

[54] **IMPACT TOOL**

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[58] Field of Search..... 173/119, 120, 134-138;
91/4 R, 5, 309

[56] **References Cited**

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[57] **ABSTRACT**

An impact tool operated by high pressure fluid has a

main piston fitted into a main cylinder, the upper chamber of the main cylinder being filled with gas of predetermined pressure. A liquid chamber for containing liquid for pressing the main piston upward by liquid pressure is provided between the lower half of the main piston and the main cylinder. A limit valve is provided in the upper part of the main cylinder, the limit valve being activated when the main piston is elevated adjacent to the upper limit thereof so that the liquid pressure source and the liquid chamber within the main cylinder are disconnected from each other by valve means provided on one side of the main cylinder activated by the gas pressure in the upper chamber of the main cylinder and the liquid chamber is placed in communication with the liquid outlet. On the lower end of the main cylinder is fitted a tool, such as a chisel and the like, which is struck by the main piston when the main piston is driven down by the gas compressed in the upper part of the main cylinder by the raising of the main piston.

1 Claim, 3 Drawing Figures

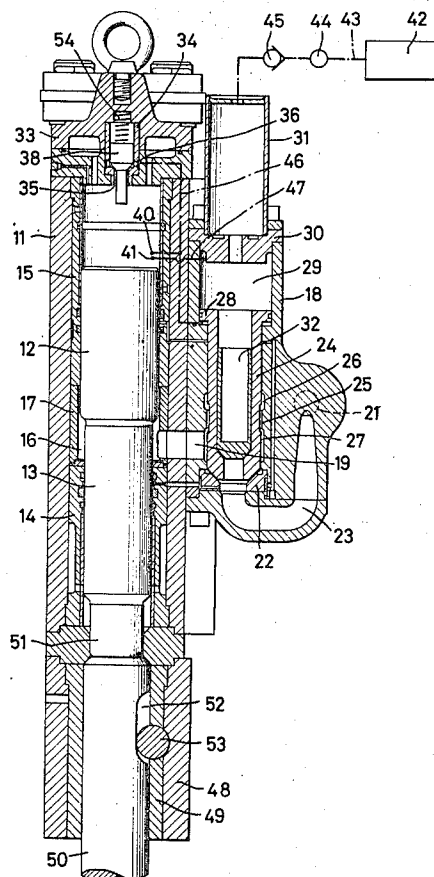


FIG. 1

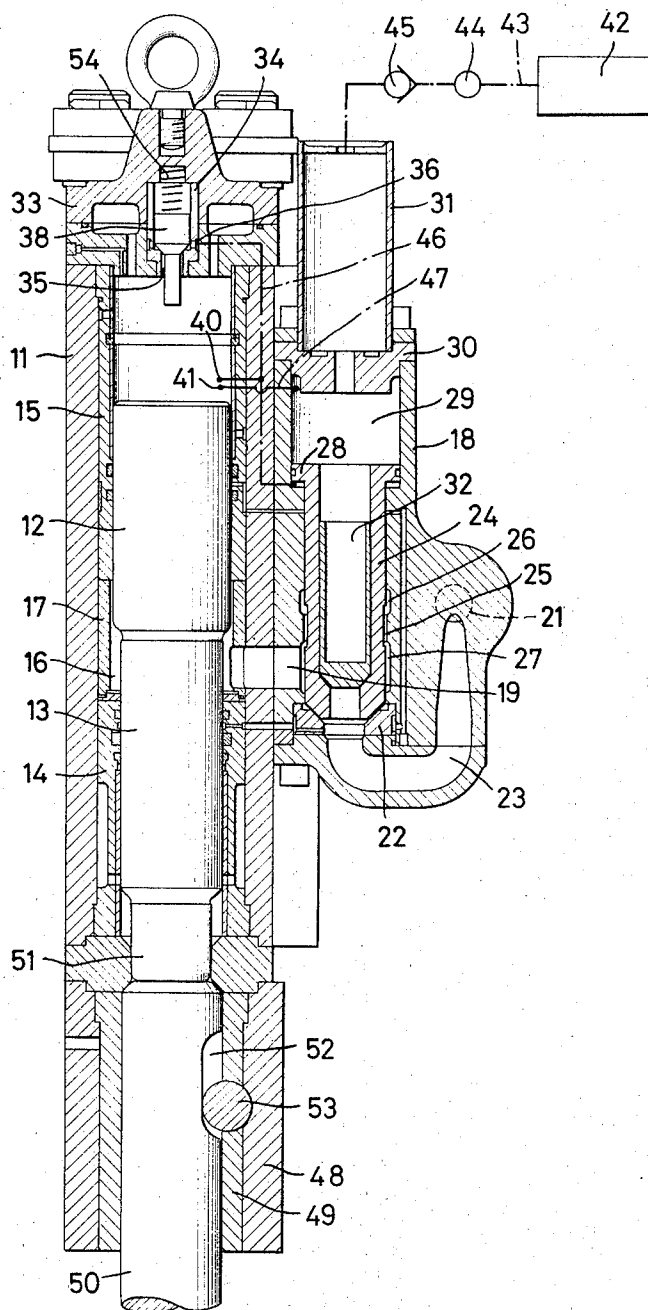


FIG. 2

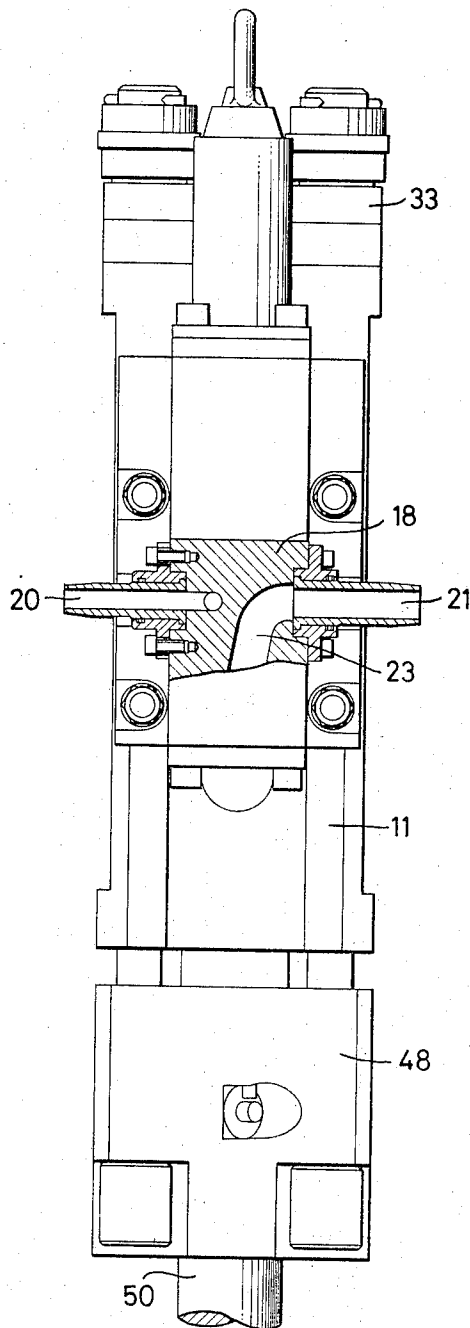
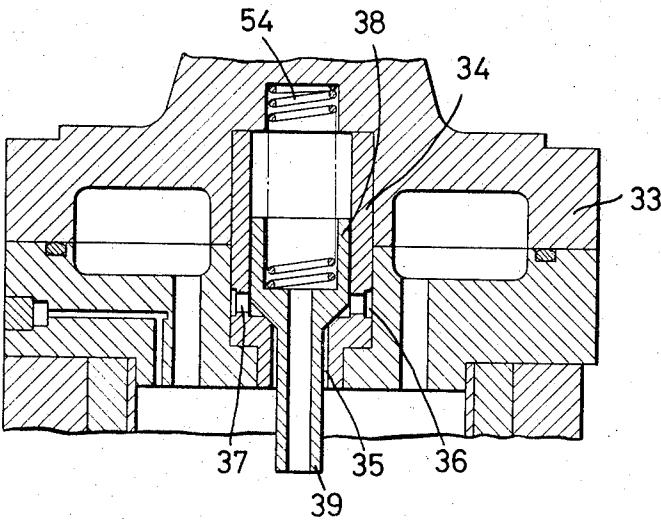


FIG. 3



1 IMPACT TOOL

This invention relates to improvements of impact tools, and more particularly to an impact tool operable by means of high pressure gas and liquid pressure.

