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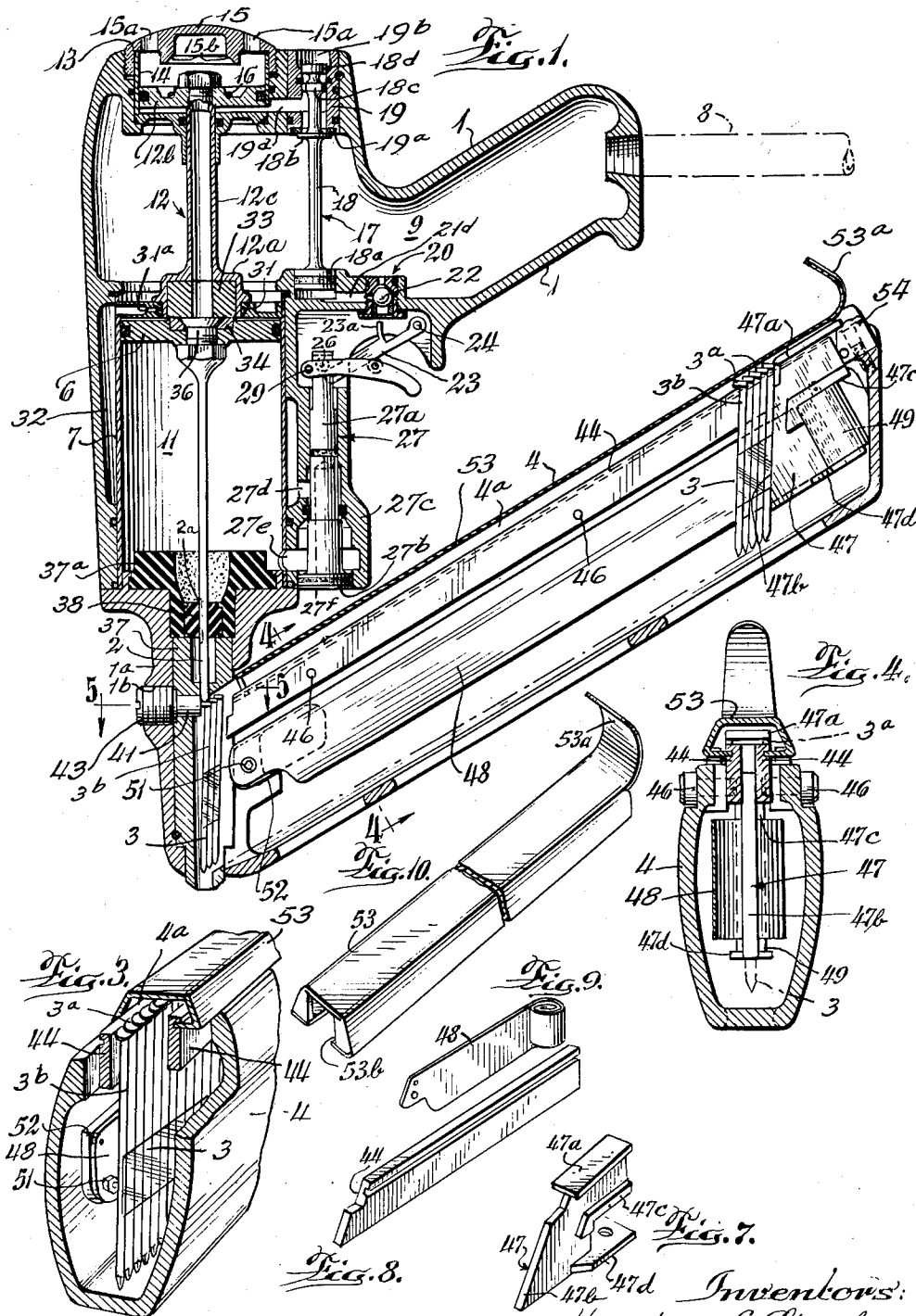
H. C. LINGLE ET AL

