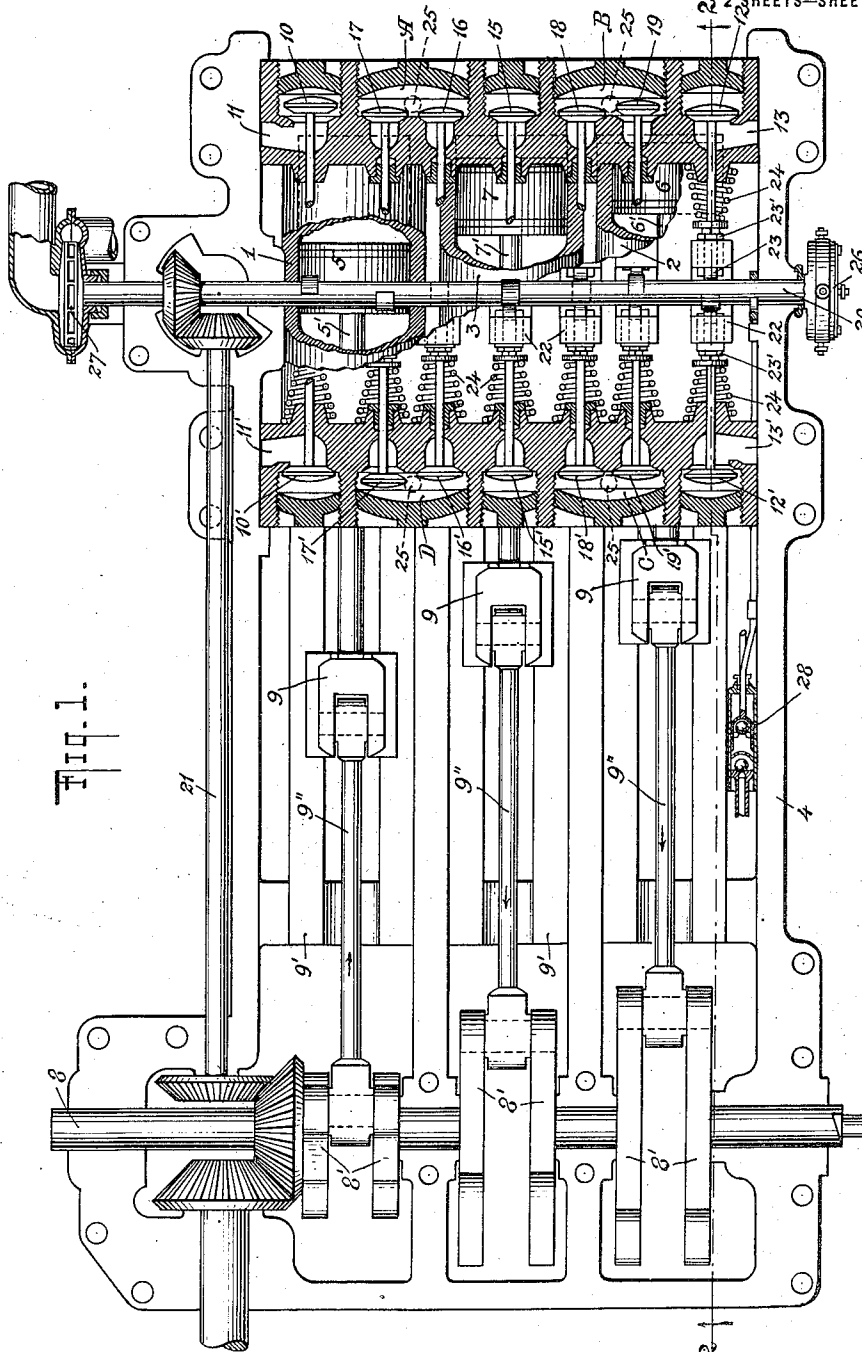


C. E. RICE.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED JUNE 18, 1913.

1,170,104.

Patented Feb. 1, 1916.

