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 [21] Appl. No. **855,795**
 [22] Filed **Aug. 21, 1969**
Continuation of Ser. No. 629,244,
April 7, 1967
 [45] Patented **Sept. 8, 1970**
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[56]

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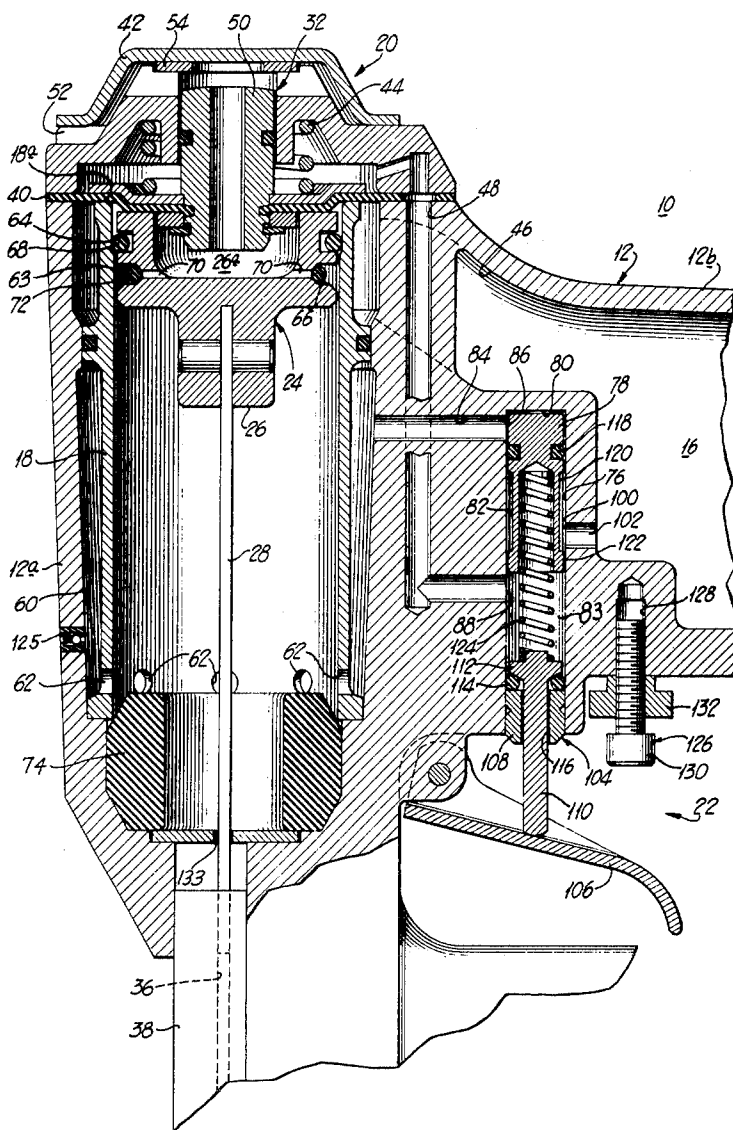
[54] **FASTENER DRIVING TOOL**
14 Claims, 3 Drawing Figs.

