Sept. 30, 1969 T. F. BROLUND 3,469,487

PRESS WITH FLUID-OPERATED ACTUATOR

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Fig. 1

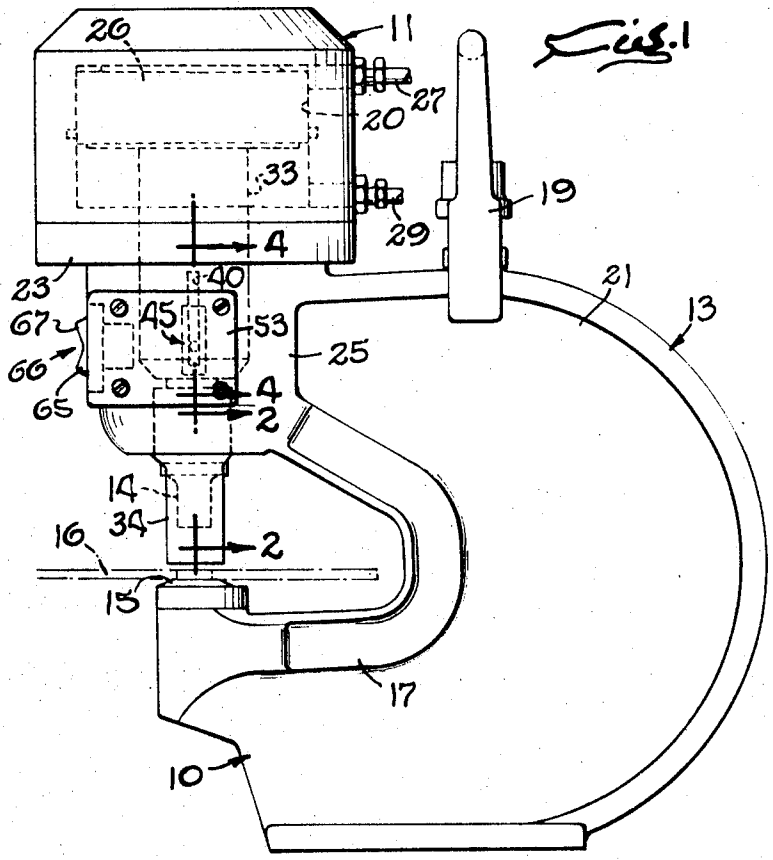


Fig. 2

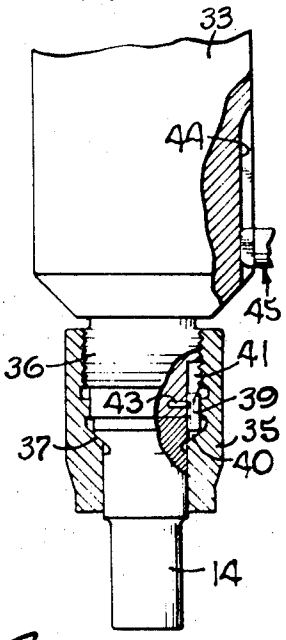
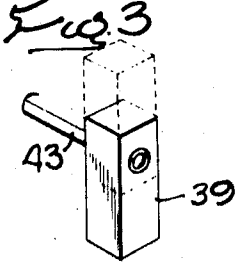


