

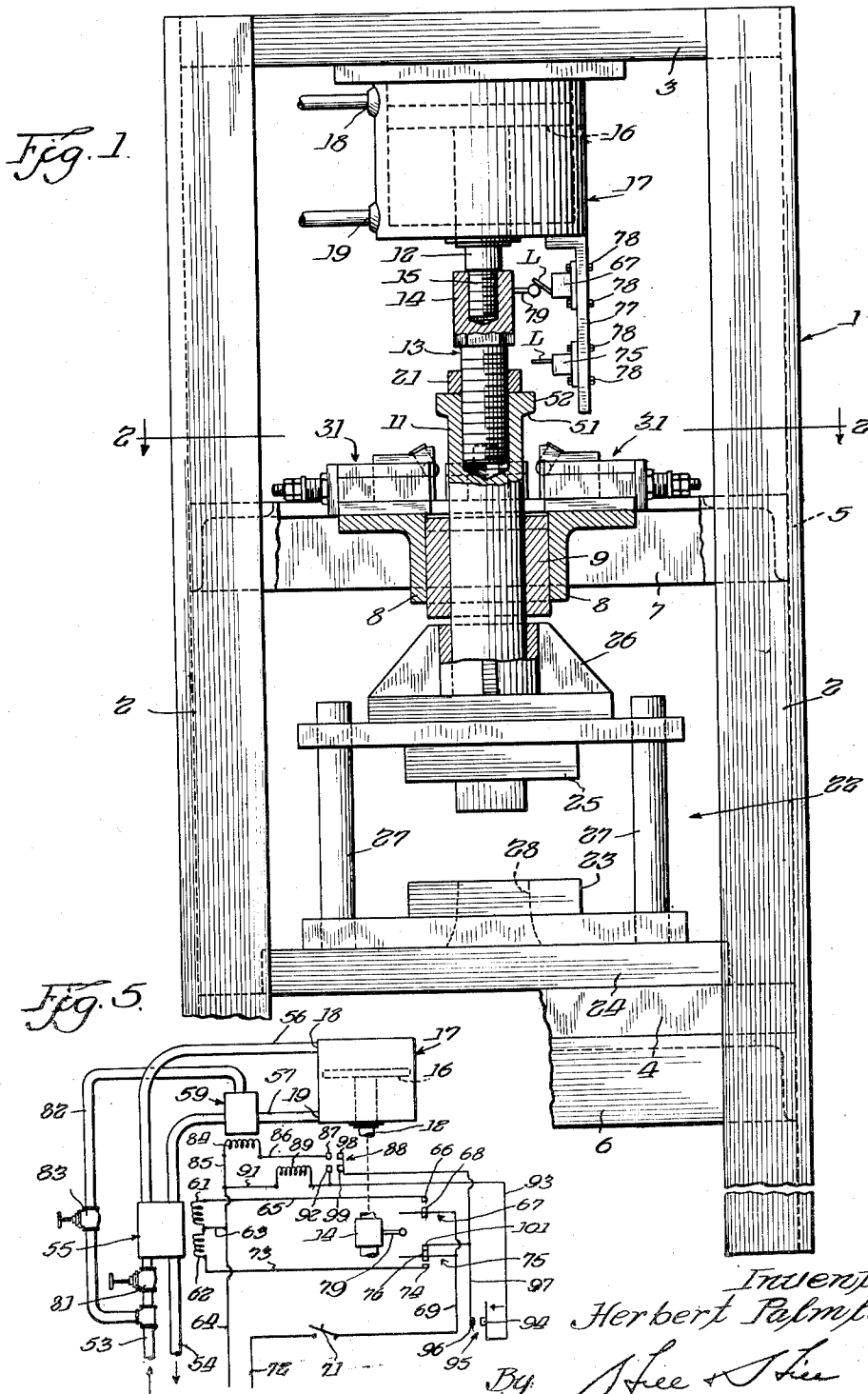
Oct. 7, 1952

H. PALMLEAF
PNEUMATIC PRESS

2,612,951

Filed Aug. 6, 1947

2 SHEETS--SHEET 1



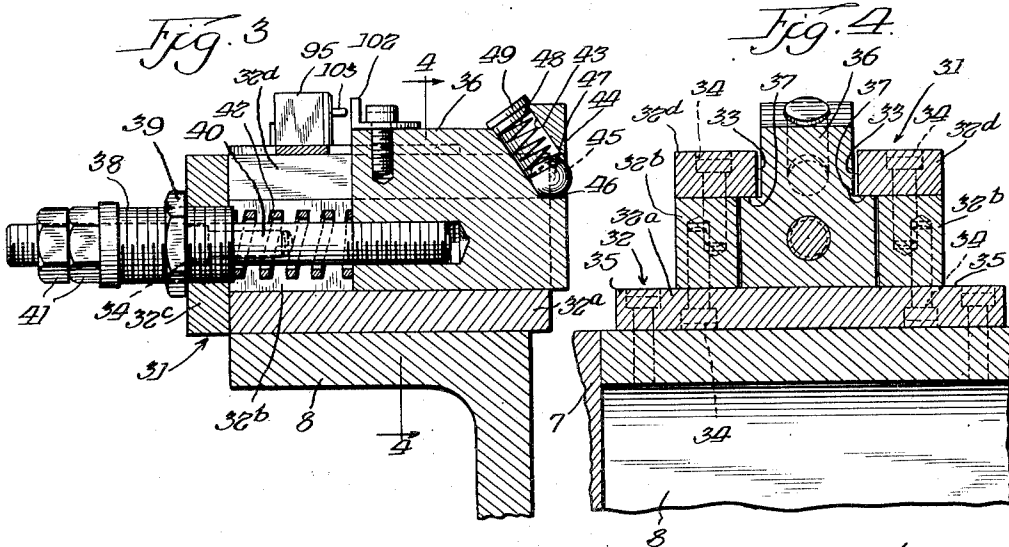
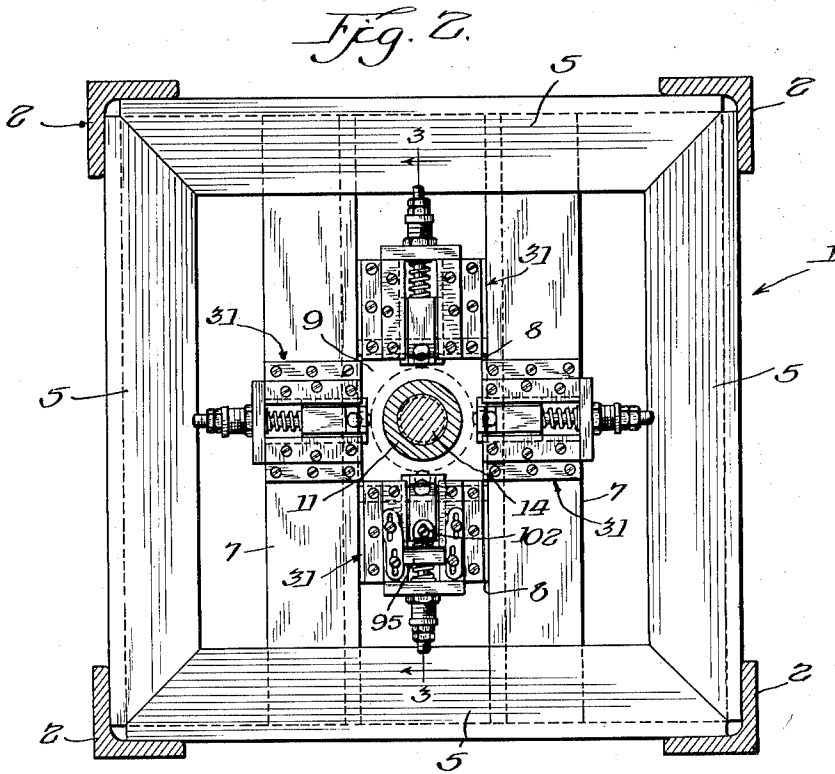
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2 SHEETS--SHEET 2



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UNITED STATES PATENT OFFICE

2,612,951

PNEUMATIC PRESS

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Application August 6, 1947, Serial No. 766,721

19 Claims. (Cl. 164—95)

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The invention relates generally to power presses and more particularly to a pneumatically operated press such as a punch press, or the like.

The invention has among its objects the production of such a pneumatic press which is so constructed that a relatively small air cylinder may be employed, at the same time producing a blow of maximum power, and which press due to its novel construction will occupy a relatively small space.

Another object of the invention is the production of such a press in which the stroke may be readily and easily adjusted from zero to the full length of travel of the pneumatic actuating unit.

Another object of the invention is the production of such a press in which the effective pressure may be varied to meet the particular operating requirements, and in which a very sharp blow may be obtained with relatively low air pressures.

A further object of the invention is the production of such a device in which the power unit may be mounted horizontally, vertically, or diagonally, as required.

A further object of the invention is the production of such a pneumatic press wherein the reciprocable member may be cushioned as it approaches the end of a power stroke.

A further object of the invention is the production of novel means for momentarily retarding the travel of the reciprocal member, whereby a sharp blow may be obtained with relatively low air pressures.

Many other objects and advantages of the construction herein shown and described will be obvious to those skilled in the art from the disclosure herein given.

To this end my invention consists in the novel construction, arrangement and combination of parts herein shown and described and more particularly pointed out in the appended claims.

