FLUID OPERATED INSERTING TOOL

3,495,755

UNITED STATES PATENT OFFICE

3,495,755 FLUID OPERATED INSERTING TOOL

Grant N. Willis, Bristol, and Irving Y. Lake, Terryville, Conn., assignors to The Arthur G. Russell Company, Incorporated, Bristol, Conn., a corporation of Connecticut

Filed May 29, 1967, Ser. No. 642,097

Int. Cl. B25c 5/06, 1/04, 5/02

U.S. Cl. 227—130

6 Claims

ABSTRACT OF THE DISCLOSURE

The hand tool of this invention includes a ram-type plunger, reciprocable between extended and retracted positions, and a fluid circuit for controlling its movement having an adjustable quick-dump control for suddenly driving the plunger toward its extended position and imparting a predetermined impact force on an article to be inserted from the tool into a workpiece opening. The tool further includes a nozzle having a slip-resistant tip for maintaining the tool in precision alignment with the workpiece opening during reciprocation of the plunger as established by a pilot portion thereof which protrudes beyond the nozzle when in extended position.

This invention generally relates to power tools and particularly concerns fluid operated hand tools for inserting roll pins, escutcheon pins, drive screws and other articles such as stand-off insulators into a workpiece.

A principal object of the invention is to provide a power tool of improved capabilities in precisely setting articles into workpiece openings to provide superior uniformity and reliability in a high speed production operation.

Another object of the invention is to provide a pneumatically operable inserting tool which is useful with sources of compressed air conventionally available at manufacturing and repair facilities.

A further object of the invention is to provide an improved fluid operated inserting tool having detachable parts that may be easily replaced for selectively adapting the tool for different types and sizes of articles and thereby provide a basic setting tool of unusual versatility.

Still another object of the invention is to provide an improved fluid operated tool which is adjustable for selectively varying the impact forces applied to articles within close limits.

A still further object is to provide an improved fluid operated inserting tool which is safe and easy to operate and which is characterized by low maintenance requirements and a combination of parts having a compact rugged construction adapted for convenient assembly and repeated use over extended periods of time.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

A better understanding of the invention will be obtained from the following detailed description and the accompanying drawings of illustrative applications of the invention.

In the drawings:

FIG. 1 is an isometric view, partly broken away and partly in section, showing a preferred embodiment of a tool constructed in accordance with this invention and mounted for operation on a supporting surface having a workpiece positioned thereon;

FIG. 2 is an enlarged longitudinal section view, partly broken away, of a portion of the tool of FIG. 1 in an operative position on a workpiece and schematically showing a control valve utilized in effecting operation of the tool; and

FIG. 3 is a further enlarged longitudinal section view, partly broken away, showing details of a quick-dump valve control incorporated in the invention.

Referring now to the drawings in detail, a fluid operated inserting tool 10 is shown having an elongated upright housing 12 comprising a lower handle portion 14 of a size suitable for convenient manual manipulation which is removably mounted to an upper body portion 16 having a vertically disposed sleeve 18 fixed therein and defining an operating cylinder 20.

Screwed into the lower end of sleeve 18 is a plug 22 having a lower portion 24 and an upper portion 25 shown in connection with FIG. 2. A pilot 26 is formed in the upper portion 25 of the plug 22 abutting the lower axial end of the sleeve 18 and the upper axial end of the handle portion 14 which are detachably connected by a spanner nut 27 for quick and easy removal and replacement without having to resort to the use of any special tools. The top of the body portion 16 is closed by a cap 28 threadably secured to the upper end of the sleeve 18 to assist in maintaining it in fixed position within the tool housing 12, and a resilient cushion 30 is fitted into a central recess 32 formed in the cap 28.

Roll pins, drive screws and other relatively small articles such as the stand-off insulator 34 shown inserted into a workpiece 36 have been conventionally applied by first moving the article and the workpiece relative to one another to bring the article into alignment with a workpiece opening such as at 38 and then bringing a tool into alignment with the article and striking it to insert the article into the workpiece. However, such inserting operations have been found to be objectionably time consuming in a precision operation involving small articles, while also requiring a degree of manual dexterity unsuited for high production. The tool 10 shown in the drawings, however, simultaneously provides precision alignment of both the article and the tool 10 with a workpiece opening 38 and effects a rapid inserting action requiring minimal skill and effort for use in a high speed operation.

