Sept. 1, 1942. H. F. MacMILLIN ET AL 2,294,675

METAL STRETCHING PRESS

Original Filed March 25, 1940

FIG. 1.

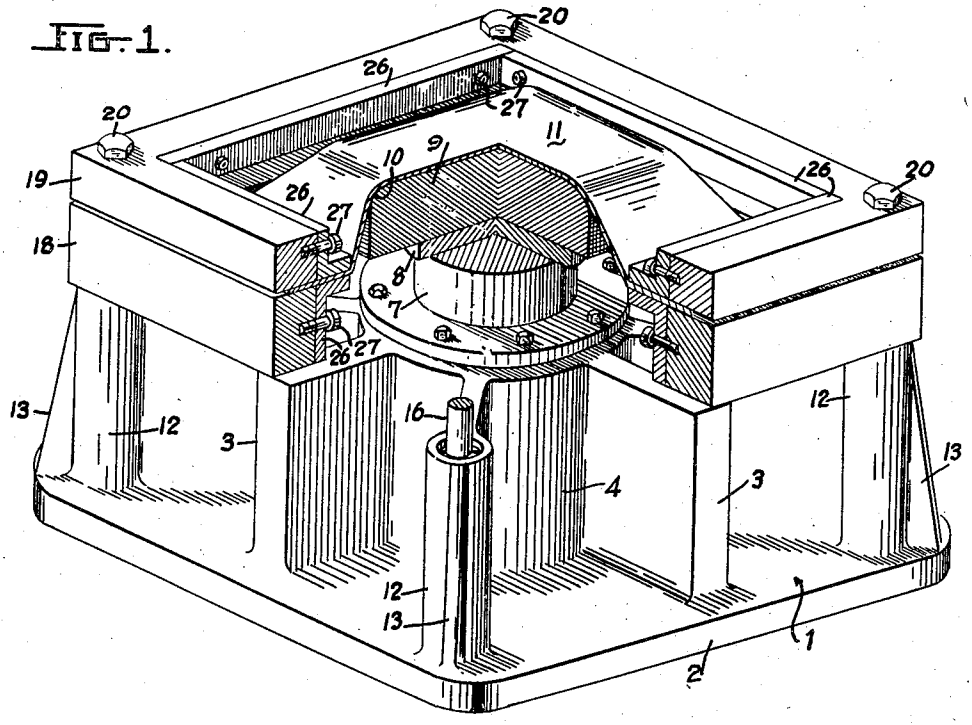
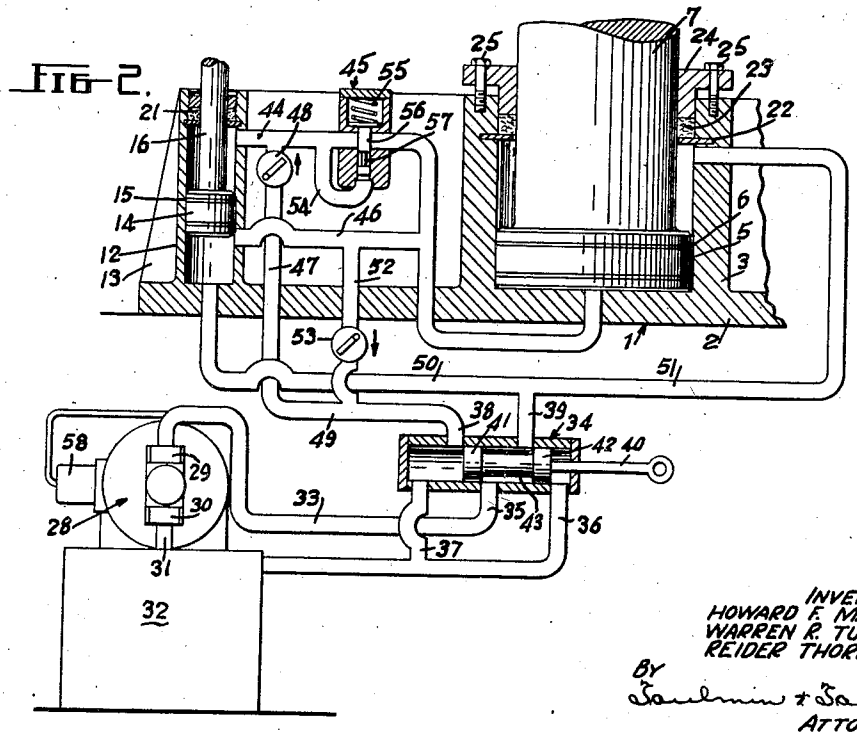


FIG. 2.



