ABSTRACT

A pneumatically powered fastener-driving tool is provided which includes a manually selective automatic recycling means. The speed of recycling may be adjusted as desired, and the exhausted compressed air is deflected so as to protect the operator, as well as the workpiece.

7 Claims, 7 Drawing Figures
NEU APEMICALLY POWEED FASTENER-DRIVING TOOL

BACKGROUND OF THE INVENTION

Various fastener-driving tools with automatic recycling features have heretofore been provided; however, because of certain design characteristics they have been beset with one or more of the following shortcomings: a. the housing in which the drive piston is mounted is formed of a plurality of component parts which are susceptible of becoming loose and out of adjustment due to vibration forces caused particularly when the tool is operating at high speeds over a prolonged period of time, b. there is no accurate means provided for varying the speed of recycling of the tool, c. the prior tools are position sensitive, that is to say they worked properly only when held in a predetermined position by the operator, d. the automatic recycling mechanism is located in an awkward and somewhat inaccessible position on the tool, e. the compressed air exhausted by the prior tools at times has entrained therein grease, dust, or other debris which is directed towards the operator or workpiece thereby causing injury to the operator or defacement to the exposed surface of the workpiece, f. the prior tools are often times of bulky, heavy construction thereby causing fatigue to the operator after only a short period of use.

SUMMARY OF THE INVENTION

Thus, it is an object of this invention to provide a fastener-driving tool which is of simple, lightweight, inexpensive construction and yet has incorporated therein an effective automatic recycling mechanism.

It is a further object of this invention to provide a fastener-driving tool with automatic recycling having a monolithic housing which significantly reduces maintenance costs.

It is a still further object of this invention to provide a driving tool of the type described which incorporates safety features for protecting the operator and workpiece against blasts of the exhausted compressed air.

It is a still further object of this invention to provide a fastener-driving tool having an automatic recycling mechanism which may be readily adjusted to accurately vary the recycling speed.

Further and additional objects will appear from the description, accompanying drawings, and appended claims.

In accordance with one embodiment of this invention a pneumatically powered fastener-driving tool is provided comprising a hollow monolithic housing having a chamber formed therein in which compressed air is accumulated. Disposed within the housing is an elongated cylinder having a pair of longitudinally spaced ports formed in the wall intermediate the ends thereof. A poppet valve is adjustable positioned adjacent one end of the cylinder and controls the introduction of compressed air into the cylinder to effect firing of a fastener-driving piston mounted for reciprocatory movement within said cylinder. The poppet valve is mounted for sliding engagement within a cavity formed in a cap, the latter being mounted on the end of the housing. The cylinder cooperates with the housing interior to form a pair of longitudinally spaced annular cavities. One of the cylinder wall ports, closest to the poppet valve, communicates with one annular cavity, and the second wall port communicates with the other annular cavity. The one annular cavity is in constant communication with the housing chamber and thus, is continually charged with compressed air. The outer periphery of the poppet valve projects outwardly beyond the cylinder wall and is exposed to the said one annular cavity. The housing is provided with first and second passageways; the first passageway having one end thereof communicating with the cap cavity. The first passageway end is separated from the end of the cylinder by the poppet valve. The opposite end of the first passageway terminates at a manually adjustable trigger valve carried by the housing. The second passageway has one end thereof communicating with the annular cavity furthest removed from said poppet valve. The opposite end of said second passageway communicates with said trigger valve. Communication between the corresponding ends of the first and second passageways is controlled by a manually adjusted spool forming a part of the trigger valve. The driving piston is of a double spool type and is provided with an enlarged head which is disposed adjacent the poppet valve when said piston is in its fully retracted position within said cylinder. Spaced longitudinally from the enlarged head is an annular flange which is in sliding sealing engagement with the cylinder interior wall. When the piston is in its fully retracted position, the annular flange is positioned so as to sealingly separate the longitudinally spaced ports formed in the cylinder wall. When the driving piston is in its fully extended, or drive, position, both of the longitudinally spaced ports communicate with the spacing formed between the head and flange of the piston. The buildup of compressed air pressure within the spacing between the head and flange of the piston when the latter is in its fully extended position is such that the piston will be automatically returned to its fully retracted position.

