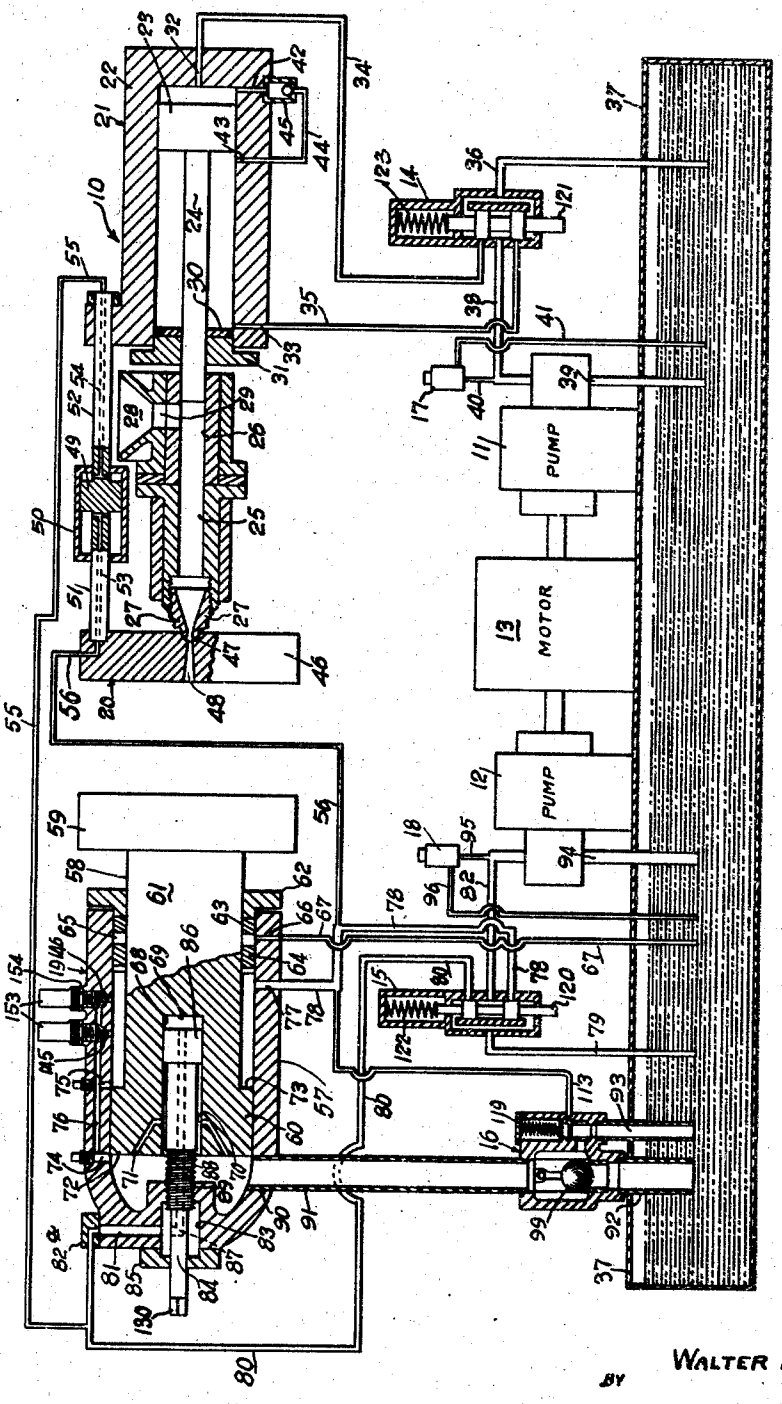
Aug. 18, 1942. W. ERNST 2,293,334

CHECK AND UNLOADING VALVE STRUCTURE

Original Filed May 5, 1939 2 Sheets-Sheet 1

FIG. 1.



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FIG. 2.

