This invention relates to presses, and in particular to presses having a relatively long and narrow platen or beam associated with means for preventing excessive tilting movement of the platen or beam.

It is an object of the invention to provide a press, such as a press brake, bending brake, or shear brake, in which a tilting movement of the platen or beam is prevented by hydraulic balancing means interconnected by simplified conduit means.

Another object of the invention consists in providing a press of the above type in which the balancing means comprises hydraulic cylinders movable in unison with the platen or beam.

Another object consists in providing a press of the character set forth in the preceding paragraph in which the balancing cylinders are so mounted on the platen as to be able to automatically remedy a slight misalignment between the balancing cylinders and the balancing pistons cooperating therewith.

It is still another object of the invention to provide a press, such as a press brake, bending brake, or shear brake, with a relatively long platen or beam, in which a tilting movement of the platen or beam is prevented by hydraulic balancing means comprising balancing pistons supported by the platen or beam and cooperating with stationary cylinders associated with the press bed and press head respectively.

A still further object of the invention consists in providing a press of the type referred to in the preceding paragraph in which the balancing cylinders hydraulically communicate with each other through the platen or beam.

Another object of the invention consists in providing a press with a relatively long and narrow platen or beam in which the tilting movement of the platen or beam is prevented by at least four cooperating cylinder-piston-assemblies communicating with each other by a simplified conduit system.

In particular it is an object of our invention to provide a platen with a main ram and a plurality of balancing cylinders, one on each corner, arranged in pairs on either side of the platen, said cylinders being hydraulically connected diagonally, i.e., a cylinder on one corner on one side is connected with a cylinder on the opposite corner on the other side. Our invention further consists in a separate pump for regulating and maintaining said cylinders constantly filled with liquid. Our invention further consists in exhausting said cylinders at the end of each cylinder in order to prevent any accumulated error by reason of a supply of an extra amount of fluid to any one cylinder in connection with the balancing operations.

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 diametrically illustrates a section through an embodiment of the invention.

Figure 1a discloses, on an enlarged scale, a surge valve used in the structure of Figure 1.

Figure 2 shows a section through a cylinder-piston-assembly which may be used in connection with the present invention.

Figure 3 is a diagrammatic illustration of a further embodiment of the invention.

Figure 4 shows a detailed construction of the balancing cylinder-piston-assembly of Figure 3.

Figure 5 shows the simplified conduit system according to the present invention in connection with a platen or beam having four balancing cylinder-piston-assemblies.

Referring first to Figure 1, the numeral 1 designates the press bed of a hydraulic press which may be connected with the press head 2 by any convenient means. The press head 2 comprises a main or press cylinder 3 having reciprocably mounted therein a double-acting piston 4 connected by means of a ram 5 and screws 6 to the platen 7. The upper portion of the press cylinder 3 communicates through a conduit 8 and conduit 9 with one side of a variable delivery pump 10, while the other side of the variable delivery pump 10 communicates through a conduit 11 and conduit 12 with the lower portion of the press cylinder 3. Branching off from the conduit 8 is a conduit 13 leading to a tonnage control valve 14 which, in response to a predetermined pressure in the press cylinder 3, opens or closes, as the case may be, an electric circuit comprising a solenoid 15. The tonnage control valve 14 does not form part of the present invention and may be of any desired type, for instance, of the type set forth in U. S. Patent No. 2,224,807, issued December 17, 1940.

The solenoid 15 has its armature 16 connected with a lever 17. The arm 18 of the lever 17 is connected by means of a linkage 19 with the flow-control member (not shown) of the variable delivery pump 10 so that when the solenoid 15 is energized the flow-control member of the variable delivery pump 10 will be shifted to cause delivery in one direction, whereas when the solenoid 15 is de-energized a spring 20, likewise con-
connected with the flow-control member of the pump 10, shifts the said flow-control member to cause the pump to deliver fluid in the opposite direction. The tonnage control valve 14 is furthermore adapted to communicate with the fluid tank by means of a conduit 22. The fluid tank 21 has mounted therein a main cylinder relief and pump by-pass valve 20, one communicating through conduits 24, 25 and 29 with one side of the pump 10, and through conduits 11 and 26 with the other side of the pump 10 and with the surge valve 21 respectively. The main cylinder relief and pump by-pass valve 23 and the surge valve 27, which do not form a part of the present invention, serve to profili the main cylinder 3 during the first portion of the downward stroke of piston 4 and also relieve the pressure side of the main piston 4 at the end of its working stroke to facilitate the initiation of the retraction stroke thereof. The operation of the valves 23 and 27 will be set forth later in connection with the operation of the press structure. The valves 23 and 27 are constructed substantially along the line of the surge valve and cylinder release and pump by-pass valve respectively disclosed by U. S. Patents 2,193,248 and 2,268,905, both to Ernst. For a more detailed description of the valves 23 and 27, reference may be had to Ernst U. S. patent application No. 286,063, filed August 24, 1959, and U. S. Patent No. 2,193,248.

