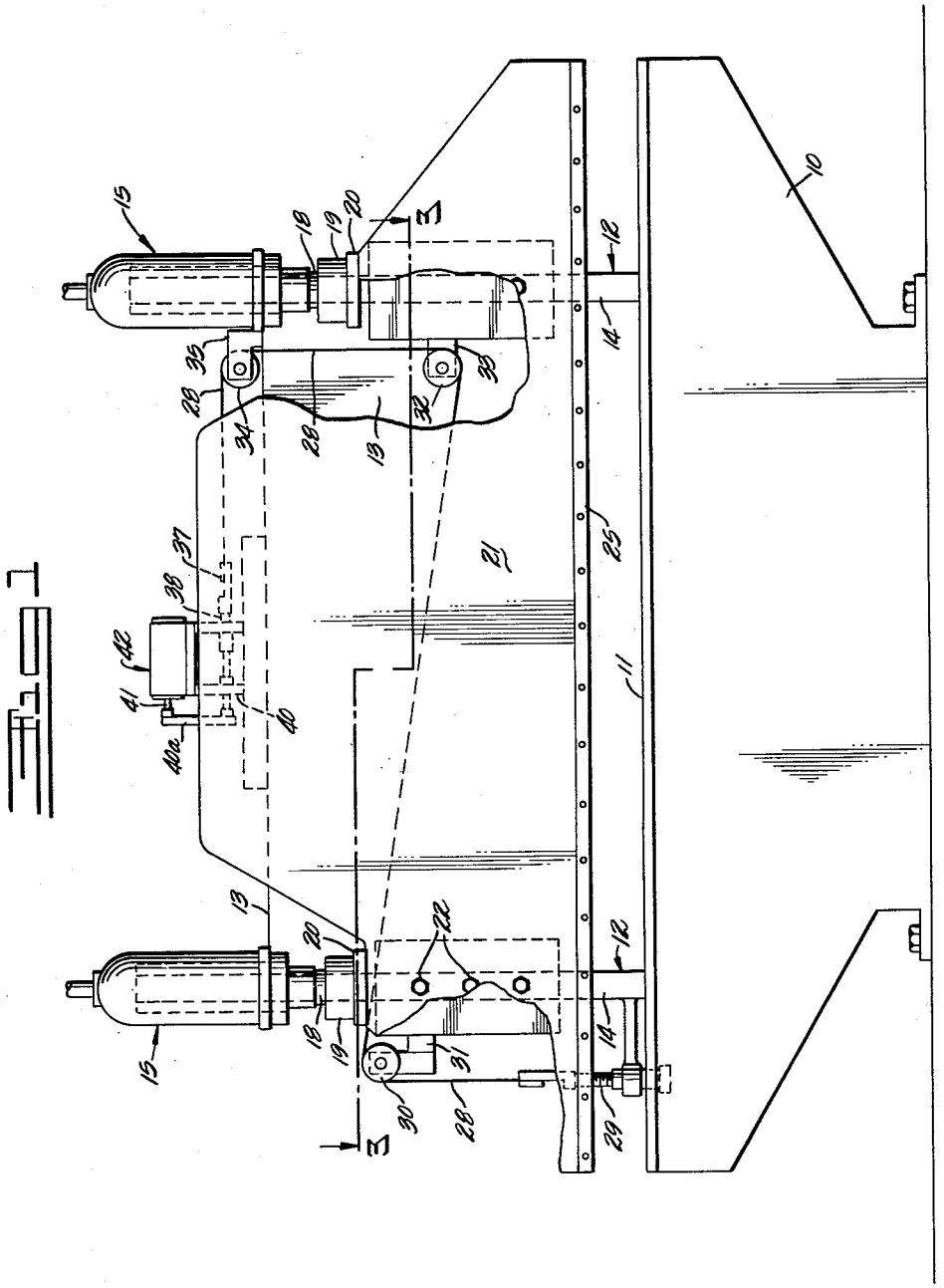
Feb. 11, 1964 J. J. STRNAD ETAL 3,120,799

PLATEN-LEVELING CONTROL SYSTEM FOR HYDRAULICALLY-ACTUATED BRAKE PRESSES

Filed June 26, 1961 4 Sheets-Sheet 1



INVENTORS.
JAMES J. STRNAD
HARRY B. VAN AUKEN
BY
MAHONEY, MILLER & RAMBO
BY W. S. Rambo
ATTORNEYS.

