

May 19, 1942.

H. F. MacMILLIN ET AL

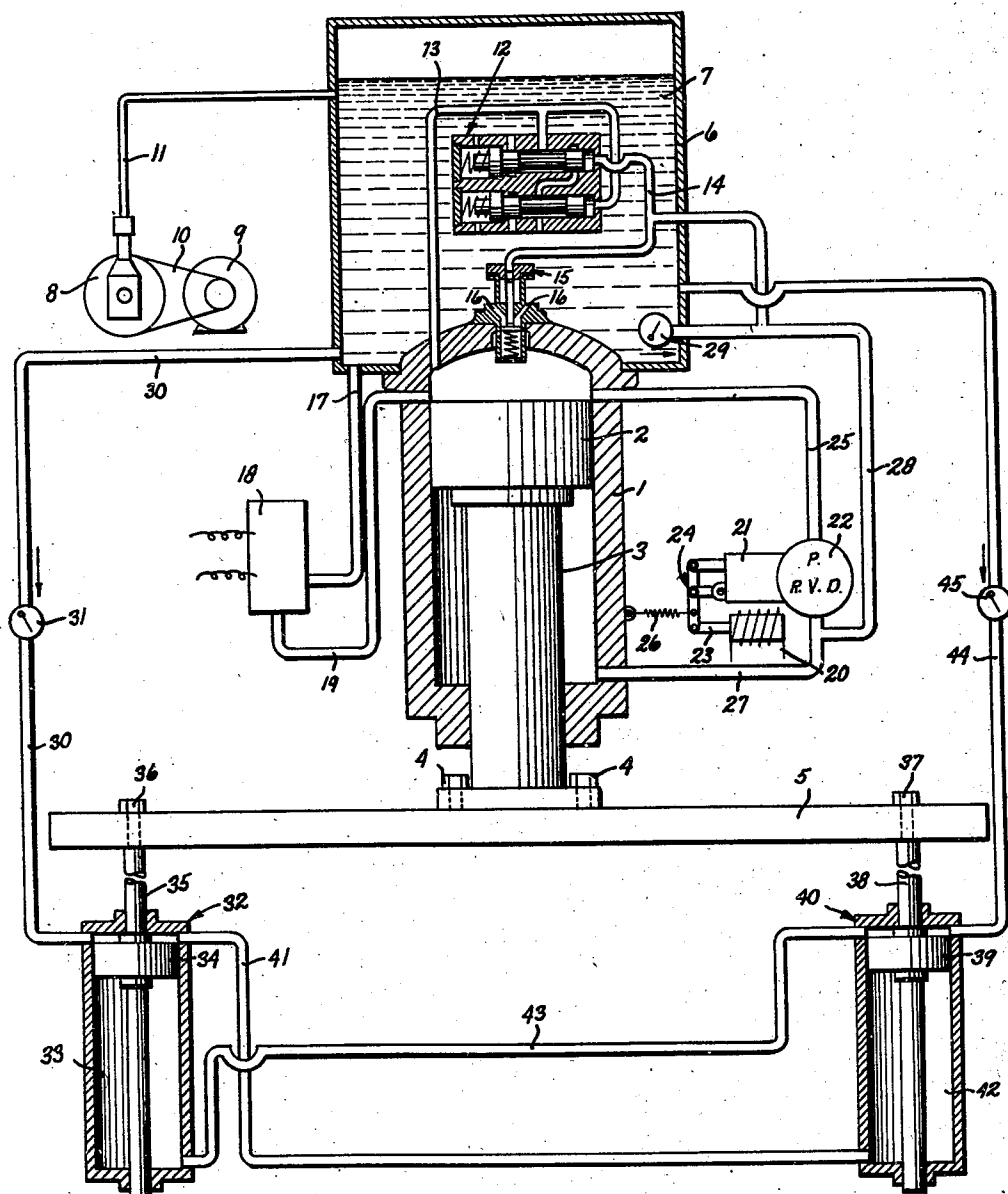
2,283,447

PRESS BRAKE

Filed July 23, 1940

3 Sheets-Sheet 1

FIG 1



INVENTORS
HOWARD F. MAC MILLIN
PAUL C. POCKOCK

BY

Saulmin & Saulmin
ATTORNEYS

H. F. MacMILLIN ET AL