In accordance with one aspect of this invention, a plunger 40 is received for longitudinal movement in a guideway jointly formed by aligned axial openings 41, 42 and 43 respectively extending lengthwise through the plug 22, the lower handle portion 14 and a nozzle 44 secured thereto at the bottom of the tool housing 12. To provide a pilot for quickly and accurately locating the tool in alignment with a workpiece opening, the plunger 40 is suitably dimensioned to protrude beyond the nozzle 44 when the plunger 40 is in a fully extended position as illustrated in FIG. 2. The plunger 40 is shown as a double diameter rod having a shoulder portion 45 formed intermediate its axial ends in reducing down to a lower end portion of preselected size, the shoulder portion 45 being shown as cooperating with handle portion 14 to prevent excessive extension of the plunger 40. The larger, upper end of the plunger 40 is fixed to an actuating piston 46 longitudinally reciprocable within the operating cylinder 20 which is divided by the piston 46 into upper and lower chambers 48, 50, and an O-ring 47 is shown fitted around the actuating piston 46 to effectively prevent fluid leakage between the chambers 48 and 50 with an additional seal 53 being provided in plug 22 to encircle the plunger 40 and thereby eliminate fluid leakage from the lower chamber 50.
Articles are introduced into the above described guideway from a side port 52 opening into an article inlet passage 34 located in the handle portion 14. A flexible inlet tube 56 is shown fitted into passage 54, and it will be understood that articles of various types and sizes may be delivered thereto one at a time with the assistance of forced air, e.g., from an associated device such as a vibratory feeder, not shown, into a properly oriented passage near the exit end of the article inlet passage 54, such as that occupied by the part illustrated at 58.

By virtue of the above described structure, the tool 10 is particularly suited to be precisely positioned in alignment with a workpiece opening by means of the protruding pin 14. The control valve 92 is readily inserted into a workpiece opening for accurately orienting the tool, and upon retraction of the plunger 40 from its fully extended position, the side port 52 is automatically gated to permit an article to drop into the lowermost portion of the guideway formed by the nozzle 44 in readiness to be driven into the workpiece opening.

To ensure that articles are properly guided into an accurately aligned position in the guideway relative to the workpiece opening before being driven home into a seated position on the workpiece 36, the nozzle 44 is provided with a tubular tip 60 of tough, resilient material such as urethane rubber having a high degree of frictional resistance to slippage on various types of workpiece surfaces. In the preferred embodiment, the nozzle tip 60 is shown screwed onto a lower end of a tubular nosepiece 62 which in turn is fixed by an end nut 64 to the bottom of the handle portion 14.

The nozzle tip 60 is provided with a completely exposed portion of discrete length axially protruding beyond the nosepiece 62, thereby providing a slip-resistant tip minimizing any tendency of the tool to move from a properly aligned position upon resection of the plunger 40 while yet exposing only a minimal length of the tip 60 to direct contact with articles passing through the guideway. Moreover, the above described structure provides facile replacement of the nozzle tip 60 for any desired reason such as to accommodate different articles of various shapes.

To further facilitate proper alignment for close tolerance work, the tool 10 in the specific illustrated embodiment is carried on a pantographic instrument 66 having a rotor 67 supported on a vertical shaft 68 journal 70 mounted in a bearing housing 70 mounted on a supporting surface 72. It will be sufficient for a proper understanding of the invention to state that the pantographic instrument 66 incorporates a plurality of links connected in series having a pivotal arm 132 with its distal end pivotally mounted at one end to the rotor 67 and a similarly constructed second arm 76 operatively connected to the opposite end of the first arm 74 by a common pivot block 78 whereby the arms 74, 76 rotate as a unit about the vertical shaft 68 while each of the arms 74, 76 is also mounted for independent swinging movement about a horizontal axis as best seen in FIG. 1. A mounting bracket 80 is secured on a free end of arm 76, and a projecting lug 82 on bracket 80 is received in a corresponding recess 84 provided in the upright body portion 15 of the tool housing 12 and is secured thereto by a vertical pivot pin 86 (FIG. 2), such that tool housing 12 is continuously maintained in a vertical position while at the same time being freely movable with minimal effort regardless of the position of the tool housing 12 relative to the workpiece 36. To counterbalance the supported weight on the free end of arm 76, coil tension springs 88 and 90 are shown located adjacent the first and second arms 74 and 76 respectively to the rotor 67 and the pivot block 78.