The fluid tank 21 furthermore communicates through a conduit 28 with the suction side of a pilot pump 29, the pressure side of which communicates with a conduit 30. Branching off from the conduit 30 is a conduit 31 comprising a safety or relief valve 32 adapted to communicate through conduit 33 with the fluid tank 21. The conduit 30 comprising a check valve 34 has a branch line 35 leading to the upper portion of the cylinder bore 36 of a balancing cylinder 37 which is slidably mounted in the press head 2 and movable in unison with the platen 7. The cylinder 37 is connected with the platen 7 by means of a ball joint comprising a ball shaped portion 38 connected with the cylinder 37 and a socket 39 held in a correspondingly shaped recess of the platen 7 by means of a holding plate 40 and screws 41. Reciprocally mounted in the cylinder bore 36 is a double-action balancing piston 42 connected with a piston rod 43 fixed to the press head 2 and extending through the ball shaped portion 38.

The lower portion of the cylinder bore 36 communicates with a conduit 44 which, in its turn, communicates with a conduit 45. The conduit 45 comprises a check valve 46 and communicates on one hand with the conduit 38, while on the other hand leading to the upper portion of a cylinder bore 36a of a balancing cylinder 37a. The balancing cylinder 37a corresponds in its construction to the balancing cylinder 37 and is connected with the platen 7 in a similar manner as the balancing cylinder 37. The parts of the cylinder 37a are, therefore, designated with the same reference numerals as those of the cylinder 37 but with the additional letter a. The lower portion of the cylinder bore 36a communicates with the conduit 30. The cylinder 37a has connected therewith a J-shaped arm 47 adapted at the end of its retraction stroke to engage the arm 48 of the lever 17 so as to shift the flow-control member of the pump 10 by means of the linkage 19 into neutral or no delivery position.

While the cylinder-piston-assemblies 37, 42, 37a, 42a, may be constructed in various manners, the construction illustrated in Figure 2 has proved itself very satisfactory. According to Figure 2, the press head 2 has connected therewith in any convenient manner, for instance by means of screws 45, a sleeve 50 through which passes a bushing 51. The bushing 51 is subdivided by a partition 52 defining together with the bushing 51 two separate bores. Connected with the upper bore 53 is a pipe 54 communicating with the conduit 35, while a pipe connection 56 is provided for conveying the fluid from the pipe 44 to the bore 54. The bore 53 is adapted to supply fluid to the upper portion of the cylinder bore 36 above the piston 42, while the bore 54 is adapted to supply fluid to the lower portion of the cylinder bore 36 below the piston 42. To prevent leakage between the piston 42 and the wall of the cylinder 37 a ring 57 engaging a correspondingly shaped recess in the piston 42 is provided as well as packing material 58 compressed by glands 59. The upper portion of the cylinder 37 is closed by a cylinder head 60 connected with the cylinder 37 in any convenient manner and provided with packing material 61 compressed by a gland 62 to prevent leakage from the upper portion of the cylinder 37 to the outside. The lower portion of the cylinder 37 is, as mentioned in connection with the description of Figure 1, provided with a ball shaped portion 63 joined in a correspondingly shaped socket 65 held within the platen 7 by means of the holding plate 40 and screws 41 between the cup shaped portion 63 of the cylinder 37, which surrounds the socket 39, and the socket 39 has a ring 66. The piston rod 43 connected with the piston 42 passes through the ball shaped portion 38 and is surrounded by packing material 65 compressed by a gland 58 to prevent leakage from the lower portion of the cylinder bore 36 toward the outside.

It will be appreciated that the construction of Figure 2 allows the arrangement of stationary pipes 35 and 44, thereby materially simplifying the piping system.

While Figure 1 merely illustrates a platen associated with two balancing cylinders, the platen may, if desired, also be provided with four balancing cylinders. In this instance the piping connection between the cylinders is as diagrammatically illustrated in Figure 5. As will be seen, the connection is such that, only the diametrically opposed cylinders are connected with each other in such a manner that the upper portion of the balancing cylinder 61 is connected with the lower portion of a balancing cylinder 68, while the upper portion of the balancing cylinder 68 is connected with the lower portion of the balancing cylinder 61. Similarly, the upper portion of the balancing cylinder 65 communicates with the lower portion of the balancing cylinder 70, while the upper portion of the balancing cylinder 70 communicates with the lower portion of the balancing cylinder 69. In other words, the connection is the same as shown in Figure 1.

