Feb. 10, 1959 J. E. GOLDRING ET AL 2,872,901

PNEUMATIC FASTENER DRIVING MACHINE

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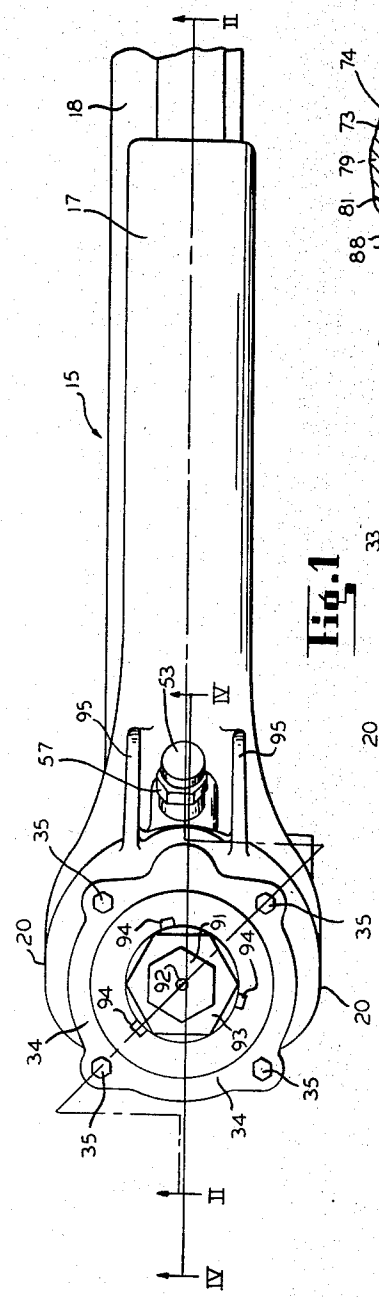

Fig. 1

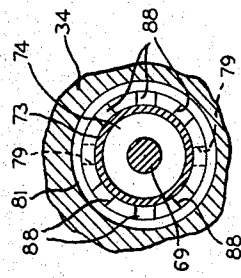

Fig. 9

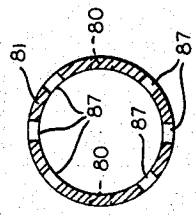

Fig. 8

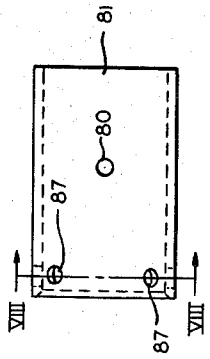

Fig. 7

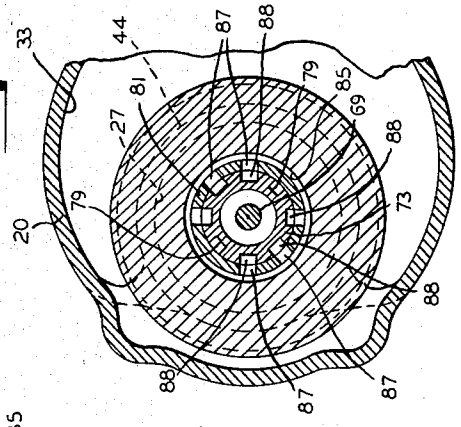

Fig. 6

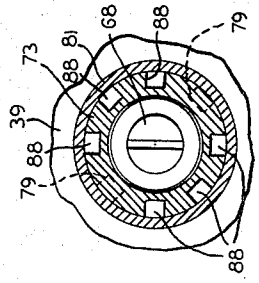

Fig. 5

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PNEUMATIC FASTENER DRIVING MACHINE

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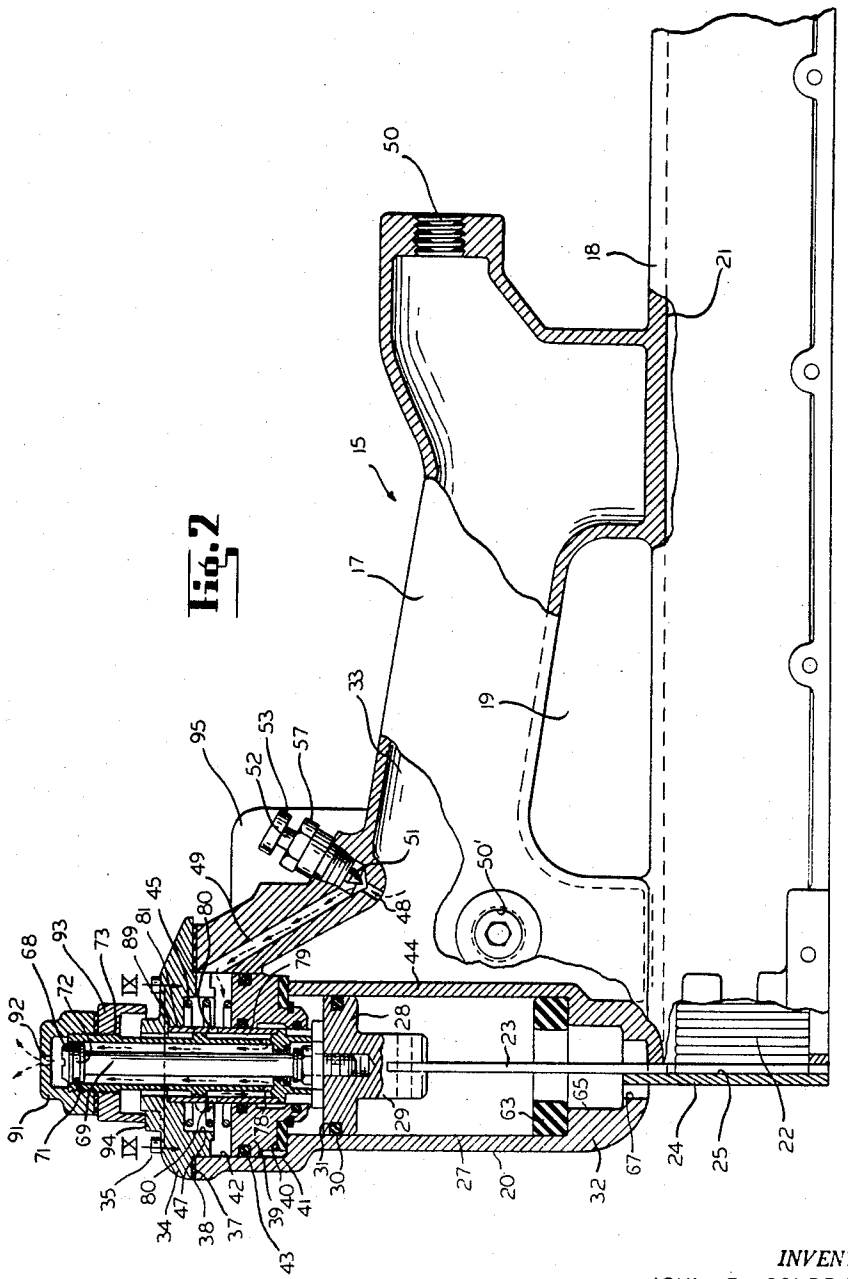
Fig. 2



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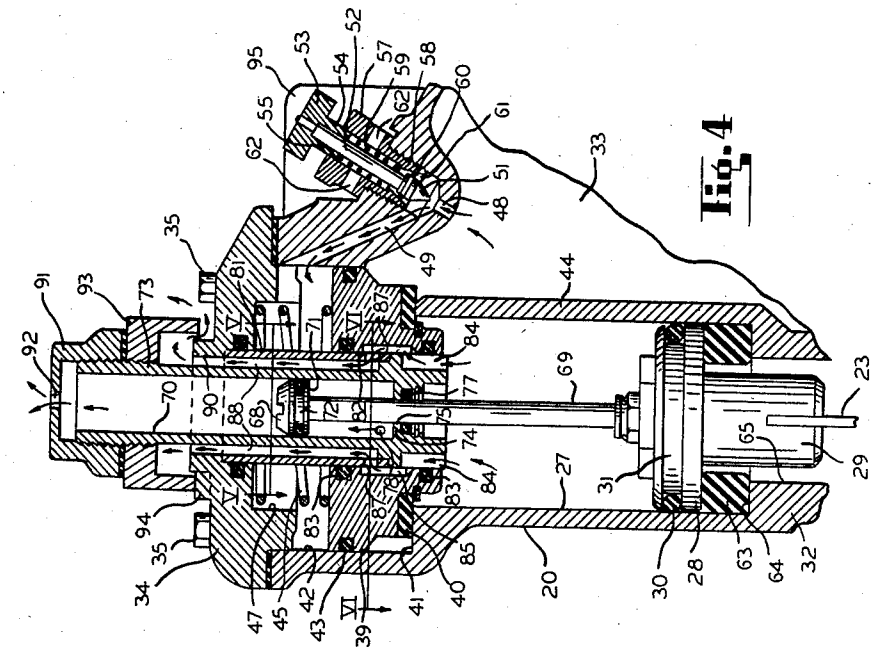