A manually actuated automatic recycling valve is mounted on said housing and when in one position of adjustment, will cause automatic recycling or repeated firing of the driving piston, provided the trigger valve is depressed.

For a more complete understanding of the invention reference should be made to the drawings wherein:

FIG. 1 is an elevational view of one form of the improved fastener-driving tool.

FIGS. 2 and 3 are fragmentary vertical sectional views of the tool of FIG. 1 and showing, respectively, the driving piston in its fully retracted and fully extended positions.

FIG. 4 is a fragmentary sectional view taken along line 4—4 of FIG. 2 and showing the automatic recycling valve in a non-recycling position.

FIG. 5 is similar to FIG. 4, but taken along line 5—5 of FIG. 3 and showing the recycling valve in position for automatic recycling of the piston.

FIG. 6 is similar to FIG. 2, but showing a modified form of the improved fastener-driving tool.

FIG. 7 is similar to FIG. 5, but taken along line 7—7 of FIG. 6 and showing the recycling valve in position for automatic recycling of the driving piston.

Referring now to the drawings and more particularly to FIGS. 1—5, one form of a pneumatically powered fastener-driving tool 10 is shown which comprises a monolithic, or one piece, housing 11. The housing includes a hollow driving piston portion 12, a hollow handle portion 13, and a fastener feed portion 14. The han-
The lower end of the driver blade is adapted to be guided by the nose piece N so as to engage a fastener automatically fed from the housing feed portion 14 and drive same into a workpiece. Adjustably mounted on the upper end of the cylinder 16 and adapted to overlie same is an annular poppet valve 28. The valve is adapted to move between an open position, see FIG. 3, and a closed position, see FIG. 2, with respect to the upper end of the cylinder.

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The valve 28 is disposed within a suitable cavity 30 formed within the interior of the cap 15. Valve 28, when in its closed position, has a portion of the underside of the outer periphery thereof extending laterally beyond the cylinder upper end into annular cavity 17 and thus, is exposed to the compressed air accumulated therein. The outer periphery of valve 28 is in sliding sealing engagement with the interior surface of cavity 30.

Extending upwardly from the central portion of valve 28 is a cylindrical protrusion 31, the exterior of which is in sliding, sealing engagement with a second cavity 32 formed in the cap interior. Protrusion 31 is provided with an axial bore 33 which extends through the entire valve 28. The valve 28 is biased in a closed position with respect to the cylinder upper end by one or more suitable coil springs 34.

Mounted at the upper end of the second cavity 32 is a disc-shaped seal 35, which is adapted to be engaged by the upper end of valve protrusion 31 and close off the upper end of bore 33, see FIG. 3, when the poppet valve is in its open position.

Communicating with and extending laterally from the upper end of the second cavity 32 is an air discharge port 36 formed in the cap 15. The lower end of the port 36 is aligned with an elongated passageway 37 formed in the housing portion 12. The lower end of passageway 37, in turn, terminates in a chamber 38, see FIGS. 2 and 4, formed in the housing and in which is adjustably positioned a manual/automatic recycling valve 40. The chamber 38 is disposed to one side of cylinder 16 and extends transversely of the axis of said cylinder. Opposite ends 38a and 38b of the chamber are open to the atmosphere. Chamber end 38a is the smaller of the two ends and is adapted to accommodate in sliding, sealing engagement the small end 40a of the valve 40.

Also communicating with chamber 38 are two additional passageways 41 and 42 which are formed in the housing interior. Passageway 41 interconnects chamber 38 with the lower annular cavity 18 which encircles the lower portion of drive cylinder 16. Passageway 42, on the other hand, interconnects the chamber 38 with a ported sleeve 43 which forms a part of a trigger valve 44 carried on the handle portion 13 of the housing 11. The functions of the passageways 37, 41 and 42 with chamber 38 are in axially spaced relation, as seen in FIG. 4. Valve 40 is manually adjustable axially within chamber 38. When the valve 40 is moved to the right to the position shown in FIG. 4, passageways 37 and 42 are vented to the atmosphere and passageway 41 is blocked. When the valve 40 is in the position, shown in FIG. 4, the driver piston 22 will not recycle and continue to fire, even though the trigger valve 44 is held in a depressed condition.

