United States Patent

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[72] Inventor **John F. Reeves**
Tonawanda, N.Y.

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[73] Assignee **Robert Paul Lickliter and Earl Abbott**
Hamburg, N.Y.

[54] **PNEUMATIC PRESS**
13 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **100/53,** 100/257, 100/266, 100/269
[51] **Int. Cl.** **B30b 1/38,** B30b 15/16
[50] **Field of Search** 100/269, 266, 257, 53

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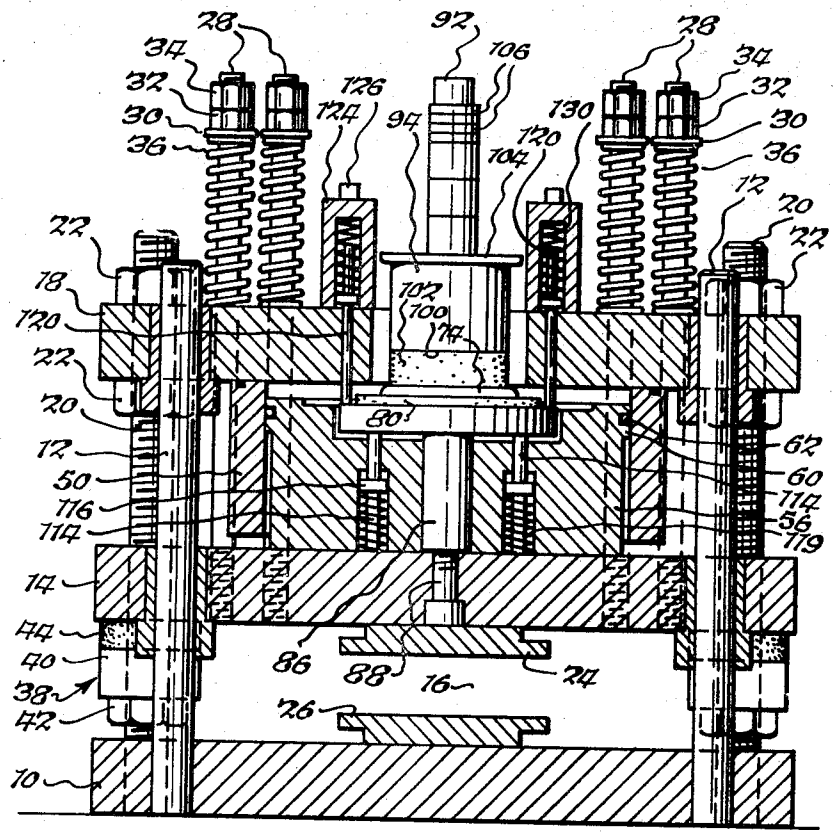
Primary Examiner—William I. Price
Attorney—Christel & Bean

ABSTRACT: A pneumatic press has a piston and cylinder mounted between an upper mounting plate and a ram plate for driving the latter downwardly. An exhaust valve controls flow of air from the cylinder through a large exhaust opening in the upper mounting plate to atmosphere. Air under pressure is trapped in a chamber provided between the piston and the exhaust valve upon closing of the exhaust valve to preload the piston for the succeeding operation. Such air pressure in conjunction with spring-biased means holds the exhaust valve closed until their force is exceeded by the force of a mechanical actuator movable with the piston.