Fig. 4

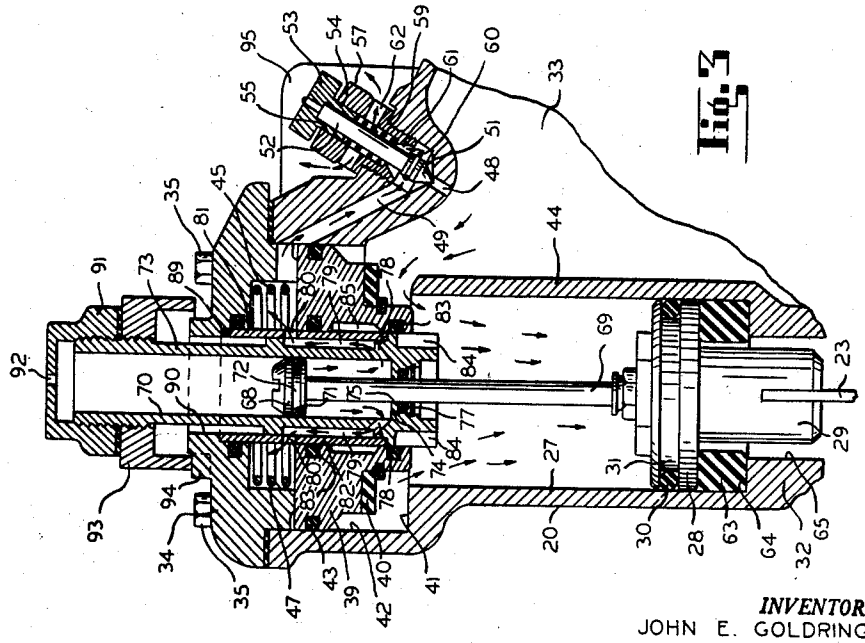

Fig. 3

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PNEUMATIC FASTENER DRIVING MACHINE

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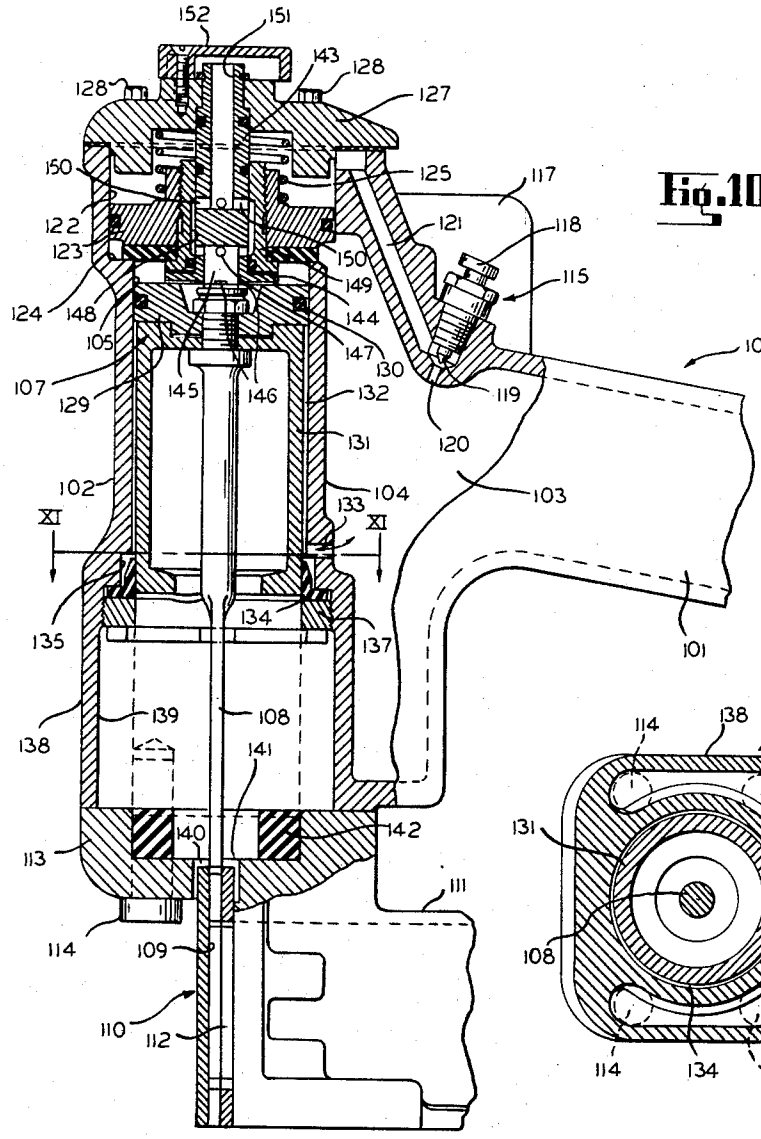

Fig. 10

Fig. 11

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PNEUMATIC FASTENER DRIVING MACHINE

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Fig. 12.

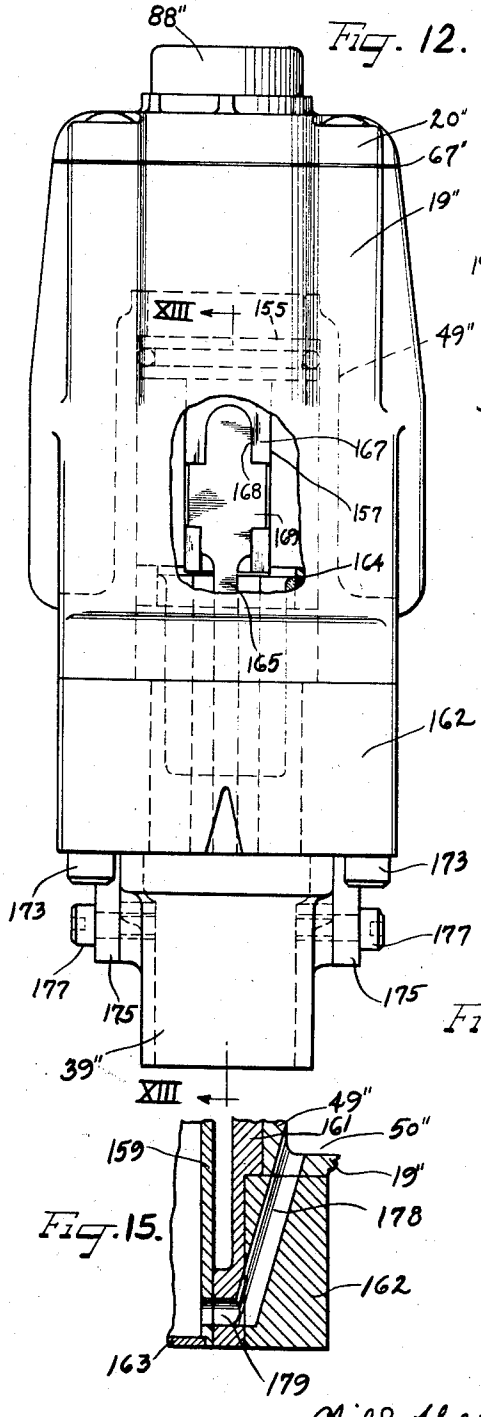


Fig. 13.

