United States Patent

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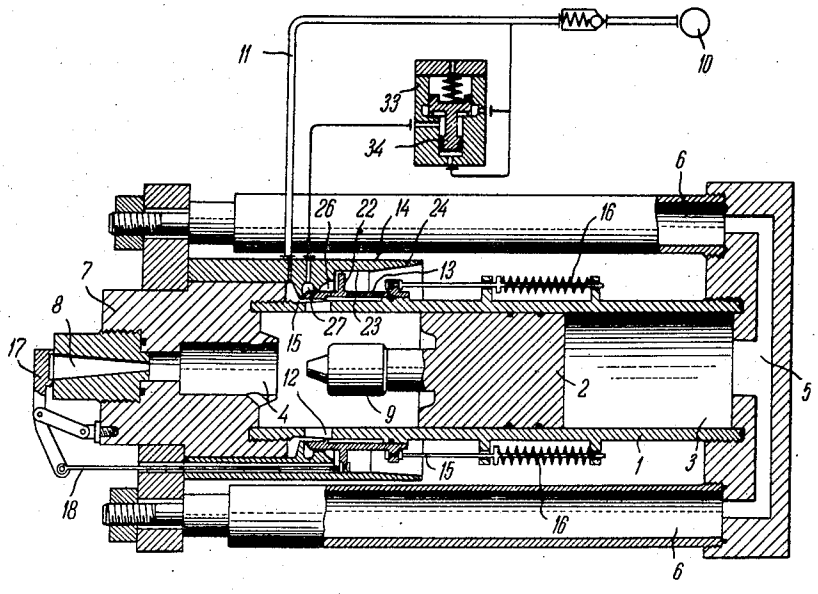
[54] **DEVICE FOR BUILDING UP HIGH-PRESSURE IMPULSE JETS OF LIQUID**
4 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** ..... **60/54.5 HA,** 60/54.5 HA, 60/10.5, 60/51, 60/57
[51] **Int. Cl.** **F15b 7/00**
[50] **Field of Search** ..... 60/54.5, 54.6 HA

[56] **References Cited**
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3,412,554 11/1968 Voitsekhovsky et al. ..... 60/54.5 HA

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ABSTRACT: The present invention provides a device for building up high-pressure impulse jets of liquid upon an impact delivered by a piston accelerated by compressed gas upon liquid disposed in a chamber provided with an aperture for the liquid outflow by jets; to bring the piston back to its initial position after an impact, the space of the cylinder before the piston being communicated with a liquid-supplying pressure main, and, to drain the liquid during the piston acceleration, the sidewalls of the cylinder are provided with drain apertures overlapped by a movable member of a locking mechanism.



