June 9, 1925. 1,541,069

G. H. PETERS

FOUR CYCLE INTERNAL COMBUSTION ENGINE

Filed Jan. 16, 1923 2 Sheets-Sheet 1

Fig. 1

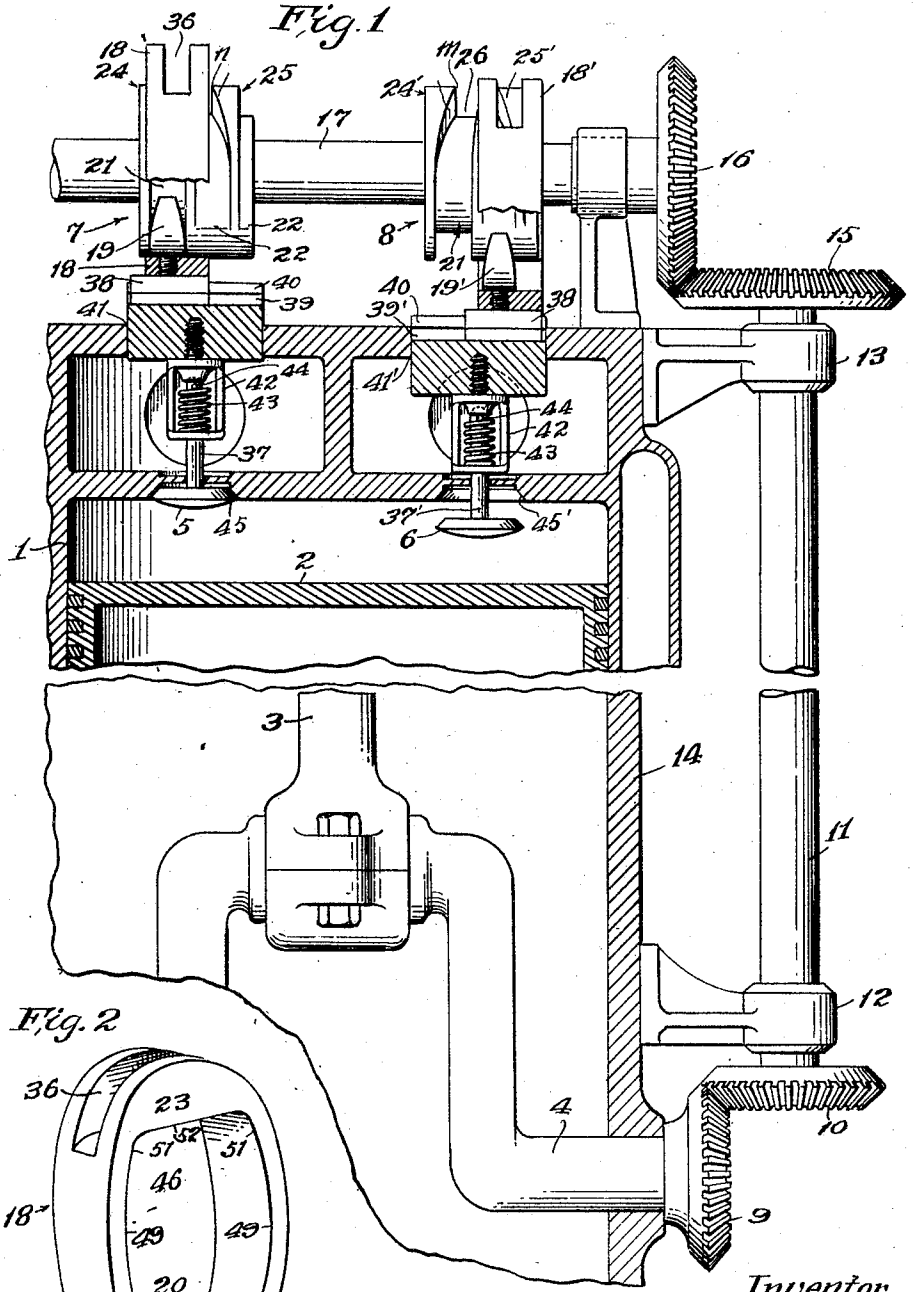


Fig. 2

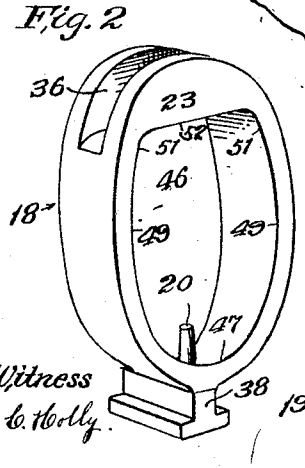
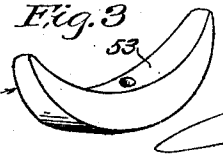


Fig. 3



Witness
C. C. Holly.

