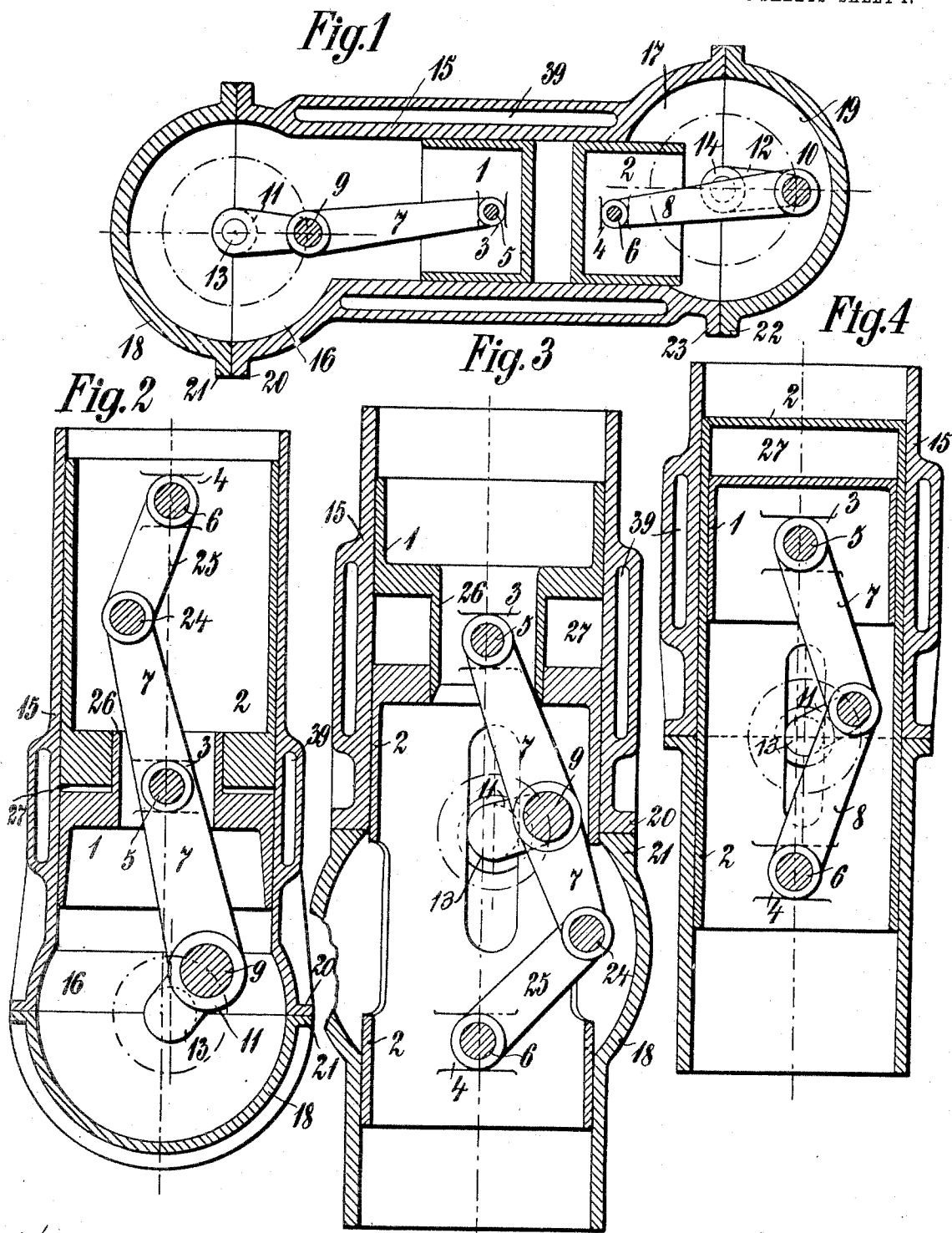


R. SLABY.
VALVELESS INTERNAL COMBUSTION MOTOR.
APPLICATION FILED NOV. 17, 1911.

1,099,576.