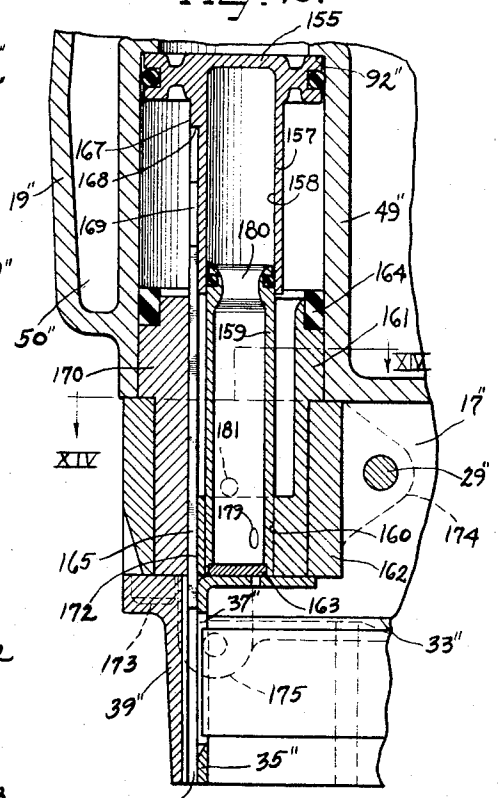
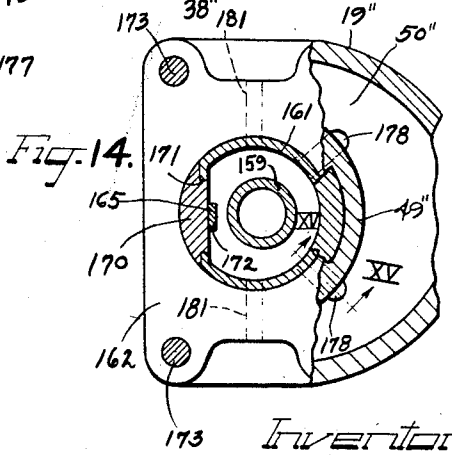


Fig. 14.



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PNEUMATIC FASTENER DRIVING MACHINE

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Fig. 16.

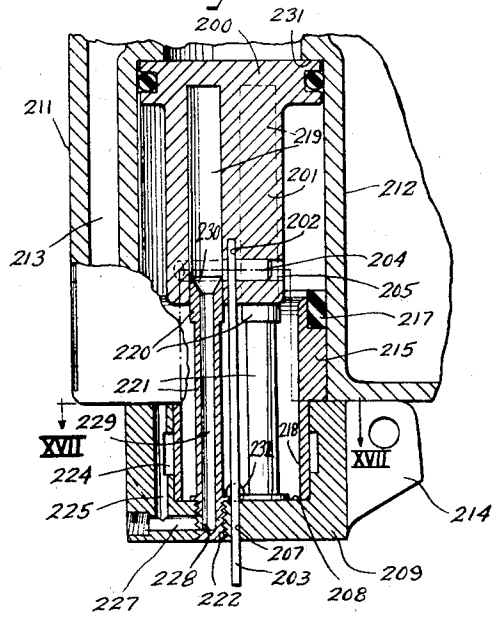


Fig. 17.

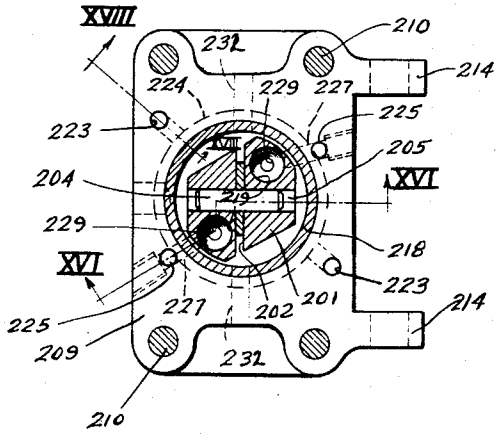
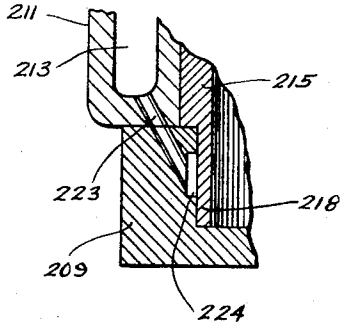


Fig. 18.



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United States Patent Office 2,872,901 Patented Feb. 10, 1959

2,872,901

PNEUMATIC FASTENER DRIVING MACHINE

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Application May 16, 1958, Serial No. 735,862

10 Claims. (Cl. 121—13)

The present invention relates to improvements in fastener driving machines and is more particularly concerned with pneumatically operated machines of this character especially adapted for efficiently driving industrial fasteners of the staple, nail or pin type, and while the machine may be of stationary, factory bench type for securing together certain mass produced assemblies such as window and door sash, furniture, and the like, the machine is especially suitable for portable manually operable usages where a suitable source of motivating pressure fluid such as compressed air or its equivalent (all to be encompassed by the term "pneumatic" in its various forms) is available for operation of the machine.

This application is a continuation-in-part of our copending applications Serial No. 546,509, filed November 14, 1955, and Serial No. 618,773, filed October 29, 1956. In said copending applications, we have described a new mode of operating pneumatic fastener driving machines wherein the driving piston is motivated by pneumatic pressure directly from a fluid reservoir by exposing the piston head to the fully pressurized reservoir in each operative stroke, and without any of the conventional time lag or delayed action disadvantages of valved passages or ducts between the reservoir and the cylinder. Extremely prompt, rapid and powerful motivation of the driving piston is thus attained, free from recoil, coupled with unusual economy in pressure fluid expenditure.

An object of the present invention is to provide a fastener driving machine of high power and impact capacity wherein return springs for the driving piston or plunger are entirely eliminated for thereby enabling virtually unlimited fastener driving stroking of the piston and driver as compared to return spring types of machines wherein it is necessary to replace broken return springs with some frequency due to inevitable fatigue failures of such springs.

A further object of the invention is to provide an improved fastener driving machine wherein both the driving and return strokes of the driving piston or plunger are pneumatically effected, and more specifically are effected by pressure fluid from a common reservoir.

Still another object of the present invention is to improve greatly the efficiency in the use of motivating fluid by minimizing and eliminating restrictive orifices and passages in the dynamic pressure fluid operating or use portions of the driving system of the machine.

It is a further object of the invention to provide improved automatically pressure fluid actuated control means for fastener driving machines.

Yet another object of the invention is to provide a pneumatic fastener driving machine construction wherein unusual freedom from wear-engagement of moving parts is attained.

It is also an object of the present invention to provide in fastener driving machines improved operating control means functioning on the principle of pressure differential or unbalancing motivation of control members or by negative valving instead of line interposed

or positive valving where a valve located in a fluid duct or passage must be opened to permit flow of fluid through the passage.

A still further object of the invention is to provide an improved fastener driving machine of sturdy, economical construction that can be produced by low cost mass production methods of manufacture, and which is of such simple and readily accessible assembly that repairs can be readily effected.

