Feb. 10, 1931. A. C. PETERSON 1,792,028

MULTIPLE CYCLE ENGINE

Filed June 16, 1927 3 Sheets-Sheet 1

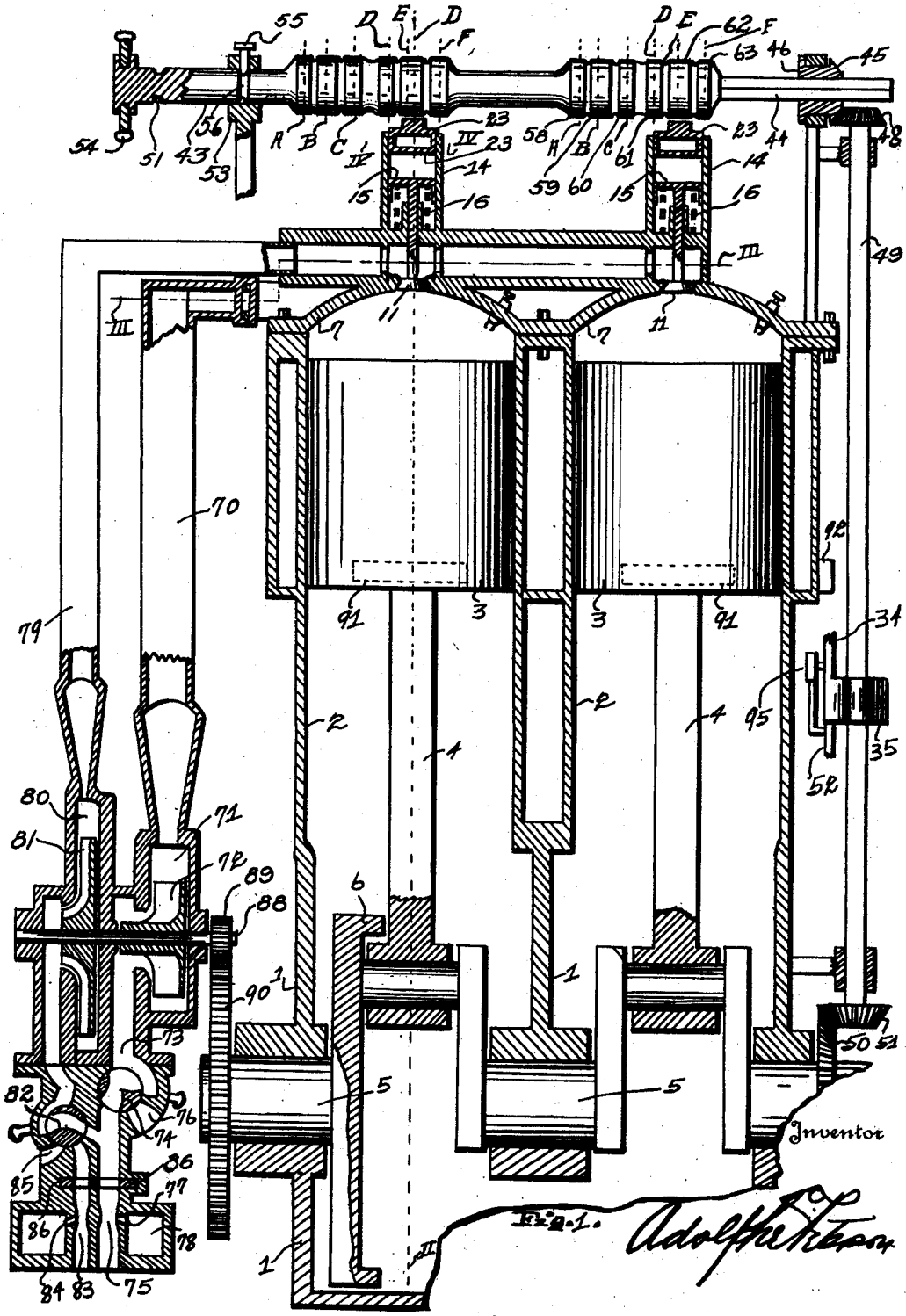


Fig. 1.