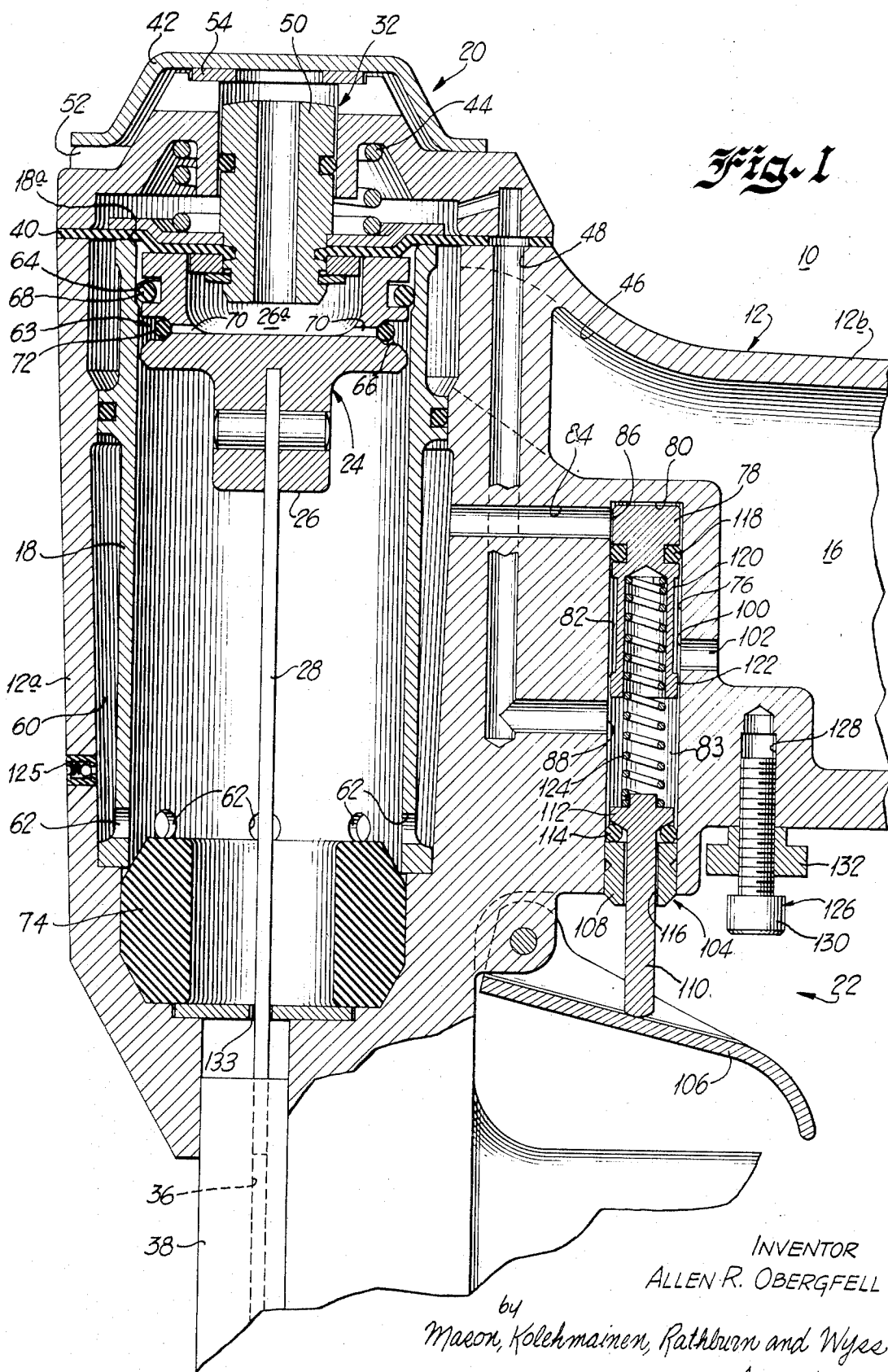
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227/130