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METAL STRETCHING PRESS

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6 Claims. (Cl. 113—45)

The present invention relates to hydraulic presses, and particularly to presses of the type that employ mechanism for clamping the workpiece to the press.

This application is a division of our application Serial Number 325,780 filed March 25, 1940 and entitled "Metal stretching press."

In certain forms of hydraulic drawing presses it is sometimes necessary to clamp the sheet of metal to the bed or top plate of the press. Various methods for doing this have been proposed, and practically all of these methods depend on the use of clamping or gripping forces derived from pneumatic cylinders, electric motors or hand-power-operated through levers. The use of these forces obviously requires a source of energy different from that employed in the press, which adds to the expense of the press as a whole, also to the installation and to the complexity of operation. Furthermore, the power-multiplying levers are often of a complicated mechanical character due to the manner and direction in which the force is applied.

Presses of this general type quite frequently require precise timing between the clamping and pressing forces, particularly to insure that the gripping effect is provided before the metal is worked. Obviously, this timing requirement is difficult to achieve and maintain, where separate sources of energy are employed for the gripping and pressing operations.

Another precaution which must be taken is to insure that the clamping effect is not withdrawn until the punch of the press has broken contact with the metal. Moreover, in so-called "stretching" presses in which certain slippage of the metal is permitted and required to accommodate the drawing or forming operation, it is often difficult to make the necessary adjustments of the prior-art clamps to not only insure proper timing but also the proper amount of slippage, and it is harder yet to change the adjustments of the clamps individually to produce local pressing effects.

The primary object of the present invention is to provide a hydraulic press which is adapted to grip the work with or without slippage, and to eliminate all of the disadvantages in connection with prior-art presses of this general character.

Another object is to provide a press in which the gripping or blank holder jaws are acted upon by the same source of power which is employed for operating the press.

A further object is to provide a hydraulic press in which the clamping effects are obtained by direct hydraulic pressure, thus insuring perfect coordination between the press and the work-clamping mechanism. Only a single source of hydraulic power is required for these two purposes, so that when pressure is applied to the fluid of the press the clamping mechanism is simultaneously subjected to the pressure of the same fluid.

A still further object is to provide a hydraulic press in which the workpiece is gripped at a number of different areas throughout the surface of the workpiece, and ready adjustment may be made of the final clamping effects at the various clamping positions.

In carrying out the above objects there is provided a number of hydraulically actuated pistons for applying pressure to a similar number of clamps or gripping devices spaced about the workpiece and receiving their power from the same source of pressure fluid which operates the press. Each of these pistons reciprocates in cylinders, the pressure of which may be adjusted as a whole or individually in order to provide the necessary general or special clamping effects.

Other objects and features will be apparent as the specification is perused in connection with the accompanying drawing.

In the drawing:

Figure 1 is a perspective view with a part broken away and in section, of a hydraulic press, improved in accordance with the present invention.

Figure 2 is a fragmental view, or sectional view, of the improved press showing a hydraulic circuit in diagram which may be employed in connection with the press.

Referring to the drawing, numeral 1 designates in general, the bed of the press. This bed is provided, at the bottom, with a base 2 of rectangular configuration from which extend upwardly, preferably midway between opposite edges of the base, a number of webs 3. These webs radiate outwardly from a hub or cylinder 4 integrally joined to the base. The interior of the cylinder wall is preferably ground and receives a piston 5 provided with the usual rings 6, the piston being carried by a plunger 7 to which is secured at the upper end a platen 8. The latter detachably carries a punch 9, having rounded edges, as indicated at 10 and of a configuration determined by the shape of the article, indicated at 11, which is being pressed.

The base 2 is provided at each corner with an upstanding cylinder 12, preferably formed integral with the base, as by casting, these cylin-

ders being reenforced by the triangular webs 13. Each cylinder contains a reciprocatory piston 14 with rings 15 and carried by the piston rod 16, which is provided with a top threaded portion of smaller diameter than the lower or main portion, to leave a shoulder (not shown). The piston rods 16 extend loosely through openings provided in the hollow rectangular frame member 18 which is normally termed a top plate. The shoulders, on the piston rod 16, carry a gripping plate 19 having a configuration similar to that of the top plate, the gripping plate being secured to the piston 16 by a nut 20 which engages the threaded portion of each rod.

The piston 14 is provided with the usual packing material and gland 21. The centrally positioned piston 5 is provided with a washer 22, packing material 23, and a packing gland 24 which can be drawn toward the cylinder 4 by the bolts 25. As indicated in the drawing the cylinders 12 terminate at the same height, and provide a support at their upper surfaces for the top plate member 18.

