

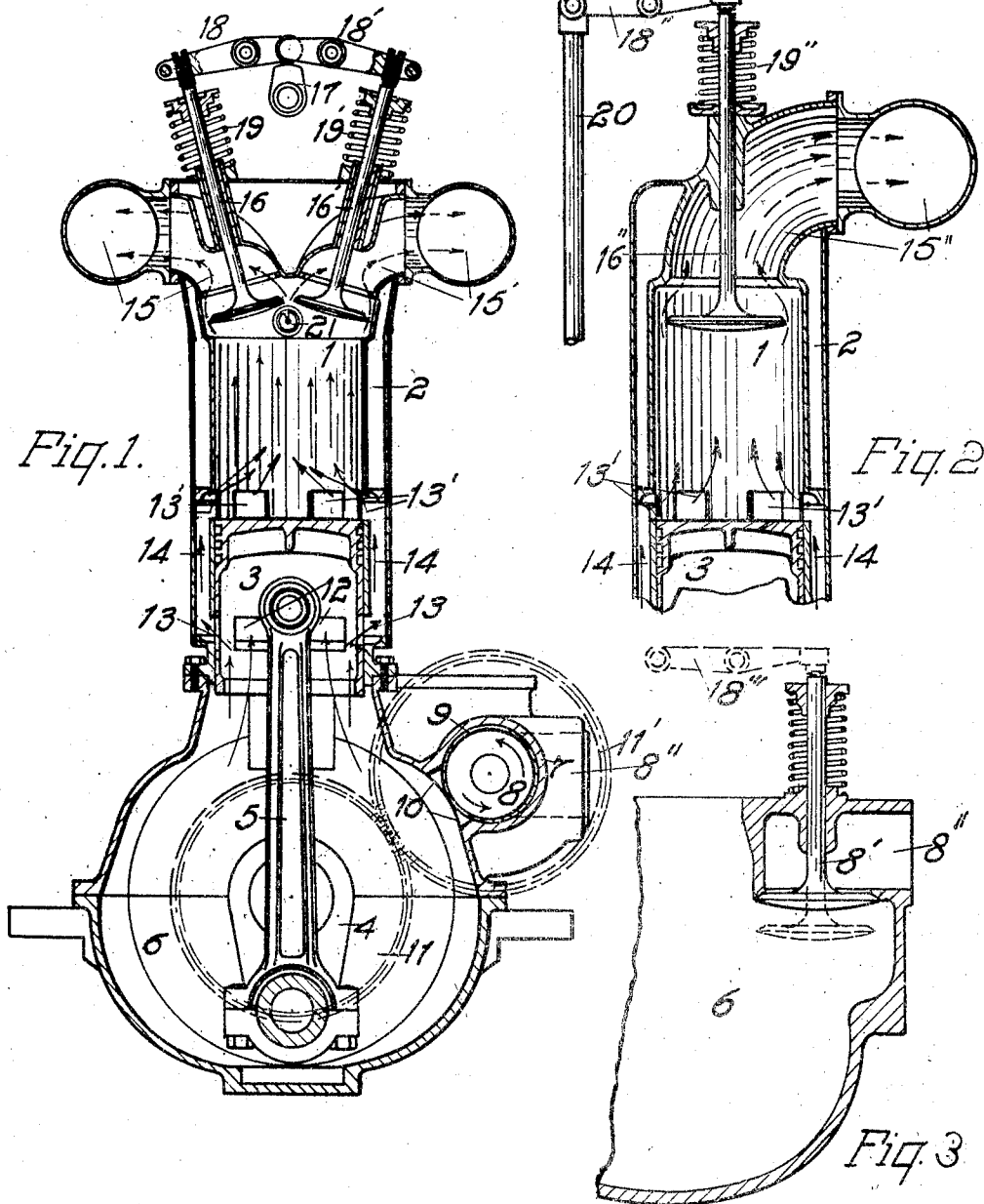
June 2, 1925.