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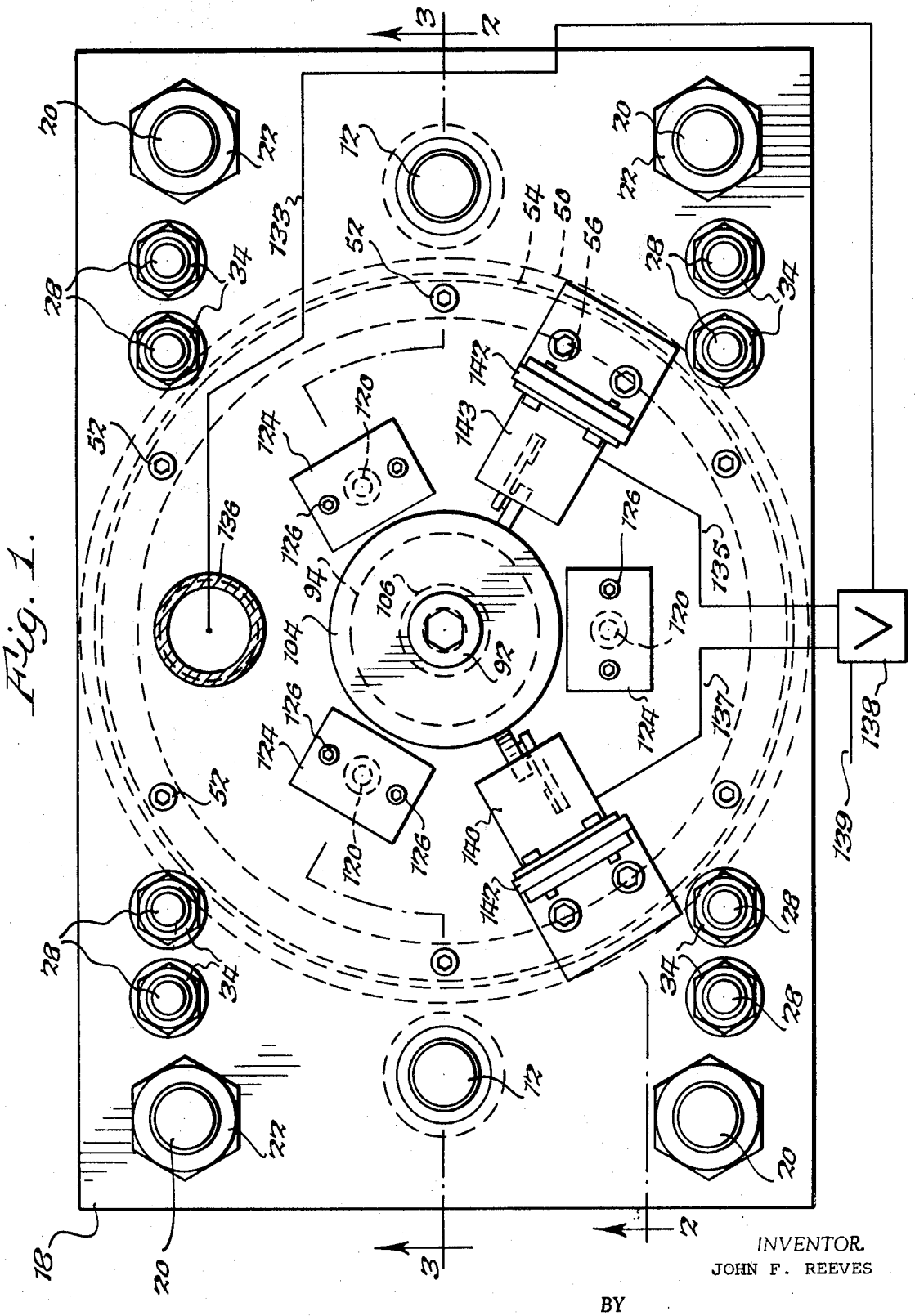


Fig. 1.