Patented June 9, 1914.

3 SHEETS—SHEET 1.



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3 SHEETS—SHEET 2.

Fig. 5

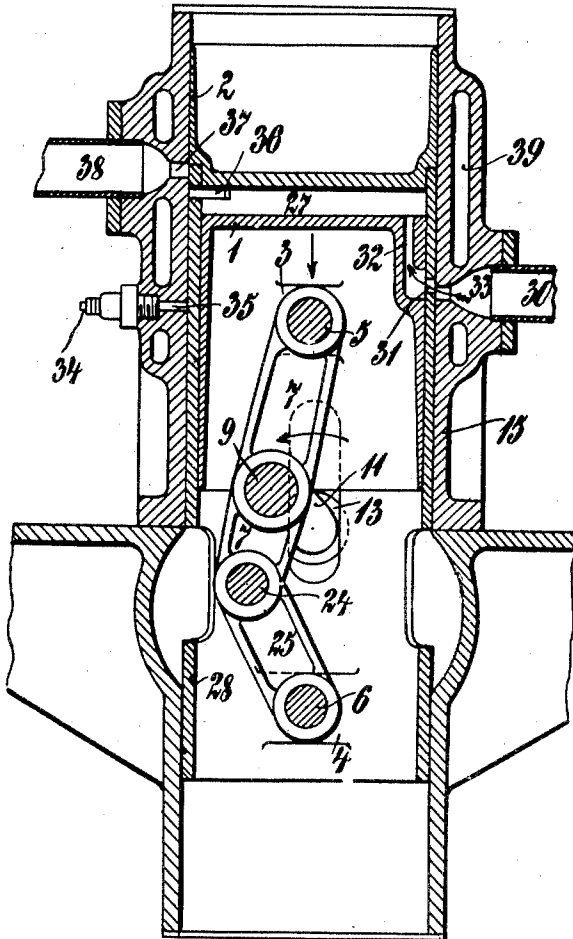


Fig. 6

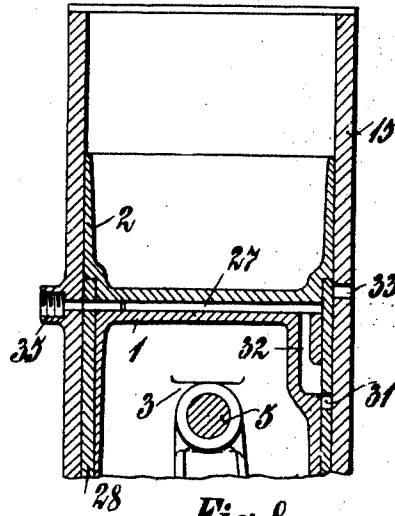


Fig. 8

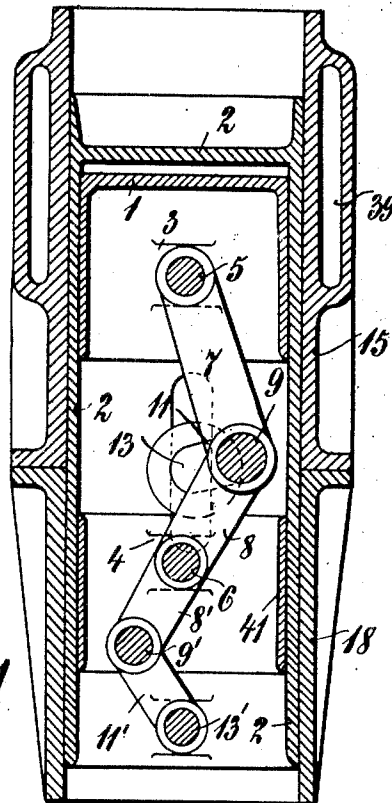


Fig. 7

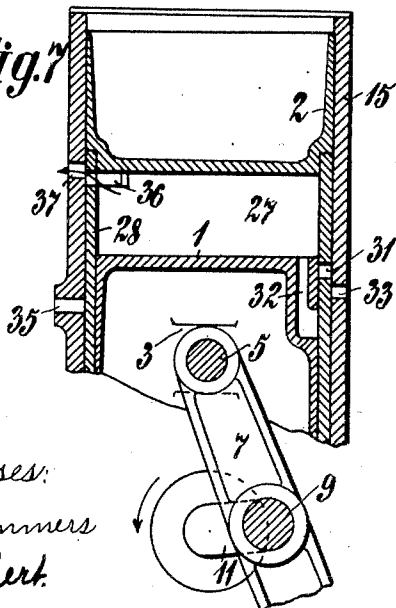