Fig. 3



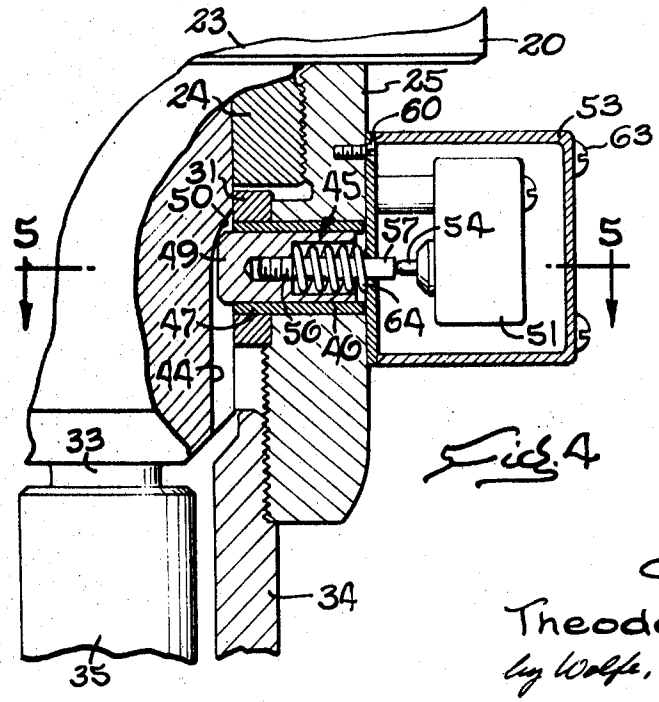


Fig. 4

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Fig. 5

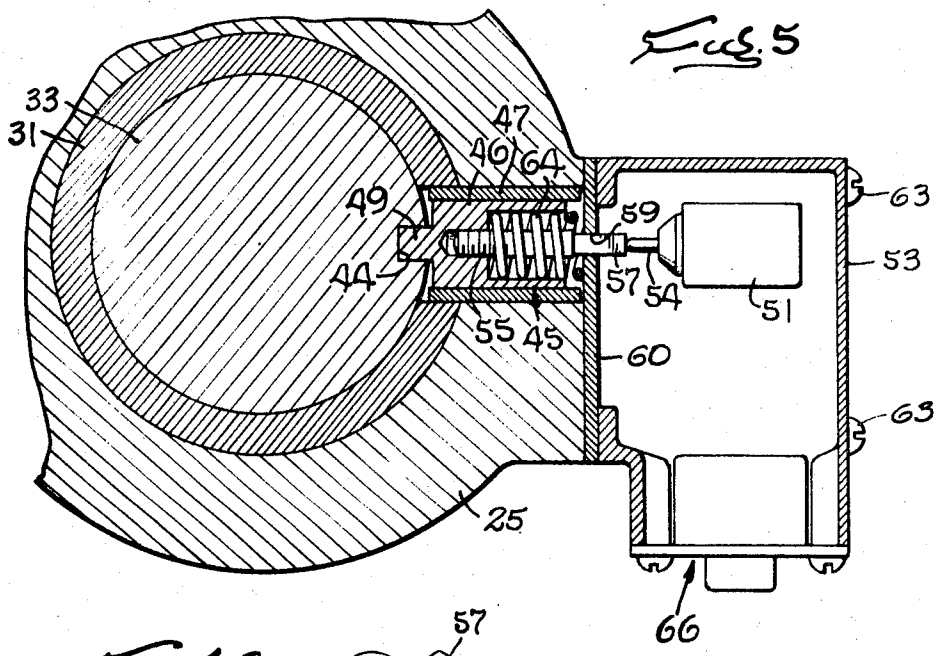


Fig. 6

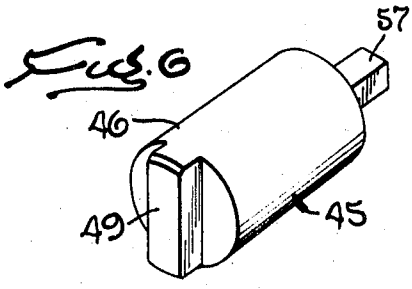


Fig. 7

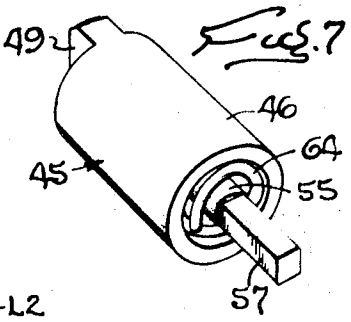
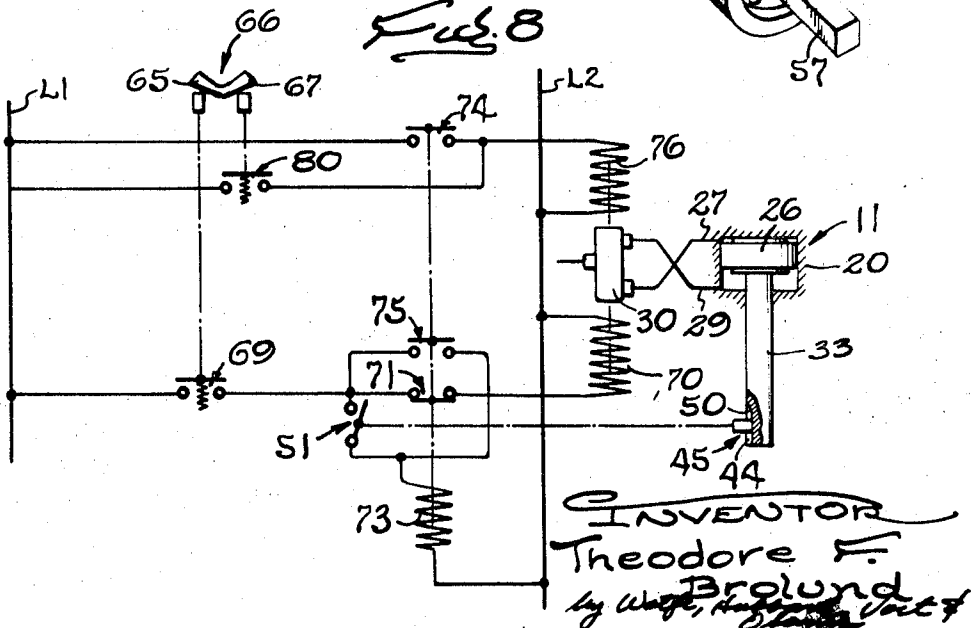


Fig. 8



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United States Patent Office 3,469,487
Patented Sept. 30, 1969

3,469,487

PRESS WITH FLUID-OPERATED ACTUATOR

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Filed Oct. 4, 1967, Ser. No. 672,831
Int. Cl. B26d 5/12
U.S. Cl. 83—527 8 Claims

ABSTRACT OF THE DISCLOSURE

For reciprocating a tool element of a punch press, a fluid-operated actuator includes a cylinder, a piston slidable up and down in the cylinder in response to the admission of pressure fluid alternately into opposite ends of the cylinder, and a ram anchored at one end to the piston and attached at its opposite end to the tool element. A key slidable radially in a sleeve surrounding and guiding the ram holds the latter in a fixed angular position relative to the sleeve and is slid outwardly of the sleeve by the ram as the piston approaches the bottom of the cylinder. Movement of the key is detected by a limit switch which controls the flow of pressure fluid to the cylinder and commands reversal of the direction of movement of the piston before the piston engages the bottom of the cylinder and causes an overload of the components of the fluid actuating system of the actuator. The key may be lengthened or shortened so as to actuate the switch at any predetermined point in the downstroke of the piston thereby to enable selective adjustment of the length of stroke of the tool element.

Background of the invention