Inventor
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FOUR CYCLE INTERNAL COMBUSTION ENGINE

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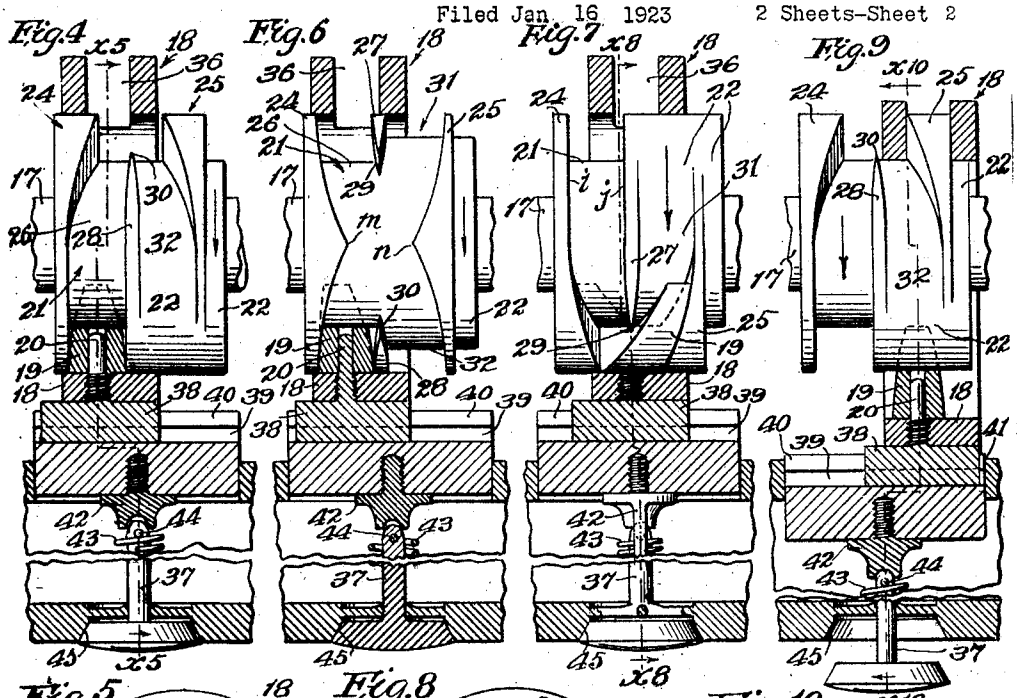

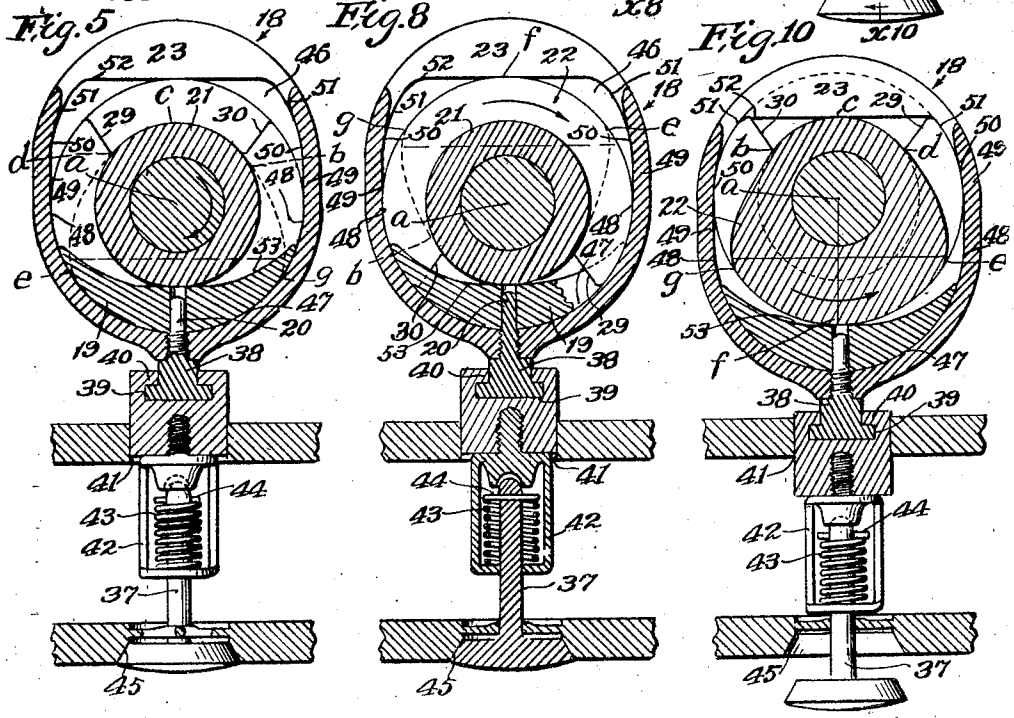

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Patented June 9, 1925. 1,541,069

UNITED STATES PATENT OFFICE.

