

April 18, 1933.

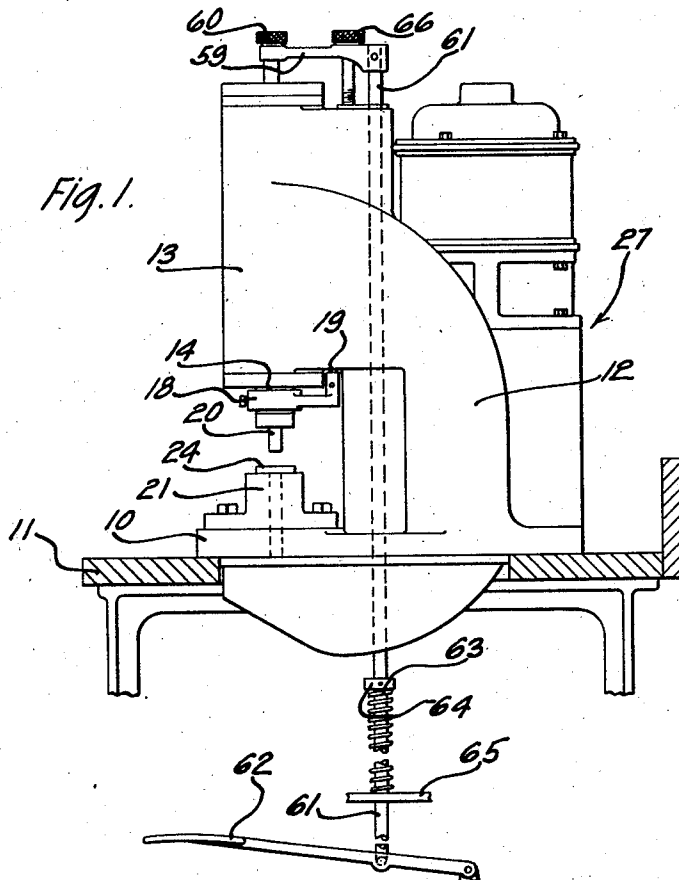
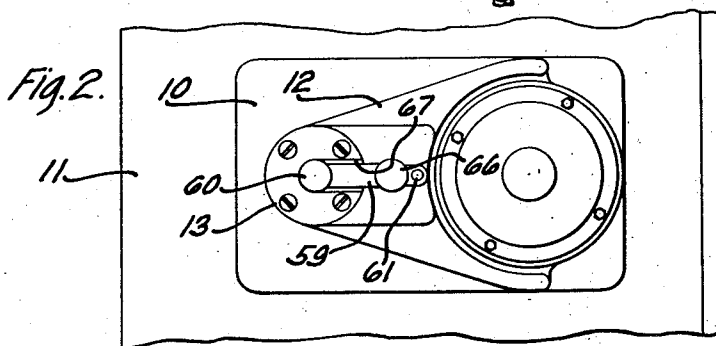
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MATERIAL WORKING APPARATUS