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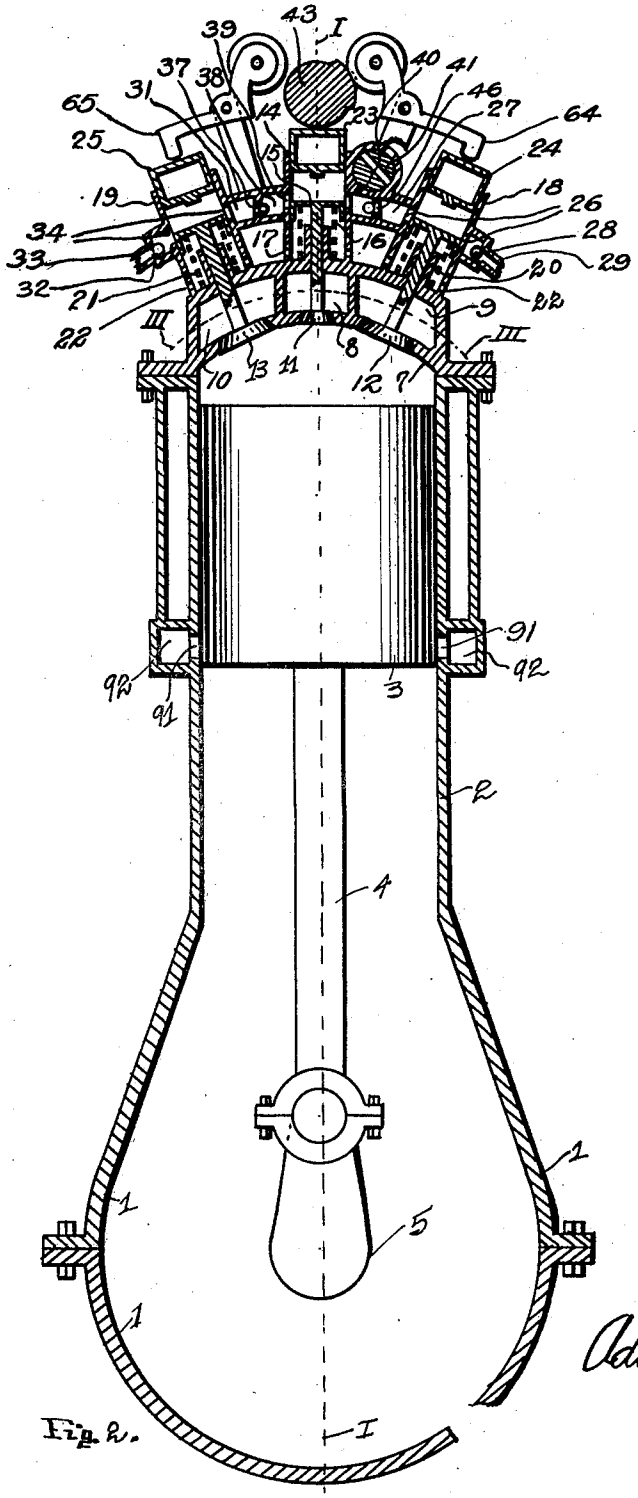


Fig. 2.

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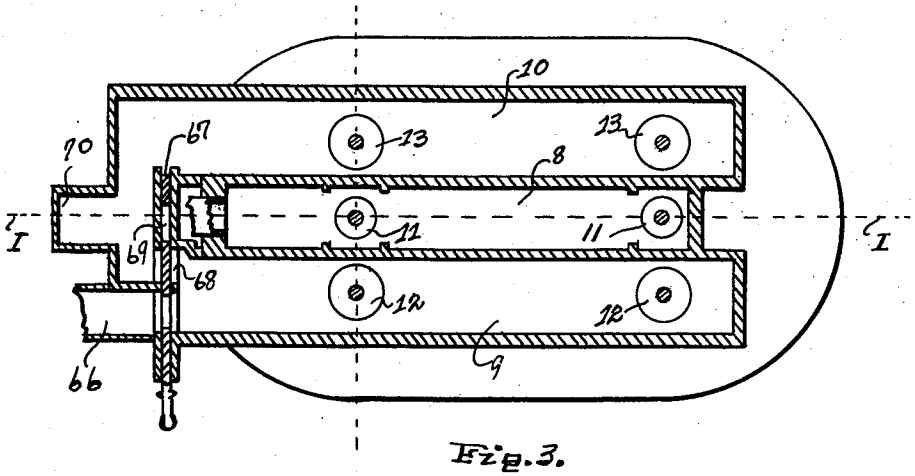


Fig. 3.

