

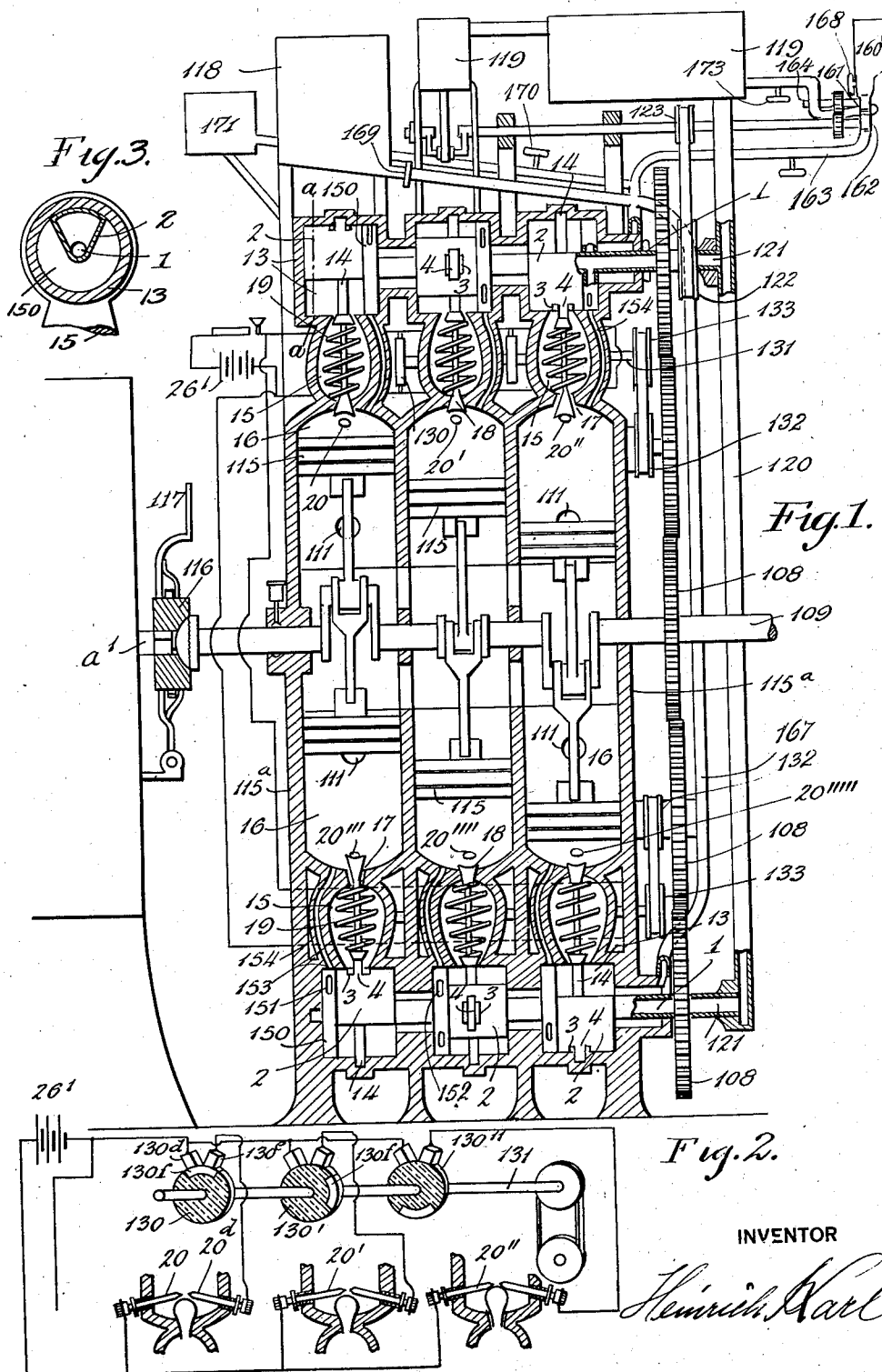
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RECIPROCATORY INTERNAL COMBUSTION ENGINE

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RECIPROCATORY INTERNAL COMBUSTION ENGINE

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This invention relates to internal combustion engines of the kind described in the specification of concurrent United States application Serial No. 673,260, filed November 7, 1923, in which there is described as applied to an internal combustion reaction turbine a means for feeding explosive fuel and compressed air to explosion chambers, said means including a rotary hollow inner shaft receiving compressed air; a chamber or rotor shaft surrounding the inner shaft receiving the explosive fuel and rotary compressed air chamber valves carried by the inner shaft adapted to force the air and fuel through valve-controlled ante-chambers into the explosion chambers where the charge is ignited.

In said specification the charge passed from the explosion chambers through nozzles and reacted against grooved parts of a fixed stator casing whereby all the parts previously described were caused to rotate.