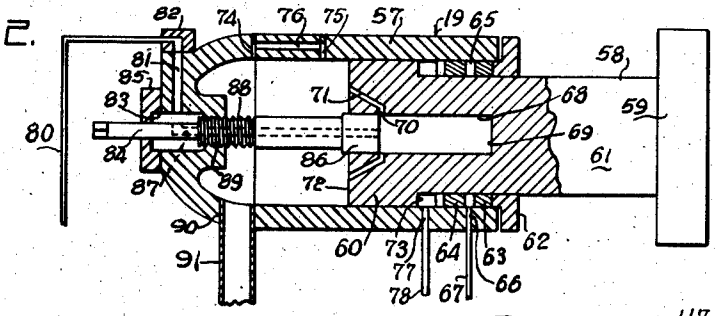
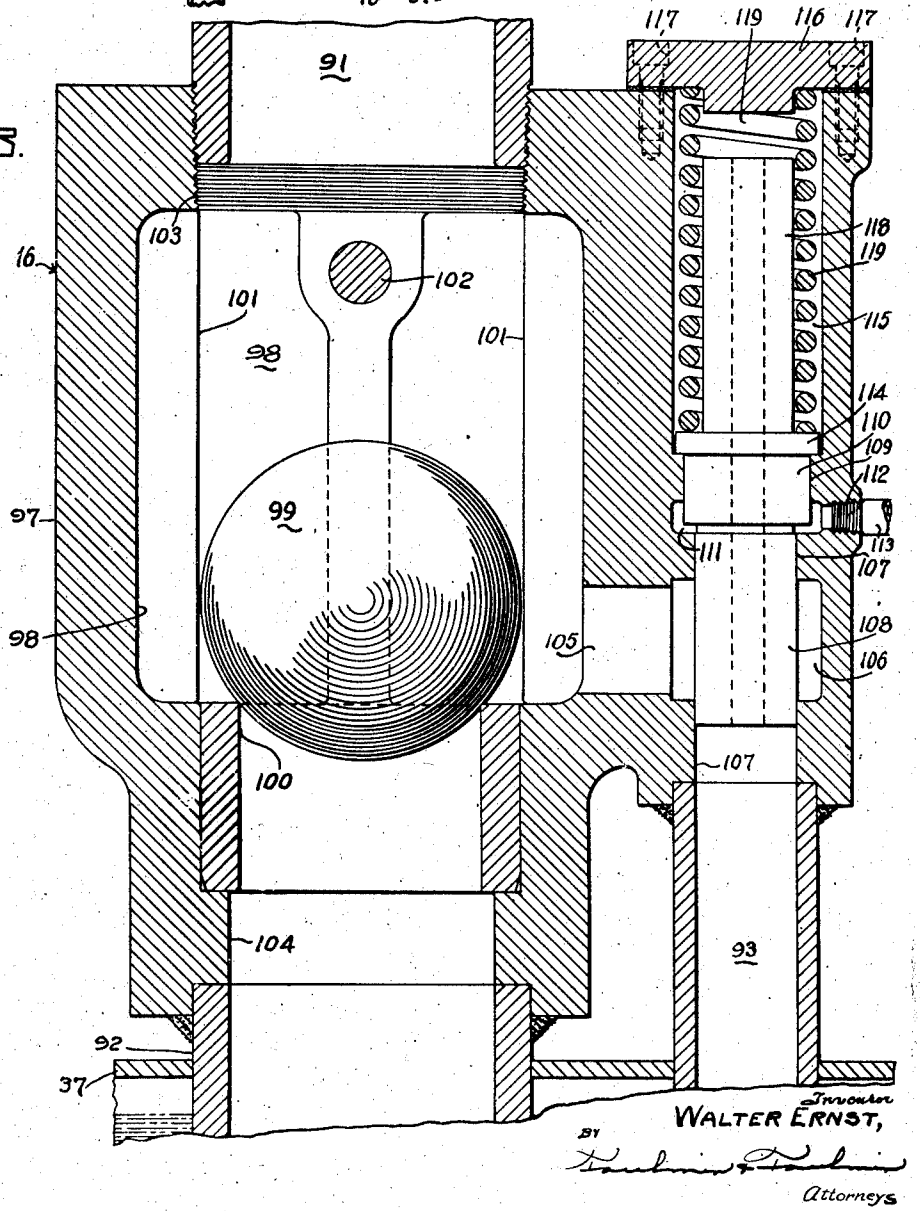


FIG. 3.



