Aug. 29, 1944. A. K. NOWAK ET AL 2,357,019

HYDRAULIC DOUBLE-ACTION DRAW PRESS

Filed Oct. 5, 1942 4 Sheets-Sheet 1

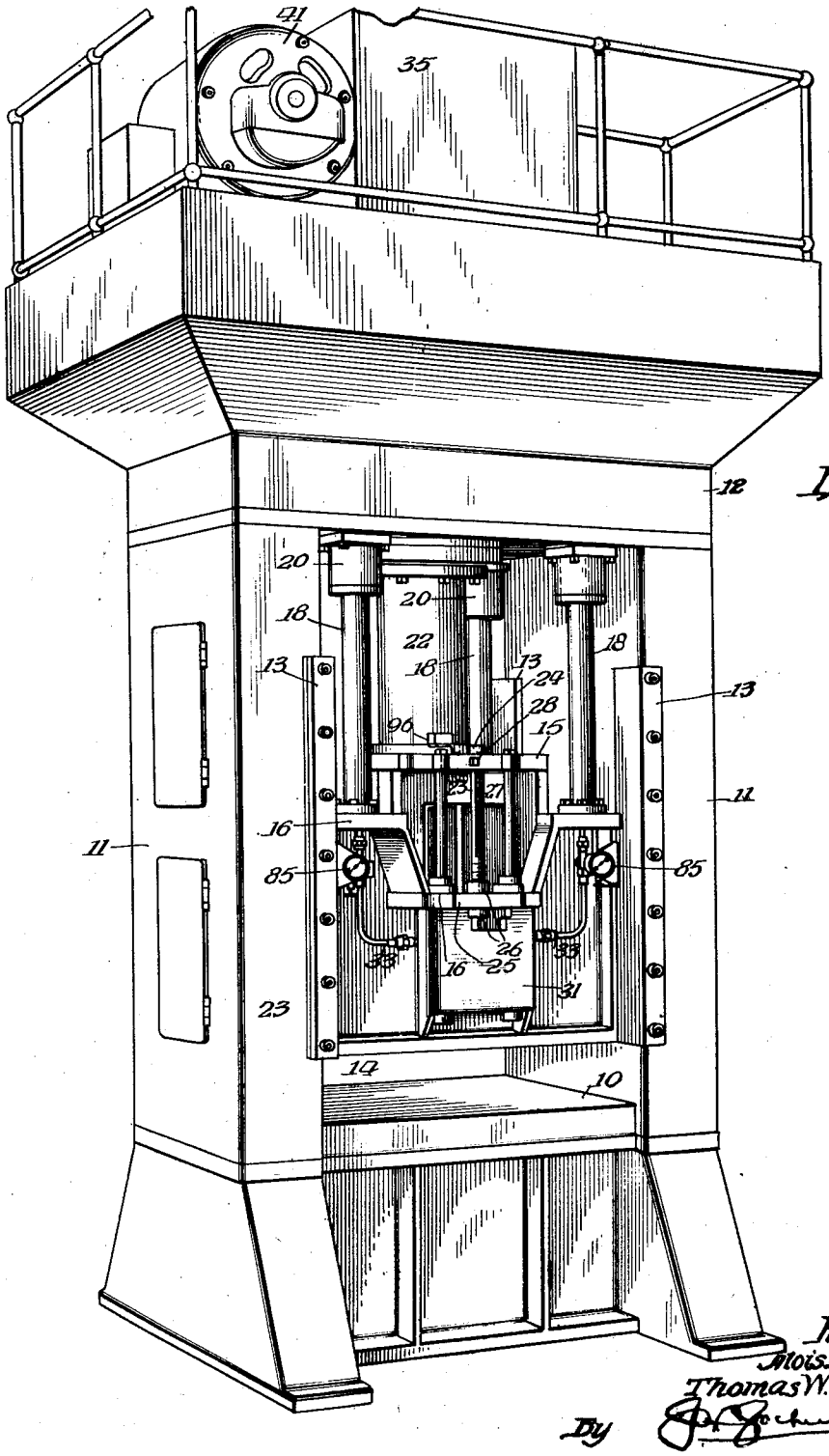


Fig. 1

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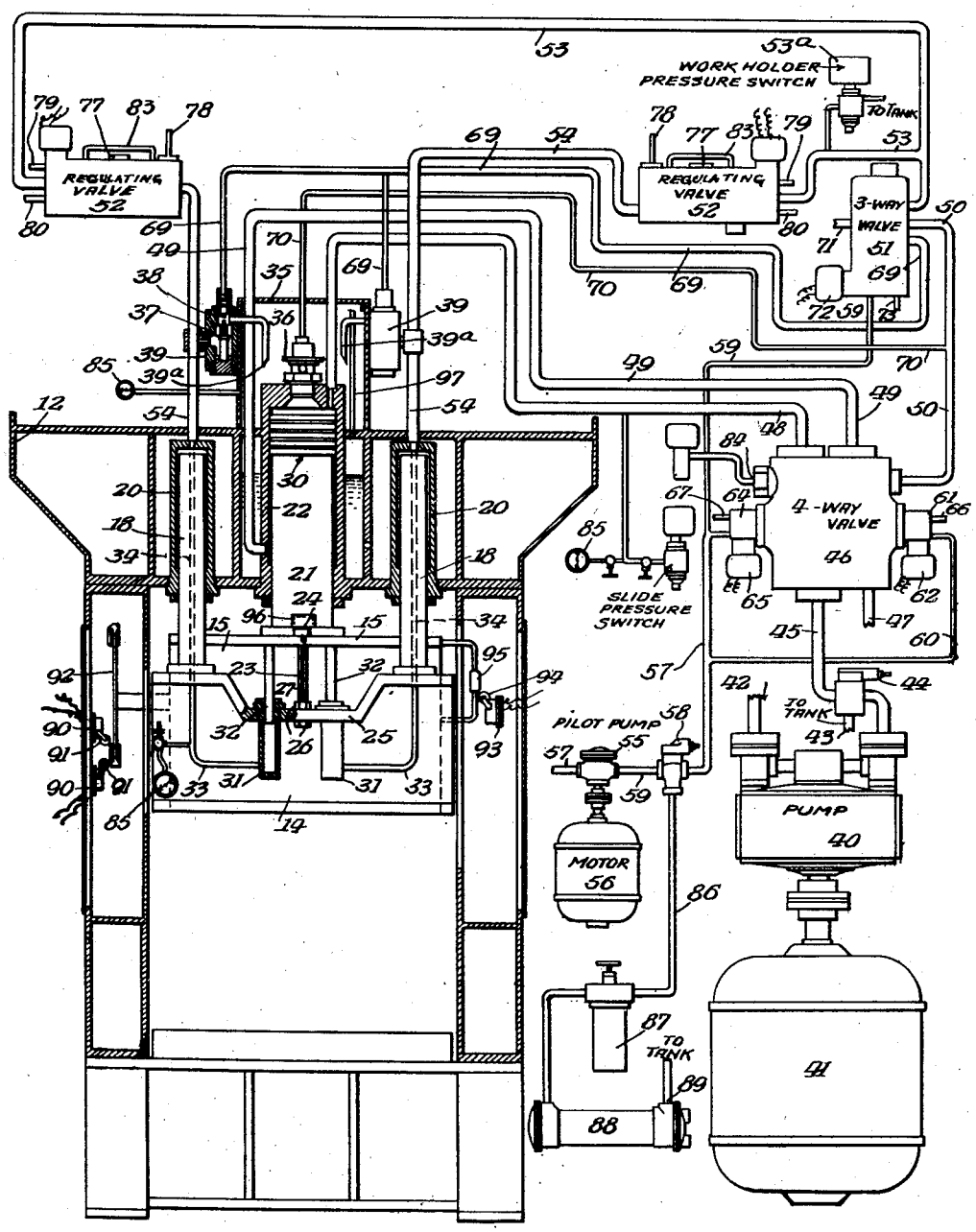


