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[54] **METHOD FOR ACCOMPLISHING A HIGH DRIVING FORCE AT A COMBUSTION GAS DRIVEN IMPACT DEVICE AND AN IMPACT DEVICE FOR CARRYING OUT OF SAID METHOD**

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[51] **Int. Cl.** **F02b 71/00**

[58] **Field of Search** ..... 123/46 R, 46 SC, 46 A, 123/46 H; 173/134; 60/26.1

[56] **References Cited**

UNITED STATES PATENTS

2,208,730	7/1940	Pfeiffer	173/134
2,273,095	2/1942	Fitch	173/134
2,402,920	6/1946	Seibold	60/26.1
3,105,153	9/1963	James	123/46
3,161,184	12/1964	Koftan	123/46 H
3,253,399	5/1966	Bakhtar et al.	60/26.1
3,320,740	5/1967	Hamkins	60/26.1
3,468,222	9/1969	Cordes et al.	173/134

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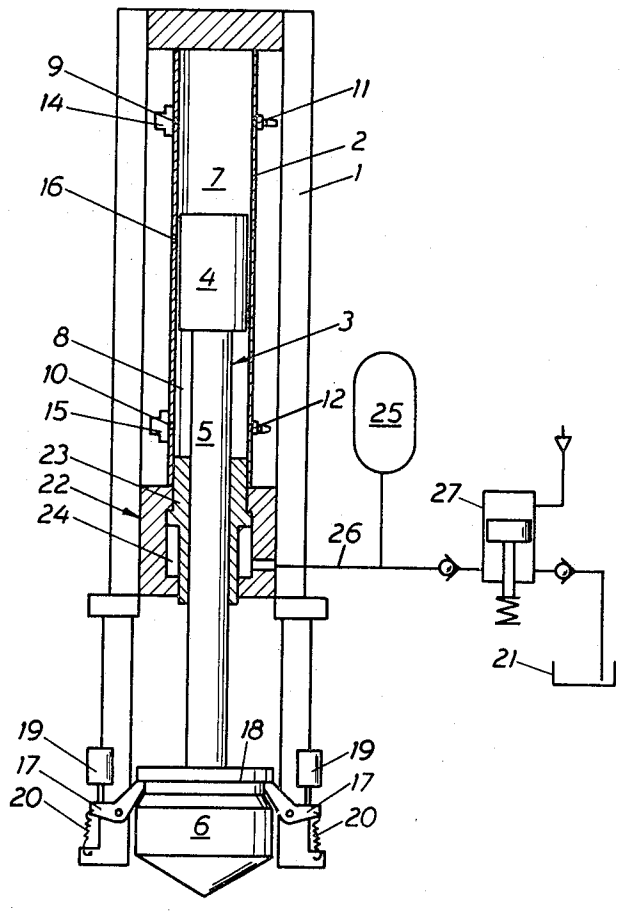
[57] **ABSTRACT**

A method and a device for obtaining high energy impacts mainly for demolishing purposes. In a piston-cylinder device, the cylinder is charged with pressurized combustible gas at both sides of the piston and a rearwardly directed compression stroke is initiated by ignition of the gas volume at the forward end of the piston. At a certain pressure, the compressed gas volume within the rear end of the cylinder is ignited and a forwardly directed working stroke is initiated. The device comprises a gas supply system and two ignition systems, one of which is manually controlled for the compression stroke initiating and the other is a pressure sensitive automatic system for the working stroke initiating. The impact device also comprises a retarding device by which kinetic energy is absorbed from the piston unit at the end of the working strokes.