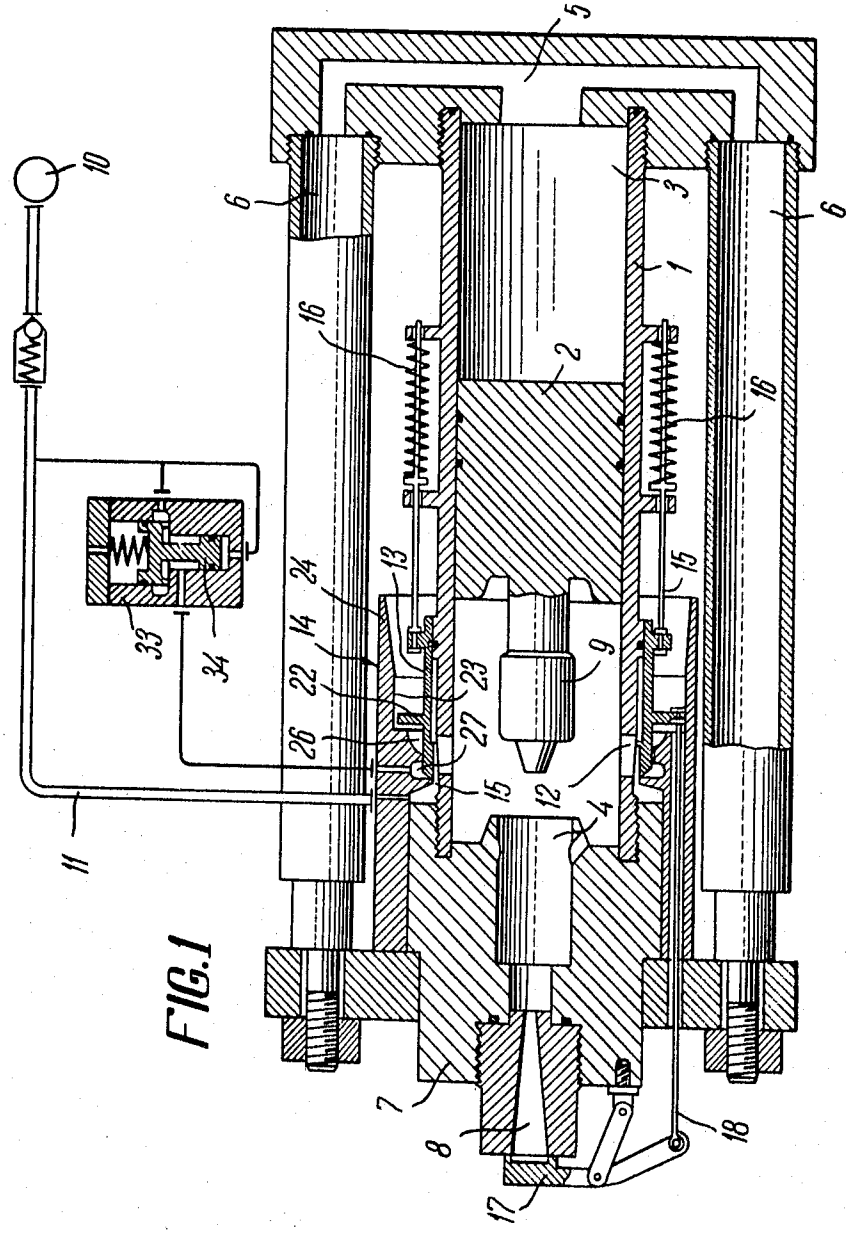


FIG.1

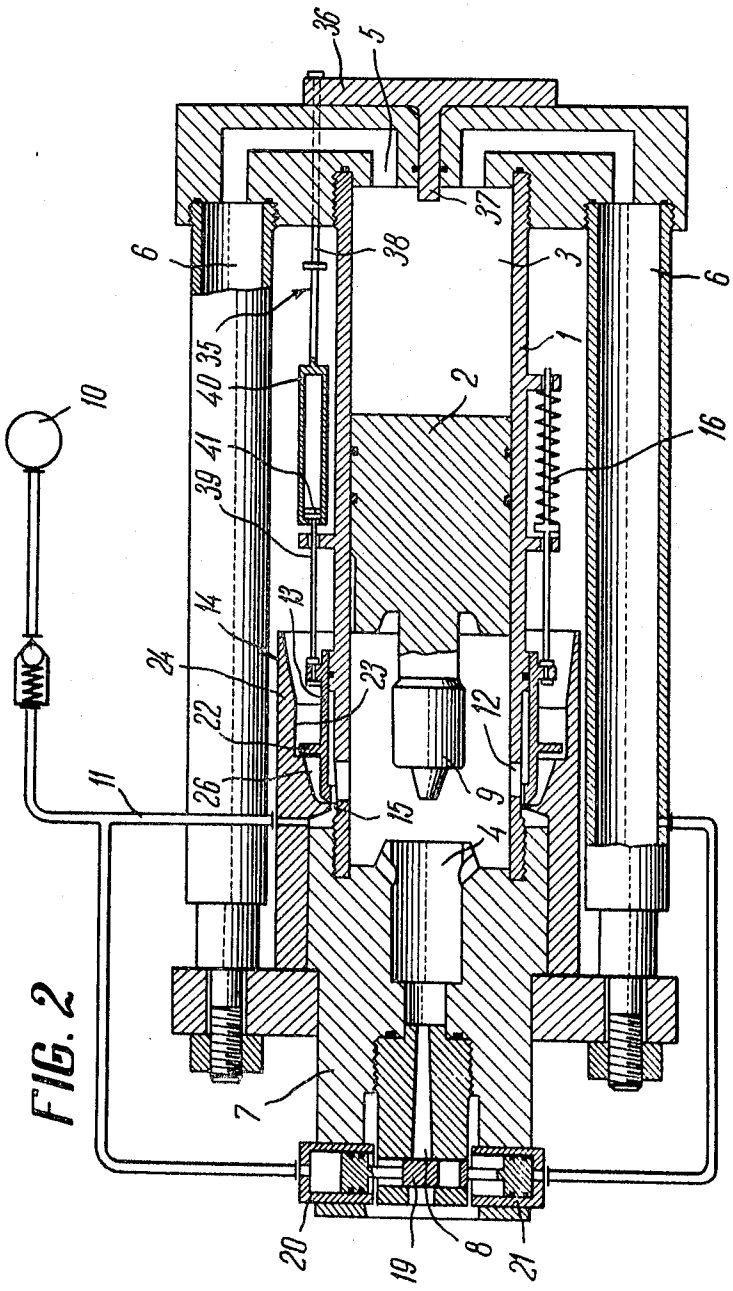

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FIG. 2

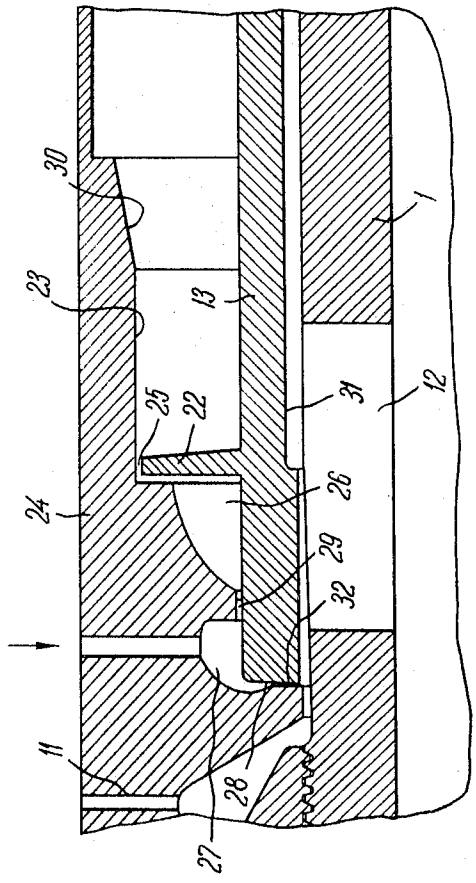


FIG. 3

DEVICE FOR BUILDING UP HIGH-PRESSURE IMPULSE JETS OF LIQUID

The present invention relates to devices for building up high-pressure impulse jets of liquid, created as a result of impacts delivered by a piston upon liquid in a chamber having an aperture for the outlet of pressurized liquid, and, more particularly, to devices in which the return of the piston to its initial position after an impact is effected by the liquid.

The device according to the present invention may be used for crushing rocks by direct action of a high pressure jet; for hydraulic stamping, when the pressurized liquid flowing out of the chamber is delivered into a closed die having a blank disposed therein; as well as for forging, pressing and cutting metals, when pressurized liquid acts upon the movable piston carrying a working tool.

Known in the prior art are devices for building up high-pressure impulse jets of liquid (for example, British Pat. No. 1,081,076; U.S. Pa. No. 3,412,554; French Pat. No. 1,415,034 to Voitzechovsky B. V. et al.), which comprise a cylinder having a piston disposed therein and dividing its space into two chambers. The first chamber communicates with a compressed gas tank, whereas the other one is filled up with liquid and has an aperture for pressurized liquid forced out as a result of an impact delivered thereupon by a piston accelerated by compressed gas in the first chamber.

According to the principle of the piston retraction into its initial position after an impact, done in order to compress the gas in the first chamber, the known devices are divided into two types.