The plates 18 and 19 constitute a frame with large rectangular openings therein which are adapted to receive the sheet metal 11 while it is being formed to the required shape. There are a number of die strips 26 detachably secured to the interior surfaces of the plates 18, 19, as for example by means of bolts 27. These strips are preferably made of hardened steel, and may have any form and dimensions, depending on the configuration of the metal article 11. These strips may advantageously take the form of an angular bar, as illustrated, one leg of which is wide enough to receive the bolts 27.

For operating the press there is provided a single one-way hydraulic pump 28, which may be actuated by an electric motor (not shown). The outlet of the pump is indicated at 29 and the inlet at 30. The latter is connected, through a metal conduit 31, with a tank 32 containing a suitable fluid, for example, oil. The outlet of the pump is connected through a metal conduit 33 to a four-way valve 34 of any suitable and well known type. The high pressure ingress to the valve is indicated at 35 and the low pressure egress at 36. There is also a low pressure pipe 37. The high pressure discharge pipes are shown at 38 and 39. The valve 34 contains a piston rod 40 which is secured to a pair of pistons 41 and 42 respectively, joined together by a rod 43. The pistons 41 and 42 are spatially related in such a way as to control the passage of the pressure fluid to and from the valve, in accordance with the longitudinal movements of the rod 40 and for purposes which will be explained presently. This rod may be pivotally secured to any convenient form of hand or automatic operating mechanism, such as a lever system or the movable core of an electromagnet or a crank driven by a motor. In any of these cases the rod 40 is adapted to be moved in a horizontal direction at a predetermined time and for a predetermined distance, depending upon the operation desired of the press.

There is a pipe 44 taken from the rear side of the clamping piston 14 to the under or working side of the piston 5 with a pressure limit valve, or admission valve, generally indicated by the reference character 45, placed in this pipe so as to assure that the main piston will not elevate until a predetermined pressure has been built up in the clamping cylinders.

A pipe 46 is connected to the pipe 44 at a point between the admission valve 45 and the lower side of the piston 5, this pipe 46 being also connected to the clamping cylinder 12, at a position in front of the clamping piston 14 and at a distance upwardly from the base 2. There is also a vertical pipe 47 connected through a check valve 48 at the top of the pipe 44 at a position between the admission valve 45 and the clamping cylinder. The lower end of the pipe 47 is extended through a horizontal length, indicated at 49 which connects with a high pressure discharge pipe 38. The other high pressure pipe 39 connects through branch pipe lines 50 and 51 to the lowermost portion of the clamping cylinder 12 and to the rear of the main piston 5 respectively. As shown in the drawing, there is also a short length of pipe 52 connected between the two horizontal pipes 46 and 49 through a check valve 53.

The position of the main piston is shown as having completed its downward stroke, and the clamping pistons as having been elevated to raise the gripping plate 19 to such a position as to enable the previously formed article to be removed and a new sheet of metal 11, placed in position between the plates 18 and 19. Assuming that the pump 34 is delivering high pressure fluid through the pipe 33 and that it is desired to start the main piston 5 on its downward working stroke, the rod 40 is moved to the left in any suitable manner, automatically or manually through the use of levers, a motor or electromagnet. Under these circumstances, high pressure fluid passes through the valve 34, through the pipe 49 and the check valve 48 (noting that the vane of the check valve is pivoted to permit upward flow of fluid), into the space to the rear of the piston cylinder 14.

It will be understood that there are four such cylinders and that suitable lateral connections are made from the various pipes shown in Figure 2 to assure the instantaneous admission of fluid to all of the clamping cylinders. This fluid, after filling up the spaces in the clamping cylinders, will cause the pistons 14 to move downwardly and permit a lowering of the gripping plate 19, eventually causing the nuts 20 firmly to clasp the plate 19 and its die strips 26 against the metal sheet 11.

When sufficient pressure has been built up to the rear of the pistons 14, in the manner described, the excess fluid from the pump, or rather the pressure exerted thereby, is effective through the pipe 54 (depending on the pressure adjustment of the spring 55) to move the pistons 56 out of the path of the pipe 44. The undercut portion 57 of the admission valve is now presented to the pipe 44, allowing easy access for the surplus pressure fluid to pass through the right-hand portion of the pipe 44 to the lower side of the main piston 5. It is apparent that as long as the pressure to the rear of the clamping pistons 14 remains as great as the pressure for which the admission valve 45 is set, all of the output from the pump will be passed through the valve to the working side of the main piston 5, causing the plunger 7 to be elevated.