Operation of first embodiment

Assuming that the press is in the position shown in Figure 1, which position corresponds to the end of the retraction stroke, and that it is now desired to perform a working stroke. To this end, the circuit comprising the solenoid 15 and the tonnage control valve 14 is closed in any convenient manner. Closure of this circuit causes energization of the solenoid 15, thereby actuating the armature 16 which, in its turn, by means of the lever 17 and the linkage 19, shifts the flow-
control member of the variable delivery pump to full stroke forward position. Pressure fluid is then supplied by the pump 10 through the conduits 11 and 12 into the upper portion of the cylinder 3.

During the first portion of the downward stroke of the piston 4, which moves downwardly by gravity, the fluid supplied by the pump 10 is supplemented by fluid from the tank 21 which passes through the valve 22. To prove the statement that the suction effect created in the upper portion of the press cylinder 3 by the downwardly moving piston 4 causes the surge valve plunger 100 to move downwardly, thereby establishing fluid connection between the tank 21 and the upper portion of the press cylinder 3 through the bores 181, 182 and 183. The fluid expelled by the piston 4 passes through the conduits 13 and 11 to the suction side of the pump 10. Since the pump 10 has to deliver more fluid into the upper portion of the cylinder 3 than is expelled by the piston 4, additional fluid is conveyed from the tank through the check valve 71 and conduit 11 to the suction side of the pump 10. Since the piston 4 is connected by the ram 6 with the platen 7 carrying the cylinders 37, 37a, movement of the piston 4 downwardly causes a downwardly movement of the cylinders 37, 37a, while the balancing pistons 42, 42a, remain stationary. During this downward movement of the cylinders 37, 37a, fluid expelled from the upper portion of the cylinder bores 38, 38a, is respectively conveyed through the check 72 to the left hand side of the check valve 71. As soon as the platen engages the work piece, pressure builds up in the upper portion of the cylinder 3, thereby causing the plunger 100 of the surge valve 27 to move upwardly so as to close the bores 183. Pressure fluid supplied by the pump 10 now causes a further downward movement of the piston 4 and the cylinders 37, 37a, until the drawing operation is finished. The pressure prevailing in the upper portion of the press cylinder 3 is also conveyed through conduits 26 and 28 to the right-hand end conduits 20 and 28, to the left-hand side of the check valve 71, and to the upper portion of the cylinder bores 38, 38a, by which the pressure is conveyed to the lower portion of the cylinder bores 36, 36a, thereby causing the cylinder to speed up or, if the cylinder 4 cannot speed up, slowing down the movement of the cylinder 4. At this point, the movement of the cylinders 37 and 37a, which is due to the communication of the upper portion of the cylinder 37a with the lower portion of the cylinder 37, has speeded up the lower portion of the cylinder bore 36a, thereby either causing the cylinder 37 to speed up or, if the cylinder 37 cannot speed up, slowing down the movement of the cylinder 37.

As soon as the pressure acting upon the piston 4, during the working stroke, has reached a predetermined value, the solenoid 18a, thereby de-energizing the latter. The spring 20 then shifts the flow-control member of the pump 10 to full stroke retraction position for initiation of the retraction stroke of the press. When this shifting movement has been effected, the conduit 11 becomes the pressure line, and pressure in line 11 is conveyed through conduit 26 to the bore 180. In the surge valve 27, where it acts upon the plunger 101. However, since the upper portion of the press cylinder 3 is still filled with fluid, the plunger 101 cannot shift the plunger 100 downwardly and, consequently, no fluid can escape at this time through the surge valve into the tank 21. The pressure in line 11 is also conveyed to the bore 180 in the valve 23 where it causes the valve member 103 to move toward the left so as to establish fluid connection between the bore 180 and the bore 181 through the passage 28 and the valve 27. Therefore, fluid delivered by the pump 10 is by-passed through conduit 11, bore 180, passageway 184, bores 184 and 184 into the tank 21. Furthermore, the fluid from the upper portion of the press cylinder 3 can escape through conduits 8 and 29, bores 186 and 182 into the tank 21, since the leftward movement of the valve member 103 has established fluid connection between the conduit 24 and the bore 162. Due to the release of pressure from the upper portion of the press cylinder 3, the pressure prevailing in the conduits 11 and 26, and acting on the plunger 101, now enables the latter to move the plunger 100 downwardly, thereby establishing fluid connection between the bores 183 and 181, so that fluid can escape from the upper portion of the cylinder 3 through said bores to the left-hand side of the check valve 71, and the fluid can escape from the upper portion of the cylinder 3 through the surge valve into the tank 21, the pressure in conduit 28 drops and the spring 103 returns the valve member 103 to the position shown in Figure 1, in which position fluid connection between the passageway 186 and bore 187 is interrupted.