The conventional impact tools, such as a pneumatic hammer and the like, were operated by compressed air alone. Consequently, the exhaust discharged directly to the outside was the cause of the production of loud noises together with the percussion noise of the piston and the chisel or the like. Moreover, since the compressed air was completely discharged into the atmosphere, the compressor had to be in constant operation during the use of the tool resulting not only in the production of a continuous noise but also in waste of energy.

An object of this invention is to obviate the foregoing defects of the conventional impact tools by obtaining the power source from liquid pressure, such as oil pressure and the like, a piston being elevated by the liquid pressure so as to compress gas, the piston being lowered by the force of resitution of the compressed gas thereby making it possible to increase the impact of the piston by making use of the rapidity of action which is characteristic of gas, the gas being confined in a closed circuit thereby making it possible to limit the gas consumption to a small leakage during the circulation, with the result that the impact tool of this invention is free from the conventional compressor, and consequently from the exhaust noise thereof.

More specifically, it is an object of the invention to provide a liquid pressure relief means in such an impact tool.

This and other objects are accomplished by the parts, improvements, combinations and arrangements constituting this invention, a preferred embodiment of which is shown by way of example in the annexed drawings and herein described in detail. Various modifications and changes in details of construction are comprehended within the scope of the appended claims.

FIG. 1 is a longitudinal, sectional elevation showing an embodiment of an impact tool according to this invention, in which the lower end of the chisel is cut off.

FIG. 2 is a side elevation of the same, longitudinally sectional in part, the lower end of the chisel being cut off.

FIG. 3 is a longitudinal section, on a magnified scale, of a limit valve at the upper end of the impact tool of this invention.

In the drawings, the numeral 11 designates a main cylinder, the numeral 12 designating a main piston, of which the lower half comprises a smaller diameter portion 13, the smaller diameter portion 13 being slidably fitted into a bushing 14 fitted to the inside of the lower portion of the main cylinder 11, a liquid chamber 16 being formed on the inside of a bushing 17 fitted between the smaller diameter portion 13 and a bushing 15 fitted into the main cylinder 11. The numeral 18 designates a valve casing secured to one side of the main cylinder 11, a liquid hole 19 being provided so as to connect the inside of the valve casing 18 to the liquid chamber 16.

A liquid inlet 20 and a liquid outlet 21 are formed on the outside of the middle portion of the valve casing 18. To the lower end of the inside of the valve casing 18 is secured an annular valve stop 22 of which the upper face constitutes a valve seat, the inside of the stop 22

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communicating with the liquid outlet 21 through a hole 23.

The numeral 24 designates a main valve body elevatably fitted into the valve casing 18, a broad peripheral groove 25 being formed slightly below the middle portion of the main valve body 24. On the interior periphery of the valve casing 18 are horizontally formed a narrow peripheral groove 26 and a broad peripheral groove 27 so as to extend over the entire periphery thereof which is brought into contact with the main valve body 24, the peripheral groove 27 communicating with the hole 19. The peripheral groove 26 communicates with the liquid inlet 20. When the tapering lower end of the valve body 24 abuts on the valve seat on the stop 22, the hole 23 and the peripheral groove 27 are blocked off from each other, the peripheral groove 25 of the main valve body 24 being adapted to cause the peripheral grooves 26, 27 within the valve casing 18 to communicate with each other. When the main valve body 24 is elevated, the peripheral groove 26 is blocked off from the peripheral groove 27 by the lower exterior periphery of said main valve body 24, the peripheral groove 27 communicating with the hole 23.

On the exterior periphery of the upper end of the main valve body 24 is integrally formed a valve piston 28, the valve piston 28 being fitted into a piston chamber 29 on the upper inside of the valve casing 18. A gas reservoir 31 is provided on a top lid 30 secured to the upper end of the piston chamber 29 so as to communicate with said piston chamber 29. The main valve body 24 is in the shape of a cylinder open at the upper and lower ends thereof, a subsidiary valve body 32 being slidably fitted within said main valve body 24.

