J. E. SEARS, Jr.

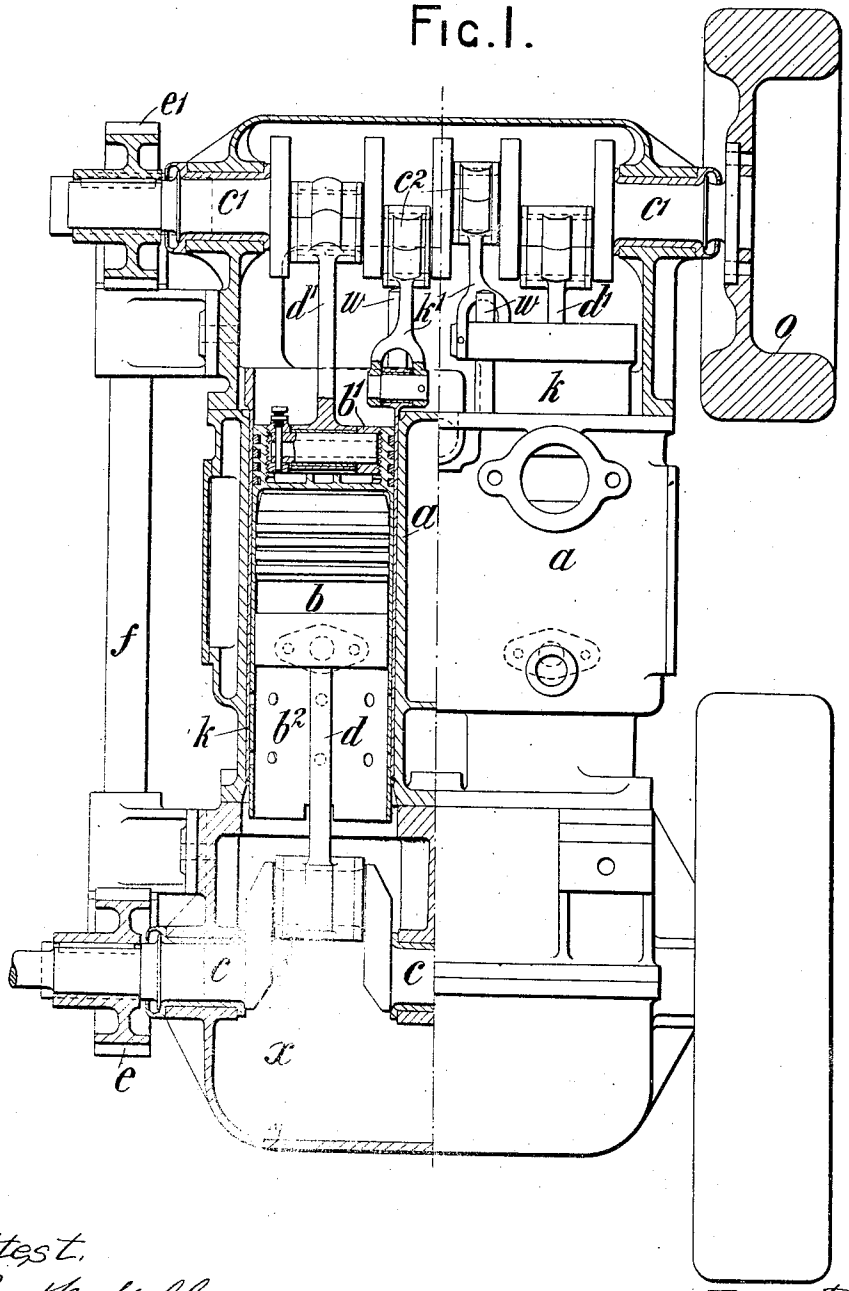
INTERNAL COMBUSTION ENGINE.

APPLICATION FILED DEC. 28, 1909.

977,334. Patented Nov. 29, 1910.

2 SHEETS—SHEET 1.

Fig. 1.



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2 SHEETS—SHEET 2.

