Jan. 10, 1967 H. BÊCHÉ 3,296,853

FLUID-OPERATED PRESS

Filed Jan. 25, 1966 2 Sheets-Sheet 1

Fig.1

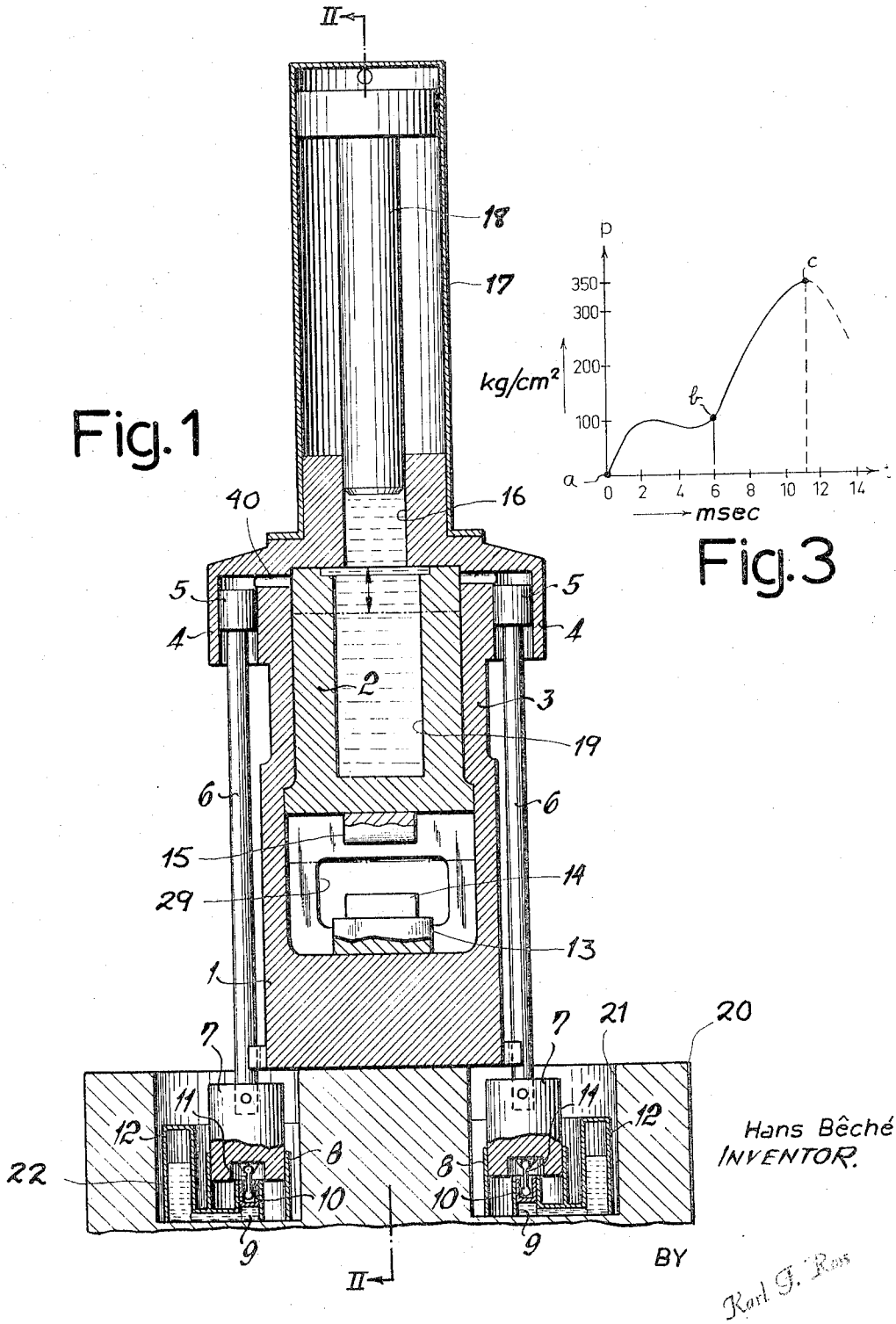


Fig.3

Hans Bêché
INVENTOR.

