United States Patent

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El Monte, Calif.

[54] **SLIDE-LATCH VALVE FOR AIR-DRIVEN TOOLS**
28 Claims, 12 Drawing Figs.

[52] **U.S. Cl.** **91/443,** 91/461, 137/625.6, 137/625.66, 227/130
[51] **Int. Cl.** **F15b 11/08,** F15b 13/042, B25c 1/04
[50] **Field of Search** 91/461, 304, 469, 470, 443; 227/130; 137/625.25, 625.66, 625.6, 625.68, 625.2

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Assistant Examiner—Irwin C. Cohen
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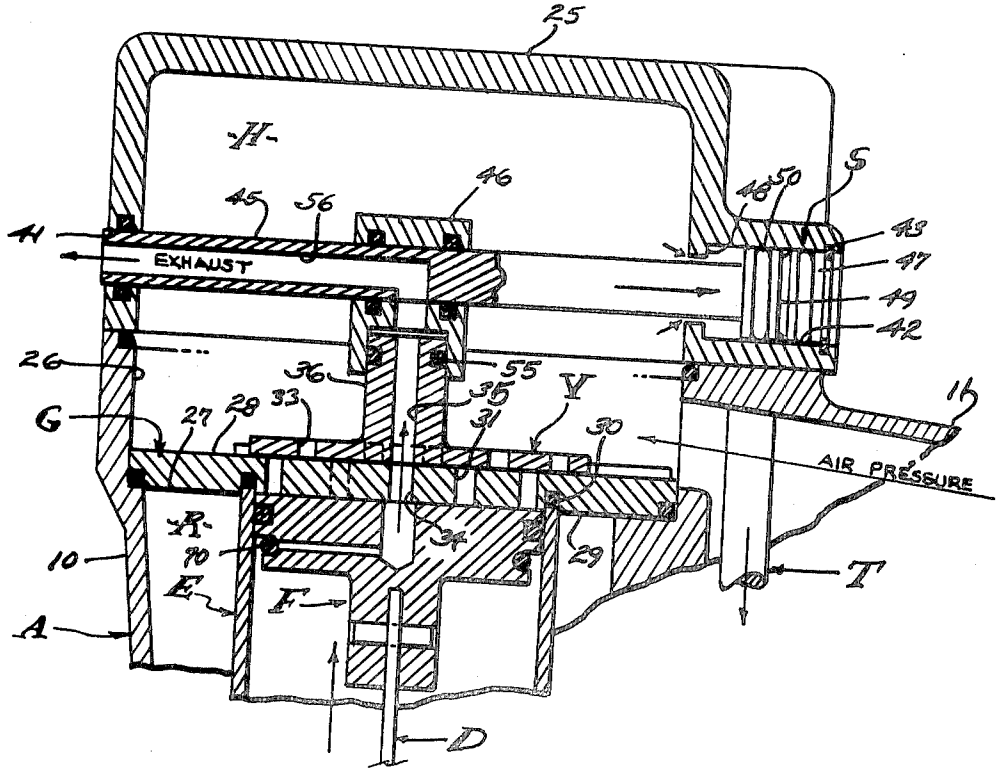
ABSTRACT: A latch valve of the slide type is provided in the air storage chamber of an air-operated cylinder and piston tool which requires a percussive or striking action followed by return to a condition prepared for subsequent and rapidly repeated action. In the returned and prepared condition the latch valve captures a charge of compressed air in the storage chamber while exhausting the cylinder so as to permit the preceding return stroke. In the fired condition the latch valve opens the storage chamber directly into the cylinder while closing the exhaust. In one form the latch valve includes a port that opens into a return air reservoir when in the fired condition to charge the same. In another form the latch valve includes a transfer tube that cooperates with said port to exhaust the return air reservoir after each full cycle of operation.



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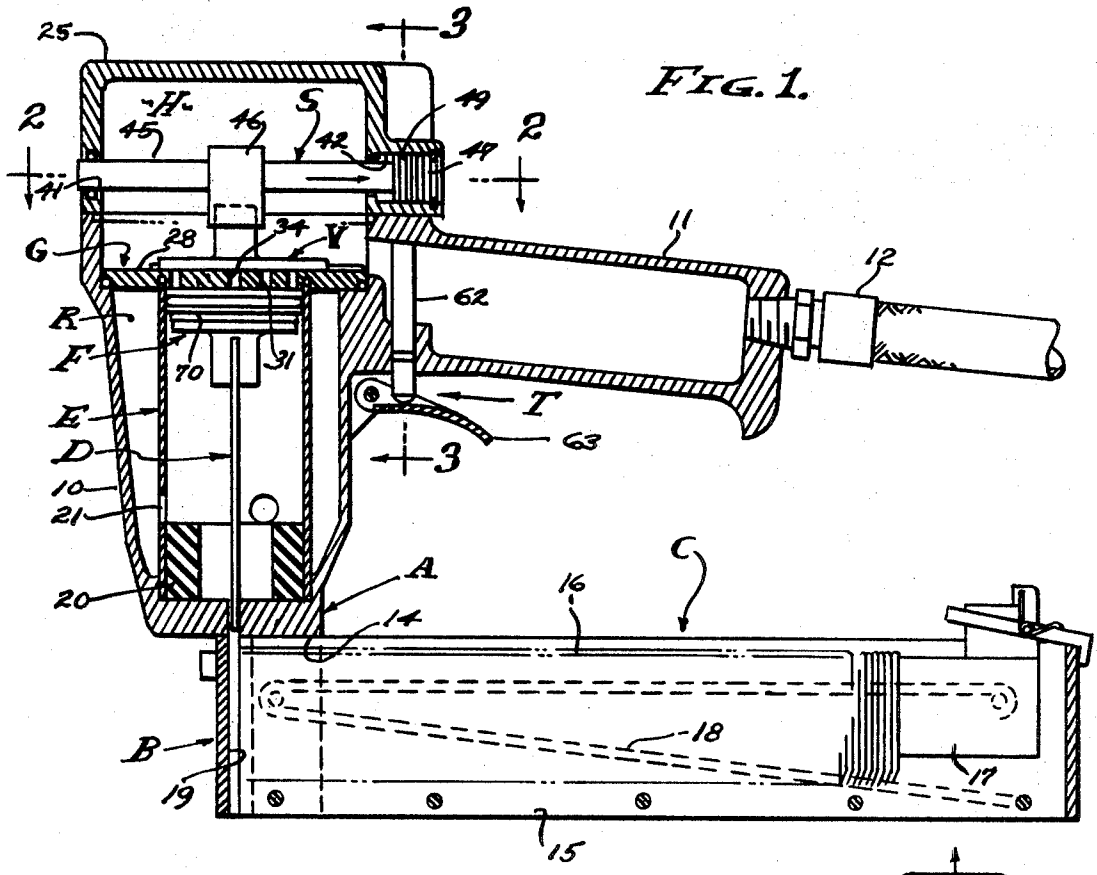

FIG. 1.

FIG. 2.

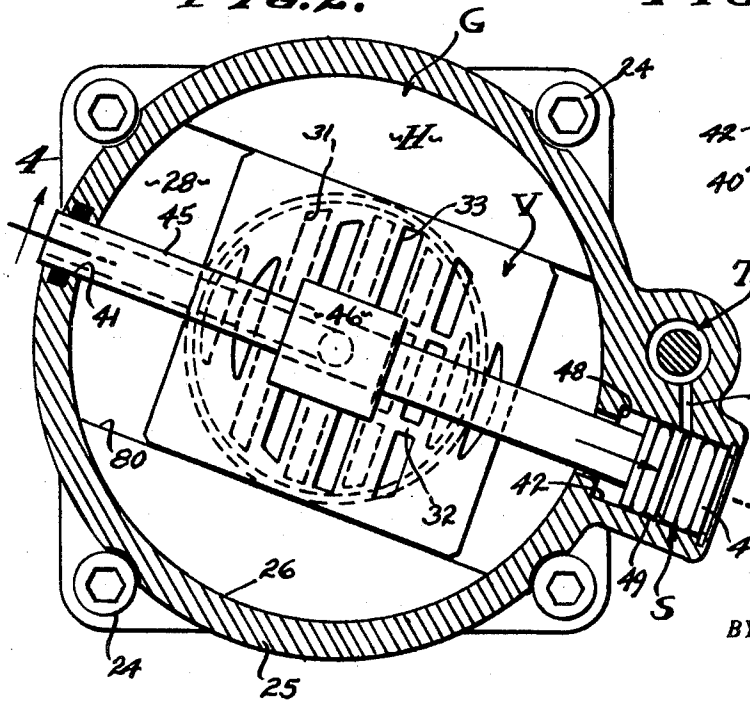

FIG. 3.