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CHECK AND UNLOADING VALVE STRUCTURE

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Original application May 5, 1939, Serial No. 272,011. Divided and this application September 28, 1939, Serial No. 296,969

6 Claims. (Cl. 121—38)

This invention relates to hydraulic machinery, and in particular, to hydraulic press systems.

One object of this invention is to provide a hydraulic press system having a hollow main ram with a booster area in a booster chamber, and an adjustable booster ram therein, arranged initially to supply pressure fluid to the booster area and subsequently to automatically supply pressure fluid to the main ram area after the main ram has traveled a predetermined variable distance, dependent upon the adjustment of the booster ram.

Another object is to provide a hydraulic press system having a main ram with a main ram area and a booster area within the main ram, and a fluid passageway interconnecting the main ram area with the booster area, the pressure fluid being conveyed to the booster area by means of a fixed booster plunger having a bore therethrough, the head of the fixed plunger being adapted to uncover one end of the passageway after the main ram has moved a predetermined distance so that the pressure fluid flows into the booster ram chamber and then through the passageway to the main ram chamber so as to apply the full force of the pressure fluid to the entire area of the main ram.

Another object is to provide a hydraulic press system of the type set forth in the preceding objects wherein a single pressure fluid connection suffices for the supplying of pressure fluid to both the booster ram area and the main ram area.

Another object is to provide a hydraulic press system having a main plunger with a chamber connected to a combination check and unloading valve, the latter being pilot-operated to open automatically when pressure fluid is supplied to the pilot chamber.

Another object is to provide a combination check and unloading valve in a single casing having a check valve chamber connected to an unloading valve chamber within which an unloading valve plunger reciprocates, this plunger having a plunger lifting chamber which is connectible to a source of pressure fluid so that the ball check valve portion permits flow of fluid in but one direction, yet the unloading plunger when operated by pressure fluid within its pilot chamber permits flow of fluid in the opposite direction wherein the ball check valve is closed.

Another object is to provide a hydraulic press system having a ram within a cylinder, together with a by-pass passageway interconnecting the cylinder bore portions on opposite sides of the piston head of the ram, this passageway having a plurality of spaced ports so as to cause by-passing of the fluid and halting of the plunger at one of a plurality of predetermined positions.

This application is a division of my application Serial No. 272,011, filed May 5, 1939.

In the drawings:

Figure 1 is a diagrammatic view, partly in section, showing the hydraulic press system of this invention in a preferred embodiment.

Figure 2 is a fragmentary view of a portion of Figure 1 showing the main ram in its advanced position.

Figure 3 is a central vertical section through the combination check and unloading valve of the invention.

In general, the hydraulic press system of this invention consists of a main cylinder having a main ram area and main chamber connected to a combination check and unloading valve, which, in turn, communicate with a fluid reservoir, such as an oil tank. The main ram is hollow, being provided with a central chamber into which a stationary piston projects. This stationary piston is hollow and at its outer end is connected to a source of pressure fluid through suitable control valves. The main ram is provided with one or more internal passageways opening into the chamber within the main ram through ports, which are arranged to be uncovered as the main ram travels relatively to the head of the stationary hollow piston. In this manner pressure fluid is first conveyed through the hollow piston to the central or booster chamber of the main ram and after the latter has traveled a predetermined distance this fluid also reaches the main ram area through the passageways.

The combination check and unloading valve connected to the main ram chamber consists of a single casing having two chambers, namely a check valve chamber and an unloading valve chamber. A ball member is free to move to and fro within the check valve chamber, whereas a spring urged plunger reciprocates in the unloading valve chamber. Above the unloading valve chamber is a separate plunger lifting chamber to which pressure fluid may be admitted to cause the unloading valve plunger to lift, thereby opening communication from the check valve chamber through the unloading valve chamber to a discharge conduit. This discharge conduit may lead to the fluid reservoir such as an oil tank.