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3 Sheets-Sheet 2

FIG 2

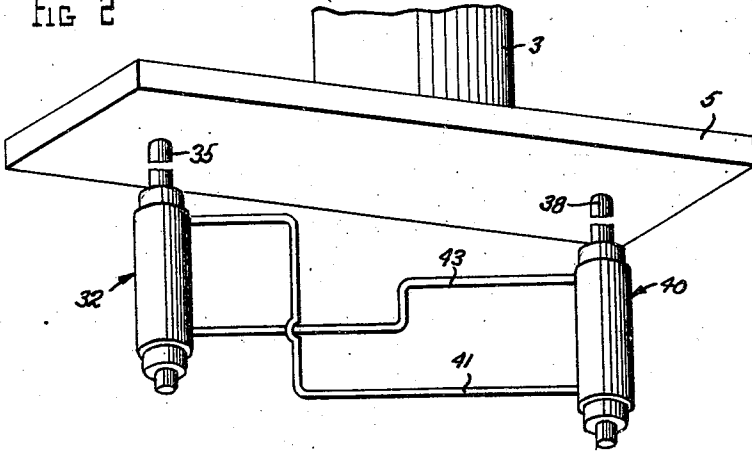
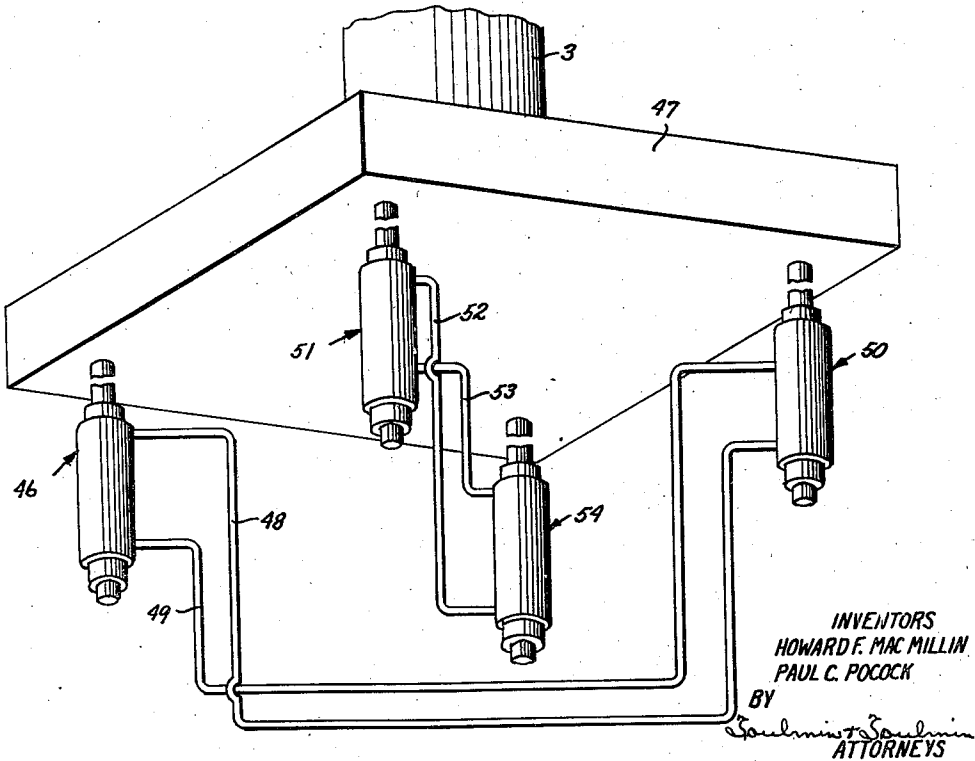


FIG 3



INVENTORS
HOWARD F. MAC MILLIN
PAUL C. POCOCK

BY

Paulmint & Paulmint
ATTORNEYS

May 19, 1942.