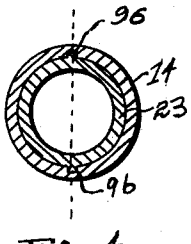


Fig. 4.



Fig. 5



Fig. 6



Fig. 7



Fig. 8.



Fig. 9.



Fig. 10.

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Adolph C. Peterson.

Patented Feb. 10, 1931

1,792,028

UNITED STATES PATENT OFFICE

ADOLPHE C. PETERSON, OF MINNEAPOLIS, MINNESOTA

MULTIPLE-CYCLE ENGINE

Application filed June 16, 1927. Serial No. 199,374.

My invention relates to internal combustion engines and particularly to a form of valve operating means and to a form of dual cycle engine, wherefore it is called a multiple cycle engine.

The principal objects of my invention are to provide a form of valve operating means which shall provide in connection with poppet valve engines a more silent operation, which shall provide in such engines a valve means which is easily adjusted or which requires no adjustment and which therefore will save considerable time in the repair or maintenance of such engines. The object of this valve operating means is to provide a valve means which shall be simple in construction and simple in maintenance, which shall be durable in use or operation and cheap in manufacture and which in general shall be an improved valve means and valve operating means for internal combustion engines.

Another object of my invention is to provide an improved form of engine which shall have the advantages of the four cycle engines and which shall also have the advantages of the two cycle engines, and which shall be adapted to operate upon either the two or the four cycle method at the will of the operator and which shall therefore provide the great power of the two cycle engine under some conditions of operation, particularly at low speeds and when heavy loads are encountered and which shall provide the high speed and efficiency of the four cycle at high speeds or light loads. In particular the object is to provide an engine which shall have the efficiency of the usual four cycle engine at one half loads and which shall have large efficiency at full loads and large load ability.

The principal devices and combinations of devices comprising my invention are as hereinafter described and as defined in the claims. In the accompanying drawings which illustrate my invention in several different forms like characters refer to like parts throughout the several views.

Referring to the drawings:

Figure 1 is a view chiefly in vertical section through the axis of the crank shaft and the axes of the cylinders of a multiple cylinder engine embodying my invention, and taken on the line I—I of Figures 2 and 3.

Figure 2 is a vertical section on the line II—II of Figure 1, this section being at right angles to the section of Figure 1.

Figure 3 is a horizontal section on the line III—III of Figure 1, this section being taken in part as shown on one elevation and in part another elevation of Figure 1, and being also on the line III—III of Figure 2.

Figure 4 is a detail horizontal section on the line IV—IV of Figure 1.

Figures 5, 6, 7, are detail sections of the cams on the lines A, B, C, respectively of Figure 1, these sections being through the cams for two cycle operation.

Figures 8, 9, 10, are detail sections of the cams on the lines D, E, F, of Figure 1, respectively, these sections being through the cams for four cycle operation.

Referring again to the drawings, the numeral 1 indicates a crank case whereon are mounted cylinders 2 preferably cast as a unit with the upper half of the crank case. Within the cylinders are reciprocating trunk type pistons 3 which by connecting rods 4 cooperate with the crank shaft 5 which latter is rotatably mounted in bearings in crank case 1. The crank shaft 5 has a flywheel 6 formed with one of its crank arms as shown. As shown in Fig. 2, the cylinders have mounted upon their upper ends a head casting or forging 7 which has formed with it a so-called rich-gas conduit 8 and an exhaust conduit 9 and an air or carburetted air conduit 10. These three conduits extend along the upper ends of the heads of the cylinders parallel to the axis of the crank shaft and each of them are isolated from each other except for the communicating means hereinafter described.

The rich-gas conduit 8 has one port delivering to each cylinder 2 at the extreme central upper end of its head and each port is controlled by a relatively small poppet valve 11. The exhaust conduit has one port delivering from each cylinder 2 each port being controlled by one poppet valve 12, relatively large. The air or carburetted air conduit 10 has one port delivering to each cylinder each

being governed by a poppet valve 13, relatively large.