Filed June 13, 1930

2 Sheets-Sheet 1



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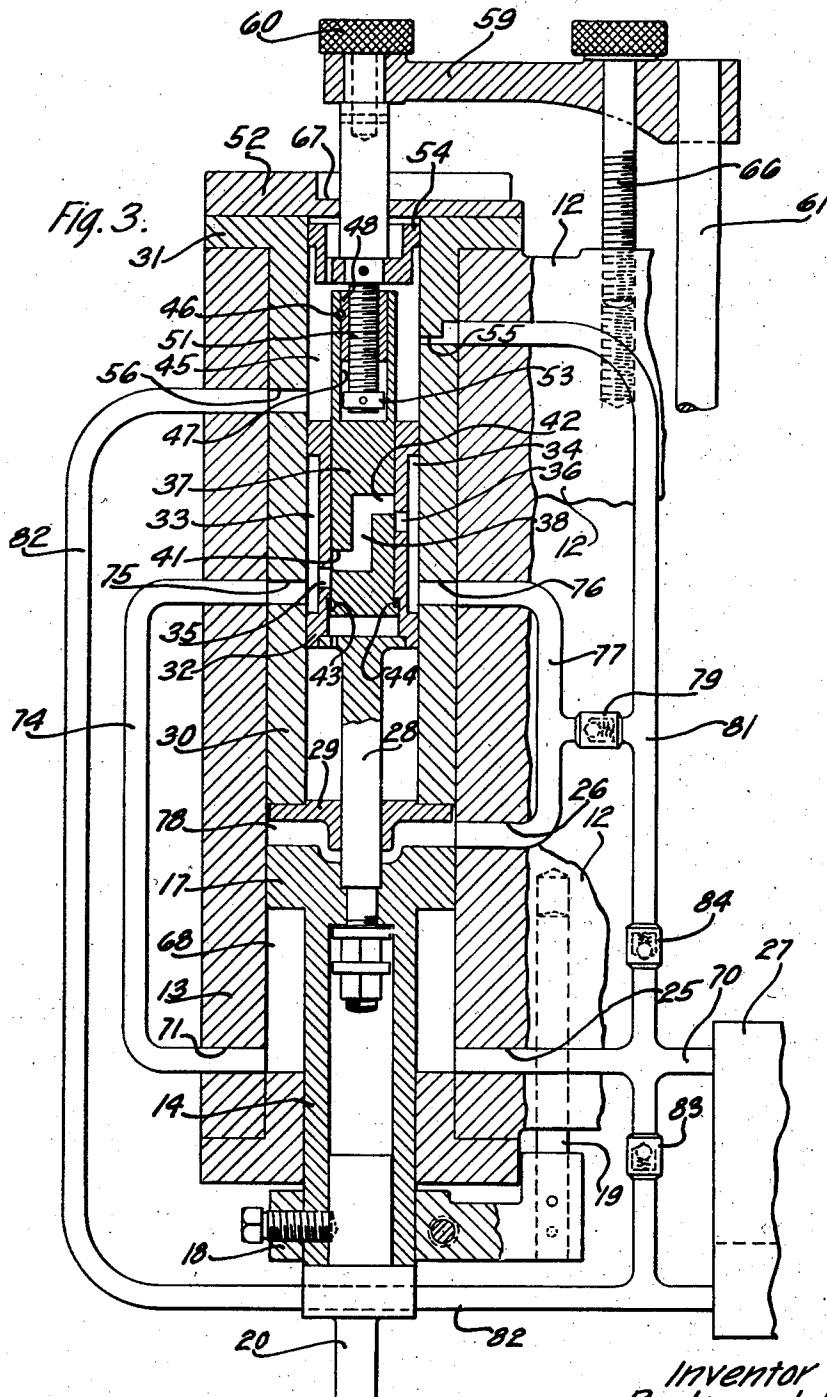
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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MATERIAL WORKING APPARATUS

Application filed June 13, 1930. Serial No. 461,035.

This invention relates to material working apparatus, and more particularly to a pressure fluid actuated material working apparatus and a control system therefor.

The primary object of this invention is the provision of a simple, reliable and efficient control mechanism for pressure fluid actuated material working apparatus.

In accordance with one embodiment of this invention as applied to a hydraulically actuated machine press having a tool carrying ram carrying a piston at one end reciprocable in a pressure fluid cylinder, there is provided a hydraulic transmission system connected to the cylinder including a fluid pump and a manually operable control valve for the system. By actuating the control valve the operator may control the flow of the fluid thorough the system so as to cause the ram to advance under a predetermined low pressure for a predetermined distance, maintain it for any desired period of time, release the pressure at will, reverse the ram under low pressure, or may advance the ram to complete the stroke under high pressure and maintain it under the latter pressure as long as is desired, the high pressure preferably first becoming effective at a point just above the work.

Means are provided for varying the normal distance between the tool and the work within certain limits by an adjustment of the ram and also for varying the length of the stroke of the ram within certain limits by varying the position of an upper stop.

Other objects and advantages of this invention will more fully appear from the following detailed description, taken in connection with the accompanying drawings, wherein.

Fig. 1 is a fragmentary side view, partly in section, of a hydraulically actuated bench type machine press equipped with one embodiment of the control mechanism of this invention for controlling the reciprocation of the press ram;

Fig. 2 is a plan view of Fig. 1, and

Fig. 3 is a diagrammatic vertical sectional view of the press shown in Fig. 1 and of the

control mechanism and the hydraulic transmission system therefor.