The devices of one type have an actuating mechanism used for retracting the strike piston and comprising at least one power cylinder whose movable part interacts periodically with the strike piston of the device with the aid of a cam-gripping arrangement.

In the devices of the other type the strike piston is retracted to its initial position after an impact by supplying pressurized liquid into the cylinder space from the side of the second chamber, said liquid being drained through apertures in the sidewall of the cylinder during the piston working stroke in the direction of the second chamber. During the piston return movement said apertures are overlapped by a movable member of the locking mechanism and are opened by the same member for draining liquid from the cylinder space in front of the piston at the end of the reverse stroke of the latter after an impact.

The operation of the locking mechanism is controlled by a slide valve inserted into a liquid-supplying pressure main, the body of the slide valve being secured in the face wall of the cylinder at the side of the first chamber, and the movable member thereof projecting into said chamber and interacting with the piston during its coming to the initial position after an impact.

In order to communicate the cylinder space in front of the piston with the drain by the moment the piston is accelerated by the compressed gas, use was made of a means providing for the slowed-down motion of the piston at the beginning of its working stroke in the direction of the second chamber. This means was formed by a duct made in the piston and a valve mounted in said duct and providing for gradual flow of the compressed gas from the tank into the first chamber of the cylinder until the piston opened the ports communicating the compressed gas tank with the first chamber, whereupon its acceleration was started. During the slowed-down motion of the piston the movable member opened completely the drain apertures so that the piston could be freely accelerated and deliver an impact upon the liquid contained in the second chamber.

The slowed-down motion decreased the number of impacts the piston delivered per unit time and, consequently, the efficiency of the device.

The principal object of the invention is to increase the efficiency of the device, i.e., to increase the number of impacts delivered by the piston per unit time by way of improving the locking mechanism.

It is another object of the invention to simplify the design of the device and to make it more reliable in operation.

According to the invention the proposed improvement consists in that the device of the invention is provided with a means adapted for the initial opening of drain apertures by a movable member to the moment the piston moves towards the second chamber, and with a means providing for the full opening of the drain apertures by the movable member under the effect of the flow of liquid forced out of the cylinder space during the piston travel towards the second chamber.

The proposed technical solution provides for automatic opening of the drain apertures synchronously with the piston travel owing to the repulsion of the movable member by the liquid forced by the piston out of the cylinder space during the working stroke.

It is preferable that the means providing for the full opening of the drain apertures by the movable member be essentially a flange provided on said member and arranged with a gap in a cylindrical recess in the locking mechanism body, and a main space provided in said body, said space being opened at the side of the flange and periodically discommunicated from the drain apertures of the cylinder by the movable member.

In one embodiment of the invention the means adapted for in the initial opening of the drain apertures by the movable member is formed by an auxiliary space in the body of the locking mechanism, communicated with the pressure main and adapted to receive the butt end portion of the movable member, said auxiliary space being in constant communication with the main space in the body of the locking mechanism.

In another embodiment of the invention the last described means is formed by a cross member connected by rods to the movable member, abutting the rear portion of the cylinder and having a projection entering the first chamber of the cylinder and cooperating with the piston at the end of its reverse stroke after an impact.

The following description of possible embodiments of the present invention is given with reference to the accompanying drawings, in which:

FIG. 1 shows a longitudinal section of the proposed device, in which the body of the locking mechanism has a main and an auxiliary spaces;

FIG. 2 shows a longitudinal section of the proposed device, in which the movable member of the locking mechanism is connected by rods with a movable cross member;

FIG. 3 is an enlarged partial view of the longitudinal section of the locking mechanism of the device, as shown in FIG. 1.

As shown in FIGS. 1 and 2, the proposed device comprises a cylinder 1 housing a piston 2 dividing the space of the latter into the two chambers 3 and 4. The first, low-pressure, chamber 3 is communicated through ports 5 with tanks 6 containing compressed gas, said tanks 6 being secured to the cylinder 1. The other, high-pressure, chamber 4 filled up with liquid has an aperture 8 provided in the face wall 7 of the cylinder 1 and designed for the outlet of pressurized liquid after an impact has been delivered thereupon by the piston 2 advancing for the purpose under the action of the compressed gas in the first chamber 3.