8 Claims, 3 Drawing Figures



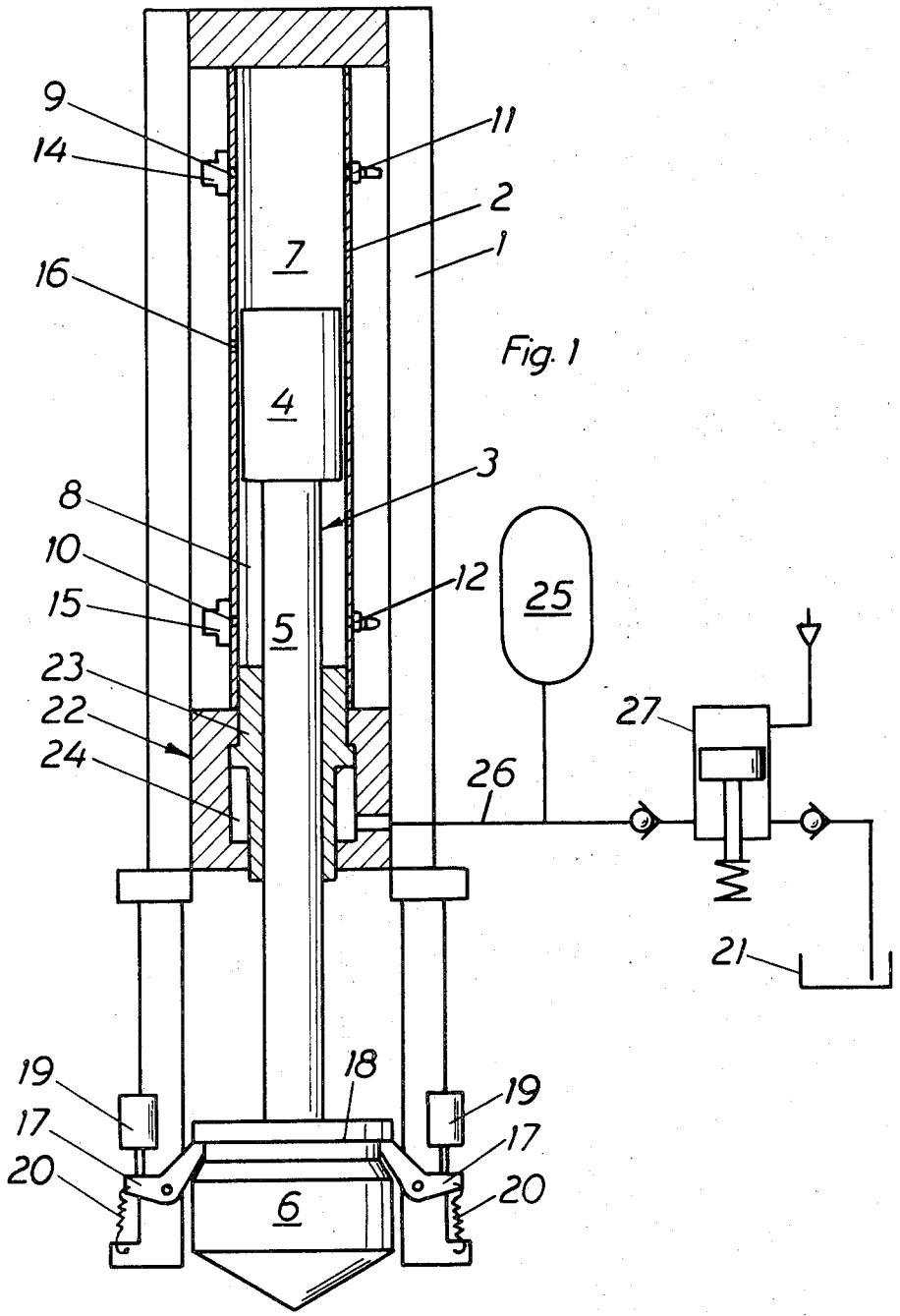
