United States Patent

[11] 3,596,499

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[21] Appl. No. 768,042

[22] Filed Oct. 16, 1968

[45] Patented Aug. 3, 1971

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[32] Priority Oct. 16, 1967

[33] Austria

[31] A 9341/67

[54] MACHINE FOR PRESSURE FORMING AND IMPACT FORMING WORKPIECES

12 Claims, 3 Drawing Figs.

[52] U.S. Cl. 72/407, 72/453, 100/269

[51] Int. Cl. B21j 9/10

[50] Field of Search 72/453, 407; 100/269

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ABSTRACT: A pressure-fluid-operated machine for forming a workpiece between two ram heads, at least one of which is reciprocatable relatively to the other, capable of operating alternatively as a press or as a counterblow hammer, by means of an hydraulic coupling with two coupling branches laterally engaging at least one of the rams incorporating a clapper valve, a reversed-run cylinder chamber and two impact (hammering) chambers bounded by pistons engaging the movable ram and arranged beside the press cylinder chamber, and other ancillary means.

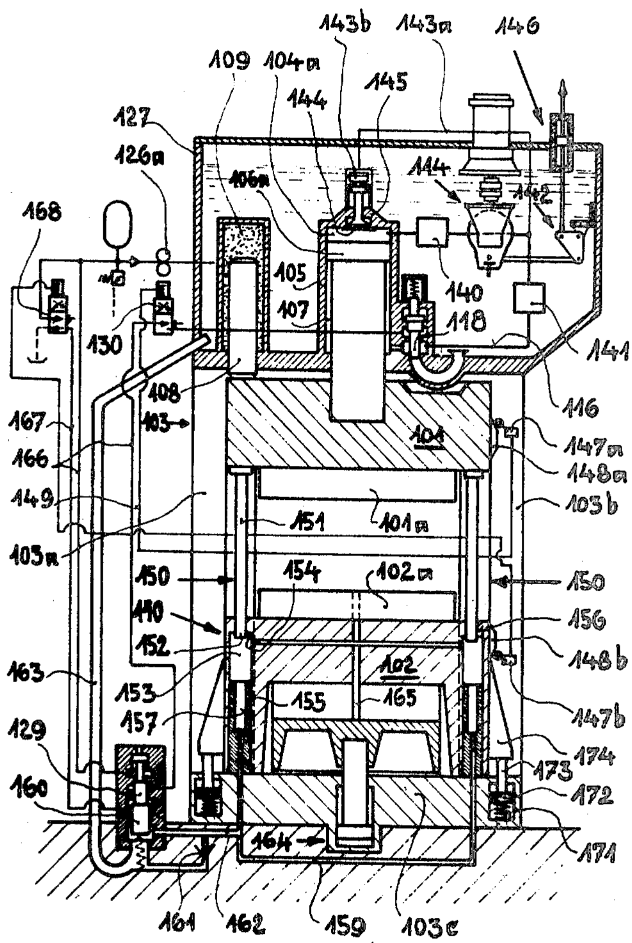

Fig: 1

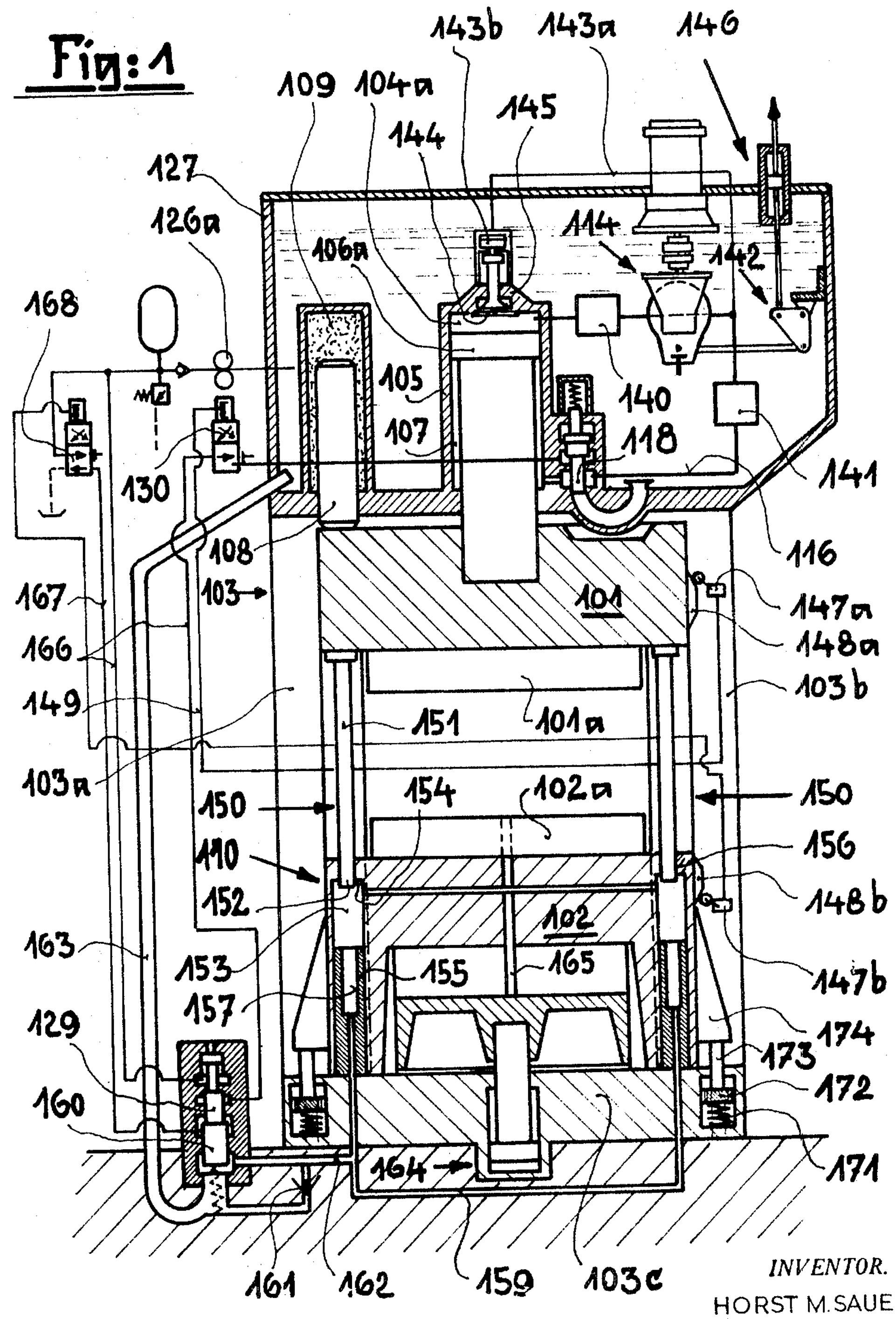

