July 24, 1934. E. G. BAKER 1,967,734

INTERNAL COMBUSTION ENGINE

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Fig. 1.

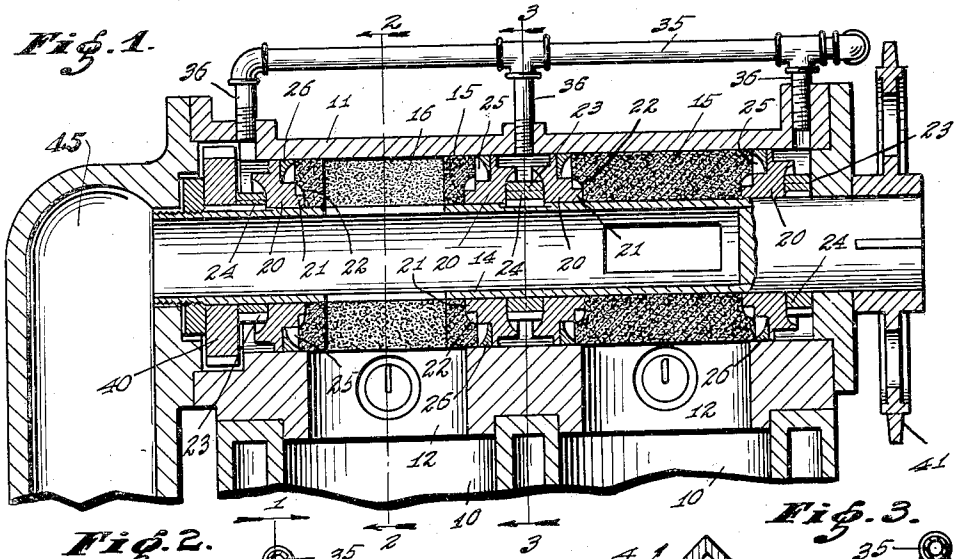


Fig. 2.

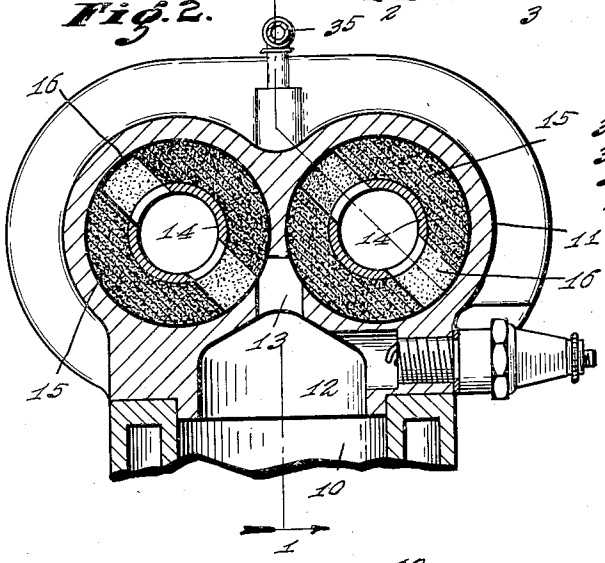


Fig. 3.

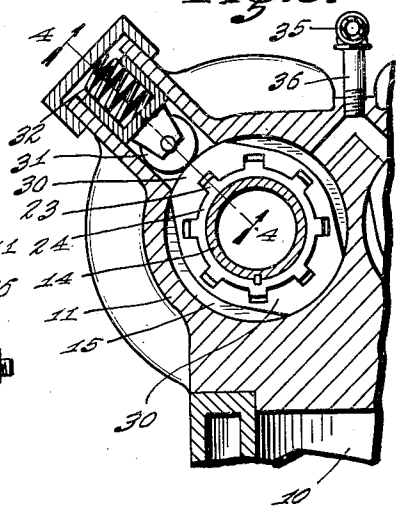
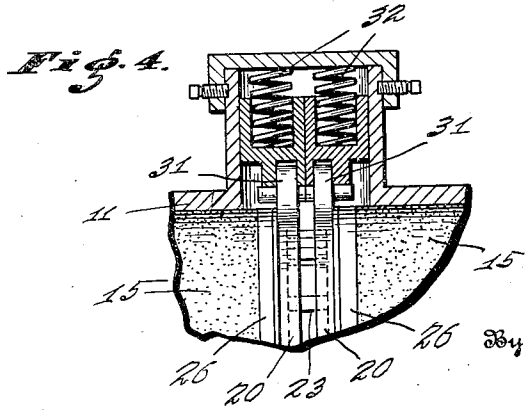


Fig. 4.