For selectively extending and retracting the plunger 40, a control valve 92 is schematically shown as being positioned in a remote location from tool housing 12 for connection, e.g., to an external source of compressed air, not shown. The control valve 92 is preferably a single bleed pilot operated four-way valve of a type well-known in the art, and is connected through a port 94 and passage 96 in the upper body portion 16 of the tool housing 12 to a pilot bleed valve 98 operated by a trigger 100 pivoted vertically on the body portion 16 for simultaneously actuating control valve 92.

When trigger 100 is in its illustrated released position, it will be understood that the bleed valve 98 is normally closed with the control valve 92 positioned to supply compressed air to the upper chamber 48 of the operating cylinder 20 through a supply and exhaust port 102. The latter communicates with the upper chamber 48 via a passage 104 in the body portion 16, a channel 106 extending longitudinally of the sleeve 18, and an accumulator 108 formed in the body portion 16 to surround the operating cylinder 20 and to communicate with its upper chamber 48 through a port 109 provided in the upper end of sleeve 18.

With line pressure applied to the upper chamber 48, the actuating piston 46 is maintained at the lower end thereof with the plunger 40 in its fully extended position, and the lower chamber 50 of the operating cylinder 20 is normally open to atmosphere through a side port 110 in sleeve 18 which is connected by passage 112 to a quick-dump valve control 114 best seen in FIG. 2.

More specifically, the quick-dump valve control 114 comprises a sleeve 115, threadably secured to the body portion 16 and extend laterally of the tool housing 12, and a hollow plug 116 which is screwed into the outer end of the sleeve 115 whereby the sleeve 115 and the plug 116 jointly define a valve chamber 117. The plug 116 has an axial end opening 118 of reduced size forming an internal shoulder 120 providing a stop at the left hand end of the valve chamber 117 for seating a reciprocal valve plunger 124 in an open position, and the opposite end of the valve chamber 117 has a sealing ring 122 fixed adjacent sleeve 18 for positioning valve plunger 124 in a closed position at the right hand end of chamber 117 as viewed in FIG. 3.

The preferred embodiment of the valve plunger 124 is illustrated as comprising a generally cylindrical rod having an enlarged intermediate segment 126 adapted to cooperate with an inner peripheral portion of a cup seal 128 secured within the valve chamber 117 intermediate its opposite ends, and a fluid-tight seal is provided therebetween upon moving valve plunger 124 toward its right hand closed position. Inner and outer shoulders 128, 130 are formed on the ends of the enlarged intermediate segment 126 to reduce to adjacent rod segments of smaller diameter, and the inner end of valve plunger 124 is shown having a seal 134 retained in a groove 136 circumferentially extending around piston 132 to effectively prevent the passage of air between inner and outer compartments 138 and 140 defined in valve chamber 117 by piston 132.

Compartments 138 and 140 are each provided with inlets in continuous communication respectively with the upper and lower chambers 48 and 50 of the operating cylinder 20. In this regard, an annulus 142 is formed between the ends of sleeve 115 with a plurality of radial holes therethrough such as at 144, 146 forming an inlet to the outer compartment 138 in communication with passage 112 leading to the lower chamber 50, and a second inlet is provided on the inner axial end of valve chamber 117 by the sealing ring 122 and a longitudinally extending channel 148 formed in sleeve 18 for continuously connecting the inner compartment 138 with the accumulator 108 which communicates with the upper chamber 48 of the operating cylinder 20 as described above. Suitable fluid seals are shown provided at 149 to ensure against any outward passage of air between body portion 16 and the sleeve 115.

An inner face 150 of the valve piston 132 is thereby subjected to line pressure when the trigger 100 is in a released position, and the valve plunger 124 is normally seated in its illustrated left hand open position against the biasing force of a compression spring 152 coiled about an
outer stem segment 154 of valve plunger 124 with one end of the spring seated on the internal shoulder 120 of the plug 116 and the opposite end of the spring bearing against shoulder 130 of the valve plunger 124 and continuously urging it toward its closed right hand position.

