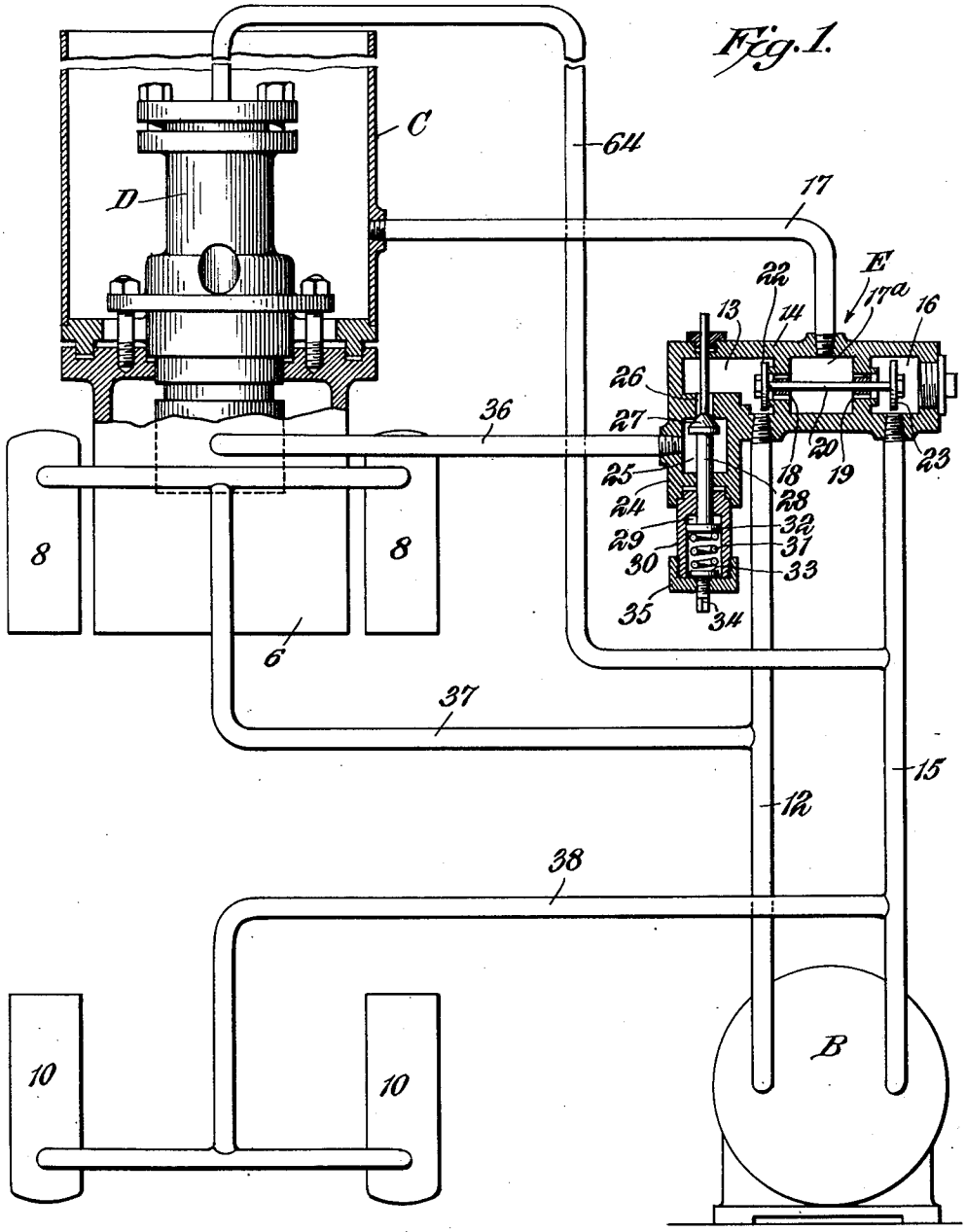
Dec. 27, 1932. W. ERNST 1,892,568

SURGE VALVE FOR HYDRAULIC PRESSES OR THE LIKE

Filed Dec. 12, 1930 2 Sheets-Sheet 1

Fig. 1.



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Fig. 3.