FIG. 2.

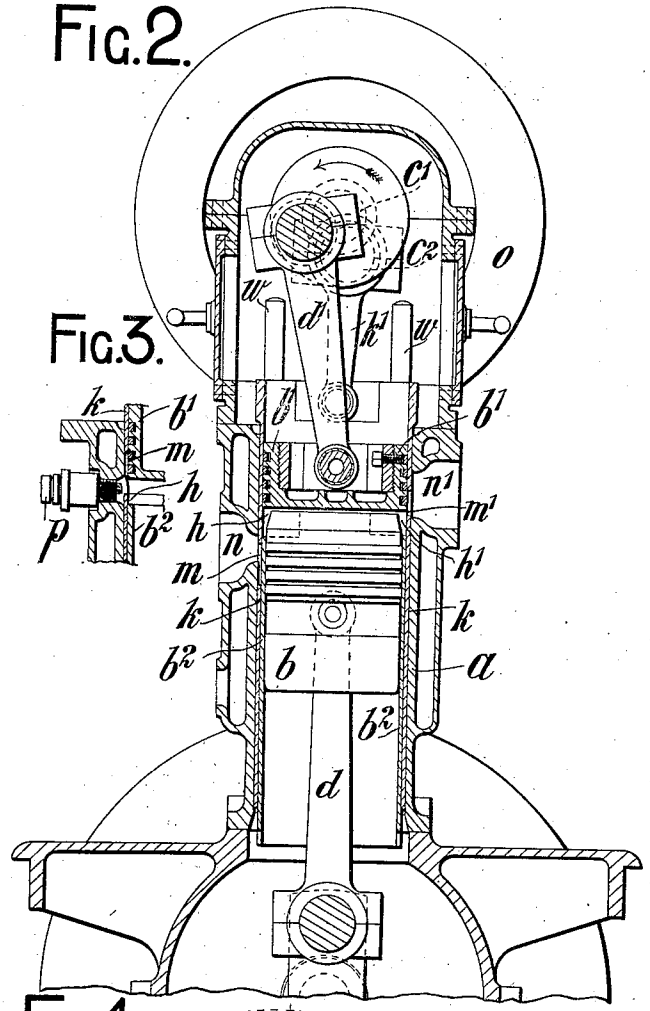
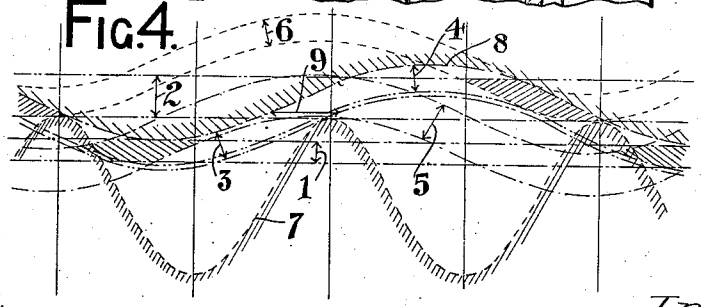


FIG. 3.

FIG. 4.



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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

977,334. Specification of Letters Patent. Patented Nov. 29, 1910.

Application filed December 28, 1909. Serial No. 535,285.

To all whom it may concern:

Be it known that I, JOHN EDWARD SEARS, Jr., B. A., a subject of the King of Great Britain and Ireland, and residing at 6 Percy Terrace, in the city of Newcastle-upon-Tyne, in the county of Northumberland, England, have invented certain new and useful Improvements in and Relating to Internal-Combustion Engines, of which the following is a specification.

This invention relates to four stroke cycle internal combustion engines of the type in which two pistons driving separate shafts are used in the same cylinder and its object is to provide an engine of this type with a silent positive valve mechanism, in which a working stroke of expansion ratio greater than the preceding ratio of compression is followed by the completest possible mechanical scavenging.

