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FASTENER DRIVING APPARATUS

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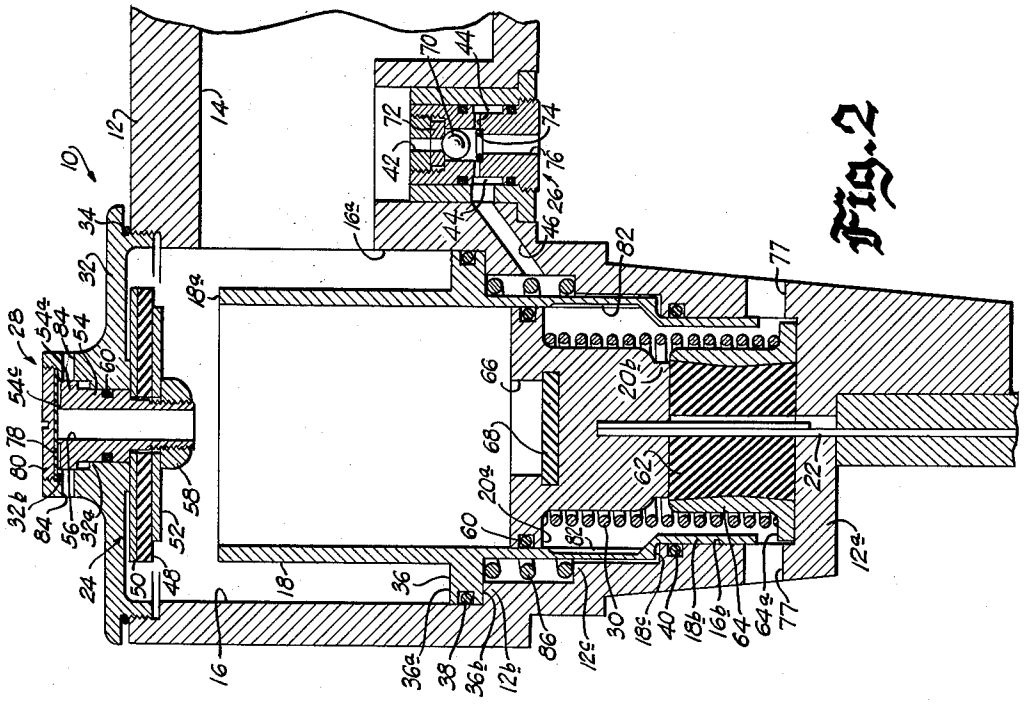

Fig. 2

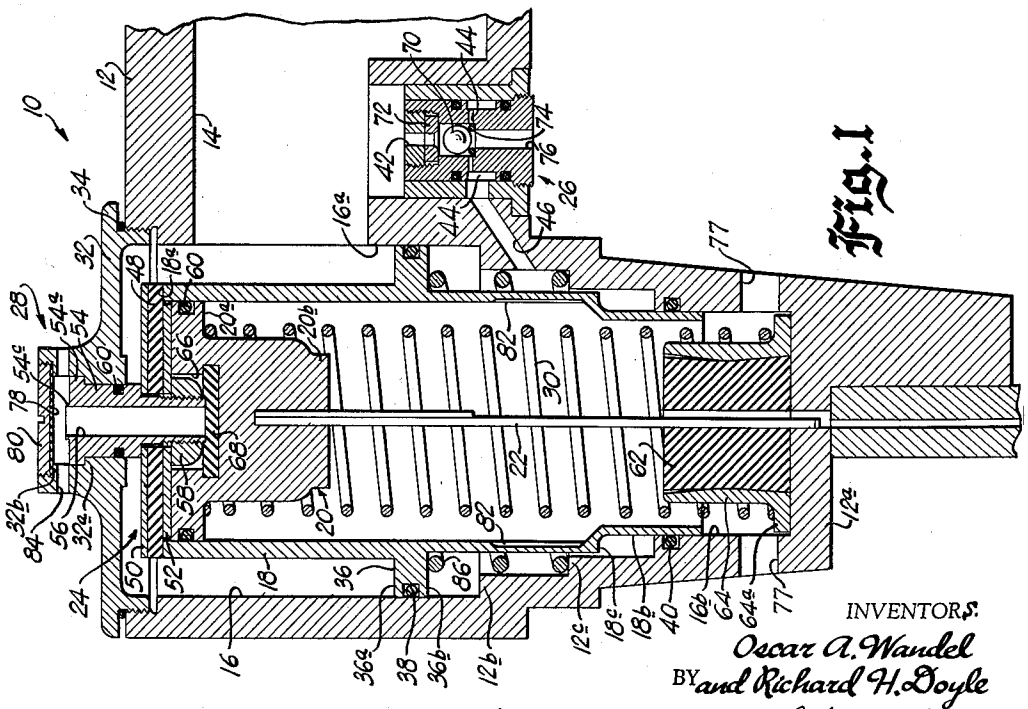

Fig. 1

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FASTENER DRIVING APPARATUS

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This invention relates to a fastener driving apparatus, and, more particularly, to an improved pneumatic stapler or tacker providing increased fastener penetration.

With the increased utilization of pneumatically operated tools for driving fasteners, a problem has been encountered in securing adequate penetration of the fasteners, such as nails or staples, into relatively hard substances without resorting to increased compressed air pressures or multiple power stroke devices. To overcome the deficiencies of these types of apparatus, an application of Oscar A. Wandel and Richard H. Doyle, Serial No. 546,377, filed November 14, 1955, now abandoned, discloses a pneumatically operated tacker including an air reservoir capable of being placed in direct communication with the drive cylinder so as to afford a large volume of compressed air at full line pressure for actuating the drive piston. The driving force created in this apparatus, due to the mass of the drive piston and the blade and the velocity of movement thereof, provides deep fastener penetration but, in some instances, produces a recoil due to the mass of the piston which may become objectionable.

Accordingly, one object of the present invention is to provide a new and improved fastener driving device of the type including an operating medium reservoir.

Another object is to provide a fastener driving device wherein deeper fastener penetration is achieved by the use of a relatively light piston moving at increased driving velocities.

Another object is to provide a fastener driving device including new and improved means for supplying a compressed medium to a work cylinder.

A further object of the present invention is to provide a fastener driving device having reduced recoil.

A further object is to provide new and improved valve means for controlling the flow of compressed air to a cylinder in a fastener driving device.

Another object is to provide a fastener driving device including a movably mounted work cylinder.

Another object is to provide a pneumatically operated fastener driving device including new and improved means for exhausting a work cylinder.

A still further object is the provision of a pneumatically operated fastener driving device including a cylinder for receiving a fastener driving piston in which the cylinder is movable to different positions to control the admission of compressed air to the cylinder for actuating the piston.