This invention relates to a press having a reciprocating tool element for performing machining operations on workpieces and, more particularly, to a press of the type in which the tool element is connected to and reciprocated by a fluid-operated actuator having a piston slidable back and forth in a cylinder in response to the admission of pressure fluid into the cylinder. To insure accurate machining of the workpiece, the tool element usually is held in a fixed angular position with respect to the workpiece by keying the piston relative to the cylinder in a manner that prevents turning of the piston and the tool element while still permitting the desired back and forth reciprocation of the two.

Summary of the invention

The primary aim of the present invention is to utilize the same key which prevents turning of the piston for also limiting the stroke of the piston in order to prevent the piston from "bottoming" against the end of the cylinder and causing application of the full fluid force of the actuating system to the cylinder. More specifically, limitation of the stroke of the piston with the key is accomplished by mounting the key for movement relative to the piston, by moving the key automatically as the piston approaches the end of its stroke, and by relying on such movement to control the flow of pressure fluid to the cylinder and to stop the piston short of the end of the cylinder. Other objects are to enable adjustment of the length of the stroke of the piston through a simple adjustment of the key; to provide for automatic reversal of

the direction of movement of the piston at one end of its stroke together with selective termination of the movement of the piston at the other end of its stroke; and to fasten the tool element to the fluid actuator in a novel manner facilitating the use of the same actuator with different types of tool elements.