Other objects, features and advantages of the present invention will be readily apparent from the following detailed description of certain preferred embodiments thereof taken in conjunction with the accompanynig drawings in which:

Figure 1 is a fragmentary, top plan view of a fastener driving machine embodying features of the invention;

Figure 2 is a fragmentary, vertical sectional view, partially in elevation, of the machine taken substantially on the line II—II of Figure 1;

Figure 3 is an enlarged fragmentary vertical sectional view taken substantially in the same plane as Figure 2 and showing the head end portion of the machine with the driving piston as well as other mechanism of the unit in the positions assumed thereby during a driving stroke of the piston;

Figure 4 is an enlarged fragmentary vertical sectional detail view taken substantially on the line IV—IV of Figure 1;

Figure 5 is a fragmentary sectional detail view taken substantially on the line V—V of Figure 4;

Figure 6 is a fragmentary sectional detail view taken substantially on the line VI—VI of Figure 4;

Figure 7 is a side elevational view of the sleeve member serving as a valve piston guide and air flow control member in the driving head assembly of the machine;

Figure 8 is a sectional detail view taken substantially on the line VIII—VIII of Figure 7;

Figure 9 is a fragmentary sectional detail view taken substantially on the line IX—IX of Figure 2;

Figure 10 is a fragmentary vertical sectional view through the driving head end portion of a modified construction;

Figure 11 is a sectional detail view taken substantially on the line XI—XI of Figure 10;

Figure 12 is a front elevational view of another modified machine utilizing the principle of pressing fluid return of the driving piston;

Figure 13 is a fragmentary sectional detail view taken substantially on the line XIII—XIII of Figure 12;

Figure 14 is a fragmentary sectional detail view taken substantially on the line XIV—XIV of Figure 13;

Figure 15 is a fragmentary sectional detail view taken substantially on the line XV—XV of Figure 14;

Figure 16 is a fragmentary vertical sectional elevational detail view through the driving piston and fastener driving head portion of a further modification taken substantially on the irregular line XVI—XVI of Figure 17;

Figure 17 is a sectional elevational detail view taken substantially on the line XVII—XVII of Figure 16; and

Figure 18 is a fragmentary vertical sectional detail view taken substantially on the line XVIII—XVIII of Figure 17.

In the embodiment of Figures 1 and 2, a fastener driving machine **15** is equipped for portable manual use and for this purpose has a frame structure including a combination handle and fluid reservoir **17** providing with a fastener magazine section **18** therebelow a convenient hand hole **19**. On the forward end of the handle portion or section **17** and above the forward end of the magazine portion or section **18** is a driving head portion or section **20**. All of the several portions or sections of the ma-

chine frame are adapted to be constructed as a unitary casting of light weight material such as aluminum or magnesium alloy.

Interiorly the magazine section 18 is hollow and provides a longitudinal fastener magazine chamber 21 within which is housed a replenishable supply of a substantial number of fasteners 22 adapted to be pushed forwardly by any suitable means for successive disposition in driving position under a driver preferably in the form of a blade member 23 extending downwardly from within the head section 20. For receiving and holding in driving position and for guiding the driver 23, a preferably removably attached thrust plate or nose or gate structure 24 is carried by the front end of the magazine section 18 and under the head section 20 and provides a downwardly opening fastener driveway and driver guide passage 25.

Within the head section 20 is a vertically elongated cylindrical chamber 27 for accommodating a driving piston 28 provided with a depending lug or boss 29 to which the driver 23 is attached. The diameter of the piston 28 is slightly smaller than the inside diameter of the cylinder 27 whereby to avoid direct mechanical contact, and an O-ring seal member 30 is seated in a peripheral groove 31 in the piston and makes sealing contact with the opposing cylinder wall and maintains the piston concentric within the cylinder.

For enabling assembly of the piston 28 and the driver blade 23 from the top of the driving head section 20 so that the bottom of the cylinder 27 can comprise a solid base of substantial mass forming an integral part of the machine frame in one piece with the frame casting, the upper end of the inside diameter of the cylinder 27 opens freely upwardly, that is, it is free from any built-in obstruction to insertion or removal of the piston 28 through the top end of the cylinder. At the same time, for the attainment of instantaneous full power thrust or driving acceleration of the piston 28 at the inception of a driving stroke thereof, the upper, open end of the cylinder 27 opens normally freely into a preferably large volume capacity pressure fluid reservoir 33 which substantially surrounds the cylinder 27 within the head section 20 and includes the hollow space within the handle 17 (Figures 2 and 5).

Access into the reservoir chamber 33 above the cylinder 27 is adapted to be effected through an opening in the top of the head section 20 of the machine and closed for service by a closure member or cap plate 34. Removable attachment of the cap 34 may be effected as by means of screws 35 having the shanks extending therethrough and threadedly drawn up into the upper end of the head section 20 which provides a preferably flat seat 37 against which the cap plate is clamped with a sealing gasket 38 interposed therebetween.

Mechanism for controlling operation of the driving piston 28 includes means normally closing the top end of the cylinder 27 but shiftable toward open position for opening the cylinder to full fluid pressure within the reservoir 33 for driving the piston 28 and the driving member 23 in a driving stroke thereof. To this end, a control piston or valve member 39 is provided with a lower end face carrying a resilient valve disk ring 40 which is sealingly engageable against a closure valve seat 41 defining the top of the cylinder 27. Reciprocable guiding of the valve piston 39 is effected within a cylinder 42 concentric with the cylinder chamber 27 and of somewhat larger diameter, provided in the upper portion of the head section 20 and spaced above the cylinder 27. By preference, an O-ring seal 43 is provided in the periphery of the valve piston for engagement with the opposing wall of the cylinder 42.

By having the valve piston 39 of larger diameter than the outside diameter of that portion of a generally cylindrical barrel wall 44 defining the cylinder 27 and exposed within the reservoir 33, pressure fluid within the reservoir normally acts on the margin of the valve piston 39 exposed within the reservoir tending to drive the valve piston from its seat 41. However, the pressure fluid is also normally active on the upper face of the piston valve 39 which is of greater effective area than at least the overhanging or radially outwardly projecting marginal portion of the valve piston contiguous the valve seat 41. In addition, a light biasing or priming coil spring 45 seated abuttingly within a centering recess 47 in the inner face of the closure cap 34 and thrusting against the upper face of the valve piston 39 normally overbalances the valve piston toward the cylinder closing position thereof on the valve seat 41.

Valve piston closing pressure fluid is conducted from the reservoir 33 through a supply orifice 48 preferably located generally adjacent juncture of the handle section 17 with the head section 20, that is, at the back portion of the head section 20, and opening into a supply duct 49 which opens or ports into the upper extremity portion of the cylinder 42 above the valve piston 39. The cross-sectional flow area of both the supply orifice 48 and the supply duct 49 are preferably such that pressure fluid from the reservoir 33 will pass therethrough substantially without restriction to the cylinder 42. This assures that when pressure fluid is initially introduced into the reservoir 33 from a suitable source as by means of the usual piping or flexible duct connection (not shown) connected into a threaded orifice 50 opening into the handle through its rear end portion or through a side orifice 50' (Figure 2) the force of the pressure fluid will be instantaneously effective upon the upper face of the piston valve 39 in differentially greater pressure than upon the lesser exposed underside margin about the valve seat 41 so that the piston valve is held quite firmly upon its seat for thus blocking access of the pressure fluid that fills the reservoir 33 to the top of the driving piston 28. In view of such free access of the pressure fluid to the top of the valve piston 39, there is no danger of premature firing of the driving piston 28 and the driver 23. Nevertheless, full unrestricted large volume motivating pressure fluid supply surrounds the valve seat 41 and is statically impressed upon the exposed underside margin of the valve piston in readiness to unseat the valve piston and fire the driving piston 28 when the pressure differential on the valve piston 39 is reversed.

Such reversal of the pressure differential is effected by a negative valve arrangement, that is, a valve arrangement whereby pressure fluid to the upperside of the valve piston 39 is blocked, while the cylinder 42 above the valve piston is depressurized. Herein, this is efficiently accomplished by means of a needle or taper end valve 51 concentric with the supply orifice 48 but normally open or backed off away from the orifice in the direction of pressure fluid flow so as to leave unrestricted passage between the orifice 48 and the supply duct 49.

Support for the valve 51 in a manner to enable ready operation thereof from the outside of the machine is provided by a valve stem 52 carrying a button type head 53 on its outer end portion including a stem or skirt portion 54 that is slidably guided in a central guide bore 55 of a fitting 57 secured as by means of a threaded connection in a bore 58 of substantial diameter concentric with the supply orifice 48 (Figures 3 and 4). Normally a coiled compression biasing spring 59 urges the valve member 51 toward open position wherein an O-ring valve seal 60 carried by the valve immediately adjacent the widest end of the tapered valve tip engages sealingly with a flaring mouth or seat 61 at the inner end of a vent passage defined by the bore 55 within the fitting or bushing 57 and communicating with transverse vent openings 62 in the outer head end portion of the fitting. In the thus normally open position of the valve 51, pressure fluid is of course freely active from the reservoir 33 as indicated by the broken directional arrows in Figure 2 for holding the valve piston 39 closed.