Fig. 2

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Fig. 3

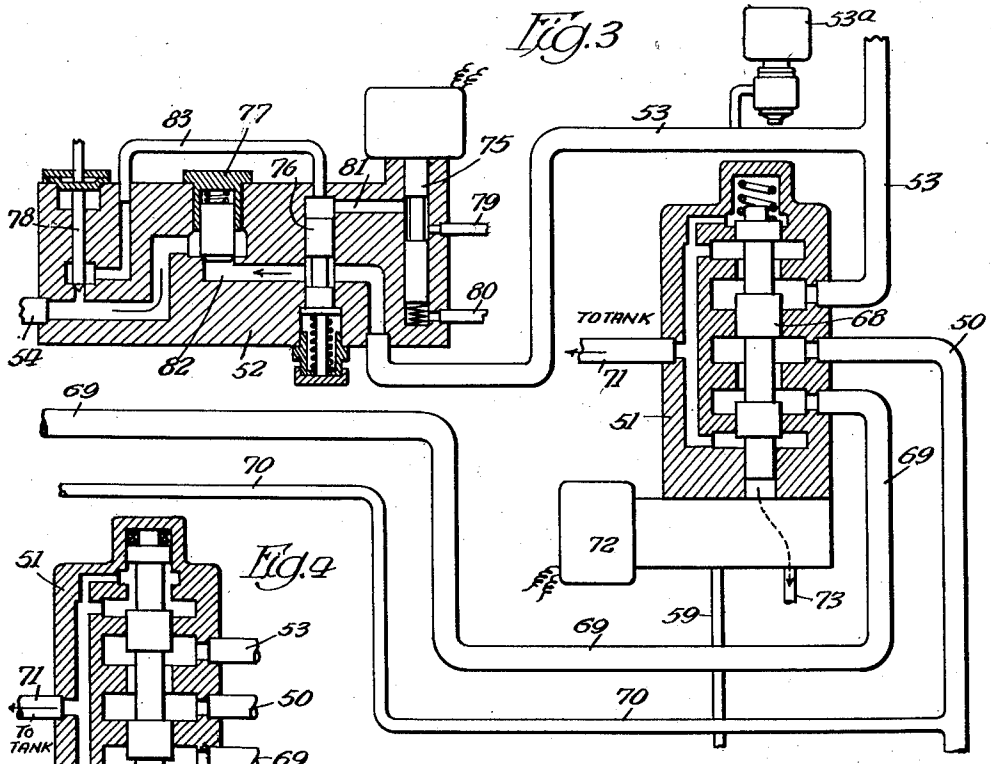
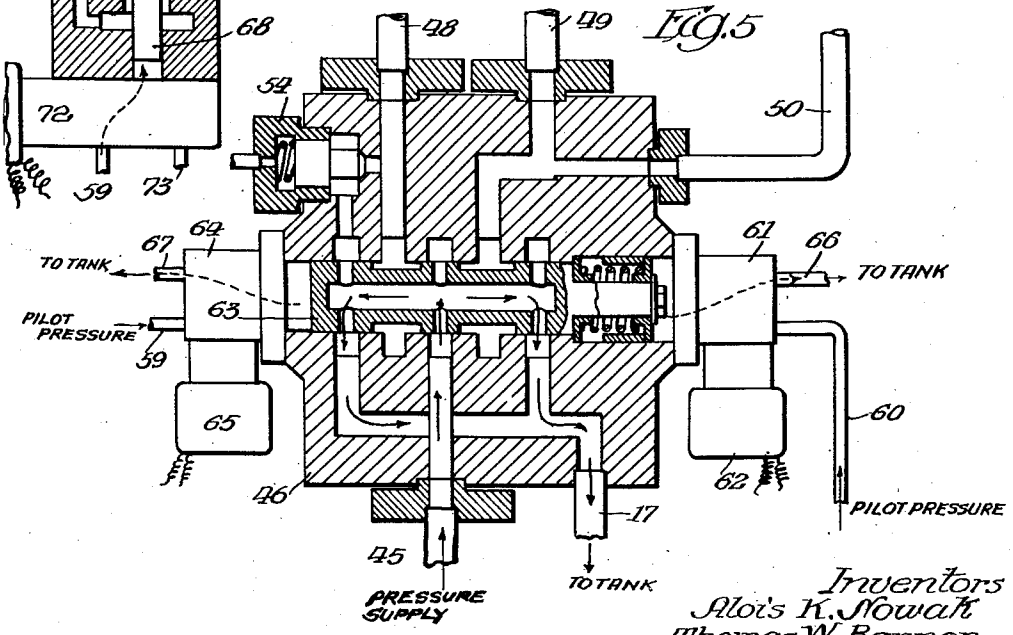