Feb. 11, 1964 J. J. STRNAD ETAL 3,120,799

PLATEN-LEVELING CONTROL SYSTEM FOR HYDRAULICALLY-ACTUATED BRAKE PRESSES

Filed June 26, 1961 4 Sheets-Sheet 2

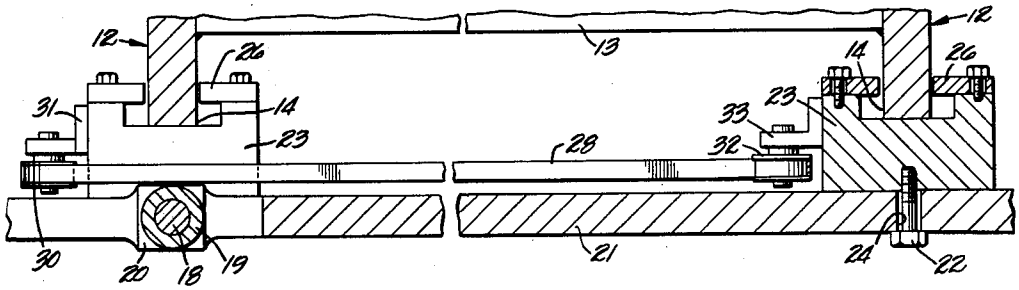


FIG. 3

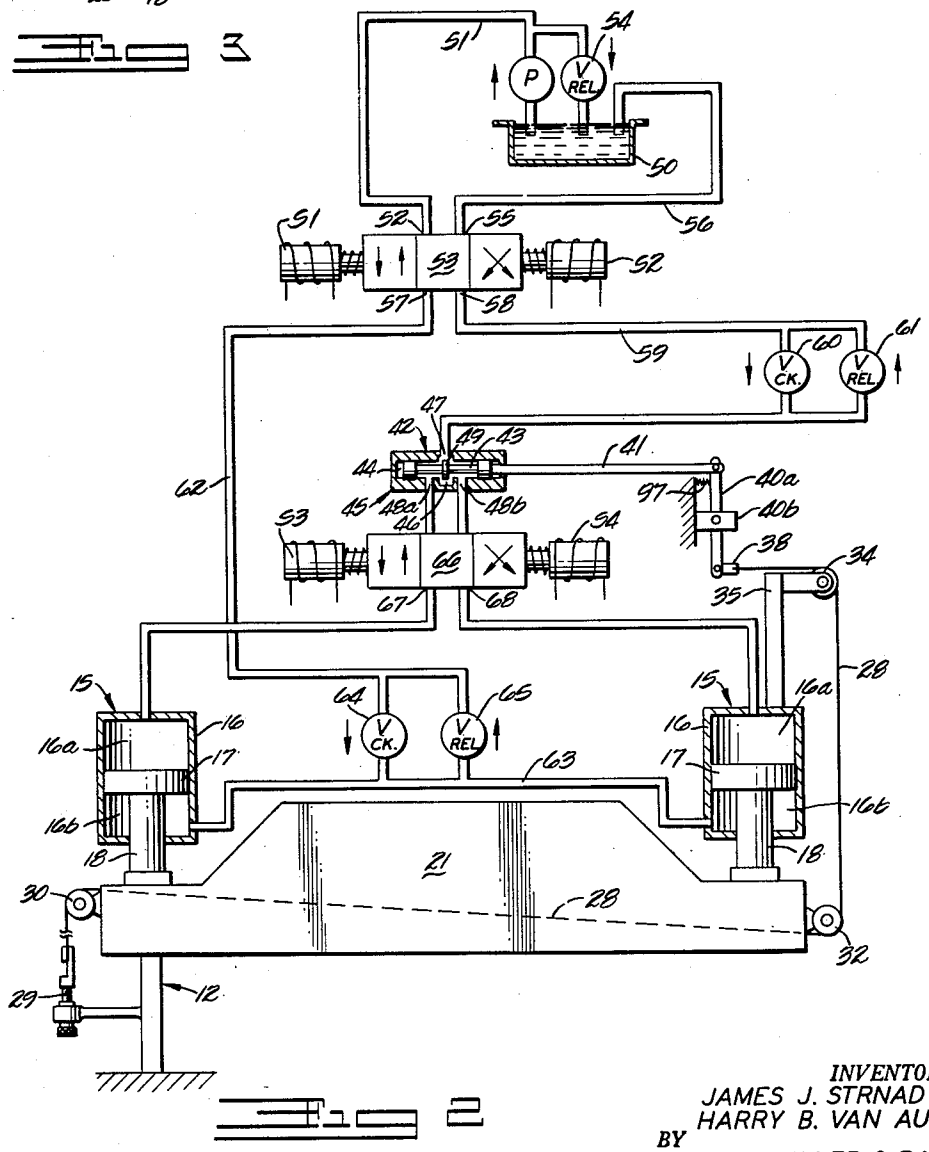


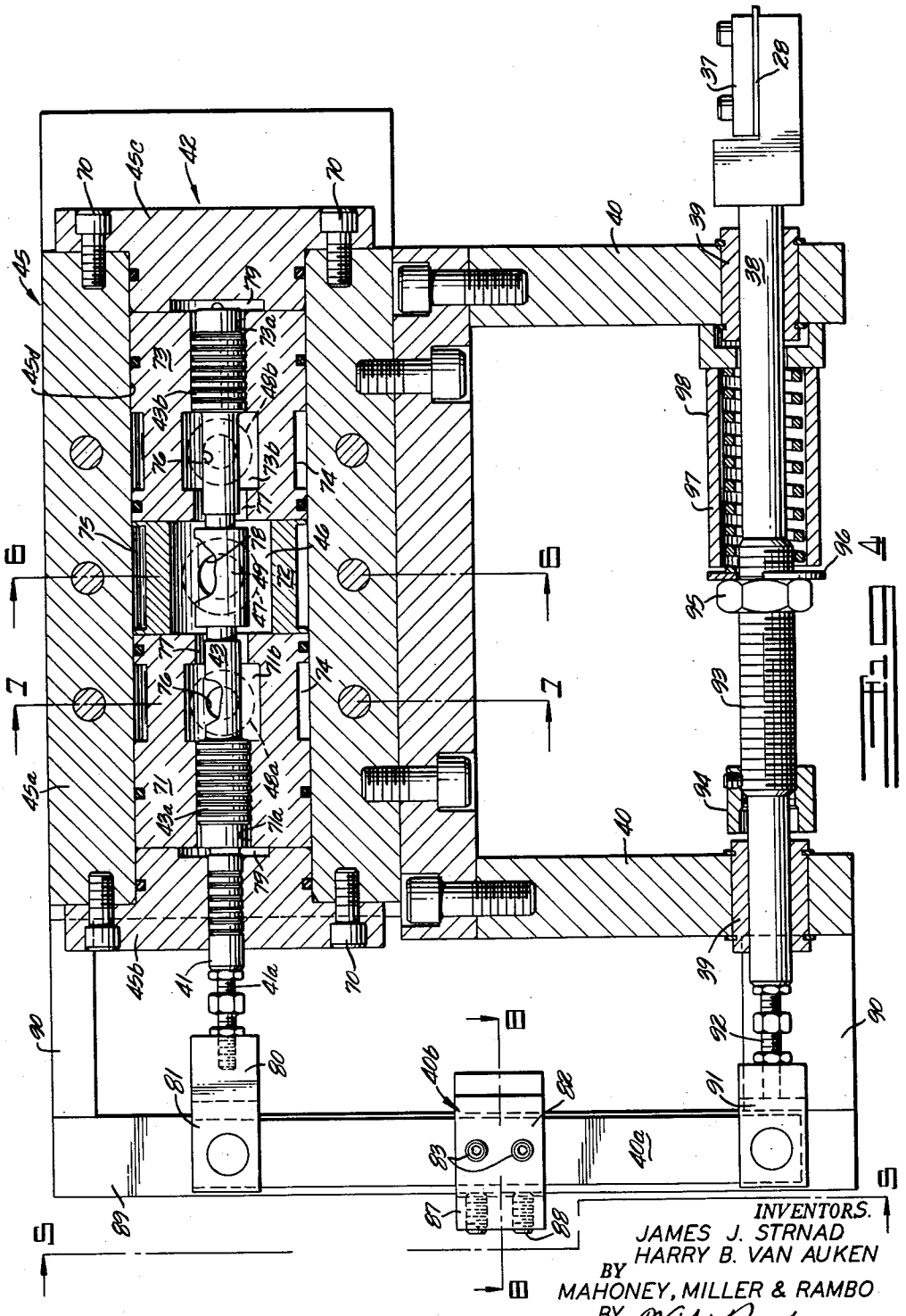
FIG. 2

INVENTORS.
JAMES J. STRNAD
HARRY B. VAN AUKEN
BY
MAHONEY, MILLER & RAMBO
BY W. J. Rambo
ATTORNEYS.