As soon as the surge valve 27 has opened in the manner just described, the pressure fluid conveyed through conduits 11 and 12 to the lower portion of the press cylinder 3 causes the plunger 4 to move upwardly. The platen 37 and the cylinders 37 and 37a will then move upwardly so that fluid expelled from the lower portion of the cylinder 36 will be conveyed to the upper portion of the cylinder 36a, while fluid expelled from the lower portion of the cylinder bore 36a will be conveyed through the conduit 26 into the upper portion of the cylinder bore 36. It will be noted that, during the retraction stroke of piston 4, the check valves 24 and 28 are closed, due to the pressure in the conduits 38 and 44 respectively. Since no pressure is exerted upon the platen during the retraction stroke, the cylinders 37 and 37a will, in general, move upwardly in synchronism. When the piston 4 approaches the end of its retraction stroke, the J-shaped arm 47 will engage the lever 48 and shift the latter so that the flow-control member of the pump 10 will move to neutral position. The press will then come to a standstill and is ready for a new cycle.

It will be noted that at the end of the retraction stroke of the piston 4 the initial hydraulic conditions are restored and that whatever leakage may have occurred in the cylinder bores 38, 38a, will have been made up by the pilot pump 29. In case any excess pressure should occur in the conduits 38 and 39, this excessive pressure will be relieved through the safety valve 14.

If, instead of two balancing cylinders, four balancing cylinders are provided, as indicated in Figure 5, the balancing operation will be exactly the same as that disclosed in connection with Figure 1. In other words, cylinder 67 will be held in synchronism by cylinder 37 and vice versa, and the same conditions apply to the cylinders 65 and 70.
While the operation has been described in connection with the balancing cylinder-piston-assembly shown in Figure 1, the operation will obviously be the same when the cylinder-piston-assembly of Figure 2 is substituted for the balancing cylinder-piston-assembly of Figure 1.

**Second embodiment**

Referring now to Figure 3, the press disclosed therein comprises a press bed 12 and a press head 13 connected with each other by any convenient means. The press head 13 has connected therewith a main cylinder 74 in which a double-acting piston 75 is reciprocably mounted. The piston 75 is connected with a platen 76 by means of a ram 77. The piston 76 and the ram 77 comprise a cylinder bore 78 in which is stationarily mounted a booster plunger 79 with a bore 80 therethrough. The bore 80 communicates through a conduit 81 with a reversible variable delivery pump 82 and is adapted to communicate through a conduit 83 and check valve 84 with the fluid tank 85.

Branching off from the conduit 81 is a conduit 86 leading to an admission valve, generally designated 87. The admission valve 87 comprises a casing 88 having reciprocably mounted therein a piston 89 continuously urged by a spring 90 toward the left so as to close communication between the conduit 86 and a conduit 91 leading to the upper portion of the main cylinder bore 92. The upper portion of the cylinder bore 92 is adapted to communicate through a conduit 93 and conduits 94 and 95 connected on one hand with a conduit 96 leading to the pump 82 and the lower portion of the cylinder bore 92, and on the other hand with a check valve 97 adapted to admit fluid from the tank 85 into the conduit 95.

Branching off from the conduit 94 is a conduit 98 leading to a main cylinder relief and pump by-pass valve 99 which latter, through conduits 100 and 101, communicates with the conduit 91. The surge valves 102 and the main cylinder relief and pump by-pass valve 99 correspond in their construction and purpose to that of the surge valve 27 and the main cylinder relief and pump by-pass valve 28 of Figure 1.

The fluid tank 85 further communicates through a conduit 102 with a control valve, generally designated 103, and comprises a cylinder bore 104 having reciprocably mounted therein a valve member 105. Operatively connected with the valve 105 is a valve rod 108 passing through an arm 107 of the platen 76 and having adjustably mounted thereon a collar 109 adapted to be engaged by the arm 107. The valve member 105 is adapted to control communication between the conduit 102 and a conduit 109 comprising a check valve 110 and leading to a conduit 111. The conduit 111 comprises two check valves 112 and 113 and leads on one hand to the upper portion of a balancing cylinder 114 and on the other hand to a balancing cylinder 115. These balancing cylinders are in contradistinction to the embodiment in Figure 1, arranged stationarily and cooperate with balancing cylinders 116 and 117 stationarily arranged in the press bed 72. Reciprocably mounted in the cylinder bores 114 and 115 are plungers 118 and 119 connected in any convenient manner, for instance, by screws 120, with the upper portion of the platen 76. Similarly, the plungers 121 and 122 adapted to the lower portion of the platen 16 respectively, cooperate with the balancing cylinders 116 and 117. The plungers 118 is provided with a bore 123 communicating through a passageway 124 in the platen 76 with the bore 125 in the plunger 122 so as to continuously effect communication between the cylinder bore 126 of the balancing cylinder 114 and the cylinder bore 127 of the balancing cylinder 117. Similarly, the cylinder bore 128 of the balancing cylinder 115 continuously communicates with the cylinder bore 129 of the cylinder 116 through the bore 130 in the plunger 119, the passageway 131 in the platen 76 and the bore 132 in the plunger 121.