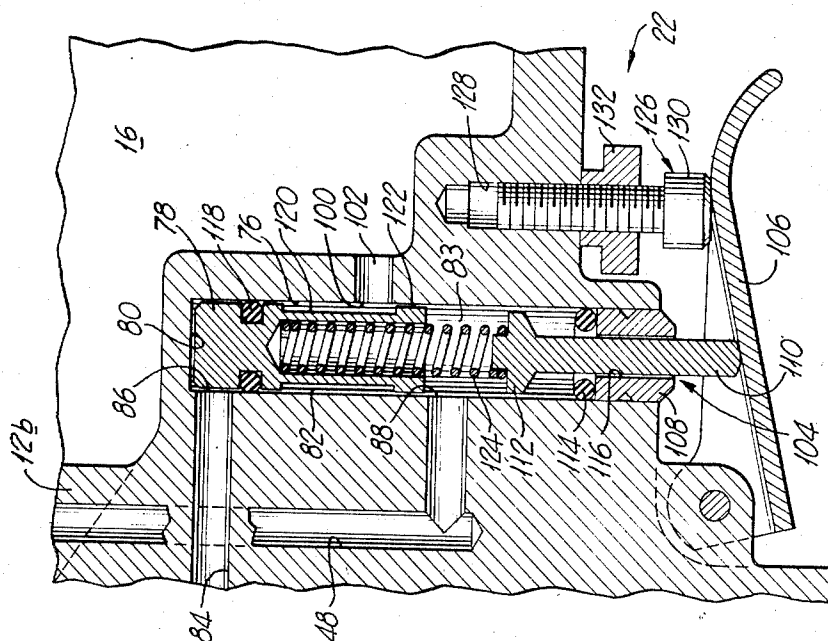
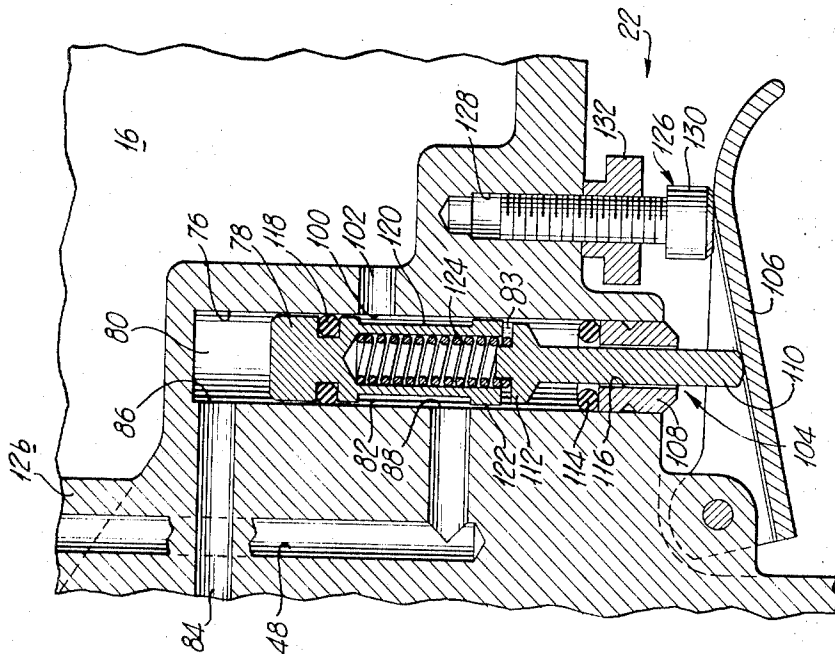
[51] Int. Cl. **B25c 1/04,**
F01I 25/04

[50] Field of Search **227/130;**
91/318, 461, 308

ABSTRACT: There is provided a pneumatic fastener driving tool having control means providing for successive fastener driving operations upon a single depression of the tool trigger. The control means includes a control piston responsive to a suitable pneumatic signal such as the pressure in the piston return chamber and effective to recycle the driving piston of the tool so long as the trigger is depressed. In addition means are provided for varying the rate of recycling as a function of the displacement of the tool trigger.







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FASTENER DRIVING TOOL

The present application is a continuation of application Ser. No. 629,244, filed April 7, 1967, now abandoned.

This invention relates to a fastener driving tool and, more particularly, to a fastener driving tool including new and improved control means providing for successive fastener driving operations upon a single depression of the tool trigger.

Commercially available pneumatic fastener driving tools generally provide a single fastener driving stroke upon each depression of the tool trigger. However situations have arisen where it would be desirable to drive a plurality of fasteners in successive fastener driving operations at suitably short intervals upon a single depression of the tool trigger. Such pneumatic fastener driving tools known to the applicant have not been entirely satisfactory.