Feb. 11, 1964 J. J. STRNAD ETAL 3,120,799

PLATEN-LEVELING CONTROL SYSTEM FOR HYDRAULICALLY-ACTUATED BRAKE PRESSES

Filed June 26, 1961 4 Sheets-Sheet 3



INVENTORS.
JAMES J. STRNAD
HARRY B. VAN AUKEN
BY
MAHONEY, MILLER & RAMBO
BY W. J. Rambo
ATTORNEYS.

Feb. 11, 1964 J. J. STRNAD ETAL 3,120,799

PLATEN-LEVELING CONTROL SYSTEM FOR HYDRAULICALLY-ACTUATED BRAKE PRESSES

Filed June 26, 1961 4 Sheets-Sheet 4

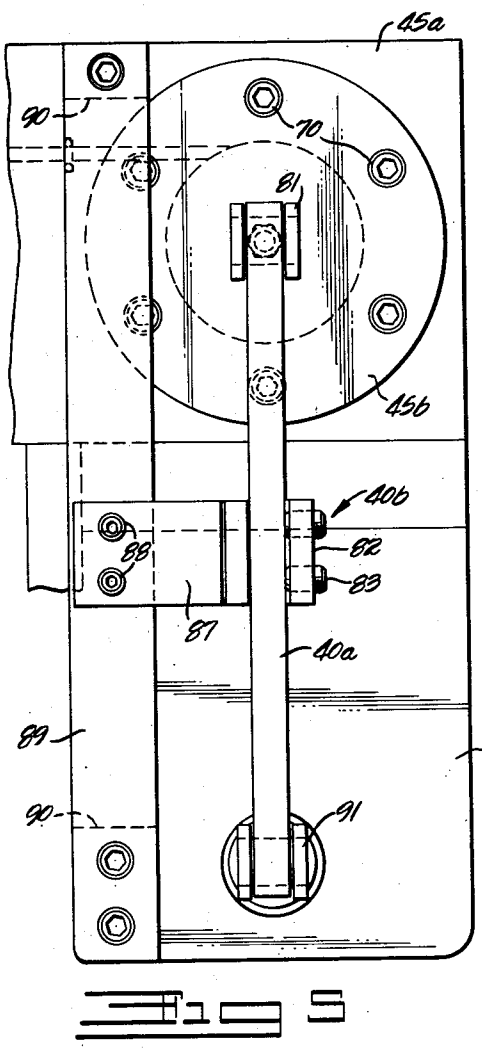


FIG 5

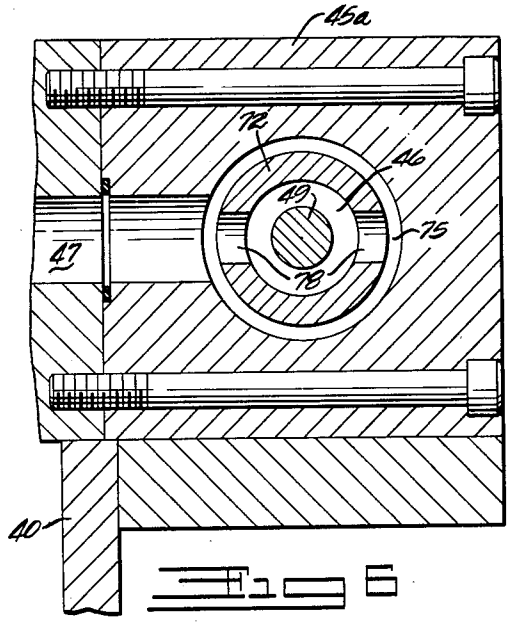


FIG 6

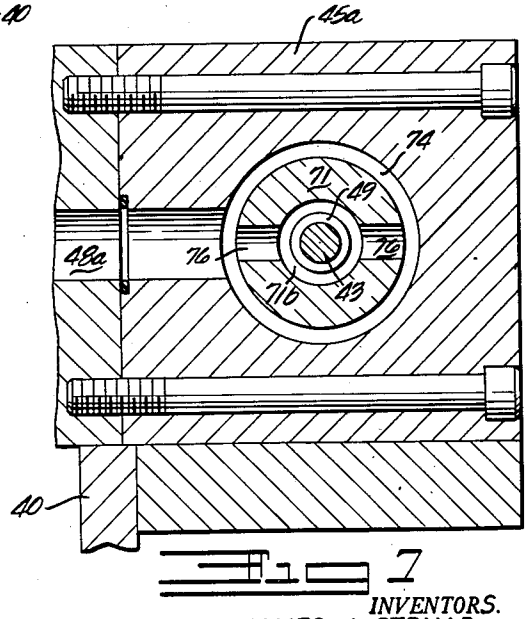


FIG 7

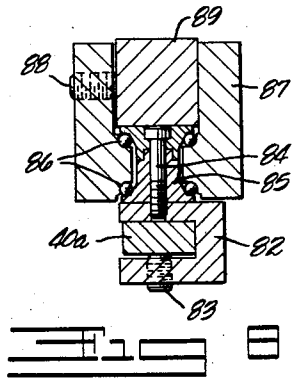


FIG 8

INVENTORS.
JAMES J. STRNAD
HARRY B. VAN AUKEN
BY
MAHONEY, MILLER & RAMBO
BY W. A. Rambo
ATTORNEYS.

United States Patent Office 3,120,799 Patented Feb. 11, 1964

3,120,799

PLATEN-LEVELING CONTROL SYSTEM FOR HYDRAULICALLY-ACTUATED BRAKE PRESSES

James J. Strnad, Shaker Heights, and Harry B. Van Auken, Brooklyn Heights Village, Ohio, assignors to Lempco Products, Inc., Bedford, Ohio, a corporation of Ohio

Filed June 26, 1961, Ser. No. 119,441
5 Claims. (Cl. 100—46)

The present invention relates generally to hydraulic presses, and more particularly to an improved control system for maintaining the movable platen of a hydraulically operated brake press, or the like, in a preselected level position during movement thereof toward and away from the bed of the press.