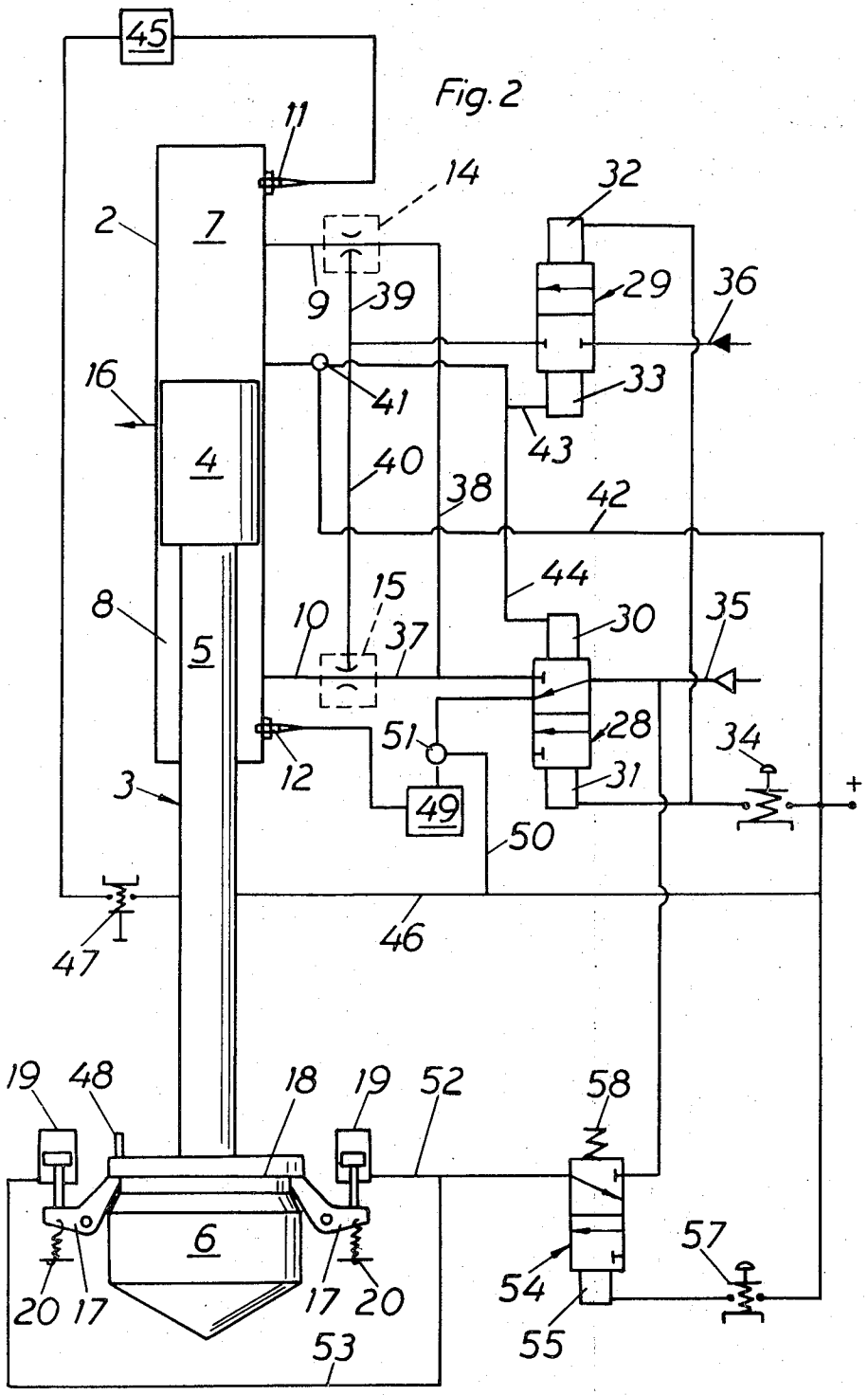


