H. B. ROSS.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED MAR. 16, 1906. RENEWED JAN. 10, 1910.

1,006,132. **Patented Oct. 17, 1911.**

2 SHEETS—SHEET 1.

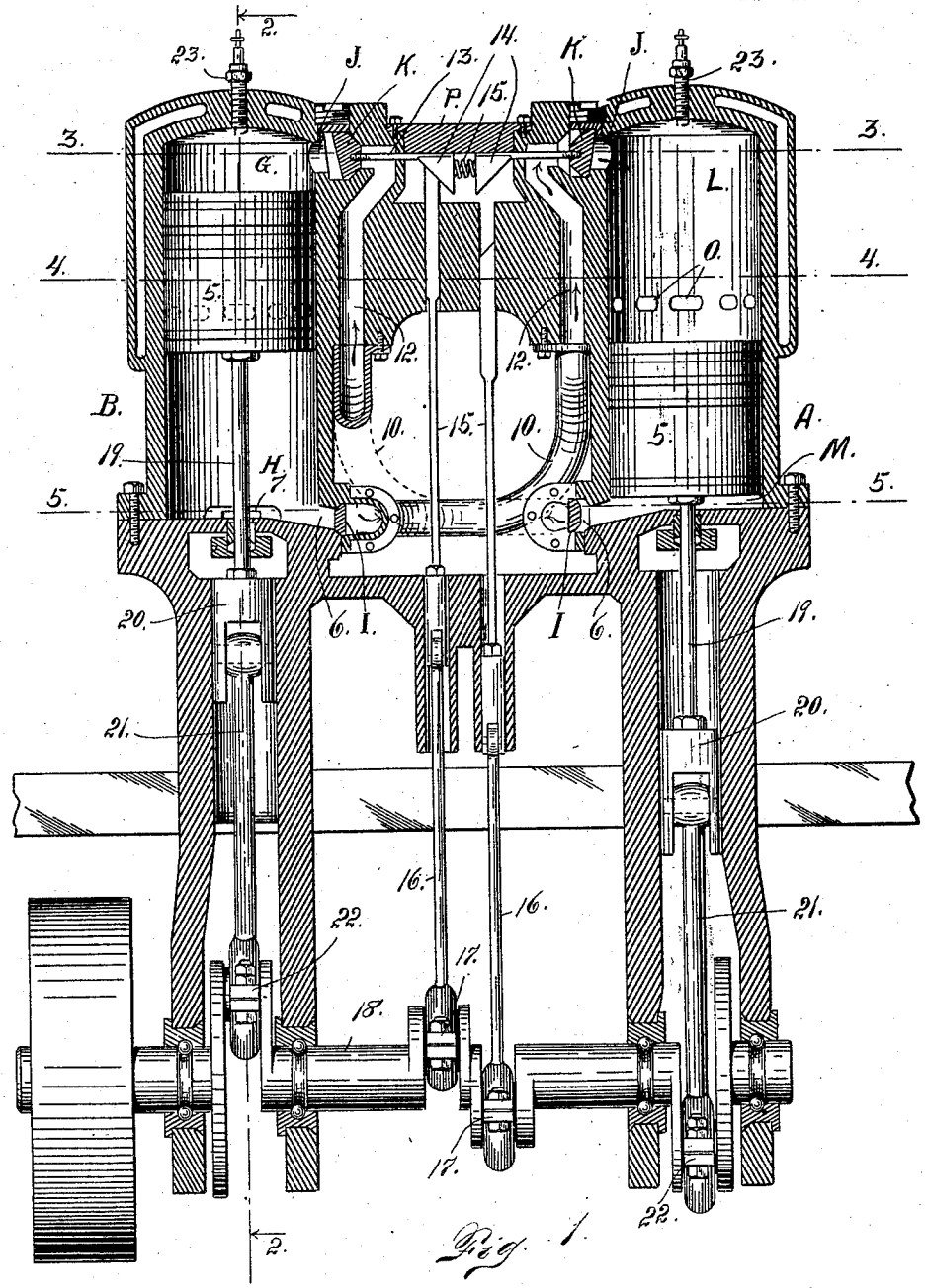

Fig. 1.