Certain types of hydraulic presses, notably hydraulic brake presses, embody a relatively elongated platen, knife or die-supporting blade which is arranged for reciprocating movement in a vertical plane relative to the stationary bed of the press and/or a complemental die carried upon the bed of the press. Ordinarily the elongated platen of such presses is supported and reciprocated during its working movements by means of a pair of relatively widely spaced apart hydraulic rams which are connected with the platen toward the opposite end portions thereof, and which are operable in response to fluid pressure supplied thereto to move the platen downwardly toward the bed of the press to perform the desired pressing or bending operation and to retract the platen upwardly following the pressing or bending operation. Due to the extreme length of such platens and the relatively wide spacing of the hydraulic rams, the platen and its associated bending die oftentimes tend to tilt or cock and assume an undesirable angular relationship with respect to the bed of the press during reciprocating movement of the ram. This undesirable tilting of the platen is particularly aggravated during pressing operations in which the load or reaction forces applied to the platen by a particular workpiece are unbalanced and are off center with respect to the platen. As will be readily understood by those skilled in the art of brake press operations, the movable platen of the press will tend to tilt or cock downwardly toward the end thereof which encounters the least load resistance during the pressing stroke. This is due to the fact that the hydraulic rams which actuate the platen, whether they are connected in parallel in a common hydraulic supply circuit or operated by independent hydraulic supply circuits, will tend to advance the end of the platen under the least load more rapidly than the end which encounters the greater load.

While numerous attempts have been made in the past to eliminate or minimize the angular tilting of a press platen actuated by a pair of relatively widely separated hydraulic rams, such attempts have been largely unsuccessful, and the particular platen-leveling control systems proposed for this purpose have been comparatively complex, insensitive and inefficient in their intended usage.

Accordingly, it is the primary object of the present invention to provide an improved platen-leveling control for plural ram hydraulic brake presses or the like which is characterized by its mechanical simplicity and yet which is particularly sensitive and efficient in detecting an undesired tilting of the platen and in controlling the supply of pressure fluid to the individual hydraulic rams of the press in a manner to quickly restore the platen to its desired level during both pressing and retracting strokes of the platen.

Another object of this invention is to provide a platen-leveling control for a plural ram hydraulic press which comprises a structurally simple and mechanicaly efficient motion-transmitting linkage and flow-proportioning valve mechansm which is responsive to an angular tilting of the movable platen of the press in either direction away from a preselected angular relationship with the stationary bed of the press for controlling the volume of pressure fluid flowing to and from the hydraulic rams of the press in a manner to quickly restore the platen to the desired preselected angular relationship.

A further object is to provide a platen-leveling control for a plural ram hydraulic press which comprises a flow-proportioning valve connected in a common hydraulic supply circuit for the respective rams of the press and operable to proportionately increase or decrease the volume of pressure fluid flowing to each of the rams and thereby to control the rate of movement of the opposite end portions of the platen of the press, in combination with a flexible valve-actuating assembly which is responsive to an undesired angular tilting of the press platen for operating the valve in a manner to cause the rams of the press to restore the platen to a desired level condition.

Yet another object is to provide a platen-leveling control of this character which is so constructed and arranged as to be insensitive to and unaffected by load strains, forces and deflection of parts of the press encountered during usual press operations, thus making the control more sensitive and accurate in its operation.

For a further and more complete understanding of the invention and the additional objects and advantages thereof, reference is made to the following description and the accompanying drawings, wherein:

FIG. 1 is a front elevational view of a brake press illustrating the present platen-leveling control in diagrammatic form;

FIG. 2 is a diagrammatic view of the present platen-leveling control and the associated hydraulic circuit therefor;

FIG. 3 is a horizontal sectional view taken along the line 3—3 of FIG. 1;

FIG. 4 is a longitudinal vertical sectional view, partly in elevation, of the flow-proportioning valve and operator mechanism of the present platen-leveling control;

FIG. 5 is an end elevational view of the valve and operator mechanism looking from the left hand end of FIG. 4;

FIG. 6 is a transverse vertical sectional view taken along the line 6—6 of FIG. 4;

FIG. 7 is a similar view taken along the line 7—7 of FIG. 4; and

FIG. 8 is a detailed horizontal sectional view taken along the line 8—8 of FIG. 4 and showing the adjustable fulcrum for the valve operator.

Referring now to the drawings, and particularly to FIG. 1 thereof, there is illustrated a hydraulically operated brake press which includes the usual stationary, floor-mounted bed **10** on which is suitably supported an elongated, stationary bending die **11**. Secured to and arising vertically from the rear side of the bed are a pair of transversely spaced stanchions or strain plates **12** which are connected together by a transverse frame plate or strong back **13**. The stanchions **12** are formed or otherwise provided at their forward edges with vertically arranged, rectangular guide surfaces **14**. Supported upon the upper ends of the stanchions **12** in relatively widely spaced apart relation are a pair of double-acting hydraulic rams or motors **15**, each of which includes an internal cylinder **16** and a fluid pressure-responsive piston **17**. Connected with each piston **17**, and extending outwardly from the bottom of the associated cylinder **16** is a relatively extensible and retractable piston rod **18**. The piston rods **18** are disposed in outwardly spaced, parallel relation to the guides **14** and are connected, as by means of the collars **19**, with a pair of relatively enlarged shoulder bosses **20** formed on the upper portion of an

elongated, vertically movable platen or knife member 21. The connecting collars 19 preferably provide for limited pivotal movement of the platen 21 with respect to the lower ends of the piston rods 18 for a purpose which will hereinafter be more fully explained.

Connected with the rearward side of the platen or knife member 21, as by means of cap screws 22, are a pair of slide members 23. As will be seen in FIG. 3, the cap screws 22 extend through relatively enlarged openings 24 formed in the platen 21 and into cooperatively threaded sockets formed in the slide members 23. Thus, the relatively enlarged or oversize openings 24 provide for limited angular adjustment of the platen or knife member 21 on the slides 23, when it is desired that the bending die 25 carried at the lower edge of the platen be disposed in slightly angular relation to the horizontal upper surface of the bed 10 of the press. As will be understood by those familiar with brake presses, this limited angular adjustment of the movable platen or knife member is commonly provided for the purpose of enabling the press to perform special bending operations, such as in the bending of conical shapes. The slide members 23 are arranged for sliding engagement with the stationary guides 14 and are preferably provided with adjustable gibs or bearing blocks 26 which snugly engage the sides of the guides 14 in a manner to prevent lateral displacement or side sway of the platen during vertical advancing and retracting movement thereof. The structure and arrangements of parts previously described are common to various types of brake presses, and as such, form no part of the present invention.