BY

Karl G. Ross
Attorney

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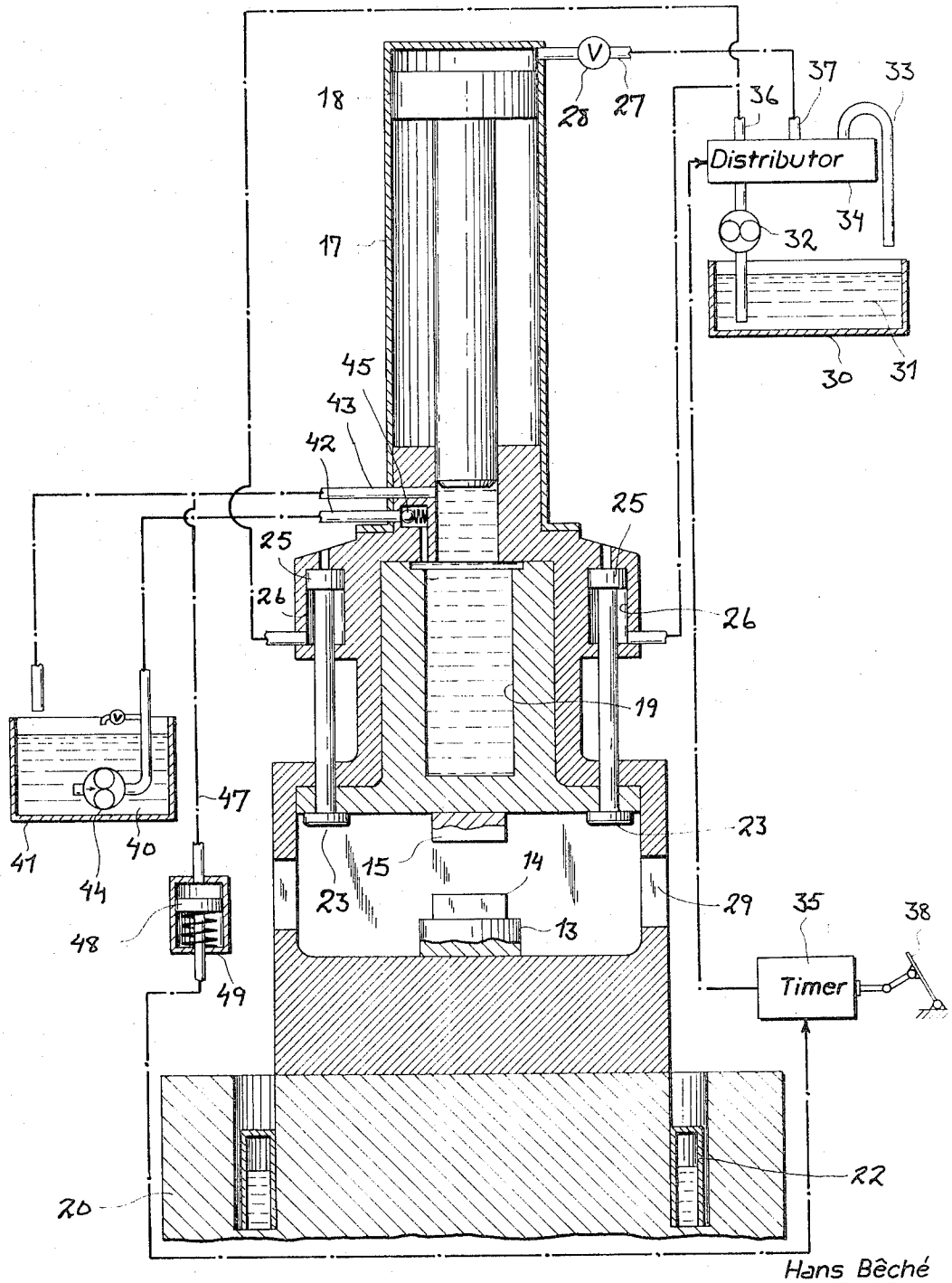


Fig. 2

Hans Bêché
INVENTOR.

BY Karl F. Ross
Attorney

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FLUID-OPERATED PRESS

Hans Bêché, Gardelenbergstrasse 29, Huckeswagen, Rhineland, Germany

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Claims priority, application Germany, Jan. 26, 1965, B 80,273
8 Claims. (Cl. 72—453)

This application is a continuation-in-part of my application Ser. No. 316,373, filed October 15, 1963.

My present invention relates to a press for forging, stamping or otherwise deforming metallic bodies between dies of which one may be stationary while the other is carried on a fluid-operated ram reciprocably guided on the press frame.