Fig. 4

Fig. 5



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Fig. 6

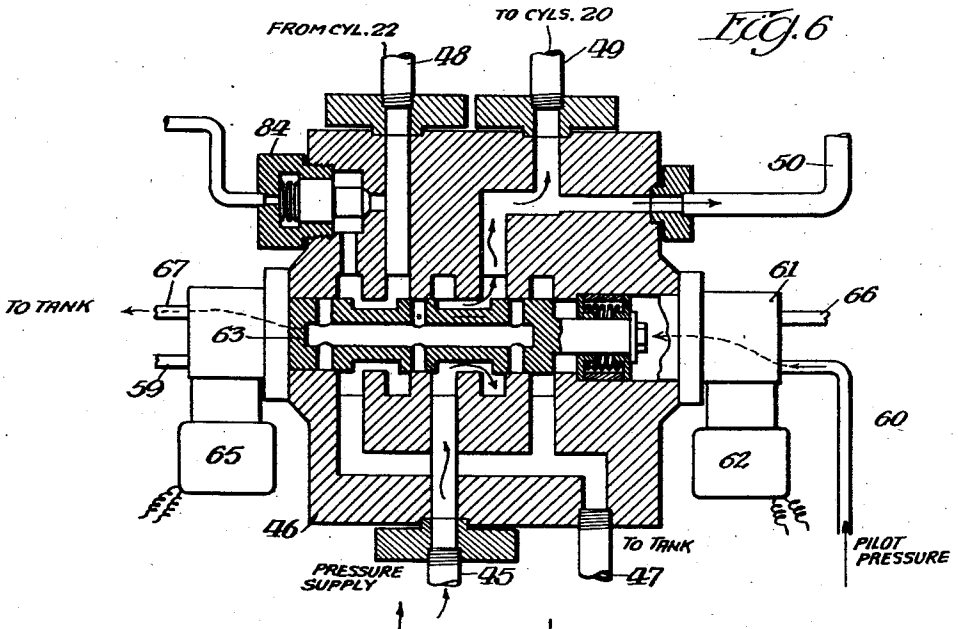
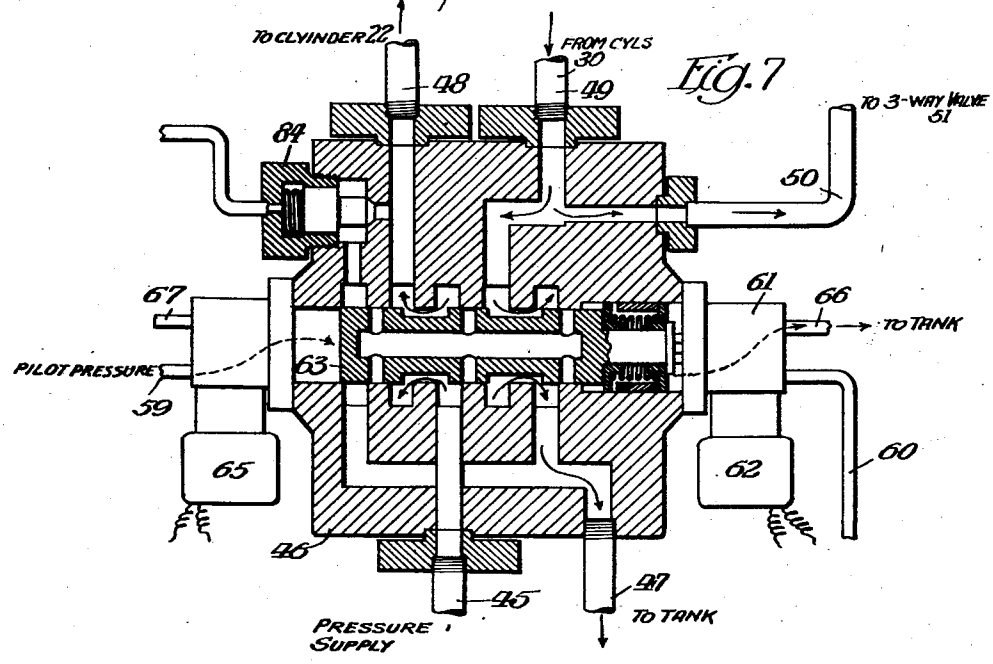


Fig. 7



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UNITED STATES PATENT OFFICE

2,357,019

HYDRAULIC DOUBLE-ACTION DRAW PRESS

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Application October 5, 1942, Serial No. 460,840

9 Claims. (Cl. 113—45)

This invention relates, in general, to presses, but more specifically to hydraulic presses which embody hydraulically operated means for actuating both a blank or work-holding slide and a work-performing slide.

Heretofore, in presses of this general character, the motion of the work-performing slide has been employed as a means for generating fluid pressure which has been utilized to actuate an auxiliary hydraulic ram for increasing or intensifying the pressure of the work holder upon the work. That is, when one slide is forced down to operate upon the work, the same downward force will cause pressure in the cylinders of the blank or work-holding slide, so that a greater pressure upon the work-performing slide will be acquired.

It has also been customary, in presses of this character, to provide separate sources of fluid pressure; that is, one source for the operation of the slides, and an independent source of fluid pressure for operating the other or blank-holding slide, the clamping or blank-holding slide being independently operable.

It is one of the objects of the present invention to provide an improved hydraulically operated double-action press, in which the blank or work-holding slide is not independently operable, but the operation of which is a part of the cycle of operation of the press.

A further object is to provide a press of this character, in which the relative movement of the slides is utilized, not as a means for generating or increasing pressure, but for the purpose of maintaining the predetermined generated pressure which acts upon the blank or work holder.