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Fig. 5.

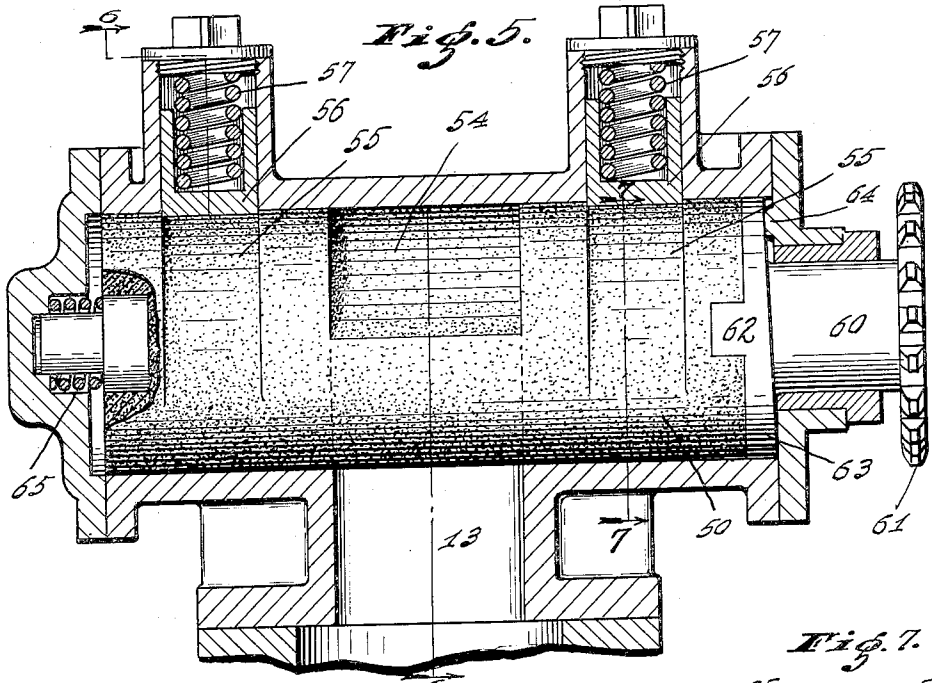


Fig. 7.

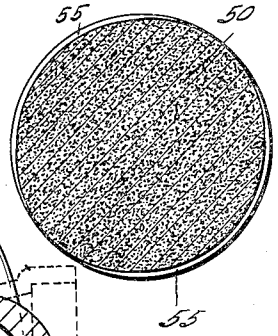
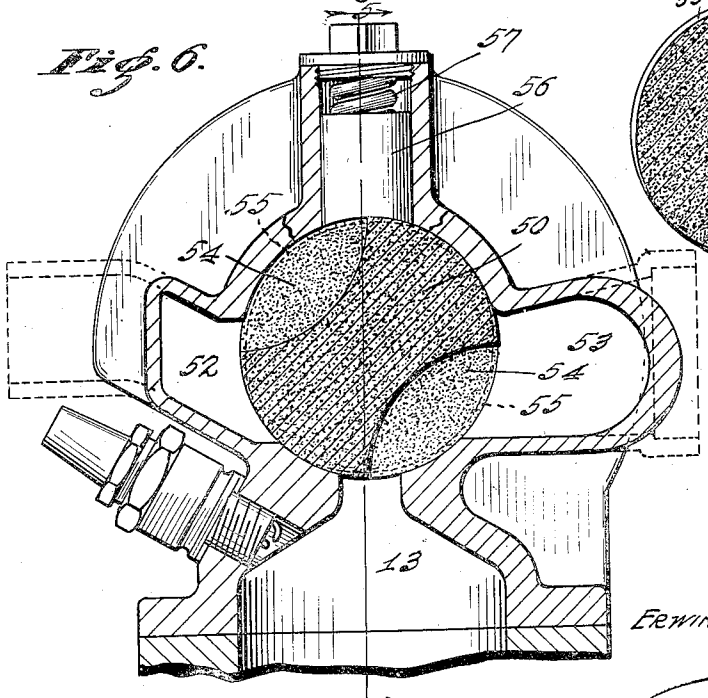


Fig. 6.