In the present invention, however, the said parts with the exception of the inner shaft and rotary chamber valves thereon do not rotate and the explosion chambers are replaced by ordinary cylinders in which operate reciprocating pistons actuating a crank or driving shaft.

Therefore the invention consists of a reciprocating internal combustion engine of the single or compound type having means for charging liquid, gaseous, powdered or granulated fuel and compressed air to the cylinder or cylinders, said means comprising a rotary hollow shaft, adapted to admit compressed air, a rotary chamber valve on said shaft, an ante-chamber and apertures in connection with the inner shaft adapted to allow compressed air in said shaft to flow into said ante-chamber and also into said cylinder.

The invention also comprises features of construction, arrangement and combination of parts as set forth in appended claims and hereinafter fully described.

An embodiment of the invention is illustrated in Fig. 1 of the accompanying drawings which show in section a six cylinder reciprocating engine and means for coupling it to or compounding it with a turbine. Fig. 2 is a part perspective and part diagrammatic

view of the ignition devices and electrical connections thereof. Fig. 3 is a sectional view of one of the rotary chamber valves taken on the line *a-a* of Fig. 1.

In the drawings, 1 designates the inner hollow shaft on which are mounted the rotary chamber valves 2 and 150 which consequently revolve in unison when said shaft will be revolved by the gears 108 that will be described later. The chambers of said chamber valves communicate with the hollow of said shaft 1. Each chamber valve 2, together with a chamber valve 150, is arranged within a chamber 13 that has a cylindrical shape and which is of such diameter that the chamber valves 2 and 150 can just move within it. While the chamber valve 150 whose purpose will be described later is so designated that its circumference equals nearly that of the chamber 13, it is different with the chamber valve 2 which fills out only as much space as a segment that represents about one quarter of the space within which the chamber valve 2 has to move. This particular shape of the revolvable chamber valve 2 has the purpose of allowing combustibles to accumulate in the space that is left between the walls of chamber valve 2 and those walls of chamber 13 and chamber valve 150 that limit said space. The character of and the method of introduction of these combustibles into said chamber 13 will be described later. As best seen in Fig. 3, one wall of chamber valve 2 lies closely against the inner side of the circumferential wall of chamber 13. This last-mentioned wall of chamber valve 2 has two outlets or apertures 3 and a rib 4 between them (see Fig. 1). At certain parts of each of said chambers 13 is a groove 14 which permits the rib 4 to move therein as the shaft 1 revolves. At certain points of the chambers 13 along the grooves 14 are apertures which communicate with an intermediate chamber 15 and the cylinders are held closed by valves 18 under the control of springs 19, said valves extending so far inwards that they will engage the ribs 4 of the rotary chamber valves 2 and will be forced thereby against the pressure of the springs 19 whereby the inlet ports 17 are opened sufficiently to permit com-

pressed air also admitted through hollow shaft 1 to pass through the apertures to blow the charge, previously forced partly through the revolving motion of the rotary chamber valve 2 into the chambers 15, into the cylinders.

At the moment when a valve 18 is so acted on by the rib 4 it will come in contact with two spark plugs designated by 20, 20', 20'', etc. in Fig. 1 which extend inward through the wall of the cylinder and will thus prevent the formation of sparks between them so long as it so remains in contact. As soon however as the rib 4 comes out of contact with the valve 18 its spring 19 forces the valve rapidly towards the shaft 1 and thus closes the inlet port 17.

The said cylinders 115^a contain reciprocating pistons 115 connected by rods to a crank or driving shaft 109, transmission gearing 108 of uniform ratio being provided so that the rotary chamber valves 2 on shaft 1 make a revolution at the same time as said crank shaft.

The rotary chamber valves 2 are so arranged that the ribs 4 thereof will operate the gas inlet valve 18 at the moment at which the piston 115 in the respective cylinder reaches the point at which it passes an exhaust port 111 in the wall of said cylinder, or at least part of said port, so that the exploded gas in said cylinder can escape.

The piston in returning compresses the air and fuel and thereby makes it still more susceptible of producing a powerful explosion which takes place when the piston reaches the point farthest from the crank shaft 109.

The spark plugs produce the ignition only at this moment because the electric current is allowed to pass through them only at that moment. This is obtained by a revoluble contact device 130 shown in Fig. 2, which electrically engages the contact parts of the conductors only at the moment at which the piston reaches the said position farthest from the shaft.

The inlet valve 18 will close its port 17 shortly before the piston takes the mid-position in its cylinder.

In this contact device on a rod 131 are mounted three circular commutators 130, 130', and 130'' of non-electric conductivity except a specially arranged electric current conducting section 130ⁱ which is arranged preferably at the circumference of the commutator.