GALEN H. PETERS, OF LOS ANGELES, CALIFORNIA.

FOUR-CYCLE INTERNAL-COMBUSTION ENGINE.

Application filed January 16, 1923. Serial No. 612,939.

To all whom it may concern:

Be it known that I, GALEN H. PETERS, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented new and useful Improvements in Four-Cycle Internal-Combustion Engines, of which the following is a specification.

An object of this invention is to increase the power of four stroke cycle internal combustion engines.

Heretofore the valve controlling mechanism of four cycle engines have depended upon the operation of a spring for return movement of the valve after the valve has been operated by a cam.

An object of this invention is to improve the operation of four stroke cycle one-to-one movement for internal combustion engines.

This invention involves novel means for the operation of the supply and exhaust poppet valves of four cycle internal combustion engines and broadly includes an engine in which such valves are operated positively in both directions by cams having one-to-one movement with respect to the crank shaft.

Heretofore the inlet and exhaust poppet valves of internal-combustion engines of the so-called four cycle type have been operated by mechanism that gives a slow opening and closing of such valves respectively; and I have discovered that a notable economy and efficiency over such engines may be secured by operating the valves positively in both opening and closing movements directly through a cam shaft and one-to-one gearing between the crank shaft and said cam shaft.

The invention involves novel means for opening and closing the exhaust and inlet valves, and such means may be of various forms of construction in which a cam shaft is timed to synchronous revolutions with the crank shaft and the cams are directly connected by suitable tappets to positively operate the valves in appropriate alternation.

This invention may be applied with the cam shaft arranged either above or below the cylinder, but it will be sufficient for a proper understanding of the invention to illustrate it in the form in which an overhead cam shaft is used.

An object of the invention is to increase the efficiency of the engine, and this is done by increasing the speed with which the inlet and exhaust valves are opened and closed and also increasing the period of the full opening of the valves.

By this invention I am able to increase the volumetric efficiency of the engine.

The invention may be applied by cams in the crank case or above the crank case as may be desired. Suitable connecting mechanisms being provided between the cams and the valves to open and close the valves. It is sufficient for the present application to show a form in which the cam shaft is mounted above the cylinder and the invention will be thus shown in the drawings.

The invention comprises the combination with a cam having a grooved cylindrical portion, of an eccentric ring on said cam, said eccentric ring being provided with a slotted rider and with a follower; said follower adapted to run in the grooves of the cam, and said rider adapted to ride upon the grooved cylindrical portion of the cam throughout the major portion of two revolutions of the cam, said cam being provided with a wiper adapted to act upon said follower to open the valve during a minor portion of one revolution of the cam and said rider being accommodated in the groove of said cam throughout a major portion of two revolutions of the cam.

This invention includes an improvement on the invention described and claimed in my forfeited application Serial No. 260,072, filed October 28, 1918, and allowed March 29, 1922, and this application is a continuation of said forfeited application with respect to the appended claims numbered 1, 2, 3 and 4 which correspond to like numbered claims allowed in said forfeited application.

Other objects, advantages and features of invention may appear from the accompanying drawings, the subjoined detailed description and the appended claims.

The accompanying drawings illustrate the invention.

Figure 1 is a fragmental view of an internal combustion engine provided with this invention; fragments of the mechanical con-

nection between the crank shaft and the cam shaft are shown. The parts are shown on the point of closing the exhaust while the intake is closed.

Fig. 2 is a detached perspective view of the eccentric ring shown in Fig. 1.

Fig. 3 is a detached perspective view of the traveller that operates in the eccentric ring.

Fig. 4 is an elevation partly in axial section of mechanism constructed in accordance with this invention showing the parts in the position with the valve closed.

Fig. 5 is a section on line x^5, Fig. 4.

Fig. 6 is a view analogous to Fig. 4 showing the valve still closed and the cam in position just before shifting the tappet to the right, being about 90° from the position shown in Figs. 4 and 5.

Fig. 7 is a view analogous to Figs. 4 and 6 showing the valve still closed and the cam and traveller turned to within 180° of opening the valve.