In the drawings wherein like reference characters indicate like or corresponding parts:

Fig. 1 is a front elevational view of a press embodying the present invention with portions broken away to show the details thereof;

Fig. 2 is a sectional view taken approximately on the line 2—2 of Fig. 1;

Fig. 3 is a sectional view through one of the retarding elements taken approximately on the line 3—3 of Fig. 2;

Fig. 4 is a sectional view of the retarding element taken approximately on the line 4—4 of Fig. 3; and

Fig. 5 is a schematic diagram of one pneumatic

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and electrical circuit that may be employed with the device.

In the past, pneumatic punch presses and similar equipment have not been satisfactory as relatively large air cylinders and extremely high air pressures were required to produce a blow comparable to a mechanically actuated press, inasmuch as the pressure exerted would be dependent upon the area of the piston employed and the air line pressure. For example, employing a pressure of 100 lbs. per square inch on a piston 8 inches in diameter would result in a total pressure of approximately 5,500 lbs., which is insufficient for the operation of a large die or tool. However, by the use of the present invention a sharp blow may be obtained with approximately ten times the effective force than that previously obtained while employing the same size air cylinder and same air line pressures.

This result is accomplished in the present invention by employing means for momentarily interrupting the power stroke of the reciprocable member of the device after such stroke has been partially completed, and then suddenly releasing the reciprocal member at substantially the peak of the additional force built up in the air cylinder, resulting in a very sharp impact on the punching die, or the like.

Referring to the drawings and more particularly to Figs. 1 and 2, 1 indicates generally a supporting frame or structure, comprising in the embodiment of the invention illustrated, four vertical corner members 2 connected by an upper plate 3, a lower plate 4 and intermediate side members 5, the latter in the present instance, as well as the uprights 2, being formed from angle iron. The various elements thus far described are suitably fastened together, as for example, by welding, and if desired, the plate 4 may be suitably reinforced by cross members 6. Also secured to the uprights 2 and extending between the front and rear cross members 5 are a pair of spaced members 7 illustrated in the present instance as being formed from angle iron, and similarly secured by welding, or the like, to the respective cross members 5. The two members 7 are likewise connected by cross members 8, formed from the same size stock as the members 7, and are rigidly connected to the latter by welding, or the like to define a square opening in which is positioned a guide sleeve 9, the latter being secured in position by welding, or if desired, may be removably mounted by means of bolts, or the like passing through the adjacent frame members 7 and 8.

Slidably positioned in the sleeve 9 is a re-

reciprocable work member 11, corresponding to the usual extension of the common punch press, which is cylindrical in shape and connected to the piston rod 12 by a screw 13 having a shank 14 threaded into the work member 11, the opposite end of the screw 13 terminating in an internally threaded head 14 into which is threaded the end 15 of the piston rod 12. The latter in turn is operatively connected to a piston 16 of a suitable air cylinder indicated generally by the numeral 17, which is rigidly secured to the upper plate 3 of the supporting structure, and is provided with air ports 18 and 19 communicating respectively with the air cylinder above and below the piston 16. The air cylinder 17 may be of any suitable type and readily procured on the open market, consequently the details thereof form no part of the present invention. The work member 11 is securely held in position relative to the screw 13 by any suitable means such as a lock nut 21.

For the purposes of illustration, a die set, indicated generally by the numeral 22, is illustrated in Fig. 1 and comprises a lower die element 23 mounted on the bed plate 24 carried by the plate 4, and an upper die element 25 operatively connected to the ram 26 carried by the lower end of the extension member 11. The lower die element 23 may be provided with the usual leader pins 27 passing through bores in the upper die element 25 for maintaining the same in alignment throughout the punching operation. Likewise, the lower die element 23 may be provided with a bore 28 through which punched articles may pass, in which case the bed member 24 and plate 4 likewise may be provided with openings for permitting the stamping to pass therethrough. Obviously, these details of construction will depend to a great extent on the character of the operations to be performed on the machine.

Carried by the members 7 and 8 are a plurality of retard members, each indicated generally by the numeral 31. Each member comprises a stationary base 32 having a base portion formed by the block 32a, side walls formed by the blocks 32b, an end wall formed by the block 32c, and opposed flange or shoulder portions 33 formed by the blocks 32d positioned on the blocks 32b. In the embodiment of the invention illustrated, the members 32a, b, c and d, are secured together by screws 34 connecting the respective members. It will be apparent, however, that the base member 32 may be constructed from a single piece of material if desired, rather than in the assembled form as illustrated. The members 31 are secured to the respective cross members 7 and 8 by screws 35 extending through the base portion 32a into the respective member 7 or 8, as the case may be.