A further object is to provide in a press of this character, improved means for pre-filling the cylinders to fill the voids or spaces created by the relative movement of the cylinder and piston elements without increasing the pressure in the system.

A further object is to provide an improved press of this character, in which one of the slides is supported by the other slide to move therewith and with respect thereto, and improved means whereby the work shaping or performing slide will be maintained against engagement with the work in advance of the blank or work-holding slide, the latter being directly lifted by the inner slide, and being controlled in its movement toward and away from the work by the movement of the inner slide.

A further object is to provide, in a press of this character, an improved pilot fluid pressure system for controlling the operation of the valves, which latter in turn control the operation of the fluid pressure upon the respective parts.

To the attainment of these ends and the accomplishment of other new and useful objects as will appear, the invention consists in the features of novelty in substantially the construction, combination and arrangement of the several parts, hereinafter more fully described and claimed and shown in the accompanying drawings illustrating this invention, and in which—

Fig. 1 is a perspective view of a press of this character, constructed in accordance with the principles of this invention.

Fig. 2 is a view, in diagram, of a portion of the press frame and the slides of the hydraulic system employed in the operation of the press, portions of the press and slides, with the actuating mechanisms, being in elevation, and portions in section.

Fig. 3 is a view, in diagram, of a portion of the system, and illustrating, partly in elevation and partly in section, some of the valve mechanisms.

Fig. 4 is a view of the three-way valve shown in Fig. 3, and showing such valve in a different position.

Figs. 5, 6 and 7 are sectional views of the main control valve for controlling the direction of flow of the fluid, and showing the valve in different positions.

Referring more particularly to the drawings, in Fig. 1 there is shown a press having a base 10, uprights 11, and a crown 12, and supported by the crown is the operating mechanism for the slides.

The uprights or side members 11 of the press are provided with guides 13 for receiving and guiding an outer slide member 14, and within the outer slide 14 is arranged an inner slide 15.

Connected to the outer slide 14 are pistons 18, operable in cylinders 20, which latter are supported by the frame, such as the crown 12 of the press.

Connected with the inner slide 15 is a piston member 21, which extends into and operates within a cylinder 22, the latter being supported by the press frame. As a means for permitting and also regulating relative movement of the slides, one with relation to the other, there may be provided a rod or bolt 23 which passes through a portion of the inner slide 15 and is provided with a head 24. The other end of the rod passes through a portion 25 of the outer slide, and is screw-threaded to receive nuts or collars 26 dis-

posed on opposite sides of the portion 25 of the outer slide.

In order to prevent the rod or bolt 23 from rotating with respect to the parts with which it is connected, there may be provided a slot or keyway 27 for the reception of a screw or bolt 28.

With this construction, it will be manifest that the slides may be relatively moved in one direction, as the rod 23 passes freely through the portion 15 of the inner slide, and the relative movement in the opposite direction will be limited by the engagement of the head 24 with the portion 15 of the inner slide. Obviously, the degree or extent of such relative movements may be varied at will, by adjusting the nuts or collars 26 upon the rod or bolt 23.

The pistons and cylinders 18—20 constitute pressure-creating units for applying pressure against the outer slide 14 when the latter is in engagement with the work. The cylinder and piston elements 22—21 constitute a unit whereby the inner slide 15 may be lowered and raised, and also serve to create pressure upon the inner slide 15 when work is being performed.

The outer slide 14 is supported by means of the inner slide 15 and piston 21 operating in the cylinders 22, by fluid pressure operating upon the portion 30 of the piston 21, in a manner to be described.

Connected with the outer slide 14 are cylinders 31 in which pistons 32 operate, and these pistons 32 are connected to the inner slide 15, so that when there is a relative movement between these slides, the pistons 32 will be moved with respect to their respective cylinders 31. Any number of the cylinder and piston elements above described may be employed.

Leading from each of the cylinders 31 is a pipe or passage 33, each of which communicates, respectively, with a passage 34 in the respective pistons 18, so that when fluid is in the cylinder 31 and the slides 14 and 15 are relatively moved in directions toward each other, fluid which is beneath the piston 32 will be forced out of the cylinder 31 through the passage 33 and passage 34 in the piston 18, into the cylinder 20, for the purpose of maintaining constant, the pressure created in the cylinder 20. That is, by the relative movement of the slides 14 and 15, the fluid pressure in the cylinder 20 will not be increased, but the pressure will be maintained constant during the operative strokes of the slides.

The cylinder 22 has communication with a fluid supply tank 35 through a pre-fill valve 36. This valve may be of any desired or suitable construction, is similar to the pre-fill valve for the cylinder 20, and comprises a valve element 37 having connected therewith a piston 38. The valve is adapted to be opened by suction created in the cylinder 22 when the piston 21 is moving to lower the slide 15. However, the valve closes when suction ceases upon stoppage of piston 21 in the cylinder 22, so as to prevent the discharge of the liquid from the cylinder during the pressure stroke of the press.

A similar valve construction 39 is provided for each of the cylinders 20.

Fluid pressure is supplied to the system from any suitable source, preferably from a pump 40 suitably located, and preferably supported by the crown of the press. All of the operating parts, including the control valve mechanisms, are also located upon the crown of the press.

The pump is operated by means of a motor 41, and to one side of the pump is connected a fluid supply line 42, and the other side of the pump is connected, by means of a pipe 43, to a relief valve 44, which may be provided, and from this valve 44 a connection 45 leads to a four-way valve structure 46, the preferred construction of which valve is illustrated in Figs. 6 and 7, the valve being provided with an outlet pipe 47 that leads to the tank.

Leading from the four-way valve 46 is a pipe 48 which has communication with the cylinder 22 for supplying fluid pressure to the piston 21, to operate the inner slide 15. Leading also from the four-way valve 46 is another pipe 49 which has communication with the cylinder 22 beneath the piston head 30, and through which pipe 49 fluid pressure is supplied to raise the slide 15.

The four-way valve 46 also has communication, by means of a pipe 50, with a three-way valve 51, and this three-way valve 51 has communication with a regulating valve structure 52 by means of a pipe 53.