Instantaneously upon shifting the valve **51** into closing or blocking relation to the orifice **48**, as seen in Figure 3, by application of inward axial pressure to the valve stem **52** as by means of digital force against the button head **53** and venting of the cylinder **42** to atmosphere through the passage **55** and the vent opening **62** as shown by directional arrows in Figure 3, the pressure fluid within the reservoir **33** pops the valve piston **39** from its seat and the full force of fluid pressure within the reservoir **33** spills into the cylinder **27** and drives the piston **28** under full head of pressure in a driving stroke.

At the end of the firing or driving stroke (Figure 3), wherein the driving blade **23** drives one of the fasteners **22** from the magazine and into work positioned under the machine and more particularly under the head section **20** thereof, the underside of the driving piston **28** comes to rest against an annular resilient bumper **63** supported upon a shoulder **64** provided by the bottom portion **32** which is solidly integral with the rest of the head section **20** and more especially the cylinder barrel **44**. At this time the driver blade carrying boss **29** projects downwardly through the resilient annulus **63** into a clearance recess or well **65** in the base portion **32**. A central opening **67** (Figure 2) in the lower end of the clearance recess **65** provides a vent to atmosphere for the lower end of the cylinder **27**.

Pressure fluid from the reservoir **33** is utilized for returning the piston **28**. For this purpose, an arrangement is provided including pneumatic return means for the piston **28** having a differentially pressured relationship to the side of the piston that is exposed to the pressure reservoir upon opening of the cylinder, so that in the closed condition of the cylinder **27** the pneumatic return means maintains the piston **28** in returned position. Herein the pneumatic return means comprises a piston **68** of substantially smaller diameter than the driving piston **28** and secured preferably concentrically to the top of the piston **28** through the medium of a piston rod **69** of substantial length.

Actuation of the return piston **68** is effected within an elongated cylinder **70** mounted in the head of the head section **20** and preferably in the closure cap **34**. An O-ring seal member **71** mounted in a peripheral groove **72** of the return piston **68** effects sealing engagement with the opposing cylinder wall and maintains the return piston in slightly spaced concentric relation to the cylinder wall.

By preference, the cylinder **70** is provided within a sleeve or bushing member **73** extending at its lower end a short distance into the upper end of the cylinder **27** and thereby providing a return stop for the piston **28** to maintain the driving piston below the upper end of the cylinder **27** as best seen in Figure 2. A base wall **74** in the lower end portion of the bushing **73**, closes the lower end of the cylinder **70** and has a central passage **75** for the piston rod **69** provided with a fluid seal **77** such as an O-ring engaging the piston rod. Thereby a pressure chamber is provided between the underside of the return piston **68** and the end wall **74**.

Pressure fluid for driving the return piston **68** in a return stroke, that is upwardly as seen in Figs. 2 and 4, and for maintaining the return piston in the returned position positively while the reservoir **33** contains fluid under pressure, is conducted to the pressure chamber within the cylinder **70** from the pressure chamber above the control valve piston **39**. To this end, a pair of preferably diametrically opposite ports **78** lead into the lower end of the pressure chamber in the cylinder **70** from vertical peripheral passage grooves **79** in the outer wall surface of the sleeve member **73** and extending upwardly to be clear of the top of the valve piston **39** to communicate through respective ports **80** in an encompassing closure sleeve **81** opening into the spring recess **47** in the lower face of the closure member **34**. It will be observed that the valve piston **39** has a central bore **82** slidably clearing the sleeve **81** and the lower portion of the bushing sleeve **73** and is provided adjacent its opposite ends within the bore **82** with respective O-ring seals **83** engaging sealingly about the sleeve **81** and the lower portion of the bushing **73** which thus provide a guide stem structure on which the valve piston **39** reciprocates. Through this arrangement, during the inactive condition of the driving piston **28**, when pressure fluid is freely delivered into the pressure chamber within the cylinder **42** above the valve piston **39**, pressure fluid freely enters through the passage provided by the ports **80**, the passage grooves **79** and the ports **78** to the pressure chamber within the cylinder **70** as indicated by the broken directional arrows in Figure 2 and the directional arrow in Figure 4. Upon venting of the valve piston pressure chamber as shown in Figure 3, the pressure chamber within the return cylinder **70** is also vented as indicated by the directional arrows through the ports **78**, the passage grooves **79** and the ports **80** so that the driving piston **28** is freed from pressure fluid restraint upon full driving force of the pressure fluid from the reservoir **33** upon the driving piston.

Instantaneously upon return of the control valve **51** and reopening of the pressure fluid port **48**, and thereby snapping of the valve piston **39** into closing relation upon its seat **41**, the pressure fluid enters the pressure chamber within the return cylinder **70** and drives the return piston **68** upwardly to return the driving piston **28** to its initial or uppermost position. At the same time, the cylinder **27** above the driving piston **28** is vented freely to atmosphere so that the relatively small pressure area provided by the return piston **68** is fully effective to produce the return stroke of the driving piston. Such venting is effected as best seen in Figure 4 by way of a plurality of vertical outer peripheral grooves **84** in the lower end portion of the bushing member **73** and an internal annular channel **85** in the bore **82** of the valve piston **39**, thence through a plurality such as 6 ports **87** (Figs. 4, 6, 7 and 8) in the lower end portion of the sleeve **81** and vertical grooves **88** in the outer periphery of the bushing **73** to atmosphere above the closure cap plate **34**. Through this arrangement, it will be observed that the passages for pressure fluid and venting of the return cylinder pressure chamber under the piston **68** and the venting of the cylinder **27** are effectively isolated from one another in a structurally simple manner by the joined bushing and sleeve members **73** and **81** which in turn are secured in the cap plate member **34**. In fact, in the construction shown the bushing member **73** is actually carried by and within the sleeve **81** and the sleeve **81** is in turn secured within a shouldered counterbore **89** of a central bushing clearing bore **90** through the cap plate member **34**.

At its upper end portion, the bushing member **73** projects substantially above the cap member **34** and carries a protective cap **91** over the cylinder **70** provided with a bleed bore **92**. In addition, a baffle cap and muffle member **93**, serving also as a lubricant guard is secured between the cap **91** and a plurality of radiating spacer lugs or projections **94** on the top of the cap member **34**. Not only does this muffle and diffuse exhaust air but prevents spraying of oil up into the surrounding atmosphere incident to the return of the driving piston **28**.

In a cycle of operation of the machine, depressing of the valve button **53** closes the valve **51** and at the same time opens the vent for the piston valve cylinder chamber **42** as shown in Figure 3, thereby raising the piston valve **39** and releasing the pressure fluid in the reservoir **33** for driving the piston **28**. This also effects bleeding of the pressure chamber within the return cylinder **70** by way of the ports **78**, passages **79** and ports **80**. At the same time, the exhaust passages for the driving piston cylinder **27** through the vertical slot grooves **84** in the lower end of the bushing **73** and the exhaust ducts **88** are sealed off by shifting of the control valve

piston 39 so that the exhaust groove 85 is moved upwardly out of registration with the exhaust slots 84 and sealed off by the lower O-ring 83 from the internal pressure established within the cylinder 27 by opening of the valve piston. Thus leakage of pressure fluid is precluded.

Upon release of the valve 51 and return of pressure fluid to the control valve piston chamber 42, the control piston 39 snaps back into closing position upon its seat 41, and reopens to atmosphere the vent for the cylinder 27 while the pressure fluid for activating the return piston 68 enters by way of the ports 78 into the pressure chamber within the cylinder 70, as shown in Figures 2 and 4. This causes the driving piston 28 to be snapped back in a return stroke. Since the effective pressure area of the return piston 68 is relatively small, the force with which the piston 28 is returned against the stop end of the bushing 73 is minimal. If desired, of course, a cushioning bumper device may be provided either on the upper end of the piston 28 or on the stop end of the bushing 73.

