A. RIGAUD.

DOUBLE ACTING INTERNAL COMBUSTION ENGINE.

APPLICATION FILED OCT. 6, 1911.

1,132,386. Patented Mar. 16, 1915.

2 SHEETS—SHEET 1.

Fig. 1.

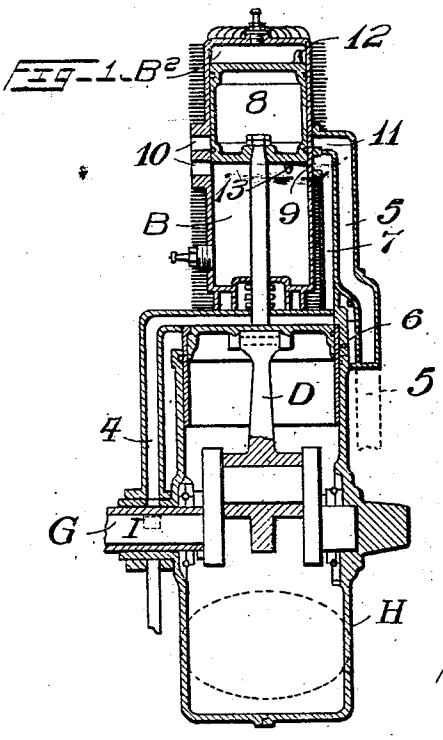


Fig. 4.

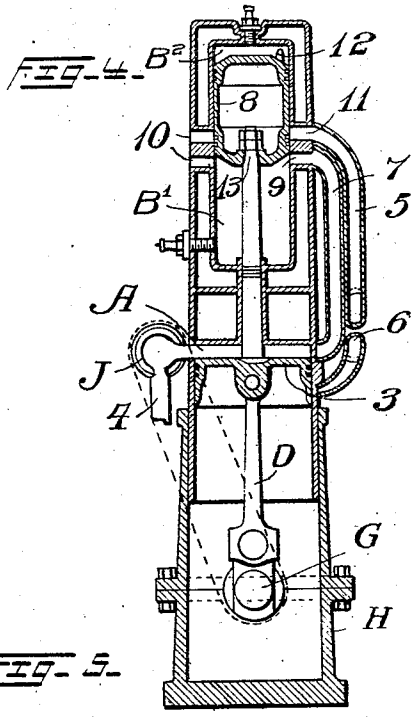
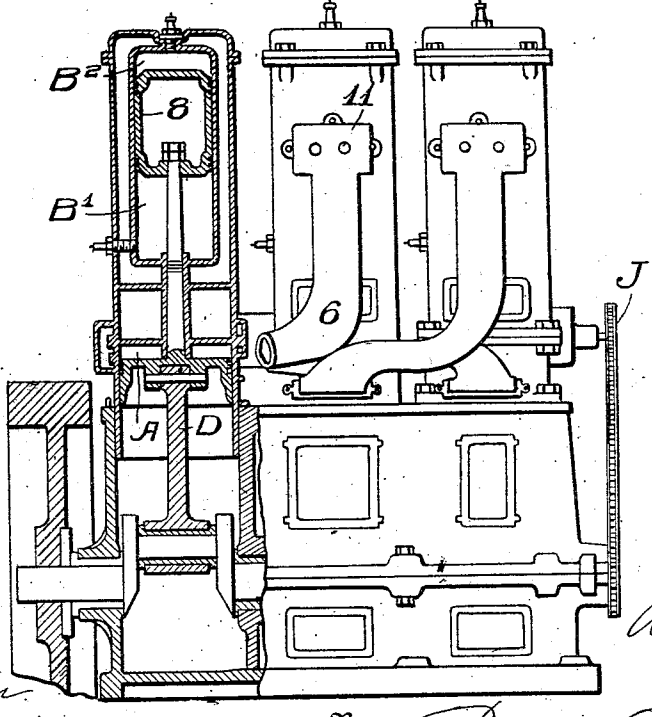


Fig. 5.