Leading from the regulating valve structure 52 is a pipe 54 which has communication with the cylinders 20 to supply pressure fluid to these cylinders above the pistons 18, and thereby create pressure upon the outer slide 14 when the latter is in engagement with the work to hold the work. The fluid pressure which is thus supplied to the cylinder 20 will pass through the opening 34 in the piston 18 and, by means of the pipe or passage 33, will enter the cylinder 31 below the piston 32, so that as the outer slide is supported by the inner slide, the outer slide will descend, by gravity, with the inner slide, thereby maintaining the two slides in such a relative position that the inner slide will not contact the work in advance of the outer slide. When the outer slide 14 does contact the work, its descending movement will be arrested, while the inner slide 15 will continue in its downward movement under the force of the pressure exerted in the cylinder 22 upon the top of the piston 21.

During this relative movement of the inner slide with respect to the outer slide, the pressure fluid which is in the cylinder 31 will be forced therefrom by the movement of the piston 32 with respect to the cylinder, and the pressure fluid will then flow through the passage 33 and opening 34 in the piston 18, into the cylinder 20, thereby maintaining the predetermined pressure which has been created, upon the outer slide, without increasing such pressure, the action being merely that the fluid will be transferred from the cylinder 31 into the cylinder 20.

The slides are raised by exerting fluid pressure in the cylinder 22 beneath the piston head 38 by the action of the four-way valve, in a manner to be described. When the pressure is admitted into the cylinder 22 beneath the piston head 38, the inner slide will raise until the head of telescoping bolt 23 contacts the top plate of the inner slide, to raise the former. As the inner slide raises, fluid in the cylinders 20 will flow through the openings 34 and pipes 33, back into the cylinders 31 under the pistons 32.

As the slides descend, the pre-fill valves 36 and 39 will open, due to suction prevailing in cylinders 22 and 20, and will close when suction ceases in these cylinders, due to momentary stoppage of slides when contacting the work. These valves then remain closed during working pressure stroke of inner slide 15. In order to permit the slides to be raised, it is necessary to open the pre-fill valves so that the fluid which is in the

cylinders 20 and 22 will be discharged therefrom back into the tank 35. This is accomplished by means of pressure fluid from pipes 69 and 70.

There is provided a pilot system pump 55, which is operated by a motor 56 and receives a supply of fluid through a pipe 57. A relief valve 58 is provided in a pipe 59 leading from the pump 55. The pipe 59 has a connection 60 leading to a valve 61 which is preferably operated by a solenoid 62, and this valve 61, which may be of any desired construction, controls the movement of a valve element 63 in one direction. The pipe 59 also has connection with another valve 64 which is preferably operated by a solenoid 65 for controlling the movement of the valve element 63 of the four-way valve 46 in the opposite direction, the pilot pressure fluid flowing from the valve case 61 through a pipe 66, and from the valve 64 through a pipe 67.

This pipe 59 also has connection with the three-way valve 51 for moving a valve element 68 in one direction, to control the flow of fluid pressure through a line 69, to direct fluid pressure to operate the pre-fill valves 39 to open the latter to establish communication between the cylinders 20 and the tank 35. A branch 70, leading from the pipe 50, operates the pre-fill valve 36 to open the latter and establish communication between the cylinder 22 and the tank 35.

With this construction, it will be manifest that when the control valves are properly actuated, the pressure fluid will control the operation of the pre-fill valves.

The three-way valve is provided with a discharge outlet 71, which communicates with the tank 35, and the operation of the valve element 68 of the three-way valve 51 is controlled, preferably, by a solenoid-operated valve 72, which may be of any desired or suitable construction, the valve 72 having a discharge outlet 73, which communicates with the tank.

The pipe 53 also has communication with the blank holder pressure regulating valve 52, the latter embodying a solenoid-operated valve 75, a shut-off valve 76, a check valve 77, and an air-operated relief valve 78. The solenoid-controlled valve 75 operates to cut off passage 81 from communication with passage 79, so that when a predetermined pressure in the cylinders 20 has been built up, the valve 78 will open by this fluid pressure. This will establish communication between the passage 54 and the pipe or passage 83, so that the fluid pressure will be manifested upon the shut-off valve 76.

The valve 76 will then be shifted from the position shown in Fig. 3 to a position to close the passage 82, thereby cutting off the source of fluid supply to the cylinders 20 through the pipe 53. The pressure built up in the cylinders 20, however, is controlled by the valve 78, which itself may be set to open at any predetermined pressure.

Any number of the pressure regulating valves 52 may be provided, according to the number of blank holder cylinders, and are so arranged that different fluid pressures may be obtained in the different cylinders. The difference in degree of pressures may be obtained according to the predetermined opening pressures for which the respectvie relief valves 78 are set.

After the predetermined pressures in the cylinders 20 have been established, and during that part of the cycle of operation of the slides when one moves with respect to the other, in a direction towards the work, the fluid will be discharged from the cylinders 31.

In order to prevent the fluid discharged from the cylinders 31 from increasing the pressure in the cylinders 20 and, at the same time, maintain the predetermined established pressure in these cylinders, provision is made to permit the fluid from the cylinders 31 to flow back to the tank through the relief valve 78, which latter valve maintains the predetermined pressure.

At this time the valve 75 is open, establishing communication between passages 81 and 79, so that the fluid thus displaced from cylinders 31 will flow through the passage 83, thence through the valve 75 to passage 79, back to the tank.

The volume of liquid in the cylinders 31 also serves as a means to compensate any leakage in the blank holder or outer slide hydraulic system.

A pressure release valve 84 may be provided for the valve 46, and pressure gauges such as those illustrated at 85 (shown more particularly in Figs. 1 and 2), may be employed wherever necessary or desired. If desired, the pilot fluid from the pipe 59 may be directed through a pipe 86 (see particularly Fig. 2), through a filter 87, thence to a cooler 88, before being directed back to the tank through a pipe 89.