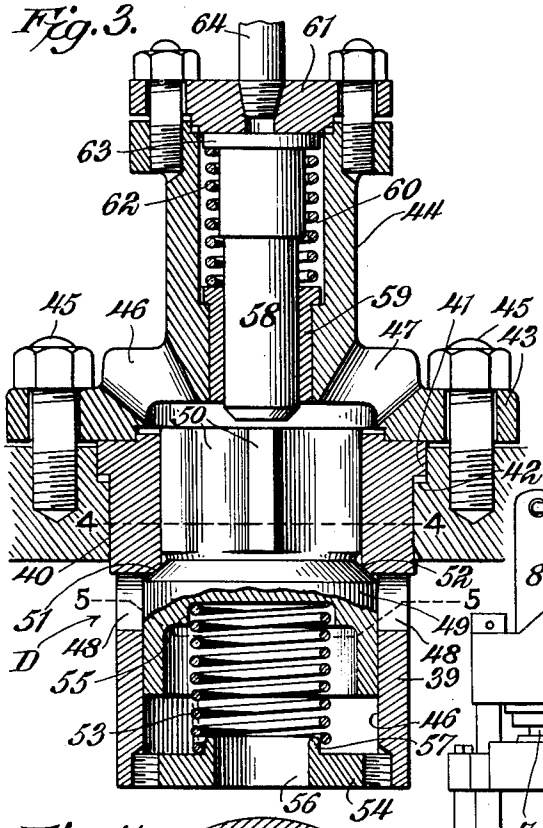


Fig. 2.

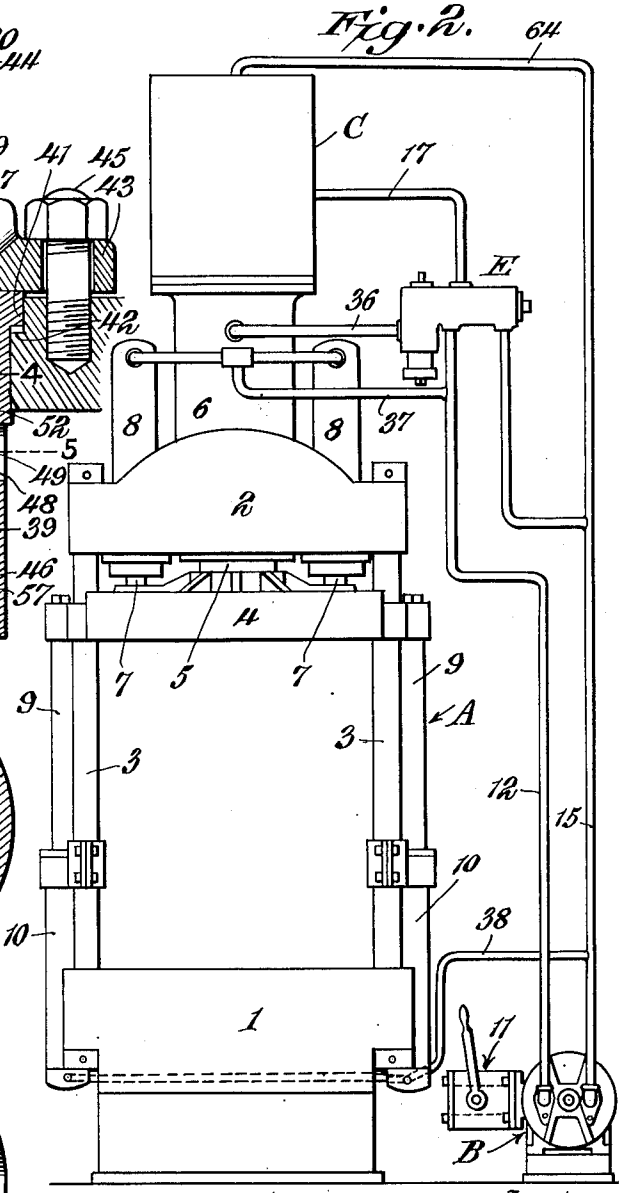


Fig. 4.

