first chamber in which it seals said first chamber from the venting passageway and a position in which it places the first chamber in communication with said venting passageway, an opening in the valve member through which pressurized fluid may flow from said second side into said first chamber, a pilot valve spaced from said second side and movable between a fluid admitting position wherein pressurized fluid is introduced against said second side of the valve member to maintain said valve member in its sealing position and flow into said first chamber and a fluid discharging position wherein the pressurized fluid

acting on said second side is conducted away therefrom and the pressurized fluid then in said first chamber displaces the valve member away from said sealing position and flows out of said venting passageway, and resilient means extending between the pilot valve and said second side of the valve member at all times urging the pilot valve toward its fluid admitting position and the control member toward its sealing position.

5. In combination, a cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side thereof, flow of pressurized fluid into and out of said first chamber controlling the movement of the piston within the cylinder, a passageway for venting fluid from said first chamber, a valve member having one side facing said first chamber and a second side facing away therefrom, said valve member being movable between a position adjacent said first chamber in which it seals said first chamber from the venting passageway and a position in which it places the first chamber in communication with said venting passageway, an opening in the valve member through which pressurized fluid may flow from said second side into said first chamber, a pilot valve spaced from said second side and movable between a fluid admitting position wherein pressurized fluid is introduced against said second side of the valve member to maintain said valve member in its sealing position and flow into said first chamber and a fluid discharging position wherein the pressurized fluid acting on said second side is conducted away therefrom and the pressurized fluid then in said first chamber displaces the valve member away from said sealing position and flows out of said venting passageway, and resilient means extending between the pilot valve and said second side of the valve member at all times urging the pilot valve toward its fluid admitting position and the control member toward its sealing position, the means for conducting pressurized fluid away from said second side of the valve member comprising an opening through said pilot valve and a second venting passageway in communication therewith when the pilot valve is in fluid discharging position, said second venting passageway being sealed by said pilot valve when it is in fluid admitting position.

6. In combination, a chamber arranged to contain pressurized fluid, a valve casing communicating with said chamber, said casing having two exhaust ports, a control valve movable in said casing and controlling the flow of pressurized fluid from said chamber through one of said exhaust ports, said control valve having a restricted passage therethrough providing communication between opposite sides thereof whereby both of said sides are exposed to the pressure of the fluid in said chamber when the two exhaust ports in the valve casing are closed, a pilot valve movable in said casing and controlling the flow of pressurized fluid from said casing through the other exhaust port, a spring at all times urging said control valve to its exhaust port closing position, and means for moving the pilot valve to open said other exhaust port permitting rapid release of the pressure in the valve casing whereby the pressure of the fluid in the chamber moves the control valve against the action of the spring to permit rapid exhaust of the pressurized fluid from said chamber.

7. In combination, a chamber arranged to contain pressurized fluid, a control valve movable into one position to seal said chamber and movable into a second position to permit exhaust of fluid from said chamber, said valve being subjected to the pressure of the fluid in said chamber tending to move the valve into the second position, a pilot valve, a valve casing containing said pilot valve and said control valve, said control valve having a restricted passage therethrough connecting said chamber with said casing, said casing having an exhaust port covered by said control valve with said valve in said first position and arranged when uncovered by movement

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of said control valve to permit rapid release of pressure from said chamber, said casing having a second exhaust port covered by said pilot valve when in a first position and arranged to be uncovered when the pilot valve is moved into a second position, a spring at all times urging said control valve toward its first position, and means for moving said pilot valve into its second position.

8. In combination, a cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side thereof, flow of pressurized fluid into and out of said first chamber controlling the movement of the piston within the cylinder, a passageway for venting fluid from said first chamber, a valve member having one side facing said first chamber and a second side facing away therefrom, said valve member being movable between a position adjacent said first chamber in which it seals said first chamber from the venting passageway and a position in which it places the first chamber in communication with said venting passageway, an opening in the valve member through which pressurized fluid may flow from said second side into said first chamber, a pilot valve spaced from said second side and movable

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between a fluid admitting position wherein pressurized fluid is introduced against said second side of the valve member to maintain said valve member in its sealing position and flow into said first chamber and a fluid discharging position wherein the pressurized fluid acting on said second side is conducted away therefrom and the pressurized fluid then in said first chamber displaces the valve member away from said sealing position and flows out of said venting passageway, and resilient means acting on said second side of the valve member at all times urging it toward its sealing position.

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