In my above-entitled copending application I have disclosed a press of this character having a ram or tup integral with a piston slidably received in a main cylinder which communicates with an auxiliary cylinder accommodating a fluid-actuated plunger whose effective surface area is a fraction of that of the piston and which, conversely, has a stroke length representing a corresponding multiple of the piston stroke. When this plunger is accelerated to a relatively high speed within its cylinder, it transfers its momentum to the plunger and ram by way of a constant volume of hydraulic fluid present in the two communicating cylinders. The kinetic energy of the plunger is rapidly translated into a forward motion of the ram at a rate greatly exceeding the operating speed of conventional forging presses so that a heated workpiece placed between the dies will not undergo appreciable cooling before being deformed by the ram stroke.

While the system disclosed in my copending application is generally satisfactory, a press so constructed is subject to stresses and vibrations resulting from an uncompensated force component acting in the direction of the working stroke of the ram; thus, if $R=A/a$ is the ratio of the effective surface area A of the piston to the effective surface area a of the plunger, a fraction P/R of this pressure will not be absorbed by the walls of the main cylinder but will be propagated as a shock wave through the ram, the dies and the press bed to the foundation of the press frame. It should be understood that this shock wave is distinct from the impact of the ram motion upon the workpiece which is dissipated as a permanent deformation of the latter.

Since in a typical press of this character the driving pressure may on the order of 1,000 tons, with a piston ratio R equal to about 6 to 8, the force of the shock wave may range between approximately 125 and 175 tons which is not negligible, especially when iteratively generated in rapid succession.

In my copending application Ser. No. 490,527, filed September 27, 1965, I have disclosed and claimed a system which solves the problem of eliminating the aforedescribed shock wave by the provision of two counteracting plungers symmetrically disposed in an auxiliary cylinder extending at right angles to the ram stroke.

The general object of my present invention is to provide means for absorbing such shocks in a press wherein, as in the various embodiments described in my first-mentioned application, there is but a single plunger for the actuation of the ram.

This object is realized, in accordance with my present invention, by the provision of one or more masses accelerable in the direction of the working stroke of the ram, thus generally in a downward direction, these masses being rigid with respective pistons which enter an extension of the working space of the ram cylinder so as to be subject to the pressure of the ram-actuating plunger through the intermediary of a common hydraulic medium. Normally, in the absence of such pressure, these pistons—which preferably are arrayed symmetrically and parallel with reference to the ram stroke—are maintained in a retracted position, generally at the upper limit of their stroke, by a suitable restoring force which may be provided by a liquid or gaseous fluid. This restoring force, which of course must be less than the driving force developed by the plunger, advantageously is so chosen that the masses are not accelerated until the ram pressure reaches a value which is a fraction of the maximum operating pressure and which lies at the level where the workpiece undergoes plastic deformation so that the ram pressure remains nearly constant preparatorily to rising steeply in the latter part of the stroke. The piston or pistons are thus normally biased into an elevated position from which they are displaced downwardly only during the short last portion of the working stroke, the resulting acceleration of their masses balancing the force of the descending plunger if the effective surface area of the latter is substantially equal to the combined effective area of the pistons confronting the common hydraulic medium. Advantageously, according to a further feature of this invention, the hydraulic medium acting upon the pistons is cut off from the plunger pressure as long as the ram is in its withdrawn (i.e., raised) position so that no part of the plunger force is wasted upon the displacement of the pistons and their associated masses until the ram has undergone its initial acceleration; this action also insulates the pistons from the force of a preferably hydraulic lifting mechanism which re-elevates the ram after its working stroke.

In general, the period of acceleration for the piston-entraining masses will be only a small fraction of a second so that these masses need not be large in order to give rise to a reaction force absorbing at least a substantial part of the shock front due to the unbalanced plunger pressure.

My invention will be described in greater detail with reference to the accompanying drawing in which:

FIG. 1 is a sectional elevation of a press assembly according to the invention;

FIG. 2 is a sectional elevational view taken on the line II—II of FIG. 1; and

FIG. 3 is a time/pressure diagram relating to the system of FIGS. 1 and 2.

In FIGS. 1 and 2 I have shown a drop-forging press of the general type described in my aforementioned application Ser. No. 316,373. The frame 1 of this press has a bed 13 supporting a stationary die 14 which co-operates with a movable die 15 suspended from a ram 2. The upper part of ram 2 is slidably guided, for vertical reciprocation, in a main cylinder 3 whose interior communicates via a bore 16 with the interior of another cylinder 17 accommodating a plunger 18. A chamber 19 within ram 2 is open toward the plunger 18 and contains a hydraulic fluid, such as oil, which is displaceable by the descending plunger into the interior of cylinder 3 as soon as the ram begins its downward stroke. A pair of flanges 4, integral with cylinder 3, form two symmetrically opposite auxiliary cylinders within which a pair of pistons 5 at the top of two rods 6 are vertically movable. The lower end of the piston rods 6 are secured to respective weights 7 which are slidable in upright tubes 8 in an annular recess 21 of base 20 and which in turn are connected by short links 11 with respective counterpistons 10 vertically slidable in corresponding cylinders 9. The last-mentioned cylinders are in communication with a pressure accumulator 12 in the shape of a hollow ring which is partly filled with liquid 22, such as oil or water, and which also has an air space above the liquid level to exert upon the undersurfaces of counterpistons 10 a force

tending to maintain the pistons 5 in their illustrated elevated position.