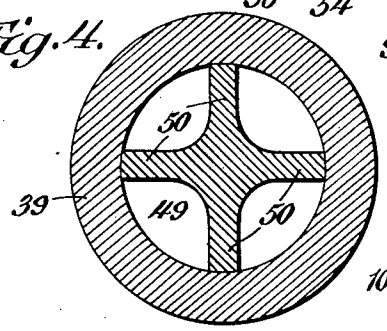
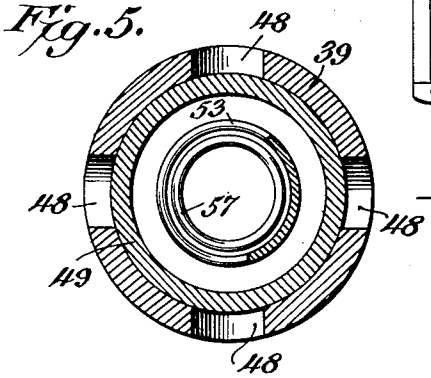


Fig. 5.



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Patented Dec. 27, 1932 1,892,568

UNITED STATES PATENT OFFICE

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SURGE VALVE FOR HYDRAULIC PRESSES OR THE LIKE

Application filed December 12, 1930. Serial No. 501,994.

This invention relates to improvements in surge valves for hydraulic presses or the like.

In certain kinds of hydraulic machinery which include power cylinders into which fluid under pressure is introduced for causing a ram to move a platen, die, punch, or the like towards a table supporting material to be worked upon, it is usual to so arrange the press operating circuit that the initial part of a pressing or working stroke is performed by the gravitational descent of the ram and platen, or to provide auxiliary or booster cylinders for advancing the main ram toward the work during the initial part of the working stroke. Such booster cylinders are of lesser diameter than the main work cylinder and the fluid delivered under pressure from the pump therefore acts to move the booster ram and the main ram downwardly more rapidly than would be the case if the fluid were directed to the larger main cylinder during the entire working stroke. During initial part of the working stroke, when the fluid from the pump is being delivered to the booster cylinders, or, in presses in which no booster cylinders are provided, when the ram and platen are descending gravitationally, it is necessary that the main cylinder be placed in communication with a surge tank in order that the main cylinder may be "prefilled" by a gravity flow of fluid from the tank, so that during the latter part of the work stroke when the pump discharge is directed to the main cylinder, the latter will be full of fluid. Various kinds of surge valves for controlling the communication between the surge tank and the main cylinders of presses of this kind have been heretofore used and within limits have functioned satisfactorily. One difficulty or defect in valves of this kind previously employed is that they have been so constructed and so arranged relative to the other parts of the press-operating circuit as to result in there being a considerable resistance to the gravity prefilling action, this resistance being due to pipe connections interposed between the surge tank and the valve and between the valve and the cylinder, to bends in such pipe connections, and to inefficient arrangement of the parts and passages of the valves.

An object of the present invention is to provide a surge valve so constructed and adapted to be so arranged with relation to a surge tank and the main cylinder of a hydraulic press or the like as to efficiently provide for, and control communication between the tank and cylinder and affording a minimum of resistance to the free flow of fluid therebetween. Other objects will become apparent from a reading of the following description of a practical embodiment of the invention, the appended claims, and the accompanying drawings in which:

Figure 1 is a diagrammatic view of a press-operating circuit including a surge valve embodying the invention;

Figure 2 is a view in front elevation of a hydraulic press forming part of the circuit;

Figure 3 is a central vertical sectional view of a surge valve embodying the invention;

Figure 4 is a horizontal sectional view taken on the line 4—4 of Figure 3, and

Figure 5 is a horizontal sectional view taken on the line 5—5 of Figure 3.

The surge valve illustrated herein as embodying the present invention may be used in connection with various kinds of presses and press-operating circuits, and for purposes of illustration is shown as forming a part of a hydraulic circuit including a hydraulic press A of the downward pressure type adapted to be operated by means of a reversible flow circuit including a radial reversible pump B of a well-known kind and a surge tank C mounted on top of the press.