H. F. MacMILLIN ET AL

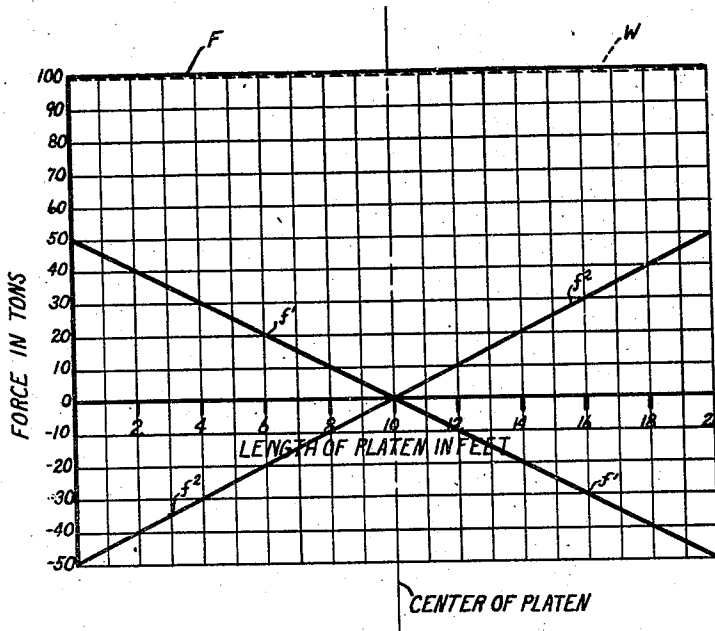
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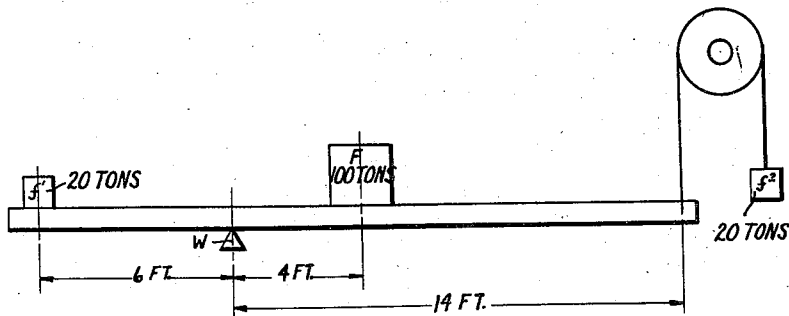
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FIG. 5



W = WORK RESISTANCE
 F = PRESSING FORCE OF MAIN CYLINDER
 S' = FORCE OF LEFT-HAND BALANCING CYLINDER
 S² = FORCE OF RIGHT-HAND BALANCING CYLINDER

FIG. 4



INVENTORS
 HOWARD F. MAC MILLIN
 PAUL C. POCKOCK

BY
 Saulmin & Saulmin
 ATTORNEYS

UNITED STATES PATENT OFFICE

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PRESS BRAKE

Howard F. MacMillin and Paul C. Pocock, Mount
Gilead, Ohio, assignors to The Hydraulic De-
velopment Corporation, Inc., Wilmington, Del.,
a corporation of Delaware

Application July 23, 1940, Serial No. 346,945

4 Claims. (Cl. 100—71)

This invention relates to presses and in particular to presses having a long and narrow platen.

It is an object of the invention to provide a hydraulic press having a long and narrow platen in which any substantial tilting movement of the platen is automatically prevented.

It is a further object of the invention to provide a hydraulic press with a relatively long and narrow platen in which hydraulic means are provided for synchronizing the movement of the ends of the platen.

A still further object of the invention consists in the provision of a hydraulic press in which a single ram is connected with the central portion of a relatively long and narrow platen, while hydraulic balancing means are connected with the platen ends for preventing any substantial movement of the platen in the direction of the longitudinal axis thereof.

Still another object of the invention consists in the provision of a hydraulic press in which a long and wide platen is reciprocable by a ram arranged centrally thereof, while the platen ends have associated therewith hydraulic means for preventing any substantial tilting movement in the longitudinal direction of the platen and transverse thereto.

A still further object of the invention consists in the provision of a hydraulic press in which a long and wide platen is reciprocable by a ram having connected therewith, at each corner thereof, hydraulic balancing means for preventing tilting movement of the platen in any direction irrespective of the location of the load relative to the ram.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic illustration of a press according to the invention.

Figure 2 illustrates a pressing platen having centrally connected therewith the pressing ram, while being connected at the lower surface thereof with two balancing cylinder-piston-assemblies.

