D. ROBERTS & C. JAMES.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED DEC. 13, 1909.

972,024.

Patented Oct. 4, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

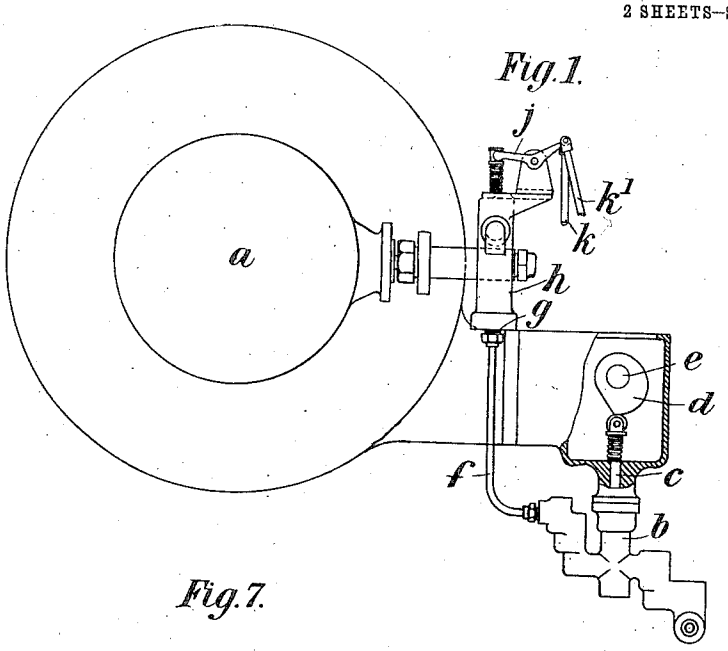


Fig. 7.

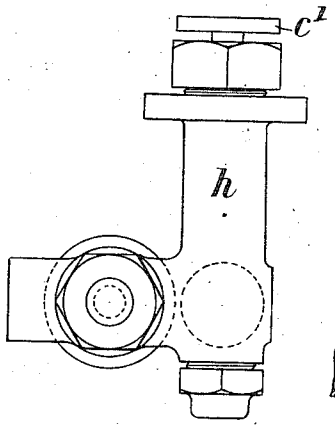
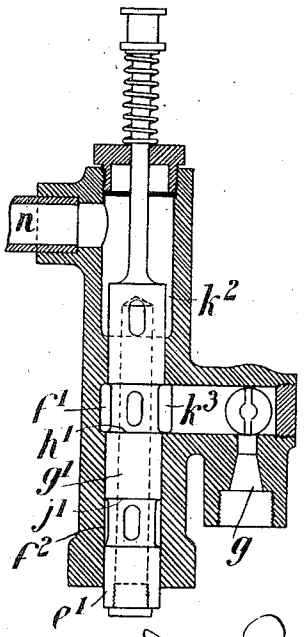


Fig. 6.



Witnesses
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2 SHEETS—SHEET 2.

Fig. 2.

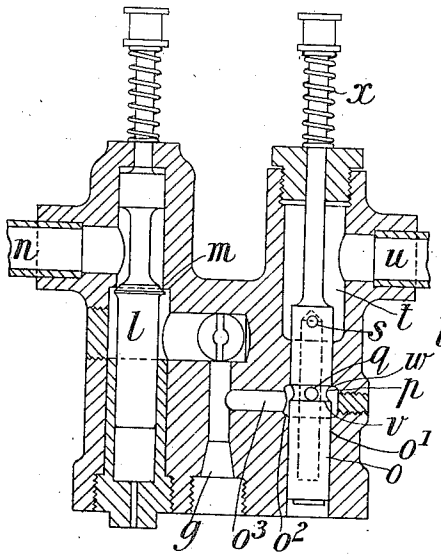


Fig. 3.

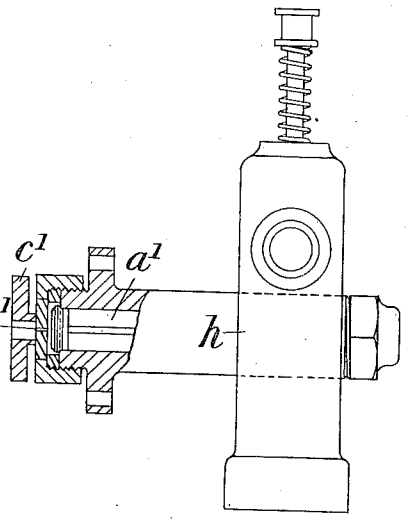


Fig. 4.