The press A includes a base 1, a press head 2 connected to the base by strain rods 3 and a platen 4 mounted for reciprocatory movements on the strain rods. A main ram 5 is connected to the platen and extends into a main cylinder 6 while booster rams 7 also connected to the platen extend into booster cylinders 8. Push back rams 9, also connected to the platen, extend downwardly into push back cylinders 10. The surge valve embodying the present invention and generally designated D is mounted in the top of the main cylinder 6 and is adapted to afford com-

munication between the latter and the surge tank C in a manner to be described. The pump B is provided with a suitable flow control device indicated at 11. This device forms no part of the present invention and since several kinds of devices for controlling the direction and volume of flow through radial pumps of the kind illustrated are well known in the art, the details of the device 11 are not shown or described.

In order that the detailed description of the press operating circuit and associated valve mechanism, which is to follow, may be more readily understood it may here be stated in general that when a pressing or working stroke is to be performed fluid is first introduced into the booster cylinders 8, this fluid then acting upon the booster rams to move the platen downwardly, which will also effect a downward movement of the main ram 5 and the consequent vacating of the main cylinder by the ram 5. As will be later described, during this period of operation the surge valve D opens to permit a gravity prefill of the main cylinder from the surge tank. When the platen encounters the work, fluid under pressure delivered by the pump is directed to the main cylinder as well as to the booster cylinders. This fluid entering the main cylinder under high pressure is active to close the surge valve, that is, to close communication between the main cylinder and the surge tank after which the pressing operation will be performed by high pressure fluid in the main and booster cylinders. When this operation has been completed fluid under pump pressure is directed to the push back cylinders 10, thus moving the platen and associated parts upwardly. During such movement fluid is exhausted from the main cylinder to the tank by means of the surge valve, and from the booster cylinders to the tank and pump.

For conducting fluid under pressure to the several cylinders of the press to effect the above-described sequence of platen movements, hydraulic connections and suitable valve mechanism are connected between the pump, the tank and the press cylinders. In the circuit illustrated these connections include a pipe line 12 which connects one side of the pump to a chamber 13 of a valve casing 14 of a valve mechanism generally designated E, and a pipe line 15 which connects the other side of the pump to a valve chamber 16 also formed in the casing 14. A pipe 17 affords communication between the surge tank and a chamber 17^a in the valve casing 14, the chamber 17^a being disposed between the chambers 13 and 16 and being separated therefrom by partitions 18 and 19 respectively. A valve stem 20 extends through openings 20^a and 21 in the partitions 18 and 19 and is provided at its ends with heads 22 and 23 which are adapted to close the openings 20^a and 21 respectively.

The casing 14 is formed with a depending casing portion 24 which includes a chamber 25 which is adapted to communicate with the chamber 13 by means of a passage 26. This communication is controlled by a valve head 27 formed on a valve stem 28 which extends through and is mounted for sliding movements in the valve depending casing portion. The lower end of the stem 28 extends into a recess 29 in a separate casing 30 having threaded connection with the depending portion 24. A spring 31 is interposed between a head 32 on the lower end of the stem 28 and a head 33 on the inner end of an adjusting screw 34 which extends through and has threaded connection with a cap 35 screwed onto the lower end of the depending casing 24. A pipe 26 affords constant communication between the surge tank and the valve chamber 25. A branch pipe 37 leads from the pipe line 12 to the booster cylinders; and a branch pipe 38 leads directly from the pipe line 15 to the push back cylinders.

The press and press-operating circuit described above are in general shown, described and claimed in my prior U. S. Patent 1,672,561 issued June 5, 1928; and it is to be understood that the description of this circuit has been included in the present disclosure only in order that the operation of the surge valve forming the subject matter of the present invention and its arrangement relative to other parts of the press and circuit may be readily understood.

The surge valve D constructed and arranged in accordance with the invention includes a cylindrical valve casing 39 positioned in an opening 40 in the top of the cylinder 6 and extending downwardly into the cylinder, the casing being provided with a peripheral flange 41 positioned in a seat 42 on the top of the cylinder. The valve casing is clamped in place by means of a clamping ring 43 which forms part of a separate casing member 44 disposed directly above the valve casing 39 and which is drawn downwardly against the flange 41 by means of suitable securing means such as bolts 45.