1,540,286

E. W. ROBERTS

INTERNAL COMBUSTION ENGINE

Filed Oct. 23, 1920 2 Sheets-Sheet 1



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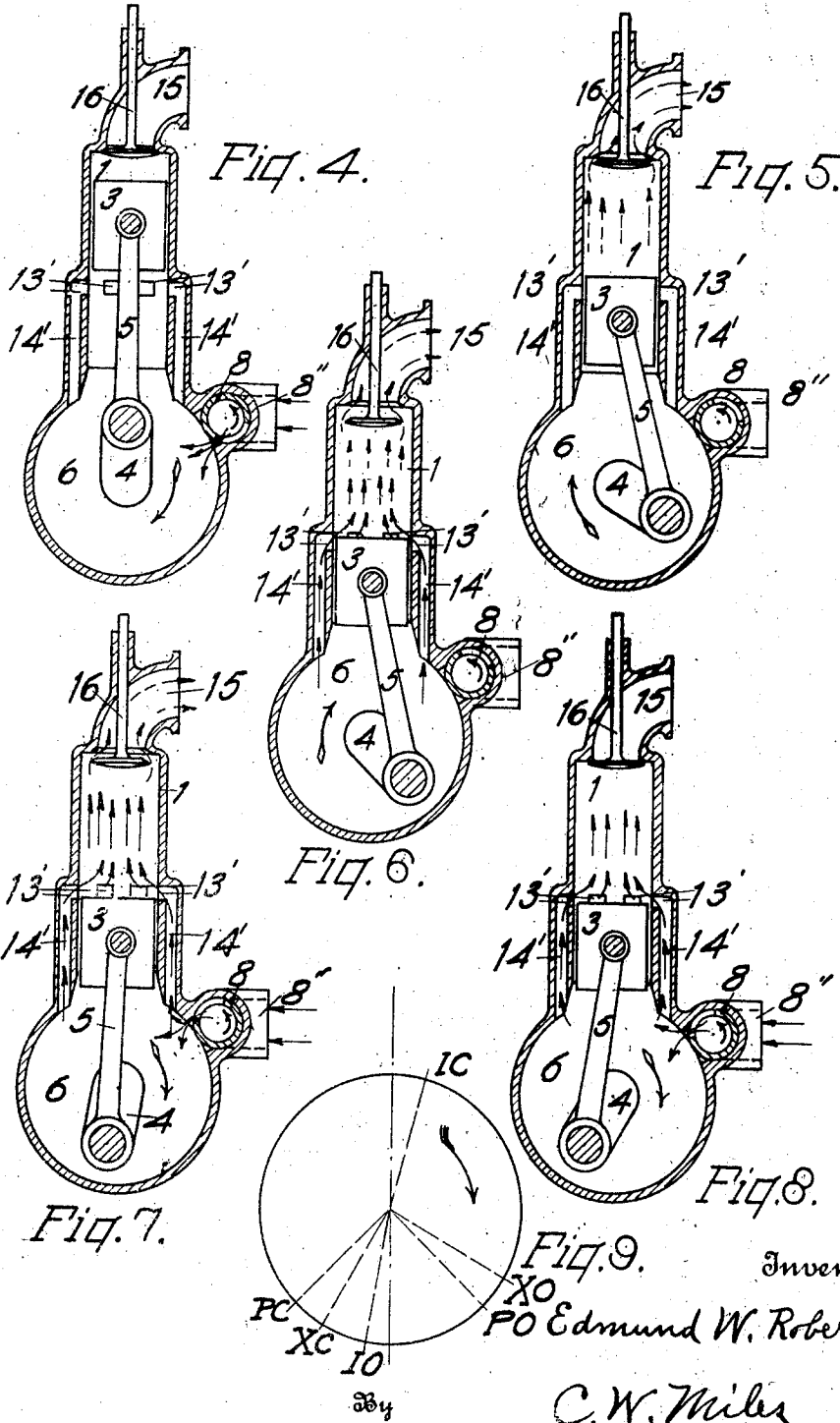
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UNITED STATES PATENT OFFICE.

EDMUND W. ROBERTS, OF CINCINNATI, OHIO.

INTERNAL-COMBUSTION ENGINE.