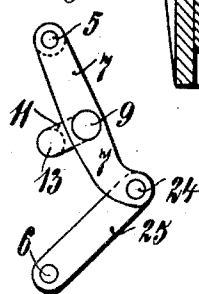


Fig. 11



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3 SHEETS—SHEET 3.

Fig.9

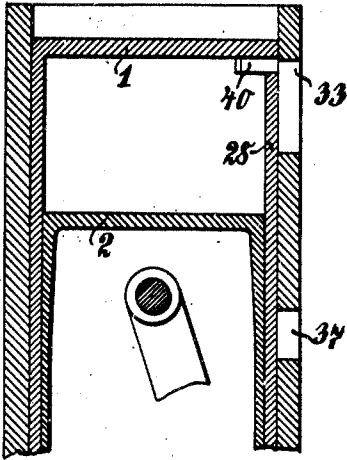
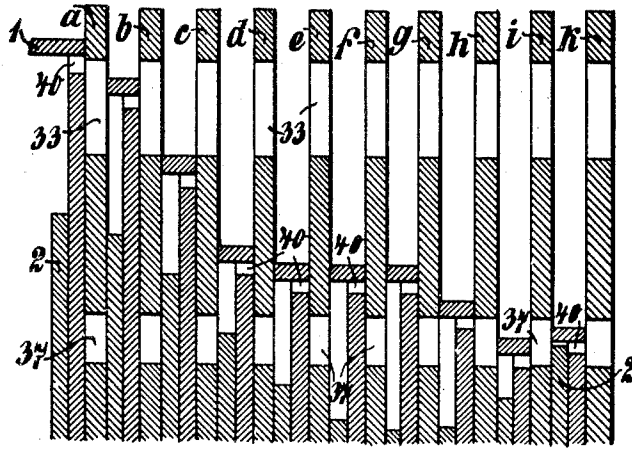
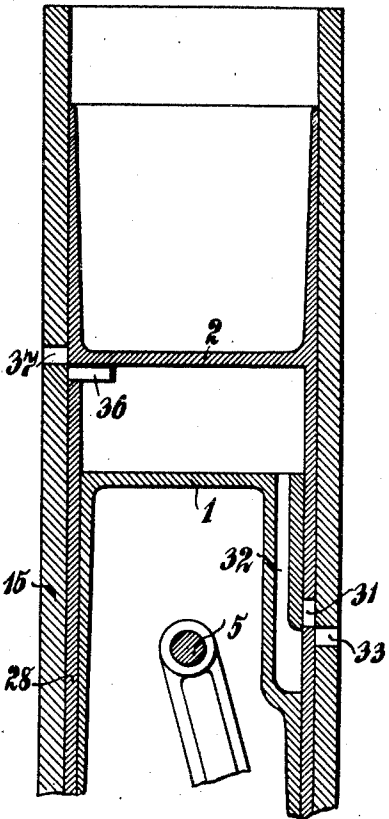
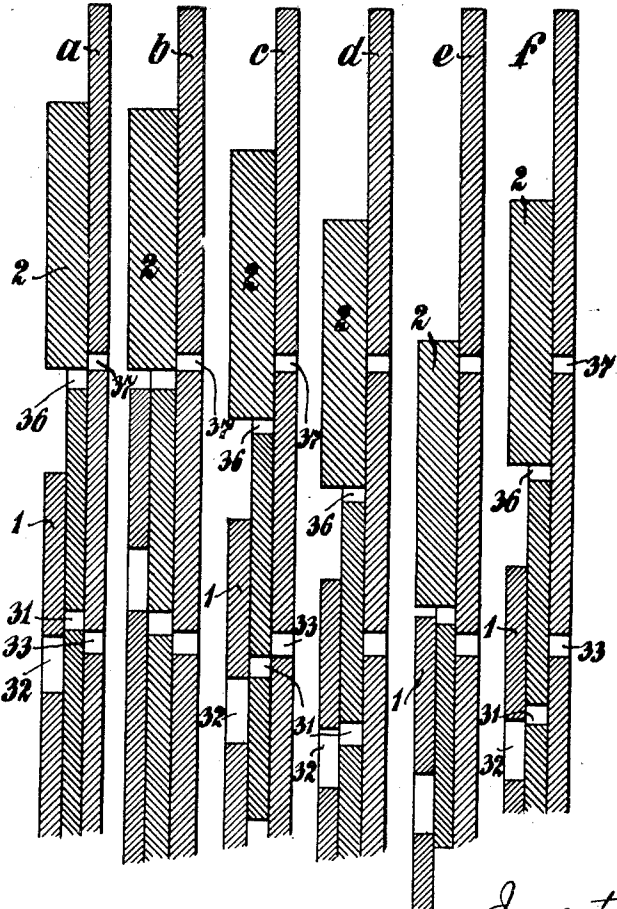


