

[54] **HYDRAULIC PRESS FOR COMPRESSION OF POWDER**

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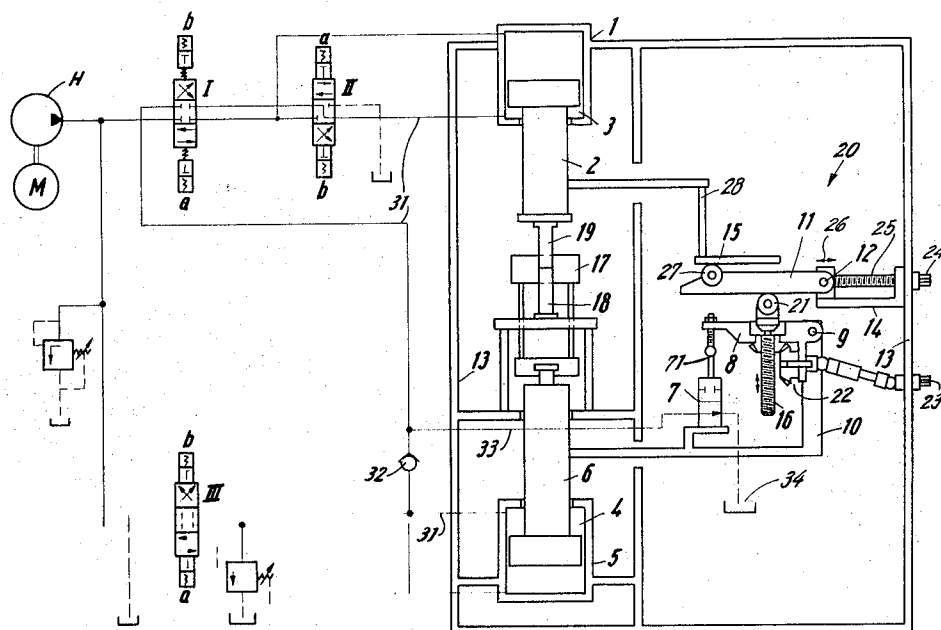
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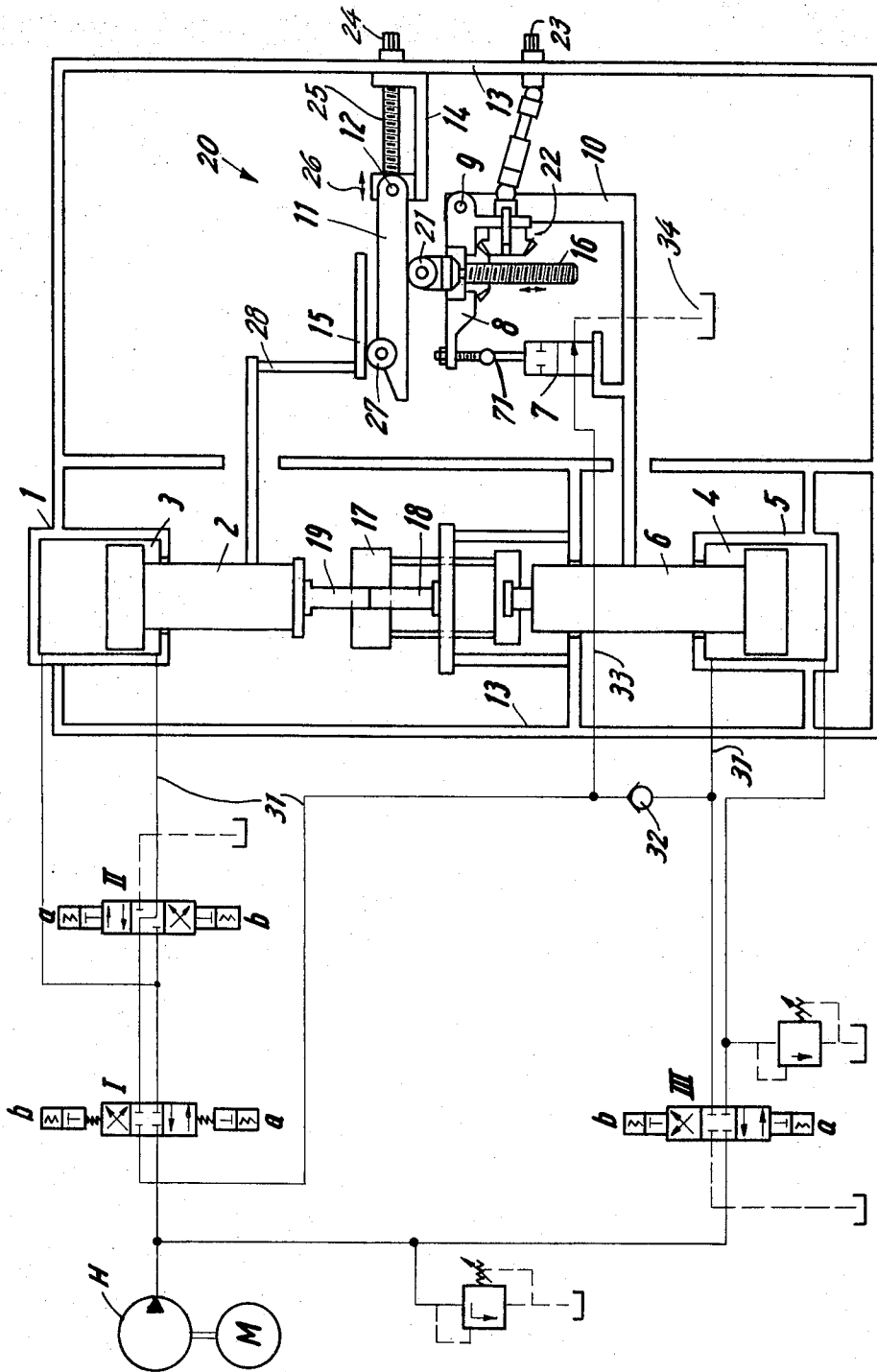
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[57] **ABSTRACT**