Fig. 1

Fig. 2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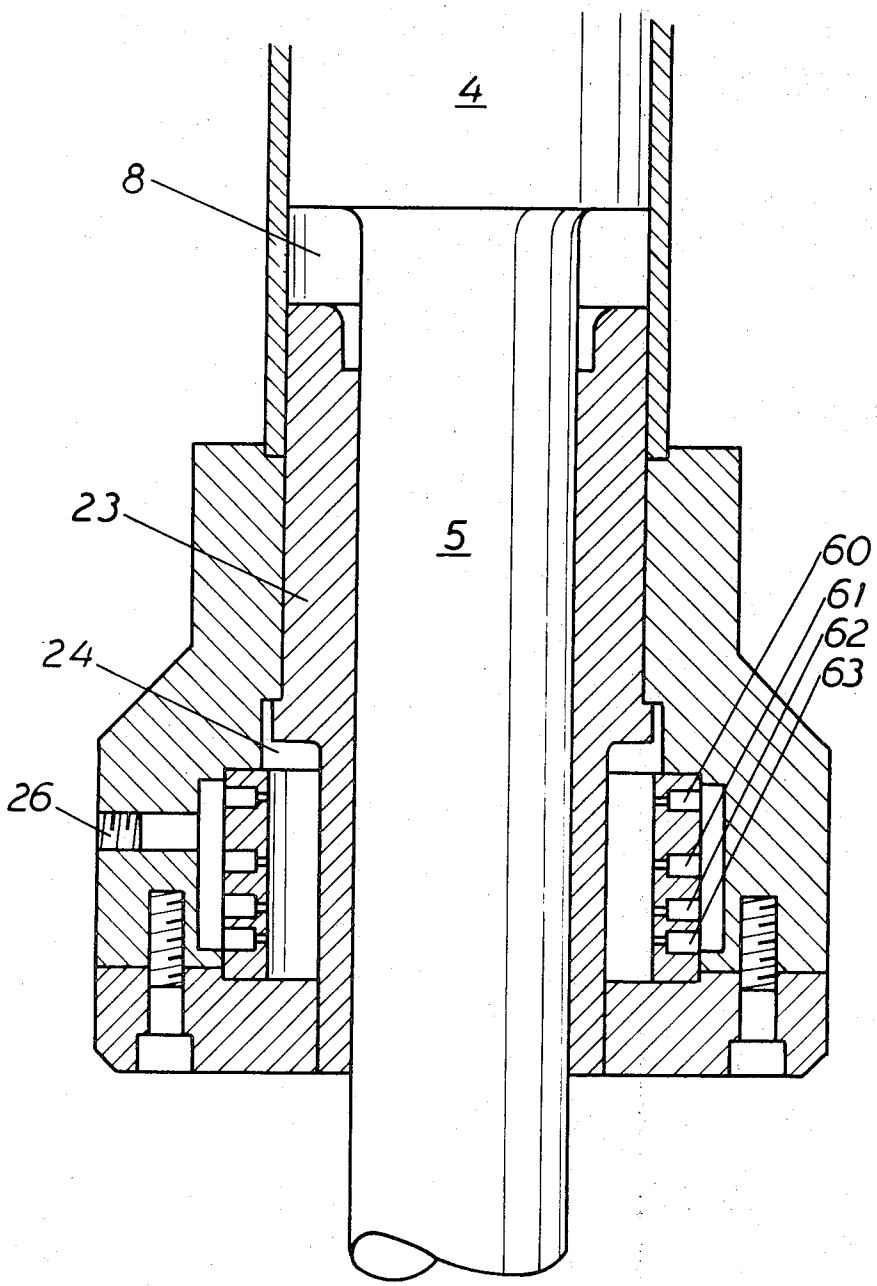

Fig. 3

METHOD FOR ACCOMPLISHING A HIGH DRIVING FORCE AT A COMBUSTION GAS DRIVEN IMPACT DEVICE AND AN IMPACT DEVICE FOR CARRYING OUT OF SAID METHOD

This invention relates to a method for accomplishing a large driving force at a combustion gas driven impact device as well as an impact device for carrying out of said method. The object of the invention is to make an impact device develop a considerable amount of energy at each working stroke.

The invention intends to solve the problems concerned with demolition of reinforced concrete constructions as foundations, houses, roads and bridges. Such jobs are very time consuming and difficult to carry out. One way of making such jobs faster and more rational would be to demolish the constructions by applying a limited number of high power strokes thereon. However, there has not been any impact devices available which develop sufficient high impact energy and which are suitable for practical use.