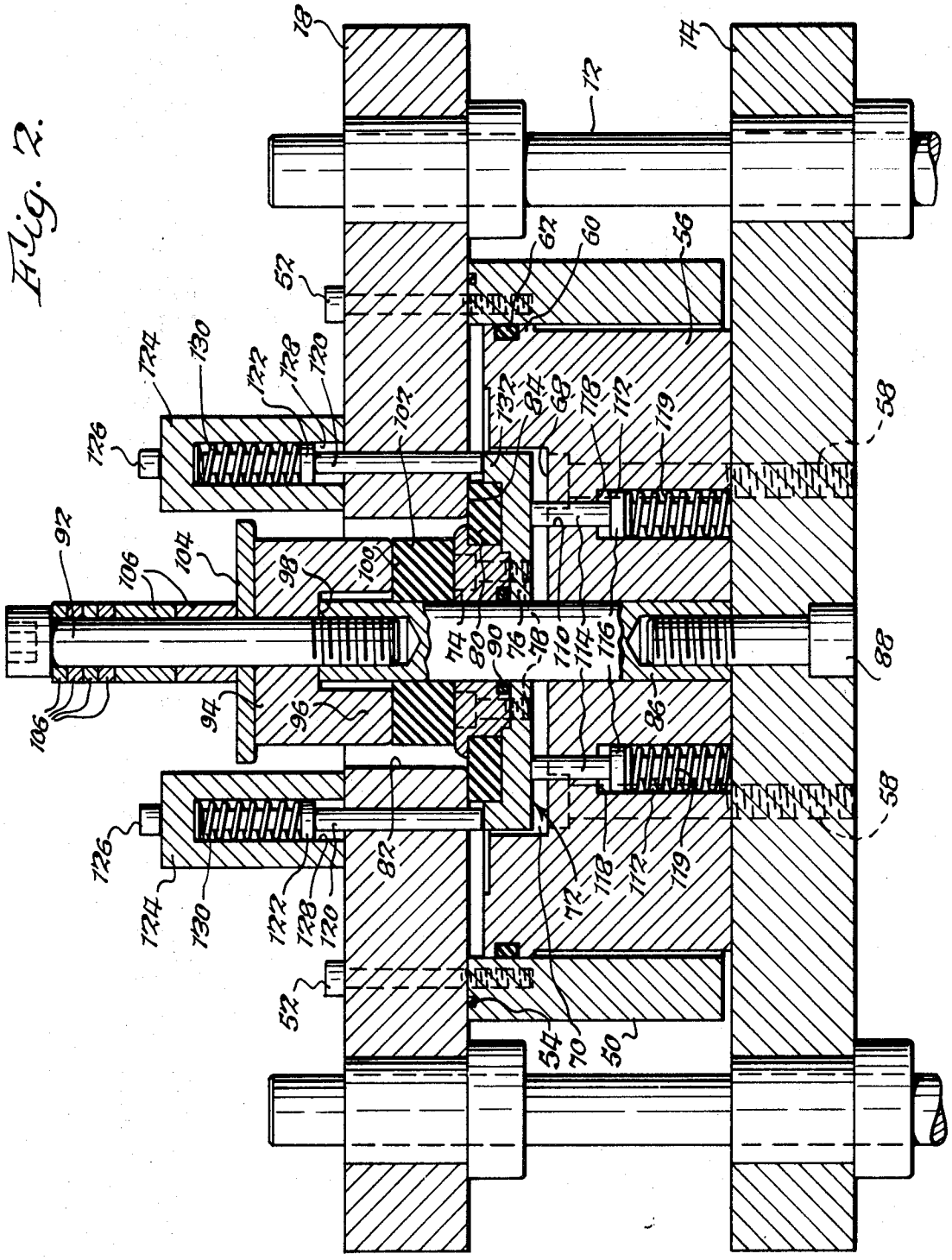
INVENTOR.
JOHN F. REEVES

BY

Christel & Bean

ATTORNEYS.

Fig. 2.



INVENTOR.
JOHN F. REEVES

BY

Christel & Bean

ATTORNEYS.

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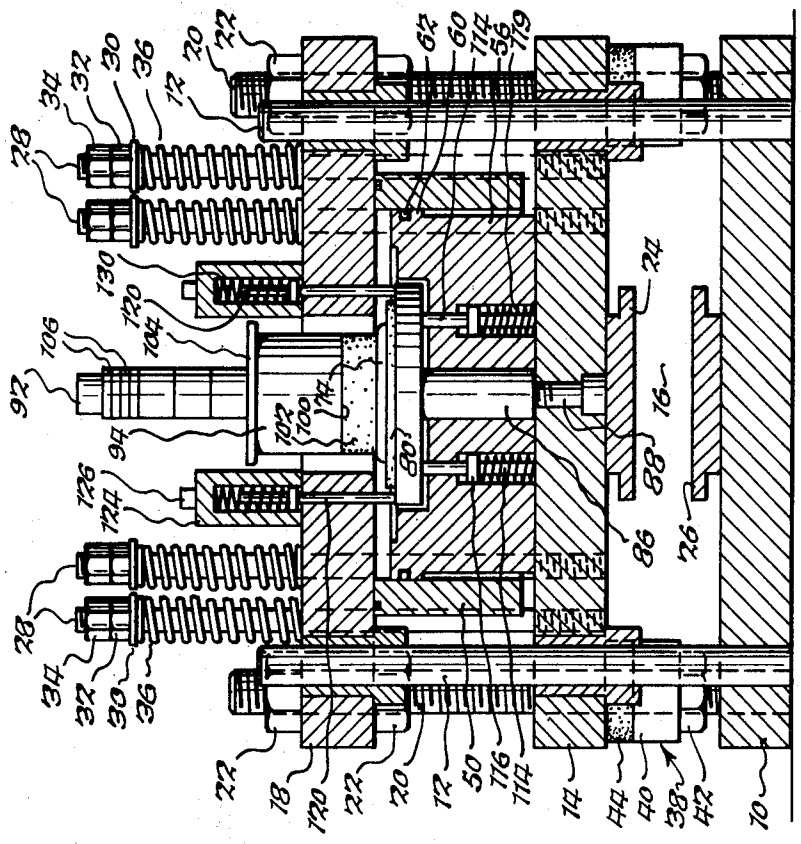

Fig. 4.