A bushing 34 is secured to a vertical hole formed to a predetermined depth from the lower part of the center of a cap 33 mounted on the upper end of the main cylinder 11, a valve gate 35 of a diameter smaller than the bore of the bushing 34 being formed at the lower end of said bushing 34 so as to communicate with the inside of the main cylinder 11. On the lower exterior periphery of the bushing 34 is formed a peripheral groove 36 above the valve gate 35, the peripheral groove 36 being adapted to communicate with the inside of the bushing 34 through a plurality of holes 37. Within the bushing 34 is slidably fitted a limit valve 38, a tubular projection 39 at the lower end of the limit valve 38 being loosely fitted into the valve gate 35 so as to project into the main cylinder 11. The limit valve 38 is provided with a hole extending through the center thereof, a spring 54 for bringing the limit valve 38 into pressure contact with the valve seat at the upper end of the valve gate 35 being mounted between said limit valve 38 and the cap 33.

Two openings, 40, 41 are provided within the main cylinder 11 each at a location slightly above the top surface of the main piston 12 when lowered to its lowest limit, the opening 40 being adapted to communicate with the lower end of the piston chamber 29 and the peripheral groove 36 by means of a hole 46. The opening 41 is adapted to communicate with the upper part of the piston chamber 29 by means of a hole 47.

The numeral 42 designates a gas cylinder containing compressed nitrogen gas or the like. The gas cylinder 42 is adapted to communicate with the gas reservoir 31 through an air-pipe 43, the air-pipe 43 being provided with a depressor valve 44 and an arrest valve 45 for

precluding an inverse flow of the gas to the gas cylinder 42.

The numeral 48 designates a tubular chisel holder connected to the lower end of the main cylinder 11, a chisel 50 being slidably fitted into a bushing 49 secured within the holder 48. The upper end of the chisel 50 is opposed to the lower end of an impact member 51 which has a still smaller diameter portion at the lower end of the smaller diameter portion 13 of the main piston 12. A notch 52 is formed on one side of the chisel 50, a pin 53 engageable with the notch 52 being fitted to the chisel holder 48 thereby making it possible to limit the scope of reciprocation of the chisel 50. Furthermore, the liquid inlet 20 is adapted to communicate with the jet of a liquid compressor through a pipe, a control valve being provided on said pipe thereby making it possible to freely switch over from the state in which liquid pressure is applied to the liquid inlet 20 to the state in which said liquid inlet 20 is free from the liquid pressure. The liquid outlet 21 is connected to a liquid tank through a pipe.

The operation of the foregoing embodiment will hereinunder be described in detail with reference to the annexed drawings.

The drawings illustrate the state in which the liquid inlet 20 is free from the liquid pressure. In this state, the gas pressure from the gas cylinder 42 is applied through the gas reservoir 31 to the upper chamber within the main cylinder 11 by way of the piston chamber 29, the hole 47 and the opening 41, and simultaneously to the peripheral groove 36 and the lower end of the piston chamber 29 by way of the opening 40 and the hole 46. However, the limit valve 38 is pressed downward by a spring 54 thereby closing the valve gate 35, the main valve body 24 being pressed downward by the gas pressure due to difference between the upper and lower areas of the valve piston 28, the subsidiary valve body 32 being also pressed downward.

Now, if a liquid, such as oil and the like, of pressure higher than the gas pressure in the upper chamber of the main cylinder 11 is fed into the liquid inlet 20, said liquid travels to the liquid chamber 16 by way of the peripheral grooves 26, 25, 27, and the hole 19 in the order named thereby applying liquid pressure to the shoulder portion of the main piston 12. Consequently, upward pressure is applied to the main piston 12, the main piston 12 being elevated since said upward pressure is far greater than the downward pressure of the gas pressing the main piston downward. When the elevated main piston 12 closes the openings 40, 41, the gas trapped within the upper chamber of the main cylinder 11 is strongly compressed as the main piston 12 is elevated.