Comparing the embodiment of Figure 3 with that of Figures 1 and 2, it will be noted that aside from the fact that the balancing cylinders are stationary and the plungers are movably mounted, each balancing cylinder is split up into two balancing cylinders and the conduit system connecting the balancing cylinders of Figure 1 is replaced by passageways through the platen.

The embodiment of Figure 3 furthermore comprises a conduit 133 with a check valve 134 which is adapted to effect communication between the cylinder bore 126 and the conduit 105. A conduit 135 likewise branching off from the conduit 111 comprises a pilot pump 136 which is connected with the fluid tank 85. Branching off from the conduit 135 is a conduit 137 having arranged therein a relief valve 138 and leading likewise to the fluid tank 85.

While the plungers 118, 119, 121 and 122 may be constructed in any convenient manner, a preferable construction of the said plungers is illustrated in Figure 4. As will be seen therefrom, the press head 73 comprises the stationary cylinder 114, while the press bed 72 comprises the stationary cylinder 116. In contradistinction to the embodiment of Figure 3 however, the plungers 118 and 121 are replaced by a single plunger 139 having its upper portion reciprocably mounted in the cylinder 114, whereas the lower portion 141 is reciprocably mounted in the cylinder 116. The central portion of the plunger 133 is connected with the plate 76 in any convenient manner. The plunger portion 142 has a longitudinal bore 143 which communicates with the passageway 124 of the platen 76, and the plunger portion 141 has a longitudinal bore 143 communicating with the passageway 131 in the platen 76. To prevent leakage from the cylinders 114 and 116, the plunger portions 142 and 143 are respectively surrounded with packing material 144 and 145, compressed by glands 146 and 147 respectively.

**Operation of second embodiment**

Assuming that the press is in its retracted position, that is, that the main pressing piston 75 is somewhat higher than the position shown in Figure 3, and that it is now desired to perform a working stroke. To this end the reversible variable delivery pump 82 is shifted to full stroke position by any convenient means, for instance, by means of the solenoid 15, illustrated in Figure 1. While the piston 75, during the first portion of its working stroke, moves downwardly by gravity, pressure fluid is supplied by the pump 82 through the conduit 70 to the booster cylinder bore 78, thereby speeding up the downward movement of the piston. Simultaneously therewith, the upper portion of the main cylinder bore 23 is filled by fluid from the tank 85 passing through check valve 81, the conduit 83 and the surge valves 84. Fluid expelled from the lower portion of the cylinder bore 92 passes
through the conduit 96 to the suction side of the pump 82. Simultaneously with the downward movement of the ram 77 and the platen 76 connected therewith, also the balancing plungers 112, 113, 112, move downwardly. During this operation fluid expelled by the plunger 121 passes through the bore 132, the passageway 131 and the bore 130 into the balancing cylinder bore 128. Similarly, the fluid expelled by the plunger 122 from the balancing cylinder bore 127 passes through the bore 136, the passageway 124 and the plunger bore 123 into the balancing cylinder bore 126.

When the platen 76 engages the work piece, pressure builds up in the upper portion of the main cylinder bore 92 causing the surge valves 88 to close, while the pressure in the conduits 81 and 86 acts upon the piston 85 so as to move the latter against the spring 89, thereby establishing communication between the conduits 86 and 81. The pump 82 now supplies pressure fluid through the conduits 81, 86 and 81 into the upper portion of the main cylinder bore 92.

If, during the downward or working stroke of the platen 76, the right end of the platen tends to run ahead of the left platen due to the fact that the work piece is located closer to the last mentioned platen, the fluid in the balancing cylinder bore 127 will be compressed, while the pressure of the fluid in the balancing cylinder bore 128 is somewhat relieved. Due to the communication of the balancing cylinder bore 127 with the balancing cylinder bore 128, the pressure in the balancing cylinder bore 128 will be the same as that in the balancing cylinder bore 127. Similarly, equal pressure will prevail in the cylinder bore 126 and the cylinder bore 125 of the balancing cylinders 110 and 116 respectively. Consequently, the increased pressure prevailing in the cylinder bore 126 will either cause an additional downward movement of the left platen or the pressure fluid in the cylinder bore 127 will slow down the movement of the right platen, thereby, in each case, re-establishing synchronous movement of the platen ends.