Referring to the drawings in detail, Figure 1 shows diagrammatically the hydraulic system of the invention as applied to a plastic injection

molding press. The press, generally designated 10, is supplied with pressure fluid from a pair of pumps 11 and 12 driven by a motor 13. The distribution of the pressure fluid from the pumps 11 and 12 is regulated by a pair of four way valves 14 and 15, these valves being arranged to be shifted either by the operator or by automatic means. The details of the construction of these pumps and valves form no part of the present invention. Also associated with the circuit is a combination check and unloading valve 16. A pair of safety valves 17 and 18 serve to release pressure fluid in the event of the failure of other safety devices. The pumps 11 and 12 are preferably of the variable delivery type having a flow control member which is movable to vary the amount of reciprocation of the pistons and accordingly to vary the rate of discharge of the pumps. As is well-known to those skilled in the art, such variable delivery pumps are usually supplied with mechanism for automatically shifting these flow control members to neutral positions when the pressure in a part of the circuit reaches a predetermined maximum. The safety valves 17 and 18 protect the circuit against overpressures in the event that this so-called pump centering mechanism fails to operate.

The plastic injection molding press to which the invention is applied is shown at the top of Figure 1 and consists of a clamping unit 19, a die cushioning unit 20, and an injection unit 21. The supporting structures, such as the machine frame, are omitted in order to simplify the showing and illustrate the remaining details more clearly.

The injection unit 21 consists of a cylinder 22 within which a double-acting piston 23 reciprocates. Connected to the piston 23 is a piston rod 24 which for puposes of simplification is shown to constitute an injection plunger which reciprocates in the material injecting chamber 25. The latter has a bore 26 and a nozzle 27, together with a hopper 28 having a passageway 29 communicating with the bore 26. The piston rod 24 is surrounded by a packing 30 adapted to be compressed by a gland 31 in order to prevent leakage. The opposite ends of the cylinder 22 are provided with ports 32 and 33 connected by the conduits 34 and 35 to the injection control valve 14. The latter is provided with an exhaust conduit 36 leading to the oil tank 37, and likewise with a pressure fluid inlet conduit 38 connected to the pump 11. The pump 11 is provided with a suction conduit 39 opening into the oil tank 37. The safety valve 17 is connected by the conduit 40 to the conduit 38 and discharges through the conduit 41 into the tank 37. The injection cylinder 22 is provided with a pair of additional ports 42 and 43 interconnected by the conduit 44 containing the ball check valve 45. This arrangement serves to halt the retraction of the piston 23 when it passes the port 43 at its rear edge, thereby serving to bypath the discharge of the pump through the line 44 and check valve 45.

The cushioning unit consists of a substantially stationary die head 46 upon which one of the molding dies is mounted (not shown). The die head 46 is provided with a socket 47 for receiving the nozzle 27. The socket 47 communicates with a material conveying passageway 48 which leads to the die cavity within the mold or die mounted upon the die head 46.

The die head 46 is relatively stationary but is capable of a limited amount of motion for cushioning purposes. For this reason the die head 46 is mounted upon a plurality of cushioning pistons 49 (one only being shown), these reciprocating in die cushioning cylinder 50. The piston 49 is connected to the die head 46 by means of a piston rod 51, and a tail rod 52 extends in the opposite direction from the piston 49. The piston rod 51 and tail rod 52 are provided with longitudinal passageways 53 and 54 leading respectively to conduits 55 and 56. These conduits are connected as described below.

The die clamping unit 19 consists of a cylinder 57 within which the main ram 58 reciprocates. On the end of the main ram 58 is mounted a platen 59 serving to support and move the movable die or mold (not shown) which cooperates with the stationary die or mold mounted upon the die head 46. The main ram 58 is provided with a head 60 and a piston rod 61 connecting the head 60 with the platen 59. Leakage around the piston rod 61 is prevented by a gland 62 and spaced packings 63 and 64 separated by a chamber 65. From the latter the port 66 is connected to the drainage conduit 67 leading downward to the tank 37.