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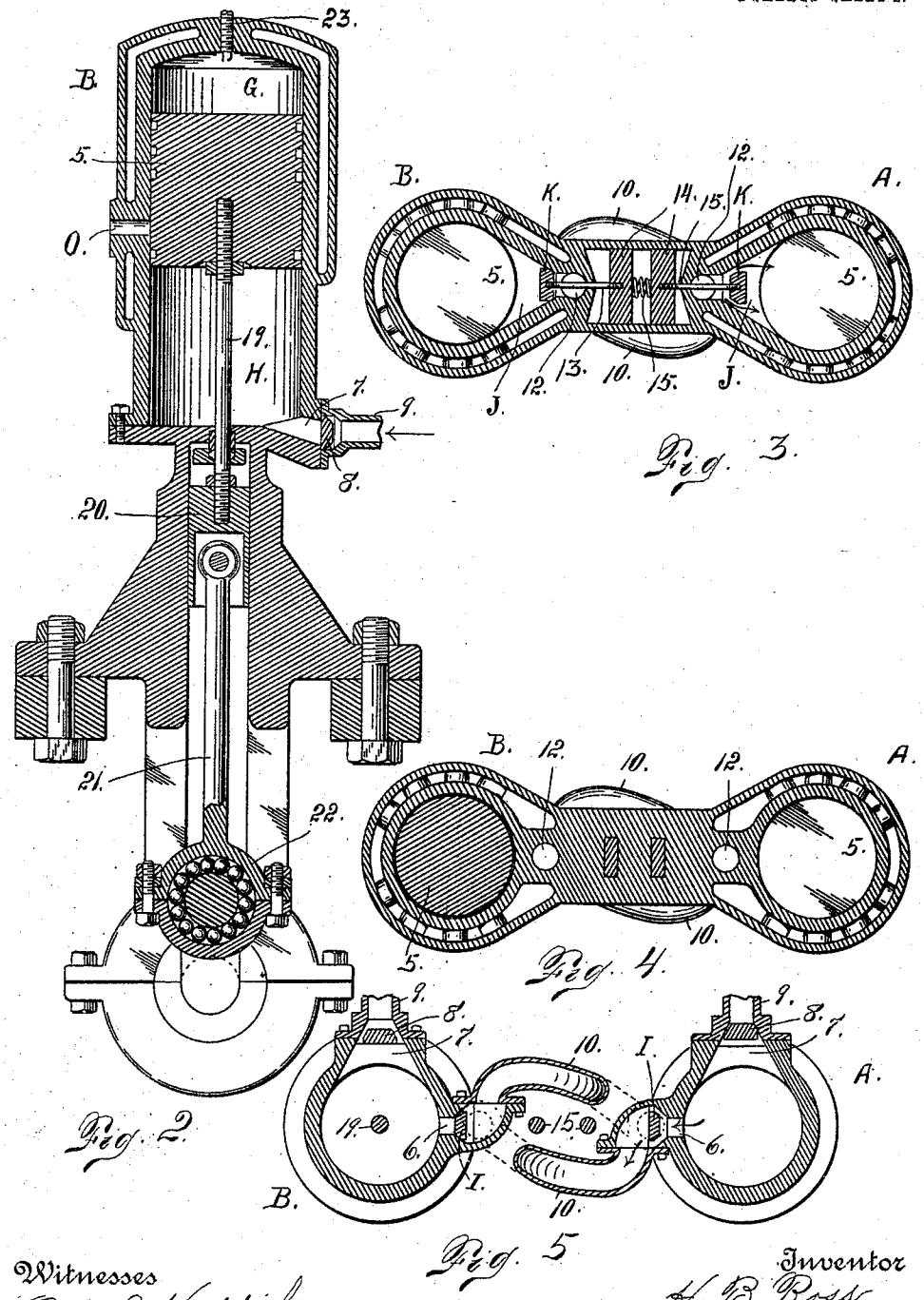

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5

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UNITED STATES PATENT OFFICE.