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Fig:3

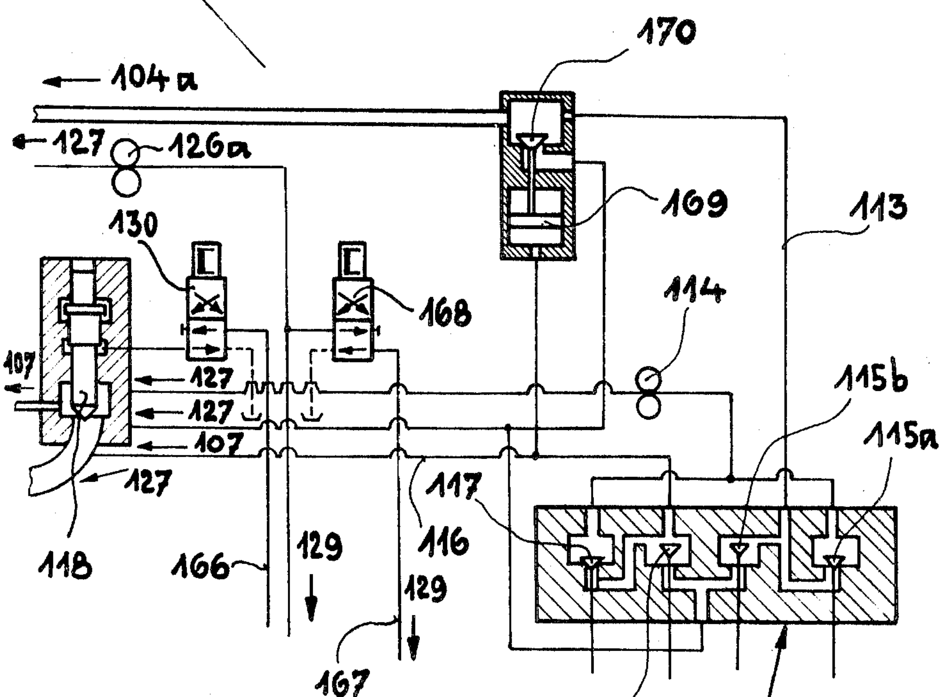
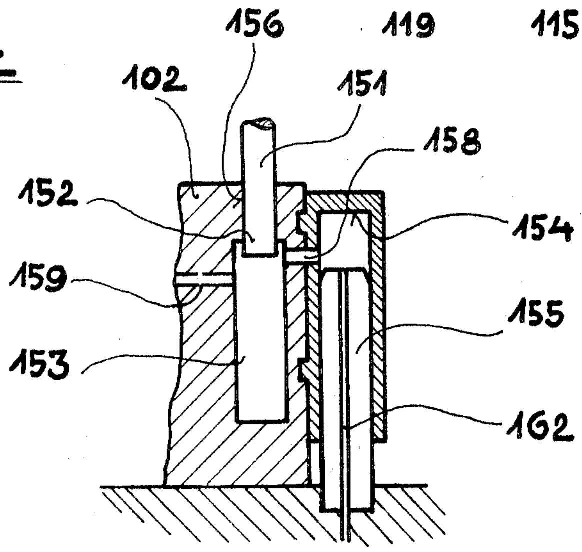


Fig:2



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MACHINE FOR PRESSURE FORMING AND IMPACT FORMING WORKPIECES

The invention relates to a machine for forming a workpiece between two ram heads wherein one of the two heads can be driven vertically upward and downward with respect to the other head, wherein there are further provided upon the machine a pressure cylinder chamber and a reversed-run cylinder chamber which contain pistons engaging the drivable ram head, and wherein a supply duct for pressure fluid runs from a valve means to the pressure cylinder and the reversed-run cylinder chambers.

Machines of this type are known e.g. from the German Pat. No: 876 796 or the German Pat. No: 1 116 510, which operate as presses, as simple hammers or as counterblow hammers with hydraulic coupling. It is also known to develop a press that can be operated as a simple hammer when desired. The object of the invention is to provide a machine of the type mentioned above which is formed substantially as a press, but can be operated as a counterblow hammer.

For this purpose the invention envisages a machine of the kind mentioned above which is characterized in that the two ram heads movable in opposition to each other can be coupled up by means of an hydraulic coupling, which comprises an outlet valve and can be filled through a supply duct, with two coupling branches which engage the heads from the side, that a clapper valve is connected to the reversed-run cylinder chamber, and that two impact cylinder chambers, which are bounded by pistons engaging the drivable ram heads are arranged laterally beside the press cylinder chamber.

The invention envisages a machine, for cold or hot forming a workpiece, capable of operating as a complete hydraulic drawing press or forging press, the bottom ram head being comparable to an "anvil" and in a pressing operation bearing against a baseplate; the machine, however, can in addition deliver any desired number of blows of any desired energy as a counterblow hammer following immediately upon a pressing operation the two hammer tups moving towards each other by means of a controllable coupling.