The piston rod 61 is provided with an internal bore 68, the end 69 of which forms the so-called booster area of the main ram 58. Opening into the bore 68 are ports 70 having passageways 71 to the main ram area 72 on the end of the piston head 60, the opposite end 73 of which forms the retraction area. On the opposite side of the main ram piston head 60, when the latter is in its retracted position, are spaced ports 74 and 75 interconnected by a bypath passageway 76.

Near its forward end the cylinder 57 is provided with a port 77 connected to a conduit 78 leading to the four way clamping control valve 15. The latter is served by a conduit 82 connecting it with the pump 12 so as to receive a supply of pressure fluid. Also connected to the valve 15 is an exhaust conduit 79 discharging into the oil tank 37. A port conduit 80 leads from the clamping control valve 15 to the port 81 at the rearward end of the main cylinder 57 by way of the connection cap 82a. The port 81 leads into a passageway or chamber 83 surrounding the piston rod 84. The chamber 83 is closed by an end plate 85. The piston rod 84 carries a piston head 86 fitting smoothly into the bore 68 within the main ram 58. Piston rod 84 and piston head 86 are traversed by an L shaped passageway 87 leading from the chamber 83 to the bore 68 adjacent the booster area 69. The piston rod 84 and piston 86 are held in a stationary position by means of the threaded portion 88 threaded into the threaded bore 89 in the cylinder 57. It will be observed that the conduits 55 and 56 leading from the opposite end of the piston rod 51 and tail rod 52 associated with the cushioning unit 20 are connected respectively to the conduits 80 and 78 leading to the opposite end of the main cylinder 57. The rearward end of the main cylinder 57 is provided with a port 90 to which is connected the conduit 91 leading to the combination check and unloading valve 16. From the opposite side of the latter the exhaust conduits 92 and 93 lead into the oil tank 37. The pump 12 is provided with a suction conduit 94 and the safety valve 18 with an intake conduit 95 connected to the conduit 78, together with an exhaust conduit 96 which discharges into the tank 37.

The combination check and unloading valve 16 (Figure 3) consists of a casing 97 having a cham-

ber 98 for receiving a ball check valve member 99 which is engageable with an annular seat 100 in the form of a sleeve coaxial with the chamber 98. The latter is provided with guide ribs 101 along its inner walls and serving to guide the ball 99 in its up and down motion, limited also by the rod 102. The conduit 91 opens into a threaded port 103 at the top of the chamber 98 whereas the conduit 92 opens into a port 104 at the bottom thereof beneath the ball 99. A side port 105 leads into an adjacent unloading valve chamber 106 communicating with a vertical bore 107 within which the unloading valve plunger 108 reciprocates. Above the upper end of the bore 107 there is provided an enlarged coaxial bore 109 serving to receive the pilot head 110 on the valve plunger 108. The latter is surrounded by the annular plunger lifting chamber 111 having a threaded port 112 to which is connected the conduit 113 leading to a connection with the conduit 78, and thereby connected to the retraction circuit for the main ram 58. Above the enlarged head 110 the plunger 108 is provided with a further enlargement 114 reciprocable within a spring chamber 115 closed by a cap 116 secured to the casing 97 by the screws 117. Beyond the enlargement 114 the plunger 108 is provided with a reduced diameter portion 118 surrounded by a spring 119 urging the unloading valve plunger 108 downwardly to a position closing the bore 107 leading into the pipe 93. Consequently when pressure fluid is admitted into the pipe 113 and then into the plunger lifting chamber 111 the valve plunger 108 rises and opens the port 105 into communication with the conduit 93.

Operation

In the operation of the hydraulic press system of this invention the operator starts the motor 13, thereby placing in operation the pumps 11 and 12. Assuming the parts of the press 10 to be in the retracted positions shown in Figure 1, the operator now operates the clamping control valve 15 and the injection control valve 14 to operate the press 10 in its various movements.