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Patented July 24, 1934 1,967,734

UNITED STATES PATENT OFFICE

1,967,734

INTERNAL COMBUSTION ENGINE

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Application July 9, 1931, Serial No. 549,721

3 Claims. (Cl. 123—190)

My invention is concerned with rotary-valve mechanism for internal combustion engines, and it is my object to produce such a mechanism in which the rotary valve will adequately confine the gases under pressure in the engine in order to prevent leakage and loss of power; in which the valve will at all times run freely without scoring in the casing which encloses it; and in which oil will be definitely excluded from contact with the gases that pass through the engine, whereby to prevent the formation of smoke resulting from burning or heating of any such oil.

In carrying out my invention I may provide separate valves for inlet and exhaust gases, these valves being respectively mounted in bores in the cylinder head, which bores communicate, preferably through a common port, with each cylinder of the engine. The gases are fed and removed from the engine through axial passages in the rotary valves, the communication between such passages and the engine cylinders being controlled by ports in the valve, such ports passing into and out of registry with the cylinder ports as the valves are rotated. My invention may also be embodied in a single rotary valve, in which case the inlet and exhaust passages will be located exteriorly of the valve. The valve, or at least those portions of it which contain the valve ports, are formed of carbon, as will be more particularly set forth hereinafter. Associated with the valve is means for forcing it to seat during the periods in which it is closed in such a way as to prevent leakage of gases during the power stroke of each cylinder of the engine. To prevent scoring, I provide means for imparting an axial reciprocation to the valve as it rotates.

The accompanying drawings illustrate my invention: Fig. 1 is a longitudinal section through one valve of a two-valve engine; Figs. 2 and 3 are transverse sections on the lines 2—2 and 3—3 of Fig. 1 respectively; Fig. 4 is a fragmental section on the line 4—4 of Fig. 3; Fig. 5 is a longitudinal section on the line 5—5 of Fig. 6 showing the valve of a single-valve engine; and Figs. 6 and 7 are transverse sections on the lines 6—6 and 7—7 of Fig. 5 respectively.

The engine with which my device is associated may have any number of cylinders 10 the upper ends of which are closed by a head 11 which contains the valve mechanism. As shown in Figs. 1 and 2, the head is provided with two parallel valve-receiving bores which extend parallel to the cylinder block and which are located on opposite sides of the plane containing the cylinder axes, as is clear from Fig. 2. The head 10 is provided with a combustion chamber 12 for each cylinder, such combustion chamber communicating with both bores in the cylinder head through a centrally located port 13.

Each of the bores in the cylinder head 11 contains a rotary valve preferably formed of a single piece of tubing 14 which extends for the length of the head and is mounted at its ends in suitable bearings which support it concentric with the associated bore. Opposite each cylinder, there is mounted for rotation with each of the tubes 14 a sleeve 15 the outer diameter of which is such that each tube 14 with its associated sleeves can rotate freely in the bore which receives it. Ports 16 are provided in the tube 14 and in each of the sleeves 15, these ports being arranged to pass into and out of registry with the cylinder port 13 as the valve rotates. Preferably, each of the sleeves has two ports located diametrically opposite each other, as indicated in the drawings; but this particular number of ports is not essential.

The sleeves 15, in the preferred form of my invention, are formed of carbon of the general type used for brushes in electrical machinery. This material is fine-grained, requires no lubrication, and will not score the surface of the bore in which the sleeves 15 are located. Further, I have found that by making the sleeves 15 of carbon they will not, as the result of dimensional changes resulting from variations in temperature, bind in the bore which receives them or become loose therein to permit the escape of gases, nor will they deteriorate under the high temperatures to which they are subjected.

For the purpose of holding each of the sleeves 15 in place on the tube 14, I may employ the means illustrated in Fig. 1.

This means comprises a collar 20 located at each end of the sleeve 15 and non-rotatably secured thereto as by being provided on one face with extensions 21 which are received in radial slots 22 in the end face of the sleeve. On the other face, each of the rings 20 is provided with one or more radial slots which receive teeth 23 on a ring 24 which is rotatable with the tube 14 and which preferably is keyed thereto. This construction insures that each sleeve 15 will occupy a constant angular position on the tube 14 and will rotate with the tube to provide the opening and closing of the cylinder ports necessary to engine operation.