Slidably positioned between the blocks 32b and 32d is a retard block 36, the lower portion of the block 36 being provided with shoulders 37 slidably engaging the adjacent overhanging surfaces of the shoulders 33 formed by the blocks 32d, thereby restricting the movement of the block 36, other than in a longitudinal direction. Threaded into the end wall formed by the block 32c is a sleeve 38 adapted to be held in position by a lock nut 39, and threaded into the block 36 and extending through the sleeve 38 is an adjusting stud 40, having lock nuts 41 threaded on the free end thereof and engageable with the free end of the sleeve 38 to limit movement of the block 36 in a direction away from the end wall

formed by the member 32c. The block 36 is urged in the latter direction by a spring 42 encircling the stud 40 and seated at its respective ends on the block 35 and the inner end of the sleeve 38. Thus, by adjusting the sleeve 38 relative to the base 32, and the nuts 41 on the stud 40, the outward travel of the block 36 may be limited and the biasing pressure exerted by the spring 42 on the block 36 may be readily varied as required.

The blocks 36, are each provided with a small bore 43 opening on the exposed end 44 of the block, the axis of the respective bores extending at an angle of approximately 30° with respect to the axis of the extension 11, which in the construction illustrated is vertical. As clearly illustrated in Fig. 3, the lower surface of the bore 43 adjacent the mouth 45 of the bore is flat, as indicated at 46. Positioned in the bore 43 is a ball 47 adapted to rest upon the flat surface 46 and partially extend through the mouth 45 of the bore 43, the ball being biased in this position by a suitable spring 48, seated at one end upon the ball and at the other end upon a cap member 49 threaded or otherwise secured to the block 36.

Referring to Fig. 3, it will be apparent that a downward force applied to the portion of the ball 47 extending from the mouth 45 of the bore 43 will lock the ball in position so that it is in effect a rigid part of the block 36 while such force is so applied thereto. On the other hand, if an upward force is applied to the extending portion of the ball, such force, upon overcoming the biasing pressure of the spring 48, will move the ball upwardly into the bore 43.

As illustrated in Fig. 1, the work member or extension 11, is provided with a shoulder or cam surface 51. By adjusting the blocks 36, the latter may be so positioned with respect to the path of the shoulder 51, that the latter will engage the portions of the respective balls 47 extending from the blocks 36, as the member 11 is moved downwardly in a power stroke. This engagement of the shoulder 51 with the balls 47 will momentarily retard or impede the downward movement of the work member 11 and piston 16 until the force exerted on the member 11 is sufficient to retract the pressure exerted on the blocks 36 by their respective springs 42, the pressure required being dependent upon the adjustment of the sleeve 38. Obviously, as soon as the blocks 36 have moved outward or rearward sufficiently to permit the cylindrical surface 52 of the member 11 to pass between the balls 47, the member 11 will be free to continue its downward movement to the end of its stroke, and by varying the relationship between the member 11 and screw 13, the point along the power stroke at which the shoulder 51 will engage the balls 47 may likewise be varied so that this point of engagement may occur anywhere along the power stroke.

Fig. 5 illustrates one form of circuit that may be employed to control the device, in which the ports 18 and 19 of the air cylinder 17 are operatively connected to a pressure air line 53 and an exhaust line 54, through a four way valve indicated generally by the numeral 55, the latter being of common construction and readily procurable on the open market. The valve 55 is connected to the port 18 through a conduit 56 and to the port 19 by a conduit 57, a three way valve indicated generally by the numeral 59 being interposed in the line 57, if desired, for purposes which will hereinafter be described. In the con-

struction illustrated in Fig. 5, the valve 55 is of the electrically operated type, being actuated from one position to another by solenoids 61 and 62, diagrammatically illustrated. The construction is such that when the solenoid 61 is energized, port 18 and the upper end of the air cylinder 17 will be connected to the pressure air line 53, while port 19 and the lower end of the air cylinder 17 will be operatively connected to the exhaust line, thus driving the piston 16 downwardly. Similarly, when the solenoid 62 is energized, it will reverse the valve 55 to connect the port 18 with the exhaust line 54 and air pressure line 53, thereby reversing the travel of the piston 16. The particular valve 55 illustrated, is of the type in which the energization of the solenoids 61 and 62 are required only in actuating the valve, and the latter will remain in either position when the solenoids are de-energized until the valve mechanism is reversed by the action of the proper solenoid. Obviously, if another form of valve is employed, the electrical circuit could be varied accordingly to provide proper operation thereof. One side of each solenoid is connected by a conductor 63 to one side 64 of a power line, the other side of the solenoid 61 being connected by a conductor 65 to the stationary contact 66 of a single pole single throw switch indicated generally by the numeral 67, the movable contact 68 of the switch 67 being connected by a conductor 69 through a master switch 71 to the other side of the power line, so that when the contacts 66 and 68 are closed, and the master switch 71 is closed, the solenoid 61 will be energized. In like manner, the other end of the solenoid 62 is connected by a conductor 73 to the stationary contact 74 of a single pole double throw switch indicated generally by the numeral 75, the movable contact 76 of the switch 75 being connected to the conductor 69. As illustrated in Fig. 1, the switches 67 and 75 are rigidly supported relative to the frame structure 1 by any suitable means, as for example, a bracket 77, rigidly connected to the air cylinder 17. The switches 67 and 75 are adapted to be actuated by a projection 79 rigidly mounted, in the present instance, on the head 14 of the screw 13, the projection 79 being engageable with the actuating levers L of the respective switches during reciprocation of the piston 16. The switches 67 and 75 are preferably adjustably mounted on the bracket 77, whereby the switches may be moved vertically along the bracket and securely locked in any desired vertical position, the adjustable mounting of the switches being accomplished by any suitable means such as providing slots in the bracket through which the mounting screws 78 of the respective switches may extend, so that by loosening the screws 78 the switches may be moved vertically up and down and locked in place by retightening the screws.