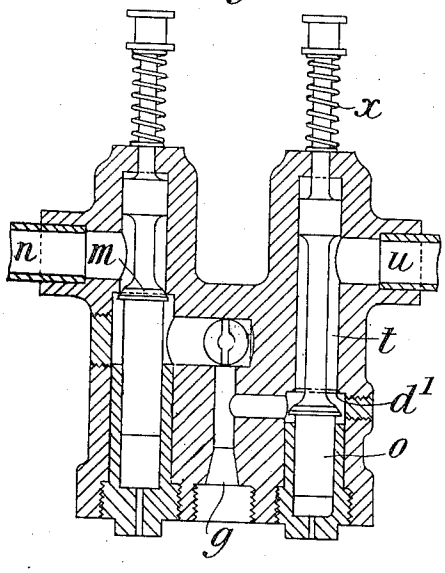
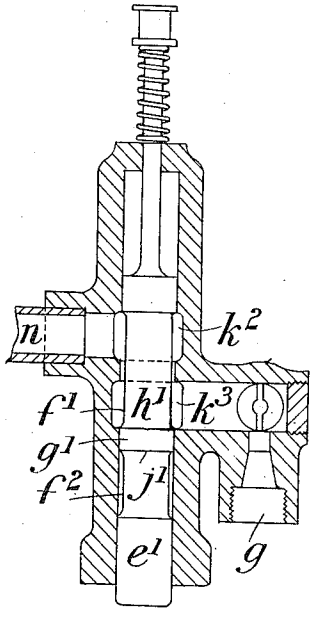


Fig. 5.



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UNITED STATES PATENT OFFICE.

DAVID ROBERTS AND CHARLES JAMES, OF GRANTHAM, ENGLAND.

INTERNAL-COMBUSTION ENGINE.

972,024. Specification of Letters Patent. Patented Oct. 4, 1910.

Application filed December 13, 1909. Serial No. 532,864.

To all whom it may concern:

Be it known that we, DAVID ROBERTS and CHARLES JAMES, subjects of the King of Great Britain, residing at Spittlegate Iron Works, Grantham, Lincolnshire, England, engineer, have invented new and useful Improvements in or Connected with Internal-Combustion Engines, of which the following is a specification.

Our invention relates to improvements in or connected with internal combustion engines of the kind in which hydrocarbon fuel is injected into the vaporizer, the object being to provide improved means for effecting and controlling the said injection. In such engines as hitherto usually constructed the oil or hydrocarbon is injected through an oil spray nozzle by means of a pump, the plunger of which is actuated by a cam or eccentric which operates a striker and slack or lost motion being provided between the striker and the pump plunger, so that only that part of the cam or travel of the eccentric which gives the quickest motion is made use of. The said oil spray nozzle is located in the vaporizer valve-box, which is attached to the combustion chamber, and is fitted with horizontal valve which acts as a check-valve against the explosion in the combustion chamber, and with a vertical or relief-valve, through which the excess of oil is by-passed back to the container. Such engines have been governed by controlling the oil supply by mechanically operating the aforesaid vertical or relief-valve through the medium of a cam driven from any convenient part of the engine, such as the cam shaft, and under the control of the governor, which brings its operative face into action either earlier or later in accordance with the load upon the engine. The result of this construction is that the relief or vertical valve is opened either when the pump has completed its full delivery or effective stroke, or earlier on lighter loads, thus reducing the length of the pump delivery stroke. Now, according to our invention we provide for operating the pump plunger direct by a cam or eccentric, that is to say, without the above mentioned slack, or lost motion, and we arrange an additional by-pass or relief-valve in the vaporizer valve-box, the said valve being of any suitable type, such as a piston-valve or miter-valve. The valve is arranged to be operated mechanically by a cam from any convenient rotating part of the engine, in such a manner that it is open when the pump plunger commences its forcing stroke, thus by-passing the oil or hydrocarbon, and at a predetermined point, is mechanically closed. On the valve thus closing, the oil or hydrocarbon is forced by the horizontal valve through the spray nozzle into the combustion chamber at a high velocity, without noise or shock. On the return stroke of the additional relief-valve the by-pass is again opened and the cycle of operations begins *de novo*.