The solenoids which operate the valves may themselves be controlled in any desired or suitable manner, but preferably by means of a suitable switch for controlling the limit of movement of the slides in directions away from the work. Any number of suitable switches may be provided, such as that diagrammatically illustrated at 90 (in Fig. 2), in which there is provided a switch arm or member 91 which may be fastened to the frame of the press and is adapted to be engaged by a member 92, preferably carried by one of the slides 14—15, to operate the switch. A suitable switch device 93 having an operating arm 94, actuated by an adjustable cam device 95, may be provided as a release switch for controlling the work stripping operation.

It is thought that the operation of this press will be clearly understood from the foregoing description, but, briefly stated, it is as follows:

When the valve element 63 of the four-way valve 46 is in a neutral position, that is, in the position shown in Fig. 5, the supply of pressure fluid both from the main source of supply and from the pilot supply for operating the control valves, is blocked or shut off; that is, the flow of the fluid to the operating parts is obstructed.

At this time, the supply of pressure fluid from the main pump 40 will circulate through the pipe 45, through the valve element 63, and back through the pipe 47 to the tank.

To lower the slides, the valve element 63 is shifted from the neutral position shown in Fig. 5 to the position shown in Fig. 7, which will open the exhaust from the cylinders 22 so that the fluid will be forced, by the lowering of the piston 21, from the cylinder 22 through the pipe 49, thence through the valve element 63 of the four-way valve 46, and out through the pipe 47 to the tank.

The two slides will then descend by gravity, their weight forcing the fluid from the cylinder 22 back to the tank, in the manner just described. As the pistons 18 and 21 descend, suction will be manifested in the cylinder 22, which will open the pre-fill valve 36 automatically, allowing the fluid to flow from the tank 35 into the cylinder to fill the space thus created in the

cylinder, but no pressure will be generated. At the same time, the pre-fill valves 39 in the cylinders 20 will likewise open to supply fluid to the cylinders 20. The slides descend until the outer slide or blank holder strikes the work. At this time, the outer slide or blank holder is arrested in its movement, and the inner slide will continue to move downwardly, operating the control switch 96, which causes a reversal of the valve element 63 in the valve 46, and operates the valve element 68 in the three-way valve 51, through the medium of the solenoids. The valve 46 will then direct the discharge from the pump 40 into the cylinders 22, through the pipe 49, to the under side of the piston head 30, and will also direct the fluid through the pipe 50 into the three-way valve 51. This will set the three-way valve to communicate through the blank holder pressure regulating valve 52, to the blank-holding cylinders 20, causing a pressure to be built up in the blank holder cylinders toward the work, and which pressure is greater than the pressure in the pull-back cylinder 22, at the same pressure per square inch. The force of pressure in the pull-back cylinders will therefore be less than the force of pressure in the blank holder cylinders.

The pressure in the system builds up until it reaches an amount to open the relief valve 78 in the blank holder pressure regulating valve 52, and, obviously, this relief valve may be adjusted to a required predetermined pressure to open the same. The opening of this relief valve 78 permits the fluid under this pressure to flow into the shut-off valve 76, which causes the latter to shift, thereby shutting off the supply of pressure fluid from the pump to the blank holder.

A check valve 77 is arranged between the relief valve 78 and the shut-off valve 76, which traps the fluid in the blank holder cylinders 20 and prevents any return flow from the blank holder cylinders, and also prevents any drop of pressure in the blank holder cylinders.

The switch 96 controls the three-way valve 51, the four-way valve 46, also a normally open solenoid shut-off valve 75 to close the latter, during the time of building up of pressure in the blank holder cylinders. In the line 53 between the three-way valve 51 and the regulating valve 52, there is provided a pressure-operated switch 53a, set at a predetermined pressure, which, however, is higher than the blank holder pressure.

With the shut-off valve 76 having closed, the pump pressure will build up to the pressure of the pressure-operated switch 53a, and will operate the latter. This switch in turn operates the solenoid of the shut-off valve 75, and also shifts the four-way valve 46 to cause the inner slide 15 to move downwardly, in a manner already described. The outer slide 14 will now be locked, with full predetermined pressure against the work.

The four-way valve 46, being now positioned as shown in Fig. 7, will exhaust the fluid from the pull-back cylinders 20 and direct the volume of the pump discharge into the main cylinder 22 of the inner slide 15, thereby moving the inner slide downward by pressure and against the resistance of the pressure-maintaining cylinders 31, thereby eliminating the possibility of any dropping of the inner slide by gravity. The inner slide 15 will then be forced downwardly by fluid pressure from the pump, through the pipe 48, causing a displacement in the pressure-maintaining cylinders 31, which displacement is discharged through the pipe 33 and hollow passage 34 in the piston 29, into the blank holder cylinders 30, and then passes through the pressure relief valve 78 in the blank holder pressure-regulating valve 52, back into the tank, in the manner heretofore described.

This maintains the predetermined pressure in the blank holder cylinders during another draw stroke of the inner, or punch, slide. The draw stroke is terminated when a predetermined pressure is reached on the inner slide 15, at which time a suitable switch 90—91 will cause the valve element 63 in the four-way valve 46 to be shifted into a position to obtain the up-stroke of the inner slide. The main cylinder 22 of the slide 15 is thereby connected with the tank, releasing the pressure from the main cylinder.

At the same time, the pump discharge is connected with the cylinder 22, to direct fluid pressure under the piston head 30, to pull back the slides, through the pipe 49, which automatically, through the pipe 70, also connects the pump with the pilot piston for operating the pre-fill valves 36 to open the latter, allowing the fluid in the main cylinder 22 to escape into the tank, while the inner slide 15 is being thus pulled back or raised by the pressure in the cylinder 22 under the piston head 30.

The pump discharge also passes from the four-way valve 46 through the three-way valve 51 and the blank holder pressure-regulating valve 74 (lifting the check valve 77 in the latter), into the blank holder cylinders 20, thereby maintaining the pressure in the blank holder cylinders and, consequently, on the outer slide 14, holding it down, thus maintaining pressure on the work, while the inner slide 15 is being extracted or moved away from the work.