Fig.10



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UNITED STATES PATENT OFFICE.

RUDOLF SLABY, OF CHARLOTTENBURG, GERMANY.

VALVELESS INTERNAL-COMBUSTION MOTOR.

1,099,576.

Specification of Letters Patent.

Patented June 9, 1914.

Application filed November 17, 1911. Serial No. 660,810.

To all whom it may concern:

Be it known that I, RUDOLF SLABY, a subject of the King of Prussia, residing at 33 Sophienstrasse, Charlottenburg, near Berlin, Germany, have invented certain new and useful Improvements in Valveless Internal-Combustion Motors; and I do hereby declare the following to be a full, clear, and exact description of the invention.

10 My invention relates to a valveless internal combustion motor in which the distribution is controlled by the pistons, all special valves and driving gear therefor being omitted.

15 The motor comprises a cylinder containing two pistons which are individually driven by the crank-shaft in such manner that they at times move in the same direction as, and at times opposite to one another, so that during each revolution of the crank-shaft the volume of gas between the pistons is twice compressed and twice expands.

20 A primary object of my invention is to provide that the admission and exhaust are controlled through ports in the cylinder, said ports being controlled by the pistons. To this end, I provide that the motion of the two pistons is unsymmetrical to such an extent that the paths traversed by the pistons differ from one another during the suction and exhaust in a predetermined manner as is fully described hereinafter.

25 Several illustrative embodiments of my invention are represented by way of example in the accompanying drawings, wherein:—

30 Figure 1 is a longitudinal section showing a motor in which each piston is driven by a separate crank eccentric thereto; Fig. 2 is a like view of a motor in which one piston is driven by an eccentric crank gear and the second by the connecting-rod extending beyond the crosshead-pin; Fig. 3 is a like view of a motor in which the second piston is driven by the connecting-rod extending beyond the crank-pin, and Fig. 4 is a like view of a motor in which the two pistons are both driven through the medium of one common journal by an eccentric crank-gear for each. Figs. 5, 6 and 7 are like views showing a modified form of the motor according to Fig. 3 in various positions. Fig. 8 is a like view showing a form similar to that shown in Fig. 4, but the second piston is driven by two crank-gears. Figs. 9 and 10 diagrammatically show the individual relative positions of the two pistons of the

motors according to Figs. 3 and 5, respectively, and Fig. 11 shows a modified form of the crank mechanism according to Fig. 3.

Like reference numerals designate like parts in all views.