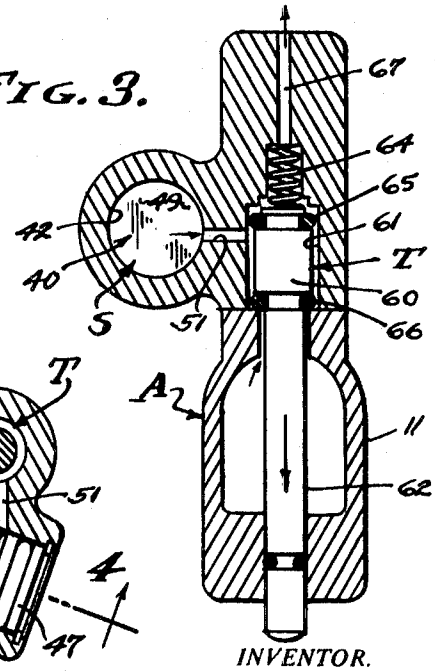

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FIG. 4.

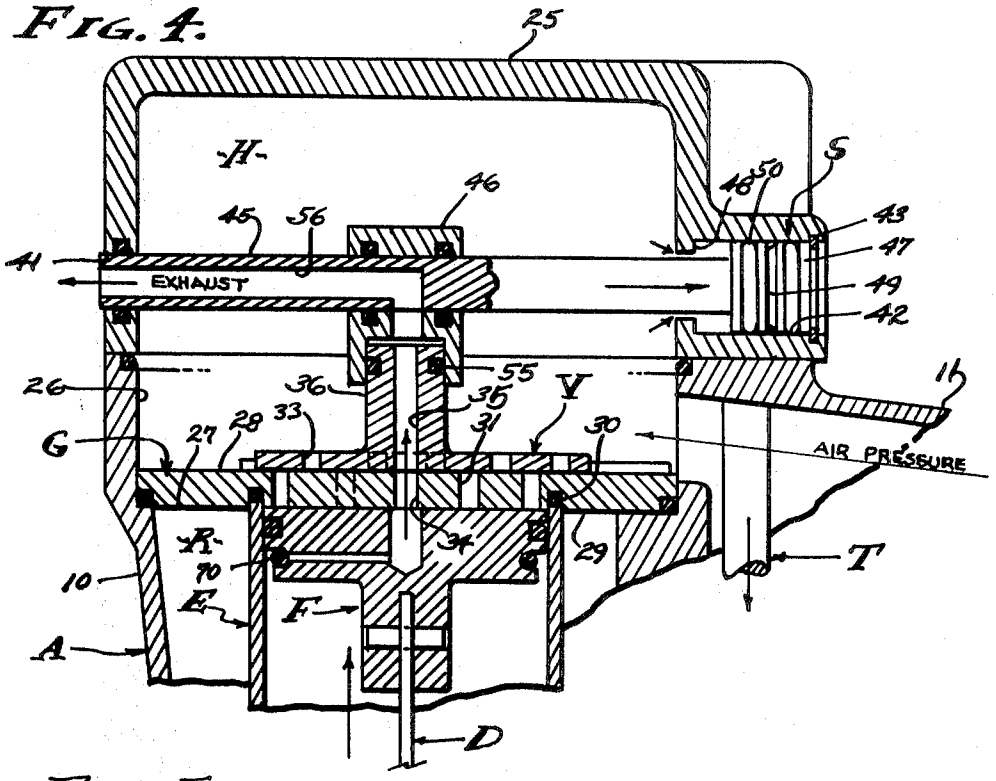

FIG. 5.

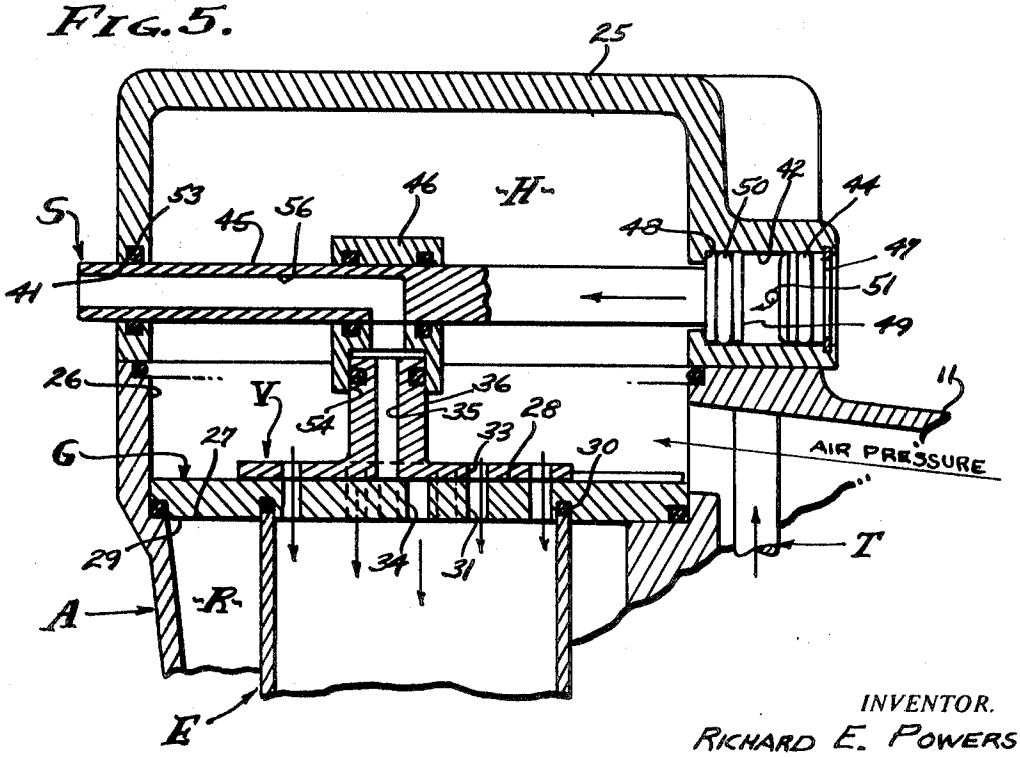

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FIG. 6.

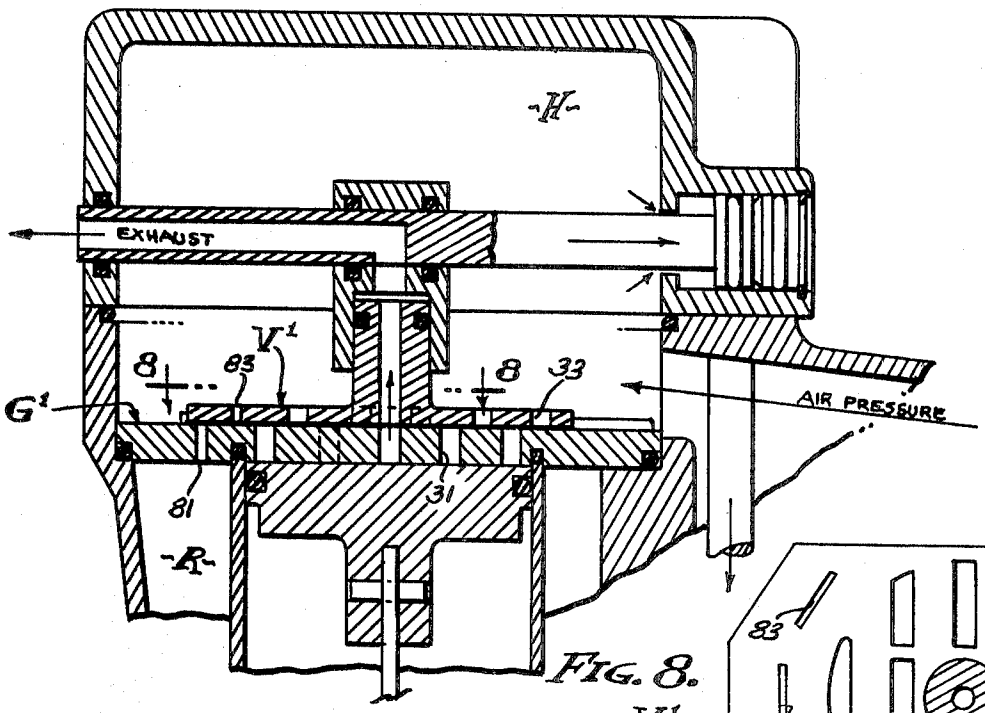

FIG. 8.