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2 SHEETS—SHEET 2.

Fig. 2.

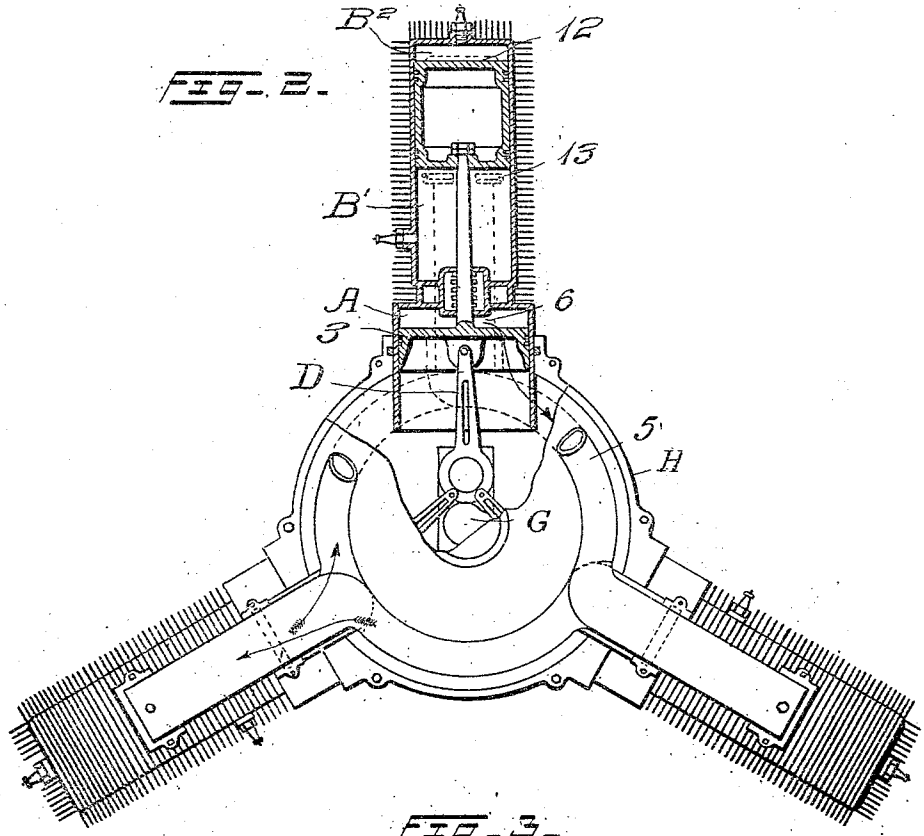
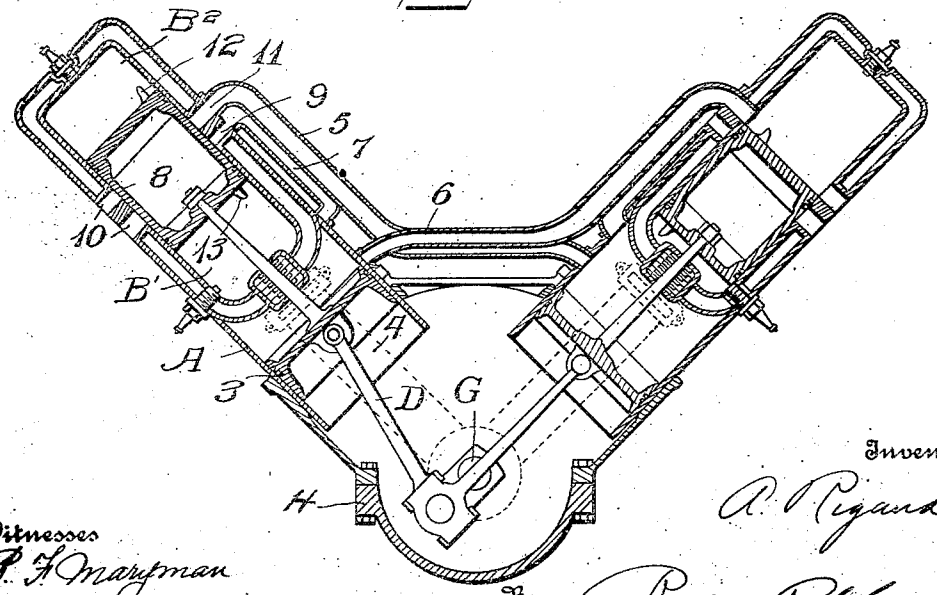