In accordance with these and many other objects, one embodiment of the invention comprises a housing defining a chamber in which is slidably mounted a work cylinder having a radially extending flange defining a piston. A circular valve seat including a resilient diaphragm is secured to a supporting member having an exhaust passageway therethrough which is slidably mounted on the housing adjacent the upper open end of the cylinder. In the normal position of the apparatus, the compressed air supplied to the housing chamber forces the circular valve

seat into engagement with the upper extremity or edge of the work cylinder to seal off communication between the chamber and the interior of the cylinder. A fastener driving means is provided including a piston slidably mounted within the cylinder having a driving blade which extends outwardly from the housing and is adapted to engage and drive fasteners supplied from a suitable magazine.

In the normal or released position of the tacker or fastener driving apparatus, a control valve arrangement supplies compressed air to a lower surface of the flange formed on the cylinder. This surface of the flange together with other adjacent surfaces formed on the cylinder have a greater effective area than the other side of the flange, and, accordingly, in the released position, the work cylinder is urged upwardly into engagement with the resilient gasket carried on the circular valve seat to close off communication between the reservoir and the interior of the cylinder. When the tacker is actuated, the control valve is operated to cut off the supply of compressed air to the lower surface of the flange and this portion of the chamber is vented to the atmosphere so that a pressure differential is produced across the flange causing the movably mounted cylinder to move downwardly. The compressed air in the chamber acts on the resilient diaphragm, which is in engagement with the upper edge of the cylinder, so that during the initial downward movement of the cylinder, the interior thereof is maintained out of communication with the chamber. However, after a predetermined movement exceeding the movement afforded by the flexible sealing element or diaphragm, this resilient element snaps away from the upper edge of the movably mounted work cylinder, thereby to provide a large opening for admitting a large volume of compressed air at full line pressure from the reservoir or chamber formed in the tacker housing into the interior of the work cylinder.

This large body of compressed air drives the piston of the fastener driving arrangement downwardly to drive a fastener. Simultaneously with the downward movement of the work cylinder following the admission of compressed air, this air acts on the lower surface of the circular valve element to provide an upwardly directed force which moves the circular valve element and the supporting member therefor upwardly so that the supporting member engages a sealing gasket carried on the housing to close the exhaust passageway, thus permitting the piston to move downwardly under the force of the compressed air in the cylinder. When the piston reaches the lowermost point of its downward travel, it engages a bumper arrangement and is held in this position by the compressed air.

When the control valve is released, the venting connection to the lower surface of the flange on the work cylinder is closed and compressed air is once again admitted thereto, thereby causing the work cylinder to move upwardly due to the greater effective area disposed beneath the flange. This upward movement continues until such time as the upper edge of the cylinder moves into engagement with the circular resilient gasket on the main valve element, which is now disposed adjacent the upper wall of the housing. In moving upwardly relative to the piston which is maintained in its lower position by the compressed air contained within the interior of the work cylinder, a pair of grooves or passageways formed on the inner wall of the work cylinder pass the piston,

thereby permitting a portion of the air contained within the piston to be vented to the atmosphere through a restricted orifice. Since communication between the chamber and the interior of the work cylinder is cut off by the engagement of the upper edge of the cylinder with the seating diaphragm, a pressure differential is produced between the upper and lower surfaces of the circular valve element so that a downwardly directed force is applied to the main valve assembly to move both the main valve and the work cylinder downwardly until stop means formed on the main valve assembly prevents further downward movement. At this time, the air pressure acting on the upper surface of the cylindrical main valve element and the compressed air pressure acting on the greater effective area beneath the flange on the work cylinder maintains the upper edge of the work cylinder in seating engagement with the resilient gasket forming a portion of the main valve assembly, thereby closing off further communication between the chamber and the interior of the work cylinder.

During the downward movement of the main valve, the upper extremity of the supporting member for the main valve moves out of engagement with the seating gasket so that the passageway through this supporting member places the interior of the cylinder in communication with the atmosphere. This vents the remaining compressed air within the work cylinder to atmosphere to permit the piston to be returned to its normal home position under the control of a return spring interposed between the lower edge of the piston and the end of the chamber. When the piston moves into engagement with the supporting member of the main valve element, thereby determining the upper limit of movement of the piston, a resilient gasket carried on the piston seals the lower end of the passageway in the supporting member to again close the exhaust means.

Many other objects and advantages of the present invention will become apparent from a consideration of the following description when taken in conjunction with the following drawings wherein:

FIG. 1 is a fragmentary sectional view of a pneumatically operated fastening device embodying the present invention which is shown in a normal or released position; and

FIG. 2 is a fragmentary sectional view similar to FIG. 1 showing the fastener driving device in an operated position.

Referring now to FIG. 1 of the drawings, a pneumatic tacker or fastener driving device indicated generally as **10** embodying the present invention includes a housing **12** in which is defined a large volume compressed air reservoir **14** and an enlarged chamber **16** in which is slidably disposed a cylinder **18**. A fastener driving means includes a piston **20** slidably mounted within the cylinder **18** and secured to a driving blade **22** which is adapted to move outwardly through a drive track formed in a nosepiece **12***a* of the housing **12** to engage and drive suitable fasteners, such as staples or nails, supplied to the drive track by a magazine (not shown). The upper end of the cylinder **18** is normally closed off from communication with the chamber **16**, which is continuously supplied with compressed air from the reservoir **14**, by a main valve assembly **24**.

When the tacker **10** is operated actuation of a control valve assembly **26**, which is of the type disclosed in the above identified copending Wandel and Doyle application, causes the work cylinder **18** to move downwardly and the main valve assembly **24** to move upwardly so that compressed air from the chamber **16** and the reservoir **14** flows into the interior of the cylinder **18** at substantially full line pressure, without turbulence, and in large quantities to drive the lightweight piston **20** downwardly at a high rate of speed so that the blade **22** engages and drives a staple. Upward movement of the main valve assembly **24** closes an exhaust valve assembly **28** to permit the compressed air pressure to build up rapidly within the cylinder **18**.