HARRY BEAUREGARD ROSS, OF DENVER, COLORADO, ASSIGNOR OF ONE-THIRD TO WILLIAM O. TEMPLE AND ONE-THIRD TO BEAUREGARD ROSS, OF DENVER, COLORADO.

INTERNAL-COMBUSTION ENGINE.

1,006,132. Specification of Letters Patent. **Patented Oct. 17, 1911.**

Application filed March 16, 1906, Serial No. 306,364. Renewed January 10, 1910. Serial No. 537,338.

To all whom it may concern:

Be it known that I, HARRY BEAUREGARD ROSS, a citizen of the United States, residing in the city and county of Denver and State of Colorado, have invented certain new and useful Improvements in Internal-Combustion Engines; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form a part of this specification.

My invention relates to improvements in internal combustion engines of the two-cycle class.

In my improved engine I employ coöperating cylinders preferably arranged in pairs. In other words each engine unit consists of at least two coöperating cylinders. In this application a single unit only will be described. It will of course be understood, however, that any number of these units may be employed according to the desired capacity of the engine.

My improvements relate more especially to the means employed for compressing the explosive mixture and transferring it to the explosion compartments of the cylinders.

Some of the objects of my improved construction are: first, to secure a better exhaust or removal of the products of combustion from the explosion compartments of the cylinders; second, to secure a higher compression of the explosive mixture; third, to provide a fresher charge for the explosion; fourth, to prevent wasteful leakage of gas; fifth, to minimize strain and wear of the machinery parts; and sixth to provide an engine of the smallest possible bulk and weight, simple in construction, that will develop the required power so quickly as to be practically self starting. I attain these objects by the use of the mechanism illustrated in the drawings in which,

Figure 1 is a central longitudinal section taken through my engine cutting the cylinders centrally. Fig. 2 is a section taken on the line 2—2 Fig. 1. Figs. 3, 4 and 5 are cross sections taken on the lines 3—3, 4—4 and 5—5 respectively, of Fig. 1.

The same reference characters indicate the same parts in all the views.

A single unit of my improved engine includes at least two cylinders each having two chamber compartments for the compression and explosion of the ordinary mixture of gas and air used in internal combustion engines. These cylinders as shown in the drawing are designated by the reference characters A and B, respectively. The explosion compartments of the two cylinders are respectively indicated by the letters G and L; while their opposite compartments are indicated respectively by the letters H and M. The explosions occur alternately in the upper chambers of the two cylinders or in the chambers more remote from the crank or driving shaft; while the compression takes place in both chambers of each cylinder. These cylinders A and B are preferably of uniform size. Each cylinder is provided with a piston 5 of the usual form, which reciprocates or works backward and forward or up and down according to the position of the engine. Each cylinder is provided with an inlet port J for the explosive mixture at or near its upper extremity; and with exhaust ports O in the walls of the cylinder, the same being hereinafter described more in detail. Each cylinder is also provided with an outlet port 6 at the bottom controlled by a valve I; and an intake port 7 controlled by a valve 8. This intake port communicates with a conduit 9 leading from a carbureter or a source of explosive-mixture supply. These intake ports are for the entrance of the explosive mixture to the compartments H and M of the cylinders, in response to the suction or vacuum produced by the upward or outward movement of the pistons. These ports must be distinguished from the inlet ports J heretofore referred to which communicate with the explosion chambers or explosion compartments of the cylinders, and through which ports J the explosive mixture is forced by the down-stroke of the piston of the opposite cylinder. The exhaust ports preferably consist of a number of small open-

ings or perforations in the side of each cylinder, so arranged that a straight line drawn at right angles to the direction of the piston's stroke would pass through the openings. These ports are so arranged that all of them belonging to the same cylinder are opened and closed simultaneously by the movement of the piston. That part of the cylinder remaining between these different openings serves as a bridge or series of bridges over which the piston rings pass without danger of spreading or other interference.