In the machine according to the invention pressure fluid is directed into the reversed-run cylinder chamber to effect the withdrawal or reversed motion of one or both of the ram heads. This pressure fluid acts upon the piston which bounds the reversed-run cylinder chamber and engages the drivable ram head and thus moves the latter back. A pressing forward motion of the drivable ram head is obtained in a similar way by supplying pressure fluid to the pressure cylinder chamber. In the impact motion of the two ram heads the pressure fluid in the additionally provided impact cylinder chambers acts upon the pistons bounding the impact cylinder chambers and engaging the drivable rams. The blow is initiated by opening the clapper valve, which is known as cuh. The clapper valve is of so large a cross section that the fluid contained in the reversed-run cylinder chamber can drain away from it almost unhindered.

If the outlet valve of the hydraulic coupling for a pressing operation is kept open, one hammer tup remains in its withdrawn position during the pressing operation and no power is transmitted through the hydraulic coupling. The structural height of the machine is low, because the impact cylinder chambers are located laterally, at the side of the pressure cylinder chamber. It is not necessary to sink the machine into foundations in an upstanding arrangement, as one ram head is not driven directly and is moved for impact through the coupling. There may be provided a complete draw pad or an ejector means with several ejector bars, as is necessary for deep-drawing work or continuous hot pressing and is not possible with a ram head which is engaged by a centrally arranged piston for press or impact work. The impact cylinder chambers, on the one hand and the press cylinder chamber, on the other, as well as the reversed-run cylinder chambers, are spatially separated, so that no pressure fluid can pass between these chambers. The machine can hammer immediately following a pressing operation.

A further advantageous development of the machine according to the invention is obtained if a control duct connecting an impact release valve with the impact valve is made to pass through an impact safety valve coupled with the outlet valve. It is ensured, by this construction, that the impact valve shall not be actuated by the impact release valve until the outlet valve has been closed and so the impact safety valve, which is coupled with it, opened. Such a safety arrangement is introduced because the machine is designed for counterimpact and not for simple impact.

Additionally the invention envisages providing a machine of the type defined above, wherein the two ram heads are connected by an hydraulic coupling with one or more coupling branches, every coupling branch having a coupling rod which is rigidly connected with one of the two ram heads and is immersed together with a movable plunger, in a fluid-filled coupling arm which is bounded by a piston face on the other ram head and in which a plunger, stationary relatively to the upright, is immersed.

The fluid of this hydraulic coupling is moved only a little and in a simple way when the hydraulic coupling is actuated. Owing to this hydraulic coupling, undesirable relative movements of the one ram head relative to the other, such as e.g. chattering blows, which depend on the coupling, are reduced. The compressibility and the characteristic oscillation of the coupling fluid are so chosen that undesirable relative movements of the two ram heads and double impacts arising therefrom are prevented. The hydraulic coupling according to the invention has a plunger that responds solely to pressure and only a little fluid, which, when the machine is working as a press, is pulsed almost without pressure through an outlet valve between the coupling chamber and an hydraulic tank. This coupling can, therefore, be used to particular advantage in a machine according to the invention.

The invention will now be described with reference to the accompanying drawings, which illustrate the invention but in no restrictive sense. The drawings show a preferred embodiment of the invention, and thus

FIG. 1 shows in section a machine for forming a workpiece;

FIG. 2 shows an hydraulic coupling for the machine shown in FIG. 1, and;

FIG. 3 shows a control arrangement for the machine shown in FIG. 1.

The illustrated machine is designed substantially as a press which can be used either as a draw press or as a forging press without sacrificing its properties and is so complemented by simple ancillary means that it can also operate as a counterblow hammer. It is a vertically operating machine comprising an upper ram head **101** carrying an upper die **101***a* and a lower ram head **102** carrying a lower die **102***a*. The two ram heads **101**, **102** have large working faces, as is characteristic of a press. The two ram heads **101**, **102** are guided movably in opposition to one another in an upright frame **103**.