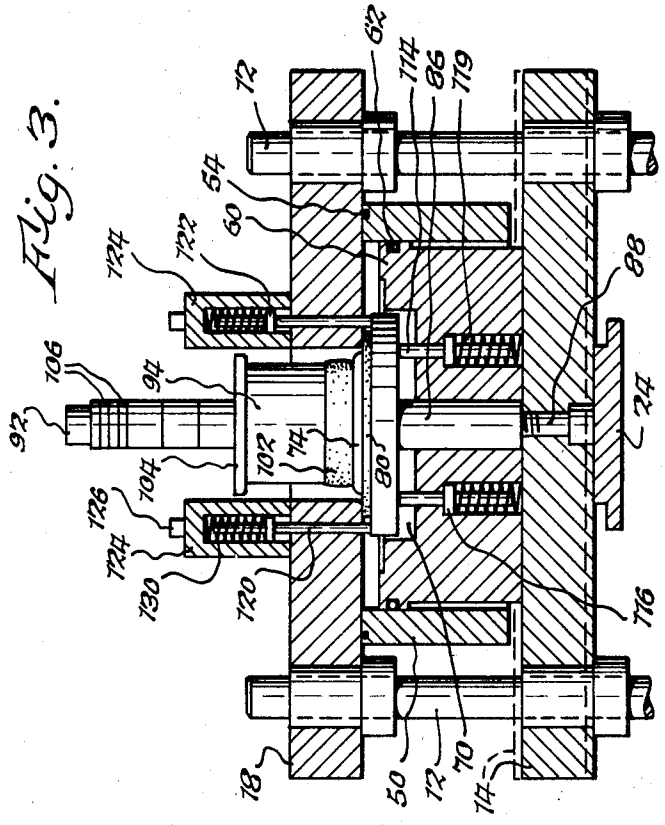

Fig. 3.

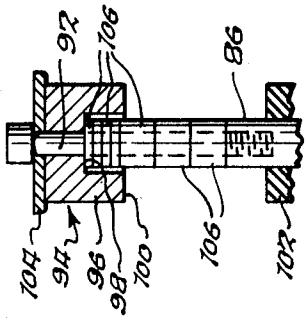

Fig. 5.

INVENTOR.
JOHN F. REEVES

BY

Christel & Bean

ATTORNEYS.

PNEUMATIC PRESS

BACKGROUND OF THE INVENTION

This invention relates to a pneumatic press and, more particularly, to a new and improved pneumatic press incorporating a valving arrangement for preloading the cylinder with air pressure and for rapidly evacuating air pressure from said cylinder.

Certain known presses include a ram plate mounted for vertical sliding movement on a plurality of vertical guideposts upstanding from a stationary bed, the ram plate and stationary bed defining a die set area therebetween. The upper ends of the guideposts are secured to an upper plate for maintaining the guideposts in vertical alignment thereby permitting free sliding movement of the ram plate. In some recent developments, the ram plate is fluid actuated by a piston and cylinder arrangement to drive the ram plate downwardly into the die set area, the ram plate being mechanically returned by springs or the like. Because of the large diameter pistons employed in these fluid actuators, a large volume of fluid under pressure is required to efficiently actuate these pistons. Conventional three-way control valves are unsatisfactory for controlling efficient rapid actuation of such pistons because of considerable "blow by" in such valves when shifting between exhaust and operative positions. It has been found that more fluid is lost due to "blowby" than is lost in exhausting the pressure fluid to atmosphere during piston retraction. Also, a certain time elapses during which pressure builds up to the level required to move the piston on the downstroke, thereby producing a lagging and inconsistent ram plate response to the actuating control. Accordingly, overall press operation time is increased and variations in work in the die set area are introduced. Also, it is desirable to instantaneously exhaust the pressure in the cylinder for rapid cyclic operation of the press.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a pneumatic press having means for preloading the actuating cylinder to provide instantaneous response upon the application of additional pressure thereto.

It is another object of this invention to provide a pneumatic press having an improved exhaust valving arrangement for rapidly exhausting air pressure in the actuating cylinder immediately upon completion of the downstroke.