In accordance with the present invention, there is provided an improved control mechanism for detecting an undesired angular tilting or cocking of the platen or knife member 21 during vertical advancing or retracting movement thereof and for restoring the platen to its desired horizontal position or to its preset angular relationship to the bed of the press. This control mechanism comprises a flexible metallic tape 28, or a similar non-elastic, flexible member, such as a flexible wire, belt or chain, which has one end thereof fixedly, but adjustably, secured to the lower portion of the left hand strain plate or column 12, as by means of an adjustable screw clamp 29. From the screw clamp 29, the tape 28 extends upwardly behind the normal plane of movement of the platen 21 and is trained over a first pulley 30 which is rotatably carried upon a supporting bracket 31 rigidly secured to the left hand slide 23 of the platen. From the pulley 30, the tape extends across and to the rear of the platen 21 and is trained over a second pulley 32 which is rotatably supported on a bracket 33 rigidly secured to the opposite slide 23 of the platen. The tape 28 is then directed upwardly from the pulley 32 and around a third pulley 34 which is rotatably carried at the outer end of an arm 35 which has its lower end rigidly anchored to the right hand strain plate or column 12 at a point thereon not subject to normal strain deflection. The tape 28 then continues horizontally across and above the frame plate 13 of the press and has its opposite end rigidly secured, as by means of a clamping block 37, to a reciprocating rod or lever 38 which is slidably carried in bearings 39 mounted in a pair of relatively spaced valve-supporting plates 40 secured to the upper surface of the frame plate or strong back 13 of the press.

As shown diagrammatically in FIG. 2, and as will be hereinafter more fully described by reference to FIG. 4, the rod 38 is pivotally secured to the lower end of a lever 40*a* which, in turn, is pivoted intermediate its ends to an adjustable fulcrum 40*b*. The upper end of the lever 40*a* is pivotally connected with the outer end of a valve stem or operator rod 41 of a proportioning valve 42. The valve 42 includes a movable spool member 43 which is connected directly with the operator rod 41 and which is slidable within an elongated valve chamber 44 formed in the valve casing 45. The main valve chamber

44 communicates with a relatively enlarged central chamber 46 which is connected with an inlet port 47 of the valve. Communicating with the main valve chamber 44, on either side of the inlet port 47, are a pair of relatively spaced outlet ports 48*a* and 48*b*. The spool member 43 of the valve includes a central spool part 49 which is normally arranged in the plane of the inlet port 47 of the valve, but which, upon movement of the valve member 43 in either direction away from its neutral or centered position, as shown in FIG. 2, serves to proportionately decrease the amount or volume of fluid passing to one of the outlet ports 48*a* or 48*b*, while increasing the volume of fluid passing to the opposite outlet port.

The proportioning valve 42 is connected in the hydraulic supply circuit for the hydraulic motors 15 of the press. The hydraulic circuit includes a reservoir 50 for supplying hydraulic fluid to the inlet of a motor-driven pump P. The outlet of the pump P is connected with a conduit 51 which leads to the inlet port 52 of a solenoid-actuated, four-way reversing valve 53. The conduit 51 is provided with the usual pressure relief by-pass valve 54 which functions to return pressure fluid from the pump to the reservoir in response to a predetermined build-up of pressure in the line 51. The valve 53 is of conventional form and includes an exhaust port 55 connected by way of the return line 56 to the reservoir 50, and a pair of motor ports 57 and 58. The valve 53 is of the three position type and is normally arranged to connect the inlet port 52 with the exhaust port 55 and to block ports 57 and 58 when both of the solenoids S1 and S2 are de-energized. When the left hand solenoid S1 is energized, the valve is conditioned to connect the inlet port 52 with the left hand motor port 57, and the exhaust port 55 with the right hand motor port 58. Conversely, when the right hand solenoid is energized, the inlet port 52 is connected with the motor port 58 and the opposite motor port 57 is connected with the exhaust port 55.

Leading from the right hand motor port 58 of the valve 53 is a conduit 59 which extends to the inlet port 47 of the proportioning valve 42. Connected in the conduit 59, in by-passing relation to one another, is a check valve 60 and a pressure relief valve 61. The check valve 60 is arranged to open in the direction of the proportioning valve 42, while the pressure relief valve 61 is adapted to open toward the reversing valve 53 in response to a predetermined pressure at the inlet port 47 of the valve 42. The left hand motor port 57 is connected to a conduit 62 leading to a manifold conduit 63 which has its opposite ends communicating with the ram-retracting chambers 16*b* of each of the hydraulic motors 15 of the press. Connected between the manifold 63 and the line 62, in by-passing relation to one another, is a check valve 64 and a pressure relief valve 65. The check valve 64 opens toward the manifold 63, while the relief valve 65 is adapted to open toward the conduit 62 in response to a predetermined pressure within the manifold 63.

The outlet ports 48*a* and 48*b* of the proportioning valve 42 are connected respectively with the inlet and exhaust ports of a second solenoid-actuated, four-way reversing valve 66. The valve 66 may be identical in construction and operation to the valve 53 or may be of the two position type and includes a pair of motor ports 67 and 68 connected respectively, to the ram-advancing chambers 16*a* of each of the hydraulic motors 15 of the press. The valve 66 includes the solenoids S3 and S4 which are alternately energizable to connect the outlet port 67 of valve 66 with the outlet port 48*a* of valve 42, and the outlet port 68 with the outlet port 48*b*, or to connect outlet port 48*b* with outlet port 67 while connecting the port 48*a* with outlet port 68.

FIGS. 4–8 of the drawings illustrate in detail the construction of the proportioning valve 42 and its associated operating levers and linkage. The valve casing 45 comprises a main body portion 45*a* of generally rectangular form and a pair of opposite end caps 45*b* and 45*c* of

generally circular form which are bolted to the main body portion 45*a* as by means of cap screws 70. The main body portion 45*a* is formed with an axial bore 45*d* which is closed at its opposite ends by the end caps 45*b* and 45*c*. Positioned within the bore 45*d* of the casing are three annular chamber-forming blocks 71, 72 and 73. The chamber-forming blocks 71 and 73 are identical, and each is formed on its peripheral surface with an annular groove 74 which communicates, respectively, with the outlet ports 48*a* and 48*b* of the valve. The intermediate or central chamber-forming blocks 72 is also formed with an annular peripheral groove 75 which communicates with the inlet port 47 of the valve. The blocks 71 and 73 are formed to provide axially disposed spool-receiving bores 71*a* and 73*a* which slidably receive the peripherally grooved balancing spools 43*a* and 43*b* of the movable spool member 43. The bores 71*a* and 73*a* terminate at their inner ends in relatively enlarged chambers 71*b* and 73*b* which are connected, respectively, with the annular grooves 74 by means of the radially disposed passages 76. The central chamber-forming block 72 is formed with the axially disposed and relatively enlarged chamber 46 in which the central spool 49 of the movable valve member 43 is positioned. As will be noted, the chamber 46 is of larger diameter than the chambers 71*b* and 73*b*, but is disposed in communication therewith by way of the relatively reduced throats 77. The chamber 46 also communicates with the annular groove 75 and the inlet port 47 of the valve by way of the radially disposed passages 78.