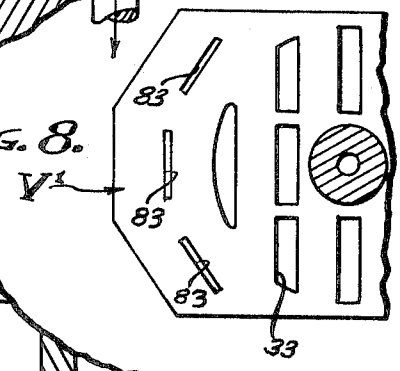

FIG. 7.

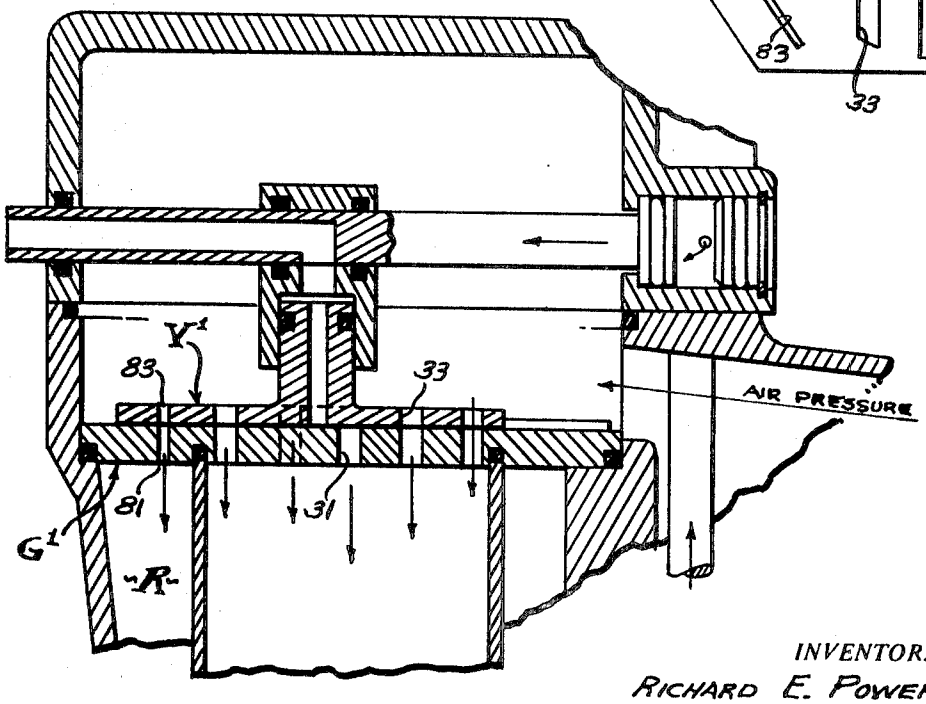

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FIG. 9.

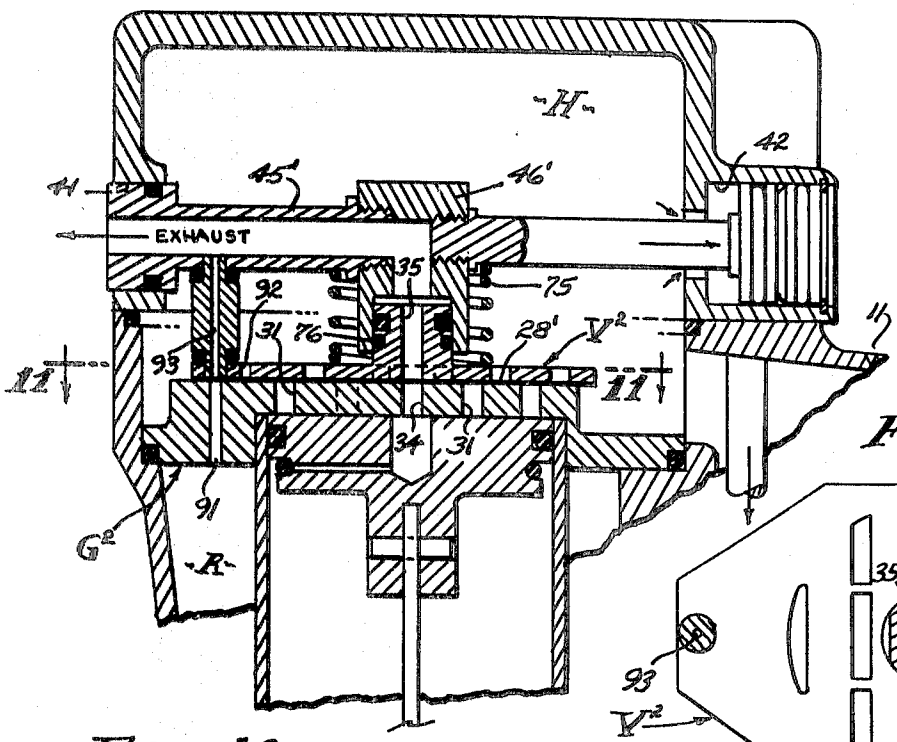


FIG. 11.

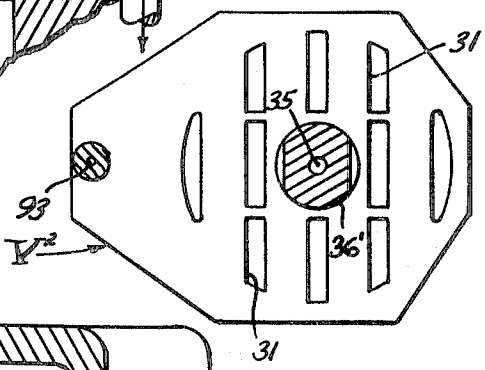


FIG. 10.

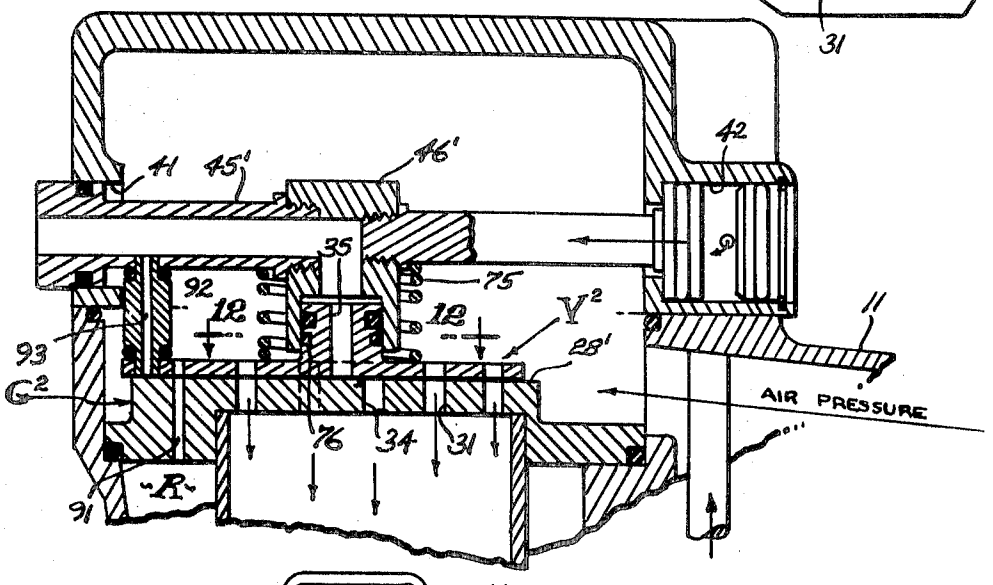
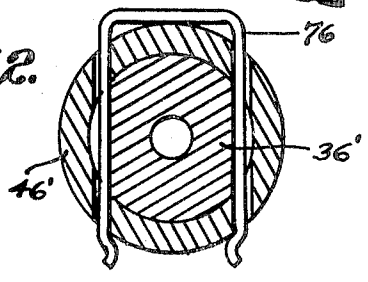


FIG. 12.