Fig. 3.



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UNITED STATES PATENT OFFICE.

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DOUBLE-ACTING INTERNAL-COMBUSTION ENGINE.

1,132,386. Specification of Letters Patent. Patented Mar. 16, 1915.

Application filed October 6, 1911. Serial No. 653,173.

To all whom it may concern:

Be it known that I, ALBERT RIGAUD, citizen of the Republic of France, residing at Lille, in the Republic of France, have invented certain new and useful Improvements in Double-Acting Internal-Combustion Engines, of which the following is a specification.

This invention relates to a simplified and improved form of double-acting two-stroke-cycle internal combustion engine.

In order to feed with fresh gas the two motor cylinders, a pump of larger diameter displacing at least double the volume, has a piston connected on the one hand by a rod which carries packing rings or passes through packing rings, to the motor piston, and on the other hand to a connecting rod or slide which converts the reciprocating motion into a rotary motion of the motor shaft, except in the case of the rotary type of motor in which case the shaft being fixed the motor revolves by reaction about this shaft. The advantages of these motors are shown by a better torque, double that of a two-stroke single-acting motor; by a reduction in the losses by friction and an increase in the thermal efficiency owing to less loss through the walls.

The diminution of the number of the cylinders and the avoidance of any delicate distributing organ allow of a reduction of weight and greater compactness.

I thus obtain a better thermal efficiency, great output per unit weight and an improvement in the mechanical efficiency, so that I can easily obtain four times the work of a similar four-stroke motor having an equal stroke, bore, and number of revolutions, and at the same time effect great simplification and diminution of parts.

Figure 1 is a vertical section taken on the line of the axis of the crank shaft through a multiple cylinder engine embodying the features of the present invention. Fig. 2 is a view in side elevation thereof, one of the cylinders being shown in section and parts being broken away for disclosing the interior structure. Fig. 3 is a vertical section of a two cylinder engine embodying the features of the invention. Fig. 4 is a vertical section of a further modified embodiment; and Fig. 5 is a view partly in elevation and partly in vertical section through a still further embodiment of the invention.

Now referring to Figs. 1, 2, 3, 4, 5, of the accompanying drawings, the pump cylinder A is located beneath the motor cylinder B^1, B^2. The pump piston 3 when descending draws gas through pipe 4 coming from the carburetor. In rising it forces this gas during the first half of its stroke either into a storage pipe 5 or in the case of multi-cylinder engines, a pipe 6 passing to the adjacent motor cylinder space B^2. After reaching half stroke, the piston 3 closes the ports of the pipes 5 or 6 and continues the second part of its course, forcing gas into its own motor cylinder space B^1 by way of the pipe 7, as soon as the motor piston 8 has uncovered the gas admission ports 9 a little before the upper end of its stroke. The products of combustion from the previous charge are first exhausted, the exhaust ports 10 being opened before those for admitting the gas. In its descending movement the motor piston 8 will uncover, shortly before the end of its stroke, the admission ports 11 at which enters the gas which has been stored or is being compressed in the adjacent cylinder which in its turn feeds the cylinder space B^2. Thus fed the charges of gas will be successively compressed, exploded, expanded, and the products of combustion exhausted. Deflectors 12 and 13 on the piston 8 send toward the cylinder heads fresh gas which thus replaces the burnt gas. Connecting rods D, convert the reciprocating movement into a rotation of the main shaft G located in the crank case H.