These commutators are shown in perspective view, while the other parts are shown diagrammatically. Two contacts 130^d, 130^e are suitably held against the circumference of each commutator and one 130^d is in electric connection with the positive side of the battery 26' while the other 130^e has electric connection with the respective spark-plug 20^d. The other spark-plug 20 in the same cylinder

is in electric connection with the negative side of the battery. The section 130ⁱ is so arranged on the commutator 130 that at the turning of same which is in the same ratio as that of the crank shaft 109, this section 130ⁱ will come into electric connection with the two contacts 130^d, 130^e and close the circuit when the piston 115 of the upper left hand cylinder is nearest the spark-plugs in that cylinder as shown also in the drawings. It is apparent that the circuit which serves for igniting the fuel-charge in the cylinder next to said first mentioned cylinder must be closed at a different predetermined moment and for achieving this, a second commutator, viz., one designated 130', is arranged and a special circuit is necessary in which similarly to the scheme already mentioned in connection with the first mentioned circuit the spark-plugs but only those of the upper central cylinder are included and it is also apparent that the section 130ⁱ of the commutator 130' must come into contact with the contacts 130^d, 130^e of this commutator 130' at a different moment to the section 130ⁱ of the commutator 130 coming into contact with the contacts 130^d, 130^e of the commutator 130.

The commutator 130'' which serves for closing the circuit in connection with the upper right hand cylinder spark-plugs is so arranged as to bring its section 130ⁱ into contact with the two respective contacts 130^d, 130^e at a still different moment, namely, when the respective piston of the upper right cylinder is nearest to the spark-plugs of that cylinder.

For the lower cylinders a similar arrangement for closing the circuits at the correct time is made and the sections 130ⁱ on the respective commutators must be so arranged on them that the circuit will be closed in which those two spark-plugs are included which are approached nearest by the respective piston in the same cylinder.

In Fig. 1 118 designates the fuel tank, 119 an air pump, and 119' a compressed air reservoir, the latter being connected by pipe 120 and revolvable branches 121 with the hollow shafts 1 leading to the rotary chamber valves 2. The pump is driven by belt and pulley gear 122, 123 from the shafts 1 and the ignition timing contact devices 130 are mounted on shafts 131 driven by belt and pulley gears 132, 133 driven from certain of the gear wheels 108.

In order to prevent a premature explosion of the fuel or explosives blown into the cylinders when there are still some explosion gases left in the explosion chamber, which explosion gases as known are of a very high temperature, it is necessary to provide means for scavenging the cylinder quickly just before the piston 115 completely covers the exhaust port 111 and before the valve 18 is pushed by the rib 4.

To this effect an annular hollow part 150 whose hollow communicates with that of the body 2 is arranged for revolving movement in the casing 13. It is united with the part 2 and therefore is moved simultaneously with this part. There are two holes 151, 152 arranged on the periphery of the annular part 150 and these communicate at certain times with an aperture 153 of a pipe 154, so that when the hole 151 comes in alignment with the aperture 153 the hole 152 is then closed by the wall of the chamber 13 and vice versa. The pipe 154 is in communication with the interior of the cylinder 16.

Whenever one of these holes 151, 152 communicate with the pipe 154 compressed air will rush through said hole and the pipe 154 and will drive out from the cylinder 16 through the still open exhaust port 111 the remainder of the explosion gases so that the combustibles that at the next moment will be blown into the cylinder 16 will not be ignited before the piston reaches its outermost position (that is nearest to the valve 18). After the combustibles are blown into the cylinder the rib 4 releases the valve 18 and this valve closes the inlet port 17. Simultaneously with this function the other of the two holes 151, 152 comes into communication with the pipe 154 and again compressed air will be blown into this pipe but the charge already contained in the cylinder being still more compressed by the outward going piston will set up such counter-pressure to the compressed air that comes out of said other hole 151 or 152 that there will not be any other effect than that of an encountered strong resistance. The purpose of arranging two holes 151, 152 is that, to have the cylinder 16 also then scavenged when the shaft 109 rotates in the inverse direction.

There is also provided a device for detachably connecting the shaft *a'* of a turbine as previously mentioned with the crank shaft 109 of the reciprocating internal combustion engine, this device embodying for example a coupling 116 and a clutch 117 of any appropriate construction.

The powdered or granulated explosives are confined in the tank 160 and are dosed by means of automatically opening and closing valves 161, 162. When the valve 161 that is nearest to the tank is open, the valve 162 is closed and powdered or granulated combustibles fall into the space in the pipe 163 that is situated between these two valves. At the moment in which the valve 161 is closed again the valve 164 of a pipe that communicates with the compressed air reservoir 119' and also the valve 162 will be opened and compressed air blows or entrains the combustibles into the pipes 163, and into the upper chambers 13; they also enter into the pipe 167 wherefrom they will be blown into the lower shaft 1 and chambers 13 and into the cham-

bers 15 wherefrom they will be blown into the cylinders by the compressed air that comes out of the apertures 3. The supply of powdered or granulated explosives or combustibles can be shut off by means of the valve 168.