Referring now to the drawings in detail wherein like reference numerals indicate similar parts, and particularly to Fig. 1, there is illustrated a hydraulically actuated machine press having a base or bed 10 secured to a bench top 11, and integral with the base is a vertical frame 12 having formed therein a hydraulic cylinder 13. A vertically reciprocable ram 14 (Fig. 3) is mounted in the lower end of the cylinder 13, the ram having an integral piston 17 at its upper end within the cylinder. Clamped to the lower end of the ram 14 is a guide 18 provided with an arm at its right side to which is fixed a guide rod 19 reciprocable in an opening provided in the press frame 12, the guide, it will be apparent, serving to prevent rotation of the ram at all times, but permitting it to reciprocate in the operation of the press. The ram 14 at its lower end is provided axially with an aperture within which is suitably secured a punch or other material working tool 20. The punch 20, in the operation of the press, cooperates with a die 21 carried upon the bed 10 of the press to shear, form, or shape articles from material 24 positioned upon the die. The piston 17 is actuated by pressure fluid, for instance oil, supplied to the cylinder 13 at opposite ends of the piston 17, which are of different areas, providing a differential piston, for a purpose to be explained hereinafter, through ports 25 and 26 formed in the cylinder 13.

The pressure fluid for operating the ram 14 is supplied by a motor driven pump 27 of a known type mounted upon the press frame 12 (Fig. 1) and shown diagrammatically in Fig. 3. Since the details of the pump 27 are not necessary to a complete understanding of this invention a detailed disclosure and description thereof will not be given herein.

Referring to Fig. 3 wherein the control mechanism and the hydraulic transmission system is shown diagrammatically, a stem or rod 28 fixed axially to the ram 14 extends upwardly from the upper end of the piston 17 thereof and through a cap or head 29

secured to a stationary sleeve 30 fitted into the upper end of the bore of the cylinder 13, the sleeve 30 having a flange 31 at its upper end fixed to the upper end of the cylinder 13. Secured to the upper end of the rod 28 is a shouldered sleeve 32 formed exteriorly with a plurality of oppositely disposed slots 33 and 34, forming fluid passages, which extend for the greater portion of the length of the sleeve and also with displaced fluid inlet and outlet ports 35 and 36, respectively, one communicating with each of the slots, the sleeve 32 being reciprocally mounted in the bore of the sleeve 30 and movable with the ram 14. Reciprocally mounted in the bore of the sleeve 32 is a control valve 37 having a central vertical passage 38 terminating at opposite ends in fluid inlet and outlet ports 41 and 42, respectively. In the actuation of the valve 37 to be described hereinafter the ports 41 and 42 are aligned with the ports 35 and 36, respectively, of the sleeve 32 to permit a free passage of the pressure fluid through the passage 38 of the valve. The lower end of the valve 37 is formed with a flange 43 having an upper annular surface which normally is spaced from a shouldered annular surface 44 of the sleeve 33, and at times, as will be described hereinafter, engages the surface 44, while the lower surface of the valve 37 is predeterminedly spaced from the upper surface of the rod 28 when the control mechanism is in its normal position, as shown in Fig. 3. The upper surface of the rod 28 forms an inner lower wall of the bore of the sleeve 32. The upper end of the valve 37 extends above the upper end of the sleeve 32 and into a no pressure return chamber 45 provided by the bore of the sleeve 30. Secured by a pin 46 within a depression 47 in the upper end of the valve 37 is an internally threaded collar 48 extending into the depression for substantially one-half of its depth. Threaded into the collar 48 is a shouldered threaded rod 51 which extends through a cap or head 52 secured to the flange 31 and carries at its lower end within the depression 47 a stop collar 53. Fixed to the rod 51 above the upper end of the valve 37 and within the chamber 45 is a slide valve collar 54 which is movable with the valve 37. The chamber 45 is provided with fluid inlet and outlet ports 55 and 56, respectively, formed in the cylinder 13 and the sleeve 30, and at a predetermined point in the actuation of the valve 37 the slide valve collar 54 covers the inlet port 55 to the chamber 45, as will be explained hereinafter to build up the pressure of the pressure fluid acting against the piston 17 to move it downwardly.