The upright frame **103** comprises four posts, the two rear ones **103***a*, **103***b* being shown. The posts are of wedgelike cross section, enclose the corners of the two ram heads **101**, **102** and stand on the corners of a baseplate **103***c*. In each of the four corners of the baseplate **103***c* there is provided a bore wherein is accommodated a spring **171** upon which a disc **172** rests. The disc **172** carries a pin **173** projecting upwards from the baseplate **103***c*. A flange **174** on each of the four sides of the lower ram head **102** presses down upon the respective pin **173**. Below the disc **172** the bore is filled with fluid. In this way in each of the four corners of the baseplate **103***c* there is provided an hydraulic cushion which ensures a deformable mounting for the lower ram head **102** upon the baseplate **103***c*.

Higher up on the upright frame **103** there is provided a pressure cylinder chamber **104***a*, which is bounded by cylindrical walls **105**. An upper piston **106***a* is reciprocally mounted in the cylinder chamber **104***a*, and is rigidly connected with the upper ram head **101**. A reversed run cylinder chamber **107** is likewise bounded at its sides by the cylindrical walls **105** and upwardly bounded by the upper piston **106***a*.

The upper piston **106*a*** is located centrally, relative to the upper ram head **101**. Laterally beside the upper piston **106*a*** there are provided two further plungers or pistons **108**, only one of which is shown. Each of the further pistons **108** is reciprocally mounted in an impact cylinder chamber **109**, which is located upon the upright frame **103**. The two further pistons **108** engage diagonally opposite corners of the upper ram head **101**. Each impact cylinder chamber, which constitutes a pressure chamber, is filled with compressed gas, e.g. nitrogen, which is at high pressure when the upper ram head **101** moves back. The gas can be introduced, in a suitable manner not specifically shown, from a pressure container through a pressure reducing valve and a shutoff cock into the impact cylinder chambers **109**, which are closed when the machine is working, at an adjustable pressure, which pressure is controlled by a gas manometer and an excess pressure valve. Instead of two impact cylinder chambers **109** and two further pistons **108**, any suitable number of these may be provided.

The upper ram head **101** and the lower ram head **102** can be mechanically coupled up for opposed motion through an hydraulic coupling **110**. The coupling **110** has four branches **150**, which are spaced from the center line of the machine and engage the two rams close to their corners.

Associated with every coupling branch **150** is a coupling rod **151**, which is rigidly or resiliently mounted at one end upon the upper ram head **101** and has mounted at its other end a plunger **152** movable therewith. The movable plunger **152** enters a coupling chamber **153**, which is filled with liquid, say oil, and which is stationary relative to the lower ram head **102**. A piston face **154** on the lower ram bounds the coupling chamber **153**, which is entered from below by a plunger **155** which is stationary relative to the upright **103**. The piston face **154** is provided above the end of the stationary plunger **155** inserted into the coupling chamber **153**. The stationary plunger and the movable plunger **152** are reciprocatable on parallel axes relatively to the lower ram head **102**.

The coupling chamber of every coupling branch **150** is partly formed by the lower ram **102** and the coupling rod **151** is guided in a bore **156** leading to the coupling chamber **153** in the lower ram head **102**. In the embodiment shown in FIG. 1 the whole of the coupling chamber **153** is arranged in the extension of the stationary plunger **155**, and the stationary plunger has a bore **157** that opens towards the movable plunger **152**, the said movable plunger being slidable therein-to. In the embodiment shown in FIG. 2, on the other hand, the coupling chamber **153** consists of two partial chambers, arranged side by side, and communicating through a port **158**. Here the partial chamber receiving the plunger **155** is formed by an additional cylinder, rigidly mounted upon the lower ram head **102**.

The coupling chambers **153** of every two coupling branches **150** are interconnected by an equalizing duct **159**. In the embodiment according to FIG. 1 an outlet valve **160** is located, in a way that is not shown, in an outlet passage **162** which extends from only one of the coupling chambers **153** and runs through a stationary plunger **155**. In the embodiment shown in FIG. 2, on the other hand, owing to the design of the stationary plunger **155**, the outlet passage **162** leads to the coupling chambers **153** of all the coupling branches **150**.