The pneumatic press of the present invention is characterized by a valving arrangement which provides rapid exhaust of air pressure from the actuating cylinder to permit immediate return of the piston upon the completion of the downstroke and which closes the exhaust opening prior to complete depletion of the air pressure to provide an air cushion thereby preloading the cylinder in readiness for the next cycle and eliminating the time-consuming buildup of pressure in the cylinder.

The foregoing and other objects, advantages and characterizing features of the air-actuated press of the present invention are pointed out in detail in the following description of a typical embodiment thereof considered in conjunction with the accompanying drawings depicting the same wherein like reference numerals represent like parts throughout the various views.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of the pneumatic press of the present invention;

FIG. 2 is a vertical sectional view of the pneumatic press taken about on line 2–2 of FIG. 1 parts being deleted for ease of illustration;

FIG. 3 is a vertical cross-sectional view, on a reduced scale, illustrating an operative position of the piston just prior to the opening of exhaust valve;

FIG. 4 is a view similar to FIG. 3 illustrating the open position of the exhaust valve, with parts added to more clearly show the structure of the press of FIG. 1; and

FIG. 5 is a fragmentary, vertical sectional view illustrating the means for adjusting the stroke of the ram plate.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawing, and particularly to FIGS. 1 and 4, there is shown an illustrative embodiment of the pneumatic press of the present invention comprising a stationary bed **10**, a plurality of vertically extending guideposts **12** suitably fixed at their lower ends to bed **10**, a ram head plate **14** vertically slidable on guideposts **12** and defining a die set area **16** with bed **10**, and an upper mounting plate **18** slidably adjustable on guideposts **12**. Guideposts **12** extend upwardly from bed **10** through suitable bores and bushings in ram plate **14** and mounting plate **18**. A plurality of upstanding threaded posts **20** are threaded at their lower ends into bed **10** and extend upwardly through openings in ram plate **14** and mounting plate **18**, the former being freely movable relative to posts **20** and the latter being secured to posts **20** adjacent their upper ends between nuts **22** to adjustably fix the height of mounting plate **18** above bed **10**.

Bed **10** and plates **14** and **18** are preferably rectangular in plan form and can be formed of steel plating. Track members **24** and **26** are suitably secured on the undersurface of ram plate **14** and on the upper surface of bed plate **10**, respectively, and are adapted to receive the upper and lower dies of the usual die set, not shown. However, it should be understood that the press of this invention is not restricted to use with die sets, but has general utility in varied applications.

Ram plate **14** is suspended below mounting plate **18** by a ram plate return assembly comprising, in the illustrated form, rods **28** suitably fixed at their lower ends to ram plate **14** and passing upwardly through openings in mounting plate **18**. The upper end of each rod **28** mounts a washer **30**, a nut **32** and a locknut **34**, and a compression spring **36** encircles each rod **28** with its opposite ends bearing against washer **30** and the upper surface of mounting plate **18**. Ram plate **14** is thus resiliently supported for reciprocating sliding movement on guideposts **12** by springs **36** with downward movement thereof into die set area **16** being against the bias of springs **36** and limited by a plurality of stops **38** vertically adjustably mounted on posts **20** between ram plate **14** and bed plate **10**. Stops **38** comprise sleeves **40** threaded on posts **20** and fixed in vertically adjusted position by jam nuts **42** engaging against their undersurfaces. The upper surface of each sleeve **40** has a resiliently deformable cushion **44**, preferably formed of rubber, glued or otherwise fixed thereon, for limiting downward movement of ram plate **14** and providing a noiseless initial return thrust to ram plate **14** at the end of its downstroke.

A pneumatically actuated piston and cylinder arrangement is disposed between mounting plate **18** and ram plate **14** to drive the latter downwardly into die set area **16**. To this end, press cylinder **50** is suitably secured to the undersurface of mounting plate **18** inwardly of guideposts **12**, posts **20** and rods **28** as by capscrews **52** (FIGS. 1 and 2) and is provided with a suitable O-ring seal **54** sealing against mounting plate **18**. Cylinder **50** preferably is as large in diameter as can be accommodated between posts **12**, **20** and rods **28**. A piston **56** is suitably secured to the upper surface of ram plate **14** in vertical registry with cylinder **50** as by capscrews **58** (FIG. 2) and is formed of a heavy material providing considerable inertia to ram plate **14** during its downstroke. The upper edge of piston **56** has a pair of peripheral flanges **60** having a suitable O-ring seal **62** carried therebetween for sealing against the inner surface of press cylinder **50**.