An object of the present invention is to provide a new and improved pneumatically actuated fastener driving tool of the type to continuously and repetitively operate through its working cycle so long as the trigger thereof is depressed.

Another object of the present invention is to provide a fastener driving apparatus having new and improved control means.

Yet a further object of the present invention is the provision of a fastener driving tool of the type wherein the tool will repetitively and continuously operate through its working cycle so long as the trigger member is depressed, and wherein the rate of recycling of the tool may readily be varied.

Further objects and advantages of the present invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In accordance with these and other objects, there is provided a new and improved control means for a fastener driving tool. As heretofore described, a known type of commercially available fastener driving tool includes a housing having a cavity defining a fluid reservoir and containing a cylinder in the housing slideably receiving a main piston therein. Cylinder valve means are provided for controlling admission of fluid to and the exhaustion of fluid from one end of the cylinder. In accordance with the present invention, automatic firing control means are connected to control the cylinder valve for automatic recycling of the piston through repetitive strokes. The control means includes a multiple firing valve piston within a valve cylinder and dividing the valve cylinder into first and second chambers. A signal port in the first one of the chambers is connected to receive a pneumatic control signal. When depressed the trigger valve is connected to exhaust the second chamber. A cylinder port is provided in the second chamber connected to the cylinder valve and a reservoir port in the second chamber is connected to the fluid reservoir. The piston includes means defining a pneumatic seal between the signal port and the reservoir port throughout the stroke of the valve piston and further includes means defining a restricted passage between the reservoir port and both the cylinder valve port and the trigger valve when the valve piston is in its normal position, and movable to place the cylinder valve port in substantially unrestricted communication with the reservoir port. Means are provided for biasing the valve piston to its normal position.

In accordance with another feature of the present invention, means are provided for varying the force of the biasing means so that the rate of recycling of the fastener driving tool may readily be varied.

Many other objects and advantages of the present invention will become apparent from considering the following detailed description in conjunction with the drawings in which:

FIG. 1 is a fragmentary cross sectional view of a fastener driving tool incorporating the improved multiple firing control means according to the present invention and illustrated with the drive piston and driver blade in its static or at rest position;

FIG. 2 is a fragmentary cross sectional view of the improved control means of FIG. 1, illustrated with the trigger depressed at the beginning of a firing stroke; and

FIG. 3 is a fragmentary cross sectional view of a fastener driving tool of FIG. 1 illustrating the improved control means at the completion of the drive stroke of the fastener driving tool.

Referring now to the drawings, there is fragmentarily illustrated a fastener driving tool generally illustrated as 10, which embodies a control valve assembly according to the present invention. The tool 10 may be of known construction, and, as illustrated, comprises a housing 12 including a generally vertically extending head or forward portion 12a, FIG. 1, and a rearwardly extending hollow handle portion 12b defining a fluid reservoir 16. Pressurized fluid such as compressed air is supplied to the fluid reservoir of the tool 10 by a suitable flexible line. The drive system for the tool 10 includes a main or power cylinder 18 mounted within the head portion 12a and having an open upper end 18a that is adapted to be selectively connected to the reservoir 16. The open upper end of the cylinder 18 is in engagement with a diaphragm type main or cylinder valve assembly 20, here shown of the poppet type, under the control of a control valve assembly 22 according to the present invention. A fastener driving assembly 24 slideably mounted within the cylinder 18 includes a work or drive piston 26 and has connected thereto a depending driver blade member 28. The fastener driving assembly 24 is normally biased to a position with the piston 26 adjacent the cylinder valve assembly 20. An exhaust valve assembly indicated generally as 32 is provided for controlling the selective connection of the upper end of the cylinder 18 to the atmosphere.