To actuate the tool, an operator simply squeezes the trigger 100 which opens the pilot bleed valve 98 causing the control valve 92 to shift, immediately opening port 102 to atmosphere for exhausting air from both the upper chamber 48 of the operating cylinder 20 and inner compartment 138 of the valve chamber 117 through supply and exhaust ports 168 and 170. Such shifting of the integral piston 132 to shift to its right hand closed position under the bias of its spring 152 whereby plunger 124 forms a seal on surface 123 to close outer compartment 140 and passage 112 to atmosphere. Simultaneously, line pressure is applied to a port 156 whereby a normally closed, spring loaded check valve 158 is opened and compressed air is directed into the lower chamber 50 through a communicating passage 160 formed in the upper body portion 16, a longitudinally extending channel 164 provided in sleeve 18 and a side port 162 formed therein.

More specifically, as the air pressure is reduced in the upper chamber 48 and 152, plunger 124 begins to move to the right until its shoulder 128 contacts cup seal 123, thereby closing off the lower chamber 50 of the operating cylinder 20 from a plurality of exhaust ports formed in the sleeve 115 such as at 168, 170 and subj ecting shoulder 128 of the valve plunger 124 and an outer face 172 of valve piston 132 to the increasing air pressure in the lower chamber 50. Since the area of face 172 is considerably larger than that provided by shoulder 128, the valve plunger 124 is then thrust into its right hand closed position against the sealing ring 122 by the force of the differential air pressure applied to valve plunger 124 and the biasing force of spring 152.

As the air pressure builds up in lower chamber 50 below the actuating piston 46, the piston 46 is caused to rise until its stem portion 174 is stopped against cushion 30 during which time side port 52 is automatically gated as the plunger 40 is being withdrawn so that airflow 58 drops into a properly aligned position relative to a workpiece opening.

The tool is now cocked in readiness to be fired which is accomplished by release of the trigger 100 by the operator while continuing to hold the nozzle 44 firmly in alignment with the workpiece opening with the aid of the above mentioned tip 60. Upon release of the trigger 100, the control valve 92 returns to its normal position whereupon accumulator 108 and the upper chamber 48 of the operating cylinder 20 are once again connected to line pressure through the supply and exhaust port 102 while the check valve 158 prevents any exhaust of air from the lower chamber 50 of the operating cylinder 20 through supply port 156.

The trapped air in the lower chamber 50 below the actuating piston 46 is thereby maintained at substantially full line pressure to effect an air latch permitting the air pressure in the accumulator 108 to build up and simultaneously apply a continuously increasing force on the valve piston 132 for urging the plunger 124 toward its open position. An exposed pressure-sensing surface 176 is shown centrally defined on the inner face 150 of valve piston 132 by an annular projection 178 extending around the entire circumference of the valve piston 132 which is of exposed to the air pressure in the upper chamber 48, when plunger 124 is in its closed position, is thus of a reduced size preselected to prevent any movement of the valve plunger 124 until the air pressure in the upper chamber 48 has been built-up, say, to approximately 90 percent of that of the trapped air below the actuating piston 46.

When the pressure acting on the centrally exposed pressure-sensing surface 176 of valve piston 132 reaches a maximum to shift valve plunger 124 slightly to the left, the annular projection 178 is unseated to suddenly expose the entire end area of the valve piston 132 to back pressure from the accumulator 108, thereby producing a snap action opening of the valve plunger 124, driving it into its illustrated left hand open position with its outer stem segment 154 seated against the internal shoulder 120 of the plug 116.

The sudden opening of valve plunger 124 quickly exhausts the lower chamber 50 via port 110 and passage 112, to vent air into the outer compartment 140 of the valve chamber 117 and through the center of the cup seal 123 to atmosphere through the exhaust ports 168, 170 and the compressed air in the accumulator 108 drives the actuating piston 46 downwardly at a high velocity whereby plunger 40 impacts a hammer blow driving the article home into the workpiece opening.