To the upper end of the rod 51 is attached an arm 59 by means of which the rod and the valve 37 carried thereby may be moved longitudinally, the connection being such that the rod may be rotated relative to the arm. A

headed pin 60 attached to the rod 51 serves to lock the arm 59 to the rod so that it will move with the arm when the latter is moved downwardly and upwardly by means to be presently described. The head of the pin 60 also provides means for rotating the rod to vary the distance between the punch 20 and the die 21 after the latter has been adjusted to a position approximately the desired distance from the punch by the use of suitable shims thereunder. It will be apparent that by rotating the rod 51 in a direction which will lower the collar 48 relative to the rod, due to the threaded engagement therebetween, the upper annular surface of the flange 43 of the valve 37 will move away from the shouldered annular surface 44 of the sleeve 32 and simultaneously therewith the fluid ports 41 and 42 of the valve 37 will be moved slightly to provide free fluid communication with the ports 36 and 35, respectively. As will be made apparent hereinafter the fluid will then be immediately directed to the upper end of the piston 17 as well as the lower end thereof and thereby move the ram 14 downwardly a distance corresponding to the distance the valve 37 was moved downwardly and thus bring the ports 41, 42, 35 and 36 back to the same relative positions they occupied before the adjustment of the valve.

The arm 59 is attached to a vertically reciprocable rod 61 operatively connected at its lower end to a foot treadle mechanism 62. Surrounding the rod 61 at a point between the arm 59 and the foot treadle 62 is a compression spring 63, opposite ends of which about a collar 64 fixed to the rod 61 and a stationary bracket 65, shown fragmentarily. Upon a depression of the foot treadle 62 the rod 61 will move downwardly and carry the arm 59, rod 51, slide valve collar 54, and the valve 37 therewith and compress the spring 63. When the operator releases the foot treadle 62, the spring 63, previously compressed, returns the parts to their normal upper position as determined by an adjustable headed stop screw 66 freely extending through an aperture in the arm 59 and threaded into the press frame 12, the upper surface of the arm 59 engaging the under surface of the head of the screw. It will be apparent that the length of the stroke of the ram 14 can be varied within the distance between the lower surface of the arm 59, surrounding the rod 51, and a shouldered upper surface 67 of the head 52 by rotating the stop screw in one direction or the other to vary the elevation of the under surface of the head thereof.

The pressure fluid from the pump 27 is normally entered into a chamber 68 of the cylinder 13 and against the lower end of the piston 17 by a conduit or pipe 70 (Fig. 3) connected to the cylinder port 25, and passes from the cylinder through a port 71 thereof

into a pipe 74. The opposite end of the pipe 74 is connected to a port 75 formed in the cylinder 13 and the sleeve 30, thereby directing the fluid into the slot 33 and also into the port 35 of the sleeve 32, which is slightly opened at this time to permit fluid to pass through the valve 37, as shown in Fig. 3, for a purpose to be referred to hereinafter. An opposite port 76 in the sleeve 30 and the cylinder 13 directs the fluid from the slot 34 into a pipe 77 connected by means of the port 26 to a chamber 78 of the cylinder 13 and against the upper end of the piston 17. The pipe 77 is connected intermediate the ports 76 and 26 to a relief valve 79, in turn connected to a pipe 81, the latter terminating at its upper end at the port 55 of the no pressure return chamber 45. The opposite port 56 of the chamber 45 is connected to a pipe 82 connected to a suitable fluid reservoir associated with the pump 27. At its lower end the pipe 81 is connected to the pipes 70 and 82 and between the latter pipes the pipe 81 includes a relief valve 83. Also included in the pipe 81 between its connection with the pipe 70 and the port 55 of the no pressure return chamber 45 is a relief valve 84. The relief valves 79, 83 and 84 are adjusted to create the desired pressure during the first part of the downward movement, to create the desired operating pressure at the lower end of the downward movement, and to create the desired upward pressure to raise and hold up the piston 17 and attached parts upon the completion of the operating stroke, respectively.