The upper surface of piston **56** is cylindrically recessed as at **68** defining a chamber **70** within which is received an exhaust valve, generally designated **72**, comprising an upper ring **74** and a lower ring **76** suitably secured together as by screws **78**

and clamping therebetween a resiliently yieldable sealing ring 80. A relatively large central exhaust opening 82 is provided in mounting plate 18 and is surrounded by an annular valve seat 84 disposed on the undersurface of mounting plate 18. With piston 56 in the position shown in FIG. 2, sealing ring 80 of exhaust valve 72 is in sealing engagement with valve seat 84.

Extending axially through piston 56 and exhaust valve 72 is a rod 86 secured to ram plate 14 by a capscrew 88. Rod 86 moves vertically with piston 56 and relative to exhaust valve 72. An O-ring seal 90 (FIG. 2) is carried in an annular groove in exhaust valve 72 to provide a fluidtight seal between exhaust valve 72 and rod 86. Threadably secured to the upper end of rod 86 is an elongated capscrew 92 extending through an exhaust valve actuator 94 in the form of an inverted cup having an annular wall 96 and a bottom wall 98 seated against the upper end of rod 86. Actuator 94 is adapted to open exhaust valve 72 with the free end 100 thereof engaging an annular resiliently yieldable ring 102 surrounding rod 86 and interposed between exhaust valve 72 and actuator 94. An annular disc 104 is supported on actuator 94 and is adapted to trip microswitches 140 and 143 (FIG. 1) for purposes hereinafter explained.

A plurality of washers 106, of varying thicknesses, are slip fitted onto capscrew 92 and are interposed between the head of capscrew 92 and disc 104. These washers 106 can be selectively removed from above actuator 94 and placed adjacent bottom wall 98 of actuator 94 as shown in FIG. 5 to vary the length of stroke of rod 86 prior to the opening of exhaust valve 72 by actuator 94. Also, this adjustment varies the length of stroke of piston 56 and ram plate 14.

Piston 56 is provided with a plurality of bores 110 counterbored as at 112 (FIG. 2) for receiving a corresponding number of pins 114 having annular enlargements 116 thereon. Annular shoulders 118 are defined between the transition of counterbores 112 to the reduced diameter of bores 110 for limiting upward movement of pins 114. Downward vertical movement of pins 114 is limited by the lower ends of pins 114 engaging ram plate 14. The lower end of each pin 114 is surrounded by a helical spring 119 seated against ram plate 14 at one end and engaging enlargement 116 for urging the pin 114 upwardly against the bottom of exhaust valve 72. While preferably four such pins 114 are employed at circumferentially spaced intervals of 90°, it should be understood that any required number may be used and spaced in any pattern desired.

Similar, but longer, pins 120 having annular enlargements 122 are provided for engaging the other or top side of exhaust valve 72. Pins 120 are housed in suitable blocks 124 circumferentially spaced about the upper surface of mounting plate 18 and secured thereto by screws 126. Each block 124 is provided with a bore 128 for receiving annular enlargement 122 and a helical compression spring 130 seated at one end against the bottom of bore 128 and abutting annular enlargement 122 at the other end for urging pin 120 downwardly against exhaust valve 72. Pins 120 extend downwardly through openings provided in mounting plate 18 and engage an annular peripheral rim 132 (FIG. 2) extending upwardly from lower ring 76 of exhaust valve 72. While three such pins 20 are provided in the illustrative embodiment of FIGS. 1 and 2, it should be appreciated that any required or desired number can be used.

It will be appreciated that the diameter of piston 56 is very large providing a substantial area on the upper surface of piston 56 against which air entering press cylinder 50 can react whereby low-pressure air can provide a considerable force. Also, the large lateral dimension of the piston and cylinder arrangement and the direct connection thereof to the ram and mounting plate, respectively, maintain ram plate 14 in accurate vertical slidable registry on guideposts 12 without undue friction therebetween.

An inlet opening (FIG. 1) is provided in mounting plate 18 and communicates with the interior of cylinder 50 for admitting air under pressure into cylinder 50. A control valve, schematically illustrated in FIG. 1 and identified by reference numeral 138, preferably of the two-way type, is employed for controlling the admission of air under pressure into cylinder 50. Control valve 138 is provided with a conduit 139 connected to a suitable source of air under pressure (not shown) and is connected to inlet 136 by means of a conduit 133. Control valve 138 has only two positions, one for admitting the flow of air under pressure into cylinder 50 and the other for interrupting such flow. It has been found that when conventional three-way or four-way control valves are used to control the admission of air under pressure into a cylinder and the exhaust of air from the cylinder, a considerable amount of pressure is lost through "blowby" in shifting the valve from pressure to exhaust or vice versa. Not only does this waste pressure but also results in erratic and lagging piston and ram plate response. Accordingly, the provision of a two-way control valve 138 which is operable only to admit and interrupt pressure flow in conjunction with a separate exhaust valve operative to open or close a separate large exhaust opening eliminates the above deficiencies and permits rapid and instantaneous operation of the ram plate piston. Of course, a three- or four-way control valve can be employed provided that all ports except the pressure inlet and outlet be plugged.

