

UNITED STATES PATENT OFFICE.

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COMPRESSOR APPARATUS.

1,343,536.

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To all whom it may concern:

Be it known that I, WALTER S. WEEKS, a citizen of the United States, and a resident of Berkeley, county of Alameda, State of California, have invented a new and useful Compressor Apparatus, of which the following is a specification.

My invention relates to internal combustion engines and compressors and is in fact a combination of both.

An object of my invention is to provide an apparatus operated by the internal combustion of fuel in which the motor piston and cylinder also function as a compressor piston and cylinder.

Another object of my invention is to provide an apparatus for accumulating hot gases under pressure.

Another object of my invention is to provide a simple and efficient means for securing an operative medium for driving rock drills, riveters or comparable mechanisms, or for operating a prime mover.

The invention possesses other features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of my invention which is illustrated in the drawings accompanying and forming part of the specification. It is to be understood that I do not limit myself to the showing made by the said drawings and description, as I may adopt variations of the preferred form within the scope of my invention as set forth in the claims.

Referring to the drawings:

Figure 1 is a vertical section through the cylinder of the compressor apparatus. The parts are shown at the beginning of the stroke during which the air and fuel are drawn into the cylinder.

Figs. 2, 3 and 4 are diagrammatical representations, showing the positions of the pistons during the compression, working and storage strokes respectively.

Fig. 5 is a view showing a modification of a portion of the mechanism of my invention.

Broadly, my invention comprises an internal combustion engine, which conveniently may be of the four-cycle type, so constructed that the products of combustion at a relatively high pressure are delivered to a storage chamber or receiver, or directly to an engine for the performance of work. The

motor piston and cylinder during one phase of the operation of the apparatus becomes the compressor piston and cylinder during another phase of the operation, the power developed during the motor phase being expended during the compressor phase.

Obviously, my apparatus may be constructed with a plurality of cylinders, each cylinder-unit functioning alternately as motor and compressor, but in its simplest form, only one cylinder is used and for convenience I have selected a single cylinder apparatus for description herein.

Referring first to Fig. 1, a cylinder 6 is provided with the attached crank case 7. A shaft 8 formed with the crank 9 is revolvably arranged in suitable bearings in the crank case and a connecting rod 11 connects the crank to the piston 12 slidably arranged in the cylinder 6 in the usual manner. A fly wheel 13 is arranged on the end of the shaft 8 outside the crank case. Ordinary gas engine practice may conveniently be followed in this, except that the crank shaft is not extended to transmit the power of the engine as a prime mover to any other machine. The chief function of the crank shaft is to control and relate the several movements of the piston 12. Power is also taken from the crank shaft to operate the two cam shafts 14 and 15, and this is preferably accomplished by gears 16 arranged on the inside of the crank case.

The upper portion 6^a of the cylinder 6 is formed with a larger bore than the lower portion, and a differential piston 18 is slidably arranged in both bores, forming a chamber A between the two pistons and a chamber B between the differential piston and the end of the cylinder. A rod 19 is secured to the piston 18 and at its outer end is coupled to the rod 20 by the arm 21 rigidly secured to both rods. The rod 20, together with the piston 18, is actuated by its engagement with a cam 22 located upon the cam shaft 14.

In its lower position the piston 18 almost touches the top of the piston 12 when the latter is at the top of its stroke, but in the upper position of the piston 18 there is considerable clearance between the two pistons. It is understood that the differential piston would move from its lower position to its higher, and from the higher to the lower by

reason of the gas pressure alone, but in order to time its movement properly and insure proper and smooth operation, the use of the cam is preferred. The cam is designed, however, to act at a time when the pressure of the gases also tends to operate the piston so that a minimum of energy is consumed in moving it. The cam 22 is also designed to lock the piston in the lower and upper positions. Its rounded surface 24 while in contact with the upper and lower surfaces of the yoke 26 holds the piston 18 immovable.

The cylinder 6 is provided with an inlet valve 28 through which charges of air and fuel are drawn into the cylinder on the suction stroke of the piston 12. The products of combustion are discharged from the cylinder on the exhaust stroke through the passage 29 controlled by the valve 31. Both valve 28 and 31 are of the usual puppet type and are actuated by cams 32 and 34 on the cam shafts 14 and 15 respectively.