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PNEUMATIC FASTENING TOOL

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2 Sheets-Sheet 1



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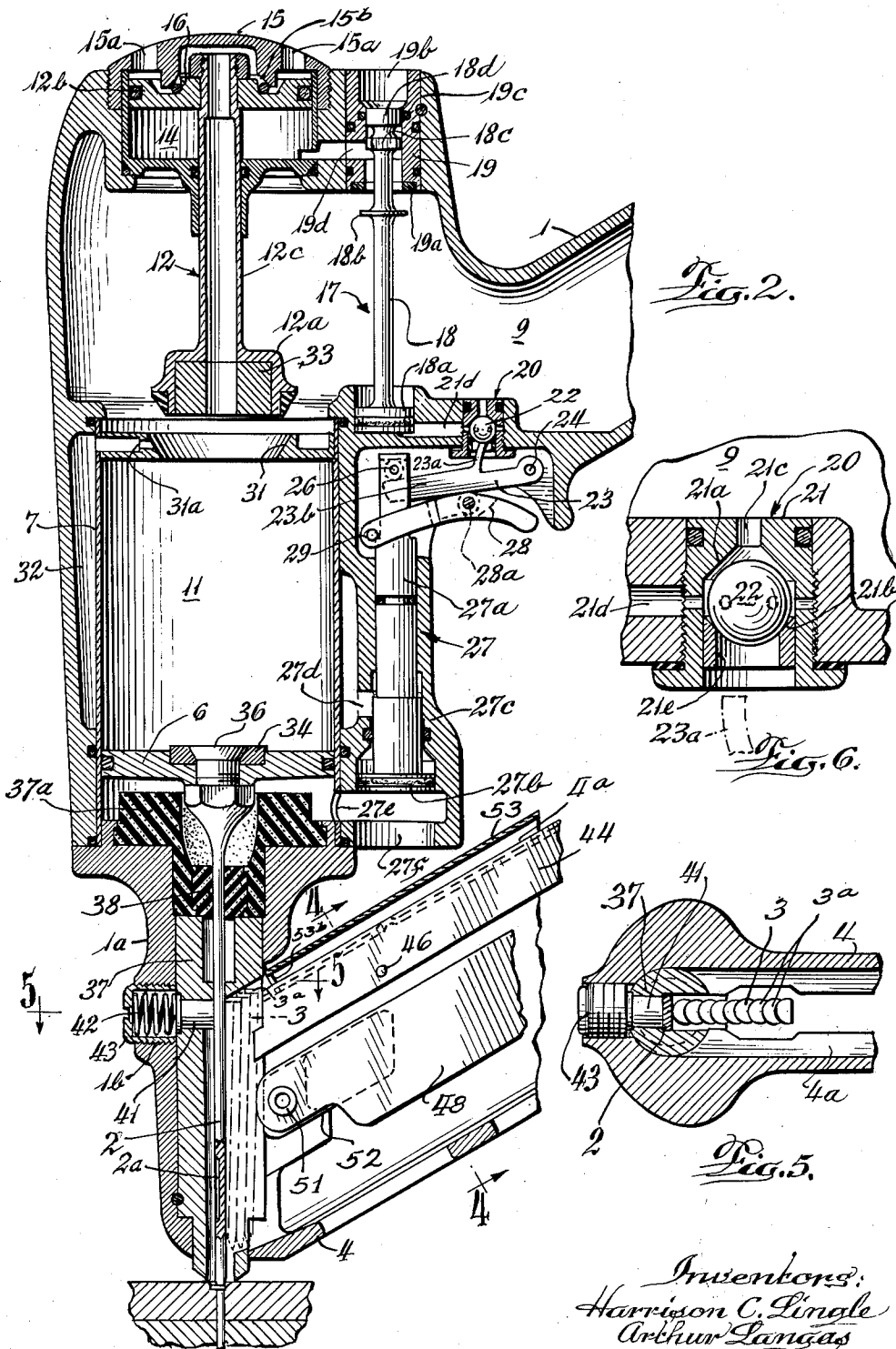
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PNEUMATIC FASTENING TOOL

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12 Claims. (Cl. 1—44.4)

This invention relates to automatic fastening devices and, particularly, to a portable pneumatic nailer for automatically driving nails at a very rapid rate.

With the advent of large automatic nailing devices, and the availability of nails in strip form, the next logical step was to provide portable automatic nailing devices which are both light in weight and easy to handle. Such a portable unit should be equipped to handle cohered strips of nails to drive the maximum amount of nails in the minimum time. These devices must be very fast acting and contain the most power possible in the smallest possible package. This has logically led to the employment of pneumatically operated devices which merely require a supply of high-pressure air.