Fig. 1 is a view partly in section of a rotary three-cylinder flying machine motor. Fig. 2 is a section on a plane at right angles to that of Fig. 1. The peculiarity of this machine is the drawing in of the gas through pipes 4. The pipes 4 are connected to a sleeve surrounding the hollow shaft G of the motor and this shaft is provided with a port I which, in revolving, uncovers in turn the ports arranged at the ends of the pipes 4 where these abut against the hollow shaft in the same plane as the port therein. Consequently gas will pass in turn into each pump space at predetermined times. The gas is then fed to the adjacent motor cylinder during the first portion of the stroke of the pump through the pipe 6 and thence into the inlet port of the adjacent motor cylinder space B^2. The second part of the charge will enter through the pipe 7 and inlet port 9, the motor cylinder space B^1. This [illegible] engine [illegible] no special

distributing member and affords the maximum of security as an aviation motor.

Fig. 3 is a motor of the same kind with two cylinders relatively disposed in the form of a V. In this case also the gas is drawn in through a hollow shaft revolving in front of the ports I in connection with fixed pipes 4. The charge passes partly through a pipe 6 to the adjacent cylinder and the remainder by a pipe 7 to the cylinder B^1 with the piston of which the pump piston is connected.

Fig. 4 is a vertical three-cylinder motor in which the fresh gas is drawn in from a carbureter or the like through a passage controlled by an automatic valve, or controlled by a rotary distributing valve such as J which may be driven from the crank shaft by means of chain transmission. The compressed charge is fed by each pump partly to the adjacent motor cylinder space B^2 and the remainder to the motor cylinder space B^1 of the adjacent motor. The pumps only draw in air which the motor cylinders B^2 and B^1 compress to high pressure, and into which the liquid combustible is injected under pressure a little before the end of the stroke, in order to produce the explosion.

I declare that what I claim is:—

1. A double acting two-stroke internal combustion engine comprising a plurality of working cylinders, a pump cylinder for each working cylinder, a piston for each working cylinder, a piston for each pump cylinder connected to be actuated by the respective working cylinder piston, a crank shaft with which the pump cylinder pistons are connected, said crank shaft being tubular and adapted to supply the explosive charge for the working cylinders, connections from the crank shaft to the pump cylinders for supplying explosive charge to the pump cylinders during the intake stroke of the pump pistons, means for cutting off the supply during the compression stroke of the pump pistons and connections for supplying the explosive charge from the pump cylinders to respective adjacent working cylinders and then to the coöperating working cylinders of the respective pump cylinders.

2. A double acting two stroke internal combustion engine comprising a plurality of working cylinders, a pump cylinder arranged in line with each of said working cylinders, means for connecting the piston in each of said working cylinders with the piston in the corresponding pump cylinder, means for coupling said connected pistons with the crank shaft, means for conducting compressed gas from each pump cylinder to the upper end of an adjacent working cylinder, means for conducting compressed gas from each pump cylinder to the lower end of its own working cylinder, and means for distributing the compressed charge from each pump cylinder to the two conducting means alternately.

3. A double acting two stroke internal combustion engine comprising a plurality of double acting working cylinders, a hollow crank shaft, a pump cylinder arranged in line with each of said working cylinders, means for feeding each end of each of said working cylinders with compressed gas from the pump cylinders, means for distributing gas to each of said pump cylinders, said means consisting of a port communicating with the interior of the hollow crank shaft of the engine, a valve member surrounding the crank shaft adjacent to said port, and distributing pipes connecting said valve member with said pump cylinders.

In witness whereof, I have hereunto signed my name this 25th day of September, 1911, in the presence of two subscribing witnesses.

ALBERT RIGAUD.

Witnesses:
GEORGES VALDELIEVREY,
ALBERT VURGARE.