Brief description of the drawings

FIG. 1 is a side elevation of a press embodying the novel features of the present invention.

FIG. 2 is an enlarged fragmentary cross-section taken substantially along the line 2—2 of FIG. 1.

FIG. 3 is an enlarged perspective view of parts shown in FIG. 2.

FIG. 4 is an enlarged fragmentary cross-section taken substantially along the line 4—4 of FIG. 1.

FIG. 5 is an enlarged fragmentary cross-section taken substantially along the line 5—5 of FIG. 4.

FIG. 6 is a perspective view of the key as viewed from one end of the key.

FIG. 7 is a perspective view of the key as viewed from the opposite end of the key.

FIG. 8 is a schematic view of electric and fluid circuits for controlling the fluid actuator.

Description of the preferred embodiment

As shown in the drawings for purposes of illustration, the invention is embodied in a portable press **10** having a fluid-operated actuator **11** supported on a C-shaped frame **13** and operable to reciprocate a movable tool element **14** through advance and return strokes relative to a fixed tool element **15** on the frame and cooperating with the movable tool element to perform a machining operation on a workpiece **16** such as a piece of sheet metal disposed between the two elements. Herein the fixed tool element is a female die supported on a lower arm **17** of the frame and vertically alined with the movable tool element which is a punch adapted to telescope downwardly into the die and punch out rectangular holes in the workpiece on the downstroke of the actuator. The press is suspended from a grapple **19** (FIG. 1) of an overhead crane (not shown) and may be moved to various positions within the work area to operate on different workpieces or on different portions of the same workpiece.

As shown most clearly in FIG. 1, the fluid-operated actuator **11** includes a cylinder **20** disposed above an upper arm **21** of the frame **13** and formed on its bottom wall **23** with a tubular fitting **24** (FIG. 4) which is threaded into an overhanging sleeve **25** on the free end of the upper arm. The cylinder slidably receives a piston **26** adapted for up and down reciprocation in the cylinder in response to the admission of pressure fluid to the cylinder alternately on opposite sides of the piston through conduits **27** and **29** communicating through a four-way control valve **30** (FIG. 8) with a suitable pressure source (not shown) for supplying oil to the cylinder at a pressure of approximately 5,000 p.s.i. Anchored to the lower end of the piston and guided for vertical reciprocation in the fitting and in a ring **31** (FIGS. 4 and 5) disposed in the sleeve is a piston rod or ram **33** to which the punch **14** is connected. The usual stripper **34** (FIG. 4) is threaded into the lower end of the sleeve to limit upward movement of the workpiece **16** on the return stroke of the punch.

To attach the punch **14** to the ram **33**, the punch is

telescoped loosely into a coupling nut 35 (FIG. 2) which is threaded at its upper end onto a cylindrical neck 36 formed on the lower end of the ram. As the nut is tightened, mating tapers 37 on the nut and the punch engage one another to draw the upper end of the punch into tight abutment with the lower end of the neck. Angular movement of the punch relative to the ram is prevented by a key 39 of square cross-section fastened to the neck with its free end projecting axially into a complementary keyway 40 (FIG. 2) formed in the punch. Accordingly, the punch is held against turning within the nut thereby to insure proper orientation of the rectangular holes in the workpiece 16. Advantageously, the key is disposed within a recess 41 within the neck and is fastened to the latter by a radially extending roll pin 43 (FIGS. 2 and 3) made of resilient material and pressed into a hole in the neck.The pin is offset from the vertical center of the key and thus, by turning the key about the axis of the pin through an angle of 180° as shown in phantom in FIG. 3, the free end of the key may be swung out of projecting relation with the lower end of the neck and into an inactive position in which the entire pin is disposed within the recess 41. As a result, the ram may be adapted quickly and easily for attachment to those types of tools which are not formed with keyways for receiving the key. Because of its resilience, the pin 43 holds the key securely in both active and inactive positions.