The movable spool member 43 is arranged for limited axial movement within the bores 71*a* and 73*a* and such movement is limited by the depth of the spaces or annular recesses 79 formed on the inner surfaces of the end caps 45*b* and 45*c*. As will be seen, the central spool element 49 of the movable valve member 43 controls the volumetric flow of fluid between the inlet port 47 and each of the outlet ports 48*a* and 48*b* of the valve. With the spool element 49 occupying the position as shown in FIG. 4, the ends of the spool 49 are equally spaced from the throats 77, thus permitting equal volumes of fluid to pass from the central chamber 46 to each of the outlet chambers 71*b* and 73*b*, or vice versa. However, if the valve member 43 is shifted slightly leftwardly, as viewed in FIG. 4, the same tends to restrict the left hand throat 77, thus decreasing the volumetric flow of fluid between the central chamber 46 and the outlet chamber 71*b*, while more fully opening the right hand throat 77 to increase the volumetric flow of fluid between the chambers 46 and 73*b*. Conversely, when the valve member 43 is shifted rightwardly from the position shown in FIG. 4, the flow of fluid between chambers 46 and 71*b* is increased and the flow of fluid between chambers 46 and 73*b* is proportionately decreased. Due to the relatively close spacing of the ends of the spool 49 with respect to the throats 77, only a very slight movement of the valve member 43 is required to effect a large differential in the flow of fluid between the central chamber 46 and the respective outlet chambers 71*b* and 73*b* of the valve.

As previously indicated, the valve member 43 is adapted to be moved by the operator stem or rod 41 which comprise a screw-threaded stud 41*a* threaded at one end into a cooperatively threaded socket of the valve member 43 and having its opposite end threaded into a block 80 which terminates in a clevis 81 which is pivotally connected with the upper end of the lever 40*a*. The stud 41*a* is adjustable after the manner of a turnbuckle to vary, within limits, the distance between the upper end of the lever 40*a* and the outer end of the valve member 43.

The adjustable fulcrum 40*b* is shown more particularly in FIGS. 5 and 8 of the drawings and comprises a bifurcated clamp 82 having set screws 83 arranged to clamp the intermediate portion of the lever 40*a*. The clamp 82 is connected by means of a bolt 84 to a sectional, rotatable spool 85 which is journalled in anitifriction ball bearings 86 carried by a second bifurcated clamping block 87. The second clamping block 87 is provided with set screws 88 which are adapted to clamp a stationary, vertically extending guide bar 89 carried on bracket arms 90 extending outwardly from the valve casing 45 and one of the supporting plates 40. Thus, by loosening the set screws 83 and 88, the fulcrum assembly 40*b* may be adjusted vertically on the guide bar 89 so as to vary the lever arms between the fulcrum and the valve operator stem 41 and between the fulcrum and the lower operator rod 38, whereby to vary the mechanical ratio permitting a wide range of settings for tape movement relative to spool displacement, thus facilitating an arrangement whereby the sensitivity may be selected for optimum control and leveling corrections may be made at frequencies compatible with the resonance of the press.

The lower end of the lever 40*a* is pivotally connected with a clevis block 91 which threadedly receives one end of a turnbuckle stud 92 having its opposite end threaded into a socket formed in the end of the lower operator rod 38. As will be noted by reference to FIG. 4, the rod 38 is provided with an intermediate screw-threaded section 93 on which is carried an adjustable stop collar 94 which limits the leftward movement of the rod 38, as viewed in FIG. 4. Also carried on the section 93 is an adjustable nut 95 and a washer 96 which engages the outer end of a coiled compression spring 97. The spring 97 is carried mainly within a tubular housing 98 secured to the right hand supporting plate 40. The spring 97 functions to exert pressure upon the washer 96 and nut 95 to thus urge the rod 38 to move leftwardly in opposition to a pulling force exerted thereon by the tape 28. As will be understood, the valve operator linkage, as heretofore described, provides a convenient and accurate means to adjust the connection between the upper end of the tape 28 and the movable valve member 43, so that a relatively small linear movement of the tape will result in a corresponding movement of the valve member 43, with minimal lost motion. As initially set, the valve member 43 will normally occupy a neutral or centered position wherein the flow of fluid between the inlet and outlet ports of the valve will be equal. This neutral position is maintained so long as the pulling force of the tape 28 equals the force of the spring 97.

Thus, in operation, assuming the platen 21 to occupy its fully retracted or raised position above the bed 10 of the press, and assuming further that the platen is level or is set at its desired angular relation to the bed of the press, the tape 28 is adjusted by means of the anchoring screw 29, so that all slack is removed from the tape, and the linkage for the valve member 43 is adjusted, so that the valve member occupies an exact neutral or centered position. The solenoids S2 and S4 are then energized through closure of an associated manually or automatically controlled electrical operating circuit, not shown. The pump P then delivers pressure fluid through the inlet 52 of the reversing valve 53, through the line 59, check valve 60, and the inlet port 47 of the proportioning valve 42. Pressure fluid is then divided equally by the center spool 49 of the valve 42 and is discharged in equal volumes from the outlet ports 48*a* and 48*b*. Fluid passing from the outlet port 48*a* of the proportioning valve 42 is then diverted by valve 66 outwardly from the motor port 68 and into the ram-advancing area 16*a* of the right hand fluid motor 15, while fluid from the outlet port 48*b* is diverted by the valve 66 through the motor port 67 and to the ram-advancing area of the left hand fluid motor 15. The pistons 17 of the motors and the platen 21 then advance downwardly on a pressing stroke. Fluid within the retracting areas 16*b* of the motors or rams is displaced outwardly through manifold 63, through pressure relief valve 65, line 62, through the motor port 57 of valve 53 and thence through the exhaust line 56 to the reservoir 50. It will here be understood that the pressure relief valve 65 is set