2 SHEETS—SHEET 1.



WITNESSES

G. V. Rasmussen
John A. Ferguson

INVENTOR

CHARLES E. RICE

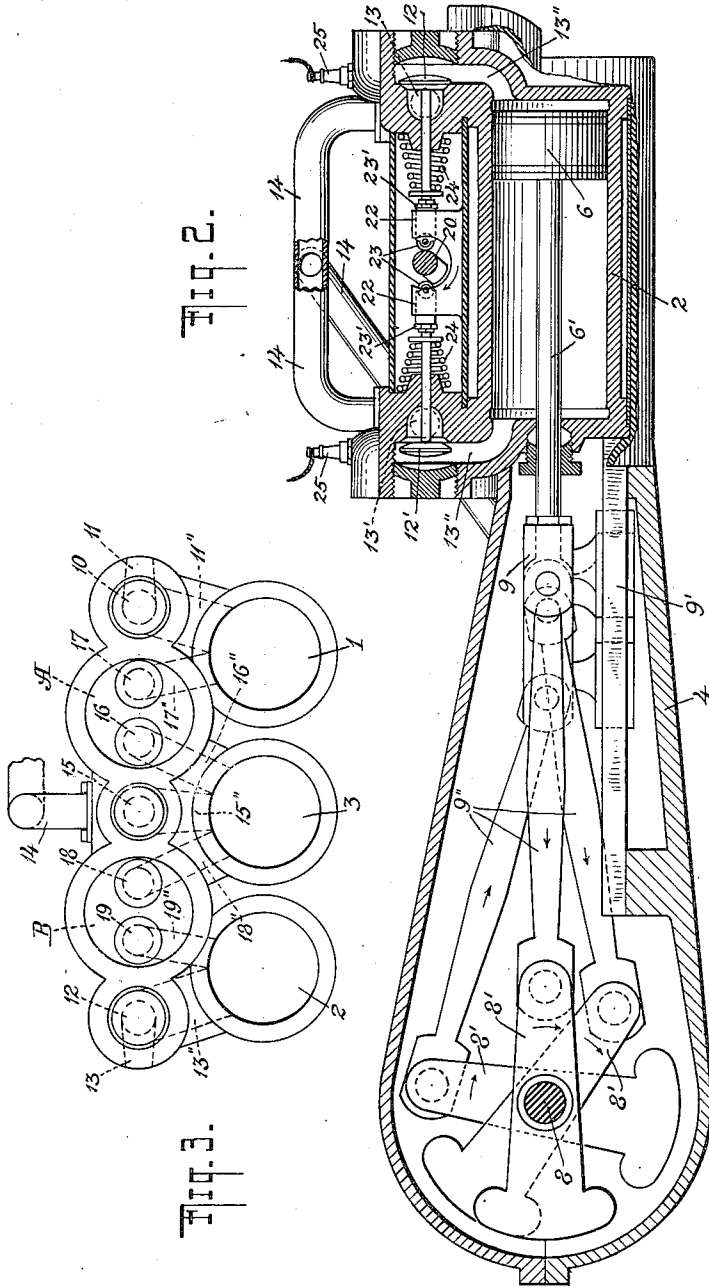
BY

Riesent Krauth
ATTORNEYS

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UNITED STATES PATENT OFFICE.

CHARLES E. RICE, OF ROUND MOUNTAIN, NEVADA.

INTERNAL-COMBUSTION ENGINE.

1,170,104.

Specification of Letters Patent.

Patented Feb. 1, 1916.

Application filed June 18, 1913. Serial No. 774,333.

To all whom it may concern:

Be it known that I, CHARLES E. RICE, a citizen of the United States, and a resident of Round Mountain, Nye county, State of Nevada, have invented a new, useful and Improved Internal-Combustion Engine, of which the following, taken in connection with the accompanying drawing, is a specification.

My invention relates to internal combustion engines, especially such as are of the two-cycle, double-acting type, and has for its object to produce an engine of great power for its weight and one which shall be simple in construction and positive and economical in operation.