Fig. 8 is a cross section showing the parts in the position of Fig. 7.

Fig. 9 is a view analogous to Figs. 4, 6 and 7 showing the parts in position with the valve fully opened.

Fig. 10 is a cross section on line x^{10}, Fig. 9.

In Fig. 1 an intake valve 5 and an exhaust valve 6 are shown and the parts pertaining to valve 6 are designated by the same characters respectively as like parts for valve 5, with the addition of an exponent. The remaining figures are views equally applicable to either of the valves shown in Fig. 1, and the designating characters are devoid of exponents.

The engine shown fragmentally in Fig. 1 is a four cycle internal combustion engine having cylinder 1, piston 2, connecting rod 3, crank shaft 4, intake valve 5, and exhaust valve 6, for said cylinder; all of which are of common construction; and the same are shown in combination with cams 7 and 8, connected to the crank shaft 4, and having synchronous revolution therewith at the rate of one to one with said crank shaft. Such mechanism may be variously constructed and is shown with bevel gear 9 on the crank shaft 4, bevel gear 10 on the connecting shaft 11, which is journalled in bearings 12, 13 to the cylinder block frame 14, of the engine; said bevel gear 10 being fixed to said shaft 11, which is connected by bevel gearing 15, 16 with the cam shaft 17 to which the cams 7 and 8 are fixed. The bevel gears 9 and 10, are of the same radius and this is also true of the bevel gears 15, 16, so that the cam shaft 17 rotates in exact synchronism with the crank shaft 4.

The slotted eccentric rings 18, 18′, respectively, are operably connected to the cams and to their respective valves, through complementary structures of peripherally grooved cam and slotted eccentric ring and a follower as at 19; the followers being connected to the eccentric rings through suitable means as the swivel pins 20 upon which the followers can oscillate, and a shiftable, adjustable connection between each eccentric ring and its respective valve.

The cams are arranged to revolve on an axis a for successive but like operations of said eccentric rings; each cam comprising concentric major and minor cylindrical faces; the minor cylindrical face 21 being formed by a portion of the floor of the groove to allow the eccentric ring to be held in predetermined closed valve position, a wiper limb 22 having a minor cylindrical face $b\ c\ d$ in an arc drawn to the radius $a\ c$ on axis a of the minor cylindrical portion 21, and a major cylindrical face $e\ f\ g$, in an arc drawn to the axis a of the minor cylindrical portion and to the radius $a\ f$, equal in length to the radius $a\ c$ of the minor cylindrical portion plus the lift $c\ f$ of the valve to which it pertains, and a grooved cylindrical body formed of major concentric portions 24, 25 drawn to the axis a and radius $a\ f$, of the wiper and adapted in succession with each other to hold the eccentric ring in closed valve position.

Each eccentric ring comprises a rider 23 and has a follower 19 spaced from the rider a distance equal to the radius of the wiper plus the radius of the outer periphery of the cam; and the cam is made up of the major cylindrical face $e\ f\ g$ and the limbs 24, 25 that form a grooved cylindrical rider support.

The radii of the major cylindrical face $e\ f\ g$, which, momentarily acting on the follower, holds the eccentric ring in open valve position, and of the cylindrical faces 24, 25 forming the grooved outer cylindrical rider support of each cam to hold such strap in closed valve position, are equal.

The inclined or tangential wiper faces $d\ e$ and $g\ b$, connect the major and minor cylindrical faces $b\ c\ d$ and $e\ f\ g$, respectively on opposite sides of the cam.

The concentric cylindrical portions 24, 25 are spaced apart to accommodate a follower way 26, the side walls of which are parallel as at $i\ j$ adjacent the face $e\ f\ g$ of the wiper, and approach each other to form cusps m, n, diametrically opposite to the crest f of said wiper for the purpose of turning the follower to cooperate with switch rails 27, 28 terminating in switch points 29, 30, and spaced apart from said side walls i, j, to shift the rider to and from the wiper. The periphery of the cam is provided with follower way extensions 31, 32 to guide the follower from the minor cylindrical limb 21 to the face $e\ f\ g$ of the wiper, and from said wiper face to the minor cylindrical portion, thus moving the rider

from the minor cylindrical portion to the outer rider support and back again.

The follower 19 pivoted on the pin 20 fixed to the eccentric ring, is adapted to be guided by the cusp *m*, from the follower way 26 to the follower way extension 31, and from the follower way extension 32 to the cusp *n* and by such to the follower way 26 as the cam is revolved. Said eccentric rings are slotted as at 36 to accommodate the limb 25 when the wiper acts upon the inner face of the follower, thus to move the eccentric ring in one direction to force the follower away from the axis of the cam, as the cam revolves in the direction indicated by the large arrows in the several views.