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SLIDE-LATCH VALVE FOR AIR-DRIVEN TOOLS

The present invention relates primarily to percussive-action tools such as fastener-driving tools which strike and/or hammer a fastener into a piece of work by means of a single blow. Therefore, a complete cycle of operation requires preparation of the tools for adequate subsequent functioning, followed by said functioning, and consummated by the function of return to a prepared condition for completing the said cycle. Heretofore, tools of the type under consideration have employed air storage chambers for supplying the immediate and high demand for the instant supply of air under pressure and such as to have an explosive action when released. However, the valve design in the prior art tools has been such as to restrict the flow of air into the drive cylinder; reference being made to the poppet-type valves that lift off the top end of the cylinders, wherein there is inherently a gradual separation from the valve seat resulting in a detainment of the percussive action desired. Therefore, it is an object of this invention to provide the slide-type latch valve hereinafter disclosed and which instantaneously moves to a fully open position and directly discharges compressed air from said chamber and into said cylinder and without turning and/or redirecting said air. Consequently, explosive action of the stored air under pressure is instantly effective at the beginning of the work stroke of the tool to accelerate the piston and in this instance the driver blade attached thereto.

Latch valves for tools of the type under consideration are most often servo operated by means of a trigger valve that either bleeds or supplies air for opening the latch valve, and in either case there is detainment in the valve action due to inertia of parts and due to the distance of travel required in order to attain full opening of the latch valve. In other words, instantaneously full-opening latch valves directly communicating the air storage reservoir and tool actuation cylinder are unavailable in the prior art, it being an object of this invention to provide such a valve that is operable through a trigger valve and preferably under positive pressure application that ensures a quick instantaneously opening to a full communication condition.

Percussive-type tools of the type under consideration include air return means that are charged during the work stroke of the tool and which operate independently of the drive function to return the piston and driver blade to a prepared condition for the next work cycle. In a sense these cylinder and piston motors are double-acting, but characterized by operating upon the drive air pressure after the end of the work stroke is reached by the piston and to thereafter return the same. Such tools have return air reservoirs that accumulate a portion of the drive air and ported into the cylinder beneath the piston to lift it when the upper end of the cylinder is exhausted, it being a general object of this invention to provide a latch valve that positively charges the return air reservoir in timed relation to release of the drive air from the storage chamber.

In practice, the inclusion of air return means operating upon accumulated drive air pressure, as generally stated in the preceding paragraph, has had its drawbacks in that a buildup of air pressure in the return air reservoir is openly ported to act beneath the piston and consequently imposes a retarding effect which prevents rapid firing of the tool. Therefore, it is an object of this invention to provide a return air bleed that is operative at the end of each complete work cycle to virtually eliminate the accumulation and/or buildup of air under pressure beneath the piston at the end of its return stroke. And it is also an object of this invention to provide a return air bleed that is operative with self-return pistons or other means which include the valving that charges the return air reservoir.

It is also an object of this invention to provide a novel assembly of elements meeting all of the requirements hereinabove referred to and which involves but a few simple and easily formed parts. The latch valve per se is a self-sealing element which is carried between two extreme positions to have a self-lapping and automatic wear takeup action. There is the usual trigger valve that operates a novel differential piston that servos the latch valve to move it instantly to the two extreme positions required. Assembly is facilitated by the use of snaprings, O-rings and with the entire latch valve mechanism accommodated in the air pressure chamber that is established by installing a single head or cover. The said cover has a diametrically disposed differential bore therethrough that operatively carries the servo piston rod, and to which the latch valve per se is keyed in position rotatably and generally as to height. The cylinder head is in the form of a ported disc that closes both the main drive cylinder and the air return reservoir, and all of which is captured in working position mainly through installation of the single head or cover on the body. It is, therefore, an object of this invention to provide a novel and most utilitarian combination of parts and elements cooperatively arranged as thus far described.

The various objects and features of this invention will be fully understood from the following detailed description of the typical preferred forms and applications thereof, throughout which description reference is made to the accompanying drawings, in which:

FIG. 1 is a cross-sectional elevation taken through a typical cylinder and piston operated tool incorporating therein the slide latch valve of the present invention. FIGS. 2 and 3 are enlarged detailed sectional views taken as indicated by lines 2—2 and 3—3 on FIG. 1. FIG. 4 is an enlarged detailed sectional view of a portion of the tool and taken as indicated by line 4—4 on FIG. 2, showing the closed positioning of the slide latch valve. FIG. 5 is a view similar to FIG. 4, showing the open positioning of the slide latch valve.

FIG. 6 is a view similar to FIG. 4 illustrating a second embodiment of the present invention, showing the closed positioning of the slide latch valve. FIG. 7 is a view similar to FIG. 6 showing the open positioning of the valve to both drive the piston and to charge the return air reservoir. FIG. 8 is a detailed fragmentary view of the slide latch valve features shown in FIGS. 6 and 7, being taken as indicated by line 8—8 on FIG. 6.

FIG. 9 is a view similar to FIGS. 4 and 6 illustrating a third embodiment of the present invention, showing a closed positioning of the slide latch valve to exhaust both the cylinder and the return air reservoir. FIG. 10 is a view similar to FIG. 9 showing the open positioning of the valve to both drive the piston and to charge the return air reservoir. FIGS. 11 and 12 are detailed views taken as indicated by lines 11—11 and 12—12 on FIGS. 9 and 10 respectively.

The air drive tools with which the present invention is concerned are for fastener driving and involve, generally, a frame A having a body portion and a handle or grip portion, a fastener guideway block B carried by the frame and adapted to direct fasteners into a piece of work, a magazine C for handling a supply of fasteners such as staples and cooperating with the guideway block B so that the fasteners are individually delivered into the work, a cylinder D and piston F operating a driver blade D, said cylinder E having a head G and all of which is arranged to establish a return air reservoir R surrounding the cylinder and an air storage chamber H overlying the cylinder and said reservoir, and in accordance with the invention a slide latch valve V cooperatively overlying the cylinder head G and a servo means S that moves and orients the latch valve for cooperation with porting in the head G. And in carrying out the invention there are various and other unique features all as hereinafter described.

The frame A carries the various elements of the total, and is shaped to be conveniently handled by a person. The body portion of the frame is a simple elongate case 10 having a cylindrical wall extending longitudinally thereof and having an opening and recess at the lower end for receiving and positioning the guideway block B. The handle or grip portion 11 of the frame is provided to give the person handling the tool a convenient means to hold the tool and is a simple grip of ordinary construction that projects from the body. In practice, the grip

is substantially normal to the axis of the body and projects therefrom. In structures of the type under consideration the body and grip portions of the frame are hollow and establish an air storage chamber H, and it is common practice to provide a continuously open fluid-pressure supply connection **12** at the grip. It is to be understood that any suitable fluid-pressure supply can be provided and in the case illustrated the hose of the pressure connection is attached to the grip through a quick disconnect.

The guideway block B extends through the lower end of the frame A and is provided to receive and deliver fasteners such as staples into the work being acted upon by the tool. The guideway block B is carried by the body in the recess provided therefor and has a limited leakage guideway therethrough that opens at its top into the cylinder and at its bottom to atmosphere or against the work. The driver blade D is slender elongate, part rectangular in cross section, and corresponding to the cross section of the guideway in block B to slide freely therein with said limit leakage of air thereby. The driver blade terminates at its forward end at a flat driving face and has an upper driven portion which couples with and has driving engagement with the piston E.