In a modified construction we employ a single piston-valve in lieu of the two relief or by-pass valves in the vaporizer valve-box, the said piston valve being formed with two peripheral grooves, separated by a bar, the opposite edges of which serve to open and close two ports formed in the vaporizer valve box and corresponding approximately to the peripheral grooves in the piston valve. The piston valve may be mechanically operated by a cam or eccentric in any known manner so that its length or travel can be controlled by the governor in such a manner that the time of closing the upper port and opening the lower port can be varied, thus varying the length and time of the pump delivery stroke according to the load upon the engine.

In the accompanying drawing: Figure 1 is a sectional end view of a vaporizer valve-box having our improvement applied thereto. Fig. 2 is a sectional elevation of a vaporizer valve-box having an additional by-pass or relief-valve of the piston type. Fig. 3 is a sectional side elevation of the same. Fig. 4 is a view similar to Fig. 2 illustrating a modification. Figs. 5 and 6 are sectional elevations illustrating still further modifications, and Fig. 7 is a plan view of the arrangement shown in Fig. 6.

Referring first to the construction illustrated in Fig. 1 *a* is the vaporized, *b* is the oil pump, *c* is the pump plunger and *d* is the cam which is mounted on the shaft *e*, and by which the said plunger is operated directly and without slack or lost motion. *f* is the oil delivery pipe which conveys the oil from the pump *b* to the inlet *g* in the vaporizer valve-box *h*. *k*, *k'* are rods which are designed to actuate the vertical relief and additional by-pass or relief-valves through the medium of the bell crank levers *j*. The relief and additional valves may be of differ-

ent forms and we have shown several in the accompanying drawing.

In the construction shown in Figs. 2 and 3 l represents the ordinary vertical by-pass valve which is operated by a cam controlled by the governor, the valve in the drawing being shown in its closed position that is to say resting on the seat m. n is the overflow outlet from the said valve. o is the additional relief or by-pass valve which is of the piston type, and in the drawing is shown in the open position. This valve o works in a cylindrical passage o' which is formed with a pocket o^2 in communication by a passage o^3 with the oil inlet g, and the said valve is formed with an annular recess or groove p from the bottom of which holes q extend to the hollow bore of the said valve. The upper end of the interior of the piston valve o is also in communication with the periphery thereof by means of the hole or holes s which places the interior of the said valve in communication with the space t from which there extends the overflow outlet u passing back to the oil container.

With the described construction, when the piston valve o is in the open position, that is to say, in the position indicated in the drawing, the surplus oil passes from the passage g through the passage o^3 into the pocket o^2 and thence through the hole or holes q into the interior of the valve o from the upper end of which it issues through the hole or holes s into the space t whence it passes through the overflow outlet u and back to the oil container. It will be understood that the valve o remains open to by-pass the oil so long as the grooved or recessed portion p thereof remains within the pocket o^2, the oil being cut off on the lower edge v of the said groove or recess p passing over the upper edge w of the pocket o^2. As will be understood from the foregoing description, the valve o is opened by a cam actuated from any suitable rotating part of the engine and is closed by the spring x; or, the said spring may effect the opening and the cam closure of the valve.

a' Fig. 3 represents the usual horizontal check-valve, b' being the oil spray nozzle and c' the spraying pad.

The construction illustrated in Fig. 4 is similar to that shown in Figs. 2 and 3 with the exception that the additional by-pass valve o is formed with a mitered seat d' in lieu of the annular recess above referred to.

In Fig. 5 we have illustrated a construction wherein a single piston-valve is employed in lieu of the two relief or by-pass vales. e' represents this single piston-valve and f', f^2 are the two peripheral grooves which are formed on the said valve, g' being the bar which separates these two grooves and h' and j' being the operating or cutting off edges of the valve. k^2 and k^3 are the two ports in the vaporizer valve-box and n the overflow outlet.