In order to avoid accidental actuation of the shut-off and bleeder valve 51, 60, guard means are provided adjacent to the actuating button 53, herein comprising a pair of laterally spaced, upwardly and rearwardly projecting guard flange ears 95. These ears 95 are preferably formed integrally with the housing or frame casting generally in the angle between the handle 17 and the upwardly projecting portion of the head section 20, and project sufficiently beyond the depressible valve button 53 to avoid actuation of the latter except by application of an operator's finger or thumb thereto and down between the guard ears or ribs 95.

In the modification of Figures 10 and 11, a fastener driving machine 100 is depicted which in general operates on the same principles as the pneumatically operated fastener driving machine 15 just described and includes among other things, the features of utilizing pressure fluid from a common reservoir for not only driving the driver piston but also for returning the driving piston, instantaneous full acceleration of the driving piston by direct exposure thereof to reservoir pressure at the inception of each driving stroke, negative operating valve control, and assembly access for the driving piston and control valve piston structure and driver through the top of the head section of the machine. To this end, the machine 100 includes a housing or frame casting provided with a handle and auxiliary reservoir section 101 connected at its forward end to a vertical head section 102 having therein a reservoir 103 within which is disposed an integral vertical cylinder portion 104 having therein a cylinder 105 within which is reciprocably mounted a driving piston 107 carrying a driver blade member 108. At its lower driving end, the driver 108 is drivingly guided and operable in a fastener driveway 109 in a suitable nose and gate assembly 110 mounted on the front end portion of a magazine housing section 111 providing the lower portion of the machine and from which fasteners 112 are successively fed into the driveway 109 under the driving blade 108. In this instance, the magazine section 111 is preferably constructed as a separable unit having a forward end and upwardly facing attachment and cylinder base closure portion 113 secured as by means of suitable screws 114 to the lower end portion of the head section 102.

Operating control of the machine 100 is adapted to be effective by means of a combination shut-off and bleeder valve assembly 115 disposed between protective rib ears 117 behind the upwardly projecting portion of the head section 102 at juncture thereof with the handle section 101, similarly as the corresponding valve assembly in the machine 15 of Figures 1 and 2. Depressing of a valve button 118 moves a taper tipped, substantially needle type valve member 119 against its spring bias into closing relation to a supply orifice 120 providing an entry for air into a supply duct 121 leading into the upper end of a pressure cylinder 122 within which is reciprocably mounted control valve piston 123 normally held seated by pressure fluid from the reservoir 103 upon a closure seat 124 at the upper end of the cylinder portion 104. Such unbalancing of the fluid pressure on the control piston 123 causes it to snap off of its seat and the fluid thereabove is bled off to atmosphere through the valve assembly 115.

Normally the valve piston 123 is biased by a primer spring 125 toward the valve seat 124, such spring being maintained under biasing pressure by a cap plate 127 that is secured in closing relation to the cylinder 122 upon the upper end of the head section 102 as by means of screws 128.

Opening of the valve piston 123 instantaneously exposes the entire upper surface or head of the driving piston 107 to the full pressure of pressure fluid in the reservoir 103 and thus actuates the driving piston with instantaneous full acceleration.

When the control valve 119 is released so that the control valve piston 123 is snapped back to closing relation to the cylinder 105, the piston 107 is instantly snapped back to initial position, that is it is returned to load position ready to be fired, by the pneumatic pressure fluid from the reservoir 103. In this instance, such result is attained by direct exposure of the piston 107 to reservoir pressure in pressure differential relation to the head end of the piston. That is, a relatively smaller underside area of the piston is exposed to return pressure from the reservoir 103 as compared to the crown area of the piston exposed to reservoir pressure during a firing or driving stroke of the piston. To this end, the driving piston 107 includes an upper main piston portion 129 which is closely diametrically proportioned to the diameter of the cylinder 105 and has an O-ring seal 130 mounted peripherally for centering and sealing engagement with the cylinder wall. Concentrically assembled with the underside of the main piston 129 is a skirt portion 131 of substantial length depending therebelow and of slightly smaller diameter so as to afford between its outside diameter and the wall of the cylinder 105 a return air space 132 which communicates directly with the reservoir 103 through an air port 133 adjacent the lower end of the cylinder. A sliding air seal 134 in the form of a resilient sealing ring is accommodated in a rabbet groove 135 located below the air port 133 in the cylinder portion 104 and within which the sealing ring is maintained by a retaining ring nut 137. For accommodating this structure, the lower end portion of the head section 102 is preferably somewhat enlarged as shown at 138 so as to provide a downwardly opening counterbore recess 139 of ample diameter to enable access through the lower end of the head portion 102 for assembly of the seal 134. This construction and relationship is such that during a driving stroke of the piston 107, the pressure fluid within the return air space 132 is driven back into the reservoir 103 through the port 133 and thus actually supplements the pressure within the reservoir. Promptly upon closing of the upper end of the cylinder 105 by the control valve piston 123, and relief of pressure upon the crown of the piston 129, pressure fluid returns through the port 133 into the return air space 132 and returns the piston 107 to its load or initial position. Since the underside area of the piston exposed to pressure fluid from the common reservoir 103 within the return air space 132 is only a small fraction of the crown area of the piston exposed to the reservoir during a firing or driving stroke, there is such a great unbalance during firing as to substantially avoid resistance to firing from the fluid in the return air space 132. Venting of the major area of the underside of the driving piston assembly 107 is through the lower end of the head section 102 and preferably through a vent opening 140 in the bottom of a bumper recess 141 in the upper face of the bottom closure por-

tion 113 carrying a resilient bumper 142 engageable by the lower end of the piston skirt 131 at the end of a driving stroke.

Venting of the cylinder 105 above the piston 107 during return stroke is effected through a combination vent and stop mechanism carried by the closure plate member 127. To this end, a stem member 143 is carried rigidly by the cap member 127, and projects downwardly therefrom concentrically through the valve piston 123, being provided at its lower end with a lateral bumper flange 144 disposed below the valve seat 124 and engageable as a stop by the crown of the piston portion 129. In the lower end portion of the stem 143 is a downwardly opening short blind end bore 145 communicating by way of radial slots or grooves 146 in the underside or stop face of the flange 144 with the top of the cylinder chamber 105 even when the piston 129 abuts the stop. A plurality of lateral ports 147 at the upper inner end of the bore 145 open into an annular channel 148 in the inner periphery of a combination sleeve and valve piston face sealing ring clamping bushing 149 secured centrally within the control valve piston 123 and slidably coacting with the outer periphery of the stem 143. This bushing 149 provides a check valve against escape of pressure fluid from the reservoir during firing of the piston 129, since when the control valve piston 123 is unseated, the bushing 149 is carried upwardly thereby and thus moves the channel 148 upwardly out of registration with the exhaust ports 147.

Instantly upon return of the control valve piston 123 to its seat 124, the channel 148 provides communication between the exhaust or vent ports 147 and exhaust ports 150 opening into the lower end of an upwardly opening blind end bore 151 in the upper portion of the stem 143. The upper end of the bore 151 opens to atmosphere above the closure cap 127. Thus, the piston valve 123 automatically closes and opens the exhaust or venting system for the cylinder 105 in properly coordinated relation to load and fire actions of the driving piston 107.

Above the upper open end of the stem 143 a baffle cap 152 is preferably mounted so as to prevent spraying of oil from the exhaust outlet of the bore 151 incident to exhausting of air, and to protect the exhaust outlet from blockage or damage.

It will thus be apparent, that the machine 100 operates substantially the same as the machine 15. Upon depressing of the control valve button 118, blockage of the supply port 120 by the valve 119 and coincident bleeding off of pneumatic fluid through the duct 121 from the control valve piston cylinder 122 causes the fluid pressure within the reservoir 103 to snap the valve piston 123 from its seat 124 and thus opens the top of the cylinder 105 throughout its mouth diameter fully to the pressure in the reservoir, resulting in instantaneous full acceleration firing of the piston 107. This also causes the fluid in the return space chamber 132 under the piston to be returned to the reservoir 103 supplemental to the pressure therein. Release of the valve 119 opens the supply port 120 and pressure from within the reservoir 103 conveyed to the upper larger exposed or crown area of the valve piston 123 drives the piston valve back onto its seat 124 and at the same time opens the venting system through the ports 147, the channel 148 and the ports 150 into the exhaust passage 151 for return of the piston 107 by action of the return air pressure from the reservoir 103 in the return chamber 132 on the underside of the piston member 129.