As will be noted in FIG. 5, when valve 40 has been manually moved inwardly to the fullest extent into the chamber 38, the inner end 40a of the valve 40 is pro-
vided with a reduced cross-sectional portion 40c which will effect interconnection between passageways 41 and 42 and cause automatic recycling and continuous firing of the driver piston 22, provided the trigger valve 44 is manually held in a depressed state. The method by which automatic recycling will occur will be described more fully hereinafter. As shown in FIGS. 4 and 5, the central portion of valve 40 may be provided with external threads 40d which are adapted to mesh with internal threads formed in the wall of chamber 38.

Because of the discharge of compressed air out through the enlarged end 38b of chamber 38, an annular deflector piece 45 is carried by the exposed end 40b of valve 40, see FIGS. 4 and 5. The deflector piece diffuses the blast of the discharged compressed air and thus protects the operator of the tool and the work-piece into which the fasteners are driven, against any foreign matter or debris, which might be entrained in the air blast. Frequently droplets of oil or similar fluid become entrained in the discharged air blast and if left unchecked, might cause injury to or soiling of the face of the operator or the exposed surface of the work-piece. It will be noted that the exposed enlarged end 40b of the valve may be knurled to facilitate manual manipulation of the valve. The location of the valve 40 on the housing 11 may be varied from that shown without departing from the scope of the invention. For example, if desired, the valve 40 may be located in the cap 15.

The trigger valve 44, as aforementioned, is preferably located in the handle portion 13 of the housing 11, see FIG. 2. The valve 44 includes the ported sleeve 43 which is shrunken into a cylindrical bore 46 formed in the handle portion. The upper end of the sleeve is open and exposed to the handle chamber 13a in which compressed air is accumulated. The sleeve 43 is provided with two sets of apertures 47a and 47b which are in axially spaced relation. Apertures 47a communicate with a passageway 48 formed in the housing portion 11. Passageway 48, in turn, communicates with a passageway 50 formed in cap 15 and leading to the upper end of cavity 30 formed in the cap. Apertures 47b, on the other hand, communicate with passageway 42.

Slidably mounted within sleeve 43 is a trigger valve piece 51. The lower end 51a of the piece projects downwardly from the end of the sleeve and is adapted to be manually depressed. The piece 51 may be biased by a spring, to assume its downwardly extended position, see FIG. 2. The valve piece 51 is retained in a conventional manner within the sleeve 43 by means of the trigger lever, as seen more clearly in FIG. 1. A portion 51b of the piece has a reduced cross section. The axial length of portion 51b is greater than the axial spacing between apertures 47a and 47b formed in sleeve 43. Adjacent end each of portion 51b is an O-ring 52 and 53 which is in sliding sealing engagement with the interior surface of sleeve 43. When the tool is at rest, that is to say the trigger piece 51 has not been manually depressed, as seen in FIG. 2, O-ring 52 is disposed intermediate the sleeve apertures 47a and 47b thereby preventing interconnection between passageways 42 and 48. When the trigger piece 51 is in said position, passageways 48 and 50, and the portion of cavity 30 disposed above poppet valve 28, are charged with compressed air because apertures 47a are in communication with the high pressure chamber 13c of the hollow handle portion 13 of the housing 11 through the upper end of bore 46. The combination of the air pressure within the upper portion of cavity 30 and the bias of spring 34 exerted on poppet valve 28 are sufficient to hold the latter in closed position over the upper end of cylinder 16 and thus prevent firing of the driver piston 22.