The magazine C is adapted to handle a supply or stack of fasteners such as U-shaped staples and involves a case **15** carried by the frame A, a guide **16** within the case, a follower **17** adapted to advance the staples, and a feed spring **18** yieldingly urging the follower toward the guideway and block B. A fastener or staple-receiving opening **14** extends laterally through the guideway block B, which opening enters through and into the guideway therein so that the fasteners fed to the guideway are properly guided and aligned before they are engaged by the driver blade D. The case **15** is carried by the body of the frame A and is an elongate shell-like part, and the guide **16** is a corelike part that is coextensive with the case **15** and is carried between the sidewalls thereof. A longitudinal passage **19** is formed by the case **15** conforming in general configuration to the fasteners being deployed, for example the U-shaped staples. The guide **16** enters the fastener or staple-receiving opening **14** and terminates in a flat end short of the drive blade D, and in the usual manner whereby one fastener is removed from the magazine upon each drive stroke of the tool.

The piston F operates in the cylinder E and has coupled driving engagement with the driver blade D. The piston F is adapted to drive or move the drive blade D forwardly or downwardly and is adapted to be damped or snubbed in momentary sealed engagement with a bumper **20** at the lower end of the cylinder E and after which it is returned to the upper end of the cylinder. The cylinder is carried in the surrounding cylindrical body of the frame A on the longitudinal axis thereof, being seated in the body at the lower end thereof to stand free in the body with its upper end opening into the chamber H through the cylinder head G, and leaving an annulus within the cylindrical body establishing the return air reservoir R. The piston F moves the length of the cylinder E, arresting against the cylinder head G and rebounding from the bumper **20**, said bumper being formed of an elastomer material with a parallel opening therethrough to pass the driver blade D. In carrying out the invention and in order to effect return of the piston F to an arrested and prepared condition at the upper end of the cylinder E, there are ports **21** opening through the wall of the cylinder E at the lowermost end thereof and immediately above the bumper **20**. Thus, the return air reservoir R is in continued open communication with the interior of cylinder E and always below the piston F.

The slide valve of the present invention is cooperatively combined into the tool hereinabove described, as follows: the cylinder head G is installed upon the top end of cylinder E and in sealed engagement with the cylindrical body of frame A. The servo means S is installed in the cover **25**, and the trigger valve T is installed in either the cover **25** or the body **10** and preferably in the latter. The latch valve V is then installed upon the servo means S previously installed and carried thereby into working position and slideably engaged with the cylinder head G when the cover **25** is brought into mating and closed engagement with the body **10**. The final mating of cover **25** with body **10** also places the valving elements of trigger valve T in working position in a valve chamber preferably in the cover **25**. Suitable means such as screw fasteners **24** secure the cover **25** to the body **10**, preferably at a parting line parallel to and spaced above the cylinder head G, and consequently said head is carried in a bore **26** and rests upon a shoulder **27** where it is sealed by an O-ring.

The cylinder head G is a flat disc-shaped part of substantial thickness and strength as shown, preferably made of metal with a flat and smooth upwardly exposed sealing face **28** in a plane normal to the cylinder axis. The downwardly disposed face **29** of the head closes the cylinder E and the reservoir R, there being an O-ring **30** carried in a annular groove that receives the upper terminal end of cylinder E. Thus and in accordance with the invention the cylinder head G presents the upwardly disposed sealing face **28** that is ported at **31** so as to open axially from chamber H into the interior of cylinder E. In order to gain a maximum port area with minimized valve travel, there is a multiplicity of ports **31** equally spaced in the direction of valve travel, and as shown each port **31** is a slot disposed transversely of valve travel or movement and extending between the inner diameter walls of the cylinder E. The multiplicity of slotted ports **31** are each less in width than the distance therebetween, so as to establish a substantial overlap with the latch valve V next to be described. And in practice, the slot-shaped ports **31** are suitably interrupted by interconnecting webs **32** that reinforce the head G, while the ends and/or sides of the slotted ports next adjacent the inner diameter walls of the cylinder are contoured to the curvature of said cylinder wall, coextensively with the area of the cylinder as shown. Thus, a substantial and maximum cross-sectional area of porting is attained. Further and in accordance with the invention certain areas of the cylinder head G are reserved for exhausting the cylinder E, for charging the reservoir R and for exhausting reservoir R all as hereinafter described, the porting **31** serving to instantaneously charge the cylinder E.

In accordance with the invention, the latch valve V is provided and cooperatively engages upon the sealing face **28** to move into and out of register with the port or ports **31**. Therefore, the latch valve V is provided with one or more ports **33** complementary to the ports **31** and arranged in a like pattern, so that the ports of the latch valve V align with the ports of the head G for open communication, or so that they move out of register thereby to close off the cylinder E from the chamber H. The latch valve V is also a flat part overlying the cylinder E, and preferably more than coextensively overlying the same, and preferably made of polypropelene or the like and which has a coefficient of friction with metal such as aluminum to slide freely thereon, with or without lubrication. The body of the latch valve V is essentially a flat platelike rectangular solid as shown in FIGS. **1** and **2**, and it is provided with a reserved area overlying a complementary area of the head G. In practice, these said reserved areas are for exhausting the cylinder E and are advantageously located on the central axis of the cylinder and in open communication when the latch valve is closed to shut off the ports **31**. Since the return stroke of the tool need not be percussive, the exhaust porting is minimized and relegated to a single relatively small port **34** through the head G and a like port **35** through an upstanding boss **36** projecting from the latch valve body. From the foregoing it will be seen that a full open position of the latch valve V is attained by moving the same one-half the oncenter distance between slotted ports **31** (or **33**), the ports **34** and **35** being offset in position said one-half distance for exhaust alignment and which is the starting point of said movement for opening the latch valve V. Thus the latch valve V has two reciprocally opposite positions, a normal position (see FIG. 4) where the exhaust ports **34** and **35** are aligned, and an operated position (see FIG. 5) where the charge ports **31** and **33** are aligned.

The servo means S moves and orients the latch valve V and is characterized by its ability to instantly reciprocate the valve from its normal closed-exhaust positioning to its operated cylinder-charging positioning. As shown, the servo means S is primarily a double-acting fluid-operated cylinder and piston means that includes a manually operable trigger valve T. In its preferred form the means S involves a differential cylinder and piston **45** incorporated in the cover **25**, with a crosshead **46** carrying the latch valve V, and the trigger valve T incorporated in the combined and mated body **10** and cover **25**. With the chamber H continuously charged with air under pressure the differential cylinder and piston normally holds the latch valve V in its closed-exhaust positioning, and alternately is operable through the application of positively applied air pressure to instantly shift the latch valve V into its fully open cylinder-charging position. Said positively applied air pressure is supplied to and exhausted from the operating cylinder of the servo means S by the trigger valve T which is essentially a three-way valve having two positions, one a normal position exhausting air to atmosphere from the servo cylinder, and the other a manually operated position directing air under pressure from chamber H and into the servo cylinder.

The cylinder and piston **45** of the servo means S is disposed on an axis extending transversely of the cover **25** and intersecting the axis of the cylinder E. The cover **25** is a shell-like hat-shaped part that establishes a chamber H of substantial volume overlying cylinder head G, and the differential cylinder portions **41** and **42** are bored concentrically in the diametrically opposite sidewalls of the cover, and preferably through the sidewalls. The smaller cylinder portion **41** and larger cylinder portion **42** reciprocally carry fitted opposite ends of the piston **45**, there being a stop plug **47** arresting the piston in the normal unactuated position (exhausting cylinder E) and there being a stop shoulder **48** arresting the piston in its operated or actuated position (charging cylinder E). The piston **45** has an enlarged head **49** with an O-ring seal **50** operable to move reciprocally in the larger cylinder portion **42**, and the stop plug **47** is secured in place with a snapring **43** and has a static O-ring seal **44** engageable in the cylinder. The cylinder portion **42** is ported between the movable piston head **49** and plug **47** by a channel **51** that supplied and exhausts air from and/or to the trigger valve T. The piston **45** is of reduced diameter at X and extends through the smaller cylinder portion **41** and an O-ring seal **53**.