In accordance with the present invention, we have provided a pneumatic nailer which includes a nail hammering device that severs a nail from a nail strip located in a magazine and drives the nail into position upon the application of high-pressure air to one side of a nail hammer. The supply of high-pressure air to the hammer is controlled by a main pilot valve. The force exerted on the nail hammer quickly drives the hammer and nail associated therewith into the members being connected. The operation of the main pilot valve is in turn controlled by an auxiliary pilot valve which regulates the flow of high-pressure air to the main pilot valve. In the illustrated embodiment, the chain of events to sequentially operate the auxiliary pilot valve, main pilot valve, and nail hammer includes a trigger mechanism which functions to position a valve that directs the flow of high-pressure air to operate the auxiliary pilot valve.

During the nail driving operation, high-pressure air is stored in a chamber which is in communication with the main piston chamber. After the nail has been driven, the fluid stored in this chamber is directed to act against the underside of the nail hammer to return the hammer to its retracted position where it is out of engagement with the strip of nails. The flow of fluid between the main storage chamber is controlled by an exhaust valve, which exhaust valve is operated during the triggering action. Thus, there is provided a pressure-operated pneumatic nailer in which all the valves are pressure-actuated so they will operate quickly and efficiently and without the sluggishness found in similar devices. Furthermore, the above arrangement results in a very compact nailer since the length of cylinder containing the hammer and associated piston need only be as long as the hammer stroke plus the width of the piston.

A cohered array of nails is disposed in a magazine adjacent the nail hammer. The nails are biased into an area where they are to be engaged by the nail hammer by a pusher mechanism which is spring loaded to maintain it in constant engagement with the strip of nails.

An illustrative embodiment of the invention is described in detail in the following specification, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a sectional view showing the pneumatic nailer with the nail hammer in the retracted position;

FIGURE 2 is a partial cross-sectional view showing the positions of the various devices at the instant the nail is driven into place;

FIGURE 3 is a cross-sectional view, in perspective, of the nail magazine;

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FIGURE 4 is a view taken along lines 4—4 of FIGURE 1;

FIGURE 5 is a view taken along lines 5—5 of FIGURE 1;

FIGURE 6 is an enlarged view of the ball check valve which is operated by the trigger mechanism;

FIGURE 7 is a view, in perspective, of the pusher mechanism;

FIGURE 8 is a perspective view of a nail guide rail;

FIGURE 9 is a view, in perspective, of the spiral coil spring; and

FIGURE 10 is a perspective view of the magazine cover.

As shown in FIGURE 1, the pneumatic nailer disclosed is operated by a high-pressure fluid such as air that is introduced into the nailer housing 1 and directed against the upper enlarged piston area of nail hammer 2 to engage nails 3 and drive them into position. The nails 3 are located in magazine 4 in the form of an adhered strip. A nail hammer 2 is secured to a piston 6 that is slidably disposed in a sleeve cylinder 7. The axial length of cylinder 7 is substantially equal to the length of the hammer stroke plus the width of piston 6. The piston 6 presents an enlarged surface area to the high-pressure air which results in a large explosive impact force being imposed on nail hammer 2 during the nail driving operation.

Considering the nailer in detail, high-pressure air is supplied through a conduit 8 to housing chamber 9. The flow of air between chamber 9 and chamber 11 where hammer piston 6 is located, is controlled by a main pilot valve 12. The pilot valve 12 includes head 12a, piston 12b, and hollow stem 12c. With the nailer components in the position shown in FIGURE 1, the air under pressure in chamber 9 acts on the upper surface of head 12a to maintain valve 12 closed. However, the surface area of piston 12b is larger than head 12a and thus when both areas 12a, 12b are exposed to high-pressure air, valve 12 will be moved to the open position shown in FIGURE 2.

The piston 12b is slidably mounted in cylinder 13 which defines a chamber 14 that is covered by cap 15. Cut into cap 15 are exhaust ports 15a which vent the upper portion of chamber 14. Thus, as seen in FIGURE 1, when valve 12 is closed, the portion of chamber 11 above piston 6 is vented to atmosphere through valve stem 12c and exhaust ports 15a. This construction also brings about the very fast opening of valve 12, since high-pressure fluid directed to the underside of piston 12b results in a large unopposed force acting to move the valve in the open direction. This fast positive opening of valve 12 to obtain quick action of hammer 2 is found in presently available nails of this general type. Such rapid operation enables the operator to drive more nails within a given time period.