In the modification of Figures 12 through 15, a further arrangement is shown embodying a somewhat differently constructed air return for the driving piston but operating on the same principle as the air return of Figures 10 and 11. Various details of the structure aside from the air return may be substantially the same as described in connection with Figures 10 and 11 or in our copending application Serial No. 735,740, filed

May 16, 1958. In general, this machine includes a body portion 17'' carrying on its forward portion a head portion 19'' which is hollow and is closed at its top by a crown closure 20'', a sealing gasket 67'' providing an air tight joint. On top of the cap 20'' is mounted an exhaust guard baffle cap 88''. Within the head portion 19'' is an upstanding cylinder barrel or boss 49'' surrounded by a reservoir 50'' and having on its upper end portion an internal downwardly facing lip or shoulder 92'' above which the piston motivating pressure fluid control valve mechanism is operable.

Referring to Figure 13, it will be observed that a driving piston 155 is provided having a depending hollow stem-like underside portion 157 provided with a downwardly opening blind upper end cylinder bore 158 of substantial diameter. Into this bore extends a tubular elongated piston member 159 which is fixedly supported within a vertical bore 160 in a cavitated elongated combination return piston supporting and driving piston stop member 161 supported by a bottom closure and attachment yoke member 162. Where, as herein, the bore 160 opens through the lower end of the tubular member 161, a closure plug or disk 163 is supplied to seal the lower end of the piston sleeve 159. Preferably, the telescopically assembled members 159, 161 and 162 are secured in non-rotatable relative relation as for example by pinning, brazing, or other suitable connecting means.

On its upper end portion, the member 161 carries a resilient bumper and shock absorbing ring 164 engageable by the underside of the margin of the piston 155 in its down position or terminal end of the driving stroke.

Since the interior of the piston stem 157 is largely occupied by the cylinder chamber 158, a driving blade 165 is mounted on the forward outer side of the piston stem which for this purpose is provided with a preferably flat face 167 (Figures 12 and 13) provided with a preferably generally cruciform recess 168 therein within which a cruciform shaped head 169 on the driving blade fits in assembly. At its forward face the blade 165 is slidably engaged by a back-up piece 170 which for the purpose of machining convenience is provided as a separate piece that is inserted in a suitable longitudinal slot 171 in the front portion of the wall of the member 161 (Figure 14). A vertical guide slot 172 for the blade may be provided in the face of the lower portion of the member 161 that opposes the back-up piece 170. Below the driving tip of the driving blade 165 a member 35'' has an opening 37'' through which fasteners are delivered into a fastener driveway 38'' defined between the member 35'' and a nose piece 39''.

Removable attachment of the lower closure unit supported by the member 162 to the underside of the head 19'' is preferably effected by means such as screws 173. Detachable connection to the body 17'' of the machine is effected by means of yoke ears 174 and a connecting pin 29''. In addition, the supporting and yoke piece 162 may be provided with depending supplementary attachment ears 175 respectively detachably secured to the nose piece 39'' as by means of respective screws 177.

In the present instance, effective air pressure bleed from the reservoir 50'' for pneumatic return of the piston 155 is effected quite simply and directly. To this end, as best seen in Figures 14 and 15, a pair of passage duct bores 178 of substantial cross-sectional flow area extend from the reservoir 50'' through the floor of the head portion 19'' down through the supporting and yoke member 162 and communicate by way of respective ports 179 through the lower end portion of the member 161 and the tubular member 159 with the bore chamber in the latter which opens upwardly through a flaring mouth 180 into the piston return cylinder chamber 158.

Through this arrangement, during driving strokes of the piston 155, the air within the return cylinder 158 is displaced into the sleeve member 159 and by way of the ports 179 and ducts 178 into the reservoir 50''. Instantly upon reversal of the pressure differential by exposure of the top of the piston 155 to atmosphere, the continuous reservoir pressure by way of the ducts 178 and the ports 179 into the return cylinder 158 snaps the piston 155 in return stroke and into limit engagement against the stop shoulder 92''.

Freedom from restraint upon driving and return stroke movements of the piston 155 in the movement clearance spaces below the piston outside of the stem 157 and the fixed piston sleeve 159 is assured by venting such space to atmosphere as by means of one or more vent openings 181 leading from the lower end of the recess within the member 161.

In operation, upon release of pressure fluid into the cylinder 49'' onto the top of the piston 155 instantaneous acceleration of the piston in a driving stroke is attained. During such driving stroke, the pressure fluid within the much smaller effective pressure area return cylinder 158 is displaced into the sleeve 159 and thence by way of the ports 179 and the passages or ducts 178 into the reservoir 50'' where it supplements the volume of air in the reservoir. At the same time, air in the static area outside of the piston stem or sleeve 157 and the elongated stationary sleeve piston member 159 exhausts to atmosphere through the passages or ports 181.

When, at the end of the driving stroke of the piston 155, the cylinder 49'' is closed off from the reservoir 50'' and the chamber above the piston 155 exhausted to atmosphere, the force of pressure fluid from the reservoir 50'' entering by way of the ducts or passages 178 and the ports 179 into the stationary hollow piston tube 159 and acts with full piston returning effect within the return cylinder 158 and more particularly upon the blind upper end thereof under the crown of the piston 155 to snap the piston 155 in a return stroke until it comes to a stop against the shoulder 92'' at the top of the cylinder 49''.

In the modification of Figures 16, 17 and 18, a further expedient is shown wherein a return spring for the drive piston is eliminated and the pressure head of the compressed fluid within the reservoir of the machine is utilized for returning the piston after a driving stroke. In other respects the mechanisms of the machine may be substantially the same as described in connection with Figures 12 through 15.

In this air return modification, a drive piston 200 is provided which has a substantially elongated depending boss portion 201 of substantial diameter or cross-sectional mass provided with a central lower end downwardly opening transverse slot 202 within which the head of a driving blade 203 is received and secured removably as by means of a pin 204 pressed into a transverse bore 205 and through a registering aperture in the driving blade head. The lower portion of the driving blade extends down through a clearance aperture 207 in the bottom of a recess 208 provided in a lower closure member 209 secured as by screws 210 to the underside of a head portion 211 of the machine in substantially closing relation to the bottom of the cylindrical piston chamber within an upstanding cylinder barrel or boss 212 in a pressure fluid reservoir chamber 213. Rearwardly extending ears 214 on the closure member 209 adapt the same for attachment to the front end of a machine body such as the body structure 17'' of Figure 13.

It will be observed that the inside diameter of the recess 208 is slightly smaller than the inside diameter of the cylinder 212 and thus the closure member 209 provides a seat for a piston stroke stop ring 215 provided with an upwardly facing and projecting cushioning and bumper ring 217 for engagement by the opposing lower marginal surface of the drive piston 200. A depending reduced thickness flange extension 218 on the stop ring 215 extends in closely fitting relation down into the recess 208 and is preferably secured permanently as by means of brazing or the like to the cylindrical wall defining the recess.

To afford a pneumatic return for the piston 200, the depending boss 201 is provided with a pair of diametrically spaced vertically elongated downwardly opening blind end cylinder bores 219 (Figs. 16 and 17) located on opposite sides of the blade slot 202 and the pin bore 205. Closely slidably fitting within the cylinder bores 219 are respective piston heads 220 fixedly carried on respective stems 221 anchored as by means of screw threaded base end portions 222 within suitable tapped bores in the base wall of the closure member 209. The lengths of the return piston bores 219 and the fixed return pistons 220 and their stems 221 are related to enable full driving and return strokes of the piston 200.

Compressed air for driving the piston 200 in a return stroke is supplied directly from within the reservoir chamber 213 by suitable duct means which may be provided internally of the casing of the machine as by means of one or more, herein shown as two, reservoir tapping bores 223 extending down from the bottom of the reservoir through the adjacent portion of the closure member 209 into an annular distribution channel 224 provided in the cylindrical wall within the closure member recess 208 and closed off by the flange 218. Intersecting the distributor channel 224 are respective vertical delivery ducts 225 leading into horizontal delivery ducts 227 aligned with respective inlet ports 228 in the base portions 222 of the fixed piston stems and opening into vertical air duct bores 229 having flaring mouths 230 opening from the tops of the piston heads 220. Through this arrangement air pressure within the reservoir chamber 213 normally acts within the cylinder bores 219 to urge the piston 200 toward its return or inactive position abutting a stop shoulder 231.