To promote accurate orientation of the holes in the workpiece 16, the punch 14 not only must be held in a fixed angular position with respect to the ram 33, but the ram and the piston 26 also must be held in fixed angular positions within the sleeve 25 and the cylinder 20, respectively, to prevent turning of the punch. For this purpose, the ram is formed along one side with an axially extending keyway 44 (FIG. 4) which slidably interfits with a key 45 disposed within the sleeve. The key prevents rotation of the ram and the piston while permitting the necessary reciprocation of the two for advancing and retracting the punch.

In accordance with the present invention, the same key 45 for preventing rotation of the ram 33 is used advantageously to limit the stroke of the piston 26 and to stop the piston short of the bottom wall 23 of the cylinder 20 thereby to avoid the full application of fluid pressure on the piston together with a resulting overload of the components of the fluid-actuating system for the actuator 11. To these ends, the key is movably mounted relative to the sleeve 25 and is moved through a short distance each time the piston approaches the bottom wall of the cylinder. Such movement of the key is detected and is utilized to control the flow of pressure fluid to the cylinder in order to stop downward movement of the piston before the latter reaches the bottom wall of the cylinder. Accordingly, the build-up of extremely high pressure within the cylinder and the actuating system and the application of the full fluid force to the cylinder are prevented thereby significantly increasing the service life of the press 10.

More specifically, the key includes a generally cylindrical body 46 extending radially through the sleeve 25 and the ring 31 and mounted for in and out sliding in a bushing 47 (FIG. 4) fixed within a hole in the sleeve. At its inner end, the body of the key is formed with an ear 49 sized and shaped to interfit slidably with the keyway 44 in the ram 33. As shown most clearly in FIG. 4, the upper end portion of the bottom of the keyway is curved upwardly and outwardly to form an inclined cam or operating surface 50 which engages the upper side of the ear as the piston 26 approaches the bottom wall 23 of the cylinder 20, and thereafter slides the key outwardly relative to the sleeve 25 through progressively greater distances as the piston moves progressively nearer to the bottom wall.

For sensing the sliding movement of the key 45 and for controlling the flow of pressure fluid to the cylinder 20, a limit switch 51 (FIGS. 4, 5 and 8) is housed within a walled casing 53 attached to the outer side of the sleeve 25 and includes a button-type operator 54 disposed in the path of sliding of the key. After the key has been cammed outwardly through a predetermined distance, the outer end of the key depresses the switch operator to close the switch. Closure of the switch results in shifting of the control valve 30 in a position terminating the flow of pressure fluid to the head end of the cylinder. Accordingly, the downward stroke of the piston 26 is stopped automatically before the piston reaches the bottom wall 23 of the cylinder.

Provision is made to adjust the length of the downstroke of the piston 26 by adjusting the effective length of the key 45. For example, after shortening of the key, the latter must be slid through a greater distance to close the limit switch 51, and thus the piston must move downwardly through a longer stroke before a sufficient length of the inclined cam surface 50 engages the key to slide the key through such greater distance. Conversely, if the key is lengthened, the limit switch will be closed after the key has been slid through a relatively short distance as a result of engagement with only the initial portion of the cam surface while the piston is still considerably short of the bottom wall 23 of the cylinder.

In the present instance, adjustment of the length of the key 45 is accomplished by forming the key as two relatively adjustable parts, namely, the body 46 and a plunger 55 (FIGS. 4 and 7). The latter is simply a cylindrical stem whose one end 56 is threaded into a hole in the body 46 and whose other end 57 projects outwardly through the sleeve and is alined with the switch operator 54 to close the switch 51 in response to sliding of the key. By manually threading the plunger into and out of the body, the effective length of the key may be decreased and increased, respectively, to enable closure of the switch precisely when the ram 33 and the piston 26 have reached a desired position in their downward stroke. As a result, the stroke of the punch 14 can be shortened or lengthened selectively in accordance with the thickness and particular characteristics of the workpiece 16 being machined.