The valve casing 39 is formed with a bore 46, the upper end portion of which is of reduced diameter. This bore faces directly up toward the surge tank and communicates directly therewith by means of a plurality of openings 47 in the separate casing member 44. The bore communicates directly with the main cylinder by means of a plurality of radial passages 48 extending through the casing and lying in a common horizontal plane disposed substantially at the vertical center of the casing 39. It will be seen that by arranging the valve casing to communicate directly with the main cylinder and tank, the use of connecting piping is rendered unnecessary

and efficient prefilling and exhausting of the cylinder is provided for. It is not necessary that the valve casing be disposed within an opening in a cylinder wall which forms a partition between the cylinder chamber and surge tank but it is important that the casing be disposed between the cylinder chamber and tank and so arranged that the ends of the casing open substantially directly into the tank and cylinder respectively without the use of connecting piping. A valve element 49 is mounted for vertical sliding movements within the bore and is provided with a plurality of vertically extending ribs or wings 50 which cooperate with the reduced upper portion of the bore for guiding the valve element. This element is formed with a seat engaging surface 51 which is tapered outwardly and downwardly and which is adapted to seat upon a peripheral seat 52 formed in the bore 46, the seat being similarly tapered outwardly and downwardly, and being disposed above and immediately adjacent to the radial passages 48. Means are provided for biasing the valve element upwardly to closed position and in the form shown the lower part of the valve element 49 is hollow and accommodates a biasing spring 53 interposed between a plate 54 secured to the lower end of the casing 39 and a spring seat 55 formed in the hollow part of the valve element. The plate 54 is perforate as at 56 and is provided with a spring centering rib 57. The spring 53 is just strong enough to maintain the valve element in its upper position against its own weight and is readily yieldable to permit the element to move downwardly when the pressure on the lower side thereof is slightly less than that on the top side.

In operation, when the platen and main and booster rams are being moved downwardly under the action of high pressure fluid directed to the booster cylinders only, the vacating of the main cylinder by the main ram will tend to create a suction in this cylinder. As soon as this takes place the static pressure due to the head of fluid in the surge tank will move the valve element 49 downwardly and fluid will flow downwardly from the surge tank through the openings 47, the spaces between the ribs 50 and thence through the radial passages 48 and into the cylinder. It will be observed that with the exception of the change from downward to outward flow at the plane of the radial passages 48, the fluid has a direct and unobstructed path over which to travel in passing from the surge tank to the cylinder so that a minimum of resistance to fluid flow is offered. The drag on the descent of the platen and rams usually due to restricted flow is therefore reduced to a minimum and more efficient operation of the press is made possible. It will also be observed that due to the particular arrangement of the tapered valve engaging surface 52, the fluid is deflected smoothly outward through the passages 48 so that no seriously abrupt changes in the direction of fluid flow take place. By locating the surge valve in the opening in the cylinder, the piping usually necessary to connect the tank, the valve and the cylinder is dispensed with and losses heretofore due to frictional resistance to the prefilling of the main cylinder are further reduced.

In certain kinds of press operating circuits, such as that illustrated in the accompanying drawings, it is necessary that the surge valve be opened when fluid is introduced into the push back cylinders to effect a return movement of the platen. This is necessary in order to provide for the expelling from the cylinder of the fluid remaining therein at the end of a working stroke. In accordance with one feature of the present invention I provide a pressure actuated plunger 58 mounted for vertical sliding movements in a bushing 59 in the separate casing member 44, the upper end of the plunger extending into a pressure chamber 60 closed at its upper end by means of a plate 61. A spring 62 is interposed between a head 63 on the upper end of the plunger 58 and the top face of the bushing, this spring serving to normally maintain the plunger out of contact with the top of the movable valve element 49. A pipe 64 affords constant communication between the pipe 15 and the chamber 60 and, as will be later described, when fluid is introduced into the booster cylinders, fluid under pump pressure will also be introduced into the chamber 60 which will result in the plunger's being moved downwardly into engagement with the valve element 49 for moving the latter downwardly.