A control switch 140, secured to a mounting bracket 142 secured to mounting plate 18 and electrically connected to control valve 138 by conductor 137, is positioned to be engaged by disc 104 in its upward travel to shift control valve 138 for admitting air under pressure into cylinder 50. On downward movement of disc 104, another switch 143, connected to control valve 138 by conductor 135, is actuated to shift control valve 138 to a position interrupting the flow of air pressure into cylinder 50. Thus, only two control switches are incorporated in the present invention to admit or block pressure flow into cylinder 50, the exhaust valve being actuated by mechanical elements as hereinafter described.

It should be appreciated that in employing control switches, a certain time interval, although only of microsecond duration, is inherent between the actuation of the control switch and the response of its control function. The pneumatic press of the present invention does not rely on such electrical switching components to actuate the exhaust valve and accordingly, obviates all of the disadvantages attendant therewith.

With reference to FIGS. 2, 3 and 4 of the drawings, the mode of operation of the pneumatic press of this invention is as follows:

Referring to FIG. 2, piston 56 is shown in its uppermost position with the upper central surface thereof slightly spaced below exhaust valve 72. A certain amount of air pressure exists in chamber 70, as will hereinafter become apparent. The combined force of pressure acting against the effective area of the underside of exhaust valve 72 and the bias of springs 119 urging pins 114 against the underside of exhaust valve 72 is greater than the force of pins 120 biased against the upper side of exhaust valve against seat 84 closing exhaust opening 82.

Upon the admission of air pressure into chamber 70 through opening 136, piston 56 immediately moves downwardly to drive ram plate 14 downwardly. Piston 56 moves downwardly carrying along with it actuator 94 which bears against resilient ring 102 compressing the same and transmitting a downward force acting on the upper side of exhaust valve 72. Piston 56 continues to move downwardly relative to lower pins 114 and reaches the position shown in solid lines in FIG. 3 wherein annular enlargements 116 abut shoulders 118 while upper pins 120 remain engaged with the upperside of exhaust valve 72 by means of springs 130. At this position of piston 56, disc 104 engages control switch 143 and actuates the same to shift control valve 138 to interrupt the flow of air pressure into cylinder 50. At this point, the net force produced by the air pressure against the underside of exhaust valve 72 and the spring biased pins 114 is approximately equal to the net downward force of the now bulging, compressed ring 102 transmitted by actuator 94 and the spring-biased pins 120. FIG. 3 illustrates the rela-

tive position of the various components just prior to exhaust valve **72** popping open.

Although the air pressure supply is interrupted, piston **56** is moved further downwardly slightly below the position shown in FIG. **3** by inertia. Corresponding movement of actuator **94** further compresses ring **102** forcing exhaust valve **72** off seat **84** allowing air pressure to be exhausted from cylinder **50**, around exhaust valve **72**, and through exhaust opening **82** to atmosphere. Exhaust valve **72** is moved downwardly to the position shown in FIG. **4** by upper spring-biased pins **120** and by compressed ring **102** which returns to its normal uncompressed state against the reduced pressure acting on the underside of exhaust valve **72**. Downward movement of exhaust valve **72** is limited by the engagement of the lower ends of pins **114** with ram plate **14**.

As piston **56** reaches the bottom of its downstroke as shown in FIG. **4**, it immediately returns upwardly by means of mechanical return springs **36**, stop cushions **44** and the rapid exhaust of air pressure through the large exhaust opening **82**. As piston **56** moves upwardly carrying along with it ram plate **14**, rod **86** and actuator **94**, exhaust valve **72** also moves upwardly by the stronger force of the spring-biased pins **114** acting against the smaller force of the spring-biased pins **120**. Exhaust valve **72** moves upwardly until sealing ring **80** engages valve seat **84** closing off exhaust opening **82**. At this point piston **56** continues to be raised a slight amount compressing the air in chamber **70** until it has reached its uppermost position shown in FIG. **2**. During this last movement of piston **56**, disc **104** trips control switch **140** to actuate control valve **138** to supply air pressure into inlet **136** and cylinder **50** to initiate another cycle of ram plate **14**.