The operation of the pneumatic and electrical circuit thus far described is as follows:

Assuming the valve 55 is set to admit air into the upper end of the air cylinder 17 and exhaust it from the lower end thereof, the piston 16 and associated elements will move downwardly until the projection 79 closes the contacts 74 and 76 of the switch 75, thereby energizing the solenoid 62, reversing the valve 55 to admit air into the lower end of the cylinder 17 and exhaust air from the top end thereof, whereby the piston 16 and associated elements will move upwardly. This upward movement will continue until the projection 79 closes the contacts 66 and 68 of the switch 67, energizing the solenoid 61 to reverse the valve 55 to its original position and repeat

the cycle of operation. The device may be controlled by the master switch 71 as well as by a master valve 81 in the air line 53.

It may oftentimes be desirable to provide a cushioning effect at the lower or terminating end of the power stroke, and this can be accomplished, for example, by inserting the three way valve 59 in series with the conductor 57 into the port 19 and lower end of the air cylinder 17. The third side of the valve 59 is connected to the pressure air line 53 through a conduit 82, a valve 83 being interposed in the latter line. For illustrative purposes, it will be assumed that the three way valve 59 is of the spring biased single solenoid type, commercially procurable and adapted to be actuated by the solenoid winding 84, the valve being so connected that when the solenoid winding 84 is de-energized the port 19 is directly connected with the valve 55 and air from the pressure line 53 is cut off. However, when the solenoid winding 84 is energized, the port 19 is cut off from the valve 55 and connected through the conduit 82 and valve 83 to the pressure line 53.

The electrical wiring for the valve 59 is as follows:

One side of the solenoid winding 84 is connected by a conductor 85 to the side 64 of the power line, and the other side of the winding 84 is connected by a conductor 86 to the stationary contact 87 of the normally open relay, indicated generally by the numeral 88, the latter having an actuating winding 89, one side of which is connected by the conductor 91 to the side 64 of the power line, and the other side of the winding 89 connected to the contact 92. Contact 92 is also connected by a conductor 93 to contact 94 of the switch 95, the other contact 96 of the switch 95 being connected by conductor 97 to the contacts 98 and 99 of the relay 88 and to the other stationary contact 101 of the switch 75. The contacts 92 and 99 of the relay 88 are lock-in contacts serving to maintain the relay 88 energized until the circuit is broken elsewhere. It will be noted that when the contacts 76 and 101 of the switch 75 are closed, contacts 98 and 99 of the relay 88 are connected to the side 72 of the power line, and when the contacts 94 and 96 of the switch 95 are closed under such conditions, the relay 88 will be energized and locked in by the contacts 92 and 99 so that it will remain energized until the contacts 76 and 101 are broken, following which the relay 88 will not be energized until contacts 76 and 101 of the switch 75 and contacts 94 and 96 of the switch 95 are both closed. Obviously, when the relay 88 is energized contacts 87 and 98 will be closed, energizing solenoid winding 84 of the valve 59.

In the circuit illustrated in Fig. 5, the switch 95 may be actuated by any suitable means, as for example, one of the blocks 36, as illustrated in Fig. 3, wherein the switch 95 may be mounted on the blocks 32d by the same screws 34 that secure the latter to the blocks 32b, the switch 95 being preferably slidably mounted so that it may be longitudinally adjusted. Rigidly carried by the cooperating block 36 is a projection 102 adapted to engage the actuating pin or member 103 of the switch 95 to actuate the switch 95 when the block 36 is moved toward the same. Thus, the switch 95 may be so adjusted, with respect to the block 36, that the valve 59 will be actuated at substantially the same time the work member 11 begins its accelerated downward movement after having been retarded by engagement of the shoulder 51 with the balls 47 carried by the blocks 36. The amount of air admitted to the lower end of the cylinder when the

valve 59 is actuated may be controlled by the valve 83, thus controlling the cushioning effect to be achieved.

