R. C. REED.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED FEB. 14, 1921.

1,413,541. **Patented Apr. 18, 1922.**

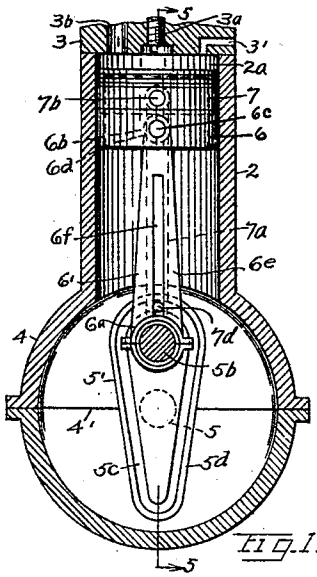

Fig. 1.

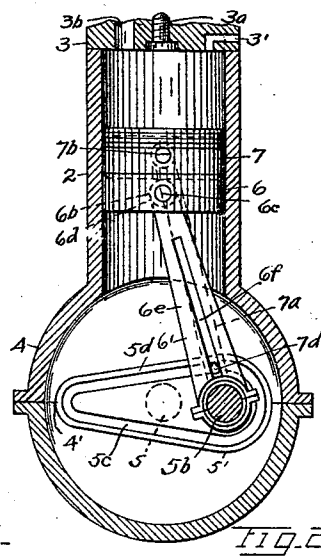

Fig. 2.

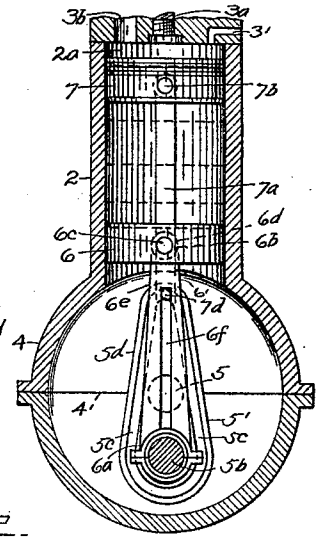

Fig. 3.

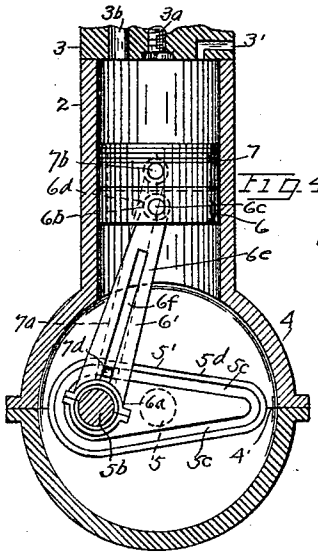

Fig. 4.

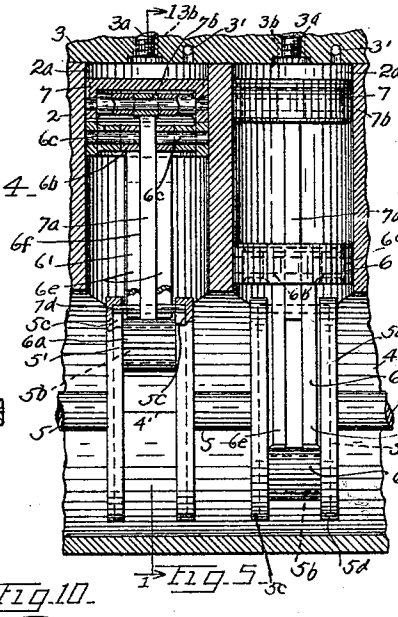

Fig. 5.

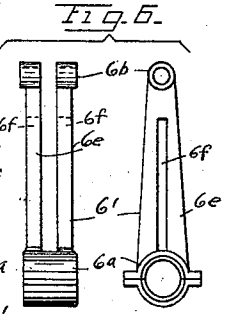

Fig. 6.

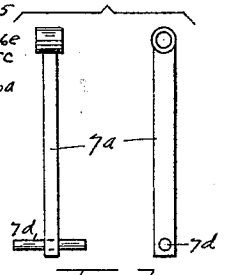

Fig. 7.