Figure 3 is a view similar to Figure 2, however, with the provision of one balancing cylinder-piston-assembly at each corner of the platen.

Figure 4 is a diagrammatic illustration of the distribution of the forces acting upon the platen.

Figure 5 illustrates, by means of a graph, the variation of the forces acting upon the platen in correspondence with the location of the work piece relative to the platen.

General arrangement

In general, the press, according to the present invention, comprises a long and relatively narrow platen having attached thereto and arranged centrally thereof a press ram, while the ends of the platen are connected with hydraulic balancing means. The hydraulic balancing means preferably consists of a plurality of cylinder-piston-assemblies which are hydraulically interconnected in such a manner that when one end of the platen tends to run ahead of the other platen end, the fluid pressure in the cylinder-piston-assembly adjacent the first mentioned platen end is conveyed to the cylinder-piston-assembly adjacent the other platen end so as to retard the latter, thereby re-establishing uniform movement of the platen ends.

Structural arrangement

The press illustrated in Figure 1 comprises a main cylinder 1, having reciprocably mounted therein a double-acting pressing piston 2, which is connected by means of the ram 3 and screws 4 with the central portion of the pressing platen 5. Connected with the main cylinder 1 and supported thereby is a fluid reservoir or surge tank 6 filled with fluid 7. The fluid 7 is held under pressure by means of a compressor 8 operatively connected with a motor 9 by means of a belt 10 and adapted to supply compressed air through the pipe 11 into the surge tank 6. The surge tank 6 comprises a main cylinder relief and pump by-pass valve 12 which is connected by means of a conduit 13 with the upper portion of the cylinder 1, while another conduit 14 leads from said main cylinder relief and pump by-pass valve 12 to a surge valve, generally designated 15, arranged in the upper portion of the cylinder 1 and adapted selectively to allow fluid to pass from the surge tank 6 through the openings 16 into the upper portion of the cylinder 1 and vice versa.

The main cylinder relief and pump by-pass valve 12 and the surge valve 15 do not form a part of the present invention and merely serve to prefill the upper portion of the main cylinder 1 when the piston 2 moves downwardly by gravity during the first portion of its working stroke and to facilitate initiation of the retraction stroke at the end of the working stroke of piston 2. For a more detailed description of the surge valve 15 and the main cylinder relief and pump by-pass valve 12, reference may be had to U. S. Patent No. 2,193,248 to Ernst, issued March

12, 1940, and the Ernst patent application, Serial No. 286,063, filed July 24, 1939.

Connected with the surge tank 6 is, furthermore, a conduit 17 leading to a tonnage control valve 18 which, in its turn, is adapted to effect communication between the conduit 17 and a conduit 19, leading to the upper portion of the cylinder 1. The tonnage control valve 18 is arranged in an electric circuit which comprises a solenoid 20 associated with the servomotor 21 of a reversible variable delivery pump 22. The arrangement of the solenoid 20 is such that when the solenoid is energized its armature 23 acts through the intervention of a linkage, generally designated 24, upon the control member (not shown) of the variable delivery pump 22 in such a manner as to move the pump in position for full stroke forward delivery. In this instance pressure fluid is supplied by the pump 22 through the conduit 25 into the upper portion of the main cylinder 1. When the solenoid 20 is de-energized a spring 26, connected to the cylinder 1, urges the linkage 24 into the opposite direction, thereby moving the flow control member of the variable delivery pump 22 into full stroke reverse position. In this instance pressure fluid is delivered from the pump 22 through the conduit 27 into the lower portion of the main cylinder 1.

The tonnage control valve 18 which, as previously mentioned, is arranged in the same circuit as the solenoid 20, is adapted to be actuated by a predetermined pressure acting upon the upper surface of the piston 2 so that, at the attainment of said predetermined pressure, the tonnage control valve 18 breaks the said circuit. The tonnage control valve 18 in itself does not form a part of the present invention and for a more detailed description thereof, reference may be had to U. S. Patent No. 2,224,957 to Ernst.

Branching off from the conduit 27 is a conduit 28 leading to the fluid tank 6 and comprising a check valve 29 arranged in the tank 6. The purpose of the check valve 29, in connection with the conduit 28, consists in supplying additional fluid to the suction side of the pump 22 during the first portion of the downward movement of the piston 2.