The exhaust passage 29 is continued by a conduit 35 which connects into a receiver 36 in which the gases are stored until used.

A check valve 37 is arranged in the exhaust passage to prevent any back flow of gases from the receiver. Connected into the exhaust conduit on the pressure side of the check valve or directly into the receiver 36 is a conduit 38 which leads into chamber B, the space above the differential piston, so that this chamber is always in communication with the receiver. The upper surface of the differential piston 18 is, therefore, always subject to the pressure existing in the receiver 36.

The operation of the apparatus will now be made clear by following it through a complete cycle.

First phase. Intake. Fig. 1. The valve 31 is closed and the intake valve 28 is open. The differential piston 18 is in the lower position. The motor piston 12 descends, drawing in the fuel mixture.

Second phase. Compression. Fig. 2. Both valves 28 and 31 are closed. As the piston 12 rises to compress the mixture, the differential piston 18 rises to the top position where it lies firmly against the end of the cylinder 6^a. The piston is locked in this position while the curved surface 24 of the cam 22 is in contact with the upper face of the yoke 26. As before noted, the piston 18 would rise without the cam as soon as the total pressure against its lower surface rose to a point above that upon its upper surface, but preferably the cam is used to insure smooth operation and prevent pounding. By the rising of the differential piston, a clearance space is provided for the compressed fuel mixture.

Third phase. Working. Fig. 3. Both valves 28 and 31 are closed and the differential piston remains in its upper position.

The fuel mixture is exploded by a spark in the usual manner, and the motor piston is driven downward.

Fourth phase. Storage. Fig. 4. Valve 28 remains closed while valve 31 opens the discharge passage to the pressure chamber. As the piston 12 rises and the gases exhaust from the chamber A into the receiver, the same pressure per unit area is at once exerted in chamber B upon the upper and larger surface of the differential piston, thus tending to force it to its lower position as soon as the cam 22 turns to permit the movement. When piston 12 reaches the top of its stroke, piston 18 has reached the lower position in its stroke and only a very small clearance exists between the surfaces of the two pistons. Practically all the products of combustion are thus forced out of the cylinder into the receiver.

On the next downward stroke of the piston 12, the piston 18 is held in the lower position by the pressure in the chamber B as well as by the cam 22 and a new charge of fuel is drawn into the chamber A, the operation continuing as just explained.

The movement of the differential piston 18 is controlled or permitted by the cam 22, but the operating force is preferably derived wholly or chiefly from the pressure of the gases exerted on the faces of the piston, the cam preferably serving chiefly to control and time the movement.

In order to secure highest efficiency the gases should be used while hot, and it is contemplated that the mechanism which is to be operated thereby, as for instance a rock drill or riveter, will be best connected to the receiver 36 by a suitable conduit 41. The connection between compressor apparatus and operated mechanism may be direct in some instances.

In order to avoid resistance to the movement of the differential piston 18, by the formation of a vacuumized chamber under the head thereof, a vent 42 is formed in the cylinder wall.

Fig. 5 shows a modification of the mechanism for controlling the movement of the differential piston. An eccentric disk 44 is arranged on the cam shaft 14. The eccentric imparts reciprocal motion through the eccentric rod 45 to the rod 20 to which the eccentric rod is pivotally connected. The relative speed of movement of the differential piston and the motor piston is for a complete cycle the same in either of the constructions,—1 to 2. In the case of the eccentric the motion of the differential piston is constant though not uniform. With the cam the motion of the differential piston is intermittent and nearly uniform during the period of motion.

I claim:

1. In a device of the character described,

a cylinder, a motor piston adapted to operate said device arranged in said cylinder and means operated by the pressure of the exhaust gases for varying the clearance above said motor piston.

2. In a device of the character described, a cylinder, a motor piston adapted to operate said device arranged in said cylinder, means operated by the pressure of the exhaust gases for varying the clearance above said motor piston and means for controlling the operation of said clearance-varying means.

3. In a device of the character described, a cylinder, a motor piston adapted to operate said device arranged in said cylinder, means operated by the pressure of the exhaust gases for varying the clearance above said motor piston and means for timing the operation of said clearance-varying means in respect of the movement of said piston.