To prevent the leakage of high-pressure air through stem 12c when valve 12 is open, there is connected to piston 12b a seal 16 which engages a seat 15b defined by cap 15.

The operation of valve 12 is regulated by an auxiliary pilot valve 17 which includes a valve spool 18 and a valve housing 19 to control the flow of high-pressure air between chamber 9 and the underside of piston 12b. The auxiliary pilot spool 18 consists of piston portion 18a, valve head 18b, and cylindrical lands 18c, 18d. The land 18c is squared off to permit the flow of air to atmosphere when spool 18 is positioned as shown in FIGURE 1. On the other hand, land 18d is of a size to sealingly engage with valve housing 19 to prevent the passage of air to atmosphere when spool 18 is in the open position shown in FIGURE 2. The valve housing 19 defines a valve seat 19a against which valve head 18b seats. Also included in housing 19 is an atmospheric vent 19b, a piston seal 19c which seals off the flow past land 18d when engaged

thereby, and a part 19d through which the air from chamber 9 flows to the underside of piston 12b. The piston 18a has a larger diameter than valve head 18b so that valve 17 will be moved to the open position when equal pressures act on the upper surface of piston 18a and the undersurface of head 18b.

When valve head 18b is in the open position, as shown in FIGURE 2, the underside of piston 12b is exposed to the high-pressure air in chamber 9 to very quickly open valve 12. The opening allows the high-pressure air in chamber 9 to act on hammer piston 6 with an explosive force to drive nails 3 into position.

The opening of auxiliary pilot valve 17 and main pilot valve 12 is controlled by a trigger-operated ball check valve 20. When pilot valve 12 is opened, air under pressure is admitted into chamber 11 containing nail hammer piston 6. The ball valve 20 includes a housing 21 which defines an upper valve seat 21a and a lower valve seat 21b (see FIGURE 6). The ball 22 located in valve housing 21 controls the flow of air between the valve inlet port 21c and control port 21d; and between control port 21d and exhaust port 21e. Ball 22 is normally biased by gravity or the air pressure in chamber 9 against seat 21b. With valve 19 in this position, high-pressure air from chamber 9 is admitted to port 21d leading to the underside of piston 18a of auxiliary pilot valve 17. This results in unbalanced forces acting on valve 17 which moves valve head 18b to the closed position. The position of the various valve mechanisms when ball 22 is positioned in this manner is shown in FIGURE 1.

To position valve 20 to operate the pneumatic nailer, there is provided a trigger mechanism which includes a lever 23 having an arm 23a adapted to engage ball 22 and an arm 23b that is pivotally mounted about a pin 24 secured to housing 1. The lever arm 23b extends under a pin 26 that is secured to valve stem 27a of exhaust valve 27. The valve 27 functions to exhaust the portion of chamber 11 under hammer piston 6 when a nail is being driven and directs high-pressure air against the undersurface of piston 6 to move it to its retracted position after the nail has been driven. The operation and construction of valve 27 will be described in greater detail hereinafter.

The pivotal movement of lever 23 is controlled by trigger 28 which is pivotally mounted on a pin 29 secured to housing 1. Rotatably mounted in trigger 28 is a roller 28a which engages the underside of level 23. Thus it can be seen that when trigger 28 is moved upwardly, roller 28a engages lever 23 to move lever arm 23a into engagement with ball valve 22 to close off inlet port 21c and exhaust the fluid from the underside of piston 18a to atmosphere through exhaust port 21e. This sequence of events unbalances piston valve 17 so that the pressure acting on the upper side of piston 18a moves valve 17 into the open position, as shown in FIGURE 2.

When valve 17 is positioned as shown in FIGURE 2, high-pressure air flows past valve seat 19a, through port 19d and into chamber 14 where it acts on the underside of piston 12b to move valve 12 to the open position. The upward movement of piston 12b moves seal 16 into engagement with cap seat 15b to prevent the escape of high-pressure air through valve stem 12c and exhaust ports 15a.