Upon manual depressing of the trigger piece 51, as seen in FIG. 3, communication between chamber 13c and passageway 48 is cut off by the upper end of piece 51 and in place thereof portion 51b of the piece interconnects passageways 42 and 48. Depending upon the position of the recycling valve 40 in the chamber, the compressed air within the upper portion of cavity 30 is vented through passageways 50, 48, and 42 to the atmosphere out through the narrow end 38a of chamber 38 (see FIG. 4), or is vented from passageway 42 by valve portion 40a to passageway 41 and then into annular cavity 18 and into the interior of cylinder 16 through ports 21. Once the compressed air in the upper portion of cavity 30 has been vented to the atmosphere, the force exerted on the underside of the outer periphery of poppet valve 28, which extends beyond the cylinder 16, by the compressed air in cavity 17, will overcome the bias of spring 34 and raise the poppet valve off the upper end of the cylinder and cause the compressed air to be exerted on the upper surface of head 23 and move the piston 22 through its drive stroke. Upon the compressed air entering the interior of cylinder 16 beneath flange 24, it will initially be exhausted to the atmosphere through opening 27 at the lower end of the housing; however, as the driver piston 22 moves downwardly, the apertures 21 will become registered with the spacing 8 between the head 23 and flange 24 of the piston 22, which, in turn, will cause the cavity 18, passageways 41, 42, 48 and 50 and the upper portion of cavity 30 to once again be charged with compressed air. Once this occurs, the poppet valve 28 closes and the driver piston 22 returns to its fully retracted position. Upon the piston 22 reaching its fully retracted position, the compressed air above the poppet valve is once again vented out through housing opening 27 in a manner as previously described provided the auto-recycling valve 40 is in the position shown in FIG. 5.

The speed of return of the driver piston from its fully extended position (FIG. 3) to its fully retracted position (FIG. 2) will depend upon the speed with which the compressed air above the piston head 23 is exhausted out through bore 33, passageways 36 and 37 and the enlarged end 38b of chamber 38. It will be noted in FIGS. 4 and 5, that the portion 40c of valve 40, which is adjacent the threading portion 40c, is outwardly tapered. Thus, as valve 40 is manually moved to the left or inwardly, as seen in FIG. 5, the size of the exhaust passage E, which is formed between the interior surface of chamber 38 and the exterior of the large end of the valve 40, becomes increasingly more restricted. Thus, upon rotating valve 40 into chamber 38, a greater or lesser amount than shown in FIG. 5, the operator can vary the speed of return or recycling, as desired.

FIGS. 6 and 7 show a modified form of pneumatically powered tool 110 which is similar in construction to tool 10 except as to the auto-recycle valve and the manner of controlling the air exhaust from above the driver piston head. To simplify understanding of tool 110, the corresponding parts thereof have been numbered the same as tool 10 except in 100 series. In lieu of passageway 36 in the cap 15 of tool 10, communicat-
ing with a passageway 37 formed in the housing portion 12, tool 110 eliminates passageway 37 and in place thereof passageway 136 is ported directly to the atmosphere. Threadably mounted on cap 115 is an exhaust air regulator screw 200. The inner end 200a of the screw extends into passageway 136 so as to restrict same. A deflector piece 201 is also mounted on cap 115 and diffuses the exhaust air discharged from passageway 136 so as to prevent any debris entrained in the exhaust from striking the operator or workpiece surfaces.

FIG. 7 shows a modified form of auto-recycle valve 140 which is substituted for valve 40 shown in FIGS. 4 and 5. Valve 140 is slidably disposed within a chamber 138, which is disposed to one side of cylinder 116 and extends transversely with respect thereto. Passageways 141 and 142 junction with chamber 138 in axially spaced relation. The inner end portion of the valve 140 carries an O-ring 202 which is in sliding sealing engagement with the interior surface of chamber 138. Disposed outwardly of O-ring 202 is a portion 140a of reduced cross section, which, when the valve is pushed inwardly relative to chamber 138 so that the O-ring 202 is disposed between passageways 141 and 142, causes the passageway 142 to be vented to the atmosphere through flutes 203 formed in the outer end portion of the valve. An annular collar 204 is formed on the exterior of the exposed end of valve 140 to facilitate manual manipulation thereof. Suitable stop means, not shown, may be provided to limit the extent to which valve 140 can be withdrawn from chamber 138 so as to render the tool on automatic recycling.