According to this invention I combine with an engine of the above type a sliding, reciprocating, rotating, or circumferentially oscillating valve sleeve, working between the piston or pistons and the cylinder wall. At the same time by suitably proportioning the parts of the engine and by the adoption of a suitable relation between the crank angles on the two shafts, as hereinafter explained, I secure the desired cycle of operations as indicated above.

The accompanying drawings illustrate one mode of carrying out the invention.

Figure 1 is a part sectional side elevation of one form of internal combustion engine constructed in accordance with the present invention. Fig. 2 is a sectional end elevation. Fig. 3 is a fragmentary view showing one arrangement of the sparking plug, while Fig. 4 is a diagram showing the cycle of operations of the pistons and sliding valves.

In the working cylinder, *a*,—which is made of a suitable length—are the two working pistons *b* and *b'*, the former being connected to the crank-shaft, *c*, by a connecting rod, *d*, in the usual manner and the latter to the crank-shaft *c'*, by the connecting rod, *d'*. The main crank-shaft *c* is mounted as usual in the crank-chamber *x* and the auxiliary shaft *c'* is mounted over the top of the working cylinder or cylinders. The two crank-shafts *c* and *c'* are geared together by means of any suitable gearing so that the speed of rotation of *c'* is one half that of *c*. The gear illustrated consists of skew gear wheels *e* and *e'* mounted on the two crank-shafts and gearing with similar wheels on a vertical shaft *f*, but a chain or other positive drive might equally well be used.

The auxiliary piston *b'* is prolonged backward so as to form a sleeve b^2 within which the main piston *b* works. Ports *h* and *h'* are provided in this sleeve to allow of the passage of the gases to and from the working cylinder, said ports being opened and closed at the appropriate times by the sliding sleeve *k* which works between the auxiliary piston *b'* and the walls of the cylinder *a*. The sleeve *k* is provided with ports *m* and *m'* which are so arranged as to put the inlet and exhaust ports *n* and *n'* in the cylinder *a* into communication with the corresponding ports *h* and *h'* in the sleeve b^2 at the times appropriate respectively to admission and exhaust. The sleeve *k* has a reciprocating motion imparted to it by a crank c^2 on the crank-shaft *c'* through a connecting rod *k'*, suitable guides being provided to prevent it from rotating. In the arrangement shown these guides take the form of pins *w* carried by the cylinder *a*.

The sparking plug *p* for igniting the inflammable gases may either be arranged in the head of the auxiliary piston, in which case a flexible connection or a wipe contact is employed, or it may be placed in the side of the cylinder, in which case it is preferably located (as shown in Fig. 3) so that the coincidence of the admission ports *h* and *m* when the piston *b* approaches the end of its compression stroke, puts the sparking plug *p* into communication with the explosive mixture contained between the two pistons. In this way the necessity for special ignition ports in the sleeves b^2 and *k* is avoided.

The cycle of operations is clearly shown in the diagram Fig. 4. In said diagram the inlet and exhaust ports in the cylinder walls are denoted by 1 and 2 respectively, the corresponding ports in the sleeve b^2 of the auxiliary piston by 3 and 4, the corresponding ports in the sleeve *k* by 5 and 6, the path of the main piston by 7, the path of the auxiliary piston by 8, and the range of the firing spark by 9. In the position shown in

the drawings the main piston is at the top of its stroke and the exhaust port is still open. The auxiliary piston is descending and gains on the main piston at the beginning of the latter's forward stroke, the nearest relative position being attained as indicated in Fig. 4 when the main piston has just begun its forward stroke. The two pistons are then almost in contact so that the whole of the burned gases are driven out. In the meantime the sliding sleeve k has been rising slowly and just as this stage is reached the relative motion of this sleeve and the auxiliary piston effects the closing of the exhaust ports n', the inlet port n being opened in the same fashion almost immediately after. This port remains open until the two pistons attain their greatest separation on the suction stroke when the communication between the ports n and m is interrupted by the rise of the sliding sleeve. The compression stroke now begins. Owing to the relative setting of the cranks of the main and auxiliary pistons the latter do not on this stroke come close together but sufficient space is left to contain the compressed charge. The mixture is exploded by a spark from the plug p in the cylinder wall, the ports m and h which control the inlet serving also at the appropriate time as a communication between this plug and the combustion chamber. On the explosion stroke the two pistons attain their maximum separation. Toward the end of the working stroke the exhaust port is opened by the movement of the sliding sleeve k which is now descending and brings the port m' (already in communication with h') into communication with n'.