Further communicating with the tank 6 is a conduit 30 which comprises a check valve 31 and leads to the upper portion of a balancing cylinder, generally designated 32. The balancing cylinder 32 comprises a cylinder bore 33 having reciprocally mounted therein a double-acting piston 34. The double-acting piston 34 carries a piston rod 35 passing with its lower end through the bottom of the cylinder 32, while the upper end of the piston rod 35 passes through the top portion of the cylinder 32 and is connected by any convenient means, for instance, screws 36, with one end of the pressing platen 5. The other platen end is similarly connected by means of a screw 37 with the piston rod 38 of a double-acting piston 39 reciprocally mounted in a second balancing cylinder, generally designated 40. The upper portion of the cylinder bore 33, pertaining to the cylinder 32, is connected by means of a conduit 41 with the lower portion of the cylinder bore 42 pertaining to the balancing cylinder 40. In a similar manner the upper portion of the cylinder bore 42 pertaining to the balancing cylinder 40 is connected by means of a conduit 43 with the lower portion of the cylinder bore 33 pertaining to the balancing cylinder 32. The upper portion of the cylinder bore 42 is, further-

more, connected by means of a conduit 44, comprising a check valve 45, with the fluid tank 6. The arrangement of the conduits 30 and 44, in connection with the check valves 31 and 45, has the purpose of maintaining the balancing cylinders 32 and 40 filled with fluid. It is, of course, understood that the necessary provisions are made to prevent leakage from the cylinders 32, 40, along the piston rods 35 and 38 toward the outside.

While, according to the embodiment of Figures 1 and 2, only two balancing cylinders are provided adjacent each end, it is often advantageous, particularly when long and wide pressing platens are employed, to provide one balancing cylinder at each corner of the platen. Such an arrangement is illustrated in Figure 3 from which it will be noted that only the diametrically arranged cylinders are connected with each other. In other words, the cylinder 46 at the rear lefthand corner of the platen 47 is connected by conduits 48 and 49 with the front right-hand cylinder 50. The arrangement of the conduits 48 and 49, with respect to the pistons in the cylinders 46 and 50, fully corresponds to the arrangement of the conduits 41 and 43, with respect to the pistons 34 and 39 of the cylinders 32 and 40. Similarly, the left-hand front cylinder 51 is connected by conduits 52 and 53 with the right-hand rear cylinder 54. Also in this instance the arrangement of the conduits 52 and 53, with respect to the pistons in the cylinders 51 and 54, fully corresponds to the arrangement of the conduits 41 and 43 with respect to the pistons 34 and 39 in the cylinders 32 and 40.

Operation

Assuming that all parts of the press occupy the position illustrated in Figure 1 which corresponds to the position at the end of the retraction stroke of piston 2, and that it is now desired to start a working cycle, the operator starts the motor 9 for driving the compressor 8 in any convenient manner, which supplies compressed air to the tank 6, thereby putting the fluid in the tank 6 under pressure. As a result thereof, pressure fluid will pass through the conduits 30 and 44 into the upper portion of the cylinders 32 and 40 respectively in case the upper portion of said cylinders should not be sufficiently filled with fluid. Similarly, the pump 22 is started. Thereupon the circuit comprising the solenoid 20 and tonnage control valve 18 is closed with the result that the armature 23, pertaining to the solenoid 20, is actuated so as to shift the flow control member of the variable delivery pump 22 into full stroke forward position. While the piston 2 is now moving downwardly by gravity, fluid is passed by the pump 22 through the conduit 25 into the upper portion of the cylinder 1 where it is supplemented by fluid from the tank 6 which passes through the openings 16 of the surge valve 15. As soon as the platen 5 engages the work piece, pressure builds up in the upper portion of the cylinder 1, which causes closure of the surge valve 15 and acts through the conduit 19 on the tonnage control valve 18.