The poppet valves 11 each have stems as shown extending vertically upward axially within a so-called follower cylinder 14, one for each valve, which are relatively small cylinders. The upper end of each poppet valve stem has a small valve piston 15 secured to it or formed integrally with it and which has a rather close but easily slidable fit in the follower cylinder related to it. Beneath this valve piston there is a small coil spring 16 which bears between the valve piston and the wall directly beneath so that the spring exerts a pressure upwardly and yieldably against the valve piston 15 related to it. There are ports 17 in the wall of the follower cylinder below the level of the valve piston whereby the space beneath the valve piston wherein the spring operates is relatively free from any liquid oil.

The poppet valves 12, and 13 have likewise individual related follower cylinders 18 and 19, and individual springs 20, and 21, and individual ports 22 which act or are relatively similar to those described in connection with the poppet valves 11, but these are located at an angle to the vertical as shown.

In each of the follower cylinders, that is in the follower cylinders 14, 18 and 19, individually related to each there are cam followers, 23, 24, 25, each of which is reciprocable within its related follower cylinder and approximately the same diameter as the valve piston related to it, and each of which is located above the valve piston in the follower cylinder. The cam followers related to the valve pistons are normally considerably separated as hereinafter described, from the valve pistons, and the cam followers have short knobs at their lower ends whereby there will under all conditions be some space between the related cam follower and valve piston.

Each follower cylinder 18, related to an exhaust poppet valve 12 has in its side wall situated at a point such that it will always remain uncovered an oil port 26 which is a port permitting free entry of oil under pressure from an individual related chamber 27, the latter having free entry of oil by way of a port controlled by a nonreturn ball check valve 28 from an oil pressure conduit 29. Each follower cylinder 19 is related to an air or carburetted air poppet valve 13, likewise has in its side wall a relatively similarly situated oil port 30, which is a port permitting free entry of oil under pressure from an individual chamber 31, the latter having free entry of oil by way of a port controlled by a non-return ball check valve 32 from an oil pressure conduit 33. The oil pressure conduits 29 and 33 all receive oil under pressure from a main oil conduit 34 which latter is supplied with liquid oil under pressure by an oil pump 35 the oil pump being driven as hereinafter described.

The chambers 27 and 31 related to one cylinder 2 (its follower cylinders) may freely deliver oil under pressure by way of ports controlled by nonreturn ball valves 36, 37, to a chamber 38 related to the follower cylinder 14 of the related set. The chamber 38 of each set, that is the chamber 38 related to each follower cylinder 14 may freely deliver oil through a related port 39 into the space between the valve piston and related cam follower in the follower cylinder 14. The chambers 38 may all be connected with the external space or with conduit delivering back to any oil reservoir, by means of ports 40 which may be simultaneously opened by means of a common cylindrical valve 41, the latter being adapted to be manually stationed by a lever so as to permit all the chambers 38 to discharge freely or may be so stationed that all the ports 40 are blocked and thereby none of the chambers 38 have delivery except through the related ports 39.

Above the cylinder heads there is horizontally mounted in bearings to rotate on an axis parallel to the axis of the crank shaft, a cam shaft 43 which at one end has a square portion 44 slidable axially in a square bore in a mitre gear 45, whereby the cam shaft may be slidable axially relatively to the mitre gear 45 but is at all times rotated in unison with the mitre gear 45. The mitre gear 45 is rotatably mounted by means of its extended portion 46 in a bearing bracket 47 and is driven by a mitre gear 48 by a vertical shaft 49, the latter being driven through mitre gears 50, 51 by the crank shaft 5, the relation being such that the cam shaft 43 is driven at one half the speed of the crank shaft, that is two to one. The vertical shaft 49 drives the pump 35 so as to draw oil from a supply conduit 52 and deliver under pressure to the conduit 34.

The cam shaft 43 at its opposite end is rotatable in a bearing 53 and may be moved axially by a hand wheel 54 the latter being freely mounted on the end of the cam shaft as shown but so that movement of the hand wheel will move the cam shaft axially. The bearing 53 has a small conical pointed screw bolt 55, manually turnable, whereby the cam shaft may be fixed to rotate in either one of two positions according to whether the cam shaft is placed so that the groove 56 or the groove 57 is in place within the bearing.