Another object of the invention is to obtain impact strokes the energy of which are large enough to perform a complete cold forging operation in one stroke.

These problems are solved by the method and the impact device as they are stated in the claims.

The invention is herebelow described with reference to the drawings on which

FIG. 1 shows partly in section a longitudinal section through an impact device adapted to the method according to the invention.

FIG. 2 shows schematically an impact device according to the invention and the pneumatic and electric control circuits connected thereto.

FIG. 3 shows, in larger scale, a longitudinal section through a hydraulic retarding device which constitutes a part of the impact device according to FIG. 1.

The impact device shown in FIG. 1 comprises a main frame 1, a cylinder housing 2 and a piston unit 3. The latter comprises a piston 4, a piston rod 5 and a tool 6 connected to the forward end of the piston rod 5. The cylinder housing 2 has a rear combustion chamber 7 and a forward combustion chamber 8 which both are provided with inlet openings 9 and 10, respectively, which are intended for supplying the combustion chambers with combustible gas. The combustion chambers 7 and 8 are also provided with spark plugs 11 and 12, respectively. To the inlet openings 9 and 10, there are connected mixture nozzles 14 and 15. The two combustion chambers 7 and 8 have in common an outlet opening 16 for draining of the cylinder housing 2. Moreover, the main frame 1 is provided with two latch dogs 17 which are pivotable between a rest position and a position in which they are in positive engagement with a flange 18 on the tool 6. The latch dogs 17 are pivoted toward their engagement positions by means of pneumatic cylinders 19 and to their rest positions by means of tension springs 20.

Furthermore, the impact device is provide with a hydraulic retarding device 22, consisting of an annular piston 23 and a cylinder chamber 24. The piston 23 is freely movable relative to the piston rod 5 and arranged so as to be struck by the piston 4 at the end of the working stroke. The cylinder chamber 24 is connected to a pressure accumulator 25 and a pneumatically driven hydraulic pump 27. The latter is connected to a tank 21.

In FIG. 2 there is shown ignition and combustible gas supply systems for an impact device according to the invention. Petrol enriched compressed air may very well be used as combustible gas. The pressure air supply is controlled by an electrically operated valve 28 and petrol is supplied through a valve 29 of the same type. The valves 28 and 29 are both provided with electromagnetic control means 30, 31 and 32, 33. These control means are connected to a current source via a common switch 34. The valve 28 is supplied with compressed air through a conduit 35 and the valve 29 is supplied with petrol through a conduit 36. The petrol pressure is preferably a bit higher than that of the air. The down-stream end of the air valve 28 is connected to the mixture nozzles 14 and 15 through conduits 37 and 38, respectively, while the down-stream end of the petrol valve is connected to the mixture nozzles through conduits 39 and 40.

The control system of the impact device comprises a pressure switch 41 which is connected to the combustion chamber 7. The electric circuit comprising the control means of the valves 28, 29 is arranged to be closed by the switch 41 as a predetermined pressure is obtained in the cylinder housing 2. Thereby, petrol and pressure air supply to the cylinder housing is interrupted. The pressure switch 41 is connected to the current source through a line 42 and to the control means 33 and 30 by conduits 43 and 44.

Moreover, the impact device is provided with an ignition device 45 for supplying high tension current to the spark plug 11 of the rear combustion chamber 7. The ignition device 45 is in turn connected to the current source via a line 46 and a switch 47. The switch 47 is actuated by a heel 48 on the tool 6.

The control system comprises an ignition device 49 for supplying high tension current to the spark plug 12 of the forward combustion chamber 8. This ignition device 49 is connected to the current source through line 50 and a pressure switch 51. The latter is connectible to the pressure air source by means of the pressure air valve 28.

Finally, the impact device is provided with a control system for actuating the latch dogs 17. They are pivotable toward their engagement position by means of the pneumatic cylinders 19. These are pressurized by the pressure air source through conduits 52, 53 and an electrically shiftable valve 54. The valve 54 is provided with electric manoeuver means 55 which are supplied with electric current from the current source through a line 56 and a switch 57. The valve 54 is shifted in one direction by means of the manoeuver means 55 and in the opposite direction by a spring 58.