In order that the function of the surge valve and its relation to the various other parts of the circuit may be readily understood, a complete operating cycle of the press provided with this valve will be briefly set forth. It will be assumed that the platen is in its upper position and that the parts are in the relative positions shown in the drawings. When it is desired to produce a working stroke, the pump control device 11 is set to cause the pump to deliver fluid under pressure through the pipe line 12. This fluid will pass through the pipe line 37 and into the booster cylinders and will act on the booster rams to move the platen and main ram downwardly. During this part of the downward stroke there is little resistance to movement of the platen so that fluid will be trapped in the valve chamber 13 by means of the valve head 27 held closed by the spring 31. While the ram is descending the suction created in the main cylinder will result in the surge valve's being opened in the manner already described and free unobstructed prefilling of the main cylinder will take place.

When the platen encounters resistance to its downward movement, pressure will build up in the booster cylinders, in the pipe lines 27 and 12, and in the chamber 13 until a predetermined pressure has been attained, at which time the fluid pressure acting on the valve head 27 will move the latter downwardly and admit fluid under pump pressure directly to the main cylinder by means of the pipe line 36. The increased fluid pressure now active in the main cylinder will close the surge valve which will then maintain an effective seal between the main cylinder and the surge tank, and the pressing operation will be completed with fluid under pressure being delivered to both the main and booster cylinders. During the downward movement of the ram just described the pump will take in fluid partly from the push back cylinders 10 by means of the pipes 38 and 15, and partly from the surge tank by means of the pipe 17, the valve chamber 17ª, the valve chamber 16, and the pipe 15. When the pressing operation has been completed the pump control device will be set to reverse the direction of discharge from the pump so that fluid will be directed under pressure through the pipe line 15, the pressure fluid entering the chamber 16 and moving the valve 20 to the left. Fluid will then be delivered by the pump to the push back cylinders 10 by means of the pipe 38 and will move the platen and rams upwardly. When the pump has been reversed to effect this upward movement of the platen, fluid under pressure in the pipe line 15 will act through the pipe 64 and in the chamber 60 to move the plunger 58 downwardly at which time the plunger will engage and move downwardly the valve element 49 thus opening the surge valve and placing the main cylinder in communication with the surge tank. The platen will then continue to ascend until its uppermost position has been reached at which time the pump control device may be set either to reverse the pump and to effect another pressing operation or to bring the platen to rest.

It is obvious that the surge valve here shown and described is not limited in application to use in connection with presses having separate booster and push back cylinders; and that the valve may be used to advantage in connection with all hydraulic presses or the like in which a pressure cylinder is "prefilled" by a gravity flow from a surge tank, for example in presses having no booster cylinders and in which the "prefill" of the cylinder takes place during gravitational descent of the ram and platen.

I claim:

1. In a hydraulic press or the like, the combination with a cylinder having an opening in its top; of a surge tank supported directly above said cylinder; a ram mounted for reciprocation in said cylinder, movement of the ram during a part of a working stroke creating suction in said cylinder; a valve casing mounted in the opening in said cylinder and having a vertically extending bore the upper end of which faces and opens into said surge tank, said valve casing being provided with a plurality of radially extending passages communicating with said bore and opening directly into the interior of said cylinder, and with a circular valve seat formed in said bore and located adjacent to and above said radial passages, said seat being tapered downwardly and outwardly towards said passages; a spring pressed valve element mounted for vertical movements in said bore and being provided with a seat-engaging surface tapered downwardly and outwardly whereby fluid in passing downwardly through said bore, will be smoothly deflected outwardly towards and through said radial passages, said valve being adapted to be opened by suction in said cylinder; a pressure chamber disposed within said surge tank and above said valve element; and a pressure responsive plunger mounted in said pressure chamber and being adapted to be actuated by fluid pressure for moving said valve element to its open position against the urge of said spring during a return stroke of said ram.