After the outlet valve **160** the outlet passage **162** connects with a feed duct **163**, which leads from the outlet valve lying below the lower ram **102** up to a tank arranged upon the upright frame **103**. The tank **127** contains a liquid, e.g. oil, into which project the impact cylinder chambers **109**, as well as the pressure chamber **104*a*** and the reversed-run cylinder chamber **107**.

The lower ram head **102** is several times heavier than the upper ram head **101**, which is drivable. Below the lower ram **102** there is provided an hydraulic ejector device **164**, which extends with an ejector rod **165** into a bore in the lower ram. A clapper valve **118** lies in a connecting passage of large cross section which joins the reversed-run cylinder chamber **107** to the tank **127**. The clapper (impact) valve **118** is so designed in such a way that once opened it is kept open by the fluid steaming in through the connecting passage. If no fluid flows through the connecting passage the clapper valve will drop under its own weight and/or through spring loading and block the connecting passage.

An electrically controlled impact release valve **130** lies in a control duct **166**, one end of which leads to the clapper valve **118**. The fluid passing through the control duct **166** to the clapper valve **118** opens the same. The control duct **166** runs through an impact safety valve **129**, which serves for impact safety. This impact safety valve **129** is so coupled with the outlet valve **160** that it does not free the passage through the control duct **166** until that outlet valve has been closed. On the other hand, the passage through the control duct **166** is blocked when the outlet valve **160** is open. From the impact safety valve **129** the control duct **166** leads to a control pump **126*a*** which pumps the pressure fluid from the tank **127**.

Further, the control pump **126*a*** supplies a control duct **167** which contains an electrically controlled actuating valve **168** and leads to the outlet valve **160**. The outlet valve **160** is urged by means of a spring into its open position and becomes closed if, due to the actuating valve **168** being open, i.e. transmitting, the fluid reaches the outlet valve **160** through the control duct **167**.

In the machine shown in !FIG. 1 there is provided a main pump **114**, which supplies pressure fluid from the tank **127** alternatively through a pressure valve battery **140** to the pressure cylinder chamber **104*a*** or through a "withdrawal" valve battery **141** and a feed duct **116** to the reversed-run cylinder chamber **107**. The feed direction of the main pump **114** can b altered by a lever mechanism **142** mounted on the walls of the tank **127** and by means of a cylinder piston arrangement **146**.

If the upper ram head **111** is to be withdrawn the pressure fluid supplied by the main pump **114** flows into the reversed-run cylinder chamber **107**. At the same time this pressure fluid brings pressure to bear through a duct **143*a*** upon a valve plunger **143*b***. If the valve plunger **143*b*** is pressed down, a plate valve **144** will be lifted off outlets **145** which connect the press cylinder chamber **104*a*** with the tank **127**. The upper piston **106*a***, which moves up when the upper ram **101** is withdrawn, displaces the pressure fluid from the press cylinder chamber **104*a*** into the tank **127**. If the upper ram head **101** is operated presswise the pressure fluid supplied by the main pump **114** flows into the upper pressure cylinder chamber **104*a***, this pressure fluid urging the plate valve **144** upwards against the outlet **145**. The fluid contained in the reversed-run cylinder chamber **107** is displaced through the "withdrawal" valve battery **141** into the tank **127**.

For hammering, the machine or the main pump **114** is set for "withdrawal" and the outlet valve **160** closed when the upper ram head **101** has reached the predetermined striking height on an electric switch **147*a***. Should the upper ram head **101** move a little further up while the outlet valve **160** is being closed fluid can be sucked up into the coupling chambers **153** of the hydraulic coupling **110** through an auxiliary suction valve **161**. This auxiliary suction valve **161** lies in a duct which connects the outlet passage **162** with the feed duct **163**.