When the tool 10 is to be operated, compressed fluid from the reservoir 16 enters the upper open end 18a of the cylinder 18 and drives the fastener driving assembly 24 downwardly to engage and set a fastener or nail supplied to a drive track 36 in a nosepiece and nosepiece structure 38. The flow of compressed fluid into the upper end of the cylinder 18 is controlled by the main valve assembly 20, which includes a diaphragm 40, the periphery of which is clamped between a cap 42 and the head portion 12a of the housing 12 and which seats against the upper edge 18a of the cylinder 18. The diaphragm 40 is resiliently biased against the upper edge surface 18a by a spring 44 located between the cap 42 and the diaphragm 40. The cylinder side of the diaphragm 40 is continuously in communication with the fluid reservoir 16 through a suitable passageway 46 so that pressurized fluid continuously acts against the cylinder side of the diaphragm 40 tending to displace the diaphragm 40 from the edge 18a of the cylinder 18. However pressurized fluid is also introduced to the opposite side of the diaphragm 40 through a passageway 48 while the fastener driving tool 10 is in a static or at rest position. The pressure acting on the diaphragm 40 is effective to maintain the diaphragm 40 in a closed position, as illustrated in FIG. 1. However, if the pressurized fluid above the diaphragm 40 is discharged, the pressurized fluid acting through the passageway 46 is then effective to unseat the diaphragm 40 from the edge 18a of the cylinder 18 to dump pressurized fluid into the top of the main cylinder 18 and to drive the drive piston 26 through a drive stroke.

When the fastener driving tool is at rest, or during the return stroke of the drive piston, the open upper end of the cylinder 18 is exhausted to the atmosphere through the exhaust valve assembly 32. In the illustrated embodiment the exhaust valve assembly comprises a hollow valve stem 50 secured to the diaphragm and connecting the upper end of the cylinder 18 to the atmosphere through a suitable exhaust passageway 52. However when the drive piston is operated through a fired or drive stroke, it is necessary for the upper end of the cylinder 18 to be closed, and to this end there is provided a valve seat 54 disposed adjacent the end of the valve stem 50 remote from the cylinder 18 and adapted to be engaged by the valve stem 50 when the diaphragm 40 is raised at the initiation of a drive stroke, thereby closing off the upper end of the cylinder 18 to the atmosphere.

To provide for the return drive of the fastener driving assembly 24, there is provided an air return chamber 60 communicating with the lower end of the cylinder 18 through a plu-

ality of ports 62. Moreover the drive piston 26 is provided with suitable one way valve means 63, which may be of the type more fully described in the application of Richard H. Doyle for Letters Patent of the United States of America, Ser. No. 602,728 filed December 19, 1966 and assigned to the same assignee as the present invention. However, briefly, to this end the piston 26 is provided with spaced peripheral grooves 64 and 66, the upper one 64 of which serves as a sealing groove while the lower one 66 functions as the one way valve means 63 to provide for the bypass of pressurized fluid to the air return chamber 60. An O-ring 68 provided in the upper one of the grooves 64 functions as a sealing member effecting a pneumatic seal between the piston 26 and the inner wall of the cylinder 18. To bypass around the groove 64 and O-ring 68, there is provided a plurality of air passageways 70 extending from the lower one 66 of the grooves and communicating with a central cavity 26a in the piston 26. An O-ring 72 defining a valve element is positioned within the lower one 66 of the grooves. The O-ring 72 is expandable upon a selected pressure differential between the upper and lower ends of the cylinder through the piston 26 so as to unseat from the ports of the air passageways 70 to provide for fluid to bypass through the piston 26 around the O-ring 72 and to supply air to the air return chamber 60.

It will be understood that in the operation of the basic tool, the piston 26 and associated driver blade member 28 is driven downwardly through a drive stroke by connection of the open upper end 18a of the cylinder 18 with the reservoir 16. Since there is no significant restraint to the piston during its downward movement, the pressure above the piston 26 will not build up sufficiently to unseat the O-ring 72 until the piston 26 approaches the bottom of its drive stroke. At this point the pressure above the piston 26 will continue to build up until it approaches the pressure in the reservoir 16 and the O-ring 72, functioning as a valve element, will be unsealed from the ports of the air passageways 70, thereby providing a source of pressurized fluid to the air return chamber 60 through the air passageways 62. Upon exhaustion of the open upper end 18a of the cylinder 18 to the atmosphere, the pressurized fluid in the air return chamber 60 will re-enter the lower end of the cylinder 18 through the ports 62 and will drive the piston 26 back to its normal or at rest position.