When the pressure acting upon the upper portion of the main cylinder 18 has reached a predetermined value or the platen has reached a predetermined position, the pump 82 is shifted to full stroke retraction position in any convenient manner, for instance, by de-energizing the solenoid 189 and allowing the spring to act upon the flow-control member of the pump, as described in connection with Figure 1. The main cylinder relief and pump by-pass valve 99 then relieves the pressure in the upper portion of the main cylinder 82 while the surge valves 83 open, and the platen 76 starts its retraction stroke. When the platen 76 approaches the end of its retraction stroke the pump 82 is shifted by any convenient means, for instance, in a manner described in connection with Figure 1, to neutral position so as to place the press into readiness for a new cycle.

While approaching the end of its retraction stroke, the platen 76 also engages, by means of its arm 187, the collar 100 on the valve rod 106, thereby lifting the valve 105 so as to establish communication between the conduits 105 and 102.

The arrangement of the control valve 103 is the following one:

Assuming that a heavy load is thrown on the right-hand cylinder assembly due to an eccentric loading which would cause a slight compression of the fluid in the right-hand upper cylinder 118 and the lower left-hand cylinder 116, whereas a reduction in pressure would occur in the upper left cylinder 114. This reduction in pressure would allow fluid to flow from the pilot pump 136 through the conduits 125 and 111 into the cylinder bore 126 so that at the completion of the operating stroke, the combined volume in the entire system is slightly in excess of what it was at the beginning of the stroke. If no provision were made to allow this excess fluid to escape and this operation were repeated, pressure would gradually accumulate in the system until an excessive pressure, accumulated in the system, might cause serious disturbances. The purpose of the control valve 103 is to correct this condition by opening the system to the fluid tank 88 at the beginning of each return stroke. It will be obvious that in the example referred to above, excessive fluid from the cylinder bore 126 could escape through the conduits 111, 133, the check valve 134, the conduit 110, the safety valve 148 and the conduit 102 to the tank.

The valve member 105 remains in its lifted position as long as the pump 82 remains in its neutral position. As soon as the platen 76 starts its downward movement the valve member 105 will follow downwardly by gravity until it reaches the position shown in Figure 3, in which communication between the conduits 105 and 102 is interrupted.

Similarly, as described in connection with the embodiment of Figure 1, the pilot pump 136 makes up for any leakage in the balancing cylinders which may have occurred therein.

If, instead of the two balancing cylinders respectively arranged above and below the platen 76, four balancing cylinders would be mounted on top of the platen and four balancing cylinders below the same, the connection of the balancing cylinders would be so that the diametrically opposed arranged balancing cylinders would communicate with each other in the same manner as the balancing cylinders shown in Figure 3.

In other words, in this instance Figure 3 should be considered a section through two diametrically arranged balancing cylinder systems.

While the invention has been described with a press having the pressing plunger centrally arranged with respect to the platen, it is understood that also a plurality of pressing plungers may be connected with the platen, for instance, at the ends thereof without affecting the operation of the balancing systems described above. 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 press, the combination of motor means, a platen connected with said motor means and adapted to be reciprocated thereby, a plurality of balancing cylinders, and a plurality of fluid operable balancing plungers associated with said balancing cylinders and operatively connected with said platen for preventing tilting movement of said platen, said plungers being provided with passageways therethrough adapted to effect communication between cylinder chambers of two separate balancing cylinders.

2. In a press, the combination of motor means, a platen operatively connected with said motor means and adapted to be reciprocated thereby,
a plurality of balancing cylinders arranged adjacent the ends of said platen, and a plurality of fluid operable balancing plungers associated with said balancing cylinders and operatively connected with said platen to maintain substantially synchronous movement of the ends of said platen, said plungers being provided with passageways therethrough adapted to effect communication between the cylinder chamber above one balancing plunger with the cylinder chamber below another balancing plunger.

3. In a press, the combination of hydraulic motor means, a platen connected with said motor means and adapted to be reciprocated thereby, a plurality of balancing cylinders arranged adjacent the ends of said platen, and a plurality of fluid operable double-acting balancing pistons associated with said balancing cylinders and operatively connected with said platen for preventing tilting movement thereof, each of said balancing pistons comprising a longitudinal bore therethrough for effecting communication between cylinder chambers of separate balancing cylinders.

4. In a press, the combination of hydraulic motor means, a platen operatively connected with said motor means and adapted to be reciprocated thereby, a plurality of fluid operable balancing plungers arranged on opposite sides of said platen and respectively reciprocable in stationary cylinders, and means connecting said balancing plungers with said platen, each of said plungers being provided with passageways therethrough and effecting hydraulic communication between two separate balancing cylinders.