The electric control system is connected to earth through the machine and because of that only one of its poles is shown in FIG. 2.

The cylinder chamber 24 of the hydraulic retarding device 22 comprises a number of outlet openings 60, 61, 62 and 63 which are disposed at different levels. During its forward directed movement, the piston 23 successively register with one after the other of these holes. As all of the openings 60–63 communicate with the conduit 26, the total outlet area of the cylinder chamber 24 is restricted as the piston covers them, whereby a retarding force is obtained.

The operation order of the impact device shown in the drawings is the following,

Before the working cycle is started, the piston unit 3 is fixed in a start position (see FIGS. 1 and 2). The piston unit 3 is locked in this position in that the switch 57 is shifted so that the manoeuver means 55 is supplied with current and shifts the valve 54 against the biasing force of the spring 58. Compressed air is now able to pass through the valve 54 and activate the cylinders 19 so that they, against the biasing force of the springs 20, pivot the latch dogs 17 toward their active positions in which they cooperates with the flange 18 of the tool 6. The switch 57, which is spring biased to its non-active position, may now break the electric circuit. Despite that, the latch dogs 17 are still kept in their locking positions because of the fact that the piston unit 3 rests upon them with all its weight. As the piston unit 3 has been fixed in its start position, the switch 34 is shifted so that the activating means 31 and 32 of the valves 28, 29 are fed with electric current. Then the valves 28, 29 are shifted so that pressure air and petrol are supplied to the mixture nozzles 14, and 15 through the conduits 37, 38 and 39, 40.

Because of the fact that the piston 4 covers the outlet opening 16 in its start position, a charge pressure is built up in both of the combustion chambers 7 and 8 of the cylinder housing 2. When full pressure is obtained, the pressure switch 41 is shifted so that the activating means 30 and 33 of the valves 28, 29 are supplied with electric current. The valves 28 and 29 are then shifted so that the air-petrol supply to the cylinder housing 2 is interrupted. On the contrary, the valve 28 directs pressure air to the pressure switch 51 which in turn connects the ignition device 49 to the electric current source. The ignition device 49 accomplishes a spark upon the spark plug 12 so that the petrol enriched pressure air in the forward combustion chamber 8 is ignited.

Due to the combustion within the forward combustion chamber 8, the piston unit 3 is accelerated into a rearwardly directed compression stroke. Immediately, the tension springs 20 return the latch dogs 17 to their rest positions. The combustible gas, enclosed in the rear combustion chamber 7, is now compressed. When the piston 4 gets close to its rear end position the outlet opening 16 is uncovered so that the forward combustion chamber 8 is drained to the atmosphere and released from pressure. As the piston 4 has reached its rear end position, the switch 47 is acted upon by the heel 48 of the tool 6, whereby the ignition device 43 is supplied with electric current. This, in turn, results in a spark upon the spark plug 11 and an ignition of the super-compressed gas in the rear combustion chamber 7.

Owing to the fact that the rear combustion chamber 7 has been over-charged with petrol-enriched pressure air, the driving force acting upon the piston 4 during the succeeding working stroke is very high. The piston unit 3 is accelerated forwards in order to perform a working stroke. As the latch dogs 17 are released from the piston unit weight they are automatically pivoted to the rest positions by means of the tension springs 20. Then, they give free passage for the tool. When getting close to its forward end position, the piston 4 uncovers the outlet opening 16 and the rear combustion chamber 7 is released from pressure.