When the valve **26**, which is manually or automatically operated, is released, the work cylinder **18** moves upwardly to engage the main valve element **24**, which is disposed immediately adjacent the housing **10** (FIG. 2), thereby closing off communication between the chamber **16** and the interior of the cylinder **18**. During this movement, the interior of the cylinder **18** is vented to atmosphere through a restricted orifice so that the compressed air pressure within the cylinder **18** is decreased below that in the chamber **16**. This pressure differential acts on the upper surface of the main valve assembly **24** to provide a force which moves the engaged cylinder **18** and main valve assembly **24** downwardly to the position illustrated in FIG. 1. In moving downwardly, the main valve assembly **24** opens the exhaust valve arrangement **28** so that the pressure of the air trapped in the cylinder **18** between the upper surface of the piston **20** and the lower surface of the main valve assembly **24** is quickly vented to atmosphere to permit the piston **20** and the drive blade **22** to be restored to the normal position illustrated in FIG. 1 under control of a piston return spring **30** which is interposed between a lower end of the piston **20** and the nosepiece **12***a*.

The housing **12**, which may comprise a casting, provides the nosepiece **12***a* forming the drive track to which fasteners are supplied by a suitable magazine and defines the chamber **16** including a portion **16***a*, which is cylindrical. The reservoir **14** defined by the housing **12** may comprise a hollow handle for the tacker **10** having a fitting (not shown) for connection to an air line which supplies compressed air to the reservoir **14** and to the cylinder **16**. The volume of the reservoir **14** and the chamber **16** is sufficient to insure an adequate volumn of compressed air for driving the piston **20**. An opening in the housing **12** above the chamber **16** is closed by a closure cap **32**, a resilient O-ring **34** being interposed between the closure member **32** and the housing **12** to prevent the leakage of air from the chamber **16**.

The cylinder **18** includes a radially extending and annular flange **36** which is recessed at its outer extremity to receive an O-ring **38**. The cylinder **18** is mounted within the chamber **16** with the flange **36** slidably received within the circular portion **16***a* of the chamber so that, in effect, the flange **36** defines a piston having an upper surface **36***a* in communication with the compressed air provided in the reservoir **14** and the chamber **16** and having a lower surface **36***b* of greater effective area than the upper surface **36***a*. A reduced diameter lower portion **18***b* of the piston **18**, which is slidably received within a reduced diameter cylindrical portion **16***b* of the chamber **16** provides an additional annular area **18***c*. An O-ring **40** maintains an airtight seal between the reduced diameter portions **16***b* and **18***b*. By the selective admission of compressed air from the reservoir **14** to the portion of the chamber **16** bounded by the O-rings **38** and **40**, a resultant upwardly directed force, due to the greater effective area of the surfaces **36***b* and **18***c* than the area of the surface **36***a*, is provided for forcing the cylinder **18** upwardly into engagement with the main valve assembly **24**. The portion of the chamber **16** bounded by the O-rings **38** and **40** is normally supplied with compressed air from the reservoir **14** through a pair of passageways **42** and **44** in the control valve assembly **26** and a passageway **46** in the housing **12**.

To normally close the open upper end of the work cylinder **18** in the inoperative or released condition of the tacker **10** and further to provide a stop for the piston **20**, the main valve assembly **24** is provided. This assembly includes a resilient and deformable washer or gasket **48** which is disposed between a pair of plates **50** and **52**. These two plates are held in engagement with the gasket **48** and are secured to a supporting member **54** having an exhaust passageway **56** passing therethrough

by a nut 58. The supporting member 54, which is recessed intermediate its ends to receive a resilient O-ring 60, is slidably mounted in an annular opening in the closure cap 32 so that the force of the compressed air acting on the upper surface of the plate 50 normally holds the main valve assembly 24 in the position illustrated in FIG. 1. This position is determined by a stop arrangement for limiting downward movement of the member 54 which comprises a flanged portion 54*a* on the supporting member 54 which engages a shoulder 32*a* formed in the closure cap 32. Accordingly, the compressed air acting on the upper surface of the plate 50 holds the main valve assembly 24 in the position shown in FIG. 1, and the compressed air acting on the surfaces 36*b* and 18*c* forces an upper edge 18*a* of the cylinder 18 into seating engagement with the resilient gasket 48, thereby closing off communication between the interior of the cylinder 18 and the chamber 16 and reservoir 14.

The piston 20, which is slidably disposed within the work cylinder 18 is preferably formed of a lightweight material, such as aluminum or magnesium, to permit higher velocity movement during a fastener driving operation than is possible with pistons of conventional design and construction. The improved fastener driving apparatus of the present invention supplies large quantities of compressed air at full line pressure to the cylinder 18 upon operation so that, by providing a lighter piston 20, this piston moves at an increased velocity. This increased velocity affords adequate driving power, but the reduced weight of the pitson reduces the recoil effect sometimes observed in prior pneumatically operated fastener driving tools having a moving piston driver.

The piston 20 comprises a flanged portion 20*a* for receiving an O-ring 60 and a reduced diameter lower portion 20*b* which is adapted to engage a resilient bumper 62. The bumper 62 is mounted within a retaining ring 64 having a flanged lower edge 64*a*, the lower surface of which is adapted to engage the housing 12. The piston return spring 30 is interposed between the upper surface of the flange 64*a* and the lower surface of the flange 20*a* so that, in the normal position, the piston 20 is urged upwardly toward the main valve assembly 24. To provide a stop for the piston 20, a recess 66 is formed in the upper end of the piston 20 which receives a resilient cushion element 68. The return spring 30 normally urges the resilient element 68 into engagement with the lower end of the supporting member 54 so as to limit upward movement of the piston 20.

The control valve assembly 26, which is mounted on the housing 12, selectively controls the admission of compressed air to and the exhaustion of air from the cavity bounded by the O-rings 38 and 40 so as to produce pressure differentials across the piston defining flange 36 for controlling selective movement of or the position of the work cylinder 18. The control valve arrangement 26 is not disclosed in detail, but it can be similar to the control valve arrangement disclosed in the above identified copending Wandel and Doyle application. As set forth above, a pair of passageways 42 and 44 in the control valve 26 are normally in communication to supply compressed air from the reservoir 14 through a passageway 46 to the above described portion of the chamber 16, thereby providing a force operating on the surfaces 36*b* and 18*c* for urging the upper edge 18*a* of the work cylinder 18 into engagement with the gasket 48 of the main valve assembly 24.

When the tacker or stapler 10 is to be operated, a ball valve element 70 is moved into engagement with a valve seat 72 by a suitable operating means to close the passage 42, thereby preventing additional compressed air from flowing to a cavity bounded by the O-rings 38 and 40. Simultaneously with this movement of the valve element 70, it is displaced from engagement with an O-ring 74 so as to place the passageways 44 and 46 in communication with an exhaust passageway 76 formed in the valve assembly 26. The opening of this exhaust passageway permits the compressed air in the cavity bounded by the O-rings 38 and 40 to be exhausted to atmosphere to produce a pressure differential across the flange 36. The force acting on the surface 36 of the flange moves the work cylinder 18 downwardly to initiate the opening of the main valve assembly 24 so that compressed air is admitted to the interior of the cylinder 18 to actuate the fastener driving arrangement.