It is to be understood that at all times the pressure fluid system comprising the chambers 68 and 78 of the cylinder 13 above and below the piston 17, respectively, slots 33 and 34, chamber 45, and the passages, ports, pipes, and valves hereinbefore mentioned, or which may be hereinafter described, are filled with the pressure fluid. The pressure fluid from the pump 27, in accordance with the setting of the relief valve 84, is sufficient to raise and hold the ram 14 in its upper normal position, the pressure of the fluid being exerted against the lower end of the piston 17 in the chamber 68. When the pump 27 is operating and the foot treadle mechanism is in a position of rest an equilibrium is created between the pressures acting upon the lower and upper ends of the piston 17, which are of different areas. The ram 14 with the attached rod 28 and the sleeve 32 will under these conditions be positioned as shown in Fig. 3 with the ports 35 and 36 of the sleeve 32 slightly opened to the ports 41 and 42, respectively, of the valve 37. When the pump 27 is not operating the valve 37 will be held in a position with the upper surface of the flange 43 thereof abutting the shoulder 44 of the sleeve 32, due to the action of the spring 63, and the effect of gravity on the piston 17 and attached parts. With the elements of the control mechanism

in the position shown in Figs. 1 and 3, and with the system filled with pressure fluid, fluid from the pump 27 will pass through the pipe 70 and be by-passed through the relief valve 84, the pipe 81, port 55, the no pressure return chamber 45, port 56, and pipe 82, and to the reservoir of the pump 27, except for the slight leakage through the valve ports which maintains the equilibrium as hereinbefore described.

When the foot treadle 62 is depressed, the rod 61 is moved downwardly and through the connections previously described the valve 37 is likewise moved downwardly and the ports 41 and 42 thereof are further opened to the ports 35 and 36, respectively, of the sleeve 32 and the fluid is permitted to flow freely from the pipe 74 successively through the port 75, slot 33, ports 35 and 41, passage 38, ports 42 and 36, slot 34, port 76, pipe 77, port 26, and into the chamber 78 of the cylinder 13 above the upper end of the piston 17. The pressure of the fluid in the chamber 78 upon the upper end of the piston 17 is just great enough to cause the ram 14 to move downwardly at a moderate pressure, as determined by the setting of the relief valve 79, the speed and distance of the ram movement being determined by and proportional to the speed and distance of treadle movement, it being understood that the maximum speed will be limited by the pump delivery. The downward force upon the piston 17 is equal to the difference between the pressures applied to the upper and lower end surfaces of the piston 17, minus the pressure necessary to overcome friction. During this portion of the stroke cycle of the ram 14 the downward movement thereof is at a moderate pressure and continues downwardly at this pressure until the lower end surface of the punch 20 is predeterminedly spaced from the upper surface of the material 24 associated with the die 21.

At this point in the stroke of the ram 14 the slide valve collar 54 covers the port 55 of the no pressure chamber 45, thereby completely stopping the flow of the fluid through the no pressure chamber 45 to the reservoir of the pump 27. With the port 55 closed the entire output of the pump 27 must flow into the chamber 78 so that as soon as resistance to the downward movement of the ram 14 is encountered the pressure of the fluid will immediately begin to build up in the chamber 78 and may continue to increase until it has reached the pressure equal to the setting of the relief valve 83, at which instant the relief valve will open and the fluid is directly by-passed to the reservoir of the pump 27. The relief valve 83 may be set at any desired pressure up to the maximum pressure of the pump and the pressure at which it opens should be greater than is sufficient to force the punch 20 through the material 24, or in the case of other forms of tools carried by

the ram 14 to perform the desired material working operations. The upper point in the high pressure zone at which the fluid pressure is built up as just described will ordinarily occur at a point as close to the work as possible and the clearance should at least be less than the thickness of an operator's fingers. It will be apparent that if the operator's fingers should be under the descending punch 20 the latter will engage the operator's fingers under a moderate pressure and prevent a further downward movement of the punch, since the pressure in chamber 78, while the port 55 is open, will not be sufficient to crush the operator's fingers. As a result, it will be impossible for the slide valve collar 54 to move to a point where it would cover the port 55 with the consequent building up of the fluid pressure, and thus the operator's fingers will not be seriously endangered should they be placed under the punch 20.