In accordance with the invention, and in order to discharge exhaust air and to orient the latch valve V, the boss **36** of the valve and the cross head **46** of the piston are coupled. A feature is the self-sealing of the latch valve V whereby the platelike valve is urged into pressured engagement with the face **28** by the fluid under pressure within the chamber H. In order to permit said pressured engagement, the coupled engagement of piston and boss permits shifting of the valve longitudinally and axially of the tool. In practice, the crosshead **46** and boss **36** are telescopically related, there being a bore **54** in the crosshead on a axis normal to the servo piston axis, the boss **36** being cylindrical to slideably enter the bore. An O-ring **55** seals the boss within the bore, and an exhaust channel **56** continues from the bore **54** and through the reduced portion of piston **45** opening to atmosphere at the exterior of the cover **25**.

The trigger valve T in its normal position exhausts air from the channel **51**, and in its operated position directs air under pressure into the channel **51**. As shown the valve T involves a valve element **60** operable between upper and lower seats in a valve chamber **61**, a stem **62** exposed to be depressed by a manually controllable lever **63**, and a return means **64**. The stem **62** is carried in a bore entering into and through the chamber H, being sealed with an O-ring and with clearance surrounding the stem at the parting line between the body **10** and cover **25**. The valve element **60** is larger in diameter than the stem **62** and has clearance within the chamber **61**. The valve elements per se are O-rings **65** and **66** at the upper and lower ends of the valve element **60** and which seat at opposite ends of the chamber as shown. The return means **64** is a compression spring that normally holds the O-ring **66** against the lowermost seat closing off the supply of air and opening the channel **51** and chamber **61** to atmosphere through an exhaust port **67** through the cover from the upper seat of the valve. Upon manual operation of the valve T the O-ring **65** engages the uppermost seat closing off the exhaust and opening the channel **51** and chamber **61** to the air under pressure within chamber H. Thus, the trigger valve T affords a positive pressure actuation of the servo piston **45**, which then acts to instantly shift the latch valve V to a position where it directly charges the cylinder E. It is to be observed that the air flow from chamber H and into cylinder E through the ports **31** and **33** is axially direct and virtually without any change in direction of airflow.

In FIGS. **1–5** I have shown the tool and slide latch valve V as it is hereinabove described and wherein the valve boss **36** is free to shift telescopically within the crosshead **46**, the air pressure in chamber H serving as the sole bias to hold the latch valve V against the cylinder head face **28**. As the latch valve V is reciprocated by the servo means S there is an inherent wearing-in action and automatic takeup therefor, said telescoped coupled engagement of the boss **36** and the crosshead **46** permitting axial movement of the valve V for this purpose while maintaining vertical alignment of the valve and crosshead. As shown, means is provided in the form of a guide channel **80** (see FIG. 2) in the cylinder head G, to rotatably orient the latch valve V during its reciprocal movements. In this form of tool the piston F is self-returning, having a check valve **70** and passage therethrough that passes air under pressure during the work stroke to emanate beneath the piston thereby charging the return air reservoir R through the cylinder ports **21**. When the latch valve V is closed and port **35** thereof open to atmosphere, the stored air in reservoir R lifts the piston F to an arrested position beneath the cylinder head G.

In FIGS. **6–8** of the drawings I have shown a second embodiment wherein the cylinder head G^1 and slide latch valve V^1 include one or more parts **81** and **83** overlying the return air reservoir R. The opening and closing of ports **81** and **83** coincide with the opening and closing of ports **31** and **33** respectively, thereby being normally closed and charging the return air reservoir R only during the work stroke of the tool, and all independently of a self-returning piston as described above.

In FIGS. **9–13** of the drawings I have shown a third embodiment of the tool incorporating the slide latch valve V^2 with an improved crosshead **46'** that retains and guides the latch valve V^2 and which includes bias means **75** initially urging the latch valve into engagement with the face **28'** of the cylinder head G^2. The rotational positioning and longitudinal retainment of the latch valve V^2 is attained by means of a key **76** having parallel legs entering the bore in the boss through like-spaced horizontal openings and engaged with complementary spaced flats in the boss **36'**. The bias means **75** is a compression spring that seats upon the crosshead **46'** of piston **45'** and that presses against the latch valve V^2 to urge it downwardly into pressured engagement with the cylinder head face **28'**.

In the third embodiment of the tool a self-return piston is employed, the same as hereinabove described, and positive means is provided to exhaust the return air reservoir R at the end of each return cycle of the tool. In this form of the invention the latch valve V^2 includes a charge port **92** and a relief port **93** that move alternately into and out of register with charging and exhaust port **91** through the head G^2 and communicating with the return air reservoir R. The opening and closing of charging and exhaust port **91** coincides with the opening and closing of port **31** (or ports **31**), thereby charging and exhausting the return air reservoir R during the closed and exhaust positioning of the piston **45'** and for the duration of time that the piston F is arrested at the upper end of the cylinder E. The charging port **92** is of ample cross section so as to readily supply air into the return air reservoir R, while the relief port **93** is of restricted cross section so as to act as a

beam and thereby prevent depletion of air pressure until after completion of the return stroke of the piston F. The two positions of the valve and said porting are shown in FIGS. 9 and 10. Note that the cylinder head G^2 has a raised face 28' for increasing the stroke of the piston F while maintaining and/or increasing the volume of the chamber H through open communication into grip 11. As shown, the piston 45° can be sectional with spool-shaped piston heads operable in the cylinder portions 41 and 42.

From the foregoing it will be seen that the slide latch valve moves transversely at a right angle to the axis of the tool and its cylinder and piston motor. Characteristically, the charging of the motor cylinder is performed with compressed air that moves axially from the air storage chamber and directly into the motor cylinder. The latch valve is guided to reciprocate across the top face of the cylinder head which is exposed to the air storage chamber, and the porting arrangement in the latch valve and complementary porting in the cylinder head is such as to require but a short travel between fully closed and fully open positionings. The latch valve per se is a lightweight part of material that conforms to the seat upon which it is also free to slide; and also the servo means, a differentially operated cylinder and piston motor, is a lightweight composite of but few simply formed parts coupled with and to shift the latch valve. As a result of the substantial and positive air pressure available to operate the tool, the servo means is a rapid-operating device, whereby the moving of the latch valve, particularly into an open position, is a quick and positive operation and to the end that the supply of compressed air into the motor cylinder is instantaneous when the trigger of the tool is manually depressed. Further, the various embodiments hereinabove described show the versatility of this slide latch such as to be adapted to various useful arrangements effective to drive and return the piston requiring rapid and unimpeded cycles of operation.

Having described only typical preferred forms and applications of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any modifications or variations that may appear to those skilled in the art.

Having described my invention, I claim:

1. In combination: a single-stroke percussively operable motor having a cylinder with an actuating piston operable therein between a retracted position at one end of the cylinder and an actuated position at the other end of the cylinder, having a fluid-pressure storage chamber of capacity to percussively actuate the piston and overlying and next adjacent to said one end of the cylinder, having a cylinder head axially separating the interior of the cylinder from fluid-pressure storage chamber and with at least one axially disposed port therethrough, and having means supplying fluid under pressure into the said chamber; a slide latch valve movable transversely of the cylinder head and having at least one axial port therethrough movable out of and into alignment and with said at least one axially disposed port in the cylinder head, said cylinder head and said valve having mating planar surfaces; and a manually operable fluid-actuating pilot valve means connected to and actuating the slide latch valve from a closed position whereat the said ports are out of alignment to an open position whereat the said ports are in alignment; whereby fluid pressure stored in said chamber discharges axially through said ports when the slide latch valve is in the open position and into the said cylinder to move the piston percussively toward the said other end of the cylinder.

2. The single-stroke percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means as set forth in claim 1 wherein, the cylinder head is disposed in a plane normal to the cylinder axis, and wherein the slide latch valve moves reciprocally in said plane to align said ports for discharge of compressed fluid axially from the storage chamber and into the cylinder.

3. The single-stroke percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means as set forth in claim 1 wherein, the cylinder head has a flat sealing face exposed within the fluid-pressure storage chamber, and wherein the slide latch valve overlies the sealing face and is held slideably engaged thereupon by fluid pressure in said storage chamber.