To cushion the drive stroke of the piston 26, there is provided a resilient annular bumper 74 at the lower end of the cylinder 18 which is engageable by the piston 26 as it reaches the end of its drive stroke.

Referring now to the control valve assembly 22 in accordance with the present invention, the control valve assembly includes a valve cylinder 76 defined in the housing 12. A valve piston 78 within the valve cylinder 76 divides the valve cylinder into first, second and third chambers 80, 82 and 83. The first valve chamber 80 is connected to the air return chamber 60 through a suitable passageway 84 opening into a signal port 86. A cylinder valve port 88 at the end of passageway 48 opens into the third valve chamber 83. In addition a reservoir port 100 opens into the second valve chamber 82 and connects with the reservoir 16 through a suitable passageway 102. A trigger valve assembly 104 is connected to exhaust the third valve chamber 83 to atmosphere when a trigger 106 is depressed. As illustrated the trigger valve assembly 104 includes a sleeve 108 secured in the lower open end of the valve cylinder 76 through which extends a trigger valve stem 110 having a trigger valve element 112 at its inner end seatable on an O-ring 114 forming a valve seat. Sufficient clearance is provided between the valve stem 110 and the sleeve 108 to provide an exhaust passageway 116 therebetween. It will be understood that when the trigger 106 is depressed, the valve seat 110 will be raised off the O-ring 114 thereby exhausting the third valve chamber 83 to atmosphere through the passageway 116.

Referring now to the piston 78, the piston 78 includes an O-ring 118 defining a pneumatic seal between the first and second chambers and accordingly defining a pneumatic seal

between the signal port 86 and the remainder of the valve ports. In addition, the valve piston 78 is elongated with an annular recess 120 formed intermediate its ends and defining a substantially unrestricted chamber. The lower end of the valve piston 78 is of reduced diameter to define a restricted or seepage passageway 122 from the annular recess 120. The cylinder valve port 88 and reservoir port 100 are located in the valve cylinder 76 in a position wherein the restricted passageway 122 lies intermediate the ports when the valve piston 78 is in its normal or at rest position, as illustrated in FIG. 1, but the valve piston 78 is movable to the position illustrated in FIG. 3 wherein the restricted passageway 122 passes the port 88 to provide a substantially unrestricted passageway between the valve ports 88 and 100 to the annular recess 120.

A compression spring 124 is interposed between the valve piston 78 and the trigger valve seat 112. The biasing force of the compression spring 124 is, of course, a function of the displacement of the valve stem 110.

A ball type pressure release valve 125 in the head portion 12a is positioned to exhaust the air return chamber 60 to atmosphere in the event that the pressure therein builds up excessively. Such excessive pressure buildup may occur from rapid cycling of the tool 10 providing insufficient time for excess return fluid to bleed off to atmosphere. Excess return pressure can create back pressure during the driving stroke and is therefore undesirable.