To clamp the dies, the operator shifts the valve member 120 of the clamping control valve upwardly, thereby placing the pressure conduit 82 in communication with the conduit 80. Pressure fluid then flows from the pump 12 through the conduits 82 and 80 to the port 81, thence into the chamber 83 and through the piston rod passageway 87 into the end of the ram chamber 68 adjacent the booster area 69 thereof. As the latter area is of relatively small diameter, the main ram 58 and platen 59 move forward at a relatively rapid rate. Meanwhile, the fluid in front of the ram head 60 is discharged through the port 77, the conduit 78, the valve 15 and the exhaust conduit 79 into the oil tank 37.

When the main ram 58 has traveled forward to a point where the ports 70 are uncovered in passing the stationary piston head 86 (Figure 2) the pressure fluid within the booster chamber 68 escapes through the ports 70 and passageways 71 into the rearward end of the main cylinder 57 to the left of the main ram area 72. The full pressing force is now exerted upon the platen 59 and the die or mold halves are held firmly together with a very great force.

While this is occurring pressure fluid also flows through the conduit 55 into the cushioning cylinder 50 and thereby yieldingly support the die head 46 and the die or mold half carried thereby. The fluid on the opposite side of the piston head 49 escapes through the conduit 56 to the conduit 78 and thence to the exhaust conduit 79 and the tank 37 by way of the clamping control valve 15. When the desired clamping pressure has been reached, the flow control member of the pump 12 automatically shifts to its neutral position. Meanwhile, as the main ram 58 has advanced, fluid is drawn into the rearward end of the main cylinder 57 through the pipe 91 and past the ball check valve member 99, which is raised by the suction thus created. In this manner, fluid passes upwardly from the oil tank 37 through the pipes 92 and 91 to the main cylinder 57. When pressure enters the rearward end of the main cylinder 57, however, as shown in Figure 2, this pressure immediately closes the ball check valve member 99 upon its seat 100, aided by gravity.

To perform an injection stroke after having placed injection molding material in the hopper 28 and suitably heated the injection cylinder 25, the operator shifts the valve member 121 of the injection control valve 14 upwardly, thereby admitting pressure fluid from the pump discharge line 38 to the conduit 34 and thence into the right hand end of the injection operating cylinder 22. This pressure acts against the piston head 23 and pushes it and the piston rod 24, together with the injection molding material through the bore 26 and out the nozzle 27 into the channel or passageway 48 from whence it passes into the mold cavity between the mold halves.

To retract the injector, the operator moves the valve member 121 downward aided by the coil spring 123 so that the flow of pressure fluid to the injector piston 23 is reversed, pressure fluid entering through the conduit 35 and the displaced fluid returning to the tank through the conduit 34 and the exhaust conduit 36. When the piston head 23 passes the port 43 in the cylinder 22, fluid then flows through the conduit 44 and past the check valve 45 into the right hand end of the cylinder 22, then through the conduits 34 and 36 into the tank 37, thenceforth by-passing the discharge of the pump 11 and halting the retraction of the piston head 23.

To unclamp the dies or mold halves, the operator moves the valve member 120 of the clamping control valve 15 downwardly aided by the coil spring 122. Pressure fluid is now supplied by the pump 12 through the line 78 and port 77 to the retraction side 73 of the main ram head 60 retracting the main ram 58 from its Figure 2 position to its Figure 1 position. At the same time pressure fluid flows from the conduit 78 through the conduit 113 to the plunger lifting chamber 111 of the unloading valve plunger 108, lifting the latter and opening the check valve chamber 98 into communication with the exhaust conduit 93. The fluid displaced from the left-hand end of the main cylinder 57 then is permitted to pass through the conduit 91, into the chamber 98, thence through the port 105 (Figure 3) and through the chamber 106, into the exhaust conduit 93. When the piston head 60 arrives at the position shown in Figure 1, it uncovers the port 75, whereupon the fluid is bypassed around the piston head 60, halting the further travel thereof. At the same time, the clamping plunger 49 moves backward and ends its cushioning action. The foregoing cycle of operation can then be repeated in the same manner.