It will be understood that if for any reason, the pressure in the upper portions of the clamping cylinders becomes less than that necessary to operate the admission valve, fluid is admitted to the clamping cylinders until the pressure has been restored to the predetermined value, at which time the excess pressure fluid will be bypassed through the valve into the main cylinder.

As the plunger 7 continues to rise, the punch 9 (Figure 1) contacts with the metal sheet 11 and forms the sheet into an article of desired shape.

Upon completion of the pressing or forming operation, as may be either automatically determined or visually observed by the operator, the latter either moves or causes to be moved, the rod 40 to the right which is the position shown in Figure 2. Under these circumstances the high pressure discharge of the pump is now admitted to the discharge pipe 39 and a portion of the pressure fluid is introduced into the main cylinder to the rear of the piston 5 and the other portion into the clamping cylinders below the pistons 14. It will be noted that the pipe 44 which communicates with the lower portion of the main cylinder, is now connected through the check valve 53 and the four-way valve 34, to the low pressure pipe 37. Thus, all of the pressure is removed from the lower surface of the piston 5, permitting the plunger 7 readily to descend. In order to prevent an abrupt downward movement of the piston it may be desirable to insert a choke valve (not shown) in the pipe 37, which restricts the rate of flow of pressure fluid therethrough.

High pressure fluid travels through the pipes 39 and 51 to the space at the rear of the main piston 5, forcing the plunger 7 and the punch carried thereby downwardly and thus breaking the mechanical contact between the punch and the under side of the formed metal article.

In view of the fact that the plunger 7 tends to descend rather quickly, thus increasing the space at the rear of the piston 5 at a rapid rate, most of the pressure fluid delivered by the pump is transmitted through the pipe 51 and a very little through the pipe 50. However, as the pressure at the rear of the main piston increases more and more, pressure fluid is transmitted through the pipe 50, causing the clamping pistons 14 to ascend. These pistons will elevate to a height determined by the position of the horizontal pipe 46, which in effect, causes the pressure fluid to be exhausted through the line 52 and the valve 34, into the low pressure pipe 36. The clamping pistons 14 will therefore float or fluctuate between the position of the pipe 46 and the lower end of the clamping cylinders.

When the pistons have reached this "floating" position, the gripping plate 19, which is carried on the shoulders of the clamping plungers 16, will have reached its greatest distance removed from the plate 18 to enable the formed article 11 to be maneuvered out from between the plates 18, 19. It is apparent that the width of the space between the plates 18, 19 can be made as great as desired, depending on the shape of the formed article, by simply changing the position of the horizontal pipe 46 with respect to the lower surfaces of the cylinders 12. After the formed article has been removed, a new metal sheet can be readily inserted into position because the plunger 7 will have moved to its lower limit of travel, at which time the operator will cause the pistons 41, 42 to be moved to the left, thus applying first a clamping force to the plungers 16 and then an upward movement of the main plunger 7.

There is preferably provided, a pressure safety device 58 attached to the pump, the purpose of which is to shift the flow control ring in the pump to neutral when excess pressure has been developed anywhere within the hydraulic system during either the upward or downward movements of the clamping plungers 16 or the pressing plunger 7. It will be evident that by assuring the main piston 5 would not be moved upwardly until a predetermined pressure has developed at the rear of the clamping cylinders 14, a clamping pressure is always applied to the plate 19 and therefore on the metal sheet 11 before the punch 9 reaches the under side of the metal sheet. In view of the fact that the admission valve 45 is essentially a one-way element, the pressure built up at the rear of the clamping pistons will be maintained for an appreciable length of time after the plunger 7 has started its downward movement, thus assuring the proper amount of clamping pressure at the work when the punch 9 breaks mechanical contact (i. e. is stripped) with the under side of the formed article. This residual back pressure is relieved only when the clamping cylinders 14 are forced upwardly for a considerable distance, causing some of the fluid to the rear of the pistons 14 to be passed through the admission valve 45 and through the horizontal pipe 46 to the opposite side of each piston 14.

It is further evident that the admission valve 45 may be so designed or regulated as to provide any desired clamping pressure at the pistons 14 so as to permit the proper amount of slippage of the sheet 11 with respect to the plate 19 to accommodate the necessary stretch of the metal during the forming operation. If desired, the clamping pressure may be made so high as to prevent any slippage whatever. In any case, equal pressures are applied to all of the clamping pistons, assuring equal clamping effects at the plate 19 and therefore a perfectly symmetrical formed article.

It will be understood that we desire to comprehend within our invention such modifications as come within the scope of the claims and the invention.

Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent, is:

1. A hydraulic press comprising a main cylinder and a plurality of work-clamping cylinders arranged about the main cylinder, pistons in all of said cylinders and a direct hydraulic connection between said main and work-clamping cylinders, and means including a single source of pressure fluid for operating the pistons in the work-clamping cylinders simultaneously, said direct hydraulic connection between the main and the work-clamping cylinders serving to actuate the piston in the main cylinder in a predeterminad pressure relation with respect to the pistons in the work-clamping cylinders.

2. A hydraulic press comprising a main cylinder and a plurality of work-clamping cylinders arranged about the main cylinder, pistons in all of said cylinders, a source of pressure fluid, and conduits between said source and each of said cylinders, also a direct conduit between said main and work-clamping cylinders for actuating the pistons in the work-clamping cylinders in unison and for actuating the piston in the main cylinder in a predetermined pressure relation with respect to the pistons in the work-clamping cylinders, said means including an admission valve in said conduit system which serves to delay the operation of the piston in the main cylinder during the working stroke until after the pistons have been actuated in the work-clamping cylinders during the clamping stroke.

3. A hydraulic press comprising a main cylinder and a plurality of work-clamping cylinders

arranged about the main cylinder, pistons in all of said cylinders, a source of pressure fluid, and conduits between said source and each of said cylinders, also a direct conduit between said main and work-clamping cylinders for actuating the pistons in the work-clamping cylinders in unison and for actuating the piston in the main cylinder in a predetermined pressure relation with respect to the pistons in the work-clamping cylinders, said means including an admission valve in said conduit system which serves to delay the operation of the piston in the main cylinder during the working stroke until after the pistons have been actuated in the work-clamping cylinders during the clamping stroke, said valve serving to delay the actuation of the pistons in the clamping cylinders during the unclamping stroke until after the piston in the main cylinder has been actuated during the retraction stroke.

4. A hydraulic press comprising a main pressing cylinder and auxiliary clamping cylinders, a piston in each of said cylinders, a punch carried by the piston in the main cylinder, a work-clamping plate carried by the pistons in the clamping cylinders, and means including a source of pressure fluid and a control valve for applying the pressure fluid first to the working side of the clamping pistons and after the pressure has built up to a predetermined value said fluid is automatically and directly applied to the working side of the main piston, said means also serving to apply pressure to the rear side of the main piston during the retraction stroke and after the pressure has built up to a predetermined value the pressure fluid is applied to the rear side of the clamping pistons.

5. A hydraulic press comprising a main pressing cylinder and an auxiliary clamping cylinder, a piston in each of said cylinders, a punch carried by the main piston for forming a metal sheet into a desired shape, a clamping plate carried by the clamping piston for holding the sheet in position during the forming process, a source of pressure fluid and a control valve therefor, said valve being provided with high pressure and low pressure openings which communicate with said source, a piston in said valve, said valve also being provided with a pair of openings which are adapted to be an ingress and an egress respectively for the pressure fluid in an alternate manner depending on the position of the piston within said valve, a conduit extending from the ingress opening to the working side of the clamping piston, a conduit extending from the egress opening to the rear side of the main piston and also to the rear side of the clamping piston, a second conduit extending from the working side of the main piston to the working side of the clamping piston, and means positioned in said second conduit for assuring a predetermined pressure of the pressure fluid on the working side of the clamping pistons before the fluid in the main cylinder reaches such a pressure as to cause the punch to contact the metal sheet.

6. A hydraulic press comprising a main pressing cylinder and an auxiliary clamping cylinder, a piston in each of said cylinders, a punch carried by the main piston for forming a metal sheet into a desired shape, a clamping plate carried by the clamping piston for holding the sheet in position during the forming process, a source of pressure fluid and a control valve therefor, said valve being provided with high pressure and low pressure openings which communicate with said source, a piston in said valve, said valve also being provided with a pair of openings which are adapted to be an ingress and an egress respectively for the pressure fluid in an alternate manner depending on the position of the piston within said valve, a conduit extending from the ingress opening to the working side of the clamping piston, a conduit extending from the egress opening to the rear side of the main piston and also to the rear side of the clamping piston, a second conduit extending from the working side of the main piston to the working side of the clamping piston, and means positioned in said second conduit for assuring a predetermined pressure of the pressure fluid on the working side of the clamping pistons before the fluid in the main cylinder reaches such a pressure as to cause the punch to contact the metal sheet, said means comprising an admission valve adjusted to open the passageway through said second conduit when the working pressure on the clamping piston exceeds a predetermined pressure during the normal operation of the main piston whereby the clamping pressure is limited to said predetermined pressure.

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