Hydraulic press for compression of powder having upper punch, lower punch and die; die and upper punch operated by pistons respectively in two cylinders, there being hydraulic conduit means interconnecting the two cylinders for operating the die moving piston in dependency upon upper punch movement. A valve is connected to the conduit means and controls a hydraulic bleeder path. The valve is actuated by means connected to be responsive to the relative positions of the first and second pistons, to control the characteristics of that defining the dependency of die movement upon movement of the upper punch.

10 Claims, 1 Drawing Figure





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HYDRAULIC PRESS FOR COMPRESSION OF POWDER

The present invention relates to a hydraulic press for compression of powder of the type wherein movement of press die or lower punch during an operating stroke (for compression) is controlled in dependency upon displacement of the upper punch.

Hydraulic presses for compressing metal powder are well known. Among them constructions are known in which not only the upper punch or ram is moved but also the die member itself, whereby the beginning of the die movement is determined by appropriately positioned stops. The die moves only during part of the compression stroke while in a subsequent phase the press punch moves alone. A homogeneous metallurgical structure of the compressed blank cannot be expected by phasing the operation and providing discontinuous movement of press elements in that manner.

Another hydraulic press is known wherein die and upper punch can move relative to each other, but the instant of beginning a die follower motion cannot be determined and prescribed with sufficient accuracy. Moreover, the relative speed of the die is also not controllable with sufficient accuracy. Another known variety of hydraulic press for compression of powder has hydraulically operated pistons connected respectively to upper punch and die; and the pressure in the piston cylinders is controlled by suitably connected valves; there is provided an additional valve to branch off a particular amount of pressure liquid. The additional valve itself is not controlled, so that mutual dependency of movement of punch and die is not guaranteed, and it is not certain that the position relation remains accurate throughout the operation, so that quality of the pressed work varies significantly.