One aspect of the present invention involves the provision of a pop type acting valve which insures the immediate entrance of a large volume of air at full line pressure into the interior of the cylinder 18 so that the lightweight piston 20 is driven at increased velocities to provide greater force for securing deep penetration by the fastener. More particularly, as the cylinder 18 begins to move downwardly, the compressed air in the chamber 16 and the reservoir 14 acts on the edge or outer peripheral surface of the resilient gasket 48 so that the edge portion thereof which is not supported by the smaller diameter plate 52 pulls away from contact with the outer edge of the plate 50 to remain in sealing engagement with the upper edge 18*a* of the cylinder 18. Accordingly, during this initial movement of the cylinder 18, the diaphragm 48 stretches and remains in sealing engagement with the edge 18*a* so that a substantial separation of the main valve assembly 24 and the cylinder 18 occurs. After a predetermined movement which exceeds the length to which the resilient member 48 can be extended, the edge portion of this resilient element snaps back into engagement with the upper plate 50 so that a relatively large opening is immediately provided between the upper edge 18*a* of the work cylinder 18 and the main valve assembly 24, thereby permitting a large volume of compressed air at full line pressure to enter the interior of the cylinder 18. This body of compressed air rapidly forces the piston 20 and the driving blade 22 downwardly against the action of the piston return spring 30 so that the fastener supplied to the drive track in the nosepiece 12*a* is driven into the workpiece, the downward movement of the piston 20 being terminated by engagement of the reduced diameter portion 20*b* thereof with the resilient bumper 62. The air trapped in the cylinder 18 below the piston 20 is exhausted to the atmosphere through spaced openings 77 in the housing 12. Concurrently with the downward movement of the piston 20, the work cylinder 18 moves to the position illustrated in FIG. 2 of the drawings in which the lower surface 36*b* of the flange 36 engages an annular shoulder 12*b* formed in the housing 12.

The compressed air admitted into the interior of the cylinder 18 tends to balance the forces acting on the main valve assembly 24. However, the upper surface of the supporting member 54 is at atmospheric pressure so that a resultant upwardly directed force is provided which drives the assembly 24 upwardly until the top surfac of the plate 50 engages the closure element 32 (FIG. 2). This upwardly directed movement of the main valve assembly 24, which occurs simultaneously with the downward movement of the work cylinder 18 following the separation of the gasket 48 from the upper edge 18*a* of the cylinder 18, further increases the size of the opening for permitting compressed air to flow from the chamber 16 and the reservoir 14 into the interior of the cylinder 18. The provision of the unsupported portion of the resilient gasket 48, which permits its distortion as described above, together with the simultaneous downwardly directed movement of the cyllinder 18 and upwardly directed movement of the main valve assembly 24 provides a pop type valve for securing the instantaneous admission of a large volume of compressed air at full line pressure for driving the piston at high velocities.

The selective movement of the main valve assembly 24, in addition to providing a quick opening valve for controlling the admission of air to the interior of the

cylinder 18, also controls the selective operation of the exhaust valve arrangement 28 so that this valve is opened during return movement of the piston 20 and is closed during downward movement of the piston 20. More specifically, when the cylinder 18 moves downwardly in response to the opening of the main valve arrangement 24, compressed air is admitted into the interior of the cylinder 18, and a portion of this compressed air tends to move to atmosphere through the exhaust passageway 56. However, the main valve assembly 24, which is secured to the supporting member 54, is immediately moved upwardly, as described above, so that an annular boss 54*c* concentric with the passageway 56 moves into seating engagement with a resilient member 78, thereby immediately closing the exhaust passageway 56 to prevent the air admitted to the interior of the cylinder 18 and that provided in the chamber 16 from being exhausted to atmosphere. A lower edge of the resilient member 78 is seated on a shoulder 32*b* formed in the closure cap 32, and this member is held in engagement therewith by a plate 80 which is threadedly secured to the closure cap 32. Accordingly, when the main valve assembly 24 is opened to initiate downward movement of the piston 20, the exhaust passageway 56 is simultaneously closed by the upward movement of the valve assembly 24 which moves the boss 54*c* into seating engagement with the resilient element 78.

When the apparatus or device 10 is to be released, the displacing force is removed from the ball valve element 70 so that the compressed air in the reservoir 14 passing through the passageway 42 displaces the ball valve 70 from the seat 72 and forces it into sealing engagement with the O-ring 74, thereby closing the exhaust passageway 76. Moving the ball valve 70 out of engagement with the valve seat 72 completes the above described path including the passageways 42, 44, and 46 for again supplying compressed air to the cavity bounded by the O-rings 38 and 40. The admission of compressed air to this cavity provides a force acting on the surfaces 36*b* and 18*c* which forces the cylinder 18 upwardly. The cylinder 18 moves upwardly beyond the normal position illustrated in FIG. 1 until such time as the upper edge 18*a* thereof moves into engagement with the resilient gasket 48 in the main valve assembly 24, which is now positioned in engagement with the cap 32 as described above. During this movement the piston 20 remains in its lowermost position in engagement with the resilient bumper 62 due to the force of the compressed air in the cylinder 18.

To provide a means for moving the engaged main valve assembly 24 and work cylinder 18 to the normal position illustrated in FIG. 1, when the cylinder 18 moves upwardly relative to the piston 20, a plurality of longitudinally extending and peripherally spaced grooves or depressions 82 in the inner surface of the work cylinder 18 are moved past the flanged portion 20*a* of the piston 20 to permit the compressed air in the cylinder 18 to be partially vented to the atmosphere through the reduced area orifices or passageways 82 and the exhaust passageways 77. This reduces the pressure of the compressed air in the cylinder 18 so that, when the gasket 48 and the upper edge 18*a* of the cylinder 18 are moved into at least light sealing engagement, a pressure differential is produced between the interior of the cylinder 18 and the chamber 16 which acts upon the upper surface of the top plate 50 to move the engaged main valve assembly 24 and the cylinder 18 downwardly to the position illustrated in FIG. 1 of the drawings. As set forth above, this position is determined by movement of the annular flange 54*a* on the supporting member 54 into engagement with the shoulder 32*a* on the closure cap 32.

To provide a means for venting the remaining compressed air within the cylinder 18, when the main valve assembly 24 returns to its normal position, the downward movement of the supporting member 54 moves the boss 54*c* out of sealing engagement with the resilient member 78 so that the passageway 56 is opened. This passageway is in communication with a plurality of peripherally spaced and radially extending passageways 84 formed in the closure cap 32 which provide passageways for exhausting the compressed air from the interior of the cylinder 18. As this compressed air is exhausted, the piston return spring 30 becomes effective to move the piston 20 upwardly to the position shown in FIG. 1. In this position, the nut 58 and the lower end of the supporting member 54 enter the opening 66 in the piston 20 and engage the resilient pad 68 carried on the piston to cushion its return movement.