The cam shaft 43 has two sets of cams for each cylinder 2, one set 58, 59, 60 being the so-called two cycle set and one 61, 62, 63 being the four cycle set. The two cycle set of cams of each cylinder has one cam, the central one which is adapted to depress the related cam follower 23, twice in each revolution of the cam shaft, when the latter is placed for two cycle operation. On one side of the central cam there is a cam adapted to depress the

cam follower 24, related, by means of a rocking lever 64, related, twice in each revolution of the cam shaft when the latter is placed for two cycle operation. On the other side of the central cam there is a cam adapted to depress the cam follower 25, related, by means of a related rocking lever 65, twice in each revolution of the cam shaft when the latter is placed for two cycle operation.

The four cycle set of cams of each cylinder has one central cam which is adapted to depress the related cam follower 23, once in each revolution when the cam shaft is placed for four cycle operation. The cam on one side of the central cam is adapted to depress the related cam follower 24 once in each revolution when the cam shaft is placed for four cycle operation. The cam on the other side of the central cam is adapted to depress the related cam follower 25 once in each revolution when the cam shaft is placed for four cycle operation.

The exhaust conduit 9, under four cycle operation delivers by conduit 66 to atmosphere, but under two cycle operation, a valve 67 is placed so that it blocks passage to atmosphere but by means of passage 68 and port 69 in the valve 67, connects the exhaust conduit 9 with an air or carburetted air main 70. The air or carburetted air conduit 10 is permanently connecting with the air or carburetted air main 70. The latter may receive air or carburetted air from a centrifugal blower volute casing or collector 71 wherein is rotated at high speed a centrifugal blower 72, the latter receiving air or carburetted air from a passage 73 as controlled by hand valve 74, the latter in one position permitting passage from a Venturi tube 75 and in the other position from an air port 76 only. The Venturi tube 75 has related to it a nozzle 77 which is of such size that liquid fuel may be received under suction from the fuel chamber 78 in which liquid fuel is maintained preferably under a constant level by any means as by means of a float controlled supply, this not being shown.

The rich gas conduit 8 is permanently connected by a conduit 79 with a volute casing or collector 80 of a centrifugal blower 81 which latter receives air or a rich gas mixture or a normal carburetted air with air as controlled by a hand valve 82, the latter in one position permitting communication with Venturi tube 75, whereby the normal carburetted air mixture may be received, in another position, permitting communication with a Venturi tube 83 wherein a nozzle 84 procures a rich carburetion or gas mixture with air, and in another position with an atmospheric port 85. A throttle valve 86, flat, moved by hand lever 87 permits uniform graduation of the volume of gases passing through either Venturi tube when the two are acting in unison as hereinafter described.

The centrifugal blowers 72 and 81 are on one shaft 88 driven by a small spur gear 89 by large spur gear 90 on the crank shaft 5, whereby a high speed of the blowers is obtained. The blower 81 is adapted to deliver a relatively small volume of air but at relatively higher pressure, say about eight or ten pounds, while the blower 72 is adapted to deliver a relatively large volume but at relatively lower pressure, say at only about four or five pounds. The blower 81 may thus be relatively small but of larger diameter.

In the use or operation of my engine, the crank shaft 5 is given its initial rotation by any means as by the ordinary electric starter means, not shown, however in the drawing. When so started, the cam shaft may be set at four cycle position. The chambers 38 may be released to atmosphere, that is their pressure of oil, and the cam followers will then gravitate downwardly or may be easily pressed out of the way by the cam shaft in movement thereof axially. Approaches to the cams on the cam shaft should be gradual. Under four cycle operation, the valve 67 is placed so that the exhaust conduit 9 may deliver to atmosphere, and so that there is no communication between the exhaust conduit 9 and the conduit 10 or main 70. Likewise the Venturi tube valves are set so that both blowers receive carburetted air from the normal carburettor tube. This is preferably the setting for four cycle operation, especially at high speeds, but the setting may be such if preferred that air is received by blower 72 and rich gas by blower 81. Under operation as a four cycle engine, the discharge of oil from chambers 38 to atmosphere being blocked, the four cycle cams will function directly or by the rocking levers against the cam followers so that the four cycle cams depress the cams followers periodically as in the ordinary four cycle poppet valve engine, but the cam followers act through a body of oil located in each individual follower cylinder against the related valve piston, so that the cam follower acts through the oil imprisoned to depress the valve piston and thereby the related poppet valve. In this manner the popet valves are so depressed that each cylinder is connected with the conduit 9 during an exhaust stroke, with the conduit 10 during an inlet stroke (in which either air or normal carburetted air is received) and with the rich gas conduit 8 during either the whole of the inlet stroke or part thereof, during which either rich gas or normaly carburetted air is received depending on the setting. During succeeding compression and working strokes, there is no communication. At the lower end of each stroke of a piston in cylinder 2, the cylinder 2 may communicate by ports 91 in the side wall with exhaust conduits 92 delivering to atmosphere.