However, due to the small effective pressure area of the combined blind end areas of the cylinder bores 219 as compared to the pressure sensitive area on the head of the piston 200, when the cylinder 212 is opened to the reservoir 213 for driving the piston 200 in a driving stroke the pressure differential is so great that the piston is instantaneously driven in a full power stroke. At the same time, the air displaced from the cylinder bores 219 is driven back into the reservoir 213 with substantially injector velocity to add to the effective pressure within the reservoir simultaneously with the surge of the compressed air from the reservoir into the cylinder 212. There is thus no loss of pressure fluid from within the reservoir 213 incident to the compressed air return system, but the air that is used for returning the piston is actually made use of in the reservoir in what may be likened to a replenishment action incident to the driving stroke of the piston 200. Of course, instantaneously upon venting the cylinder 212 to atmosphere when the control valve piston returns to its seat, the compressed air from within the reservoir 213 snaps the piston 200 to its return or starting position.

All of the space under the head of the piston 200 except that occupied by the driving blade and the fixed return piston structure is vented to atmosphere through a plurality of breather ports 232 opening into the lower part of the cavity 208 in the closure member 209.

Although all of the machines described herein have been provided in forms that are especially adapted for portable, manual use, it will be appreciated that the same machines could readily be utilized in stationary set ups wherein some mechanical means of plunger or lever type, or the like, may be utilized to actuate the control valve button or head, or may even replace such head and be connected directly to the stem of the control valve.

It will be understood that modifications and variations

may be effected without departing from the scope of the novel concepts of the present invention.

We claim as our invention:

1. In a driving machine, a driving member, a pneumatic piston for actuating said driving member, a cylinder reciprocably housing said piston, and means providing a reservoir of fluid under substantially constant pressure to which said cylinder is exposed, means for closing the cylinder but operable to open the cylinder to the full effect of the fluid pressure within the reservoir for driving the piston in a fastener driving stroke, and pneumatic return means for the piston communicating with said reservoir and having a differential pressure relationship to the side of the piston that is exposed to the pressure reservoir upon opening of the cylinder so that in the closed condition of the cylinder the pneumatic return means maintains the piston in returned position.

2. In a driving machine, a pneumatically operated driving member, a cylinder within which said member is operable, a reservoir providing a source of fluid under pressure for motivating the driving member within the cylinder, and pneumatic return means for said member including a pressure surface thereon and means for effecting communication between said pressure surface and said reservoir including a passage communicating pressure fluid from the reservoir continuously to said pressure surface and operable for return stroke actuation of the driving member, said passage returning the pressure fluid from said surface to the reservoir incident to driving stroke of the driving member.

3. In a driving machine, a pneumatically operated driving member, a cylinder within which said member is operable, a reservoir providing a source of fluid under pressure for motivating the driving member within the cylinder, and pneumatic return means for said member including a pressure chamber therein and means for effecting communication between said pressure chamber and said reservoir whereby pressure from the reservoir is continuously operable for return stroke actuation of the driving member but the fluid from within said chamber is returned to the reservoir incident to driving stroke of the driving member, said chamber including an elongated cylinder and said means for effecting communication including an elongated hollow piston member fixedly mounted relative to said driving member cylinder.

4. In a driving machine including a cylinder and a driving piston reciprocable in the cylinder, the machine having pressure fluid supply means, means for controlling the supply means for selectively introducing pressure fluid into the cylinder to drive the piston in a driving stroke, and a piston return structure including a return cylinder and piston mechanism operatively connected with said driving piston and of substantially smaller effective pressure area, with means for supplying said return piston and cylinder structure with pressure fluid from said supply means to effect return of the driving piston following a driving stroke thereof.

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

6. In a pneumatic driving machine, a head portion and a frame structure providing a pressure fluid reservoir of substantial volume with means for supplying into said reservoir pressure fluid from a substantially continuous pressure source, a cylinder structure within said reservoir opening at one end for exposure to the pressure fluid in the reservoir, a piston carrying a driving member and reciprocably operable in said cylinder, said head portion having an opening aligned with said cylinder end and provided with a closure member substantially spaced from said cylinder end, said closure member having a stop member extending therefrom into the cylinder adjacent to said cylinder end and engageable with said piston to hold the same in load position adjacent to but spaced from said cylinder end, said stop member providing a guide stem structure of substantially smaller outside diameter than said cylinder, said head portion having beyond said cylinder end and aligned with the cylinder a cylinder portion of larger diameter than said first mentioned cylinder, an annular valve piston sealingly slidably reciprocably mounted within said larger cylinder and engaging said guide stem and normally closingly engaging on said first mentioned cylinder end but shiftable toward open position for opening the first mentioned cylinder to full fluid pressure within the reservoir for driving the piston and driving member in a firing or driving stroke thereof, and pneumatically operated return means acting on said piston to return the piston to load position in stopped engagement with said stop member when said valve piston is in closing relation to said piston end.

7. In a pneumatic driving machine including a casing structure defining a reservoir of substantial volume with a cylinder opening freely into the reservoir and a piston reciprocably operable in the cylinder and normally biased toward the end thereof exposed to the reservoir, a pneumatic control valve member operable by pressure fluid in the reservoir for both opening and closing movements relative to said end of the reservoir, opening exposure of said valve member being directly within the reservoir and closing exposure of the valve member being by way of a pressure chamber and a supply passage to the reservoir having a port opening into the reservoir, and a plunger control valve having a tapered end directed toward said port and a control structure exposed outside of said casing for actuation to drive said tapered control valve into closing relation to said port for disconnecting said passage from the reservoir, said control valve also having a normally closed bleeder valve structure which is opened coincident with closing of the port by said tapered valve to relieve said pressure chamber by way of said passage so as to unbalance said closure valve for opening and thus exposing of the piston to the pressure of fluid in said reservoir, said piston having biasing means in the form of a return piston of differential size connected therewith and biased by pressure fluid from said pressure chamber to maintain said piston in the cylinder adjacent to said end of the cylinder and relieving the return piston when said pressure chamber is bled by operation of said control valve.

8. In a pneumatic driving machine, a casing structure having means for providing fluid pressure and a cylinder with a driving piston reciprocably operable in said cylinder, means operable selectively for entry into the cylinder of pressure fluid from said fluid pressure means for

firing the piston from a load position, and a return piston carried by said driving piston and of substantially smaller diameter and having means for normally subjecting the return piston to pressure fluid from the reservoir for maintaining the driving piston in said load position.

9. In a pneumatic driving machine, a casing having means providing fluid pressure and a cylinder with a driving piston therein having a crown, means operable for impressing of the pressure fluid from the fluid pressure means drivingly on the crown of the piston, and return means for normally biasing the piston toward a return position comprising a return pressure chamber operable on a limited area of the margin of the piston on the side of the piston opposite to said crown and with said limited area continuously exposed to pressure fluid from said fluid pressure means but of such small area relative to the crown of the piston exposed to the pressure fluid from said fluid pressure means during driving as to be greatly overbalanced and thus substantially avoid impeding driving movement of the piston.

10. In a driving machine including a casing having means providing fluid pressure and a cylinder, means for separating the cylinder from the fluid pressure means but operable for passage of the pressure fluid into one end of the cylinder, a piston reciprocably housed within the cylinder and having a head portion substantially sealingly slidably engaging the cylinder wall and a skirt portion of substantial length and slightly smaller diameter than the cylinder wall and concentrically spaced therefrom, the cylinder having a passage to said fluid pressure means opening into the space between said skirt and the cylinder wall and thereby subjecting the piston head portion to the force of pressure fluid from the reservoir for normally maintaining the piston in a position near said one end of the cylinder ready for firing upon operation of said separating means to thereby expose the crown of the piston to the pressure fluid.

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