With the relief valve 83 opened the high pressure built up in the system may still be maintained as long as the slide valve collar 54 covers the port 55 of the no pressure return chamber 45, which condition exists as long as the foot treadle 62 is maintained depressed by the operator. Upon the operator releasing the foot treadle 62 the spring 63 acts to move the rod 61 and the attached parts to their normal upper position as hereinbefore described. Consequently the port 55 is opened, ports 35 and 36 are returned to their normal position slightly opened to the ports 41 and 42, respectively, and the relief valve 83 is closed and the pressure of the fluid is then directed into the chamber 68 against the lower end of the piston 17 which forces it upwardly, the fluid above the piston within the cylinder 13 being expelled through the port 26, pipe 77, relief valve 79, pipe 81, port 55 and back to the reservoir of the pump 27 and thereafter the pressure fluid circulates as hereinbefore described in connection with the normal position of the control mechanism.

If the operator after starting to depress the treadle 62, which depression as hereinbefore described further opens the ports 41 and 42 to the ports 35 and 36, respectively, to permit the fluid to flow into the chamber 78 above the upper end of the piston 17 and which will cause the ram 14 to move downwardly, for any reason wishes to stop the ram before it completes its operating stroke and hold it at its advanced position this may be accomplished by merely ceasing to move the treadle and holding it from returning to its normal position. The stopping of the treadle controlled valve 37 again conditions the pressure fluid system to cause an equilibrium between the pressures acting upon the lower and upper ends of the piston 17 and the sleeve 32 and the valve 37 will immediately

assume the same relative positions shown in Fig. 3 with the ports 35 and 36 slightly opened to the ports 41 and 42, respectively. Thereafter the operator may further partially depress the treadle 62 to cause another partial advance stroke of the ram, or the treadle may be fully depressed to complete the operating stroke of the ram, or the treadle may be released to permit it and the connected parts to return to their normal position whereupon the ram 17 will also return to its normal position.

It is evident with a control system of the type herein described for controlling the operation of a hydraulically actuated machine press that the operator is in complete control of the press ram 14, at any point of the stroke cycle, so that a great variety of material working operations may be efficiently performed. Also that the pressure exerted upon the work or material acted upon may be readily varied and accurately regulated, as well as the point in the stroke cycle at which the maximum pressure is applied. As applied to a bench type power press with a foot treadle mechanism for controlling the application of the pressure fluid to the ram 14, the operator's hands are left free to position work under the punch 20 or other tool carried by the ram, depending on the nature of the work to be performed, and since a minimum of force is applied by the operator upon the treadle 62 the element of fatigue in the operator is practically eliminated. For example, in the assembling and securing of parts by staking them together the operator may use both hands to bring the parts from supplies thereof at opposite sides of the press, assemble them in staking position under a staking tool carried by the ram 14 and then depress the foot treadle 62. The tool carried by the ram 14 will immediately descend due to the pressure of the pressure fluid and perform the staking operation. Thereafter by releasing the slight foot pressure applied to the foot treadle the parts return automatically to their normal position, ready for another operation. In other cases it will be desirable to maintain the tool carried by the ram 14 against the work under either low or high pressure for different periods of time. This it will be apparent may be accomplished with a minimum of exertion by the operator.

Although the invention has been disclosed as applied to a particular type of material working apparatus and is shown with the control system partly in diagrammatic form, it is clear that it may have a more general application and that modifications can be made without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a material working apparatus, a differential area piston, means for delivering

pressure fluid to the smaller area of said piston, manually controlled means associated with said first means for delivering pressure fluid to the greater area of said piston from said means, a by-pass for said means, and means connected to said manually controlled means operative after the piston has advanced through a predetermined distance to close the by-pass.

2. In a material working apparatus, a pressure fluid cylinder having a differential area piston therein, means for delivering pressure fluid to the cylinder at the smaller area of said piston, a manually controlled valve in said cylinder connected to said means for delivering pressure fluid to the cylinder at the greater area of the piston, and a by-pass for the means closed by said valve after the piston has advanced through a predetermined distance.

3. In a material working apparatus, a pressure fluid cylinder having a differential area piston therein, a sleeve in said cylinder connected to said piston, means for delivering pressure fluid to the cylinder at the smaller area of the piston, a manually controlled valve in said sleeve provided with a fluid passage communicating with fluid ports in the sleeve connected to said means for delivering pressure fluid to the cylinder at the greater area of the piston, and a by-pass for the means closed by said valve after the piston has advanced through a predetermined distance.