The piston rod 84 is provided with suitable means, such as the squared end 130, whereby the

piston rod 84 may be rotated so as to advance or retract the head 86 longitudinally. This arrangement, by reason of the threaded mounting of the threaded portion 88 in the threaded bore 89 and the annular chamber 83, enables the point at which the head 86 uncovers the ports 70 to be varied as the main ram 58 advances. By this arrangement the apparatus can be adjusted accurately to different thicknesses of dies mounted upon the die carriers 46 and 59.

The construction shown in Figure 1 also comprises means for the purpose of causing the halting of the piston head 60 at different points on its retraction stroke. A press of this type frequently employs dies of different thicknesses, depending upon the kind of workpiece to be molded. It is necessary, in designing such a press, to provide for a sufficient retraction of the main ram 58 to enable the use of the thickest dies likely to be encountered in ordinary practice. When thin dies are used, such as for the making of thin workpieces, valuable time is lost in retracting the main or clamping plunger 58 to a greater distance than is necessary for opening the dies and ejecting the workpiece. The arrangement shown in Figure 1 enables the apparatus to be adjusted so that for thin dies the main ram or clamping ram 58 will be retracted a shorter distance than with thick dies. Such thin dies are used, for example, in the making of combs or spectacle frames.

In addition to the by-pass ports 74 and 75, the by-pass passageway 76 is provided with additional ports 141 and 142 on the retraction side of the main ram head 60. These ports 141 and 142 are provided with valve seats 143 and 144, containing ball check valves 145 and 146. Opposite the valve seats 143 and 144 are threaded ports 147 and 148, into which screws 149 and 150 are threaded. By rotating these screws to bring their inner ends into engagement with the balls 145 and 146, the ports 141 and 142 may be positively closed so that the ram head 60 will not halt until it uncovers the port 75. If, however, it is desired to halt the ram head at an intermediate port, the screw 149 is rotated in a reverse direction so as to permit the ball 145 to move. Accordingly, when the ram head 60 uncovers the port 141 on its retraction stroke, the ball 145 will be forced away from its seat 143, thereby permitting fluid to flow through the port 141 and the by-pass passageway 76, through the port 74, into the opposite end of the cylinder 57, halting the retraction of the main of clamping ram 58.

If extremely thin dies are to be used, the screw 150 is also rotated to free the ball check valve 146. Accordingly, when the port 142 is uncovered by the ram head 60, during the retraction stroke, pressure fluid will flow through the port 142 into the by-pass passageway 76, after raising the ball check valve 146 away from its seat 144. Thus, the ram head 60 will halt after a shorter retraction stroke than if the port 141 or the port 75 were employed.

The screws 149 and 150 may either be solid or may be provided with sockets 151, with springs 152 engaging the ball check valves 145 and 146. Caps 153 are provided for covering the ends of the screws 149 and 150 so as to discourage tampering with the adjustment thereof. Locknuts 154 may also be optionally provided to lock the screws 149 and 150 in their adjusted positions.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims.

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

1. A combination check and unloading valve for use in circuit relation with a hydraulic motor comprising a casing having a check valve chamber and an unloading valve chamber, separate passageways respectively leading from said chambers and continuously connected with a fluid reservoir for the motor, said check valve chamber being continuously connected with the advancing side of the hydraulic motor, conduit means interconnecting said chambers, a unidirectional flow check valve member movable in response to a suction effect in said check valve chamber to open one of said passageways for fluid flow toward the advancing side of the hydraulic motor, and an unloading valve member continuously urged into closing position and having an area in continuous hydraulic communication with the retraction side of said hydraulic motor, said unloading valve member being operable by fluid pressure acting upon said retraction side for moving said unloading valve member into unloading position to open the other of said passageways, thereby by-passing said check valve.