Assuming now that the work piece W has been placed, as shown in Figure 4, between the axis passing through the piston rod 35 and the axis of the ram 3, it is obvious that there will be great resistance at one end of the platen, namely, the platen end adjacent the cylinder 32, while little resistance will prevail at the other platen end adjacent the cylinder 40. Consequently, the

platen end adjacent the cylinder 40 will tend to advance more rapidly than the platen end adjacent the cylinder 32. This is, however, prevented by the fact that the platen end adjacent the cylinder 40 can advance only when fluid below the piston 39 is adapted to escape into the upper portion of the cylinder bore 32 above the piston 34 pertaining to the balancing cylinder 32. In other words, if the piston 34 is stopped for a fraction of a second due to the resistance exerted by the work piece, the pressure built up in the cylinder bore 42 below the piston 39, due to the advancing tendency of the piston 39, is conveyed to and held in the upper portion of the cylinder bore 32, thereby braking or retarding the movement of the piston 39 and establishing synchronous movement of the platen ends. As soon as the piston 2 has reached the end of its working stroke, the pressure acting upon the piston 2 has increased to such an extent that it opens the tonnage control valve 18, thereby breaking the circuit comprising the solenoid 20 and establishing communication between the conduits 19 and 17. The breaking of the said circuit results in a de-energization of the solenoid 20 so that the spring 26, acting upon the linkage 24, shifts the flow control member of the variable delivery pump 22 to full stroke retraction position. Consequently, the conduit 27 is now connected with the pressure side of the pump 22, whereas the conduit 25 is now connected with the suction side of the pump 22. The main cylinder relief and pump by-pass valve 12 now comes into action and relieves, in cooperation with the surge valve 15, the pressure in the upper portion of the cylinder 1. Pressure fluid delivered by the pump 22 through the conduit 27 acts upon the retraction side of the piston 2, thereby lifting the latter together with the platen 5. Upward movement of the platen 5 causes upward movement of the pistons 34 and 39 so that fluid expelled by the piston 34 will flow through the conduit 41 and fill the space below the piston 39 during the advancement of the latter, while the fluid expelled by the piston 39 through the conduit 43 will fill the space below the piston 34 during the upward movement of the latter. It will be noted that no fluid expelled by the pistons 34 and 39 during the upward movement thereof can escape through the conduits 30 and 44 respectively into the tank 6, since this escape is closed off by the then closed check valves 31 and 45. Inasmuch as no material pressure acts upon the platen 5 during its upward movement, no tilting movement of the platen 5 will occur.

As soon as the pressure acting upon the piston 2 during its downward stroke has been released, the contacts of the tonnage control valve 18 will again close, while the circuit comprising the tonnage control valve and the solenoid 20 remains open. When the piston 2 has reached the end of its retraction stroke, the flow control member of the variable delivery pump 22 is actuated by any convenient means so as to move either to neutral position, in which case the press would come to a standstill, or, if full automatic operation is desired, the flow control member of the variable delivery pump 22 will be shifted to full stroke forward position so as to start a new cycle.

As will be seen from the foregoing description, the operation of the press and of the balancing cylinders in particular, will be the same whether the platen is associated with two balancing cylinders 32, 40, or with four balancing cylinders

46, 50, 51 and 54. The only difference would be that the arrangement illustrated in Figure 2 would take care of a tilting movement along the longitudinal axis of the platen 5 only, whereas the arrangement of Figure 3 would take care of a tilting movement of the platen 47 in whatever direction it may occur. As previously stated, in the last mentioned arrangement, always two balancing cylinders work together, namely, those diametrically arranged with respect to each other, while no hydraulic communication exists between those cylinders which are not diametrically arranged relative to each other.

To more clearly illustrate the forces exerted upon the platen by the balancing cylinders on one hand and the ram 3 on the other hand, reference may be had to Figures 4 and 5 of the drawings. In these figures F is the force exerted by the ram 3 upon the platen 5, while f^1 , f^2 , are the forces exerted by the balancing pistons 34 and 39 respectively. Since the balancing cylinders 32 and 40 are of the same construction and diameter and are interconnected by the conduits 43 and 41, f^1 will equal f^2 . Supposing that F is 100 tons and that the work piece W is placed six feet from the axis of the left-hand balancing cylinder and fourteen feet from the axis of the right-hand balancing cylinder, while the distance of the axis of the work piece W and the axis of the ram is four feet; it will be obvious that the inter-relationship of the acting forces can be expressed by the following equation:

$$f^1 \times 6 + f^2 \times 14 = F \times 4$$

$$F = 100 \text{ tons}$$

$$f^1 = f^2 = f$$

$$f(6 + 14) = 100 \times 4$$

$$f = f^1 = f^2 = 20$$

Using the same forces as illustrated in Figure 4, but shifting the work piece W so that its distance from the axis of the left-hand balancing cylinder is eight feet and from the axis of the right-hand balancing cylinder is twelve feet, while the distance between the axis of the work piece W and the axis of the ram 3 is two feet, the acting forces can be expressed by the following equation:

$$f^1 \times 8 + f^2 \times 12 = F \times 2$$

$$f(8 + 12) = 100 \times 2$$

$$f = f^1 = f^2 = 10$$

Marking the values of f^1 and f^2 of the above two equations in the graph of Figure 5, it will be seen that all values of f^1 and similarly of f^2 , lie on two straight lines intersecting each other in the center of the platen. In other words, the balancing forces increase in accordance with the increasing distance between the axis of the ram 3 and the axis of the work piece W . The force F remains the same irrespective of the location of the work piece.

Although the invention has been illustrated in connection with a press in which the balancing cylinders are located below the pressing platen, it will be obvious that the balancing cylinders may also be arranged above the pressing platen without affecting the scope of the invention.

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. In a hydraulic press, a pressing platen, hy-

draulic motor means operatively connected with the center portion of said platen for reciprocating the latter, a fluid source adapted to supply pressure fluid to said motor means for actuating the same, a plurality of hydraulically operable cylinder-piston-assemblies for preventing tilting movement of said platen, each of said balancing cylinder-piston-assemblies having a double acting piston with equal piston areas and being associated with one corner of said platen, and conduit means interconnecting opposed piston areas respectively pertaining to diametrically arranged balancing cylinder-piston-assemblies.

2. In a hydraulic press, a main cylinder-piston-assembly, pumping means adapted to supply pressure fluid to said main cylinder-piston-assembly for actuating the same, a pressing platen, said main cylinder-piston-assembly being arranged centrally of and operatively connected with said pressing platen for reciprocating said platen, a fluid tank containing fluid, a plurality of balancing cylinder-piston-assemblies, each having a double-acting piston with equal piston areas and being adapted to be operated hydraulically, conduit means adapted to effect communication between said tank and each cylinder of said balancing cylinder-piston-assemblies, fluid pressure means for exerting a predetermined minimum pressure on the fluid in said cylinders, said minimum pressure being independent of the pressure created by said pumping means, and further conduit means interconnecting opposite sides of separate balancing pistons for securing synchronous movement of the ends of said platen.

3. In a hydraulic press, a pressing platen, hydraulic motor means associated centrally of said platen and operatively connected therewith for reciprocating the platen, pumping means for

supplying pressure fluid to said hydraulic motor means for actuating the same, a plurality of balancing cylinders associated with said platen and having reciprocably mounted therein a double acting balancing piston with equal opposed piston areas, additional fluid pressure creating means independent of said pumping means for maintaining a predetermined minimum pressure in said balancing cylinders, means adapted to effect communication between said additional fluid pressure creating means and said balancing cylinder means in a direction from said additional fluid pressure creating means to said balancing cylinders, but not vice versa, and means adapted to convey fluid pressure created on one side of one balancing piston to the opposite side of another balancing piston for preventing tilting movement of said platen.

4. In a hydraulic press, a pressing platen, hydraulic motor means arranged centrally of said platen and adapted to reciprocate the same, first fluid pressure creating means for supplying pressure fluid to said hydraulic motor means, hydraulically operable balancing cylinder-piston-assemblies mounted on the opposite sides of said platen adjacent the ends thereof, fluid storage means, second fluid pressure creating means independent of said first fluid pressure creating means for causing said fluid storage means to supply pressure fluid to and for maintaining said balancing cylinder-piston-assemblies filled with fluid, each of said balancing cylinder-piston-assemblies comprising a single cylinder with a double-acting piston of equal opposed piston areas, and means hydraulically interconnecting opposite sides of separate balancing pistons for preventing tilting movement of said platen.

HOWARD F. MacMILLIN.
PAUL C. POCOCK.