4. The single-stroke percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means as set forth in claim 1 wherein, the cylinder head is disposed in a plane normal to the cylinder axis and has a flat sealing face and is held thereto to slide reciprocally in said plane and engaged upon said sealing face by fluid pressure in said storage chamber.

5. The single-stroke percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means as set forth in claim 1 wherein, the manually operable fluid-actuating pilot valve means includes a reversely operable cylinder and piston servo and a trigger valve operable to reversely charge the cylinder of said servo with fluid pressure.

6. The single-stroke percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means as set forth in claim 1 wherein, the manually operable fluid-actuating pilot valve means includes a differential cylinder and piston with spaced interconnected large and small pistons exposed to fluid pressure within the storage chamber, the large piston operable in a closed cylinder bore and the small piston operable in an exhaust bore, and a trigger valve operable to alternately charge said closed cylinder bore with fluid pressure and to exhaust the same.

7. The single-stroke percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means as set forth in claim 1 wherein, the cylinder head has a flat sealing face exposed with the fluid-pressure storage chamber, wherein the slide latch valve overlies the sealing face and is held slideably engaged thereupon by fluid pressure in said storage chamber, and wherein the manually operable fluid-actuating pilot valve includes a reversely operable cylinder and piston servo extending through the fluid-pressure storage chamber and on an axis parallel to the said flat sealing face and with the piston thereof coupled to the slide latch valve to reciprocally position the same, and a trigger valve operable to reversely charge the cylinder of said servo with fluid pressure.

8. The single-stroke percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means as set forth in claim 1 wherein, the cylinder head has a flat sealing face exposed within the fluid-pressure storage chamber, wherein the slide latch valve overlies the sealing face and is held slideably engaged thereupon by fluid pressure in said storage chamber, and wherein the manually operable fluid-actuating pilot valve means includes a trigger-operated fluid-actuated servo extending through the fluid-pressure storage chamber and on an axis parallel to the said flat sealing face and with a piston telescopically coupled to the slide latch valve on an axis normal to the plane of said flat sealing face to adjustably seat thereon.

9. The single-stroke percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means as set forth in claim 1 wherein, the cylinder head has a flat sealing face exposed within the fluid-pressure storage chamber, wherein the slide latch valve overlies the sealing face and is held slideably engaged thereupon by fluid pressure in said storage chamber, and wherein the manually operable fluid-actuating pilot valve means includes a trigger-operated fluid-actuated servo extending through the fluid-pressure storage chamber and on an axis parallel to the said flat sealing face and with a piston telescopically coupled to and with means yieldingly pressing the slide latch valve on an axis normal to and toward the plane of said flat sealing face to adjustably seat thereon.

10 The single-stroke percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means as set forth in claim 1 wherein, the cylinder

head has a flat sealing face exposed within the fluid-pressure storage chamber, wherein the slide latch valve overlies the sealing face and is held slideably engaged thereupon by fluid pressure in said storage chamber, wherein the manually operable fluid-actuating pilot valve means includes a differential cylinder and piston extending through the fluid-pressure storage chamber and on an axis parallel to said flat sealing face and with spaced interconnected large and small pistons exposed to fluid pressure within the storage chamber, the large piston operable in a closed cylinder bore and the small piston operable in an exhaust bore, wherein the slide latch valve is telescopically coupled to the interconnected pistons on an axis normal to the plane of said flat sealing face to adjustably seat thereon, and wherein a trigger valve is operable to alternately charge said closed cylinder bore with fluid pressure and to exhaust the same.

11. In combination: a double-acting percussively operable motor having a cylinder with an actuating piston operable therein between a retracted position at one end of the cylinder and an actuated position at the other end of the cylinder, having a fluid-pressure storage chamber of capacity to percussively actuate the piston and axially overlying and next adjacent to said one end of the cylinder, having a cylinder head separating the interior of the cylinder from the fluid-pressure storage chamber and with transversely spaced axially disposed inlet and exhaust ports therethrough, and having means supplying fluid under pressure into the said chamber; a slide latch valve movable transversely of the cylinder head and having transversely spaced axially disposed inlet and exhaust ports complementary to and alternately movable out of and into alignment with the inlet and exhaust ports in the cylinder head, said cylinder head and said valve having mating planar surfaces; a manually operable fluid-actuating pilot valve means actuating the slide latch valve from a closed position whereat the said inlet ports are out of alignment and the said exhaust ports are in alignment, to an open position whereat the said inlet ports are in alignment and said exhaust ports are out of alignment; whereby fluid pressure stored in said chamber discharges axially through said inlet ports when the slide latch valve is in the open position and into the said cylinder to move the piston percussively toward the said other end of the cylinder, and whereby fluid discharged into the cylinder is exhausted axially through said exhaust ports when the slide valve is in the closed position, and return means applying fluid pressure to beneath the piston when the slide latch valve is in said closed position.

12. The double-acting percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means and return means as set forth in claim 11 wherein, there is a multiplicity of complementary inlet ports through the cylinder head and slide latch valve and spaced equally transversely in the direction that the slide latch valve is moved.

13. The double-acting percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means and return means as set forth in claim 11 wherein, there is a multiplicity of complementary and equally spaced slot-shaped inlet ports through the cylinder head and slide latch valve and disposed normal to the transverse direction that the slide latch valve is moved.

14. The double-acting percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means and return means as set forth in claim 11 wherein, there is a multiplicity of complementary and equally spaced slot-shaped inlet ports through the cylinder head and slide latch valve and extending substantially coextensive between opposite walls of the cylinder and disposed normal to the transverse direction that the slide latch valve is moved.

15. The double-acting percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means and return means as set forth in claim 11 wherein, there is a single complementary exhaust port through the cylinder head and slide latch valve respectively and aligned on the center axis of the cylinder and piston when the slide latch valve is in said closed position.

16. The double-acting percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means and return means as set forth in claim 11 wherein, there is a multiplicity of complementary inlet ports through the cylinder head and slide latch valve and spaced equally in the transverse direction that the slide latch is transversely movable, and wherein there is a single complementary exhaust port through the cylinder head and slide latch valve respectively and aligned on the center axis of the cylinder and piston when the slide latch valve is in said closed position.

17. The double-acting percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means and return means as set forth in claim 11 wherein, there is a multiplicity of complementary and equally spaced slot-shaped inlet ports through the cylinder head and slide latch valve and disposed normal to the transverse direction that the slide latch valve is moved, and wherein there is a single complementary exhaust port through the cylinder head and slide latch valve respectively and aligned on the center axis of the cylinder and piston when the slide latch valve is in said closed position.

18. The double-acting percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means and return means as set forth in claim 11 wherein, there is a multiplicity of complementary and equally spaced slot-spaced inlet ports through the cylinder head and slide latch valve and extending substantially coextensive between opposite walls of the cylinder and disposed normal to the transverse direction that the slide latch valve is moved, and wherein there is a single complementary exhaust port through the cylinder head and slide latch valve respectively and aligned on the center axis of the cylinder and piston when the slide latch valve is in said closed position.

19. The double-acting percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means and return means as set forth in claim 11 wherein, the manually operable fluid-actuating pilot valve means includes a differential cylinder and piston with spaced interconnected large and small pistons exposed to fluid pressure within the storage chamber, the large piston operable in a closed cylinder bore and the small piston operable in an exhaust bore, said exhaust port through the slide latch valve being open through the interconnected pistons to the said exhaust bore, and a trigger valve operable to alternately charge said closed cylinder bore with fluid pressure and to exhaust the same.

20. The double-acting percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means and return means as set forth in claim 11 wherein, the cylinder head has a flat sealing face exposed within the fluid-pressure storage chamber, wherein the slide latch valve overlies the sealing face and is held slideably engaged thereupon by fluid pressure in said storage chamber, wherein the manually operable fluid-actuating pilot valve means includes a differential cylinder and piston extending through the fluid-pressure storage chamber and on an axis parallel to said flat sealing face and with spaced interconnected large and small pistons exposed to fluid pressure within the storage chamber, the large piston operable in a closed cylinder bore and the small piston operable in an exhaust bore, wherein the slide latch valve is telescopically coupled to the interconnected piston on an axis normal to the plane of said flat sealing face to adjustably seat thereon, said exhaust port through the slide latch valve being open through said telescopic couple to open through said exhaust bore, and wherein a trigger valve is operable to alternately charge said closed cylinder bore with fluid pressure and to exhaust the same.