If now it is desired to change to a two cycle

operation, the operator releases the oil pressure from chambers 38 by means of valve 41, whereby oil pressure is released from all the chambers related to follower cylinders, and thereby the cam followers may gravitate downward or may be easily depressed downwardly and the operator may then move the cam shaft into the two cycle position and lock it in that position. He may then also change the Venturi tube connection so that the blower 81 may receive rich gas and the blower 72 may receive only air. This is the preferable connection for two cycle operation but the normal carburetted air connection may be used instead if desired. When the cam shaft is so placed, and the valve 67 placed to block delivery from conduit 9 to atmosphere and permit communication of conduit 9 with main 70, the engine will then operate on the two cycle method and at each revolution of crank shaft 5 the poppet valves connecting with conduits 9 and 10 will open approximately during lower sixty, more or less, degrees of revolution, as to each piston, whereby during the whole of or most of the period when the ports 91 are uncovered, air or carburetted air from main 70 will be received both from conduit 9 and conduit 10. Likewise during this period or during the last part thereof or slightly after this period the poppet valve related to conduit 8 will be opened so that normal carburetted air or rich gas may enter from this conduit also. This connection with conduit 8 is preferably just immediately after closing of ports 91, when the high pressure volume of gas will enter, both under two and four cycle operation.

The follower cylinders at all times under either operation receive oil under pressure of say twenty to sixty or more pounds, depending on construction, but oil may never flow backwardly from these follower cylinders, so that oil will always tend to enter and fill the space and press the cam follower upwardly against the cam with which it is cooperating. During the interval when the cam follower is being pressed downwardly by the cam related to it in the action opening any poppet valve, the ball check valve described in connection with each follower cylinder absolutely prevents return flow of the oil into the oil pressure conduit delivering from the oil pump, so that therefore as the follower cylinder has under operation no other adequate outlet (valve 41 being in the closing position) the oil in the follower cylinder will provide an adequate incompressible block between the cam follower and the valve piston and thereby the valve piston together with its valve stem and poppet valve related to it will be depressed uniformly the distance required to adequately open the poppet valve. It is to be noted that the cam followers have a slidable fit in the follower cylinders as have the valve pistons but that this fit is so tight that there will not be any leakage great enough to affect the relative incompressibility or displacement of the oil body which is in the follower cylinder between the cam follower and the valve piston, but that on the other hand there may be a very slight leakage around the cam follower and the valve piston to the spaces without the follower cylinder so that there always continue to be a very slight adjustment of the parts to the effect that the cam follower will during the inactive period when there is no depression of the poppet valve be held up against the cam related but will not be in such relation to the oil body and valve piston that the latter is at all depressed to open the poppet valve in any degree, that is so that the poppet valve may always during its inactive periods remain completely against its seat. To this end the spring related to the poppet valve is of such strength that it will always push the valve piston upward against the pressure of any oil in the follower cylinder and thereby will not permit any oil surplus to enter the follower cylinder exceeding that amount which is just necessary to maintain the proper relation of parts. That is the strength of the spring is greater than the strength of the oil pressure, but the oil pressure is so great that it will always cause a sufficient amount of oil to enter to keep the follower cylinder completely full and the cam follower pressed against its cam face. A pressure relief valve 95 may be provided in the oil pressure conduit to permit by-passing of oil when the pressure exceeds a predetermined pressure. There may be a very small hole, a pin hole in the cam follower which will always permit a slight escape of oil and any air or gas in the follower cylinder so that there may be always the slight adjustment of the oil supply. It is to be noted however that at all times when the depression movement of a poppet valve by its cam occurs, this depression movement is of such speed and the relative escape of any oil from the follower cylinder so small or slight that there is no loss of oil therefrom of any consequence during the depression period of a poppet valve and therefore there is full movement or depression of the poppet valve by the cam related to it. And any escape of oil, which may be very slight, for the purpose described or may be relatively not at all, is continuously compensated for, during the inactive periods of a poppet valve by the entry of oil from the oil pressure supply. It is contemplated that the oil pressure supply may be the oil pressure supply for lubrication of the engine, the pressure used being in proper relation to the parts, the valve piston and cam follower being of a sufficient diameter to provide the necessary resistance body of oil between the two. However this body of oil need not be large in diameter because the oil is substantially incompressible and there is relatively