The underside of the ram 2 is engaged by enlarged heads 23 of a pair of piston rods 24 whose pistons 25 are guided in cylinders 26 above the ram cylinder 3. Pistons 25 serve to return the ram to its normal raised position after it has been driven downwardly by the plunger 18 upon the admission of operating fluid under pressure into the driving cylinder 17 by way of an inlet 27 containing a flow-control valve 28. Aligned holes 29 in opposite walls of frame 1 enable the insertion of a heated workpiece between the dies 14 and 15 at the beginning of a press cycle.

A source of operating fluid is represented by a vessel 30 containing a quantity of hydraulic liquid 31, e.g. oil. A pump 32 continuously withdraws oil from the vessel 30 and, in the inoperative condition of the press, returns it to the vessel 30 via a pipe 33 and a distributor 34 controlled by a timer 35. A further conduit 36 extends from distributor 34 and divides into two branches terminating at the bottom inlets of cylinders 26. Inlet 27 of cylinder 17 is connected with still another conduit 37 also extending from distributor 34. Timer 35 may be controlled by suitable means, such as a pedal 38, to initiate the downward stroke of plunger 18 and ram 2 by the admission of liquid 31 from pump 32 via conduit 37 into cylinder 17 with concurrent draining of the cylinders 26 by way of pipe 36; upon completion of the downward stroke, the timer reverses the distributor to evacuate the oil from the space above the plunger 18 and to readmit fluid under pressure into the cylinders 26 to restore the ram 2 to normal.

In order to maintain the interior of ram cylinder 3 fully occupied by hydraulic liquid, a reservoir 41 containing a supply of oil 40 communicates with the space 19 via a discharge pipe 42 and an intake pipe 43. Pipe 43 is connected to the high-pressure port of a pump 44 in reservoir 41 and also contains a check valve 45 preventing the return flow of oil from the cylinder 3 to the reservoir as soon as the plunger 18 has descended sufficiently to obstruct the outlet leading to pipe 43. The latter pipe opens into the reservoir 41 below the level of the liquid 40 and also communicates with a conduit 47 terminating at a hydraulic relay 48 whose spring-loaded plunger 49 is displaced downwardly by the fluid pressure prevailing in pipe 43 when the latter is blocked by the plunger 18. In this condition the timer 35 is enabled and responds to the operation of actuating pedal 38.

Reference will now be made to FIG. 3 in which I have plotted the specific ram pressure P, in kg./cm.^{2}, against time t, in milliseconds, for a typical press as shown in FIGS. 1 and 2. At point a (t=0) fluid is admitted into cylinder 17 by way of pipe 36 and depresses the plunger 18 to impart downward motion to the ram 3, the pressure of the fluid increasing progressively as the ram accelerates and strikes the workpiece to deform same to the elastic limit of its material (e.g. metal). As the material begins to flow, the hydraulic pressure remains approximately constant to a point b. Thereafter, with dissipation of the kinetic energy of the ram, as the final deformation takes place and excess material is extruded between the confronting die surfaces pressure builds up rapidly to a point c which represents the lower dead-center position of the ram and marks the reversal of the distributor 34 by timer 35. Thereafter, the pressure drops rapidly to 0 at a rate dependent, inter alia, on the setting of valve 28.