The operation of the multiple firing control valve 22 is believed clear from the above description. However, briefly, it will be understood that with the tool 10 in its normal or at rest position as illustrated in FIG. 1, pressurized fluid from the reservoir 16 will enter into the annular recess 120 through the passageway 102, will seep around restricted passageway 122, and will enter the port 88 into the passageway 48 to provide the necessary pressure above the diaphragm 40 of the cylinder valve assembly 20 to maintain the cylinder valve assembly 20 closed. In this position, the trigger 106 is released and the spring 124 closes the passageway 116 to the atmosphere. However upon depression of the trigger 106, the valve seat 112 is unsealed from the O-ring 114, exhausting the cylinder valve assembly 20 to atmosphere through the passageway 48, valve port 88, third valve chamber 83 and passageway 116. Although there will be seepage or leakage of pressurized fluid from the reservoir 16 through the restricted passageway 122 at this time, such leakage is negligible in its effect upon the operation of the control valve 22. Thus with the release of the fluid from above the diaphragm 40, the cylinder valve assembly 20 will open, permitting pressurized fluid to enter the top of the cylinder 18 and driving the main piston 26 through its power stroke. As heretofore described, the pressure in the air return chamber will build up and this pressure will be transmitted through passageway 84 and port 86 into the first valve chamber 80 where it will act upon the valve piston 78. As soon as the pressure in the first valve chamber 80 is sufficient to overcome the bias of the compression spring 124, the valve piston 78 will be displaced downwardly to the position illustrated in FIG. 3. At this time the fluid in the reservoir 16 will be placed in substantially unrestricted communication with the cylinder valve assembly 20 through the passageway 102, port 100, annular recess 120, port 88, and passageway 48, and the cylinder valve assembly 20 will close, exhausting the upper end 18a of the cylinder 18 to atmosphere, allowing the drive piston to return to its normal position. As the pressure in the air return chamber 60 bleeds off to atmospheric pressure, the compression spring 124 will return the valve piston 78 to its normal position. Consequently the cylinder valve assembly 20 will once again open, driving the main piston 26 through an additional drive stroke. This automatic sequence of operation will continue as long as the trigger 106 is in the depressed or actuated position and until such time as the trigger has been released to return to its normal position.

The control valve assembly 22 may be readily adjusted to provide for varying the rate of recycling of the piston 26. This is readily accomplished by altering the bias of the compression

spring 124. The loading on the compression spring 124 is proportional to the displacement of the trigger valve stem 110 and accordingly to the displacement of the trigger 106. To provide for the selective positioning of the displaced trigger 106, there is provided a stop screw 126 threaded into a suitable opening 128 in the housing 12 and having an enlarged head 130 defining a stop for the trigger 106. A thumb set nut 132 serves to lock the stop screw 126 in its selected position. It will be understood that a greater depression of the trigger 106 will provide an increased bias to the compression spring 124. Since the return of pressure in chambers 60 and 80 to atmosphere is somewhat delayed through restrictions of valve 125 and passage 133, valve 78 cannot return immediately to its uppermost position. Increased trigger displacement provides, through spring 124, the necessary bias to accelerate the valve return, and thus reduce the time interval between repetitive cycles.

Although the present invention has been described by reference to only a single embodiment thereof, it will be apparent that numerous modifications and embodiments may be devised by those skilled in the art and it is intended by the appended claims to cover all modifications and embodiments which will fall within the true spirit and scope of the present invention.

I claim:

1. In a fastener driving tool of the type having a fastener driver actuated by a piston slidable in a cylinder having an end opening selectively connected to the atmosphere and a source of pressurized fluid by a fluid controlled main and exhaust valve assembly;

a control valve means for controlling the connection of the atmosphere and pressurized fluid to the main and exhaust valve assembly to operate the main and exhaust valve assembly to alternate positions in which the cylinder is alternately connected to the pressurized fluid and the atmosphere to reciprocate the piston through an operating and a return stroke, the control valve means, when operated, automatically controlling the main and exhaust valve assembly to continuously reciprocate the piston through successive cycles of operating and return strokes;

an element included in said control valve means and movable from a normal position to various different displaced positions within a given range of positions, said element in its normal position rendering the control valve means inoperable to effect movement of the main and exhaust valve assembly between its alternate positions, said element in each of said various different displaced positions controlling the control valve means to control the main and exhaust valve assembly to automatically effect different corresponding rates of cyclic operation of the piston through its strokes;

and a manually actuated means coupled to said element and operable from a normal position through a range of displaced positions to move said element from its normal position to its various different displaced positions so that the degree of displacement of the manually actuated means determines the rate at which the piston is cyclically moved through its strokes.