The operation of this modification is as follows that is to say, when the pump begins its forcing stroke one of the peripheral grooves, say the upper one f' of the valve is opened, the lower groove f^2 being closed by the intermediate bar g'. As the oil pump plunger descends, the oil which it delivers is by-passed through the said upper groove f' into the port k^2 and thence back to the oil tank through the overflow outlet n. At a predetermined point, that is to say, at the commencement of the oil injection and when the pump plunger is executing the quickest portion of its travel, the piston valve is mechanically moved so as to close the upper port k^2, this being effected by the bar g', the plunger then travels forward to effect this delivery or forcing stroke and at the termination of its stroke the lower peripheral groove f^2 on the piston-valve is opened, this being effected by the continued upward movement of the said valve, the result being that the oil delivered by the surplus stroke of the pump plunger is by-passed. While the pump is executing its suction stroke the piston valve travels downward thereby closing the lower and opening the upper groove in the valve, after which the cycle of operations is started *de novo*.

Figs. 6 and 7 illustrate a modification which is similar to that shown in Fig. 5 except that the piston-valve e' is made hollow and the oil passes up through the center thereof instead of around the outside. In other respects the construction and action of this form of valve are the same as those described with reference to Fig. 5.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. In an internal combustion engine, the combination with the vaporizing chamber, of a liquid hydrocarbon pump, provided with a delivery passage communicating with the vaporizer, a by-pass for surplus liquid connected with said passage, a valve controlling said by-pass, mechanism operated by the engine, for positively opening said valve holding it open during a part of the cycle, to permit the liquid to return through the by-pass, and for closing said valve at a predetermined point in the cycle to force the liquid into said vaporizing chamber.

2. In an internal combustion engine, the combination with the vaporizing chamber, of a liquid hydrocarbon pump, provided with a delivery passage communicating with the vaporizer, a by-pass for surplus liquid connected with said passage, a valve controlling said by-pass, mechanism operated by the engine, for holding said valve open during a part of the cycle, to permit the liquid to re-

turn through the by-pass, and for closing said valve at a predetermined point in the cycle to force the liquid into said vaporizing chamber, a second by-pass for said delivery passage, a normally closed valve controlling said second by-pass, and mechanism operated by the engine for opening the said normally closed valve, after the closing of the first mentioned by-pass.

3. In an internal combustion engine, the combination with the vaporizing chamber, of a liquid hydrocarbon pump, provided with a delivery passage communicating with the vaporizer, a by-pass for surplus liquid connected with said passage, a valve controlling said liquid, mechanism operated by the engine, for holding said valve open during a part of the cycle, to permit the liquid to return through the by-pass, and for closing said valve at a predetermined point in the cycle to force the liquid into said vaporizing chamber, a second by-pass for said delivery passage, a normally closed valve controlling said second by-pass, and governor controlled mechanism operated by the engine for opening said normally closed valve at varying periods in the cycle, after the closing of the first mentioned by-pass.

4. In an internal combustion engine, the combination with a vaporizer, of a spraying nozzle, and check valve therefor, a liquid hydrocarbon pump connected with said spraying nozzle, a by-pass for surplus liquid, a valve controlling said by-pass, means operated by the engine for positively opening and closing said valve at predetermined times in the cycle, a second by-pass for surplus liquid, a second valve controlling said by-pass, and a governor controlled mechanism for operating said second valve, at varying times in the cycle, to automatically control the amount of liquid admitted for each charge.

5. In an internal combustion engine, the combination with the vaporizing chamber, of a valve casing provided with a delivery passage communicating with said chamber, an inlet passage for liquid hydrocarbon, and means for by-passing surplus liquid, a normally open by-pass valve, a normally closed by-pass valve, means operated by the engine for closing the normally open valve and thereafter opening the normally closed valve, and a pump connected with the inlet of the valve casing.

6. In an internal combustion engine, the combination with the vaporizing chamber, of a valve casing provided with a delivery passage communicating with said chamber, an inlet passage for liquid hydrocarbon, and means for by-passing surplus liquid, a normally open by-pass valve, a normally closed by-pass valve, said valves being integral, means operated by the engine for moving said combined valves to close the normally open valve, without opening the normally closed valve, and governor controlled devices operated by the engine for thereafter opening the normally closed valve, and a pump connected with the inlet of the valve casing.

7. In an internal combustion engine, the combination with the vaporizing chamber, of a pump for hydrocarbon liquid connected with said chamber and having an uniform stroke, means for by-passing the surplus liquid, valve mechanism operated by the engine for opening communication with a by-pass at a point in the cycle, before the delivery of a charge to the vaporizer, and governor controlled mechanism for opening communication with a by-pass at varying periods in the cycle thereafter.

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