5. In a hydraulic press, the combination of motor means, a platen connected with said motor means and adapted to be reciprocated thereby, spaced balancing cylinders connected with said platen and adapted to be reciprocated thereby, a plurality of stationary double-acting balancing plungers associated with said balancing cylinders for substantially maintaining synchronous movement of the platen ends, and conduit means adapted to effect communication between a cylinder portion above one balancing plunger with a cylinder portion below another balancing plunger.

6. In a press, the combination of hydraulic motor means, a variable delivery pump adapted to supply fluid to said motor means for operating the same, a platen connected with said motor means and adapted to be reciprocated thereby, a plurality of balancing cylinders arranged on top of said platen and jointly connected therewith, a plurality of stationary double-acting balancing plungers associated with said balancing cylinders, and conduit means for effecting communication between said balancing cylinders so as to equalize the pressure acting upon the upper surface of one balancing piston and the pressure acting upon the lower surface of another balancing piston for preventing tilting movement of said platen.

7. In a press, the combination of hydraulic motor means, a variable delivery pump for supplying fluid to said motor means to actuate the same, a platen connected with said motor means and adapted to be reciprocated thereby, a plurality of balancing cylinders for maintaining said platen level, a pilot pump independent of said variable delivery pump for filling and maintaining said cylinders filled with fluid, a plurality of balancing plungers reciprocable in said balancing cylinders and operatively connected with said platen, each of said plungers being provided with passageways therethrough for effecting fluid communication between two of said balancing cylinders.

8. In a hydraulic press, the combination of a main cylinder-piston-assembly, a fluid source adapted to supply pressure fluid to said main cylinder-piston-assembly for operating the same, a platen operatively connected with said main cylinder-piston-assembly, a plurality of stationary double-acting balancing pistons, a plurality of reciprocable balancing cylinders cooperating with said balancing pistons and jointly connected with said platen for facilitating adjustment of said balancing cylinders, a plunger hydraulically connected with each of said balancing cylinders for maintaining said balancing cylinders filled with fluid, and conduit means associated with said balancing cylinders and adapted to effect communication between the upper surface of another balancing piston.

9. In a press, the combination of a hydraulically operable main cylinder-piston-assembly, a fluid source, pressure creating means for causing the flow of pressure fluid to said main cylinder-piston-assembly for actuating the same, a relatively long and narrow platen connected with said main cylinder-piston-assembly and adapted to be reciprocated thereby, a plurality of spaced fluid operable balancing assemblies operatively connected with two opposite ends of said platen for preventing tilting movement of said platen, each of said balancing assemblies comprising a cylinder and a piston therein, and means independent of said pressure creating means for maintaining said balancing cylinders filled with fluid, each of said balancing pistons having a bore therethrough and being connected with a conduit system so as to effect communication between two separate balancing cylinders.

10. In a press, the combination of motor means, a platen connected with said motor means and adapted to be reciprocated thereby, a plurality of balancing cylinders, each having a hydraulically operable plunger movable relative thereto and being operatively connected with one of four corners of said platen, means for maintaining said balancing cylinders filled with fluid, and conduit means communicating with bores through said balancing plungers so as to effect hydraulic communication between the respective balancing cylinders at diagonally opposed corners of said platen.

11. A press comprising in combination a press head and a press bed, hydraulic motor means, a fluid source adapted to supply fluid to said motor means for actuating the same, a platen connected with said motor means and adapted to be reciprocated thereby, a plurality of balancing cylinders, half the number of said balancing cylinders being supported by said press head and the other half being supported by said press bed, a plurality of hydraulically operable balancing plungers associated with said balancing cylinders and means for supplying fluid to said balancing cylinders, said balancing plungers and said platen being provided with passageways therethrough and adapted to effect communication of one balancing cylinder supported by said press head with a balancing cylinder supported by said press bed remote from the plunger cooperating with said first mentioned balancing cylinder.

12. In a press, the combination of hydraulic motor means, a platen connected with said motor means and adapted to be reciprocated thereby, a plurality of balancing cylinders arranged adjacent the ends of said platen, and a plurality of fluid operable balancing plungers associated with said balancing cylinders and operatively connected with said platen, each
plurality of stationary balancing cylinders, means to supply fluid to said balancing cylinders, and a plurality of fluid operable balancing plungers associated with said balancing cylinders and connected with said platen for preventing tilting movement of said platen, said balancing plungers and said platen being provided with passageways therethrough, adapted to connect cylinder portions of separate balancing cylinders with each other.