A significant feature of this invention resides in trapping a certain amount of air under pressure in chamber **70** between the closing of exhaust valve **72** and the complete return of piston **56**. Such pressure serves to maintain exhaust valve **72** seated and also to preload cylinder **50** in readiness for the next cycle of operation. By preloading cylinder **50**, no time is lost in building the pressure up to the level at which piston **56** begins to move downwardly. With the initial admission of air pressure into cylinder **50**, piston **56** starts to move downwardly instantaneously. Thus, the pneumatic press of the present invention is instantaneously responsive to control commands for rapid and consistent operation. This rapid and consistent operation is enhanced by the elimination of all but two control switches to eliminate time delays inherent in a plurality of switching operations. With some modification, the exhaust control of the present invention could be adapted for use in a pneumatic press having an inlet control to the cylinder of the type disclosed in application Ser. No. 744,898, filed July 15, 1968 now U.S. Pat. No. 3,478,678 and assigned to the same assignee as the instant application.

From the foregoing, it is apparent that the objects of the present invention have been fully accomplished. As a result of this invention, an improved pneumatic press of a simple and rugged design is provided for instantaneously actuating a ram headplate in an improved and more efficient manner. Lagging and erratic ram plate response is eliminated by preloading the cylinder prior to the admission of additional air pressure thereto. Also, instantaneous response is realized by the elimination of control switches which inherently introduce time delays in control functions.

A preferred embodiment of this invention having been disclosed in detail, it is to be understood that this has been done by way of illustration only.

I claim:

1. An air-actuated press comprising: a bed; a ram plate guided for movement relative to said bed; a mounting plate on the side of said ram plate opposite said bed; a fluid cylinder mounted on said mounting plate; a piston movable in said cylinder and mounted on said ram plate; an opening in said mounting plate surrounded by a seating surface; an exhaust control valve means disposed in said cylinder in controlling relation to said opening; and means within said cylinder biasing said exhaust control valve means against said seating surface and maintaining said exhaust control valve means spaced from said piston.

2. An air-actuated press according to claim **1** wherein said control valve means comprises a resiliently yieldable seal clamped between a pair of plates and adapted to engage said seating surface of said mounting plate.

3. An air-actuated press according to claim **1** including a chamber defined between said control valve means and said piston and wherein said biasing means includes residual air under pressure in said chamber acting against said control valve means.

4. An air-actuated press according to claim **1** wherein said biasing means includes pins mounted in said piston movable relative thereto and spring means urging said pins against said control valve means.

5. An air-actuated press according to claim **4** including bias means for urging said control valve means away from said seating surface.

6. An air-actuated press according to claim **1** including an actuator for unseating said control valve means and means connecting said actuator to said piston for axial movement therewith.

7. An air-actuated press according to claim **6** wherein said connecting means comprises a rod secured at one end to said ram plate and extending through said piston and said opening.

8. An air-actuated press according to claim **6** including a resiliently yieldable ring disposed on said rod between said actuator and said control valve means.

9. An air-actuated press according to claim **6** wherein said rod is provided with a threaded extension at the other end for adjustably mounting said actuator thereon.

10. An air-actuated press according to claim **6** including adjusting means mounted on said rod for varying the length of stroke of said ram plate.

11. An air-actuated press according to claim **10** wherein said adjusting means comprise a plurality of washers of varying thicknesses selectively positioned on said rod on opposite sides of said actuator.

12. An air-actuated press comprising a bed, ram plate means guided for reciprocating movement toward and away from said bed, mounting plate means on the side of said ram plate means opposite said bed, a cylinder mounted on said mounting plate means between said mounting and ram plate means, a piston movable in said cylinder and mounted on said ram plate means, means for admitting air into said cylinder under pressure to extend said piston and drive said ram plate toward said bed, means for exhausting air from said cylinder during return of said piston, said last-named means including an exhaust control valve, and means closing said exhaust valve means as said piston approaches the end of its return movement to trap air under pressure in said cylinder as said piston completes its return movement and thereby preload said piston for its next extension movement.

13. An air-actuated press according to claim **12** together with means responsive to the return movement of said piston said exhaust valve means is closed to actuate said means for admitting air into said cylinder under pressure to repeat the cycle in a timed relationship.