In accordance with another feature of the present invention, a cylinder return spring 86 is interposed between the lower surface 36*b* of the flange 36 and an annular shoulder 12*c* formed in the housing 12. As described above, the selective movement of the work cylinder 18 is produced by the provision of upwardly or downwardly directed forces due to compressed air acting on the surfaces 36*a*, 36*b*, and 18*c* of the work cylinder 18. In the released condition of the tacker 10, the forces acting on the piston defining flange 36 are sufficient to hold the cylinder 18 in engagement with the main valve assembly 24. However, when an air line is first attached to the apparatus 10, there is a possibility that the air pressure in the chamber 16 and the reservoir 14 will increase more rapidly than the buildup of pressure in the portion of the chamber bounded by the O-rings 38 and 40, due to the somewhat restricted passageway afforded by the passageways 42, 44, and 46. This pressure differential is sufficient to cause a valve opening operation, as described above, thereby resulting in the inadvertent operation of the tacker 10. By the provision of the return spring 86, a sufficient force is provided resisting downward movement of the cylinder 18 to avoid inadvertent operation of the tacker 10 until such time as sufficient air pressure has built up in the cavity bounded by the O-rings 38 and 40.

Also, during maintenance or following assembly of the tacker 10 when air pressure is not supplied to the reservoir 14, if the cylinder 18 moves downwardly due to its own weight or due to vibration, it is possible for the flange portion 20*a* of the piston 20 to become interposed between the upper edge 18*a* of the sliding cylinder 18 and the lower edge of the valve assembly 24, thereby preventing proper operation of the tacker 10. The provision of the interposed spring 86 assures that the cylinder 18 is maintained in its normal upper position in engagement with the main valve assembly 24 and thus prevents improper alignment of the piston 20. It will readily be appreciated that, if compressed air is not supplied to the reservoir 14, the spring 86, in forcing the cylinder 18*a* upwardly, will force the main valve assembly 24 against the closure cap 32.

In view of the foregoing detailed description of the tacker or stapler 10, it is submitted that the operation will be readily understood from the following brief description thereof. When the tacker 10 is in the normal position illustrated in FIG. 1, operation of the main valve 26 displaces the ball valve 70 from engagement with the O-ring 74 into engagement with the resilient valve seat 72, thereby closing the inlet passageway 42 and opening the exhaust passageway 76. The compressed air normally supplied within the chamber bounded by the O-rings 38 and 40 is exhausted to the atmosphere through the passageways 46, 44, and 76 so that an effective force is produced acting on the upper surface 36*a* of the flange 36 to move the cylinder 18 downwardly.

During initial downward movement, the resilient gasket 48 is distorted to remain in sealing engagement with the upper edge 18*a* of the cylinder 18. After the limit of distortion of the resilient member 48 has been reached, it snaps back into engagement with the top plate 50 and out of sealing engagement with the upper edge 18*a* of the cylinder, thereby providing a large opening through which the compressed air in the chambers 16 and 14 passes into the interior of the cylinder 18. This compressed air acts on the main valve assembly 24 to move

it upwardly. The downward movement of the cylinder **18** and the concurrent upward movement of the main valve assembly **24** produces a large opening through which a large volume of compressed air moves into the interior of the cylinder **18**, thereby to drive the lightweight piston **20** downwardly at a high velocity. In moving downwardly, the cylinder **18** opens the lower end of the exhaust passageway **56**, but the concurrent upward movement of the main valve assembly **24** seats the boss **54***c* on the resilient element **78**, thereby sealing off the exhaust passageway **56** to permit a pressure buildup within the cylinder **18**.

When the control valve **26** is released, the exhaust passageway **76** is again sealed and the inlet passageway **42** opens to again supply compressed air to the chamber bounded by the O-rings **38** and **40**, thereby initiating upward movement of the cylinder **18**. The cylinder **18** moves upwardly until the upper edge **18***a* thereof again engages the resilient gasket **48** of the main valve assembly **24**, which is now positioned in engagement with the closure cap **32** (FIG. 2). As the recesses **82** in the cylinder **18** move past the flange **20***a* on the piston **20**, which remains in engagement with the bumper **32** at its lowermost position, the pressure within the interior of the cylinder **18** is reduced so that a pressure differential is produced between the chamber **16** and the interior of the cylinder **18** to cause the engaged main valve assembly **24** and the cylinder **18** to move downwardly to the position shown in FIG. 1. In moving downwardly, the boss **54***c* is moved out of engagement with the resilient element **78** to open the exhaust valve **28** including the passageways **56** and **84**, thereby exhausting the compressed air within the cylinder **18** to the atmosphere to permit the piston **20** to be restored to its normal position by the piston return spring **30**.

As set forth in detail above, it will be readily appreciated that the present invention provides a tacker **10** including improved means for admitting a large volume of air into a work cylinder to provide for high velocity movement of a lightweight piston, thereby to secure greater force for driving fasteners into workpieces. This increased volume of compressed air at full line pressure is provided by a movable cylinder **18** which operates in conjunction with a resilient element **48** on a movable valve assembly **24** so as to provide a pop valve which instantaneously affords a large area opening between a source of compressed air and the interior of the cylinder **18**. The tacker **10** also includes an improved exhaust valve arrangement **28** and a cylinder return spring **86** for the movable cylinder **18** which insures proper alignment of the movable parts of the tacker **10** and further prevents inadvertent operation thereof.

Although the present invention has been described in conjunction with a specific embodiment thereof, it should be understood that numerous other embodiments may be provided by those skilled in the art which will fall within the spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A fastener driving apparatus comprising a housing defining a chamber to which a medium under pressure is continuously supplied, a valve element, a cylinder movably mounted in said chamber and engaging said valve element so that the interior of said cylinder is closed off from communication with said chamber, a piston slidably mounted relative to and disposed within said cylinder, and means for moving said cylinder relative to said housing and away from said valve element to place the interior of said cylinder in communication with said chamber so that the piston is advanced by the medium under pressure.

2. A fastener driving apparatus comprising a housing defining a reservoir for receiving a compressed medium and a cylindrical chamber, means for continuously supplying a compressed medium to said reservoir, a cylinder slidably mounted in said chamber and operable in one position to close off communication between said reservoir and the interior of said cylinder, fastener driving means including a piston slidably mounted relative to and disposed within said cylinder, and means for moving said cylinder relative to said housing and away from said one position to place the interior of said cylinder in communication with said reservoir whereby the piston is advanced by said compressed medium.