2. A combination check and unloading valve for use in circuit relation with a hydraulic motor comprising a casing having a check valve chamber and an unloading valve chamber, separate passageways leading from said chambers and continuously connected with a fluid reservoir for the motor, a port interconnecting said chambers, conduit means continuously connecting said check valve chamber with the advancing side of a hydraulic motor, a unidirectional flow check valve member movable in response to a suction effect in said check valve chamber to open one of said passageways for fluid flow toward the advancing side of the hydraulic motor, an unloading valve member movable to open the other of said passageways independently of the control of the first mentioned passageway, a hydraulic cylinder associated with said unloading valve chamber and a hydraulic piston associated with said cylinder connected to said unloading valve member for moving the same between its closed and open positions, said cylinder having means hydraulically connecting the same with the retraction side of said hydraulic motor for operating said piston.

3. A combination check and unloading valve comprising a casing having a check valve chamber and an unloading valve chamber in continuous fluid communication with each other, a first conduit for admitting fluid to said check valve chamber, a second conduit for discharge of fluid from said check valve chamber, a third conduit for discharge of fluid from said unloading valve chamber, a check valve member in said check valve chamber arranged for unidirectional flow of fluid through said valve member casing, an unloading valve in said unloading chamber, a separate hydraulic cylinder having a piston therein operatively connected to said unloading valve member, and conduit means conveying fluid pressure to said cylinder to actuate said piston and open said unloading valve member irrespective of the pressure condition in said valve member, thereby by-passing said check valve member.

4. A combination check and unloading valve

for use in circuit relation with a hydraulic motor comprising a casing having a check valve chamber and an unloading valve chamber continuously hydraulically connected with each other, a first conduit for admitting fluid to said check valve chamber, a second conduit for discharge of fluid from said check valve chamber to the advancing side of the motor, a third conduit for discharge of fluid from said unloading valve chamber, a check valve member in said check valve chamber arranged for unidirectional flow of fluid through said valve casing, an unloading valve member in said unloading chamber, a separate hydraulic cylinder having a piston therein operatively connected to said unloading valve member, and conduit means for conveying fluid pressure to said cylinder from the push back side of the motor to actuate said piston and open said unloading valve in response to a predetermined fluid pressure acting upon the push back side of said motor, irrespective of the fluid pressure prevailing in said check valve chamber, thereby by-passing said check valve member.

5. A combination check and unloading valve comprising a valve body having a check valve chamber and an unloading valve chamber continuously hydraulically connected with each other, a first conduit for admitting fluid to said check valve chamber, a second conduit for discharge of fluid from said check valve chamber, a third conduit for discharge of fluid from said unloading valve chamber, a check valve member in said check valve chamber arranged for unidirectional flow of fluid through said valve body, an unloading valve member in said unloading chamber, and a separate hydraulic cylinder in said body having a piston arranged therein in substantial coaxial alignment with said unloading chamber and operatively connected to said unloading valve, said piston being responsive to a predetermined pressure in said separate cylinder, irrespective of the pressure condition in said unloading valve chamber, and means for conveying fluid pressure to said cylinder to actuate said piston to open said unloading valve and to by-pass said check valve member.

6. A combination check and unloading valve comprising a valve body having a check valve chamber and an unloading valve chamber continuously hydraulically connected with each other, a first conduit for admitting fluid to said check valve chamber, a second conduit for discharge of fluid from said check valve chamber, a third conduit for discharge of fluid from said unloading valve chamber, a check valve member in said check valve chamber arranged for unidirectional flow of fluid through said valve body, an unloading valve plunger reciprocable in said unloading chamber for selectively establishing or interrupting hydraulic communication between said unloading valve chamber and said third conduit, resilient means continuously urging said plunger into a position for interrupting said last mentioned hydraulic communication, and fluid pressure responsive means operatively connected with said plunger and responsive to a predetermined pressure acting upon said fluid pressure responsive means irrespective of the pressure condition in said unloading valve chamber for establishing the said hydraulic communication, thereby by-passing said check valve member.

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