When piston head 12b is quickly and positively raised by the introduction of high-pressure air to chamber 14, valve head 12a moves away from valve seat 31 located on the upper side of sleeve cylinder 7. High-pressure air then enters main piston chamber 11 where it acts with an explosive force on the upper surface of hammer piston 6 to drive nail 3, disposed beneath nail hammer 2, into position.

With the raising of valve head 12a, a portion of the high-pressure air flowing past valve seat 31 flows through port 31a to a storage chamber 32 surrounding sleeve cylinder 7. The high-pressure air stored in chamber 32 is

utilized to return piston 6 and nail hammer 2 to its upward or retracted position after a nail has been driven. The hammer will then be in position to drive a subsequent nail into place.

The flow of air between chamber 32 and the underside of piston 6, and between the underside of piston 6 and atmosphere is controlled by exhaust valve 27. The exhaust valve 27 comprises a valve stem 27a having a land portion 27b that is slidably disposed in valve housing 27c. With land 27b in the position shown in FIGURE 1, port 27d leading from storage chamber 32 is placed in communication with port 27e leading to the underside of piston 6. Thus, as shown in FIGURE 1, when trigger 28 is released, high-pressure air stored in chamber 32 will be free to flow to the underside of piston 6 to return it to its retracted position. When trigger 28 is actuated as shown in FIGURE 2, valve stem 27a is moved upwardly to vent the underside of piston 6 to atmosphere through exhaust port 27f. The pressure of the air directed to the underside of piston 6 will be less than the pressure of air in housing chamber 9, but it will be sufficiently high to retract piston 6.

It is again pointed out that the pilot valves 12, 17 and hammer 2 operate very quickly and that main pilot valve 12 will close very soon after trigger 28 is released. The air in chamber 11 above piston 6 is then immediately bled to atmosphere through valve stem 12c and exhaust ports 15a in cap 15. This reduction in the air pressure on top of piston 6 enables the air under pressure stored in chamber 32, and directed to the underside of piston 6, to move hammer 2 to its retracted position.

It remains to note that valve head 12a includes a magnet 33 which engages a ferrous piston back-up plate 34 secured to piston 6 by a bolt 36 to retain hammer 2 in the retracted position until the nailer is again actuated. The nail hammer 2 is threadedly connected to the underside of bolt 36.

Secured to the lower portion of main housing 1 is a housing section 1a in which is located a nose piece 37 which serves as a guide for hammer 2. The nose piece 37 is located adjacent the bottom of sleeve cylinder 7 and has connected thereto a bumper 37a for cushioning piston 6 when it reaches the bottom of the driving stroke. The bumper 37a is spaced from hammer 2 but has fitted therein a nylon blade seal insert 38 through which hammer 2 reciprocates. Cut into hammer 2 is a by-pass groove 2a that has an axial length greater than nylon insert 38 to bleed the air in chamber 11 under piston 6 after piston 6 has been moved to the retracted position shown in FIGURE 1. This groove serves to exhaust the air under piston 6 and on top of land 27b after the hammer has been retracted to prevent a pressure build-up which would act to resist strongly the upward movement of valve 27, when the pneumatic nailer is triggered.

The nails 3 used in this nailer are provided in the form of an adhered strip. The strip is located in magazine 4 and is resiliently biased into the position shown in FIGURE 1 by mechanisms which will be presently described. The end nail is biased into engagement with a nail back-up pin 41 which is resiliently biased by a spring 42. The spring 42 is adjustably positioned within a cap 43 that is threadedly disposed in opening 1b and housing 1a.

The nailer magazine 4 includes an elongated casing having a generally elliptical cross-section (see FIGURE 3). As illustrated, the magazine is disposed at approximately a thirty-degree angle to accommodate the nail strip. A strip of nails 3 is introduced into magazine 4 through an opening 4a extending lengthwise of the top portion of magazine 4 (see FIGURE 5).

In the instant case, the strip of nails consists of generally full-headed nails which are nested together with the heads overlapped and the shanks in contact with the shanks of the adjacent nails along substantially their full length. This results in the line of the nail heads

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forming an angle with the horizontal on the order of thirty degrees, which generally coincides with the angular disposition of the magazine.

The head portions 3a of nails 3 rest on nail guide rails 44 which are secured to the sides of magazine 4 by threaded bolts 46. The nail guides 44 are transversely spaced to admit the shank portions 3b of nails 3. The strip of nails 3 is biased downwardly into engagement with spring pin 41 by a pusher 47.