The automatic operation of the entire circuit is as follows:

Assuming the valve 55 is in a position to actuate the piston 16 in a power stroke, the work member 11 will move downwardly until the shoulder 51 engages the balls 47, thus momentarily retarding the downward movement of the member, and blocks 36, and as they are spread, as a result of the additional force by the continued downward movement of the member 11, switch 95 will be closed, and as contacts 101 and 76 of the switch 75 are closed, closing of the switch 95 will actuate relay 88, energizing the winding 84 to actuate the valve 59, the amount of air admitted to the lower end of the piston 16 being dependent upon the setting of the valve 83 to achieve the desired cushioning effect. As the member 11 nears the end of its downward travel, switch 75 will be actuated by engagement of the projection 79 with the actuating lever L of the switch closing contacts 74 and 76 to reverse the valve 55, at the same time breaking the contacts 76 and 101, thereby de-energizing relay 88 and the winding 84 of the valve 59 to reverse the same. Full air pressure is thereby applied to the lower end of the cylinder 17 reversing the travel of the piston 16 and work member 11 to move the same through a return stroke, which will continue until the projection 79 engages the actuating arm L of the switch 67 closing the contacts 66 and 68 to actuate the winding 61, reverse valve 55 and the flow of air to the air cylinder 17, and initiate another power stroke.

It will be apparent that while I have illustrated the cushioning action as being controlled by movement of one of the blocks 36, obviously the actuation of the switch 95 may be synchronized with the movement of the work member 11 by other suitable means, as for example, by direct actuation by means carried by the work member 11, or associated elements.

It will be noted from the above description that I have produced a novel punch press, or the like, which may be relatively small in size and at the same time very efficient for the purposes intended.

Having thus described my invention, it is obvious that various immaterial modifications may be made in the same without departing from the spirit of my invention; hence, I do not wish to be understood as limiting myself to the exact form, construction, arrangement and combination of parts herein shown and described or uses mentioned.

What I claim as new and desire to secure by Letters Patent is:

1. In a pneumatic punch press, the combination of an adjustable reciprocable work member of the punch press, a pneumatic actuating unit including an air cylinder and a cooperable piston, means operatively connecting said piston and member for transmitting motion from the former to the latter, valve means for controlling the flow of air to and from said cylinder, means responsive to movement of said member for actuating said valve means to reciprocate said member through a power stroke of a predetermined length and a return stroke, said adjustable reciprocable work member having a cam surface thereon permitting adjustment thereof with respect to the length of the stroke of the reciprocable work member, a retard member movable

with respect to said cam surface and having a yieldable element thereon, and means for urging said retard member toward and the yieldable element into the path of the cam surface on said reciprocable member, said yieldable element being temporarily rigid relative to said retard member and momentarily retarding movement of the work member during an intermediate fraction of a power stroke for increasing the effective impact force of the work member, and yieldable relative to said retard member during a return stroke to permit unrestricted return movement of said reciprocable work member.

2. In a pneumatic punch press, the combination of a reciprocable work member of the punch press, a pneumatic actuating unit including an air cylinder and a cooperable piston, adjustable means operatively connecting said piston and member for transmitting motion from the former to the latter, valve means for controlling the flow of air to and from said cylinder to reciprocate said member through a power stroke of a predetermined length and a return stroke, said member having a cam surface thereon and said adjustable means permitting adjustment of the position of the cam with respect to the length of the stroke of the reciprocable work member, a retard member movable with respect to said cam surface and having a yieldable element carried thereby, and means for urging said retard member toward and the yieldable element into the path of the cam surface on said reciprocable member, said yieldable element being temporarily rigid relative to said retard member and momentarily retarding movement of said reciprocable work member during an intermediate fraction of the power stroke prior to the work-engaging positioning of said member for increasing the effective impact force of the work member, and yieldable relative to said retard member during a return stroke to permit unrestricted return movement of said reciprocable work member.

3. In a device of the kind described, the combination of a supporting structure, a reciprocable work member slidably mounted in said structure, a pneumatic actuating unit including an air cylinder and a cooperable piston carried by said structure, means operatively connecting said piston and member for transmitting motion from the former to the latter, electrically operable valve means for controlling the flow of air to and from said cylinder, switch means responsive to predetermined movement of said member for actuating said valve means to reciprocate said member through a power stroke of a predetermined length and a return stroke, said member having a cam surface thereon, a retard member supported by said structure and movable transversely with respect to the path of said member, said retard member having a ball carried thereby, means for urging said retard member toward and said ball into the path of the cam surface on said reciprocable member, and a spring for biasing said ball in a position to maintain the same rigid relative to said retard member, and momentarily retard movement of the reciprocable work member during a power stroke, said spring being yieldable to allow movement of said ball relative to said retard member during a return stroke and permit unrestricted return movement of said reciprocable work member.