During this lower portion of the up-stroke of the inner slide 15, the blank holder or outer slide 14 remains down; consequently, the rams of the pressure-maintaining cylinders 32 are being withdrawn from their cylinders 31 and the voids created therein are being filled with pressure fluid from the pump, through the blank holder cylinders and their hollow blank-holding rams 29. This supply of pressure fluid into the pressure-maintaining cylinders 20 results in an uplifting force for the inner slide 15, by acting upon the pistons 32 in the pressure-maintaining cylinders 31, which results, during this part of the stroke only, in a lifting force in excess of the lifting force of the pull-back cylinders 20, which is desirable in stripping the work from the punch or die carried from the inner slide 15. During this operation, the outer slide is being held down against the work by fluid pressure from the pump 40.

After this stripping stroke has been finished by the inner slide, a switch 93—94 will be operated to cause the three-way valve element 68 to be shifted from the position shown in Fig. 4 to the position shown in Fig. 3, when the pump discharge will be diverted to the pilot pistons of the pre-fill valves 39, through the line or pipe 69, for operating the pre-fill valves 39 of the blank holder cylinders 30. These valves, however, will not open until the pressure-maintaining cylinders 31 have been relieved by the further upward movement of the inner slide 15 which pulls the pistons 32 out of the pressure-maintaining cylinders.

Pipes 39a lead from the pre-fill valve casings 39 and discharge back into the tank, and an overflow 97 maintains a liquid level in the tank 35.

With the present construction, and due to the fact that pressure is created in the cylinders 20 by the pump, and as this pressure is maintained by the fluid from the pressure-maintaining cylinders 31, the cylinders 20 are small in area; consequently, the additional force required by the inner slide 15, to displace the smaller amount of fluid, is much less than in prior hydraulic presses of this character. This also renders it possible to provide a small cylinder 22 for the inner slide, and consequently requires only a comparatively small pump and motor, resulting in a press much more economical in power consumption than other presses. Furthermore, as the outer slide pressure is independent of the inner slide pressure, each pressure can be adjusted independently of the other.

With this improved press, the outer or work clamping slide is mechanically suspended from the inner or punch carrying slide by means of the rod or bolt, any number of which may be provided, and are relatively movable.

In one stroke of the press, both the outer and inner slides descend simultaneously until the outer slide contacts the work.

In that instant, the movement of the outer or clamping slide is arrested. In the same instant, the pressure supply pump will discharge into the cylinders which create the pressure upon the outer or work holding slide, generating the clamping pressure up to a predetermined fixed amount of pressure, in a short period of time. At the instant when this predetermined clamping or holding pressure is reached, the inner slide again starts its own downward stroke, because the pump discharge will have been disconnected from the pressure creating cylinders for the clamping or work holding slide, and also will have been automatically connected with the hydraulic cylinder which actuates the inner slide.

During this further downward stroke of the inner slide, this slide actuates an auxiliary hydraulic piston and cylinder element of smaller diameter, any number of which may be provided. The fluid discharged from the auxiliary cylinder is delivered into the cylinders of the clamping or work holding slide for maintaining the established clamping pressure, but does not generate pressure to operate the clamping slide. The excess fluid ejected from the cylinders, the pistons of which are actuated by the relative movement of the slides, is by-passed through a pressure relief valve, which latter is set to the maximum clamping pressure of the outer slide.

That is, in this operation, the clamp or work holder is first brought into clamping position by the movement of the inner slide, at the will of the operator. Then the clamping pressure is developed to its predetermined value from the pressure supply pump, whereupon the source of pressure is disconnected from the clamping or work holding slide, and is connected to the inner or punch slide operating cylinders. As a result, the inner or punch slide descends and causes the pressure-maintaining fluid to pass from its auxiliary cylinder into the main clamping cylinder, without increasing the pressure in the clamping cylinder.

There has been described only one of the regulating valve structures 51 and its connection with one of the pressure creating cylinders 20 of the outer slide, and two only of such valves are shown in Fig. 2 of the drawings. It is to be understood, however, that as many of these valves 51 may be used as desired; that is, one for each of the cylinders 20. In the present type of press, there are provided four cylinder and piston units 18—20, one for each corner of the outer or work holding slide. This renders it possible to establish different predetermined pressures in the respective cylinder and piston units 18—20, as may be desired, as each valve controls the fluid pressure from the common source to the respective cylinder and piston units 18—20. By adjusting or setting the respective valves 78, according to the degree of pressure it is desired to establish, such pressure may be varied in the different cylinder and piston units.

Thus it will be seen that, with this arrangement, pressure will be built up to the pressure at which the work holding or outer slide switch 53a is set to operate, at which time this switch will trip or operate, causing the four-way valve 46 to shift, to allow the slide to continue in its downward movement.

While the preferred form of the invention has been herein shown and described, and the preferred hydraulic systems and arrangements of pipes and valves have also been shown and described, it is to be understood that various changes may be made in the details of construction and in the combination and arrangement of the several parts, within the scope of the claims, without departing from the spirit of this invention.

What is claimed as new is:

1. In combination in a press, a slide, a work clamping slide supported thereby for movement therewith and with respect thereto, means for moving the first said slide to move the clamping slide into a clamping position, cylinder and piston units connected with the clamping slide, means for creating and means for maintaining in the said units a predetermined fluid pressure upon the clamping slide, an auxiliary cylinder and piston unit operable by the relative movement of the slides, means operating when said predetermined pressure is established, to disconnect the source of fluid pressure supply from the first said units, and for connecting said source of supply to a cylinder and piston unit for actuating the first said slide to further move the latter in a direction toward the work, and means whereby upon relative movement of said slides after said predetermined fluid pressure has been established upon the work clamping slide, to transfer the pressure fluid from said auxiliary cylinder to the cylinder which fluid pressure upon the work clamping slide has been created, to compensate leakage in the clamping slide cylinders while maintaining the said predetermined pressure in the last said cylinders against variation.