Application filed October 23, 1920. Serial No. 418,538.

To all whom it may concern:

Be it known that I, EDMUND W. ROBERTS, a citizen of the United States, residing at Cincinnati, in the county of Hamilton and State of Ohio; have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to certain new and useful improvements in internal-combustion engines of the reciprocating type, and it has for its objects the complete scavenging of the cylinder, clearing it entirely of the products of combustion, supercharging without the use of extraneous pumps or blowers and, incidentally thereto, providing for the unidirectional flow of the outgoing burned gases and the incoming fresh charge of pure air or mixed air and combustible, according to the system of fuel supply in use. As will be noted in the following specification, this system is generally applicable to any and all types of internal-combustion engines, whether employed for automotive or for stationary purposes, and whether operating on the Otto, the Diesel, the "semi-Diesel," or any other of the well-known systems for supplying the engine with combustible and providing for the ignition thereof. Therefore, I do not confine myself to the particular type of construction hereinafter described and shown in the accompanying drawings, nor to the exact mechanism illustrated.

The invention in its simplest form, as applied to an engine of the two-stroke cycle type, is shown in the accompanying drawings.

In the said drawings: Fig. 1 shows a central vertical section of my improved engine, which may be considered to represent a single-cylinder engine or one cylinder of a multiple-cylinder engine, all the cylinders of said engine being the same in principle and mechanism, the particular engine shown being of especially light construction and designed for airplane service. Fig. 2 shows a partial vertical section of another form of valve arrangement, in which a single exhaust valve is employed instead of the two valves shown in Fig. 1. Fig. 3 is a partial section through the intake, showing an alternate form of inlet valve. Figs. 4 to 8 inclusive are vertical sections through the cylinder of an engine embodying my invention and showing the relative positions of the

piston, the inlet valve and the exhaust valve at different points in the cycle. Fig. 9 shows a typical valve-timing diagram and indicates the approximate points at which the valves open and close during one revolution of the crankshaft and, incidentally, during the completion of one cycle of operations. Like numbers of reference indicate like parts throughout the several figures.

Referring to the drawings, the numeral 1 designates the cylinder surrounded by the water-space 2 (Figs. 1 and 2), and in the cylinder reciprocates the piston 3 linked to the crankshaft 4 by means of the connecting rod or pitman 5, this arrangement following the well-known form of construction.

The base or crankcase 6 is made airtight, as is the usual practice with engines of the two-stroke type. In the side of the base is a cylindrical portion 7, having its axis parallel to the axis of the crankshaft. In this cylindrical portion is fitted a tubular valve 8 having an opening or port 9 arranged to register, at certain intervals in the rotation of the crankshaft, with the port 10 in the wall of the base. Valve 8 is driven at the same speed as the crankshaft 4, and in time therewith, by means of the gears 11 and 11'. Air enters valve 8 through passage 8".

In the wall of the piston 3 are openings or ports 12 which register with corresponding ports 13 in the wall of the cylinder 1, when the piston is at the bottom of its stroke. These ports furnish communication for the base with the by-pass or transfer passage 14, and therethrough with the upper portion of the cylinder by means of the cylinder ports 13'. In the upper portion of the cylinder and at its topmost end are exhaust passages 15 and 15' in Fig. 1 and 15" in Fig. 2, the passage of the gases (the products of combustion) from the cylinder being controlled by means of valves 16, 16' and 16". The opening and closing of these valves is controlled, in the usual manner, by means of the cam 17, Fig. 1 or a similar cam not shown for Fig. 2, and the rocker arms 18, 18' and 18", in conjunction with the closing action of the springs 19, 19' and 19". No particular method of driving the cam in Fig. 1 or of operating the rocker arm 18" in Fig. 2 is shown, as it is obvious that any one of the well-known methods of driving the camshaft may be employed for this purpose, and the pushrod 20 in Fig. 2

may be operated by means of the usual cam and gear train. A spark plug is indicated at 21. The general paths taken by the gases are indicated by arrows, dotted arrows signifying the exhaust gases and full-line arrows the fresh gases either air alone or mixed air and combustible

In Fig. 3 is shown one form of crankcase inlet valve 8', which may be employed instead of the rotary valve 8, shown in Fig. 1. The valve 8' may be opened automatically by the pressure of the atmosphere when the pressure within the base is lowered, or it may be operated mechanically by means of the rocker arm 18''' indicated by dotted lines.