By opening the valve 169 the liquid explosives contained in the tank 118 are admitted to the upper chambers 13, pipe 167 and lower chambers 13 and the forechambers 15. If only gaseous explosives will be employed simply the valves 168 and 169 must be closed and the valve 170 opened whereby the gaseous explosive that is under pressure in the tank 171 will flow into all the chambers 13 and 15, wherefrom it will be blown into the cylinders 16 by the compressed air rushing out through the apertures 3. By opening the valves 168, 169, 170 and 173, which latter when closed shuts off the compressed air preventing it from passing into the pipes 163, 167 and the chambers 13 and 15, all explosives will be admitted to the chambers 13 and 15 and so compounded will be blown into the cylinders and a strong explosion is thereby obtained. If it is desired, however, that only gaseous explosives and such of powdered form are introduced into the cylinders, then only the valve 169 is to be placed into closed position. By opening certain valves and closing certain others either only liquid, or powdered or granulated or only gaseous combustibles will be used for the operation of the motor or a compound between certain of these combustibles.

It is to be noted that whenever liquid or gaseous fuels are employed, no compressed air is necessary for blowing or entraining them to chambers 13, 15. The volume of compressed air used for blowing or entraining the powdered or granulated fuels to chambers 13 and 15, however, is relatively small due to the alternate closing of the valves 161, 162 and 164 and therefore it is prevented that a pressure is created in pipes 163, 167 and in those leading to the fuel containers 169 and 171 and in the chamber 13 that would prevent the liquid and gaseous fuels from flowing into chamber 13 and chamber 15. On the other hand, there must be the full pressure of the compressed air in the chambers of the rotary chamber valves 2 and 150 for blowing at certain moments the fuel accumulated in antechamber 15 into the cylinder and also for scavenging the cylinder when the piston is at the end of its outward stroke. The pressure that is caused by remaining compressed air in the antechamber 15 right after the fuel has been blown into the cylinder becomes equalized with the pressure in the chamber 13 and the pipes leading thereto as soon as the rotary valve 2 uncovers in its rotary movement the apertures of the antechamber 15 and thereby establishes communication between this chamber and chamber 13. The air thus entering chamber 13 and the pipe 167

and those leading to the fuel containers is of a relatively small quantity and will ascend and enter the containers and will settle on top of the fuel contained in them when the valves 169, 170 are open.

communicate at certain moments with a pipe that leads to the working cylinder thereby admitting compressed air to the cylinder for scavenging purposes.

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Vents or leaks may be used as is known in the art, but they should be in connection with the chambers 13 and 15 for allowing the escape of the compressed air from these chambers. These vents should be operated automatically and opened at the moment in which the valve 18 closes the inlet port 17, but they should be closed a few moments later, that is when the chamber valve 2 makes the first quarter of a rotation after the operation of the valve 18. In construction, these vents may be similar to the valve 18 and must have also a spring similar to spring 19 and they may be operated as well by the rib 4 of the rotary chamber valve 2 with the exception, however, that no compressed air will be blown through the apertures 3 because the wall of chamber 13 will keep them closed. A venting conduit should be so arranged as to communicate with antechamber 15 and the space in which the outlet port of said venting valve is located. The fuel accumulated in chamber 13 will then encounter no counterpressure in antechamber 15 and will flow therein whereby the rotary chamber valve 2 will assist through its motion in moving part of the fuel contained in chamber 13 into antechamber 15.

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

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1. A reciprocating internal combustion engine of the type having means for charging fuel and compressed air to the cylinder or cylinders comprising a rotary inner hollow shaft adapted to admit compressed air, a rotary chamber valve on said shaft, an antechamber and apertures in connection with the inner shaft adapted to allow compressed air in said shaft to flow into said ante-chamber and also into the cylinder.

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2. A reciprocating internal combustion engine having means for conveying explosive fuel to a chamber, and means in said chamber for forcing said fuel into an ante-chamber and then through the latter into the cylinder of the engine.

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3. A reciprocating internal combustion engine having an inlet port communicating with an ante-chamber, a valve, a spring tending to cause said valve to close the inlet port and a rib on a rotary chamber valve adapted to act on the valve to open said inlet port during the rotations of the inner shaft.

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4. In a reciprocating internal combustion engine, a hollow cylindrical body, a rotatable hollow body arranged within said cylindrical body, a rotatable device containing compressed air and holes in said device that com-

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