A hardened bushing 179 is desirably provided in the upper end of handle portion 14 to effect a stop for the intermediate shoulder portion 45 of the plunger 40 to minimize any possibility of its being damaged when the tool is fired without an article in the nozzle portion of the guideway.

To impart a variable impact force in accordance with the demands of different applications, the velocity of the actuating piston 46 and the resultant impact on an article is precisely controlled within close limits by means of a throttling sleeve 180 fitted onto and threadably connected to the sleeve 115 of the quick-dump valve control 114. A friction ring 182 is positioned in an annular recess 184 formed on the inside of the throttling sleeve 180 to engage the outer surface of the sleeve 115 and maintain the former in an adjusted position upon selectively rotating the throttling sleeve 180 to vary the effective size of exhaust ports 168, 170 and thereby vary the impact force of the plunger 40 to suit the application of the tool.

For handling different work parts of varying size, plunger 40 cooperates with the actuating piston 46 to provide a quick-disconnect attachment therebetween. In the illustrated embodiment, the plunger 40 is provided with a neck portion 186 fitted into a central opening 188 in the bottom of the actuati ng piston 46 after an outside annular groove 190 for receiving a garter spring 192. The garter spring 192 applies an inwardly directed biasing force against the detents 194, 195 mounted for lateral movement in openings formed in the piston 46 for engaging a recess 196 in the neck portion 186 of the plunger 40 to releasably lock the same into the actuating piston 46. The above described separable construction significantly facilitates removal of the plunger 40 and replacement thereof by a plunger having a different size tip, e.g., upon detachment of the handle portion 14 from the body portion 16 of the tool housing 12 whereby an operator is assured of having the new plunger properly aligned by simply snapping it into the central opening 188 of the actuating piston 46 and mounting the handle portion 14 onto the upper body portion 16 by tightening the spanner nut 26 to secure the tool for the next application.

To ensure that articles will be properly driven into the workpiece 36 without damage even though the impact adjustment of the throttling sleeve 180 is set too high, e.g., the central opening 188 in the piston 46 is of a sufficient axial length permitting limited relative movement of the plunger 40 which is of a preselected length to provide bottoming contact against the piston 46 after an article is driven home into the workpiece 36. The plunger 40 is continuously urged downwardly against the detents 194, 195 by a pilot compression spring 198 coiled about an upwardly extending stem 200 on the top of the plunger 40 with opposite ends of the pilot spring 198 seated against the plunger 40 and 186.

By virtue of the above described construction, any tendency of the tool to recoil upwardly at the end of an inserting stroke is virtually eliminated while at the same
time ensuring against damaging an inserted article even though the tool is operated under an impact force exceeding the requirements of a particular application.

It will be noted that upon moving the tool from the workpiece after a completed firing cycle, the biasing force of the pilot spring 198 provides for moving the plunger 40 into fully extended position to once again protrude beyond the end of the nozzle tip 60 for use as a pilot for the next inserting operation.

Thus, it can be seen that the fluid-operated inserting tool of the present invention can be easily manipulated to provide an inserting action of improved capabilities with a conventional source of compressed air. Moreover, the hand tool of the present invention is adapted for securely and accurately maintaining an insertable article in perfect alignment with a workpiece opening prior to actuation of the tool which is readily cocked by squeezing the trigger, latched in a loaded position upon the release of the trigger and thereafter automatically fired upon the exhaust of trapped air from the lower chamber of the operating cylinder by the snap action opening of the quick-dump valve control. Additionally, the hand tool of the present invention is rugged, substantially service-free and is particularly suited for selective attachment of different size plungers, nozzles and even handle portions as determined by a particular application, thereby to provide a tool of maximum versatility.

As will be apparent to persons skilled in the art, various modifications, adaptations and variations of the foregoing specific disclosure can be made without departing from the teachings of the present invention.