Referring firstly to Fig. 1, the cylinder 15, open at both ends, is enlarged at its ends to form the crank chambers 16 and 17. On the flanges 20 and 23 of these chambers are mounted the covers 18 and 19 having corresponding flanges 21 and 22, respectively. The cylinder is surrounded by a cooling jacket 39. The pistons 1 and 2, in each of which is journaled a pin 5 and 6, respectively, in a bearing 3 and 4, respectively, move in the cylinder. Attached to these pins are the ends of connecting-rods 7 and 8 whose other ends are attached to the crank-pins 9 and 10. These pins 9 and 10 are on cranks 11 and 12 fast on the main shafts 13 and 14, respectively. For obtaining the unsymmetrical motion of the pistons the two crank mechanisms are displaced in different directions, that is to say, the shaft 13 is located below and the shaft 14 above the middle of the engine. Owing to this eccentricity the velocities at which the pistons move to and fro vary in magnitude. As the two cranks are displaced in opposite directions, at the moment when the speed of the piston 2 is least the speed of the piston 1 will be a maximum. At the two dead centers the distances between the two pistons are equal. When changing from one dead center to the other, the pistons gradually move apart until the greatest distance between the pistons depending on the stroke is obtained, and then approach one another. Consequently, during each revolution of the two cranks the pistons approach one another twice and move away from one another twice. Consequently, during each revolution one complete four stroke cycle can be obtained, suction and compression taking place during one half revolution of the cranks and ignition and exhaust during the other. The slots or ports for sucking in the gaseous mixture and for expelling the products of combustion must be arranged in such manner in the cylinder that they are liberated by the pistons at the suitable moments (Fig. 5 shows one form of motor and its slots or ports). In order to obtain a specially effective variation of volume in the arrangement according to Fig. 1 the eccentricity must be sufficiently great, which

however is difficult to arrange for in this construction. A preferable arrangement is obtained when only one crank shaft is employed, the one piston being driven directly by the connecting-rod, and the other, on the contrary, by a lever attached to the latter. The four phases of the four-stroke cycle are brought about during one revolution of the crank by the joint-between the lever and connecting-rod closing twice and opening twice. The unsymmetrical operation of the two pistons for the purpose of each port being liberated once during each revolution of the crank-shaft can likewise be obtained by displacing the middle of the crank-shaft from the longitudinal axis of the cylinder or by attaching the lever to the connecting-rod at a point located laterally of its longitudinal axis. In this manner I obtain that the suction and exhaust stroke occur at different parts of the cylinder whereby simultaneous opening of the two rows of ports or double opening of one row of ports during one revolution is prevented. The displacement of the middle of the crank-shaft from the longitudinal axis of the cylinder requires to be only small in order to obtain considerable deviations in the individual working phases. Various forms are shown in the drawings.

Referring to Fig. 2, a hollow cylindrical projection or flange 26 of the piston 1 projects into the piston 2. The annular chamber 27 between the two pistons constitutes the combustion chamber. The piston 1 is driven by the eccentric crank-mechanism 11. The connecting-rod 7 projects beyond the piston-pin 5 and carries at its free end a pin 24 to which the lever 25 is attached. The latter is also attached to the pin 6 journaled in a bearing 4 in the piston 2.

In Fig. 3, the numeral 1 designates the upper and 2 the lower piston. The piston 1 is driven by an eccentric crank-gear. The connecting-rod 7 projects beyond the crank-pin and acts through the lever 25 on the piston 2. In this arrangement the hood 18 is formed as a guide for the piston 2.

In the illustrative embodiment according to Fig. 4 the piston 1 moves in the piston 2. Both the pistons are driven by eccentric crank mechanism comprising the connecting-rods 7 and 8 and the common crank 11. The middle of the crank-shaft 13 is displaced out of the longitudinal axis of the cylinder.