The present invention, therefore, has a primary object to provide a hydraulic press for compression of metal powder which guarantees a homogenic metallurgical structure of the pressed work or block. In accordance with the present invention, it is suggested to provide a controlled valve to bleed or branch off part of the flow of control liquid flowing between the cylinders in which run pistons for controlling the positions of upper punch and of lower punch or die. The controlled valve is connected to an actuator, which responds to the relative disposition of these pistons for positively establishing positional dependency. Particularly the valve may be carried by an arm that moves up and down with the die, while the valve actuator proper is particularly linked to the upper punch. The relative positions of upper punch and die determines the control state of the valve, which, in turn, determines the extent and effectiveness of bypass for the hydraulic connection between the two hydraulic motors as controlling die and punch displacement. The invention permits additionally adjustment of the relative position, e.g., between upper and lower punch from which there is to be dependency of movement. Also, the slope of the transition between independency and dependency is determinable and adjustable.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention, it is believed that the invention, the objects and features of the invention and further objects, features and advantages thereof will be better understood from the following

description taken in connection with the accompanying drawings in which:

The FIGURE illustrates somewhat schematically a flow diagram with some pertinent construction details for a hydraulic press control system in accordance with the preferred embodiment of the present invention.

Proceeding to the detailed description of the drawings, there is shown a press die member 17, a lower press punch 18, and an upper press punch 19 disposed in a housing, stand, frame, or the like, and denoted generally with reference numeral 13. These are the elements for the hydraulic powder press and they are not shown in great detail.

The upper press punch is connected to a piston 2 that runs in a cylinder 1. The die 17 is connected to a piston 6 that runs in a cylinder 4. Three valves I, II, III, control application of pressure and connection of venting outlet to the piston chambers at opposite sides of the pistons. A hydraulic pump H provides pressure fluid into the various conduits and is driven by a suitable motor M. Additionally valves I and II govern a path 31 that includes a check valve 32 between the two piston chambers.

The two pistons are stepped so that the respective opposite surfaces of the two pistons are of different dimensions. Consequently, there is an annular chamber 3 in cylinder 1, which is connected via valves I and II and check valve 32 to an annular chamber 4 in cylinder 5. The two annular chambers are, thus, particularly established adjacent the smaller surfaces of the respective pistons 2 and 6. The lower punch 18 is stationary in housing 13.

Up to this point, the arrangement is substantially known per se. The valves I, II, III, are appropriately controlled, whereby particularly piston 4 may be moved in dependency upon movement of piston 2 during an operating stroke, and pressure fluid, displaced from chamber 3, is forced into chamber 4, whereupon die 17 moves down as punch 19 moves down.

For retraction and press opening, each piston is independently displaceable so as to retract lower punch 18 (through lifting of die 17) from upper punch 19 through lifting the latter. During this phase, annular chambers 3 and 4 are not in communication for transfer of pressure fluid from one to the other. Hydraulic operation of a hydraulic press does not require detailed description. However, such a device is not adequate for controlling the motion of the die to the desired degree of dependency. For this, controlled bypass or bleeder or branch-off path 33 is needed.

In accordance with the preferred embodiment of the invention, piston 6 is connected to an arm 10 on which is mounted a follower control valve 7 which regulates branch or bleeder line 33 for discharging pressurized liquid from connection 31 to venting outlet 34. The follower control valve 7 has two terminal operating positions, but permits gradual transition from one to the other.

In the illustrated position, branch line 33 is directly connected to venting point 34. In the alternative position, line 33 is cut off and completely disconnected from venting outlet 34, so that the fluid, then displaced from chamber 3, all flows into chamber 4. For in-between positions of controlled valve 7, there is more or less strong throttling, i.e., higher or lower fluid flow impedance is established, for controlling the amount of

pressure fluid that is bled off conductor line 31 via conduit or line 33 accordingly.

Valve 7 is under control of an actuator 71. Due to disposition of valve 7 itself on arm 10, this position is part of the actuation input and establishes response thereof to the position of piston 6 and die 17. The actuator displacement relative thereto introduces the disposition of piston 2 as contributing to the control of valve 7. For this, adjustable linkage 20 is provided as connecting means.

Actuator 71 is connected to the free end of lever 8, having a pivot point 9 in an extension of arm 10. The lever 8 carries a feeler roll 21, mounted to lever 8 in between pivot point 9 and the arm end that carries actuator 71. The vertical position of roll 21 on lever arm 8 can be adjusted by means of a spindle 16.