The valve 8 of each cylinder should be made of the lightest possible material as aluminium, so as to render it highly sensitive to the influence of vacuum and pressure. This valve opens with the up-stroke of the piston and closes with the down-stroke. The valves I should also be constructed of light material and should be similar to the valves 8 in form and construction, except that the valves I should be so arranged as to close with the up-stroke of the piston and open with the down-stroke. The port controlled by each valve I serves as an outlet through which the compressed gas in the lower chamber is expelled by the down-stroke of the piston. The port controlled by each valve K as heretofore explained, serves as an inlet port through which the fresh charge of the explosive mixture is conveyed to the upper extremity of the cylinder. This charge passes from the carbureter through the conduit 9, thence through the port 7 into the compression chamber H or M (as the case may be) of the cylinder, where it is compressed by the down-stroke of the piston and forced out through the ports 6 controlled by the valves I. These ports 6 each communicate with a conduit 10 leading to a passage 12 whose extremity remote from the conduit leads to a port J controlled by a valve K. Hence as each piston makes a down-stroke, the explosive mixture in its cylinder is forced out through a port 6, causing the valve I to open, thence through a conduit 10, a passage 12 and a port J into the explosion or upper compartment L or G as the case may be of the opposite cylinder.

The action of the engine is greatly assisted by the inlet valves K which control the ports J leading to the explosion compartments of the cylinders as heretofore explained. Each valve K is connected with one extremity of a rod 13 to whose opposite extremity is attached a triangular cam 14. The two cams 14 are connected by a coil spring 15. When the coil spring is inactive the valve devices move from one side to the other as if made of one piece, sliding backward and forward along the smooth lower surface or plane of a stationary metal plate P. These valves reciprocate with each other in the performance of their functions and are automatic. For example when the charge is forced into the explosion compartment L of the cylinder A, its pressure opens the adjacent valve K by pushing it to the right and in so doing it closes the valve K of the opposite cylinder. But to insure the closing of these valves at the precise moment required, I have provided auxiliary means for closing them mechanically, consisting of metal rods 15, one for each cam 14. These rods are connected with pitmen 16 which are connected with cranks 17 of the driven shaft 18. The upper or outer extremities of the rods 15 are beveled to correspond with the inclined sides of the triangular cams 14, so that when either rod on its up-stroke is brought in contact with a cam 14, the planes of their engaging surfaces touch at every point. The entire mechanism is so constructed and adjusted, that either rod 15 is carried to the end of its up-stroke just as one of the pistons 5 has passed upward or outward to the point of explosion in its cylinder. On the up-stroke of rod 15, its top or outer extremity comes in contact with the lower surface or plane of left hand cam 14 and presses against it with sufficient force to close the corresponding valve K completely and quickly (if it has not already closed automatically as before explained) so that the explosion in compartment L takes place without any loss of power.

Each piston 5 is connected with a stem 19 which is attached to a crosshead 20, the latter being in turn connected with a pitman 21 connected with a crank 22 of the driven shaft 18. The upper extremity of each cylinder is provided with a sparking plug 23 carrying suitable electrodes which protrude into the explosion compartment of each cylinder in the usual manner. As nothing is claimed on this sparking plug construction, neither it or its electrical connections will be described more in detail.

From the foregoing description the use and operation of my improved engine will be readily understood.

It should always be borne in mind that the two cylinders A and B supplement each other and that their action is reciprocal.

Referring now to the position of the parts as shown in Fig. 1, it will be assumed that the compression compartment H of the cylinder B is full of explosive mixture admitted on the up-stroke of the piston 5. We will also assume that the said piston has reached its upward limit of movement and has commenced its return or power stroke. The explosive mixture having been compressed in the explosion compartment G, the explosion takes place just immediately after the piston has commenced its return stroke or when its corresponding pitman has passed the dead center position. As the explosion occurs in the compartment G, the already