2. The tool set forth in claim 1 in which:

the control valve means includes a valve structure; and

biasing means are provided controlled by the element for applying a bias to said valve structure that varies in accordance with the position of the element.

3. The tool set forth in claim 1 in which:

the control valve means includes both a fluid operated valve structure and a biasing means controlled by the position of said element for applying a bias varying in dependence on the position of the element to the fluid operated valve structure.

4. The tool set forth in claim 3 in which:

the biasing means includes spring means coupled between the element and the fluid operated valve structure.

5. A tool for automatically driving a series of fasteners at a controllable rate using a cylinder and a driver actuated by a piston comprising:

a fluid operated main and exhaust valve assembly for alternately connecting the cylinder to the atmosphere and pressurized fluid to reciprocate the piston and driver through a cycle of operation;

a fluid operated valve means for controlling the application of fluid to the main and exhaust valve assembly to control the operation of the main and exhaust valve assembly;

and a control means for applying a variable bias to the fluid operated valve means to control the rate of cycling of the piston and driver, the control means including a manually actuated trigger means movable through a range of different displaced positions in each of which a different bias is applied to the fluid operated valve means to effect a corresponding different rate of cycling of the piston and driver.

6. The tool set forth in claim 5 including:

fluid conveying means for supplying a portion of the fluid admitted by the main and exhaust valve assembly to the fluid operated valve means to provide the fluid for operating the fluid operated valve means.

7. The tool set forth in claim 5 in which:

the control means includes means for controlling the first operation of the main and exhaust valve assembly in response to actuation of the trigger means to one of its displaced positions.

8. A pneumatically operated fastener driving tool including a housing having a cavity defining a fluid reservoir, a cylinder in said housing, a piston slidably mounted in the cylinder, cylinder valve means controlling admission of fluid to and the exhaustion of fluid from one end of the cylinder, and automatic firing control means connected to control said cylinder valve for automatic cycling of said piston through repetitive strokes, said control means including a valve cylinder defined in said housing, multiple firing valve piston means in said valve cylinder, trigger valve piston means in said valve cylinder, said piston means dividing said valve cylinder into first, second, and third chambers, signal port means in the first one of said chambers adapted to receive a pneumatic control signal, said trigger valve being adapted to exhaust said second chamber, cylinder valve port means in said third chamber connected to said cylinder valve means, reservoir port means in said second chamber connected to said fluid reservoir, said piston including means defining a pneumatic seal between said signal port means and said reservoir port means throughout the stroke of said piston means and further including means defining a restricted passage between said reservoir port means and both said cylinder valve port means and said trigger valve means when said piston means is in its normal position, and movable to place said cylinder valve port means in substantially unrestricted communication with said reservoir port means and biasing means biasing said piston means to its normal position.

9. A pneumatically operated fastener driving tool as set forth in claim 8 wherein means are provided for varying the force of said biasing means.

10. A pneumatically operated fastener driving tool as set forth in claim 9 including means controlling the maximum force of said biasing means.

11. A pneumatically operated fastener driving tool as set forth in claim 8 wherein said biasing means is interposed between said piston means and said trigger valve means, wherein the biasing force of said biasing means is a function of the displacement of said trigger means.

12. A pneumatically operated fastener driving tool as set forth in claim 11 and including stop means for limiting the maximum displacement of said trigger means.

13. A pneumatically operated fastener driving tool as set forth in claim 8 wherein said tool includes a piston return chamber, and wherein said signal port is connected to said piston return chamber.

14. A pneumatically operated fastener driving tool as set forth in claim 8 wherein said means on said piston means defining a pneumatic seal comprises a sealing ring, and wherein said means on said piston means defining a restricted

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passage comprises a cylindrical enlargement on said piston means having clearance with said valve cylinder to provide for seepage of fluid therebetween, and wherein an annular recess is defined between said sealing ring and said cylindrical en-

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largement to provide the said substantially unrestricted communication between said reservoir port means and said cylinder valve port means.

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