4. In a pneumatic punch press, the combination of a reciprocable work member, a pneumatic actuating unit including an air cylinder and a

cooperable piston, means operatively connecting said piston and member for transmitting motion from the former to the latter, electrically operable valve means for controlling the flow of air to and from said cylinder, switch means responsive to movement of said member for actuating said valve means, to reciprocate said member through a power stroke of a predetermined length and a return stroke, said member having a cam surface thereon, a retard member movable with respect to said cam surface, and spring means for urging said retard member into the path of the cam surface on said reciprocable member for momentarily retarding movement of the latter during a predetermined intermediate fraction of the power stroke thereof prior to the work engaging positioning of said member for increasing the effective impact force of the work member.

5. In a pneumatic punch press, the combination of a reciprocable work member, a pneumatic actuating unit including an air cylinder and a cooperable piston, means operatively connecting said piston and member for transmitting motion from the former to the latter, electrically operable valve means for controlling the flow of air to and from said cylinder, switch means responsive to movement of said member for actuating said valve means to reciprocate said member through a power stroke of a predetermined length and a return stroke, and means for momentarily retarding said member during an intermediate fraction of the power stroke prior to the work engaging positioning of said member.

6. In a pneumatic punch press, the combination of a reciprocable work member of the punch press, a pneumatic actuating unit including an air cylinder and a cooperable piston, adjustable means operatively connecting said piston and member for transmitting motion from the former to the latter, valve means for controlling the flow of air to and from said cylinder, means responsive to movement of said member for actuating said valve means to reciprocate said member through a power stroke of a predetermined length and a return stroke, said member having a cam surface thereon, a retard member movable with respect to said cam surface, and means for urging said retard member into the path of the cam surface on said reciprocable member to momentarily retard movement of the latter for an intermediate fraction of a power stroke thereof prior to the work engaging positioning of said member to increase the effective impact force of the work member.

7. In a device of the kind described, the combination of a supporting structure with a reciprocable work member slidably mounted in said structure, a pneumatic actuating unit including an air cylinder and a cooperable piston carried by said structure, means operatively connecting said piston and member for transmitting motion from the former to the latter, electrically operable valve means for controlling the flow of air to and from said cylinder, switch means responsive to predetermined movement of said member for actuating said valve means to reciprocate said member through a power stroke of a predetermined length and a return stroke, said member having a transversely extending cam surface thereon, a plurality of retard members, each supported by said structure and movable transversely with respect to the path of said member, each retard member having a ball carried thereby, means for urging the respective retard members

toward and their corresponding balls into the path of the cam surface on said reciprocable member, and springs for biasing the respective balls in a position to maintain the same rigid relative to their respective retard members, and simultaneously momentarily retard movement of the reciprocable work member during a power stroke, said springs being yieldable to allow movement of said balls relative to their respective retard members during a return stroke and permit unrestricted return movement of said reciprocable work member.

8. In a pneumatic punch press, a reciprocable work member, means including a pneumatic actuating element for reciprocating said member through a power stroke and a return stroke, pressure biased means for retarding movement of said member for a predetermined intermediate fraction of the power stroke thereof until the actuating element overcomes said biasing pressure to increase the effective impact force of the work member, and means for applying a counterpneumatic force on said member to cushion the same at the end of a power stroke.

9. In a pneumatic punch press, a reciprocable work member of the punch press, means including a pneumatic actuating element for reciprocating said member through a power stroke and a return stroke, adjustable means operatively connected to said work member to momentarily retard movement of said member for a predetermined fraction of the power stroke to increase the effective impact force of said member, and means for applying a counterpneumatic force on said member to cushion the same at the end of a power stroke.

10. In a pneumatic punch press, a reciprocable work member of the punch press, means including a pneumatic actuating element for reciprocating said member through a power stroke and a return stroke, adjustable pressure-biased means operatively connected to said reciprocable work member to retard movement of said member during the power stroke of said pneumatic actuating element until the actuating element overcomes said biasing pressure to increase the effective impact force of the work member, and means for applying a counterpneumatic force on said member to cushion the same at the end of a power stroke controlled by said adjustable pressure-biased means.

11. In a pneumatic punch press, the combination of a pneumatic cylinder, including a piston and having a pair of ports communicating with respective opposite sides of said piston, electrically energized valve means for controlling the admission of air into the cylinder, switch means responsive to movement of said piston for actuating said valve to effect reciprocation of said piston through a power stroke and a return stroke and means operatively connected to the piston to momentarily retard movement of the piston as the latter moves in a power stroke to increase the impact force of the work member.

12. In a pneumatic punch press, the combination of a reciprocable work member of the punch press, a pneumatic actuating unit including an air cylinder and a cooperable piston, means operatively connecting said piston and member for transmitting motion from the former to the latter, solenoid operated valve means for controlling the flow of air to and from said cylinder, switch means operatively connected to said valve means and responsive to movement of said member for actuating said valve means to reciprocate said

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member through a power stroke of a predetermined length and a return stroke, and means operatively connected to said reciprocable work member to momentarily retard said member during a fraction of the power stroke prior to the work engaging positioning of said member.