Generally speaking, the engine of my invention comprises a power cylinder the piston of which is impelled by the explosive force of a suitable fuel mixture, the energy of said piston being in part utilized to compress and force a later explosive charge into a compression chamber; such compression is accomplished by means of a compression cylinder and piston, the latter being suitably connected mechanically with the power piston. The ignition of the compressed charge may be caused by any suitable device, as for instance by a spark plug suitably connected with a source of electric energy, and may take place either in the compression chamber or in the power cylinder. A compression chamber is arranged near each end of the power cylinder and each of said chambers is suitably connected by valved passages with one end of the power cylinder and also with one end of the compression cylinder. The power cylinder is provided at each end with valved exhaust ports and the compression cylinder is provided at each end with valved ports which are connected with the carbureter mechanism and which serve to admit gaseous fuel mixtures to the compression chamber.

In order to describe more fully my invention I will now refer to the accompanying drawings which illustrate an engine embodying the features of my invention, and in which—

Figure 1 shows such engine in plan view, portions being broken away in order to illustrate clearly the relations of the various parts; Fig. 2 is a vertical section approximately on the line 2—2 of Fig. 1, and Fig. 3 is a diagrammatic end elevation, showing particularly the location of the cylinders

and valve chambers and their connecting passages.

The engine shown comprises two power cylinders indicated by the characters 1 and 2 and one compression cylinder intermediate of the power cylinders and indicated by the character 3. These cylinders or some of them are provided with water jackets if desired and are secured in any suitable manner to the engine frame 4. The pistons 5, 6 and 7 operate within the cylinders 1, 2 and 3 respectively and their piston rods 5', 6' and 7' are each operatively connected with the crank shaft 8 through the medium of cross-heads 9, slidable on guides 9', and connecting rods 9'' coöperating with cranks 8' on the crank shaft 8. The rotation being in the direction indicated by the arrows in Fig. 2, the angular relation of the various cranks is such that, when piston 6 is at the forward end of its stroke, its crank shaft being on dead center, piston 5 is advancing forwardly and is slightly beyond the middle of its stroke, while the compression piston 7 is moving rearwardly, having shortly begun such movement.

Arranged above the cylinders and at the ends thereof are the various valve chambers which are provided with valves and connected with the various cylinders in the manner now to be pointed out. The valve chambers are equipped with screw plugs or caps having wrench-engaging projections, by the turning of which the chambers may be individually varied in capacity. The exhaust valves 10 and 10' are operable in the exhaust chambers at the ends of power cylinder 1 and serve to close and open communication between said chambers and the atmosphere through the exhaust ports 11 and 11' respectively, the chambers being at all times in communication each with one end of the cylinder 1 through the passages 11''. The exhaust valves 12 and 12' serve to close or open communication between the exhaust chambers, and the atmosphere through the exhaust ports 13 and 13' respectively, the exhaust chambers being in communication with the ends of the cylinder 2 through the passages 13''.

The fuel inlet pipe 14 leads from the carbureter mechanism to the fuel inlet valve chambers at the ends of the compression cylinder 3, in which chambers the valves 15 and 15' operate to close and open communication between said chambers and

the ends of the cylinder 3 through the passages 15''.

Inlet valves 16 and 16' control communication through the passages 16'' between the ends of compression cylinder 3 and the compression chambers A and D for the cylinder 1, and outlet valves 17 and 17' control communication through the passages 17'' between said chambers and the ends of the cylinder 1. Similarly, inlet valves 18 and 18' control communication through passages 18'' between the ends of compression chamber 3 and the compression chambers B and C for the cylinder 2, and outlet valves 19 and 19' control communication through the passages 19'' between said chambers and the ends of cylinder 2. All of the valves are operated by cams suitably arranged on the cam shaft 20 driven from the crank shaft 8 by means of bevel gears on said shafts cooperating with bevel gears on the connecting shaft 21 in such manner that the cam shaft and the crank shaft rotate at the same speed. The valve stems are guided near their ends within guide yokes 22 and are provided at their ends with rollers 23 which engage with the cams and which are adjustably positioned by means of the adjusting nuts 23'. Springs 24 serve to hold the valves in closed position until the cams come into contact with the rollers 23 and move the valves against the force of the springs 24 into open position. Ignition spark plugs 25 are provided for each ignition chamber and are suitably connected through the timing switch mechanism 26 operated by the cam shaft with a source of high potential. A rotary pump 27 driven by the cam shaft is provided for circulating a cooling fluid through the cylinder cooling jackets. A pump 28 also driven from the cam shaft serves to furnish lubricant to the cylinders and other working parts desired.