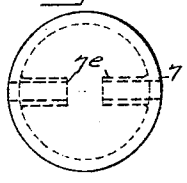

Fig. 8.

Fig. 9.

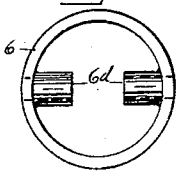

Fig. 10.

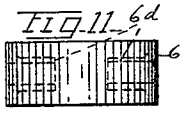

Fig. 11.

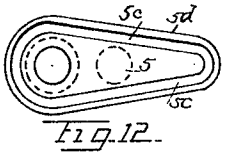

Fig. 12.

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UNITED STATES PATENT OFFICE.

ROSCOE C. REED, OF SYRACUSE, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, OF TWO-THIRDS TO KATHERINE H. REED, OF SYRACUSE, NEW YORK.

INTERNAL-COMBUSTION ENGINE.

1,413,541. Specification of Letters Patent. Patented Apr. 18, 1922.

Application filed February 14, 1921. Serial No. 444,877.

To all whom it may concern:

Be it known that I, ROSCOE C. REED, a citizen of the United States, residing at Syracuse, in the county of Onondaga and State of New York, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to improvements in internal combustion engines.

Heretofore, internal combustion engines, particularly the types employed for driving automotive vehicles, have been arranged to draw in the charges of explosive gas during one down-stroke of the pistons; then to compress the said gas during the succeeding up-stroke of the pistons; then to explode the compressed gas for driving the pistons on the second down-stroke, and to finally scavenge the cylinders on the second up-stroke of the pistons. In other words, there has usually been but one explosion during the interval in which the crank shaft makes 2 revolutions. It is a particular object of the present invention to provide a novel and simple piston and crank-shaft construction, by means of which the gas is drawn into the cylinders and compressed and exploded and the burned gases finally ejected during each revolution of the crank-shaft, thereby effecting a saving of fuel, and materially increasing the frequency and tension of the power or driving strokes of the piston.

I attain these objects by means set forth in the detailed description which follows, and as illustrated in the accompanying drawing, in which—

Figure 1 is a central vertical cross-section, taken on line 1—1 of Fig. 5. Figs. 2, 3, and 4 are similar sections showing the various positions of the pistons and the crank-shaft while the latter is making one complete revolution. Fig. 5 is a vertical longitudinal section taken on line 5—5 of Fig. 1. Fig. 6 is respectively a front and a side view of the main piston rod. Fig. 7 is a similar view of the auxiliary piston-rod. Figs. 8 and 9 are respectively a top plan view and a side elevation of the upper piston. Figs. 10 and 11 are similar views of the lower piston. And Fig. 12 is a face view of one of the cams which effect the operation of the upper piston.

In the drawing, 2—2 represent the cylinders of an internal combustion engine, 3—3 represent the heads; and 4 is the substantially cylindrical crank case which is common to several cylinders and separable at 4′. 5 represents the crank shaft, and 5′ and 5^a are the cranks for the corresponding cylinders, and which in the present case consist of wrist-pins 5^b, which are disposed between similar arms 5^c—5^d. The pair of arms of each crank are provided on their facing surfaces with similar cam-grooves 5^e, the corresponding portions of said grooves being eccentric to the wrist-pins 5^b, and the said grooves then extending on the opposite sides and past the crank-shaft 5, to a point diametrically opposite said shaft.

6 and 7 represent the members of a double piston, which reciprocate in the cylinders 2. The pistons 6 are connected directly to the wrist-pins 5^b by means of the rods 6′, and the movements of said pistons correspond to the throws of the cranks. The lower ends 6^a of the rods 6′ journal on the wrist-pins 5^b, in the usual manner, while the upper ends 6^b of said rods are pivotally connected to the pistons 6, by means of wrist-pins 6^c. Each piston 6 is preferably cylindrical and open at both ends, and the pins 6^c are supported in similar diametrically arranged sleeves 6^d, whose inner ends are spaced apart as shown in Figs. 5, 10, and 11. The piston rod 6′ is split from the hub of the bearing 6^a to its top and both of its arms 6^e are provided with coinciding longitudinal slots 6^f.