To prevent the plunger 55 from accidentally turning relative to the key body 46 during a punching operation, the outer end 57 of the plunger is squared as shown in FIG. 7 and projects through asquare hole 59 (FIG. 5) formed in a cover plate 60 sandwiched between the casing 53 and the sleeve 25 and releasably fastened to the latter by screws 61 (FIG. 4). When it is desired to change the effective length of the key 45, the cover plate may be removed to enable turning of the plunger after first gaining access to the plate and the plunger by releasing screws 63 detachably holding the casing on the sleeve. Preferably, a coil spring 64 (FIG. 5) is telescoped over the plunger and into a bore in the key body 46 and is contracted between the cover plate and the key body to urge the ear 49 into continuous engagement with the cam surface 50 and the bottom of the keyway 44.

The limit switch 51 not only stops the piston 26 at the end of its downstroke but also commands upward movement of the piston automatically without requiring any action on the part of the press operator. Electrical and hydraulic circuits for controlling the operation of the fluid actuator 11 and responsive to opening and closing of the limit switch to stop and reverse the piston are shown in FIG. 8. Assuming that the piston initially is in its uppermost position in the cylinder 20, the press operator may start the piston on its downward stroke by depressing the "down" side 65 (FIGS. 1 and 8) of an up-down switch button 66. The latter is mounted on one wall of the casing 53 for rocking in one direction from a released neutral position to a down position when the "down" side of the button is depressed or in the opposite direction to an up position when the "up" side 67 of the button is depressed.

Depression of the "down" side 65 of the switch button 66 closes a normally open down switch 69 (FIG. 8) and

results in energization of a down solenoid **70** across power lines L–1 and L–2 and through the down switch and a normally closed relay-actuated switch **71**. The energized solenoid shifts the control valve **30** from a neutral position to a down position in which pressure fluid is admitted into the head end of the cylinder **20** through the conduit **27**.

With pressure fluid flowing into the head end of the cylinder **20**, the piston **26** starts on its downstroke. As the cam surface **50** on the ram **33** slides the key **45** into operative engagement with the switch operator **54**, the limit switch **51** closes to energize a relay **73** which opens the switch **71**, closes a switch **74**, and closes a switch **75** to establish a holding circuit for the relay. Opening of the switch **71** de-energizes the down solenoid **70** while closure of the switch **74** energizes an up solenoid **76** which shifts the control valve **30** to an up position admitting pressure fluid into the rod end of the cylinder through the conduit **29**. Accordingly, the piston **26** automatically starts on its upstroke without need of the press operator releasing the "down" side **65** of the switch button **66**. Thus, no delay occurs in the operation of the press **10** as otherwise might be encountered through the possible failure of the press operator to reverse the piston promptly.

As the piston starts on its upstroke, the cam surface **50** moves away from the key **45** thereby to allow the spring **64** to slide the key away from the switch operator **54** to open the limit switch **51**. The relay **73** remains energized, however, through the holding circuit set up by the switch **75**, and keeps the up solenoid **76** energized through the switch **74** until the piston **26** approaches the upper end of the cylinder **20**. At this time, the press operator may release the up-down button **66** to open the down switch **69** and thereby break the holding circuit, de-energize the relay **73**, open the switch **74**, de-energize the up solenoid **76**, and shift the control valve **30** to its neutral position to complete one cycle of operation.

The press operator may terminate the upstroke of the piston **26** at any point desired simply by releasing the switch button **66** at the proper time, and thus the piston need not necessarily travel through its full upstroke. As a result, the piston and the punch **14** may be reciprocated selectively through relatively short strokes to produce a saving of time when operating on a workpiece of light gauge material. If the press operator, after first stopping the piston short of the end of its full upstroke by releasing the "down" side **65** of the switch button, should then find it necessary to retract the piston upwardly through its maximum stroke, he need only depress the "up" side **67** of the button to close an up switch **80** (FIG. 8) and thereby re-energize the up solenoid **76** to effect completion of the full upstroke of the piston. The up switch **80** therefore enables immediate retraction of the piston to the upper limit of its stroke without first having to reciprocate the piston through a complete down-up cycle as otherwise would be necessary in the absence of the up switch.