13. In a press, the combination of a hydraulic main cylinder-piston-assembly, a fluid source adapted to supply pressure fluid to said main cylinder-piston-assembly, a plurality of stationary balancing cylinders, half the number of said balancing cylinders being arranged on one side of said platen and the other half being arranged on the other side of said platen, a plurality of balancing plungers connected with said platen and being arranged so that each balancing plunger cooperates with two balancing cylinders on different sides of said platen, said balancing plungers and said platen having bores therethrough for effecting communication of a cylinder arranged on one side of said platen with a cylinder arranged on the other side of said platen but not pertaining to the plunger cooperating with said first mentioned cylinder.

14. In a hydraulic press, the combination of hydraulic motor means, a fluid source adapted to supply pressure fluid to said hydraulic motor means for actuating the same, a platen connected with said motor means and adapted to be reciprocated thereby, a plurality of stationary balancing cylinder pairs, the cylinders of each cylinder pair being mounted in alignment with each other so that one cylinder of each balancing cylinder pair is arranged above said platen and the other cylinder of each balancing cylinder pair is arranged below said platen, a plurality of balancing plungers adapted to be reciprocated by said platen and arranged so that one balancing plunger cooperates with one balancing cylinder pair, and means for supplying fluid to said balancing cylinders, said balancing plungers and said platen being provided with passageways therethrough adapted to effect communication between the upper cylinder of one cylinder pair with the lower cylinder of another cylinder pair.

15. In a press, the combination of motor means, a platen connected with said motor means and adapted to be reciprocated thereby, a plurality of fluid operable balancing plungers operatively connected with said platen and supported thereby, each of said plungers having a portion below said platen and another portion above said platen, a plurality of balancing cylinders cooperating with said balancing plungers, and means for supplying fluid to said balancing cylinders and adapted to maintain said cylinders filled with fluid, said plungers and said platen being provided with passageways therethrough, adapted to effect communication between a balancing cylinder cooperating with the upper portion of one balancing plunger and a balancing cylinder cooperating with a lower portion of another balancing plunger.

16. In a hydraulic press, hydraulic motor means, a fluid source adapted to supply pressure fluid to said motor means for actuating the same, a platen connected with said motor means and reciprocated thereby, a plurality of upper balancing cylinders, a plurality of lower balancing cylinders corresponding in number to said upper balancing cylinders, a plurality of double-acting balancing plungers, each plunger being supported by said platen and cooperating with an upper and a lower balancing cylinder, a pilot pump connected with said balancing cylinders and adapted to continuously maintain said balancing cylinders filled with fluid, said balancing plungers and said platen being provided with passageways therethrough adapted to convey fluid from an upper balancing cylinder to a lower balancing cylinder or vice versa, and means automatically relieving any excess fluid in said balancing cylinders at the end of the retraction stroke of said platen.

17. In a press, the combination of hydraulic motor means, a fluid source adapted to supply pressure fluid to said motor means for actuating the same, a rectangularly shaped platen connected with said motor means and adapted to be reciprocated thereby, four upper balancing cylinders, four lower balancing cylinders, said cylinders being arranged at the corners of said rectangularly shaped platen, and a fluid source adapted to supply fluid to said balancing cylinders and maintain the same filled with fluid, said plungers and said platen being provided with passageways therethrough adapted to effect communication between an upper balancing cylinder with a lower balancing cylinder arranged diametrically thereto.

18. In a hydraulic press, a main cylinder-piston-assembly, a fluid source adapted to supply pressure fluid to said main cylinder-piston-assembly, a platen connected with said motor means and adapted to be reciprocated thereby, a plurality of balancing cylinder pairs, the cylinders of each cylinder pair being in alignment with each other, a plurality of balancing plungers supported by said platen, one plunger being associated with one balancing cylinder pair, a pilot pump adapted to supply pressure fluid to said balancing cylinders and to maintain said balancing cylinders filled with fluid, and means for relieving excessive pressure in said balancing cylinders, said balancing plungers and said platen being provided with passageways therethrough for effecting communication of one cylinder pertaining to one cylinder pair with a cylinder pertaining to another cylinder pair to prevent tilting movement of said platen.

19. In a press, a platen, a main actuating ram therefor, a fluid source, pressure creating means to cause the flow of fluid to said ram for actuating the same, a plurality of balancing cylinders arranged on the corners of said platen and each having reciprocably mounted therein a plunger with a passageway therethrough for hydraulically interconnecting two diagonally disposed cylinders to maintain said platen constantly in a substantially level condition, means independent of said pressure creating means for filling said balancing cylinders with fluid and maintaining them filled, and means for evacuating said cylinders at the end of each cycle to prevent any accumulation of fluid in said cylinders beyond that desired.

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