to open at a predetermined pressure sufficient to maintain enough pressure beneath the pistons **17** of the rams to sustain the weight of the platen and prevent advance thereof by gravity and to maintain the desired degree of hydraulic rigidity within the system. Assuming that during the downward advancing movement of the platen, no unequal resistance is encountered which might tend to tilt or cock the platen, the effective length of the tape **28** will remain the same, and the tension upon the tape will remain constant. Thus, the movable valve member **43** of the proportioning valve will remain in its centered position in which equal volumes of fluid are passed to each of the rams **15**. However, if, during the advancing movement of the platen, an unequal or off center load or resistance is encountered, the platen will tend to tilt or cock due to the fact that the particular ram or motor **15** which encounters the least resistance will continue to advance while the opposite ram, being under greater load, will tend to stop or slow down. In such event, due to the arrangement of the intermediate pulleys **30** and **32**, the outer or upper end of the tape **28** which is attached to the valve operator rod **38** will move in one direction of the other, thus causing the movable valve member **43** to shift away from its centered position to a position at which a greater volume of fluid is passed to the motor or ram **15** which is under a greater load, while decreasing the volume of fluid passing to the other motor or ram. For example, referring to FIG. 2, let it be assumed that during its downward movement, the left hand side or end of the platen or knife **21** moves into contact with a workpiece prior to engagement of the right hand side or end of the platen with the workpiece. Such an off center loading will tend to tilt the platen **21** in a clockwise direction with the result that the pulleys **30** and **32** will exert a force upon the intermediate portion of the tape to thus pull the upper end of the tape rightwardly as viewed in FIGS. 2 and 4. This rightward movement of the tape **28** is transmitted through the rod **38**, the lever **40***a* and the valve operator **41** to shift the movable valve member **43** to the left, thus restricting the flow of fluid through the outlet port **48***a* while increasing the amount of fluid passing through the outlet port **48***b*. With the solenoid **S4** energized, the greater volume of pressure fluid passes from the outlet port **48***b* through the motor port **67** into the left hand ram or motor **15**, thus causing the left hand ram to exert a greater force upon the platen than the right hand ram. As the platen is restored to its original preset level, the tape tends to slacken, and the compression spring **97** forces the rod **38** leftwardly, to thus return the valve member **43** to its normal centered position to equalize the volumetric flow of fluid to each of the rams **15**. Conversely, when the platen tilts or cocks in a counterclockwise direction, the tape **28** will tend to slacken, thus permitting the spring **97** to move the rod **38** leftwardly to shift the valve member **43** in the opposite direction thereby causing a greater volume of fluid to pass to the right hand ram **15**.

It is significant to note that the present platen-leveling control system also functions during the upward or retracting stroke of the platen, as well as upon the advancing stroke thereof. Thus, assuming the downward pressing stroke to be completed, the solenoids **S2** and **S4** are de-energized and the opposite solenoids **S1** and **S3** are energized. Energization of solenoid **S1** shifts the valve **53** so as to connect the pump with the ram-retracting chambers **16***b* of each of the motors **15**, by way of the line **62**, check valve **64** and manifold **63**, while connecting the conduit **59** leading from the inlet port **47** of the proportioning valve **42** with the reservoir **50**. Energization of solenoid **S3** shifts the valve **66** so as to connect the motor ports **67** and **68** with the outlet ports **48***a* and **48***b*, respectively, of the valve **42**. Thus, as pump pressure is exerted beneath the pistons **17** of the rams **15**, the platen begins to rise from the bed of the press with equal force exerted upon opposite ends thereof. However, assuming that one end of the platen encounters a greater drag load than the other during the retracting cycle, the platen will tilt or cock downwardly toward the greater load or drag. Assuming that the right hand end of the platen is under greater load during retracting movement, the outer end of the tape **28** connected with the rod **38** will be pulled rightwardly by the pulleys **30** and **32**, thus shifting the valve member **43** leftwardly to restrict the flow of fluid from the left hand ram **15**, while permitting a greater volume of fluid to pass from the right hand ram **15**. The resistance to the flow of fluid from the left hand ram tends to equalize the drag loads on the opposite ends of the platen to thus restore the same to its desired level during the retracting stroke. During the retracting stroke of the platen, the pressure relief valve **61** functions to maintain a predetermined, relatively low pressure within the return lines from the rams **15** to increase hydraulic rigidity and stabilize the platen during its retracting stroke.

In view of the foregoing, it will be seen that the present invention provides a highly sensitive, mechanically efficient mechano-hydraulic control which functions efficiently and quickly to detect and correct undesired angular tilting or cocking of the platen of a plural ram hydraulic press. The present control system is particularly suited for use in combination with hydraulic presses of the type embodying relatively elongated platens and relatively widely spaced apart hydraulic rams, such as hydraulic brake presses, shears or the like. The invention is further characterized by its mechanical simplicity and ease of installation in new as well as existing plural ram presses. Further, due to the fact that the tilt-detecting tape **28**, and its stationary supporting pulley **34**, are both anchored to relatively stationary base components of the press, the tape is not subject to the strain loads and deflections normally encountered in the strong back and upper frame components of the press, thus avoiding inherent inaccuracies which would otherwise be obtained were the tape supported by one or more members subject to deflection or elongation during normal press operations. Another significant advantage resides in the mounting of the intermediate tape-supporting pulleys **30** and **32** upon the slide members **23** rather than directly upon the platen itself. As will be readily understood by those familiar with brake press operations, the platen of the press is subject to rather extreme deflection during particular pressing operations, and if the tape-supporting pulleys were directly connected with the platen, rather than the platen slides, such deflection could well result in inaccuracy in the operation of the present platen-leveling control system.

While a single preferred embodiment of the present invention has been illustrated and described in detail, it will be understood that various modifications as to details of construction and design may be resorted to without departing from the spirit of the invention or the scope of the following claims.

Having thus described this invention, what is claimed is:

1. In a hydraulically operated press which includes relatively stationary, non-deflectable frame components, a bed, a movable press platen, a pair of double-acting hydraulic motors connected in relatively spaced apart relation with the press platen and operable in response to pressure fluid supplied thereto to reciprocate the press platen toward and away from the bed of the press, pump means for supplying pressure fluid to said hydraulic motors, and a reversing valve having connections with said pump means and each of said motors and operable selectively to reverse the direction of movement of said motors; a control for maintaining the platen in preselected angular relation to the bed of the press during reciprocating movement of the platen, said control comprising a first valve having separate connections with each of said hydraulic motors and with said reversing valve and having a movable valve member operable to increase the volume

of fluid passing to and from one of said motors while proportionately decreasing the volume of fluid passing to and from the other of said motors; mechanical operator means supported by non-deflectable frame components of said press and having connections with the movable valve member of said first valve and with said platen, said operator means being movable in response to a deviation in angular relationship between the platen and the bed of the press to shift the valve member of said first valve to a position to cause said motors to restore the platen to said preselected angular relation to the bed of the press, said operator means including an adjustable lever means operable to vary the ratio of movement between said operator means and the valve member of said first valve; and a second valve connected between said first valve and each of said hydraulic motors and operable to reverse the connections between said first valve and said motors.