Fig. 5 shows a motor comprising the crank mechanism according to Fig. 3, but the pistons are inserted one in the other in the manner according to Fig. 4. The piston 1 moves in a bushing 28 provided below the piston 2, and is driven by the eccentric crank mechanism 11, while the piston 2 is driven by the lever 25 attached to the lengthened connecting-rod 7. The gaseous mixture en-

tering through the pipe 30 is conducted through both the ports 33 in the cylinder and through ports 31 in the bushing 28, as well as through ducts 32 in the piston 1 into the cylinder chamber 27. The piston 1 moves rapidly downward, and the piston 2 follows only slowly. Consequently, the suction ports 33, 31 remain connected with the cylinder until the greatest distance between the two pistons obtains. The suction port is now closed. The piston 2 now rapidly follows the leading piston 1 and compresses the mixture. In the lowest position of the two pistons (Fig. 6) the mixture is compressed and is ignited in the ignition-tube 35 by the spark-plug 34. During the expansion which now takes place the piston 2 leads in front of the piston 1 and in its top position establishes the connection with the exhaust port (Fig. 7) through the ports 36 and 37 in the bushing 28 and the walls of the cylinder, respectively. The piston 1 which follows expels the products of combustion until the returning piston 2 again stops the passage through the ports 36 and 37.

In Fig. 10 the various positions of the pistons are shown diagrammatically. For the sake of clearness the exhaust and admission ports are shown at the same side of the cylinder. The various positions are as follows:—

Position *a*: Expansion has finished, the exhaust ports (36, 37) are just being opened. Both the pistons are moving upward together, piston 1 more quickly than piston 2 (cf. also Fig. 7).

Position *b*: The top piston has passed its highest position and just closed the exhaust ports. Piston 1 is changing its direction of motion and opening the admission ports 33, 31, 32. Suction begins.

Position *c*: Piston has moved downward more quickly than piston 2. Suction is finished, the admission ports are closed and compression is beginning.

Position *d*: In the middle of compression. Piston 2 is now moving downward more quickly than piston 1. The ports are well covered.

Position *e*: Both the pistons are at the bottom dead centers, compression is finished and ignition takes place (cf. also Fig. 6).

Position *f*: Middle of expansion. Both the pistons are moving upward, piston 2 more quickly than piston 1.

Fig. 9 diagrammatically shows the various positions of the piston of a motor in which the piston 1 is located above the piston 2, approximately corresponding to the arrangement according to Fig. 3. In the positions *a*, *b*, until shortly before the position *c* suction takes place through the ports 33, 40, whereupon compression and ignition take place in the position *c* and *d*, respectively. Expansion takes place in the position *e*, *f*, *g*.

The piston 1 now descends and liberates the exhaust ports 40, 37. Exhaust takes place in the positions *h*, *i*, *k*. The two pistons then move upward at a fairly constant distance apart in order to move farther apart shortly after the admission port has been opened, and finally arrive again in position *a*.

It will be understood from Fig. 9 that it is possible to control the distribution solely through ports in the outer wall of the cylinder, as must be the case, moreover, in motors according to Figs. 2 and 3. It has been found, however, that the operation is the more exact and the lap greater, the larger the number of the controlling faces of the cylinder.

In the illustrative embodiment according to Fig. 8 the piston is driven by the simple eccentric crank 11 and the connecting-rod 7, while the piston 2 is driven by the two cranks 11, 11' and the two connecting-rods 8, 8', the joint 6 being guided in the piston 2 by a guide 41. The movements of the piston 2 are hereby doubled.

As mentioned above, the same action as that obtained owing to the eccentricity can be brought about by a lateral attachment of the lever which moves the second piston. Such an arrangement is shown in Fig. 11 which otherwise corresponds to the arrangement according to Fig. 3. The lever 25 is pivotally attached to the pin 24 outside the middle of the connecting-rod. In this manner a difference in the movements of the pistons is brought about. All such motors are operated according to the process described above. Obviously, numerous modifications can be made according in each instance to the selection of the individual amounts of lap and to the direction of rotation of the motor. It is also possible for one and the same motor to run in different directions when the admission and exhaust are exchanged. In general, the efficiency of the reversed motor will not be so good, but by employing a smaller displacement favorable conditions can be obtained. It remains to be added that the mode of operation of the motor can be adapted to the thermically most favorable conditions by, for example, selecting the expansion volume greater than the suction volume, or by causing the pistons to approach closer together when expelling the gases than is requisite for compression.