In the design illustrated in the accompanying drawings the strokes of the auxiliary piston b' and the sleeve k are each one-half that of the main piston b, the expansion ratio being 6 to 1 and the compression ratio 4 to 1. The increased expansion ratio is of great advantage in obtaining an increase of mechanical work for a given expenditure of fuel and by suitably modifying the design, the ratios, both of compression and expansion, may be made to take any desired values, none of the aforesaid proportions being essential to the invention.

In engines having only one or two working cylinders it is advisable to provide a small additional fly-wheel such as o on the auxiliary shaft c' to prevent the gear from chattering. It will be understood that this gear has to be strong enough to take the full force of the explosion and to transmit part of the power developed. Skew gears have been employed in the example shown for the sake of silence in running, but any other suitable type of positive gearing may be employed.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. In an internal combustion engine the combination of a working cylinder provided with inlet and exhaust ports, two pistons working in said cylinder and a cylindrical valve sleeve between said pistons and the cylinder wall.

2. In an internal combustion engine the combination of a working cylinder provided with inlet and exhaust ports, two pistons working in said cylinder, a cylindrical valve sleeve working between said pistons and the cylinder wall, and means for imparting motion to said valve-sleeve.

3. In an internal combustion engine the combination of a working cylinder provided with inlet and exhaust ports, two pistons working in said cylinder, a shaft driven by the main piston, means for driving said shaft by the main piston, a shaft driven by the auxiliary piston, means for driving said shaft by the auxiliary piston a cylindrical valve sleeve provided with ports and working between said pistons, and the cylinder wall, and means for imparting motion to said valve sleeve.

4. In an internal combustion engine the combination of a working cylinder provided with inlet and exhaust ports, a main piston in said cylinder driving the main crank shaft, an auxiliary piston in said cylinder driving an auxiliary crank shaft, a cylindrical valve sleeve provided with ports and working between said pistons and the cylinder wall, and means for reciprocating said valve sleeve from the auxiliary crank shaft.

5. In an internal combustion engine the combination of a working cylinder provided with inlet and exhaust ports, a main piston in said cylinder driving the main crank shaft, an auxiliary piston in said cylinder driving an auxiliary crank shaft, a cylindrical valve sleeve provided with ports and working between said pistons and the cylinder wall, means for reciprocating said valve sleeve from the auxiliary crank shaft, and means for gearing the main crank shaft with the auxiliary crank shaft.

6. In an internal combustion engine the combination of a working cylinder an auxiliary piston in said cylinder driving an auxiliary crank shaft, a hollow cylindrical extension of said auxiliary piston provided with ports, a main piston working in said cylindrical extension and driving the main crank shaft, a cylindrical valve sleeve provided with ports working between said pistons and the cylinder wall, means for reciprocating said valve sleeve from the auxiliary crank shaft, and means for gearing said crank shafts together.

7. In an internal combustion engine the combination of a working cylinder an auxiliary piston in said cylinder driving an auxil-

iary crank shaft a hollow cylindrical extension of said auxiliary piston, provided with ports a main piston working in said cylindrical extension and driving the main crank shaft, a cylindrical valve sleeve provided with ports working between said pistons and the cylinder wall, means for reciprocating said valve sleeve from the auxiliary crank shaft, means for gearing said crank shafts together, and a fly wheel to the auxiliary crank shaft.

In testimony whereof, I affix my signature in presence of two witnesses.

JOHN EDWARD SEARS, JR.

Witnesses:
WILLIAM DAGGETT,
ARTHUR COWENS ALDER.