We claim:

1. An inserting tool for driving articles into a workpiece opening comprising a tubular housing having a closed end and a hollow tip mounted on its opposite end for receiving an article to be inserted into a workpiece, said tip being formed of slip-resistant material and engageable with the workpiece to frictionally maintain the tool against inadvertent movement, a plunger axially reciprocable within said housing between extended and retracted positions for driving the article into a workpiece opening, said plunger in said extended position protruding beyond said slip-resistant tip and providing a pilot for cooperating with portions of the workpiece surrounding the workpiece opening to register the tool therewith, said slip-resistant tip being engageable with the workpiece to frictionally maintain the tool against inadvertent movement upon longitudinally extending operating cylinder, and manually operable motor means including fluid control means and passage means connecting the latter to said first and second chamber portions of said operating cylinder for selectively admitting pressure fluid to and exhausting it from said first and second chamber portions thereof for selectively reciprocating said pilot and manually moving said plunger between said extended and retracted positions, said fluid control means including a quick-dump pressure sensing control in said passage means for automatically exhausting fluid under pressure from one of said first and second chamber portions when the piston operating pressure in the other chamber portion increases beyond a predetermined level for fluid operation of said piston in one longitudinal direction to drive said plunger from its retracted position into its extended position.

2. The tool of claim 2 wherein said passage means includes a valve chamber formed in said tool housing, and wherein said quick-dump pressure sensing control includes a valve member having a piston at one end thereof movable in said valve chamber, said valve chamber having an outlet to atmosphere and first and second inlets positioned on opposite sides of said valve piston and continuously in communication respectively with said first and second chamber portions of said operating cylinder respective of the position of said valve member, said valve member cooperating with said tool housing to establish an open position connecting said first inlet and said outlet for venting said first chamber portion to atmosphere, and a closed position shutting off said first inlet from said outlet to close off said first chamber portion from atmosphere, whereby pressure forces are constantly exerted on said valve piston in opposed directions for automatic fluid operation of said valve member in venting said first chamber portion to atmosphere in response to the pressure of the fluid in said second chamber portion increasing beyond a predetermined level.

4. The tool of claim 2 wherein said valve piston and said tool housing cooperate to provide a pressure sensing surface of reduced size relative to the face of the piston exposed to pressure of the fluid in said second chamber portion of said operating cylinder when said valve member is in the retracted position to control pressure fluid operation of said valve member responsive to an increase in fluid pressure in said second chamber portion beyond said predetermined level, said valve member snaps into its open position in response to a sudden increase in pressure force acting on the exposed face of said valve piston thereby causing said first chamber portion to be suddenly exhausted to atmosphere.

5. The tool of claim 4 further including throttling means on said tool housing for adjusting the size of said outlet to selectively vary the rate of fluid exhaust from said first chamber portion of said operating cylinder and thereby adjust the impact force exerted by said plunger being moved from said retracted position toward said extended position.

6. An inserting tool for driving articles into a workpiece opening comprising a tubular housing having a closed end and a hollow tip mounted on its opposite end for receiving an article to be inserted into a workpiece, said tip being formed of slip-resistant material and engageable with the workpiece to frictionally maintain the tool against inadvertent movement, a plunger axially reciprocable within said housing between extended and retracted positions for driving the article into a workpiece opening, said plunger in said extended position protruding beyond said slip-resistant tip and providing a pilot for cooperating with portions of a workpiece surrounding the workpiece opening to register the tool therewith, said slip-resistant tip being engageable with the workpiece to frictionally maintain the tool against inadvertent movement upon longitudinally extending operating cylinder, and manually operable motor means including fluid control means and passage means connecting the latter to said first and second chamber portions of said operating cylinder for selectively admitting pressure fluid to and exhausting it from said first and second chamber portions thereof for selectively reciprocating said pilot and manually moving said plunger between said extended and retracted positions, said fluid control means including a quick-dump pressure sensing control in said passage means for automatically exhausting fluid under pressure from one of said first and second chamber portions when the piston operating pressure in the other chamber portion increases beyond a predetermined level for fluid operation of said piston in one longitudinal direction to drive said plunger from its retracted position into its extended position.
said plunger for longitudinal reciprocation within said housing, fluid control means, and passage means in said housing for connecting said fluid control means to opposite sides of said piston for controlling longitudinal reciprocation of said piston, said end of said plunger being received for limited relative movement within said piston, and a spring between said piston and said plunger and continuously urging the latter toward said extended position, thereby ensuring against damaging the articles and also minimizing recoil of the tool when said plunger is driven toward said extended position.