After having performed the intended work, but before reaching its forward end position, the piston 4 strikes the piston 23. As the pressure accumulator 25 has been pre-charged to a pressure exceeding the maximum driving pressure obtained in the forward combustion chamber 8, the piston 23 is kept in its rear position even during the compression stroke. The pressure accumulator 25 may very well be charged with nitrogen gas of a pressure of about 50 atmospheres. As the retard piston 23 is struck by the piston 4 and thereby driven forwardly, hydraulic fluid is pressed out through the openings 60–63 and further on through the conduit 26 to the pressure accumulator 25. The nitrogen gas is then further compressed. During its forward movement, the piston 23 successively register with the outlet openings 60–63, whereby the total outlet area of the cylinder chamber 24 is diminished. This causes restriction of the hydraulic fluid flow from the chamber 24, whereby the kinetic energy of the piston unit 3 is absorbed. As the piston unit 3 has been stopped, a return stroke is immediately started. This is accomplished by action of the pressure accumulator 25 which presses hydraulic fluid back into the cylinder chamber 24.

In order to keep up the hydraulic fluid level in the chamber 24, as a compensation for leakage, the pump 27 works continuously. The pump 27 is actuated by pulsating pressure air and is provided with two check valves for accomplishing the intended hydraulic fluid flow from the tank 21 to the retarding device 22.

Before every succeeding working cycle, the piston unit 3 has to be lifted up to and locked in its start position. This lifting operation could very well be carried out by supplying pressure air to the forward combustion chamber 8. This pressure is released before combustible gas is introduced. This operation is performed by a pneumatic circuit not shown in the drawings.

Owing to the fact that the impact device is overcharged with petrol-enriched pressure air and that the combustible gas is still more compressed during the compression stroke, the impact device according to the invention is able to develope a very high energy at each stroke. By using a high combustion pressure for driving the piston unit, it is possible to keep down the over-all dimensions of the impact device and make the latter suitable for practical use, for instance for mounting on a tractor.

At an impact device according to the invention, the drive pressure within the rear combustion chamber is of a magnitude of about 100 atmospheres at a piston unit weight of about 400 kilograms. The obtained impact energy per stroke is about 5,000 kpm.

The invention is not limited to the shown and described embodiments but can be freely varied within the scope of the claims.

What we claim is:

1. Method for accomplishing a large driving force at a combustion gas driven impact device comprising a cylinder housing and a piston unit, reciprocable in said cylinder housing, said piston unit comprising a piston and a piston rod, characterized in that, before every working stroke, the piston unit is fixed in a start position in which the piston is situated at distances from the ends of the cylinder housing, that the cylinder housing is charged with compressed, combustible gas at both ends of the piston, that a rearwardly directed compression stroke is initiated by ignition of the gas volume in front of the piston, that the front part of the cylinder

housing is released from pressure at the end of the compression stroke and that a forwardly directed working stroke is initiated by ignition of the compressed combustible gas in the rear part of the cylinder housing.

2. Method according to claim 1, characterized in that the compression stroke is initiated automatically when a predetermined charge pressure is reached within the cylinder housing and that the working stroke is initiated when the piston has reached a predetermined position relative to the cylinder housing.

3. Method according to claim 1, characterized in that, before every working cycle, the piston is fixed in its start position by mechanical means.

4. Method according to any of the claims 1, characterized in that the cylinder housing is charged with a mixture of petrol and compressed air at the beginning of the working cycle.

5. Impact device comprising a cylinder housing which is provided with combustion chambers at its opposite ends, a piston unit comprising a piston and a piston rod reciprocably guided within said cylinder housing, characterized in that the cylinder housing is provided with inlet openings for simultaneous supply of combustible gas to both of the combustion chambers, that means are arranged to fix the piston in a start position at distances from the ends of the cylinder; a first ignition system for ignition of combustible gas within the combustion chamber in front of the piston in the working stroke direction of the latter, and a second ignition system for ignition of combustible gas within the combustion chamber situated behind the piston.

6. Impact device according to claim 5, characterized in that the combustible gas is constituted by a mixture of compressed air and petrol.

7. Impact device according to any of the claims 5, characterized by a hydraulic retarding device which is arranged to absorb kinetic energy from the piston unit at the end of the working stroke.

8. Impact device according to claim 5, characterized in that means are provided to activate said first ignition system automatically at a predetermined charge pressure of the supplied combustible gas and that means are provided to activate said second ignition system automatically at a predetermined position of the piston.

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