Each of the collars 20 adjacent the abutting face of the associated sleeve 15 is provided with an annular rabbet groove 25 which groove re-

ceives a sealing ring 26. The axial thickness of the sealing ring 26 is slightly less than the width of the groove 25 which receives it, and that face of the ring which is disposed adjacent the associated sleeve 15 is countersunk for a purpose which will hereinafter become apparent. The opposite face of the sealing ring 26 and the abutting face of the collar 20 are accurately machined to have a close fit.

The sealing rings 26 are preferably of material having a higher coefficient of expansion than the material of the head 11. If the head 11 is formed of steel or iron, the sealing rings 26 may be of bronze. The outer diameter of the rings 26 is such that when both they and the cylinder head are cold the rings will have a close fit in the valve-receiving bores.

The construction just described provides an effective seal preventing axial escape of gases from the port 16 between the sleeves 15 and the surface of the valve-receiving bore. Any such gas which tends to escape axially along the outer surface of the sleeve will enter the pocket provided by the counter-sunk face of the ring 26, entrance of the gas to this pocket being made possible by reason of the fact that the axial thickness of the sealing ring is less than that of the groove in which it is located. The pressure of the gas in this pocket tends to force the sealing ring 26 outwardly into firm engagement with the adjacent face of the groove in the collar 20 to prevent the escape of gases between such surfaces. As the engine runs and the temperature increases, the rings 26, being of a material having a higher co-efficient of expansion than that of the head, will expand into firm frictional engagement with the surface of the face-receiving bore to prevent any possibility of leakage past the ring. In the operation of the engine, the rings 26 remain stationary, while the sleeves 15 and collar 20 rotate.

For the purpose of preventing circumferential leakage of gases, particularly during the power stroke in each engine cylinder, I provide means for forcing the sleeves 15 into close contact with the inner surface of the valve-receiving bore over the region adjacent the cylinder port during the power stroke in the cylinder.

To this end, each of the collars 20 is provided with cam lobes 30, there being one of such lobes for each port in the associated sleeve 15. At a point in the cylinder head 11 across each valve-receiving bore from the cylinder port, I provide cam followers in the shape of rollers 31 which bear upon the collars 20 in the plane of the lobes 30. These rollers are spring-pressed inwardly as by means of springs 32, with the result that the springs 32 tend to deflect the valve toward the cylinder ports. The cam lobes 30 are so angularly disposed relative to the ports 16 that one of the cam lobes 30 engages the roller 31 during the power stroke in the adjacent cylinder. As the cam lobe forces the roller 31 outwardly against the pressure exerted by the spring 32 during the power stroke, the sleeve 15 is forced into close contact with the wall of the bore in which it is located in the region surrounding the adjacent cylinder bore.

For the purpose of lubricating those parts of the valve mechanism which require lubrication, I provide an oil supply header 35 which receives oil from the lubricating system of the engine. At spaced points in its length, this header is connected through pipes 36 with the valve-receiving bores in the head 11 at points between two adjacent sleeves 15 and at the ends of the valves. The oil admitted through the pipes 35 and 36 lubricates the cams on the collars 20, the cam followers, and other moving parts. Such oil is confined by the sealing rings 26, and therefore does not come into contact with the sleeves 15 and cannot become mingled with the gases passing through the engine to create smoke.

The manner of operating valves 14 is subject to considerable modification. The engine illustrated in the drawing is assumed to be a four-stroke cycle engine; and as the valves have two ports for each cylinder, they are rotated at one-quarter engine speed. Conveniently, the valves are interconnected by gears 40 of equal size and one of the valves is driven by a sprocket and chain drive 41 from the engine crank-shaft.

Gases are supplied to the inlet valve and removed from the exhaust valve by means of conduits 45 each of which communicates with its associated valve through the opening in the end thereof. The opposite end of the valve is closed to prevent the escape of gases therethrough.

Figs. 5 to 7 illustrate a modification of my invention shown as embodied in a single-cylinder engine, although it is of course not limited to use in a single-cylinder engine. In this arrangement, I employ a single valve instead of the two valves shown in Figs. 1 to 4, and instead of providing a gas-conduit within such valve, I locate the gas conduits in the cylinder head.