none or no escape of oil during the depression period, depending on the construction. As shown in Figure 4 the cam followers have on their sides guides 96 which slide in grooves in the inside bore of the follower cylinder thereby maintaining the cam follower against rotation. This is to permit narrow cams in the construction as shown, but the cam followers may be permitted rotation in some constructions depending on the permissible width of cam face and the relative size of the cam follower used.

As described above the engine may have a four cycle action during which the engine functions as an ordinary four cycle engine either drawing in normally carburetted air through one main inlet valve and also from rich gas conduit 8 or it may draw only air from the conduit 10 and rich gas from the conduit 8 the richness being so proportioned that a properly proportioned mixture for combustion is made when the two supplies are mixed in the cylinder. In two cycle operation the cylinder once during each revolution receives air from both conduits 9 and 10 and rich gas from conduit 8 during charging period or it may receive normally carburetted air from all three conduits 8, 9, and 10 depending on the setting. The Venturi tube valves 74 and 82 may be so turned that air only is received as when braking effect is desired. Under any operation the throttle valve may be so placed that flow is restricted to both blowers 72 and 81 and thereby the flow may be proportionately cut off and throttling effect secured. In starting of the engine, which it is noted is an especial advantage of my system, whereas the blowers function similarly, the engine may be started on the four cycle plan and thereby a normal charging secured by the suction of the engine pistons notwithstanding that the blower effect may when starting at slow speeds be small, so that starting may be readily effected. As soon as the engine has attained a normal minimum speed, which may be that for the slow speed driving of an automobile, the engine may be caused to take up the two cycle system or the four cycle may be retained as desired, the two cycle being preferably used for heavy loads and at relatively low speeds. The high pressure blower delivering to conduit 8 is however of such pressure capacity because of its larger diameter that it will secure an adequate charging of rich gas through the conduit 8 for two cycle operation at low speeds of driving, and at such low speeds the pressure necessary to supply air for scavenging through ports 91 will be low and the low pressure blower will be adequate in pressure capacity for low driving speeds. It is to be noted that by driving speeds is contemplated the normal speeds of the engine when under proper way and as used in low speeds of an automobile, whereas by the low speeds of engine starting above mentioned, it is intended to mean merely those speeds when an electric starting motor is giving rotation to the crank shaft and the engine has not taken up its cycle sufficiently to drive the engine without the starting motor. Spark plugs should be provided as shown. The engine is shown with two cylinders which operate in unison when two cycling and alternately when four cycling, the balance wheel providing uniform rotation but it is contemplated that say four, six or eight cylinders will be used as in any four cycle engine, the impulses always coming as in the four cycling but during two cycle operation impulses from two cylinders will come at the same time.

While I have shown particular devices and combinations of devices in the illustration of my invention, I contemplate that other detailed devices and combinations of devices may be used in the realization of my invention without departing from the spirit and contemplation thereof.

What I claim is:

1. In an internal combustion engine, an engine cylinder and a cooperating piston, a port in the side-wall of the engine cylinder adapted to be uncovered by the piston in its reciprocation, an inlet valve controlling the inspiration of charge under four cycle operation of the engine, an exhaust valve controlling exhaust from the cylinder through an exhaust port under four-cycle operation of the engine, in combination with means whereby the inlet and exhaust valves may be caused to act in unison controlling admission of air under pressure to the engine cylinder under two cycle operation of the engine the exhaust in such operation occurring through the piston covered port in the side-wall of the engine cylinder, and means whereby the engine cylinder receives a charge of fuel during each cycle.