The pusher 47 includes a head portion 47a which slides on the upper surface of guide rails 44 and engages the nail heads 3a and guides 47c which engage the underside of the guide rails. The body portion 47b is sloped to abut the shanks 3b, as shown in FIGURE 1. Extending from the back of pusher 47 is a platform 47d on which a spiral coil spring 48 is located. The spiral coil spring 48 has one end affixed to the pusher 47 by a spring pin 49, and the other end secured by bolts 51 to a plate 52. The plate 52 is secured to the magazine 4 at a location adjacent the nose piece 37.

The body portion 47b of pusher 47 is sloped so that the nail clip is located at a slight angle from the vertical. The angle as shown is on the order of 4 degrees and is provided so that the axes of hammer 2 and the nail being driven are in line when the nail is finally driven into position (see FIGURE 2). It can be appreciated that this results in the full utilization of the driving force against the nail and eliminates possible bending of the nail if the force was continuously exerted off-center.

The magazine 4 is covered by a cover 53 which has a handle portion 53a and an engaging lip 53b (see FIGURE 10). The lip 53b is adapted to engage the upper flange of pusher 47 to retract pusher 47 to permit the introduction of another strip of nails after the first strip has been driven. Also located in magazine 4 is a spring detent 54 which serves to maintain the cover 53 in place during normal operation and retains the cover in the retracted position during the reloading operation (see FIGURE 1).

Operation

The operation of the nailer can be seen from the following:

With the apparatus as shown in FIGURE 1, air under pressure is introduced to chamber 9 through hose 8 and flows through inlet port 21c and past ball valve 22 to the underside of piston 18a to maintain valve 17 in the closed position. The high-pressure air acting on the upper side of valve head 12a maintains valve 12 closed along with valve 17.

When actuation of the nail hammer is desired, trigger 28 is squeezed to move lever arm 23a into engagement with ball 22 to move it away from seat 21b and into engagement with seat 21a. This action vents the underside of piston 18a to atmosphere through port 21e and at the same time prevents the escape of air from chamber 9. The high-pressure air acting on the upper side of piston 18a, which is now unbalanced, moves valve spool 18 downwardly to unseat valve head 18b and allow high-pressure air to flow past seat 19a and through port 19d into the portion of chamber 14 below piston 12b. The air in chamber 14 acts against the underside of piston 12b to raise valve 12 away from seat 31, as shown in FIGURE 2. The opening of valve 12 admits high-pressure fluid to the upper side of piston 6 to drive hammer 2 against nail 3 with a high impact force. When valve 12 is opened, a portion of the air under pressure flowing past valve head 12a enters storage chamber 32 through port 31a.

When valve 19 is triggered, the underside of piston 6 is vented to atmosphere through ports 27e by the movement of exhaust valve 27 to the position shown in FIGURE 2. The movement of valve 27 also results in the fluid directed to storage chamber 32 being trapped in chamber 32.

The nails being driven are continuously biased against

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pin 41 by spring-biased pusher member 47 to place them into a position to be engaged by hammer 2. The driving movement of hammer 2 engages the head of the lowermost nail to drive it into place, as shown in FIGURE 2.

After the nail has been driven and trigger 28 is released, the exhaust valve 27 moves downward to close off vent 27e and brings ports 27d, 27e into communication. The air stored in chamber 32 will then flow to the underside of piston 6 to return piston 6 to the retracted position shown in FIGURE 1. At approximately the same instant, ball valve 22 closes off exhaust port 21e and opens inlet port 21c to admit high-pressure air to the underside of piston 18a to close valve 17. The closing of valve 17 vents chamber 14 past land 18c and out through exhaust port 19b. The valve 12 is then closed by the force exerted by the air pressure acting on the upper surface of head 12a. When valve head 12a seats, the air in chamber 11 above piston 6 is vented to atmosphere through stem 12c and exhaust ports 14a. The magnet 33 assists in retaining piston 6 in the upward position. The apparatus is thus in position to be again operated.

It remains to note that after the piston 6 is returned to its retracted position the air in chamber 11 under piston 6 will be vented out through groove 2a. This prevents a buildup of pressure on the upper side of land 27 which would tend to prevent the upward, or venting, movement of valve 27 when the nailer is again triggered.