descending piston is driven rapidly downwardly into the compartment H, where the explosive mixture attains a very high degree of compression. This explosive mixture is drawn into the compartment H during the up-stroke of the piston, from the carbureter through the port 7, the valve 8 having assumed the position shown at the left of Fig. 5 allowing the mixture to enter from the carbureter. The down-stroke of the piston moving in the compartment H, not only compresses this charge, but forces it out of the compression chamber through the port 6 opening the valve I and driving the charge thence through the corresponding conduit 10, and passage 12 causing the valve K to open, the mixture being finally forced into the explosion compartment L of the cylinder A, just after that cylinder's exploded charge has exhausted through the exhaust ports O in that cylinder. The dead gas or burned product resulting from the explosion, is thus caught between the two opposing forces namely the fresh charge forced into the top of the cylinder as just explained, and the return stroke of the ascending piston, and by this means the dead gas is completely forced out into the atmosphere through the exhaust ports of the cylinder. The explosion compartment L is then ready for another explosion, its piston 5 having compressed the charge of gas admitted as before explained, in the upper extremity of the cylinder A. Now as the explosion occurs in the explosion compartment L the piston 5 of the chamber A is driven downward whereby the gas is compressed in the lower compartment M of the cylinder, from which it is forced by the down-stroke of the piston through the port controlled by the adjacent outlet valve I, thence through the conduit 10 and the passage 12. At the upper extremity of the latter the explosive mixture acts on the valve K and opens the latter allowing the mixture to enter the explosion compartment G of the cylinder B. The result of the two cylinders thus alternating and coöperating with each other, is to produce two explosions to one revolution of the crank shaft. In each cylinder the explosion takes place one-half of a revolution before or after the explosion in the other cylinder.

Having thus described my invention, what I claim is:

1. An internal combustion engine comprising two coöperating cylinders forming an engine unit, a piston separating each cylinder into two compartments in one of which the explosion occurs in each cylinder, a connection between the two cylinders whereby as the piston of either cylinder is moved from the explosion compartment toward the opposite compartment, a charge of explosive mixture is forced from the last named compartment of that cylinder into explosion compartment of the other cylinder, the pistons of the two cylinders being arranged to move simultaneously in opposite directions, each cylinder having a suitable port for the entrance of the explosive mixture, valves for controlling said ports, a cam connected with each valve, and having an inclined face, rods having oppositely inclined faces engaging the inclined faces of the cams, the latter being connected to reciprocate in unison whereby when one valve is opened the other is closed, and means for reciprocating these rods whereby they act alternately on the two cams.

2. An internal combustion engine in which the engine unit includes two coöperating cylinders, a piston separating each cylinder into two compartments in one of which the explosion occurs in each cylinder, a connection between the two cylinders whereby as the piston of either cylinder is moving from the explosion compartment toward or into the opposite compartment, a charge of explosive mixture is forced from the last named compartment of that cylinder into the explosion compartment of the other cylinder, the pistons of the two cylinders being arranged to move simultaneously in opposite directions, each cylinder having a suitable port for the entrance of the charge of explosive mixture, valves for controlling these ports, a connection between the two valves including cams having inclined faces, rods having oppositely inclined faces acting on the cams, means for reciprocating the rods alternately whereby as one valve is opened the other is closed, and means for producing an explosion in the explosion compartment of each cylinder for every two strokes of its piston.

3. An internal combustion engine in which the engine unit includes two coöperating cylinders, a piston separating each cylinder into two compartments in one of which the explosion occurs in each cylinder, the explosion compartment of each cylinder being in communication with the opposite compartment of the other cylinder, by suitable ports, valves for controlling said ports, a connection between the two valves, whereby they move in unison, said connection including a compensating spring and cams, rods engaging the cams whereby the valves are simultaneously actuated, means for reciprocating the rods whereby they act alternately upon the cams, the latter being constructed to cause the valves to move in one direction when acted upon by one rod, and in the opposite direction when acted upon by the other rod, and means whereby explosions are made to occur alternately in the two cylinders and whereby an explosion occurs in each cylinder for each two strokes of the piston of that cylinder.