The piston 2 has a projection 9 by which it enters the second chamber 4 and delivers an impact upon the liquid.

To bring the piston 2 back to its initial position after an impact has been delivered, supplied into the space of the cylinder 1 between the chamber 4 and the piston 2 is pressurized liquid fed by a pump 10 via a main 11 and through apertures 12 made in the sidewall of the cylinder 1, which apertures are overlapped by a spring-biased movable member 13 of a locking mechanism 14 after the piston 2 has delivered an impact upon the liquid contained in the chamber 4 and opened by said member 13 at the end of the piston 2 reverse stroke after an impact.

The space of the cylinder 1, disposed before the piston 2, is constantly communicated with the main 11 via a gap 15 between the body of the locking mechanism 14 and the cylinder 1; periodical discommunication thereof is inex-

pedient as the time required for acceleration of the piston 2 and for delivering an impact upon the liquid is insignificant as compared to the time of the working cycle.

Springs 16 displace the member 13 for overlapping the apertures 12 only.

During the piston reverse stroke the liquid from the space of the cylinder 1 enters the chamber 4, in which case the aperture 8 in the latter is overlapped either by a turnable flap 17 (FIG. 1) connected by a rod 18 with the movable member 13 of the mechanism 14, or by a flap 19 (FIG. 2) which is alternately actuated by a hydraulic 20 and a pneumatic 21 cylinders connected with the main 11 supplying the liquid and with the tank 6 containing compressed gas, respectively.

As has been stated above, the improvement in the devices described herein relates to the locking mechanism 14.

In accordance with FIG. 3, the movable member 13 of the locking mechanism 14 is provided with flange 22 disposed in a cylindrical recess 23 of the mechanism body 24 and forming together with the latter an annular gap 25.

Provided in the body 24 is a space 26 open at the side of the flange 22 and periodically communicated with the space of the cylinder 1 via the aperture 12. Besides, the body 24 of the locking mechanism 14 is provided with an auxiliary space 27 periodically communicating with the pressure main 11, the butt end portion 28 of the movable member 13 entering said auxiliary space 27 which is in constant communication via an annular clearance 29 with the space 26 and, hence, with the atmosphere.

When made as described above, the locking mechanism 14 operates in the following manner.

When supplied from the main 11 into the space 27, with the piston 2 disposed after an impact in its extreme rear position in the chamber 3 the liquid acts upon the butt end portion 28 of the member 13 and provides for the beginning of motion of the member 13, whereupon the piston 2 starts displacing in the cylinder 1 under the action of compressed gas in the chamber 3, thus forcing out the liquid disposed before it in the cylinder space.

With the liquid forced out by the piston 2 acting upon the butt end portion 28 of the movable member 13, the latter gradually displaces, overcoming the force of the springs 16. As soon as the butt end portion 28 of the member 13, enters the space 26 which, as a result, is communicated with the drain apertures 12, the liquid additionally acts upon the flange 22 making the member 13 displace quickly and open completely the apertures 12. With the flange 22 having left completely the cylindrical recess 23, there takes place gravity drainage of the liquid forced out of the cylinder space by the piston 2, and the piston 2 is accelerated freely by the compressed gas.

The member 13 is held by the flow of the liquid being drained in its extreme right position and compresses the springs 16. Then, after the piston has delivered an impact upon the liquid in the chamber 4, the flow of the liquid being drained is sharply decreased and the member 13 overlaps the apertures 12 under the action of the springs 16. To preclude hydraulic impacts and vibration of the movable member 13 while it is being moved to close the apertures 12, the cylindrical recess 23 made in the body 24 turns into a cone-shaped recess 30, and, therefore, with the member 13 moving, the gap 25 gradually decreases due to a decrease of the flow of the liquid drained out of the space of the cylinder, the liquid forced from the space 26 being drained via the gap 25. The butt end portion 28 of the member 13 is tightly pressed against the body 24 due to the liquid acting upon an inner annular recess 31 of the member 13, whose diameter is greater than that of a packing flange 32 provided on the butt end portion 28.