If the main piston 12 is further elevated and presses upward the projection 39 of the limit valve 38, the valve gate 35 so far closed by the limit valve 38 is released, the high pressure gas within the upper chamber of the main cylinder 11 travelling to the lower end of the piston chamber 29 by way of the valve gate 35, the hole 37, the peripheral groove 36 and the hole 46 in the order named thereby applying strong pressure to the lower portion of the valve piston 28, with the result that the main valve body 24 is pressed upward until the lower end thereof is separated from the valve stopper 22. Simultaneously, the peripheral groove 27 is blocked off from the peripheral groove 26 on the lower exterior periphery of the main valve body 24, whereby

the liquid inlet 20 and the hole 19 are blocked off from each other, thus said hole 19 communicating with the hole 23 from within the valve stopper 22. As a result, the liquid within the liquid chamber 16 travels to the liquid outlet 21 by way of the hole 19, the valve stopper 22 and the hole 23 in the order named, thus the liquid being restored in the tank. The liquid is discharged speedily since the foregoing discharge route is adapted to have a maximum width so as to minimize the circulation resistance of the liquid. The main piston 12 is lowered quickly by the high pressure gas within the upper chamber of the main cylinder 11 with the result that the upper end of the chisel 50 is struck by the impact member 51 fitted to the lower end of said main piston 12.

When the upper face of the main piston 12 is located below the opening 40, the upper chamber within the main cylinder 11 is expanded, whereby the gas pressure is restored to the normal pressure, the gas pressure in the lower part of the piston chamber 29 being also restored to the normal pressure, with the result that the main valve body 24 is lowered, the limit valve 38 being restored to its initial position thereby closing the valve gate 35.

If the main valve body 24 is lowered until its lower end is brought into contact with the valve seat on the valve stopper 22, the peripheral groove 25 causes the upper and lower peripheral grooves 26, 27 to communicate with each other, the liquid from the liquid inlet 20 flowing into the liquid chamber 16 again thereby pressing the main piston 12 upward. The foregoing action is repeated while the liquid pressure is applied to the liquid inlet 20, as a result of which the main piston 12 is elevated, the upper end of the chisel 50 being struck by the impact member 51, thereby making it possible to perform the required operation.

If the main valve body 24 is elevated and the exhaust liquid pressure is abnormally raised, the subsidiary valve body 32 is elevated so as to perform a damping action.

Since the gas circuit is closed, the gas is simple subject to continued repetition of compression and expansion without any appreciable consumption. Leakage of gas, if any, during the circulation is replenished by a refill from the gas cylinder 42. The limit valve 38 in the foregoing embodiment is opened when the projection 39 thereof is pressed upward by the upper end of the main piston 12. However, it may be so adapted that the limit valve 38 is pressed upward when the gas pressure in the upper chamber of the cylinder 11 is raised over the predetermined value with the elevation of the main piston 12.

What is claimed is:

1. In an impact motive implement having a main cylinder having a larger diameter upper portion and a smaller diameter lower portion, a main piston in said main cylinder having a larger diameter upper portion slidable in the upper portion of the cylinder and a smaller diameter lower portion slidable in the lower portion of the main cylinder, a tool holder on the lower end of said main cylinder and an impact tool mounted in said tool holder and against the upper end of which the lower end of the lower piston portion strikes when the main piston is lowered, said main cylinder having a liquid port opening into said lower portion of said main cylinder at a point below said lower portion of said main piston when said main piston is in the lowermost position in said main cylinder, a valve casing on

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said main cylinder having a liquid port communication with said liquid port in said main cylinder and further having a liquid inlet port and a liquid outlet port, a compressed gas operated main valve slidable in said valve casing between a first position in which it blocks off communication between said liquid port communicating with said main cylinder and said liquid inlet port and a second position in which it blocks off communication between said liquid port communicating with said main cylinder and said liquid outlet port, said main cylinder having a passage therethrough from said upper portion of said main cylinder to a position of said valve casing for supplying compressed gas thereto for actuating said main valve for moving it to said first position,

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limiting valve means in said passage and engageable by the upper portion of said main piston near the upper limit of its movement for opening said limiting valve means, and a source of compressed gas connected to said valve casing for supplying compressed gas for urging said main valve toward said second position, the improvement comprising a subsidiary valve body, said main valve having a recess therein exposed to the space within said valve casing through which the liquid flows from the main cylinder to said outlet port, said subsidiary valve body being slidable in said recess in response to overpressure in said space to relieve said overpressure.

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