The piston 7 is also hollow, but its top 7′ is closed while its bottom is open. The piston 7 is operated by a lighter rod 7^a, which is loosely disposed between the arms 6^e of the rod 6′. The upper end of auxiliary rod 7^a is pivotally attached to the piston 7 by means of a pin 7^b, which is supported by similar sleeves 7^c, as best seen in Figs. 5, 8, and 9. The lower end of the rod 7^a is provided with a pin 7^d, which projects beyond the opposite sides of the rod and passes loosely through the slots 6^f of the rod 6′, and the opposite ends of the pin 7^d are disposed and are movable in the cam grooves 5^e of the arms 5^c—5^d, so that the rods 7^a and the pistons 7 are actuated, and given variable movements relatively to the movements of the pistons 6 and their rods 6′, by the peculiar shaped grooves 5^e. The caps 3 of the cylinders are provided with the

usual gas inlet ports 3′; spark plugs 3^a, and exhaust ports 3^b. All these ports are shown conventionally in Figs. 1 to 5 inclusive.

The operation of my improved engine is as follows; Referring first to Fig. 1, it may be assumed that the cylinder 2 has been charged with explosive gas, and that the said gas has been compressed into the shallow head-space 2^a, and that the gas is being ignited by the plug 3^a. The force of the exploding gas drives the two pistons 6 and 7 (which are shown together in Fig. 1) from the position shown in Fig. 1, to the position shown in Fig. 2, which is substantially midway between the top and bottom of the cylinder. This partial downward movement of the two pistons, which have moved as one part, rotates the crank-shaft 5′ substantially one-quarter of a turn, and swings the cam-arms 5^c—5^d from the vertical to the horizontal position, and during this partial down-stroke of the pistons, the pin 7^d of the rod 7^a traverses the grooves 5^e in a quarter circle concentric to the wrist pin 5^b. This effects the movement of the piston 7 a distance equal to the first movement of the piston 6. The crank-shaft continues its rotation due to the force of the explosion, and next moves from the position shown in Fig. 2 to that shown in Fig. 3, the latter position marking the completion of the first half of its revolution. While the crank-shaft is executing the second quarter of its revolution, the free ends of the cam-arms 5^c—5^a are being swung upwardly towards the vertical axis of the cylinder 2, and in so doing they force the rod 7^a and the piston 7 upwardly from the position shown in Fig. 2 to that shown in Fig. 3, (which carries the piston 7 back towards the top of the cylinder). This upward movement of the piston 7 is effected by the action of the cam-grooves 5^e on the pin 7^d, in a well-known manner. During this last described upward movement of the piston 7, the latter forces the burnt gases out through the port 3^b thereby scavenging the cylinder 2, during the interval in which the piston 6 is moving downwardly from the position shown in Fig. 2 to that shown in Fig. 3—to the bottom of the cylinder. In other words, at the instant the crank 5′ completes the first half of its revolution, the pistons 6 and 7 are respectively at the bottom and at the top of the cylinder 2. As the crank 5′ moves clockwise towards the three-quarters point, shown in Fig. 4, it drives the piston 6 upwardly to the medial position, (Fig. 4) and swings the cam-arms 5^c—5^d into the horizontal position again. Meantime, the arms 5^c—5^d, acting on the pin 7^d, pull the piston 7 downwardly a second time until it meets and contacts with the upwardly moving piston 6, (see Fig. 4), and during this last downward movement, the piston 7 draws a fresh charge of the explosive gas into cylinder 2 through the inlet 3′. Then as the crank 5′ continues its movement through the last quarter of its revolution, it forces both of the pistons upwardly, (as one part) from the position shown in Fig. 4 to that shown in Fig. 1. This last movement of the pistons effects the compression of the gas into the head-space 2^a ready for another ignition, and so on. By the foregoing construction, arrangement, and operation of the working parts of the engine, the piston 7 alone sucks in the charges of the explosive gas; the two pistons acting as one compresses the gas; then follows the explosion of the gas, and the exhausting of the burnt gases, all of which takes place at each revolution of the crank-shaft. As the timing mechanisms for regulating the ignition and also the opening of the exhaust ports 3^b are well-known, these parts have not been shown or described. It is understood, however, that any suitable timing mechanism may be employed in connection with my improvement.