In Figs. 4 to 8, the transfer passage 14' is shown as communicating directly with the base instead of through the wall of the piston 3 as shown in Fig. 1. It is obvious that any one of the various means of furnishing communication between the base and the upper portion of the cylinder, such as a valve, or valves in the head of the piston, tubular forms of transfer passage, such as may be formed of pipe or the like, valve-controlled transfer passages, and any one of the various methods of transfer control may be employed without departing from the purpose of this invention.

With the parts constructed and arranged as hereinbefore described and as illustrated in the accompanying drawings, the operation of the engine is substantially as follows: With the parts in the position shown in Fig. 4, the piston is at the upper dead point having just completed the compression stroke, combustion has been started by means of an electric spark or other means, and the piston is about to start on its downward stroke, expanding the products of combustion. In the position of Fig. 4, the tubular valve 8 is about to close, but air is still entering the base due to the inertia of its mass. In Fig. 5, the crankshaft has rotated in the direction of the arrow through an angle of 120° beyond the position of Fig. 4 and the exhaust valve has just begun to open, the amount of such opening being exaggerated in the figure for the sake of clearness. Because of the comparatively high pressure within the cylinder, the same being about 40 pounds above that of the atmosphere, the exhaust gas, indicated by the dotted arrows, rushes rapidly from the cylinder and the pressure therein quickly reaches that of the atmosphere, and the inertia of the exhaust gas is such that the pressure within the cylinder tends to fall below that of the atmosphere and produce a partial vacuum. In the position of the parts shown in this figure the valve 8 is closed, the new charge is trapped in the base and is being compressed by the downward movement of the piston to a pressure

of from 4 to 10 pounds per square inch above the pressure of the atmosphere. In Fig. 6 the crankshaft has advanced from the position of Fig. 4, and in the direction of the arrow, through an angle of 135°. When the parts are in the position shown in Fig. 6, the exhaust valve 16 is fully open, and the top edge of the piston is just beginning to uncover the ports 13', thereby opening communication, by means of the passage 14', with the base 6. Experience with this type of engine has shown that, during the movement of the piston from the position of Fig. 5 to that of Fig. 6, the pressure within the cylinder will fall to less than that in the base at this point, and the pressure within the base will force the new charge through the transfer passage 14' and the cylinder ports 13' into the cylinder above the piston. When the parts are in the position shown in Fig. 7, the crankshaft has rotated further in the direction of the arrow and is now about 55° from the position shown in Fig. 6 and about 190° from the position shown in Fig. 4. In Fig. 7, the exhaust valve 16 has begun to close, the new mixture, as indicated by the full-line arrows, has practically filled the cylinder and the exhaust gas, indicated by the dotted arrows, has practically been driven from the cylinder by the combined effect of its own inertia and the thrust of the incoming fresh charge from the base, which is shown entering from the cylinder ports 13'. I have found that, at this point in the cycle, there is a slight vacuum in the cylinder which is communicated to the base. Advantage is taken of this fact, by opening the valve 8 at this point or earlier in the cycle, to start an initial flow of new air or of mixed air and combustible, according to the type of engine and its method of fuel supply. It will be noted that this early opening of the valve 8 is appreciably in advance of the formation of any vacuum that would be produced by the upward movement of the piston 3, and that this early opening takes advantage of the inertia of the moving column of gas leaving the base and entering the cylinder, to increase the volume of fresh charge that may be drawn into the base over and above that amount which would ordinarily be drawn into the base by the suction due to the piston alone. The fresh charge enters the base by the following path, first from the atmosphere direct or from a carburetor or similar device through the opening 8'', thence into the central hollow portion of the valve 8 through suitable openings in the wall thereof and registering with opening 8'', thence from the valve through port 9 in the valve and port 10 in the wall of the base. Fig. 8 shows the relative positions of the parts when the crankshaft has advanced in the direction of the