4. An internal combustion engine in which the engine unit includes two cylinders, a piston in each cylinder separating the cylinder into two compartments in one of which the explosion occurs, the central portion of the wall of each cylinder being open for exhaust purposes, the exhaust opening being uncovered before the piston reaches the limit of its working stroke in either cylinder, the explosion compartment of each cylinder being in communication with the opposite compartment of the other cylinder by suitable ports, valves for controlling said ports, a connection between the two valves whereby they are caused to operate in unison, the said connection having a compensating spring, and means for actuating the two valves whereby they are caused to move simultaneously in opposite directions, one being opened and the other closed during each movement, the arrangement being such that the explosions occur alternately in the opposite cylinders, the communicating connection between the two cylinders being such that while each piston is making its working stroke, it is forcing a charge of explosive mixture from its own cylinder into the outer end of the explosion compartment of the opposite cylinder, causing the said charge to coöperate with the approaching piston of the last named cylinder to expel the products of combustion through the exhaust opening.

5. An internal combustion engine in which the engine unit is composed of two coöperating cylinders in which the explosions occur alternately, pistons in the respective cylinders, each piston separating its cylinder into two compartments in one of which the explosion occurs, the explosion compartment of each cylinder being in communication with the opposite compartment of the other cylinder by suitable ports, valves for controlling said ports, a connection between the two valves, mounted to have a reciprocating movement, and means acting on the said connection for moving both valves alternately in opposite directions, the central portion of the wall of each cylinder being open for exhaust purposes, the parts being so constructed and arranged that while either piston is making its return stroke, a charge of explosive mixture is drawn into the cylinder compartment opposite the explosion compartment, while when either cylinder is making the working stroke, this charge is driven into the explosion compartment of the other cylinder and coöperates with the approaching piston of the last named cylinder to expel the exhaust products.

6. An internal combustion engine including a cylinder provided with an exhaust port in its central portion, and a piston adapted to reciprocate therein, and means whereby the charge of explosive mixture is driven into the explosion compartment of the cylinder on one side of the exhaust port, each cylinder having an inlet port for the charge of explosive mixture, connected valves for controlling said ports, and means acting on the said connection for moving the two valves alternately in opposite directions, while the piston of the cylinder is approaching the exhaust port from the opposite side whereby the two agencies simultaneously coöperate to expel the exhaust products.

7. An internal combustion engine in which the charge of explosive mixture is delivered to the explosion compartment of the engine cylinder on one side of the exhaust port, while the piston of the cylinder is approaching the exhaust port from the opposite side, whereby the two agencies simultaneously coöperate to expel the exhaust products, each cylinder having an inlet port for the charge of explosive mixture, valves for controlling the two ports, rods for connecting the valves, each rod being provided with a cam, a compensating spring connecting the two cams, and means acting on the cams for simultaneously moving both valves alternately in opposite directions, whereby one valve is opened simultaneously with the closing of the other valve, substantially as described.

8. A two-cycle internal combustion engine in which the engine unit includes two coöperating cylinders, and means whereby a charge of explosive mixture is forced by the working stroke of the piston of each cylinder, into the explosion compartment of the other cylinder during the return stroke of the piston of the last named cylinder, each cylinder having an inlet port for the explosive charge, valves for controlling said ports, a connection between the valves, mounted to reciprocate in a direction at right angles to the movement of the pistons, and means for alternately moving both valves simultaneously in opposite directions, substantially as described.

9. An internal combustion engine including two coöperating cylinders having pistons separating their respective cylinders into two compartments in one of which the explosion occurs, the apparatus being provided with passages whereby the explosion compartment of each cylinder communicates with the opposite compartment of the other cylinder, and valves controlling the cylinder ports at the opposite extremities of these passages, a connection between the said valves, mounted to reciprocate at right angles to the axes of the cylinders, and means acting on the said connection for simultaneously imparting movement to both valves alternately in opposite directions, substantially as described.

10. An internal combustion engine including two coöperating cylinders, each cylinder having a piston separating it into two compartments in one of which the explosion occurs, the apparatus being provided with passages whereby the explosion compartment of each cylinder communicates with the opposite compartment of the other cylinder, valves controlling the cylinder ports at the opposite extremities of these passages, the said valves being arranged to open and close automatically at properly timed intervals under the influence of fluid action, and means coöperating with the automatic fluid action for operating the valves to control the ports of the explosion compartments of the two cylinders, comprising rods having cams, a connection between the two cams, the valves being mounted to reciprocate in a direction at right angles to the axes of the cylinders, and means acting on the cams for alternately moving both valves simultaneously in opposite directions, substantially as described.