2. In combination in a press, a slide, a work clamping slide supported thereby for movement therewith and with respect thereto, means for moving the first said slide to move the clamping slide into a clamping position, cylinders and pistons connected with the clamping slide, means for creating and means for maintaining in the said cylinders a predetermined fluid pressure upon the clamping slide, an auxiliary cylinder and piston unit operable by the relative movement of the slides, means operating when said predetermined pressure is established in the clamping slide cylinders, to disconnect the source of fluid pressure supply from the first said cylinder, and for connecting said source of supply to a cylinder and piston unit for actuating the first said slide to further move the latter in a direction toward the work, means whereby upon relative movement of said slides after said predetermined

fluid pressure has been established upon the work clamping slide, to transfer the fluid from said auxiliary cylinder to the cylinder in which fluid pressure upon the work clamping slide has been created, to compensate leakage in the clamping slide cylinders while maintaining unvaried the said predetermined fluid pressure in the clamping slide fluid pressure cylinders, means embodying valve mechanism for supplying fluid to the cylinders to fill the space created by the relative movement of the cylinder and piston element, and means for opening said valve.

3. In combination in a press, a slide, a work clamping slide supported thereby for movement therewith and with respect thereto, means for moving the first said slide to move the clamping slide into a clamping position, cylinder and piston means connected with the clamping slide, means for creating and means for maintaining in the said cylinder a predetermined fluid pressure upon the clamping slide, an auxiliary cylinder and piston unit operable by the relative movement of the slides, means operating when said predetermined pressure is established in the clamping slide cylinders, to disconnect the source of fluid pressure supplied from the clamping slide cylinders, and for connecting said source of supply to a cylinder and piston unit for actuating the first said slide to further move the latter in a direction toward the work, means whereby upon relative movement of said slides after said predetermined fluid pressure has been established upon the work clamping slide, to transfer the pressure fluid from said auxiliary cylinder to the cylinder in which fluid pressure upon the work clamping slide has been created, whereby to compensate leakage in the clamping slide cylinders, while the said predetermined fluid pressure will be maintained in the clamping slide fluid pressure cylinders, means embodying valve mechanism for supplying fluid to the cylinders to fill the space created by the relative movement of the cylinder and piston element, and means embodying a fluid pressure system for opening said valve.

4. In combination in a press, two movable slides, a source of supply of fluid pressure common to the slides, means individual to the slides for causing the fluid pressure from said source to be directed to the respective slides to operate thereupon, means whereby a predetermined fluid pressure may be established upon the respective slides, and a piston and cylinder unit one of the elements of which is connected to and movable with each of the slides, said units being relatively movable in response to the relative movement of the slides, said unit operating to transfer fluid from a supply to the fluid pressure operating means of one of the slides for compensating leakage of the fluid pressure in the last said means and for maintaining against augmentation the said predetermined pressure upon the last said slide for a predetermined period in the retraction movement of the other of the slides.

5. In combination in a press, two movable slides, a source of supply of fluid pressure common to the slides, means individual to the slides for causing the fluid pressure from said source to be directed to the respective slides to operate thereupon, the fluid pressure actuated means of one of said slides embodying a plurality of cylinder and piston units, means whereby a predetermined fluid pressure may be established in said units, the last said means embodying mechanism adapted to be set to obtain different predetermined fluid pressures in said units, and supplemental cylinder and piston units to which the fluid pressure from said source is also directed, said supplemental units being actuated by the relative movement of the slides and operating to transfer fluid from said supplemental units to the first said units, to compensate leakage in the latter and for maintaining said predetermined fluid pressure in said units against augmentation during a predetermined retraction movement of one of the slides.

6. In combination in a press, two movable slides, a source of supply of fluid pressure common to the slides, means individual to the slides for causing the fluid pressure from said source to be directed to the respective slides to operate thereupon, the fluid pressure actuated means of one of said slides embodying a plurality of cylinder and piston units, means whereby a predetermined fluid pressure may be established in said units, the last said means embodying valve mechanism adapted to be set to obtain different predetermined fluid pressures in the respective cylinders of said units, supplemental cylinder and piston units in which said predetermined pressure is also established, said supplemental cylinder and piston units being operable by the relative movement of the slides for transferring fluid from said supplemental units to the first said units, to compensate leakage in the first said units and to maintain said predetermined fluid pressure therein, while the said predetermined fluid pressure is maintained against augmentation, and means for causing fluid pressure from the first said source of supply to pull back one of said slides.

7. In combination with a press having two independently movable fluid pressure operated rams, a source of supply of fluid pressure common to the rams for applying pressure thereupon, means adapted to establish a predetermined pressure to be exerted upon one of the rams, a cylinder and piston unit, one element of which is connected to and movable with each of the rams, said cylinder having communication with one of said rams and being also supplied with fluid from said source, and in which cylinder said predetermined fluid pressure is also established, the fluid from said cylinder being transferred therefrom by the relative movement of the elements of said unit, caused by the relative movement of the rams, to compensate leakage in one of said rams, while the said degree of said predetermined pressure upon the last said ram is maintained against increase during a predetermined portion of the retraction movement of the other of said rams.

8. In combination with a press having two independently movable fluid pressure operated rams, a source of supply of fluid pressure common to the rams for applying pressure thereupon, means embodying valve mechanism adapted to be set to establish a predetermined pressure to be exerted upon one of the rams, a cylinder and piston unit, one element of which is connected to and movable with each of the rams, said cylinder having communication with one of said rams and being also supplied with fluid from said source, and in which cylinder said predetermined fluid pressure is also established, the fluid from said cylinder being transferred therefrom by the relative movement of the elements of the said units, caused by the relative movement of the rams, to compensate leakage in one of said rams, while the said degree of said predetermined pressure upon the last said ram is maintained against increase during a predeter-

mined portion of the retraction movement of the other of the rams.

9. In combination with a press having two slides independently movable, a ram for moving one of the slides, a plurality of ram units for moving the other slide, a source of supply of fluid pressure common to the rams and ram units for creating pressure thereupon, means individual to the said ram units and adapted to be set whereby different predetermined fluid pressures may be established in the respective said units, a cylinder and piston unit individual to each of the rams of the first said units and in which cylinders said predetermined fluid pressure is also established, one of the elements of the last said unit being connected to each of the slides, the fluid pressure from said cylinders being transferred to the respective rams of said ram units upon relative movement of the slides, whereby leakage in the rams of said units will be compensated, the said predetermined fluid pressure in said cylinders and in the respective rams of said ram units being maintained against increase by such transfer of the fluid during a predetermined period in the retraction movement of the rams.

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