I claim:—

1. In an internal combustion engine, the combination with a cylinder having inlet and exhaust ports; of two pistons therein between which the combustion chamber is formed and by which said ports are controlled, and means to unsymmetrically move the pistons and cause them to twice approach one another and twice separate during a single cycle.

2. In an internal combustion engine, the

combination of a cylinder, with two pistons reciprocating therein and inclosing the working chamber between themselves, said cylinder having ports for the admission of the gaseous mixture and ports for the exhaust of the products of combustion controlled by said pistons, and means for moving the pistons unsymmetrically, said means causing the paths through which the pistons travel during the suction and exhaust to be located at different parts of the inner periphery of the cylinder.

3. In an internal combustion engine, the combination of a cylinder, with two pistons reciprocating therein and moving one in the other, said cylinder having ports for the admission and exhaust of gases controlled by the pistons, and means for moving the pistons unsymmetrically.

4. In an internal combustion engine, the combination of a cylinder, two pistons reciprocating therein, said cylinder having ports for the admission and exhaust of gases controlled by the pistons, and an eccentric crank-gear for driving one of the pistons.

5. In an internal combustion engine, the combination of a cylinder, two pistons reciprocating therein, said cylinder having ports for the admission and exhaust of gases controlled by the pistons, crank mechanism comprising an eccentric crank and a connecting-rod for driving one of the pistons, and means for driving the second piston from the said connecting-rod.

6. In an internal combustion engine, the combination of a cylinder, two pistons reciprocating therein, said cylinder having ports for the admission and exhaust of gases controlled by the pistons, crank mechanism comprising an eccentric crank and a connecting-rod lengthened beyond the crank-pin for driving one of the pistons, and a lever for driving the second piston pivotally connected to the connecting-rod beyond the crank-pin.

7. In an internal combustion engine, the combination with a cylinder having a set of inlet ports and a set of exhaust ports; of two pistons in the cylinder between which the combustion chamber is formed, means for unsymmetrically moving the pistons in the cylinder and causing them to twice recede from one another during a cycle, one of said sets of ports being piston-controlled.

8. In an internal combustion engine, the combination with a cylinder having inlet ports and exhaust ports; of two pistons therein between which the combustion chamber is formed, said pistons provided with ports, and means to cause the unsymmetrical movement of the pistons twice toward and twice from one another during a cycle of operations.

9. In an internal combustion engine, the combination with a cylinder having inlet

and exhaust ports; of two pistons therein between which the combustion chamber is formed, one of said pistons having a cylindrical ported extension cooperating with the
5 other piston and aforementioned ports, a crank in the cylinder and means also within the cylinder connecting the two pistons to said crank to unsymmetrically move said pistons.

10 10. In an internal combustion engine, the combination with a cylinder having inlet and exhaust ports; of two pistons therein between which the combustion chamber is formed, said pistons having cylindrical
15 ported extensions cooperating with the aforementioned ports, a crank, and means connecting the two pistons to said crank.

11. In an internal combustion engine, a cylinder having inlet and exhaust ports,
20 two interfitting ported pistons in said cylinder, links pivotally connected together and

to the pistons, and a crank eccentric to the cylinder for operating the links.

12. In a combustion engine, the combination with a cylinder having an inlet at 25 one point thereof and an exhaust longitudinally displaced therefrom; of two pistons in said cylinder between which the combustion chamber is formed and means to unsymmetrically displace said pistons and longitudinally displace the combustion chamber
30 in the cylinder between said inlet and exhaust, said inlet and exhaust being piston-controlled.

In testimony whereof I have signed my 35 name to this specification, in the presence of two subscribing witnesses.

RUDOLF SLABY.

Witnesses:

HENRY HASPER,
RICHARD GOETZ.