The striking height, i.e. the distance between the two withdrawn ram heads **101, 102** during hammering operations can be set. For this purpose there is provided on one of the posts **103*b*** the electric switch **147*a***, which can be slid up and down the column in a way which is not shown. This switch **147*a*** is actuated by a cam **148*a*** is connected by an electric lead **149** with the interposition of relays with the impact release valve **130**, which it actuates when it is itself actuated by the cam **148*a***. The impact release valve **130** switches on each blow separately. The actuating valve **168**, on the other hand, is turned on at the beginning of the coupling and so shortly before the first blow and drops off once the lower ram head **102** with a cam **148*b*** has reaches an electric switch **147*b***.

In the form of embodiment shown in FIG. 3 the main pump **114**, which may be formed e.g. as a high-pressure axial piston pump, supplies pressure fluid from the tank 127 through a feed duct 116, and through a reversed-run valve 117 to the reversed-run cylinder chamber 107, if the reversed-run valve is open. The main pump 114 feeds its pressure fluid into the pressure cylinder chamber 104*a* and through a feed line 113, as well as through a pressure valve 115, when this is open, while the reversed-run valve 117 is closed. The pressure valve 115 comprises a first partial valve 115*a*, whereby the pressure cylinder chamber 104*a* can be put into communication with the main pump, and a second partial valve 115*b*, whereby the pressure cylinder chamber can be connected with the tank. If the second partial valve 115*b* is open, while the first partial valve 115*a* and the reversed-run valve 117 are closed, the pressure cylinder chamber 104*a* will be in communication with the tank 127, whence the fluid will flow under prefilling pressure into the pressure cylinder chamber. Finally, there is provided a routing valve 119, which, when open, sets the reversed-run cylinder chamber 107 into communication with the tank 127.

The pressure valve 115, the reversed-run valve 117 and the routing valve 119 are actuated by rods. If the first partial valve 115*a* and the reversed-run valve 117 are close, while the routing valve 119 and the second partial valve 115*b* are open, the upper ram head 101 will move in pressing advance, fluid flowing into the press cylinder chamber 104*a* at prefilling pressure. If the reversed-run valve 117 and the second partial valve 115*b* are closed, while the routing valve 119 and the first partial valve 115*a* are open, the upper ram head 101 will move in pressing advance, fluid entering the pressure cylinder chamber 104*a* at high pressure. If the reversed-run valve 117 and the second partial valve 115*b* are open, while the routing valve 119 and the first partial valve 115*a* are closed, the upper ram 101 will move back.

In the reversed run, the high pressure of the fluid supplied by the main pump 114 acts upon a control piston 169 of a nonreturn valve 170 in the opening sense. The fluid displaced from the pressure cylinder chamber 104*a* can escape into the tank 127 through the open nonreturn valve 170. A part of this fluid will escape into the tank 127 also through the second partial valve 115*b*.

Thus when the machine is working as a press, the outlet valve 160 is opened by actuating the actuating valve 168, so that the coupling chambers communicate with the tank 127. For hammering, the outlet valve 160 is closed when the upper ram head 101 is withdrawn and the "withdrawal" position of the press valve 115, the reversed-run valve 117 and the routing valve 119 is maintained. A hammer blow is initiated by opening the impact valve 118 by the impact release valve 130. When a blow is being delivered the fluid contained in the reversed-run cylinder chamber 107, as well as the additional fluid supplied to it by the main pump 114 flows back almost unhindered.

If the machine according to FIG. 1 of the drawings operates as a "counterstroke" hammer, the two rammers 101, 102 are in the position shown in FIG. 1 before an impact is performed. The outlet valve 160 is then closed. It is shown open in FIG. 1. When the outlet valve 160 is closed, the spaces 153, 157, 159 form an intrinsically closed hydraulic system.