In practice, the exhaust port 3^b is opened at the end of the first quarter turn of the crank-shaft, as when the pistons reach the position shown in Fig. 2. This tends to relieve the pressure of the exploded and expanding gas against the piston 7 and allows said piston to start back on its upward stroke for scavenging the cylinder. Obviously, the port 3^b will be closed at the end of this upstroke of the piston 7 (see Fig. 3), and the inlet 3′ will be opened for the admission of the fresh gas, which is sucked into the cylinder 2 by the second downstroke of the piston 7 (as from the position shown in Fig. 3 to that shown in Fig. 4), and then both ports 3′ and 3^b will be closed during the compression stroke of the pistons 6—7, while said pistons move from the position shown in Fig. 4 back to that shown in Fig. 1. In my engine, the duration of the force of the explosions is shorter than in the older engines of the class, but as the greater proportion of the explosive force is exerted during the first half of the power stroke, the provision for an explosion, at each revolution of the crank-shaft, tends to greatly increase the yield of power during a given interval of time, and as the suction stroke, during which the cylinders are charged with fresh gas is correspondingly shorter, less gas is consumed during each explosive period, than by the older makes of internal combustion engines.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is—

1. The combination with the cylinder and the crank shaft of an internal combustion engine, of a piston operatively connected to the crank of said shaft, a piston disposed

above and concentric to the first piston, a rod for operating the upper piston, said rod having a pin and said crank having grooves engaging said pin and adapted for moving said upper piston in opposite directions independent of the lower piston.

2. An internal combustion engine, including a cylinder, a two-part piston reciprocable in said cylinder, a main and an auxiliary rod for operating said pistons, a shaft having a crank comprising spaced arms connected by a wrist-pin, said wrist-pin adapted to drive said main rod and the lowermost piston, the said arms having corresponding cam-grooves adapted to receive a part carried by the auxiliary rod for moving the uppermost piston in unison with the lowermost piston and also in opposite directions thereto during each revolution of said shaft and crank.

3. The combination with the cylinder of an internal combustion engine, of a crank-shaft, the crank of said shaft comprising a wrist-pin extending between similar spaced arms, and the said arms having endless facing cam-grooves, a piston in said cylinder operatively connected to said wrist-pin, a piston disposed above the first piston and separable therefrom, a rod for operating the upper piston, said rod having a part which traverses said cam-grooves, adapted to move said upper piston independently of the lower piston for scavenging as well as for charging said cylinder with fresh explosive gas.

4. In an engine of the class described, the combination with the cylinders and the crank-shaft thereof, of a plurality of cranks on said shaft, each crank comprising spaced arms connected by a wrist-pin the facing surfaces of said arm having continuous cam-grooves which encircle the wrist-pin and also the said shaft, a two-part piston in each cylinder, said pistons adapted to be reciprocated together and also separately, means connected with the wrist-pin for operating one piston, and means connecting with said arms for operating the other piston.

5. In an engine of the class described, the combination with the cylinders and the crank-shaft thereof, of a plurality of cranks on said shaft, each crank comprising spaced arms connected by a wrist-pin, the said arms having continuous cam-grooves facing each other and which surround the wrist-pin and also the said shaft, a two-part piston in each cylinder, said pistons adapted to be reciprocated together and also separately, a rod connecting one of said pistons to the corresponding wrist-pins, and an independent rod operatively connecting the other piston with the grooved portions of said arms.

6. In an engine of the class described, the combination with a cylinder, of a crank-shaft, the crank of said shaft comprising similar arms disposed at right angles to the axis of the shaft and projecting equi-distantly in opposite directions past said shaft, the facing surfaces of said arms provided with similar continuous cam-grooves, a wrist-pin connecting the corresponding ends of said arms, two pistons in said cylinder, said pistons disposed axially and capable of reciprocable motions independent of each other, said pistons adapted to be reciprocated as one part during the initial and final movements of each revolution of the crank-shaft, a main rod connecting one of said pistons to the wrist-pin, and a rod connecting the other piston with said cam-grooves whereby the said rod is reciprocated twice during each revolution of the crank-shaft while said main rod reciprocates but once during said revolution.

In testimony whereof I affix my signature.

ROSCOE C. REED.