As aforementioned, the location of the automatic recycling valve on the tool may be varied from that shown so as to serve the convenience of the operator. Thus, it will be seen that a tool has been provided with an automatic recycling feature which is of simple, sturdy construction and may be readily adjusted by the operator to vary the speed of recycling. The improved tool is provided with a safety feature which diffuses the blast of exhaust air so as to protect the operator, as well as the workpiece, from any debris which might be entrained in the exhaust air. The improved tool has a monolithic housing which materially reduces maintenance of the tool.

We claim:
1. A pneumatically powered fastener-driving tool comprising a hollow housing; an elongated cylinder mounted within said housing and cooperating therewith to form a pair of longitudinally spaced upper and lower cavities adjacent the exterior of said cylinder, said cylinder being provided with a pair of longitudinally spaced upper and lower openings, communicating respectively with the upper and lower cavities, said upper cavity being continuously charged with pneumatic pressure; a pneumatically responsive driver piston mounted for reciprocatory movement within said cylinder between a fully retracted position and a fully extended position, said piston having a head in sliding sealing engagement with an upper portion of the cylinder interior surface, and a flange spaced longitudinally from said head and in sliding sealing engagement with a lower portion of said cylinder interior surface and cooperating with said head to form a pressure chamber therebetween; the longitudinal spacing between said head and flange being greater than the spacing between said upper and lower openings, the surface of said head adjacent said pressure chamber having a greater area than the corresponding surface of said flange, said driver piston flange being disposed intermediate said upper and lower openings when said piston is in said fully retracted position, and both said upper and lower openings being in communication with said pressure chamber when said piston is in said fully extended position, a poppet valve mounted within said housing interior adjacent the upper end of said cylinder for movement between open and closed positions and biased to normally assume a closed position, said poppet valve, when in open position, effecting communication between the interior of said cylinder above the driver piston head and said upper cavity whereby said piston moves from said fully retracted to said fully extended positions, said poppet valve, when in a closed position, interrupting communication between said upper cavity and the interior of the cylinder above said driver piston head and effecting exhaust of the cylinder interior above said driver piston head whereby said driver piston automatically returns to said fully retracted position; a manual trigger valve mounted on said housing and when in an actuated position effecting a pressure differential on opposite sides of said poppet valve wherein the latter moves to said open position; and a manually adjustable control valve mounted on said housing and having a first portion for regulating the time interval for exhausting the cylinder interior above said driver piston head subsequent to said poppet valve assuming said closed position; said control valve having a second portion, when in one position of adjustment, interconnecting said lower cavity and housing interior above said poppet valve and effecting continuous recycling of said driver piston when said trigger valve is manually retained in said actuated position.
2. The pneumatically powered fastener-driving tool of claim 1 wherein the lower opening in said cylinder communicates with said pressure chamber when the moving driver piston has reached a first predetermined position relative to the upper end of said cylinder, and said lower opening communicates with the exterior of said tool when the moving driver piston has reached said fully retracted position relative to said cylinder upper end.
3. The pneumatically powered fastener-driving tool of claim 1 wherein said manually adjustable control valve is located intermediate said cylinder and said trigger valve.
4. The pneumatically powered fastener-driving tool of claim 3 wherein said adjustable control valve includes a deflector means mounted on a component thereof.
5. The pneumatically powered fastener-driving tool of claim 11 wherein the interior of said cylinder above the driver piston head is exhausted directly to the exterior of said tool when said poppet valve is in said closed position.
6. The fastener-driving tool of claim 1 wherein said housing includes a hollow handle wherein compressed air accumulates and is in communication with said upper cavity and said trigger valve is mounted on said hollow handle.
7. The fastener-driving tool of claim 6 wherein said housing includes a fastener feed portion and said feed portion and hollow handle are of monolithic construction.

* * * * *
It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 4, line 2 "quided" should be -- guided --
Col. 4, line 55 "functions" should be -- junctions --
Col. 5, line 66 "wit" should be -- with --
Col. 6, line 28 "th inerior" should be -- the interior --
Col. 6, lines 53, 54, "exhuast should be -- exhaust --
Col. 6, line 58 "thus" should be -- Thus --
Col. 8, line 54 "claim 11" should be -- claim 1 --

Signed and sealed this 25th day of June 1974.

(SEAL)
Attest:
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Commissioner of Patents