3. A fastener driving apparatus comprising a housing defining a cylindrical chamber and a reservoir for receiving a compressed medium, means for continuously supplying a compressed medium to said reservoir, a valve element carried on said housing, a cylinder slidably mounted in said chamber and cooperating with said valve element to close off communication between said reservoir and the interior of said cylinder, fastener driving means including a piston movably disposed within said cylinder, piston means on said cylinder and cooperating with said chamber to provide a piston and cylinder drive means for said cylinder, and valve means for selectively controlling the admission of said compressed medium from said reservoir to said piston and cylinder drive means so as to move said cylinder away from said valve element to place said reservoir in communication with the interior of said cylinder.

4. A fastener driving apparatus comprising a housing defining a chamber and piston cylinder, a cylinder element supporting a piston, said cylinder element being disposed in said chamber with said piston slidably mounted in said piston cylinder and with an open upper end of the cylinder element in communication with the chamber, fastener driving means including a drive piston slidably mounted in the interior of said cylinder element, a valve element carried on said housing, biasing means for urging said cylinder element toward said valve element so that the upper end of said cylinder element engages said valve element to close off communication between said chamber and the interior of said cylinder element, means for continuously supplying compressed air to said chamber, and means for selectively supplying compressed air to said piston cylinder whereby said cylinder element is moved relative to said valve element to admit compressed air from said chamber into the interior of said cylinder element.

5. A fastener driving apparatus comprising a housing defining a chamber and a piston cylinder, a cylinder element having a piston connected thereto and an open upper end, said cylinder element being disposed in said chamber with said piston slidably mounted in said piston cylinder, a valve seat carried on said housing, resilient means biasing the open upper end of said cylinder into engagement with said valve seat to close off communication between said chamber and the interior of said cylinder element, a work piston movably disposed in the interior of said cylinder element, means for continuously supplying compressed air to said chamber, and means including said piston and said piston cylinder for moving said cylinder element out of engagement with said valve seat to admit compressed air to the interior of said cylinder element.

6. The fastener driving device set forth in claim 5 including an exhaust valve mounted on said housing in communication with said cylinder element and selectively opened and closed in accordance with movement of said cylinder element.

7. A fastener driving apparatus comprising a housing defining a reservoir continuously supplied with compressed air and a chamber in communication with said reservoir, said chamber having a cylindrical recess, a cylinder element having a piston structure, said cylinder element being disposed in said chamber with said piston structure slidably mounted in said recess and with one surface of said piston structure in communication with said reservoir, a valve seat carried on said housing, a fastener driving means including a drive piston slideably mounted

within the interior of said cylinder element, and valve means for selectively controlling the application of compressed air to the other surface of said piston structure so that said cylinder element is moved away from said valve seat to place the interior of said cylinder element in communication with said reservoir and is moved into engagement with said valve seat to close off communication between said reservoir and the interior of said cylinder element.

8. A fastener driving apparatus comprising a housing defining a compressed air reservoir and a chamber having a cylindrical recess, a cylinder element disposed in said chamber and carrying a piston structure slidably mounted in said recess with one surface of the piston structure in communication with the compressed air reservoir, a valve seat carried on said housing, fastener driving means including a drive piston slidably mounted in the interior of said element, and a control valve for normally admitting compressed air from said reservoir to said recess to act on the other surface of said piston structure to force said cylinder element into engagement with said valve seat, said control valve being operable to close off communication between said reservoir and said recess and to vent said recess so that the compressed air acting on said one surface of said piston structure moves said element out of engagement with said valve seat to admit compressed air to said cylinder element.

9. The fastener driving apparatus set forth in claim 8 including an exhaust valve carried on said housing in communcation with the interior of said cylinder element for selectively venting said cylinder element to the atmosphere, and means responsive to movement of said cylinder element for controlling the operation of said exhaust valve.

10. A pneumatic fastener driving device comprising a housing defining a compressed air reservoir in fluid communication with a chamber having an enlarged cylindrical recess, a cylinder element having a piston carried thereon, said element being disposed in said chamber with said piston slidably mounted in said recess, a valve seat carried on said housing, fastener driving means including a drive piston slidably mounted in the interior of said element, an exhaust valve mounted on said housing and including a portion depending into said cylinder defining an exhaust valve inlet passageway, a resilient shock absorbing member carried on said drive piston, resilient means for biasing said piston to move said resilient member into engagement with said depending portion, engagement of said resilient member and said depending portion serving to limit movement of said drive piston by said resilient biasing means, and control valve means for selectively controlling the application of compressed air from said reservoir to said recess to move said cylinder element away from said valve seat to admit compressed air for driving said drive piston.

11. A fastener driving device comprising a housing defining a chamber for receiving a compressed medium; a cylinder movably mounted in said chamber; fastener driving means including a piston slidably mounted in said cylinder; a valve element movably mounted in said chamber; and means for selectively moving said cylinder relative to said housing to move said cylinder out of engagement with said valve element to admit said compressed medium from said chamber into the interior of said cylinder, the admission of said compressed medium into the interior of said cylinder moving said valve element away from said cylinder.

12. The fastener driving device set forth in claim 11 including a valve for selectively exhausting the interior of said cylinder which is operated to a closed position in response to said movement of said valve element.

13. In a fastener driving apparatus, a housing defining a chamber supplied with a compressed medium, a cylinder movably mounted in said chamber, fastener driving means including a piston slidably mounted in said cylinder, a valve element movably mounted on said housing and engaging said cylinder to close off communication between said chamber and the interior of said cylinder, and means for selectively moving said cylinder within said chamber, said selective movement of said cylinder causing movement of both of said cylinder and said element away from each other to admit said compressed medium into the interior of said cylinder and causing movement of both of said cylinder and said element toward each other to close off communication between said chamber and the interior of said cylinder.

14. The apparatus set forth in claim 13 including a valve for exhausting the interior of said cylinder which is selectively opened and closed by said movement of said valve element and said cylinder toward and away from each other.

15. A fastener driving device comprising a housing defining a chamber for receiving compressed air, a cylinder movably mounted in said chamber, fastener driving means including a piston slidably mounted in said cylinder, a valve element slidably mounted on said housing and including resilient means engaging the cylinder to close off communication between said chamber and the interior of said cylinder, said resilient means being biased into engagement with said cylinder by said compressed air in said chamber acting on one surface of said element, and means for moving said cylinder away from said valve element to admit compressed air to the interior of said cylinder, said valve element being moved away from said cylinder by the compressed air admitted to the interior of said cylinder acting on another surface of said valve element.