The single valve comprises a cylinder 50 of carbon which is rotatably received in a recess of corresponding diameter conveniently disposed above the cylinder and parallel to the engine crank-shaft. The cylinder has a single gas port 13, while the valve-receiving bore has approximately diametrically opposite ports one of which communicates with the inlet conduit 52 and the other of which communicates with the exhaust conduit 53. In the transverse plane of these last-mentioned ports, the valve is provided with recesses 54 which, in the rotation of the valve, provide passages affording intermittent communication between the cylinder-port 13 and the inlet and exhaust ports of the valve-receiving bore.

In association with the valve just described I may employ means for forcing the valve against its seat adjacent the cylinder port 13 during the compression and explosion strokes of the engine piston. The means illustrated in Figs. 5 to 7 is very similar in principle to that previously described in that cams rotatable with the valve and associated with spring-pressed followers are used. The cams are conveniently formed in the carbon body of the valve 50, by providing diametrically opposite grooves 55 near each end of the valve. In the plane of each of these grooves there is radially slidably mounted in the cylinder head opposite the port 13 a shoe 56. Above the shoe 56 is located a compression spring 57 which tends to move the shoe downwardly into contact with the valve 50. The spring 57 is of such a length that when one of the grooves 55 is beneath the associated shoe 56, substantially no pressure is exerted by the spring. When, however, in the rotation of the valve 50, a groove 55 passes from beneath the shoe 56, the shoe will be forced upwardly against the pressure of the spring 57, and the reaction will firmly seat the valve adjacent the port 13.

The valve 50 may be driven from a drive shaft 60 which is rotatably mounted co-axial with the valve and which may be provided at one end with a sprocket 61 through which it may be driven, (at

one-quarter engine speed, in a four-stroke cycle engine). On its opposite end, the valve-driving shaft 60 is provided with a transverse key 62 adapted to be received in a transverse slot in one end of the valve 50.

I have found that in a rotary valve of the type described the amount of wear and any tendency to score may be materially reduced by reciprocating the valve axially as it rotates. To this end, I may provide the shaft 60 adjacent the key 62 with a flange 63 which overlies the end of the valve 50, and the outer surface of which is formed at an angle to a plane perpendicular to the axis of the valve. In position to cooperate with this inclined outer face of the flange 63 I mount a stationary button 64, and yieldingly press the flange 63 into engagement with such button as by means of a compression spring 65 which acts against the opposite end of the valve 50. As the valve rotates, the inclined outer face of the flange 63, cooperating with the stationary button 64, acts as a cam and produces one complete axial reciprocation of the valve for each revolution thereof.

While I have referred above to valves formed of pressed carbon, I do not wish to be understood as limiting myself to such valves of which carbon forms the sole ingredient. In addition to carbon, the valve may embody finely powdered metals which are intimately mixed with the carbon prior to the formation of the block from which the valve is machined.

I have found that rotary valves constructed so as to present a carbon wearing surface adjacent the cylinder port or ports withstand, without the necessity for any lubrication, the wear and heat to which they are subjected in service. Such valves, after hundreds of miles use in a motor-cycle engine, show no detectable wear and have a glass-smooth exterior surface. I believe this result to be due largely to the intermittent pressure to which the valve is subjected in operation coupled with the fact that a certain amount of finely divided carbon is freed in the engine cylinder and deposited on the valve surface which is exposed at the cylinder port. The fact that radial pressure on the valve is intermittently relieved during valve-rotation would give any such deposited carbon an opportunity to become evenly distributed over the valve surface before it became embedded therein.

I claim as my invention:—

1. In a rotary valve mechanism, a rotary valve element having one or more ports, a ported casing surrounding said valve element, a cam rotatable with said valve element, a cam follower mounted in said casing for radial movement toward and away from the valve element, and yielding means for forcing said cam follower toward engagement with said cam.

2. The invention set forth in claim 1 with the addition that there are two of said cams spaced apart axially of the valve element and located on opposite sides of the casing-port, there being a cam follower associated with each of said cams and said cam followers being independently movable.

3. In an internal combustion engine having a cylinder provided with a gas-passing port, valve mechanism for controlling the flow of gases through said port, said mechanism including a rotatable valve member, and means for causing axial reciprocation of said valve member as it rotates, said means comprising a cam rotatable with said valve, a stationary part co-operating with said cam, and yielding means acting on said valve and tending to maintain engagement of said cam and stationary part.

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