2. In a hydraulic press or the like, the combination with a cylinder having an opening in its top; of a surge tank supported on top of said cylinder; a ram mounted for reciprocation in said cylinder, movement of the ram during a part of a working stroke creating suction in said cylinder; a valve casing mounted in the opening in said cylinder; a peripheral flange at the upper end of said valve casing; a separate casing member positioned within said surge tank and including a clamping ring disposed above said valve casing flange; means for drawing said member downwardly against said flange to clamp the latter against the top of said cylinder, a valve element mounted for vertical movements in said valve casing for controlling communication between said tank and said cylinder; a spring mounted below said valve element and cooperating therewith for urging the latter upwardly to close said communication and being yieldable to permit opening of said valve by suction in said cylinder during a working stroke; and means including a pressure responsive plunger mounted in said separate casing member and directly above said valve element for moving said element downwardly to open said communication during a return stroke of said ram.

3. In a hydraulic motor for presses or the like, the combination of a motor cylinder; a surge tank mounted on top of the cylinder, the top of said cylinder being provided with an opening; a ram mounted for reciprocation

in said cylinder, movement of the ram during part of a working stroke being adapted to create suction in the cylinder; a valve casing mounted in the opening in said cylinder and having a bore adapted to provide communication between the surge tank and cylinder; a pressure casing member positioned within said surge tank and in axial alignment with said valve casing; a valve element mounted for reciprocatory movements in said valve casing or controlling communication between said tank and cylinder; a spring seat on the inner end of said valve casing; a spring interposed between said seat and said movable element for urging the latter towards its closed position and being yieldable to permit opening of said valve by suction in said cylinder during a working stroke; and a pressure responsive plunger mounted in said pressure casing and being adapted to be actuated by fluid pressure for moving said valve element to its open position against the urge of said spring during a return stroke of said ram.

4. In a hydraulic motor for presses or the like, the combination of a ram advancing cylinder and a ram returning cylinder; a surge tank mounted on top of the ram advancing cylinder, the top of said ram advancing cylinder being provided with an opening; ram means mounted for reciprocation in said cylinders, movement of the ram means during part of a working stroke being adapted to create suction in the ram advancing cylinder; a valve casing mounted in the opening in said ram advancing cylinder and having a bore adapted to provide communication between the surge tank and said cylinder; a valve element mounted for reciprocatory movements in said valve casing for controlling communication between said tank and cylinder; a spring engaging said movable valve element for urging the latter towards its closed position and being yieldable to permit opening of said valve by suction in said cylinder during a working stroke; and means associated with said valve element and being responsive to pressure in said ram returning cylinder for moving said valve element to its open position against the urge of said spring during a return stroke of said ram.

5. In a hydraulic motor for presses or the like, the combination of a ram advancing cylinder and a ram returning cylinder; a surge tank mounted above the ram advancing cylinder, ram means mounted for reciprocation in said cylinders, movement of the ram means during part of a working stroke being adapted to create suction in the ram advancing cylinder; a valve casing interposed between said ram advancing cylinder and said surge tank and having a vertical bore communicating directly with both said tank and cylinder; a valve element mounted for reciprocatory movements in said vertical bore for controlling communication between said tank and cylinder; a biasing spring connected to said movable valve element for urging the latter upwardly to closed position, said spring being strong enough to support the valve against the action of gravity but being yieldable to permit opening of said valve by suction in said cylinder during a working stroke; and means associated with said valve element and being responsive to pressure in said ram returning cylinder for moving said valve element to its open position against the urge of said spring during a return stroke of said ram.

6. In a hydraulic motor for presses or the like, the combination of a ram advancing cylinder and a ram returning cylinder; a surge tank mounted above the ram advancing cylinder, ram means mounted for reciprocation in said cylinders, movement of the ram means during part of a working stroke being adapted to create suction in the ram advancing cylinder; a valve casing interposed between said ram advancing cylinder and said surge tank and having a vertical bore communicating directly with both said tank and cylinder; a valve element mounted for reciprocatory movements in said vertical bore for controlling communication between said tank and cylinder; biasing means connected to said movable valve element for urging the latter upwardly to closed position, said biasing means exerting sufficient pressure on said valve to support the latter against the action of gravity but being yieldable to permit opening of said valve by suction in said cylinder during a working stroke; and means associated with said valve element and being responsive to pressure in said ram returning cylinder for moving said valve element to its open position against the urge of said biasing means during a return stroke of said ram.

In testimony whereof, I have hereunto subscribed my name.

WALTER ERNST.