2. In an internal combustion engine, cylinders and cooperating pistons, a port in the side wall of each cylinder adapted to be uncovered by its piston in its reciprocation, an inlet valve in each cylinder controlling the inspiration of a charge under four cycle operation, an exhaust valve in each cylinder controlling exhaust under four cycle operation through an exhaust port, in combination with means whereby the inlet and exhaust valves of each cylinder may be caused to act in unison controlling admission of charge to the cylinder under two cycle operation the exhaust in such operation occurring through the piston covered port in the side wall of the cylinder.

3. In an internal combustion engine, engine cylinders and cooperating pistons, a port in the side wall of each cylinder adapted to be uncovered by its piston in its reciprocation, an inlet valve in each cylinder control-

ling the inspiration of charge under four cycle operation, an exhaust valve in each cylinder controlling the exhaust under four cycle operation, in combination with means whereby the inlet and exhaust valves of each cylinder may be caused to act in unison controlling admission of air under pressure to the cylinder under two cycle operation the exhaust in such operation occurring through the piston covered port in the side wall of the cylinder, and means whereby the engine cylinder receives a charge of fuel during each cycle.

4. In an internal combustion engine, engine cylinders and cooperating pistons, a port in the side wall of each cylinder adapted to be uncovered by its piston in its reciprocation, an inlet valve in each cylinder controlling the inspiration of charge under four cycle operation, an exhaust valve in each cylinder controlling the exhaust under four cycle operation, conduit and carburetting means adapted to deliver carburetted air as controlled by the inlet valve under four cycle operation, in combination with means whereby the inlet and exhaust valves of each cylinder may be caused to act in unison controlling the admission of charge from said conduit and carburetting means under two cycle operation the exhaust in such operation occurring through the piston covered port in the side wall of the cylinder.

5. In an internal combustion engine, engine cylinders and cooperating pistons, a port in the side wall of each cylinder adapted to be uncovered by its piston in its reciprocation, an inlet valve in each cylinder controlling the inspiration of charge under four cycle operation, an exhaust valve in each cylinder controlling the exhaust under four cycle operation, conduit and carburetting means adapted to deliver carburetted air as controlled by the inlet valve under four cycle operation, means delivering air under low pressure, in combination with means whereby the inlet and exhaust valves of each cylinder may be caused to act in unison controlling the admission of the air under low pressure under two cycle operation of the engine the exhausts in such operation occurring through the piston covered port in the side wall of the cylinder, and means whereby each cylinder may be periodically charged with fuel.

6. In an internal combustion engine, engine cylinders and cooperating pistons, a port in the side wall of each cylinder adapted to be uncovered by its piston, in its reciprocation, an inlet valve in each cylinder controlling the inspiration of charge under four cycle operation, an exhaust valve in each cylinder controlling the exhaust under four cycle operation, conduit and carburetting means adapted to deliver carburetted air as controlled by the inlet valve under four cycle operation, a low pressure blower delivering air under low pressure, a higher pressure blower and carburetting means delivering a rich gas air mixture under higher pressure, in combination with means whereby the inlet and exhaust valves of each cylinder may be caused to act in unison controlling the admission of the air under low pressure to the cylinder under two cycle operation, exhaust in such operation occurring through the port in the side wall uncovered by the piston, and means controlling the admission of the rich gas air mixture to each cylinder periodically under such two cycle operation.

7. In an internal combustion engine, engine cylinders and cooperating pistons, a port in the side wall of each cylinder adapted to be uncovered by its piston, in its reciprocation, an inlet valve in each cylinder controlling the inspiration of charge under four cycle operation, an exhaust valve in each cylinder controlling the exhaust under four cycle operation, conduit and carburetting means adapted to deliver carburetted air as controlled by the inlet valves under four cycle operation, a valve having passages and relation to the carburetted air conduit and the exhaust conduit delivering from the exhaust valves as to permit delivery from the exhaust conduit to atmosphere and interrupt communication of the exhaust conduit with the carburetted air conduit under one cycle and to interrupt delivery to the atmosphere and permit communication of the exhaust conduit with the carburetted air conduit under an alternative cycle, and means for changing the valve operation for the respective cycles of operation.

In witness whereof I have hereunto set my hand this 15th day of June, 1926.

ADOLPHE C. PETERSON.