13. In a pneumatic punch press, a reciprocable work member of the punch press, means including a pneumatic actuating element for reciprocating said member through a power stroke and a return stroke, adjustable spring biased means operatively connected to said reciprocable work member during a predetermined part of the power stroke to momentarily retard movement of said member during the power stroke thereof to increase the effective impact force of the work member, and means for applying a counter-force to said member as the latter approaches the end of a desired power stroke operatively controlled by said adjustable spring biased means.

14. In a pneumatic punch press, a reciprocable work member of the punch press, means including a pneumatic actuating element for reciprocating said member through a power stroke and a return stroke, spring biased means operatively connected to said reciprocable work member during a predetermined part of the power stroke to momentarily retard movement of said member during the power stroke thereof to increase the effective impact force of the work member, and means comprising electrically energized valve means and switch means therefor controlled by movement of said retarding means for applying a counter-force to said member as the latter approaches the end of a desired power stroke.

15. In a pneumatic punch press, the combination of a reciprocable work member, a pneumatic actuating unit including an air cylinder and a cooperable piston, means operatively connecting said piston and member for transmitting motion from the former to the latter, valve means for controlling the flow of air to and from said cylinder, means responsive to movement of said member for actuating said valve means to reciprocate said member through a power stroke of a predetermined length and a return stroke, said member having a cam surface thereon, a retard member movable with respect to said cam surface and having a yieldable element thereon, means for urging said retard member toward the yieldable element into the path of the cam surface on said reciprocable member, said yieldable element being rigid relative to said retard member for momentarily retarding movement of the latter during a power stroke to increase the effective impact force of said work member, and yieldable relative to said retard member during a return stroke to permit unrestricted return movement of said reciprocable work member, and means for admitting a counter-flow of air to said cylinder as the reciprocable arm approaches the end of a power stroke.

16. In a device of the kind described, the combination of a reciprocable work member, a pneumatic actuating unit including an air cylinder and a cooperable piston, means operatively connecting said piston and member for transmitting motion from the former to the latter, valve means for controlling the flow of air to and from said cylinder, means responsive to movement of said member for actuating said valve means to reciprocate said member through a power stroke of a predetermined length and a return stroke, said member having a cam surface thereon, a retard member movable with respect to said cam sur-

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face and having a yieldable element thereon, means for urging said retard member toward the yieldable element into the path of the cam surface on said reciprocable member, said yieldable element being rigid relative to said retard member for momentarily retarding movement of the latter during a power stroke, and yieldable relative to said retard member during a return stroke to permit unrestricted return movement of said reciprocable work member, and means controlled by movement of said retard member for admitting a counter-flow of air to said cylinder as the reciprocable arm approaches the end of a power stroke.

17. In a device of the kind described, the combination of a reciprocable work member, a pneumatic actuating unit including an air cylinder and a cooperable piston, means operatively connecting said piston and member for transmitting motion from the former to the latter, valve means for controlling the flow of air to and from said cylinder, means responsive to movement of said member for actuating said valve means to reciprocate said member through a power stroke of a predetermined length and a return stroke, means for momentarily retarding said member during the power stroke prior to the work engaging positioning of said member, a second valve means for admitting a counter-flow of air to said cylinder, and means coordinated with the movement of said retarding means for actuating said second valve, and means to admit such counter-flow of air to said cylinder as the latter approaches the end of a power stroke.

18. In a device of the kind described, the combination of a supporting structure, a reciprocable work member slidably mounted in said structure, a pneumatic actuating unit including an air cylinder and a cooperable piston carried by said structure, means operatively connecting said piston and member for transmitting motion from the former to the latter, electrically operable valve means for controlling the flow of air to and from said cylinder, switch means responsive to predetermined movement of said member for actuating said valve means to reciprocate said member through a power stroke of a predetermined length and a return stroke, said member having a cam surface thereon, a retard member supported by said structure and movable transversely with respect to the path of said member, said retard member having a bore therein extending at an angle of approximately 30° to the axis of said reciprocable member in the general direction of return movement of the latter, a ball positioned in said bore, means for urging said retard member toward, and said ball into the path of the cam surface on said reciprocable member, and a spring for biasing said ball in a direction toward said reciprocable member to maintain the ball rigid relative to said retard member, and momentarily retard movement of the reciprocable work member during a power stroke, said spring being yieldable to allow movement of said ball relative to said retard member during a return stroke and permit unrestricted return movement of said reciprocable work member.

19. A compressible-fluid punch press including in combination a reciprocable work member of the punch press, a compressible-fluid actuated unit including a cylinder and co-operable piston, means operatively and adjustably connecting said piston and member for transmitting motion from the former to the latter, and spring-biased

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means operatively connected to said reciprocable work member to momentarily retard said member prior to the work-engaging positioning of said member for an intermediate fraction of the power stroke thereof.

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