After the nail clip has been used up, cover 53 is retracted to where a strip of nails can again be inserted into magazine 4.

From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the true spirit and scope of the novel concepts of the invention. For example, the pneumatically operated device of the present invention could be used to drive other types of fasteners such as staples by merely providing a conventional staple magazine in place of the one illustrated. Furthermore, the trigger mechanism could be connected directly to the auxiliary pilot valve and the ball check valve eliminated. Also, a resilient biasing means could be provided to move exhaust valve 27 to close off exhaust port 27f when trigger 28 is released.

It is intended to cover by the appended claims all such modifications and embodiments that fall within the true spirit and scope of the invention.

We claim:

1. A pneumatically operated fastening tool comprising a housing containing fluid under pressure, first and second chambers defined by said housing, a piston slidably disposed in said first chamber, a hammer secured to said piston, first valve means for controlling the flow of fluid into said first chamber for driving the piston in a driving direction, said first valve means including a pressure responsive member in said second chamber, means for venting one side of said pressure responsive member, second valve means controlling the flow of fluid under pressure to the other side of said pressure responsive member, and means for controlling the operation of said second valve means.

2. A pneumatic tool including a housing to which fluid under pressure is supplied, first and second cylinders in said housing, a first piston in said first cylinder, a hammer secured to said first piston, first valve means controlling the flow of high-pressure fluid to said first cylinder, said first valve means including a second piston member slidably disposed in said second cylinder, means for venting one side of said second piston, second valve means for controlling the flow of fluid to the other side of said second piston to open said first valve means to admit fluid to one side of said first piston to drive the hammer in a driving direction, means for venting said one side of the first piston after the hammer has been driven, third valve means for directing fluid under pressure to the other side of the first piston to return the hammer, and means for

controlling the operation of said second and third valve means.

3. A pneumatic nailer comprising a housing to which fluid under pressure is supplied, a cylinder in said housing, a piston disposed in said cylinder, a nail hammer secured to said piston, a storage chamber in said housing, means for controlling the flow of fluid under pressure to both sides of said piston, said last-mentioned means including a first valve means for controlling the flow of fluid to one side of the piston and said storage chamber and a second valve means which regulates the flow of fluid between the other side of said piston and atmosphere during the driving operation and between said storage chamber and said other side of said piston to return the piston and hammer to its retracted position after a nail has been driven, and means for controlling the operation of said first and second valve means.

4. A pneumatic fastener tool comprising a housing containing fluid under pressure, first and second cylinders in said housing, a first piston slidably disposed in said first cylinder, a fastener driver secured to one side of said first piston, first valve means for controlling the flow of fluid under pressure to the other side of said first piston to move the piston in a driving direction, said first valve means including a second piston disposed in said second cylinder and a hollow stem portion connecting said other side of said first piston with one side of said second piston, means for venting said one side of said second piston, second valve means controlling the flow of fluid to the other side of said second piston to control the movement of said first valve means, means controlling the operation of said second valve means, and means for directing fluid to said one side of the first piston to return it after the driving stroke.

5. A pneumatic nailer comprising a housing containing fluid under pressure, a cylinder in said housing, a piston slidably disposed in said cylinder, a nail hammer secured to said piston, a storage chamber in said housing, a first valve means for controlling the flow of fluid to one side of said piston to move it in a nail engaging direction and to the storage chamber, a second valve means for controlling the movement of said first valve means, third valve means controlling the flow of fluid between the storage chamber and the other side of the piston to return it, and between the other side of the piston and atmosphere, and means for controlling the position of said second and third valve means.

6. A pneumatic nailer comprising a housing containing fluid under pressure, a cylinder in said housing, a piston in said cylinder, a nail hammer secured to one side of said piston, a storage chamber in said housing, a first valve means for controlling the flow of fluid to the other side of said piston for driving the nail hammer and to the storage chamber, a second valve means for controlling the operation of said first valve means, a third valve means for controlling the flow of fluid from said storage chamber to said one side of said piston to return the piston, means for controlling the operation of said second and third valve means, and means for venting said one side of said piston after it has been moved to the return position including a notch in said nail hammer.