In the operation of the engine, a charge of explosive mixture is drawn through the conduit 14 and one of the passages 15'' into the compression cylinder 3 on the suction side of its piston 7, the proper fuel inlet valve, say 15, being open. On the forward stroke of this piston, the charge is compressed and forced in part through the forward passage 18'' into the forward compression chamber B, the chamber inlet valve 18 being open for this purpose, and in part, said valve closing when the piston has traversed about half of its stroke and valve 16 opening, through the forward passage 16'' into the forward compression chamber A. When the compression piston has finished its stroke, both valves 16 and 18 are in closed position, and on its backward stroke a new charge is drawn in and the charge drawn into the rearward end of the compression cylinder during the previous forward stroke of its piston is compressed and forced in equal amounts and

under equal compression into the two rearward compression chambers C and D. The valve 15 opens as the compression piston moves away from its position at the forward end of its stroke and closes as the piston reaches the rearward end of its stroke, and the valve 15' opens as the piston moves away from its rearward position and closes as it reaches its forward position. Valve 15 opens, therefore, when valve 15' closes and valve 15' opens when valve 15 closes. Valves 16, 16', 18 and 18' obviously should not open until valves 17, 17', 19 and 19' respectively have closed.

The power pistons 5 and 6 are forced both forwardly and rearwardly by the explosive force of the fuel. For each revolution of the crank shaft therefore there are two explosions for each cylinder; these explosions take place alternately first on one side of the piston and then on the opposite side of the piston. When one of these pistons, for example, piston 6 is being impelled forwardly by the burning of the charge compressed in chamber C, it clears the forward end of cylinder 2 of combustion products by forcing them through exhaust port 13, the exhaust valve 12 being open and the inlet valve 19 being closed. When the piston has almost reached the end of its forward stroke, the crank being about 30 degrees from dead center, the rear exhaust valve 12' opens and the forward inlet valve 19 begins to open. The compressed charge escapes from chamber B through the forward passage 19'' into the cylinder and drives out the small amount of dead gases therein through the exhaust port 13. The exhaust valve 12 immediately closes after this purging operation so that no live gases can escape and at approximately the same time, the valve 19 opening rapidly, ignition takes place and at the time the piston reaches the end of its stroke the expanding gases are exerting full power to drive the piston on its rearward stroke, the valve 19 remaining open until the piston nears the rearward end of its stroke. The valve 12 may, of course, be closed if desired before the opening of the valve 19, the purging effect being eliminated, and the rear valve 12' may be operated at a time different from that described. Near the end of the rearward stroke of piston 6 a similar operation takes place, the operation of valves 12, 12' and 19' corresponding with the operation respectively of the valves 12', 12 and 19 previously described. The power piston 5 operates in like manner as the power piston 6, the operation of valves 10', 10 and 17 being similar to that respectively of valves 12', 12 and 19 when piston 5 is near the forward end of its stroke, and the operation of valves 10, 10' and 17' being similar to that respectively of valves 12, 12' and 19' when the piston is near the rearward end of its stroke.

In the drawings the compression piston 7 is shown just after it has begun to move on its rearward stroke, at which time the power piston 6 is at the end of its forward stroke and the power piston 5 is on its forward stroke being impelled by the burning gas from compression chamber D. The valve 19 is open, the valve 12' is opening and the valve 18 is closed, the compressed charge of the chamber B has just been ignited by the spark plug of this chamber and the piston 6 is about to be forced rearwardly. When the piston 5 reaches a point near the forward end of its stroke, the valves 10 and 17' being open during this movement, the valves 10' and 17 will open, valve 10 will close (in the drawings this valve is beginning to close), ignition will occur and the expanding gases will drive the piston on its rear stroke; and when the piston 6 reaches a position near the rearward end of its stroke, valves 12 and 19' will open, valve 12' will close, ignition will occur and the expanding gases will drive the piston on its forward stroke.