4. In a device of the character described, a cylinder, a motor piston in said cylinder, and a differential piston in said cylinder arranged to be operated in one direction by the compression of gases between said pistons and in the other direction by the pressure of said gases after explosion.

5. In a device of the character described, a cylinder, a motor piston in said cylinder, a differential piston in said cylinder between said motor piston and the end of the cylinder, and a passage connecting the chambers on opposite sides of said differential piston.

6. In a device of the character described, a cylinder, a motor piston in said cylinder, a differential piston in said cylinder between said motor piston and the end of the cylinder, a passage connecting the chambers on opposite sides of said differential piston and a valve for controlling the movement of gases from the chamber between the pistons to said passage.

7. In a device of the character described, a cylinder, a motor piston in said cylinder, a differential piston in said cylinder between said motor piston and the end of the cylinder, valves for controlling the movement of gases into and out of the chamber between said pistons and a passage connecting the chambers on the opposite sides of said differential piston.

8. In a device of the character described, a cylinder, a motor piston in said cylinder, a differential piston in said cylinder between said motor piston and the end of the cylinder, a receiver, and a passage connecting the receiver to the chamber between said pistons.

9. In a device of the character described, a cylinder, a motor piston in said cylinder, a differential piston in said cylinder between said motor piston and the end of the cylinder, a receiver, a passage connecting the receiver to the chamber on one side of said dif-

ferential piston, a check valve in said passage, and a passage connecting the receiver to the chamber on the other side of said differential piston.

10. In a device of the character described, a cylinder, a motor piston in said cylinder, a differential piston in said cylinder between said motor piston and the end of the cylinder, a receiver, a passage connecting the receiver to the chamber on one side of said differential piston, a check valve in said passage, a passage connecting the receiver to the chamber on the other side of said differential piston, and valves for controlling the movement of gases into and out of the chamber between said pistons.

11. In a device of the character described, a cylinder, a motor piston in said cylinder, a differential piston in said cylinder between said motor piston and the end of the cylinder, means for admitting fuel to the chamber between said pistons on the suction stroke of the motor piston, means for firing the fuel, a receiver for the products of combustion, and means for permitting said products to act upon said differential piston.

12. In a device of the character described, a cylinder, a motor piston in said cylinder, a differential piston in said cylinder between said motor piston and the end of the cylinder, means for admitting fuel to the chamber between said pistons on the suction stroke of the motor piston, means for firing the fuel, a receiver for the products of combustion, means for conducting said products to said receiver, and means for permitting said products to move said differential piston toward said motor piston.

13. In a device of the character described, a cylinder, a motor piston in said cylinder, a differential piston in said cylinder between said motor piston and the end of the cylinder, means for admitting fuel to the chamber between said pistons on the suction stroke of the motor piston, means for controlling the raising of said differential piston on the compression stroke of said motor piston, means for firing the fuel, a receiver for the products of combustion, means for conducting said products to said receiver, and means for permitting the pressure exerted by said products to lower said differential piston.

14. In a device of the character described, a cylinder, a motor piston in said cylinder, and means for varying the clearance above said motor piston, said means arranged to be operated in one direction by the compressed fuel mixture, and in the other direction by the exhaust gases.

15. In a device of the character described, a cylinder, a motor piston in said cylinder, means for varying the clearance above said motor piston, said means arranged to be operated in one direction by the compressed fuel mixture and in the other direction by

the exhaust gases, and means for controlling the movement of said clearance-varying means.

16. In a device of the character described, 5 a cylinder arranged to receive charges of fuel, a motor piston in said cylinder, a second piston in said cylinder, a receiver, a passage connecting the receiver to the chamber between the pistons, and means for moving said 10 second piston to enlarge said chamber prior to explosion of the charge therein and for moving said second piston to reduce the size of said chamber following the said explosion.

17. In a device of the character described,

a cylinder arranged to receive charges of 15 fuel, a motor piston in said cylinder, a second piston in said cylinder arranged to be operated in one direction by the compression of said fuel between said pistons, means for moving said second piston in the opposite 20 direction after the combustion of said fuel and a receiver for the storage of the products of combustion of said fuel.

In testimony whereof, I have hereunto set my hand at Berkeley, California, this 12th 25 day of February, 1917.

WALTER S. WEEKS.