7. A pneumatic nailer comprising a housing, a piston in said housing, a hammer secured to one side of said piston, a first valve means regulating the flow of fluid to the other side of said piston, a storage chamber defined by the housing for storing fluid under pressure when the first valve is opened, a second valve means controlling the flow of fluid from the storage chamber to said one side of said piston, a pilot valve means for controlling the operation of said first valve means, means for controlling the operation of said second valve means and said pilot valve means to control the flow of fluid to the nail hammer to drive and retract same, means for venting said one side of the piston after the hammer has been retracted, and means for holding the hammer in the retracted position.

8. A pneumatic nailer including a housing, means for supplying fluid under pressure to said housing, a cylinder in said housing, a piston in the cylinder, a nail hammer secured to the piston and disposed on one side thereof, a main valve for controlling the flow of fluid to the other side of the piston to drive the piston in a nail hammering direction, pilot valve means for controlling the operation of the main valve, a ball valve for controlling the operation of said pilot valve means, means for controlling the flow of fluid to said one side of the piston to return the piston to its retracted position, and a trigger mechanism for controlling the operation of said ball valve.

9. A fastener driving tool including a housing defining first and second chambers, a first pressure responsive member in said first chamber, a fastener driver secured to said first pressure responsive member, first valve means controlling the flow of high pressure fluid to said first chamber, said first valve means including a second pressure responsive member in said second chamber, means for venting the portion of said second chamber on one side of said second pressure responsive member, second valve means for controlling the flow of fluid to the other side of said second pressure responsive member to open said first valve means to admit fluid to one side of said first pressure responsive member to drive the fastener driver in a driving direction, means for venting the portion of the first chamber on said one side of the first pressure responsive member, and third valve means for directing fluid under pressure to said other side of the first pressure responsive member to return the driver.

10. A pneumatic fastener tool comprising a housing containing fluid under pressure, first and second chambers in said housing, a piston slidably disposed in said first chamber, a fastener driver secured to one side of said piston, first valve means for controlling the flow of fluid under pressure to the other side of said piston to move the piston in a driving direction, said first valve means including a pressure responsive member disposed in said second chamber and including a passageway interconnecting the space adjacent said other side of said piston with the space adjacent one side of said pressure responsive member, means for venting the space adjacent said one side of said pressure responsive member, second valve means for closing off said passageway from said vent means when the first valve means is in the open position, and third valve means controlling the flow of fluid to the other side of said pressure responsive member to control the movement of said first valve means.

11. A pneumatic fastener tool comprising a housing containing fluid under pressure, first and second chambers in said housing, a piston slidably disposed in said first chamber, a fastener driver secured to one side of said piston, first valve means for controlling the flow of fluid under pressure to the other side of said piston to move the piston in a driving direction, said first valve means including a pressure responsive member disposed in said second chamber and including a passageway interconnecting the space adjacent said other side of said piston with the space adjacent one side of said pressure responsive member, means for venting the space adjacent said one side of said pressure responsive member, second valve means for closing off said passageway from said vent means when the first valve means is in the open position, said pressure responsive member on said one side thereof defining a first area exposed to the fluid under pressure in said housing when the first valve means is in the open position, and an enlarged area adjacent said first area whereby after the first valve means moves to open said second valve means the first valve means will be moved very rapidly to its closed position, and third valve means controlling the flow of fluid to the other side of said pressure responsive member to control the movement of said first valve means.

12. A pneumatic fastener tool comprising a housing containing fluid under pressure, first and second cylinders

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in said housing, a first piston slidably disposed in said first cylinder, a fastener device secured to one side of said first piston, first valve means for controlling the flow of fluid under pressure to the other side of said first piston to move it in a driving direction, said first valve means including a second piston disposed in said second cylinder, and a hollow stem portion interconnecting the space adjacent said other side of said first piston with the space adjacent one side of said second piston, means for venting the space adjacent said one side of said second piston, second valve means for closing off said hollow stem portion from said vent means when the first valve means is in the open position, said second piston on one side thereof defining a first area exposed to the fluid under pressure in said

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housing when the first valve means is in the open position and an enlarged area surrounding said first area whereby after the first valve means moves to open said second valve means the first valve means will be moved rapidly to the closed position, third valve means controlling the flow of fluid to the other side of said second piston to control the movement of said first valve means, and means controlling the operation of said third valve means.

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