16. The fastener driving means set forth in claim 15 in which said valve element includes an exhaust passageway communicating with the interior of said cylinder which is closed by said movement of said valve element away from said cylinder.

17. In a fastener driving apparatus, a housing defining a chamber supplied with a compressed medium, a cylinder movably mounted in said chamber, fastener driving means including a piston slidably mounted in said cylinder means, means for moving said cylinder for selectively admitting said compressed medium into the interior of said cylinder to move said piston, and means effective when said piston and said cylinder are in predetermined positions relative to each other for venting the interior of said cylinder above said piston.

18. A fastener driving apparatus comprising a housing defining a chamber supplied with a compressed medium, a cylinder movably mounted in said chamber, a valve element movably mounted on the housing and engaging said cylinder to close off communication with the interior of said cylinder, a piston slidably mounted in said cylinder, means for moving said valve element and said cylinder away from each other to admit a compressed medium into the interior of said cylinder to displace said piston, means for moving said cylinder into engagement with said valve element, and means for venting the interior of said cylinder so that the compressed air in said chamber forces said valve element into engagement with said cylinder.

19. The apparatus set forth in claim 18 in which said means for venting the interior of said cylinder includes a passageway formed in said cylinder.

20. A fastener driving apparatus comprising a housing defining a chamber supplied with a compressed medium, a cylinder defining a piston-like member slidably mounted in said chamber, a valve element movably mounted on said housing and engaging said cylinder to close off communication between said chamber and the interior of said cylinder, fastener driving means including a piston slidably mounted in said cylinder for movement between normal and displaced positions, a control valve for selectively controlling the supply of said compressed medium to one side of said piston-like member to move said cylinder away from and toward said valve element, and means for selec-

tively venting the interior of said cylinder when said valve element and said cylinder are in engagement and said piston is in said displaced position.

21. The apparatus defined by claim 20 in which said means for venting includes a passageway formed in said cylinder.

22. A fastener driving apparatus comprising a housing defining a chamber supplied with compressed air, a cylinder mounted in said chamber, fastener driving means including a piston slidably mounted in said cylinder, a valve element in said chamber movable into and out of engagement with said cylinder to control the admission of said compressed air from said chamber into said cylinder, a member including a passageway secured to said valve element and movably mounted on said housing, said passageway terminating in a port structure on an upper surface of said member, and means for moving said valve element and said member relative to said cylinder to move said valve element against said cylinder to close the cylinder in one position and to move said port structure into an abutting relation with a transversely extending portion of said housing in another position to close said passageway thereby providing means for selectively venting said cylinder above said piston.

23. In a pneumatic driving machine, a frame structure including a head portion, said head portion having a top opening with a removably secured closure cap member closing the same, said head portion having therein a pressure fluid reservoir of large volume within which a cylinder is provided with an end opening arranged for exposure within the reservoir substantially spaced below said closure cap, a driving member actuating piston reciprocably operable in said cylinder and carrying a driving member directed toward the opposite end of the cylinder from said end opening, means normally urging the piston toward said end opening, said end opening being unobstructed so that the piston and driving member can be assembled or removed therethrough and through the open end of said head portion when said closure cap is removed, said closure cap having projecting therefrom and into the upper portion of said cylinder stop means engageable by the piston to normally hold the top of the piston below the end opening, and means normally closing said cylinder end opening but shiftable toward open position for opening the cylinder to full fluid pressure from within the reservoir for driving the piston and said member in a driving stroke thereof.

24. A pneumatic driving apparatus comprising a housing defining a chamber, means for continuously supplying said chamber with compressed air, a cylinder in said chamber, fastener driving apparatus including a piston slidably mounted in said cylinder, main valve means normally engaging the cylinder to prevent communication between the chamber and the cylinder and movable away from the cylinder to admit compressed air from the chamber into the cylinder, structure secured to the main valve means and having a passageway extending from the lower surface of the main valve means to a port, and resilient means carried on the housing above the structure and aligned with the port, said structure normally being disposed in a position with the port spaced from the resilient means when the main valve means engages the cylinder and being moved to a position in which the port of the passageway is closed by engagement between the structure and the resilient means when the main valve means moves away from the cylinder.

25. In a fastener driving apparatus, a housing including a chamber supplied with compressed air and a cylinder having an open end, fastener driving means including a piston slidably mounted in the cylinder, main valve means movable into and out of engagement with the open end of the cylinder, said housing having an opening generally aligned with the open end of the cylinder, closure means carried on said housing over said opening, structure slidably mounted on said closure means and secured to said main valve means, said structure providing a passageway extending from the side of said main valve means adjacent the cylinder to a port disposed in said closure means, said closure means having a surface that is generally aligned with said port, said structure and the connected main valve means being movable from one position in which the port is spaced from the surface to another position in which the port is adjacent the surface, and resilient means interposed between the structure and the surface for sealing communication through the passageway when the port is placed adjacent the surface.

26. In a fastener driving device of the type in which a housing forms a chamber containing a body of compressed air to which the open end of a cylinder is continuously exposed, main valve means normally engaging the open end of the cylinder, an exhaust structure secured to the main valve means and slidably mounted on the housing, said exhaust structure including an exhaust passageway extending from the surface of the main valve means adjacent the open end of the cylinder to a discharge port structure in communication with the atmosphere, said housing having a housing portion normally spaced from the discharge port structure and extending generally transverse to the direction of movement of the exhaust structure in alignment with the discharge port structure, and means for shifting the main valve means and the exhaust structure from a normal position in which the main valve means engages the cylinder and the discharge port structure is spaced from the housing portion to an operated position in which the main valve means is spaced from the cylinder and the discharge port structure engages the housing portion to close the discharge port and arrest movement of the exhaust structure and main valve means.

27. In a fastener driving device of the type in which a housing forms a chamber containing a body of compressed air to which the open end of a cylinder is continuously exposed, a member slidably mounted on the housing and having both a larger upper portion exposed to the atmosphere and a depending, smaller portion, said member having an axially extending passageway passing from the lower end of the depending portion to the upper surface of the larger upper portion, main valve means for engaging the open end of the cylinder and having a centrally disposed opening, the lower end of said depending portion being mounted in said opening so that the passageway communicates with the interior of the cylinder when the main valve means engages the open end of the cylinder, a valve surface on the housing normally spaced from the upper surface of the member, and means for moving the member and main valve means away from the open end of the cylinder so that the upper surface of the member engages the valve surface to close said passageway and prevent communication between the atmosphere and the passageway.

28. The fastener driving apparatus set forth in claim 27 in which said main valve means includes a resilient element clamped between a pair of rigid plates carried on the lower end of said depending portion.