2. A platen-leveling control for a hydraulic press having relatively stationary, non-deflectable frame components, a bed, a movable press platen, a pair of relatively widely spaced apart, double-acting hydraulic rams connected with said platen and operable to reciprocate said platen toward and away from the bed of said press, pump means for supplying hydraulic fluid under pressure to said rams and a reversing valve having connections with said pump means and each of said hydraulic rams and operable selectively to reverse the direction of movement of said rams; said control comprising a continuous, non-elastic, flexible member having an inner end portion anchored to a relatively stationary, non-deflectable frame component of the press, an intermediate portion movably trained around supports arranged substantially at opposite ends of said press platen and an outer end portion movably supported independently of the press platen, the outer end portion of said flexible member being arranged for movement in response to an angular tilting of the press platen relative to the bed of the press; a common flow-proportioning valve connected in series between the reversing valve of the press and each of the hydraulic rams thereof and having a movable valve member; an adjustable fulcrum lever connecting the outer end of said flexible member with said movable valve member and adjustable to vary the ratio of movement therebetween, the valve member of said flow-proportioning valve being arranged normally to pass equal volumes of fluid to and from each of said rams, but being operable in response to movement of the outer end of said flexible member to proportionately vary the volumetric flow of fluid to and from each of said rams; and a second reversing valve connected between said flow-proportioning valve and said rams and operable to reverse the connections between said flow-proportioning valve and each of said rams.

3. In a hydraulic press having stationary bed and frame components, a relatively elongated press platen arranged for reciprocation toward and away from the bed of the press, a pair of double-acting hydraulic rams connected with said platen toward the opposite ends thereof and operable to reciprocate said platen, a hydraulic pump operable to supply pressure fluid to each of said rams and a reversing valve having connections with each of said rams and with said pump and operable selectively to reverse the direction of movement of said rams; a platen-leveling control comprising a flow-proportioning valve connected in series between said reversing valve and each of said rams and having a movable valve element arranged normally to pass equal volumes of fluid to each of said rams, but being movable in opposite directions to pass a lesser volume of fluid to one of said rams while passing a proportionately greater volume of fluid to the other of said rams and vice versa; a second reversing valve connected between said proportioning valve and said rams and operable to reverse the connections between said proportioning valve and said rams; relatively spaced guide means carried in association with said platen; an elongated, non-elastic, flexible member having one end thereof anchored to a stationary frame component of said press, an intermediate portion movably trained about said guide means and an opposite movable end; and lever means connecting the said opposite movable end of said flexible member with said movable valve element and adjustable to vary the ratio of movement between said valve element and the said opposite end of said flexible member, said flexible member being operable to hold said valve element in its normal position during reciprocation of said platen so long as said platen occupies a given angular relationship to said bed, but being operable in response to an angular tilting of said platen in either direction away from said given angular relationship to move said valve element in a direction to restore said platen to its given angular relationship to said bed.

4. In a hydraulically operated press; a stationary bed frame; stanchions carried by and extending upwardly above said bed frame, said stanchions including a pair of transversely spaced, vertically arranged stationary guides; a pair of slide members mounted for independent vertical sliding movement on said guides; an elongated, transversely extending platen; means connecting said platen with each of said slide members and permitting limited pivoted adjustment of said platen with respect to said slides; a pair of double-acting hydraulic rams carried in transversely spaced apart relation by said stanchions, each of said rams including a vertically extensible and retractable member connected with said platen and operable in response to pressure fluid introduced to said rams to reciprocate said platen in a vertical plane toward and away from said bed frame; a hydraulic pump for supplying pressure fluid simultaneously to each of said rams; a reversing valve connected between said pump and each of said rams and operable selectively to reverse the direction of movement of the extensible and retractable members of said rams; a proportioning valve hydraulically connected in series between said reversing valve and each of said rams and having a movable valve element operable to proportion the volume of fluid passing to and from each of said rams, said movable valve element having a neutral position in which equal volumes of fluid may be passed to said rams, but being movable in opposite directions from said neutral position to pass a lesser volume of fluid to one of said rams while passing a proportionately greater volume of fluid to the other of said rams and vice versa; a second reversing valve connected between said proportioning valve and said rams and operable to reverse the connections between said proportioning valve and said rams; a pair of rotatable pulleys carried respectively by said slide members; an elongated, flexible metallic tape having one end thereof anchored to one of said stanchions at a point thereon not subject to deflection, an intermediate portion movably trained about said pulleys and an opposite end connected with the movable valve element of said proportioning valve, said tape being arranged normally to maintain said movable valve element in its aforesaid neutral position during reciprocating movement of said platen, but being movable in response to a vertical displacement of one of said slide members relative to the other to shift said valve element in a direction away from its neutral position; and motion-transmitting lever means connected between the said opposite end of said tape and said movable valve element and adjustable to vary the ratio of movement between said tape and said movable valve element.

5. In a hydraulic press having relatively stationary frame components, a press bed, a relatively elongated press platen arranged to reciprocate toward and away from said bed, a pair of double-acting hydraulic rams connected to reciprocate said platen, pump means for supplying fluid under pressure simultaneously to each of said rams, and a reversing valve connected between said pump means and said rams and operable selectively to reverse the direction of movement of said platen; a platen-leveling

control comprising a common flow-proportioning valve hydraulically connected in series between each of said rams and said reversing valve and having a movable valve element operable to control the volume of fluid passing to or from said rams, said movable valve element being arranged normally to pass equal volumes of fluid to or from said rams, but being movable in opposite directions to pass a lesser volume of fluid to or from one of said rams while passing a proportionately greater volume of fluid to or from the other of said rams; spring means urging said valve element to move in one of said directions; a second reversing valve connected between said proportioning valve and said rams for reversing the hydraulic connections between said proportioning valve and said rams; and an elongated, non-elastic, flexible member having one end thereof anchored to a stationary frame component of the press, an intermediate portion movably carried in association with the platen of the press and an opposite end portion connected with said movable valve element, said flexible member being responsive to an angular tilting movement of the platen of the press in

one direction for moving said movable valve element in a direction opposite to that urged by said spring means and responsive to an angular tilting movement of said platen in an opposite direction to permit said movable valve element to move in the direction urged by said spring means, the connection between the said opposite end portion of said flexible member and said valve element including a lever having an adjustable fulcrum and operable to vary the ratio of movement between said flexible member and said valve element.

References Cited in the file of this patent

UNITED STATES PATENTS

2,484,908	Purcell	Oct. 18, 1949
2,558,071	Castle et al.	June 26, 1951
2,759,330	Van Broekhoven et al.	Aug. 21, 1956
2,915,961	Parkinson	Dec. 8, 1959
2,958,199	Anderson et al.	Nov. 1, 1960
2,978,976	Hazleton et al.	Apr. 11, 1961