In accordance with a preferred embodiment of my invention, the normal pressure of the air and liquid in accumulator 12 (FIG. 1) is so chosen as to balance, substantially, the hydraulic pressure exerted upon the upper faces of pistons 5 at the point b, the combined area of these piston faces being substantially equal to the area of the lower face of plunger 18 within passage 16. Thus, as the pressure of the liquid in main cylinder 3 and in auxiliary cylinders 4 rises beyond point b, the pistons 5

with their rods 6 and masses 7 are accelerated downwardly, against the countervailing biasing force of accumulator 12, to absorb at least a major part of the shock of the plunger stroke. These masses, whose own stroke is relatively short so that their displacement does not materially affect the magnitude of the biasing force, reach their maximum speed in the region of point c and are rapidly decelerated as the pressure in cylinders 3 and 5 collapses, returning thereupon to their starting position under the retaining action of the accumulator. In practice, with point b located at a level corresponding to roughly one-third the pressure at point c, about two-thirds of the otherwise uncompensated plunger pressure may be thus absorbed, i.e. a force of approximately 250 kg./cm.^{2} where the maximum force (at point c) has a value of about 350 kg./cm.^{2} as shown in the diagram of FIG. 3. For larger presses, e.g. those initially mentioned with a maximum total pressure of about 1000 tons, the force absorption may be on the order of 100 tons out of an uncompensated total of, say, 150 tons; in that case, however, the time intervals a–b and b–c may each be approximately equal to 0.01 second, in lieu of the approximately 6 ms. indicated in the diagram.

It will be noted that the auxiliary cylinders 4, accommodating the pistons 5, communicate with the interior of cylinder 3 via passages 40 located somewhat below the upper wall surface of the cylinder space receiving the ram 2, whereby this ram, in its fully elevated position, cuts off the admission of fluid from bore 16 and space 19 to the pistons 5. Thus, ram 2 is initially accelerated by the plunger 18 under the same conditions as if the shock-absorbing pistons 5 had been omitted; moreover, the hydraulic pressure in cylinders 26, which must be sufficient to overcome the weight of the ram, will not be communicated to the pistons 5. Only after the passages 40 have been unblocked, and after the die 15 has contacted the workpiece to build up the pressure behind the ram 2, will the pistons 5 act upon the masses 7 to accelerate them against the restoring force of accumulator 12.

Although the symmetrical arrangement of two piston rods 6 alongside the ram 2 is preferred, it will be apparent that the benefits of the invention may also be realized with a greater or lesser number of shock-absorbing pistons.

I claim:

1. A fluid-operated press comprising a frame forming a bed adapted to support a first die; a ram reciprocally guided on said frame and adapted to support a second die confronting said first die; a main cylinder rigid with said frame, said ram having a part guided in said main cylinder for displacement by a hydraulic fluid present therein; plunger means disposed in a passage communicating with said main cylinder for exerting pressure upon said hydraulic fluid, said main cylinder being provided with an extension forming at least one auxiliary cylinder communicating with said passage at least in an off-normal position of said ram; piston means disposed in said auxiliary cylinder for displacement concurrently with said ram by said hydraulic fluid; an accelerable mass positioned for entrainment by said piston means; biasing means acting upon said piston means for substantially preventing displacement thereof by a hydraulic pressure below a predetermined limit, said limit being substantially less than the maximum hydraulic force developed by said plunger means upon operative displacement of said ram; and driving means for actuating said plunger means to displace said ram, said piston means and said mass.

2. A press as defined in claim 1 wherein said plunger means and said piston means have substantially equal effective areas exposed to said hydraulic fluid.

3. A press as defined in claim 1 wherein said biasing means is a source of substantially constant pressure of an effective value roughly equal to one-third the max-

imum hydraulic pressure exerted upon said piston means by said plunger means.

4. A press as defined in claim 1 wherein said piston means comprises a plurality of pistons extending parallel to the ram stroke and disposed symmetrically with reference thereto.

5. A press as defined in claim 4 wherein said pistons have a combined effective area exposed to said hydraulic fluid which substantially equals the effective area of said plunger means.

6. A press as defined in claim 4 wherein said pistons extend vertically for downward displacement by said hydraulic pressure.

7. A press as defined in claim 1 wherein said biasing means comprises a fluid-pressure accumulator and counter-piston means under pressure from said accumulator, said counter-piston means bearing upon said mass.

8. A press as defined in claim 1 wherein said ram is

vertically movable and provided with fluid-pressure-operated lifting means for separating said second die from said first die, said main and auxiliary cylinders being interconnected by a passage disposed to be blocked in a normal position of said ram whereby said piston means is insulated from the force of said lifting means.

References Cited by the Examiner

UNITED STATES PATENTS

1,054,194	2/1913	Gerdau	100—269
1,063,360	6/1913	Larsen	91—399
1,068,243	7/1913	Iversen	100—269
1,230,486	6/1917	Jacomini	100—269
1,230,492	6/1917	Kristufek	100—269

CHARLES W. LANHAM, *Primary Examiner.*

G. P. CROSBY, *Assistant Examiner.*