A bevel gear 22 links spindle 16 via an articulated drive to an adjusting knob 23 that is accessible from the outside of housing 13. Upon turning knob 23, the spindle turns and feeler roll 21 is lowered or lifted, depending upon the direction of turning knob 23.

Feeler 21 bears against a lever 11, having a pivot point 12, journaled on a guide 14 which is affixed to housing 13. An externally accessible adjusting knob 24 turns a spindle 25 and, thereupon, pivot 12 is adjusted in direction of double arrow 26, depending upon the direction of knob turning. This direction of pivot displacement is particularly characterized in that it takes place in direction transverse to the direction of displacement of upper punch 19.

The free end of lever arm 11 is linked via a scanning or feeler roll 27 with a straightedge 15 which is secured to piston 2 of upper punch 19 by means of suitable arm structure 28. Straightedge 15 is oriented transverse to the direction of motion of upper punch 19, so that roll 27 can roll there along as indicated by arrow 26, but only upon adjustment by knob 24.

The device as described operates as follows:

During powder press working piston 2 is moved in cylinder 1 in that hydraulic pump H, as driven by motor M, causes pressure fluid to flow into the upper portion of chamber 1, above piston 2, to move the piston and upper punch 19 in down direction. Pressure fluid that has been contained in (i.e., previously pumped into) annular chamber 3, is displaced via the valves I and II, conduit 31, and the uncontrolled check valve 32 therein, to enter the annular chamber 4, as described above. However, branch 33 bleeds some of the displaced pressure liquid, as valve 7 is fully or partially open, so that annular chamber 4 is, in fact, not pressurized. As long as valve 7 is completely or partially open, outlet 34 is fully or partially effective on the end of bleeder line 33.

The annular chamber 4 will be pressurized only if during down motion of piston 2 the controlled valve 7 is actuated via straightedge 15, lever 11, feeler 21 and lever 8, for closing the controlled valve 7. Therefor, during the initial phases of compression, piston 6 remains stationary and so does arm 10. This then delays down motion of piston 6 and die 17, even the onset of such down motion is delayed. However, as piston 2 moves progressively down, straightedge 15, as engaging feeler 27, pivots lever 11 counterclockwise and feeler 21 is pushed down, so that actuator 71 begins to throttle valve 7. The operation of the follower control valve causes throttling of the branched off pressure liquid, and after some time even a complete turn-off of the

branch is established, so that pressure builds up in chamber 4 from the fluid as displaced from chamber 3, and piston 6 with die 17 begin to move down.

The die motion is controlled, so that the relation of speed of upper punch 19 to speed of die 17 is determined by (and could be made equal to) the relation of total length of lever 11, as between pivot point 12, and the point of engagement of straightedge 15 by the feeler roll 27 to the length as established between pivot point 12 and feeler 21. Significantly now, this latter ratio can actually be adjusted down to a value of 1:1 by appropriate lateral positioning of the pivot point 12, shifting the feeler 27 directly into vertical alignment with feeler 21.

Lever 8 functions as an amplifier as to transmission of displacement and particularly provides an increase of the control deflection as acting on the actuator 71 of valve 7. The gain of that "amplifier" is given by the relation of the total length of lever 8 as between pivot point 9 and actuator valve 71, to the partial length as between pivot point 9 and the disposition of feeler 21 on lever arm 8.

By means of adjustable spindle 16, the onset of the die motion can be adjusted. It should be noted that lever 11 may normally rest on feeler 21, while upon complete retraction of piston 2, straightedge 15 does not necessarily rest on feeler 27. The tap between them represents the delay of the onset of operation of valve 7. However, that delay can be reduced to zero by adjusting spindle 16 so as to lift feeler 21 (and lever 11) until feeler 27 engages straightedge 15 so that right from the beginning there is effective coupling of punch 19 and its hydraulic drive, and valve actuator 71.