21. In combination: a double-acting percussively operable motor having a cylinder with an actuating piston operable therein between a normally retracted position at one end of the cylinder and an actuated position at the other end of the cylinder, having a fluid-pressure storage chamber axially overlying and next adjacent to said one end of the cylinder, having a return fluid reservoir in open communication into the said

other end of the cylinder, having a cylinder head separating the interior of the cylinder from the fluid-pressure storage chamber and with transversely spaced axially disposed inlet and exhaust reservoir-charging ports, and having means supplying fluid under pressure into the said chamber; a slide latch valve movable transversely of the cylinder head and having transversely spaced axially disposed inlet and exhaust and reservoir charging ports complementary to and alternately movable out of and into alignment with the inlet and exhaust and reservoir charging ports in the cylinder head, said cylinder head and said valve having mating planar surfaces; a manually operable fluid-actuating pilot valve means actuating the slide latch valve from a closed position whereat the said inlet ports and said reservoir-charging ports are out of alignment and the said exhaust ports are in alignment, to an open position whereat the said inlet ports and said reservoir-charging ports are in alignment and the said exhaust ports are out of alignment; whereby fluid pressure stored in said chamber discharges axially through said inlet ports and said reservoir-charging ports when the slide latch valve is in the open position and into the said cylinder to move the piston percussively toward the said other end of the cylinder and into said return fluid reservoir, and whereby fluid discharged into the cylinder is exhausted axially through said exhaust ports when the slide latch valve is in the closed position and the piston is returned to the normally retracted position by fluid pressure from the return fluid reservoir applied into the other end of the cylinder and beneath the piston.

22. The double-acting percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means and return-fluid reservoir as set forth in claim **21** wherein, the cylinder head extends radially of the cylinder to overlie the return-fluid reservoir with the reservoir-charging ports through the said head and slide latch valve opening from the fluid-pressure storage chamber and into the return-fluid reservoir when the slide latch valve is in the open position.

23. The double-acting percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means and return-fluid reservoir as set forth in claim **21** wherein, the cylinder head extends radially of the cylinder to overlie the return-fluid reservoir with the reservoir-charging ports through the said head and slide latch valve opening from the fluid-pressure storage chamber and into the return-fluid reservoir when the slide latch valve is in the open position, and wherein the manually operable fluid-actuating pilot valve means includes a differential cylinder and piston with spaced interconnected large and small pistons exposed to fluid pressure within the storage chamber, the large piston operable in a closed cylinder bore and the small piston operable in an exhaust bore, and a trigger valve operable to alternately charge said closed cylinder bore with fluid pressure and to exhaust the same.

24. The double-acting percussively operable cylinder and piston motor combined with the slide latch valve and manually operable means and return-fluid reservoir as set forth in claim **21** wherein, the cylinder head extends radially of the cylinder to overlie the return-fluid reservoir with the reservoir-charging ports through the said head and slide latch valve opening from the fluid reservoir when the slide latch valve is in the open position, wherein the cylinder head has a flat sealing face exposed within the fluid-pressure storage chamber, wherein the slide latch valve overlies the sealing face and is held slideably engaged thereupon by fluid pressure in said storage chamber, wherein the manually operable fluid-actuating pilot valve includes a differential cylinder and piston extending through the fluid-pressure storage chamber and on an axis parallel to said flat sealing face and with spaced interconnected large and small pistons exposed to fluid pressure within the storage chamber, the large piston operable in a closed cylinder bore and the small piston operable in an exhaust bore, wherein the slide latch valve is telescopically coupled to the interconnected pistons on an axis normal to the plane of said flat sealing face to adjustably seat thereon, and wherein a trigger valve is operable to alternately charge said closed cylinder bore with fluid pressure and to exhaust the same.

25. In combination: a double acting percussively operable motor having a cylinder with a self-returning actuating piston operable therein between a normal retracted position at one end of the cylinder and an actuated position at the other end of the cylinder, having a fluid pressure storage chamber axially overlying and next adjacent to said one end of the cylinder, having a return fluid reservoir in open communication into the said other end of the cylinder, having a cylinder head separating the interior of the cylinder from the fluid pressure storage chamber and with transversely spaced axially disposed inlet and exhaust and reservoir relief ports, having a check valve admitting fluid from said one end of the cylinder and into the return fluid reservoir, and having means supplying fluid under pressure into the said chamber, a slide latch valve movable transversely of the cylinder head and having transversely spaced axially disposed inlet and exhaust and reservoir relief ports complementary to and alternately movable out of and into alignment with the inlet and exhaust and reservoir relief ports in the cylinder head, said cylinder head and said valve having mating planar surfaces; a manually operable fluid actuating pilot valve means actuating the slide latch valve from a closed position whereat the said inlet ports are out of alignment and the said exhaust and reservoir relief ports are in alignment, to an open position whereat the said inlet ports are in alignment and the said exhaust and reservoir relief ports are in alignment, to an open position whereat the said inlet ports are in alignment and the said exhaust and reservoir relief ports are out of alignment; whereby fluid pressure stored in said chamber discharges axially through said inlet ports when the slide latch valve is in the open position and into the said cylinder to more the piston percussively toward the said other end of the cylinder, and through said check valve charging said reservoir, and whereby fluid discharged into the cylinder is exhausted axially through said exhaust ports when the slide latch valve is in the closed position and the piston is returned to the normally retracted position by fluid pressure from the return fluid reservoir applied into the other end of the cylinder and beneath the piston.

26. The double acting percussively operable cylinder and self-returning piston motor combined with the slide latch valve and manually operable means and return fluid reservoir as set forth in claim **25** wherein the cylinder head extends radially of the cylinder to overlie the return fluid reservoir with the reservoir relief ports through the said head and slide latch valve opening from the return fluid reservoir to an exhaust port when the slide latch valve is in the closed position.

27. The double acting percussively operable cylinder and self-returning piston motor combined with the slide latch valve and manually operable means and return fluid reservoir as set forth in claim **25** wherein the cylinder head extends radially of the cylinder to overlie the return fluid reservoir with the reservoir relief ports through the said head and slide latch valve opening from the return fluid reservoir to an exhaust port when the slide latch valve is in the closed position, and wherein the manually operable fluid actuating pilot valve means includes a differential cylinder and piston with spaced interconnected large and small pistons exposed to fluid pressure within the storage chamber, the large piston operable in a closed cylinder bore and the small piston operable in an exhaust bore, and a trigger valve operable in an exhaust bore, and a trigger valve operable to alternately charge said closed cylinder bore with fluid pressure and to exhaust the same.

28. The double acting acting percussively operable cylinder and self-returning piston motor combined with the slide latch valve and manually operable means and return fluid reservoir as set forth in claim **25** wherein the cylinder head extends radially of the cylinder to overlie the return fluid reservoir with the reservoir relief ports through the said head and slide latch valve opening from the return fluid reservoir to an exhaust port when the slide latch valve is in the closed position, and

wherein the cylinder head has a flat sealing face exposed within the fluid pressure storage chamber, wherein the slide latch valve overlies the sealing face and is held slideably engaged thereupon by fluid pressure in said storage chamber, wherein the manually operable fluid actuating pilot valve means includes a differential cylinder and piston extending through the fluid pressure storage chamber and on an axis parallel to said flat sealing face and with spaced large and small pistons exposed to fluid pressure within the storage chamber, the large piston operable in a closed cylinder bore and the small piston operable in an exhaust bore, wherein the last said piston operable in an exhaust bore, wherein the last said piston is telescopically coupled to the slide latch valve on an axis normal to the plane of said flat sealing face to reciprocally position the same, and wherein a trigger valve is operable to alternately charge said closed cylinder bore with fluid pressure and to exhaust the same.