The auxiliary space 27 is periodically communicated with the pressure main 11 by means of a valve 33 (FIG. 1), which is actuated at the end of the piston 2 reverse stroke when the latter thrusts against the face wall of the cylinder 1 at the side of the chamber 3.

As soon as the piston 2 thrusts against the wall, the pressure of the liquid in the main 11 immediately rises, since it is supplied into a closed volume (the space of the cylinder 1 before the piston 2). As a result of this, the plunger 34 of the valve 33 communicates the main 11 with the space 27.

The pressure level for actuating the valve 33 should be higher than that of possible accidental pressure jumps in the main 11 during the working cycle.

The auxiliary space 27 may be dispensed with. For instance, the locking mechanism 14 may be fashioned in such a manner that the butt end portion 28 of its movable member 13 be in the main space 26 at the moment the apertures 12 are overlapped by this member.

The initial motion of the movable member 13 may be provided by other means as well. As shown in FIG. 2, the movable member 13 is connected for this purpose by rods 35 with a cross member 36 which abuts the face wall of the cylinder 1 at the side of the chamber 3 and has projection 37 entering said chamber. At the end of the piston 2 reverse stroke, after it has delivered an impact upon the liquid, the piston 2 acts upon the projection 37, thus making the cross member 36 displace together with the movable member 13 connected therewith. Then, the locking mechanism 14 operates in the aforedescribed manner and does not require the valve 33 as the initial motion of the member 13 is provided for by the piston 2 proper.

The rod 35 should be made from two split portions 38 and 39, the portion 38 having guide 40 provided at the end thereof and made as a frame in which a slide 41 secured to the end of the portion 39 moves. This design makes it possible for the movable member 13 to move freely after the beginning of its motion irrespective of the stroke of the cross member 35.

The device made in accordance with the present invention provides for a more stable and efficient operation and does not require high skill on the part of the personnel.

What we claim is:

-. A device for building up high-pressure impulse jets of liquid, comprising a tank containing compressed gas; a cylinder defining an interior space; a piston disposed in said cylinder and dividing said space into two chambers, of which the first chamber is in communication with said tank containing compressed gas and the second chamber is filled with liquid and has an aperture for the outlet of pressurized liquid after an impact has been delivered thereupon by said piston in response to acceleration thereof by compressed gas in the first chamber; a pressure main supplying pressurized liquid into the space of said cylinder to convey the piston so as to decrease the volume of the first chamber after an impact; said cylinder having apertures in a sidewall thereof for draining liquid from the cylinder space during piston displacement in the direction of the second chamber; a locking mechanism with a movable member for overlapping said drain apertures, said mechanism being actuated at the end of the piston reverse stroke after an impact; means adapted for the initial opening of said drain apertures through the movable member when said piston is in the extreme rear position in said first chamber; means providing for the full opening of said drain apertures through the movable member in response to the flow of liquid forced out of the cylinder space during piston travel towards said second chamber; and means for moving said movable member so as to close said drain apertures upon the piston delivering an impact upon the liquid.

2. A device as claimed in claim 1, wherein the means providing for the full opening of the drain apertures by the movable member is essentially a flange provided on said member and arranged with a gap in a cylindrical recess in the locking mechanism body, and a main space provided in said body, said space being opened at the side of said flange and periodically discommunicated from the drain apertures in the sidewall of the cylinder by said movable member.

3. A device as claimed in claims 2, wherein the means adapted for the initial opening of the drain apertures by the movable member is formed by an auxiliary space in the body

of the locking mechanism, communicated with the pressure main and adapted to receive the butt end portion of said movable member, said auxiliary space being in constant communication with said main space in the body of the locking mechanism.

4. A device as claimed in claim 1, wherein the means adapted for the initial opening of the drain apertures by the movable member is formed by a cross member connected by rods to said movable member, abutting the rear portion of the cylinder and having a projection entering the first chamber of the cylinder and cooperating with the piston at the end of its reverse stroke after an impact.

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