29. The fastener driving apparatus set forth in claim 28 in which the lower end of the depending portion includes a shouldered portion and in which fastening means carried on the lower end of the depending portion clamps the two plates and the resilient element against the shouldered portion.

30. The fastener driving apparatus set forth in claim 27 in which said valve surface includes resilient means for engaging the upper surface of the member.

31. A fastener driving apparatus comprising a housing defining a chamber with a top opening, a cylinder in said

chamber having an open end generally aligned with the top opening, closure means removably mounted on said housing covering said top opening, said closure means including structure defining a larger diameter upper opening connected to a smaller diameter lower opening, exhaust means including a larger diameter portion slidably mounted in said larger diameter upper opening and a depending portion slidably mounted in the smaller diameter opening and projecting below the closure means, main valve means rigidly secured to said depending portion and adapted to engage and close the open end of the cylinder, said exhaust means including an exhaust passageway passing through said larger and smaller diameter portions and terminating adjacent the top of said exhaust means, a portion of said closure means being aligned with the upper end of the passageway, and means for moving said exhaust means and the main valve means between first and second spaced positions, the passageway being spaced from the portion of the closure means and the main valve means engaging and closing the open end of the cylinder in the first position, the portion of the closure member closing the exhaust passageway and the main valve means being spaced from the open end of the cylinder in the second position.

32. A fastener driving apparatus comprising a housing defining a chamber, means for continuously supplying compressed air to said chamber, cylinder means having an open end in communication with the compressed air in said chamber, fastener driving means including piston means slidably mounted in said cylinder means, main valve means for engaging and closing the open end of said cylinder means, a supporting structure secured to said main valve means and slidably mounted on said housing, said structure including an upper surface exposed to the atmosphere, and means for moving said main valve means and supporting structure between first and second positions, in said first position the main valve means engages and closes the open end of the cylinder means and the compressed air in the chamber acts on the combined upper effective surface area of the main valve means and the structure, in said second position the main valve means is spaced from the open end of the cylinder means to admit compressed air from the chamber and the compressed air acts on the combined lower effective surface area of the main valve means and the structure that is greater than the combined upper effective surface area of the main valve means and the structure, said greater lower effective surface area providing an upwardly directed component of force tending to hold said main valve means and said structure in said second position.

33. The fastener driving apparatus set forth in claim 32 including an exhaust passageway in said structure terminating in a port in the upper surface of the structure, and valve means on said housing for engaging said structure to close said port when the main valve means and structure are moved to said second position.

34. In a pneumatic driving machine, a frame structure including a head portion, said head portion having a top opening with a removably secured closure cap member closing the same, said head portion having therein a pressure fluid reservoir within which a cylinder is provided with an end opening arranged for exposure within the reservoir, a driving member actuating piston reciprocably operable in said cylinder and carrying a driving member directed toward the opposite end of the cylinder from said end opening, said piston being normally positioned adjacent said end opening, stop means extending downwardly from said top opening toward said cylinder for engaging and arresting movement of said piston adjacent said end opening, said stop means being removable through the top opening of the head portion when the closure cap is removed, said end opening of said cylinder being unobstructed so that the piston and driving member can be assembled or removed therethrough and through the top opening of said head portion when said closure cap and stop means are removed, and means normally closing said end opening of said cylinder but shiftable toward open position for opening the cylinder to full fluid pressure from within the reservoir for driving said piston and said member in a driving stroke.

35. A fastener driving apparatus comprising a housing including both a reservoir continuously supplied with a pressure fluid and cylinder means having an open end exposed to the fluid in the reservoir, fastener driving means including piston means slidably mounted in said cylinder means, said piston means being biased toward the end of the cylinder means, the end of said cylinder means being unobstructed and having an inner diameter no less than the diameter of the piston means, and combined main valve and piston stop means movably mounted on the housing and movable from a normal position in which the main valve engages the end of the cylinder and the piston stop engages the piston means to a displaced position in which both the main valve and the piston stop are displaced relative to the cylinder means.

36. A fastener driving apparatus comprising a housing including both a reservoir continuously supplied with a pressure fluid and cylinder means having an open end exposed to the fluid in the reservoir, fastener driving means including piston means slidably mounted in said cylinder means, said piston means being biased toward the end of the cylinder means, the end of said cylinder means being unobstructed and having an inner diameter no less than the diameter of the piston means, piston stop means for engaging the piston means to position the piston means at the open end of the cylinder means, and structure on the housing mounting said piston stop means for movement between spaced normal and displaced positions, said piston stop means engaging said piston means in its normal position to hold the piston means adjacent the end of the cylinder means and said piston stop means being displaced away from the cylinder means in the displaced position.

37. The fastener driving apparatus set forth in claim 36 including pneumatically operated means for shifting the piston stop means between its normal and displaced position.

38. A fastener driving apparatus comprising a housing including both a reservoir continuously supplied with a pressure fluid and cylinder means having an open end exposed to the fluid in the reservoir, fastener driving means including piston means slidably mounted in said cylinder means, main valve means carried on the housing and normally engaging and closing the open end of the cylinder means, the separation of the main valve means and the cylinder means admitting fluid to the cylinder means to operate the piston means, an exhaust means for discharging fluid from the cylinder and including a passageway communicating with the cylinder below the main valve means, said exhaust means including a member slidably mounted on the housing and defining at least a part of the passageway, said member having a port structure adjacent the upper end of the passageway, a valve seat structure on the housing normally spaced from the port structure and extending generally transverse to the direction of movement of the member in vertical alignment with the port structure, and fluid actuated means for moving the member to move the port structure on the member into engagement with the valve seat structure to close the passageway.

39. A fastener driving apparatus comprising a housing including both a reservoir continuously supplied with a pressure fluid and cylinder means having an open end exposed to the fluid in the reservoir, fastener driving means including piston means slidably mounted in said cylinder means, main valve means normally engaging and closing the open end of the cylinder means, said housing including means defining a circular opening spaced above the end of the cylinder means, structure projecting upwardly from the main valve means and including a cylindrical

portion slidably mounted in said circular opening, an axial passageway passing through the structure and the main valve means from a point at the lower side of the main valve means to a port structure adjacent the top of the structure, a valve seat structure on the housing disposed above and in vertical alignment with the port structure, said valve seat structure being normally spaced from the port structure when the main valve means engages the end of the cylinder means so that the axial passageway is open, and means for moving the main valve means and the structure to move the main valve means away from the end of the cylinder means to admit fluid for driving the piston means and to move the port structure upwardly into engagement with the valve seat structure to close the axial passageway.

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