I claim as my invention:

1. In a press of the type having a two-way, fluid-operated actuator for reciprocating a tool element, said actuator comprising a cylinder having a piston slidable back and forth therein in response to the admission of pressure fluid alternately into opposite ends of the cylinder, a sleeve on one end of the cylinder, and a ram adapted for attachment at one end to the tool element, anchored at the other end to said piston, and telescoped into said sleeve for back and forth reciprocation through a predetermined stroke to advance and retract the tool element, the improvement in said press comprising, a keyway formed in and extending axially of said ram, a key projecting radially of and mounted slidably in said sleeve and having one end slidably interfitting with said keyway to restrict turning of the ram while permitting reciprocation of the ram, a cam surface formed near one end of said keyway and movable into engagement with said one end of said key as the ram approaches one end of said stroke while moving in one direction and before said piston reaches said one end of said cylinder thereby to cause sliding of the key radially of said sleeve, and means mounted on said sleeve adjacent the other end of said key for controlling the flow of pressure fluid to said cylinder and operable in response to sliding of the key to command reversal of the direction of movement of said piston whereby the piston is stopped short of said one end of said cylinder and is automatically reversed.

2. A press as defined in claim **1** further including manually actuated means for commanding movement of said ram in said one direction and selectively operable to stop said ram in any selected position while the ram is moving in the opposite direction, and second manually actuated means selectively operable to command movement of the ram from said selected position and in said opposite direction.

3. A press as defined in claim **1** in which said one end of said ram is formed with a recess, a second key disposed in said recess and having a free end projecting axially beyond said one end of the ram and adapted to interfit selectively with the tool element to restrict turning of the latter relative to the ram, and means extending through said second key and radially into said ram and mounting said second key for swinging of said free end to an inactive position disposed within said recess and out of projecting relation with said one end of the ram.

4. In a press of the type having a fluid-operated actuator for reciprocating a tool element, said actuator comprising a cylinder having a piston slidable back and forth therein in response to the admission of pressure fluid into the cylinder and adapted for attachment to the tool element to advance and retract the latter, a sleeve on one end of said cylinder, and a piston rod anchored to and movable with said piston and telescoped in said sleeve for back and forth reciprocation through a predetermined stroke, the improvement in said press comprising, a keyway formed in and extending axially of said piston rod, a key projecting radially from and mounted slidably in said sleeve and having one end slidably interfitting with said keyway to permit reciprocation of the rod, an operator on said rod aljacent said keyway and movable into operating engagement with said key as the rod approaches one end of said stroke while moving in one direction thereby to cause sliding of the key within said sleeve, and means for controlling the flow of pressure fluid to said cylinder and operable in response to sliding of the key to stop movement of the rod in said one direction.

5. A press as defined in claim **4** in which said operator comprises a cam surface formed on said rod near one end of said keyway and engageable with said key to slide the latter radially outwardly of said sleeve.

6. A press as defined in claim **5** in which said means include a limit switch mounted on the outer side of said sleeve and having a switch operator disposed for engagement by the other end of the key as the key is slid outwardly by said cam surface.

7. A press as defined in claim **6** in which said cam surface is shaped to slide said key outwardly through a progressively greater distance as said piston rod approaches progressively nearer to said one end of said stroke, and in which said key is adjustable to decrease the distance between the ends of the key and thereby increase the distance through which the key must be slid to engage said switch operator whereby the length of the stroke of the piston rod may be selectively increased by adjusting said key.

8. A press as defined in claim **7** in which said key is formed by two parts threadably connected end-to-end and turnable relative to one another to change the distance

between the ends of the key, and further including means on said sleeve normally restricting relative turning of said two parts.

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U.S. Cl. X.R.

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