The various pistons and cylinders of the engine shown are of the same size except that the compression piston is slightly longer than the power pistons. While there is maintained the usual clearance between the power pistons and their cylinder heads, there is substantially no such clearance in the case of the compression cylinder and piston. As a consequence, all of the compressed fuel is driven from the compression cylinder into the compression chambers at each stroke and there is no loss of power such as would occur if a portion of such compressed fuel were retained in the cylinder. An increase of diameter of the compression elements would, as will readily be understood, produce an increased compression and increased power. The degree of compression may also be varied, as is obvious, by a manipulation of the screw caps forming the ends of the compression chambers. The arrangement is such that the fuel mixture is equally divided between the two forward compression chambers on the forward compression stroke and between the two rearward compression chambers on the rearward compression stroke; equal impulses are therefore given to the two power cylinders, the impulses for piston 5 following about a quarter revolution after the corresponding impulses for piston 6; there is no possibility of a dead center position for both power cranks. The four impulses for each revolution, two for each piston make the engine of substantially the same power as an eight cylinder engine of the single acting four-cycle type. It is obvious that an engine of one power cylinder or of more than two power cylinders may also be constructed in accordance with my invention by any person skilled in the art. It will be

understood, furthermore, that the construction herein shown and described may be altered in various ways without departing from the spirit and scope of my invention as defined in the appended claims.

I claim:

1. An internal combustion engine comprising a power cylinder and a piston, means for compressing an explosive fuel charge, a compression chamber connected therewith for receiving said compressed charge, manually adjustable means for varying the capacity of said chamber, means for admitting said compressed charge from said compression chamber directly to said cylinder and means in said compression chamber for igniting said charge.

2. An internal combustion engine comprising a power cylinder and piston, a compression cylinder and piston, said compression piston being driven by said power piston, a compression chamber, manually adjustable means for varying the capacity of said chamber, valved passages directly connecting said chamber with said cylinders, means for suitably operating said valves and ignition means in said compression chamber, operable when the chamber is in communication with said power cylinder.

3. An internal combustion engine comprising a power cylinder and piston, a compression cylinder and piston, said compression piston being driven by said power piston, a forward compression chamber, valved passages directly connecting said chamber with the forward ends of said cylinders, a rearward compression chamber, valved passages directly connecting said rearward chamber with the rearward ends of said cylinders, manually adjustable means for varying the capacity of each of said chambers, valved exhaust ports connecting each end of said power cylinder with the atmosphere, means for suitably operating said valves, and ignition means in said compression chambers, operable when the chambers are in communication with the respective ends of said power cylinder.

4. An internal combustion engine comprising a power cylinder and piston, valved exhaust ports connecting each end of said power cylinder with the atmosphere, compression chambers each in direct communication with one end of said cylinder through valved passages, manually adjustable means for varying the capacity of each of said chambers, means for compressing fuel charges alternately in said chambers, means for suitably operating said valves and means for igniting said charges alternately in the chambers at opposite ends of said cylinder when in communication with the latter.

5. An internal combustion engine comprising a plurality of power cylinders each provided with valved exhaust ports at the

ends thereof, a compression cylinder provided with valved fuel admission ports at the ends thereof, pistons in said cylinders, the compression piston being driven by a
5 power piston, a plurality of forward compression chambers, valved passages connecting each of said chambers with the forward end of said compression cylinder and with
10 the forward end of one of said power cylinders, a plurality of rearward compression chambers, valved passages connecting each of said rearward chambers with the rearward end of said compression cylinder and with the rearward end of one of said power cylinders, means for suitably operating said valves, and ignition means in said compression chambers.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

CHARLES E. RICE.

Witnesses:

JOHN LEO,

A. J. WADDLETON.