11. An internal combustion engine, comprising two cylinders, a piston separating each cylinder into two compartments namely, an explosion compartment and a compartment of initial compression, the initial compression compartment of each cylinder having an independent passage communicating separately with the explosion compartment of the other cylinder, the piston of the two cylinders being arranged to act alternately to compress the charge in the initial compression compartment of either cylinder, the said act of compression taking place alternately in the explosion compartments of the two cylinders, the two cylinders having oppositely located ports for the entrance of the explosive mixture, valve mechanism for controlling both ports comprising rods connected with the valves and having cams, the said mechanism being mounted to reciprocate, and means acting on the cams for alternately actuating the valve mechanism, whereby the two valves are simultaneously actuated to close one port and open the other.

12. An internal combustion engine, including two cylinders, each cylinder having a piston separating it into two compartments, one compartment of which is an explosion compartment, the explosion compartment of each cylinder having independent passages communicating separately with the opposite compartment of the other cylinder, each compartment opposite the explosion compartment of each cylinder having an intake port through which the charge or explosive mixture enters the compartment during the return stroke of the piston, and which is compressed by the last named piston during the opposite or working stroke into the explosion compartment of the opposite cylinder, the piston of the last named cylinder coöperating simultaneously to perform the act of compression in its own compartment, the said intake ports for the explosive mixture of both cylinders being oppositely located, valve mechanism for controlling both ports, the said mechanism being mounted to reciprocate and provided with cams, and means acting on the said cams and alternately actuating the same, whereby the two valves are simultaneously operated, the one to close and the other to open its intake port.

13. An internal combustion engine including two cylinders each having a piston separating it into two compartments in one of which the explosion occurs and in the other of which a charge of explosive mixture is drawn during the return stroke of the piston, the explosion compartment of each cylinder having an independent passage communicating separately with the opposite compartment of the other cylinder, by oppositely located ports, valve mechanism for controlling the two ports, the said mechanism being mounted to reciprocate and provided with cams, and means acting on the said cams for alternately actuating the said mechanism, whereby both valves are simultaneously operated, the one to open and the other to close its port, the pistons being so arranged that each, during its working stroke, is cushioned by the charge of explosive mixture which is forced out of its cylinder into the explosion compartment of the other cylinder.

14. An internal combustion engine, comprising two coöperating cylinders, a piston separating each cylinder into two compartments, in one of which the explosion occurs in each cylinder, a connection between the two cylinders whereby as the piston of either cylinder is moved from the explosive compartment toward the opposite compartment, a charge of explosive mixture is forced from the last named compartment of the cylinder, into the explosive compartment of the other cylinder, the pistons of the two cylinders being arranged to move simultaneously in opposite directions, valves for controlling the entrance of the explosive mixture into the explosive compartment of each cylinder, a cam connected with each valve, rods engaging the said cams, the cams being connected to reciprocate in unison, whereby when one valve is opened the other is closed, and means for reciprocating the rods, whereby they act alternately on the two cams.

15. An internal combustion engine, consisting of two coöperating cylinders, a piston separating each cylinder into two compartments, in one of which the explosion occurs in each cylinder, the explosive compartment of each cylinder having a passage

in communication with the opposite compartment of the other cylinder, valves for controlling the said passages, a connection between the two valves, whereby they move in unison, a cam connected with each valve, rods engaging the valves, whereby the valves are simultaneously actuated, means for reciprocating the rods, whereby they act alternately upon the cams, the cams being arranged to cause the valves to move in one direction when acted upon by one rod, and in the opposite direction when acted upon by the other rod, substantially as described.

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

HARRY BEAUREGARD ROSS.

Witnesses:
W. O. TEMPLE,
A. W. O'BRIEN.