4. In a material working apparatus, a material forming member, a pressure fluid cylinder having a differential area piston therein connected to the forming member, a sleeve in said cylinder connected to said piston, means for delivering pressure fluid to the cylinder at the smaller area of the piston, a manually controlled valve in said sleeve provided with a fluid passage communicating with fluid ports in the sleeve connected to said means for delivering pressure fluid to the cylinder, means operatively connected to said valve for adjusting the same relative to the sleeve to permit the pressure fluid to move the piston in either direction for varying the normal position of the forming member relative to the material to be worked, and a by-pass for the pressure fluid delivering means closed by the valve after the piston has advanced through a predetermined distance.

5. In a material working apparatus, a pressure fluid cylinder having a differential area piston therein, means for delivering pressure fluid, a fluid conduit means connecting said means with said cylinder at opposite areas of the piston, a control valve in said conduit means normally positioned to allow the fluid to flow therethrough without exerting a normal pressure on the greater area of the piston but still maintaining the normal pressure upon the smaller area thereof to hold the piston

in its normal position, and manually operable means operatively connected to said valve for actuating the same to direct the fluid to the greater area of the piston for moving it first at a moderate pressure in one direction and then for a predetermined distance in the same direction at a comparatively high pressure, the valve at a predetermined point in its actuation preventing the fluid from flowing and thereby building up the pressure of the fluid in the system.

6. In a material working apparatus, a pressure fluid cylinder having a differential area piston therein, means for delivering pressure fluid, a fluid conduit means connecting said means with said cylinder at opposite areas of the piston, a control valve in said conduit means normally positioned to allow the fluid to flow therethrough without exerting a normal pressure on the greater area of the piston but still maintaining the normal pressure upon the smaller area thereof to hold the piston in its normal position, a foot treadle mechanism operatively connected to said valve for actuating the same to direct the fluid to the greater area of the piston for moving it first at a moderate pressure in one direction and then for a predetermined distance in the same direction at a comparatively high pressure, the valve at a predetermined point in its actuation preventing the fluid from flowing and thereby building up the pressure of the fluid in the system, and means for returning the valve and said treadle mechanism to their normal position after a release of the treadle mechanism.

7. In a material working apparatus, a pressure fluid cylinder having a differential area piston therein, a source of pressure fluid, a fluid conduit means connecting said source with said cylinder at opposite areas of the piston, a sleeve in the cylinder connected to the piston having inlet and outlet ports in communication at all times with the conduit means, a control valve in said sleeve having a passage for interconnecting the ports of the sleeve, the sleeve normally positioned to allow the fluid to be by-passed to its source without exerting a normal pressure on the greater area of the piston but still maintaining the normal pressure upon the smaller area thereof to hold the piston in its normal position, and manually operable means operatively connected to said valve for actuating the same to interconnect the ports of the sleeve to direct the fluid to the greater area of the piston for moving it first at a moderate pressure in one direction and then for a predetermined distance in the same direction at a comparatively high pressure, the valve at a predetermined point in its actuation preventing the fluid from being by-passed to its source and thereby building up the pressure of the fluid in the system.

8. In a material working apparatus, a cyl-

inder having a pressure fluid chamber at one end and a differential area piston within the chamber, means for delivering pressure fluid to the chamber at the smaller area of said piston, a manually controlled valve in said cylinder outside the pressure fluid chamber connected to said means for delivering pressure fluid to the chamber at the greater area of the piston, a second valve connected to and movable with said first valve, and a by-pass for the means closed by said latter valve after the piston has advanced through a predetermined distance.

9. In a material working apparatus, a movable material engaging member, pressure fluid actuated means for moving the member, manually movable means for controlling the pressure fluid actuated means, said movable means being effective during a predetermined portion of its movement for causing the fluid actuated means to exert a predetermined pressure and effective upon further movement for changing said pressure, and means controlled by movement of said material engaging member for discontinuing the pressure and thereby the movement of said member whenever the manually movable means is held stationary.

In witness whereof, I hereunto subscribe my name this 29th day of May, A. D., 1930.

RALPH JONGEDYK.

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