Such adjustment will be necessary primarily in case a rather tall work is to be pressed. Furthermore, it can be seen that in the particular position as adjusted by knob 24, there is a 1:1 transmission as between down displacement straightedge 15 and down displacement of actuator 71, after the straightedge 15 has engaged feeler 27. Upon displacing pivot 12, e.g., to the right, feeler 27 is displaced accordingly and the transmission ratio is larger, to obtain complete throttling by valve 7 more quickly. It will be appreciated that manipulation of controls 23, 24, permits adjustment in the characteristics that defines the dependency of die movement upon movement of the upper punch.

After valve 7 has closed, punch 6 moves down also, and the valve closing is dynamically maintained by mechanism 20. Finally, at the end of the powder compression operation, the stepped pistons 2 and 6, as well as the upper punch 19, and die 17 are subject to individual control operation by valves I, II and III. This way, they can be independently returned to initial position. The linkage via the follower valve does not follow or track this return operation. The invention permits an exact and high accurate control of die movement using a combination of hydraulic and mechanical adjustment devices and it was found that that combination ultimately results in a very uniform microstructure of the compressed powder.

The invention is not limited to the embodiments described above but all changes and modifications thereof not constituting departures from the spirit and scope of the invention are intended to be included.

I claim:

1. Hydraulic press for compression of powder having upper punch, lower punch and die, a first and second

5

one of these three elements being movable relative to each other for press operation, the relative motion being provided by means of first and second pistons respectively connected to these first and second elements and respectively moving in first and second cylinders, there being hydraulic conduit means interconnecting the two cylinders, the improvement comprising:

a branch conduit means conductively connected to for tapping the said conduit means and leading to a venting outlet;

a valve means inserted in the branch conduit means for opening, closing or throttling a hydraulic bleeder path from the conduit means to the venting outlet;

actuation means connected for operating the valve to obtain said opening, closing or throttling of the valve means; and

connection means connected to be responsive to the relative positions of the first and second pistons, further connected to the actuation means for operating the actuation means in dependence upon a particular characteristic as between the relative positions during compression.

2. Hydraulic press as in claim 1, the connecting means comprising a first lever; means for pivotally linking the first lever to the first piston, the first lever having an arm, the arm being linked to the actuation means; a second lever; means for pivotally linking the second lever to a stationary part of the press and coupled to the first lever for transmitting displacement motion thereto; and means connected to the second piston for pivoting the second lever.

3. Hydraulic press as in claim 2, the coupling of the first to the second lever being externally adjustable for determining the onset of transmission of displacement motion by the first piston upon the actuator.

4. Hydraulic press as in claim 2, the pivot point of the second lever adjustable to be effective transverse to the direction of displacement of the upper punch upon the second lever as pivot motion thereof.

6

5. Hydraulic press as in claim 1, the second piston operating the die and having an arm, the valve being mounted on said arm, the first piston operating the upper punch, the valve actuation; means being linked by the connection means to the first piston.

6. Hydraulic press as in claim 5, the connection means comprising, a first lever pivotally linked to said arm;

an adjustable feeler on the first lever;

a second lever pivotally linked to a stationary part of the press and engaging the feeler;

a second feeler on the second arm; and

means for engaging the second feeler and coupled to the first piston, for transmitting displacement of the upper punch to the second feeler for further transmission via the second arm, the first feeler, the first lever, and the actuator.

7. Hydraulic press as in claim 6, the last means including a straightedge, displaced with the first piston in direction transverse to its extension, the pivot of the second lever adjustable in the direction of extension of the straightedge, to change the distance between the point of engagement of the second feeler and the straightedge, and the pivot of the second lever.

8. Hydraulic press as in claim 1, the connection means adjustable to determine the onset of closing the valve in the bleeder path for timing the beginning of dependent displacement of the die.

9. Hydraulic press as in claim 1, the connection means adjustable to determine the slope of the transition between independency and dependency of relative movement of first and second pistons.

10. Hydraulic Press as in claim 1, the connecting means comprising adjustable lever means respectively connecting the actuation means to the first and second piston, the said particular characteristic providing for venting through the value means so that the speeds of the pistons have a predetermined ratio as adjusted in the lever means.

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