If, to execute a blow, the upper rammer 101 is displaced downwards by pressure of the pressurized gas in the surge cylinder space 109 on the piston 108, the coupling rod 151 is thrust into the coupling space 153. The coupling space 153 is filled with fluid which cannot escape from the coupling space 153 although the coupling rod 151 presses into the coupling space. The pressure exerted by the coupling rod 151 on the fluid in the coupling space 153 is also exerted against the piston surface 154 of the lower rammer 102. In view of this pressure, the lower rammer 102 then rises upwards and the "resting" plunger 155 is thrust downwards. This increases the coupling space 153, since the lower rammer 102 moves upwards relative to the resting plunger 155, so that the coupling rod 151 can be pushed into the coupling space 153. If the machine according to FIG. 1 is operated as a press, the outlet valve 160 is opened. If the upper rammer 101, respectively the coupling rod 151 exerts downward thrust, the fluid of the hydraulic coupling can be displaced out of the coupling space 153 through the pipe 162 into the tank 127, and the lower rammer is not displaced.

I claim:

1. A machine capable of operating both as a counterblow hammer and a press, comprising: a frame; a first ram head mounted in the frame; a second ram head mounted in the frame, the first ram head being movable towards the second ram head when the machine operates as a press and the first and second ram heads being movable towards each other when the machine operates as a hammer; a cylinder chamber; a piston contained in the cylinder chamber and dividing the cylinder chamber into a press cylinder chamber and a reversed-run cylinder chamber, the piston engaging with the first ram head; supply means for pressure fluid to the press cylinder chamber and the reversed-run cylinder chamber; an impact valve connected to the reversed-run cylinder chamber; an impact cylinder chamber; a piston contained in the impact cylinder chamber and engaging with the first ram head; a hydraulic coupling connecting the first and second ram heads, said coupling including an outlet valve; whereby the first ram head can be driven away from the second ram head by pressure fluid supplied to the reversed-run cylinder chamber by the supply means; when the machine operates as a press, the first ram head is driven towards the second ram head by pressure fluid supplied to the press cylinder chamber by the supply means; and when the machine operates as a counterblow hammer the first ram head is driven towards the second ram head by pressure of compressed gas acting on the piston contained in the impact cylinder chamber and the second ram head is driven towards the first ram head by means of the hydraulic coupling.

2. A machine as claimed in claim 1, wherein the hydraulic coupling comprises two coupling branches in each case acting laterally on the two ram heads, and further comprising two surge cylinder spaces arranged laterally beside the press cylinder space.

3. A machine as claimed in claim 1, wherein the hydraulic coupling comprises two coupling branches, in each case acting laterally on the two ram heads, the two coupling branches being connected with each other by an equalizing duct, and the outlet valve being connected with only one of the coupling branches.

4. A machine as claimed in claim 1, wherein the hydraulic coupling comprises two coupling branches in each case acting laterally on the two ram heads, and further comprising a control duct connecting an impact release valve with a clapper valve and passing through an impact safety valve coupled with the outlet valve.

5. A machine as claimed in claim 1, in which, when the ram heads are being withdrawn, a pressure chamber which is blocked off in operation and encloses the impact cylinder chamber is filled with compressed gas at high pressure.

6. A machine as claimed in claim 1, in which the drivable ram head is several times lighter than the other ram head.

7. A machine as claimed in claim 1, in which the nondrivable ram head is provided with an ejector device comprising a plurality of ejector rods which project through the nondrivable head.

8. A machine as claimed in claim 1 in which a control duct connecting an impact release valve with a clapper valve passes through an impact safety valve coupled with the outlet valve.

9. A machine as claimed in claim 1, in which a feed duct fed from a tank arranged above the outlet valve is connected, through the outlet valve, with the hydraulic coupling.

10. A machine as claimed in claim 1, in which every coupling branch comprises a coupling rod which is rigidly joined to one of the two ram heads and immersed, with a movable plunger, in a fluid-filled coupling chamber which is bounded by a piston face on the other ram head and into which is inserted a plunger which is stationary relatively to the frame.

11. A machine as claimed in claim 10, in which the coupling chamber is arranged in the extension of the stationary plunger, and wherein the stationary plunger has a bore which opens towards the movable plunger and in which the said movable plunger is slidable.

12. A machine as claimed in claim 10, in which the coupling chamber is formed at least partly by one of the ram heads and the ram is guided on the coupling rod.