arrow through an angle of 20° from the position of Fig. 7, and 210° from the position of Fig. 4, or 30° past the lower dead point. In the position shown in Fig. 8, the exhaust valve 16 has just closed, the ports 13' are partially closed and the valve 8 is more fully open than in Fig. 7. Immediately following the position of Fig. 8 and after a slightly further rotation of the crankshaft through an angle of about 15° from its position in Fig. 8, the ports 13' are entirely closed by the piston and compression begins, followed shortly by ignition just in advance of the upper dead point position of Fig. 4, or by injection of a charge of fuel as in the Diesel or the semi-Deisel types of engines. Thereafter the cycle, as described, is repeated at each revolution of the crankshaft.

In Fig. 9 is shown a valve diagram which indicates approximately, the opening and the closing positions of the various valves and ports and the sequence of these events. In the figure, the closing point of the tubular valve 8 is indicated at IC, this point being about 15° after the piston has passed the upper dead point of Fig. 4. Thereafter follow in order the opening of the exhaust valve at XO, about 60° in advance of the lower dead point, the opening of the cylinder inlet port 13' at PO, approximately 45° in advance of the lower dead point, the opening of the inlet valve 8 to IO, about 10° past the lower dead point, the closing of the exhaust valve 16 at XC, about 30° past the lower dead point and the inlet port 13' at PC, about 45° past the lower dead point.

By the herein described straight flow method of operating a two-cycle engine several important advantages in performance are attained. Before a fresh fuel charge is taken into the cylinder, the cylinder has been almost completely cleared of inert gases from previous explosions, thus securing relatively greater space to receive the fresh charge. The volume of the fresh charge is thus increased and is further augmented through the surcharging of the fresh charge into the cylinder from and at a higher pressure than in the crank case, while the pressure and volume in the crank case has already been augmented due to the surcharging effect attained in introducing the fuel into the crank case. The explosive energy and mean effective pressure is therefore materially greater for a given cylinder displacement than with engines heretofore in use. The increase in mean effective pressure results in increased power per unit volume, and also results in further fuel economy through less loss of heat per unit volume by exposure to and

conduction through the cylinder walls. A further increased efficiency results through less frictional loss per unit volume, since the frictional loss is a constant in proportion to the size of the parts and irrespective of the load. Also due to the straight flow, the respective fuel ports may be of relatively greater area, and hence greater engine speeds are permissible up to practically double the speed heretofore attainable. The straight flow also enables effective compression to commence at an earlier stage than usual, so that the effective length of the cylinder is increased by approximately ten per cent over two cycle engines heretofore in use, which further adds to the mean effective pressure and hence to the efficiency and fuel economy. I am therefore enabled to develop an equal amount of power by employing a smaller engine, and one of materially less weight than heretofore required.

The most advantageous timing of the valves for any one design of engine may be determined by experiment only and the valve timing must be varied from one design to another to meet the conditions of speed, the cycle which is employed, and the conditions of the service for which the engine is to be used. Therefore I do not confine myself to the exact timing shown in the figures, but reserve the right to depart therefrom according to the requirements of each individual case, as it is obvious that a considerable variation in the points of opening and of closing the valves and the ports may be made without departing from the basic principles of my invention.

What I claim is:

A two cycle internal combustion engine comprising a cylinder, a piston, an enclosed crank pit serving as a precompression chamber, an exhaust valve located at the head end of said cylinder, a piston controlled port leading from said crank-pit to the interior of said cylinder, and a valve for the admission of a fresh charge to the crank pit, said exhaust valve piston controlled port and admission valve being timed in the following order, the exhaust valve to open, the piston controlled port to open, the admission valve to open, the exhaust valve to close, the piston controlled port to close, the admission valve to close, whereby the crank pit is surcharged from its exterior and the cylinder is subsequently surcharged from the crank-pit due to the inertia of the charging fluid in entering and leaving said crank-pit and cylinder.

In testimony whereof I have affixed my signature.

EDMUND W. ROBERTS.