The shifting connection between the eccentric ring and the valve stem 37 is in the form of a slide 38 held in a guide 39 by overhangs 40; and the guides 39, 39′ are mounted in their guideways 41, 41′ to reciprocate from and toward the axis of the cam shaft for the purpose of opening and closing the valves 5, 6 in alternation.

Referring to valve 5 in Fig. 1, the eccentric strap 18 with its rider 23, follower 19 and pin 20 go to make up the tappet operated by the cam to open and close the valve 5; and the strap 18′ with its rider 23′, follower 19′ and pin 20′ go to make up the tappet to operate the valve 6.

The yielding connection between the valve stem 37 and the guide 39 is shown as being made by a cage 42 and a spring 43 therein acting on the retainer 44 which is shown as a pin inserted through said stem; and said spring is adapted to yieldingly hold the valve in closed position as indicated at the valve seat 45 in Figs. 4, 5, 6, 7 and 8, when the rider is supported by the outer periphery of the cam.

The eccentric ring 18 has a non-circular cam receiving orifice 46 which is constructed toward effecting the desired operation of the valve. In the form shown the bottom circular segment 47 of the inner surface of said eccentric ring extending below and between the points 48, 48′ is somewhat less than 180°; the side sectors 49, 49′, are equal to each other and extend upward respectively from the points 48, 48′ to the points 50, 50′ from which the coequal arcs 51, 51′ extend respectively to the ends of the chord 52 of the top solid segment or rider 23, which is spaced from the inner face 53 of the follower 19, a distance corresponding to the diameter of the grooved cylindrical limb or body of the cam so that when the rider of the eccentric ring is shifted to said grooved cylindrical body as in Figs. 5 and 6, the valve is closed and remains closed for one full revolution during which the eccentric ring is stationary without any lateral or radial shifting.

Then the tooth or cusp *m* and switch point 29, cooperate with the follower to shift the eccentric ring to the wiper limb of the cam.

The wiper limb of the cam is made up of four surfaces, *b c d*, *d e*, *e f g*, and *g b*. The surface *b c d* is drawn to the radius of the minor cylindrical portion 21 of the cam. The surface *e f g* is drawn to a radius equal to the radius of said cylindrical portion 21 plus the lift of the valve. The surfaces *d e* and *g b* are drawn tangent to the faces *b c d* and *g e f* of the minor cylindrical portions and body of the cam.

By this construction of the cam the opposite faces *b c d*, *e f g* of the wiper limb of the cam are drawn to a common center *a* with radii of different lengths; so that when these faces are in operative contact with the tappet formed by the eccentric ring and the follower, the valve is held stationary in the position given to it by the faces *d e* and *g b* respectively. That is to say, the face *d e* acting upon the follower opens the valve, and when the valve is fully open at the point *e*, it is thereafter so held open by the face *e f g* until the point *g* is reached. Then the face *g b* permits the follower to recede for the closing of the valve until the face *a b* is reached; whereupon the valve remains closed during the remaining portion of the revolution of the cam and during the period when the ring is shifted to the cylindrical limb of the cam, where the ring is held in the closed valve position until it is shifted back to the wiper limb of the cam and the face *d e* again becomes active to open the valve. The complete cycle of the eccentric strap is thus effected by two complete revolutions of the cam and the engine crank shaft, during which cycle about 60° is used in moving the valve from fully closed to fully open position, 120° is used for holding the valve in its fully open position, 60° is used in moving the valve from open position to fully closed position, and about 480° is used in holding the valve completely closed.

It is thus seen that for each valve shown there are means such as a tappet operably connected to the valve; and means such as the various parts of the solid cam operably connected to the engine and adapted to operate and hold the engine valve open during a limited portion of one revolution of the engine shaft; and to hold the valve closed during over a full revolution of such shaft.

In each mechanism there is a cam having a wiper, and means such as a tappet operable by the cam and connected to operate the valve; and means, such as the shifting devices consisting of the way and switch and switch points, whereby a relative shifting of the cam and the parts operable thereby, as the tappet, is at one revolution brought into position to be operated by the wiper limb of the cam; so that the wiper

limb of the cam is operable within the period of one full revolution of the cam through the opening, the held open, the closing and a portion of the held closed portion; and further means is provided such as the shifting means, whereby the tappet is shifted from the wiper limb of the cam, and the valve holding means, such as the cylindrical portion of the cam, whereby the tappet is positioned to hold the valve stationary during a full revolution of the cam. By this means the valve is held closed for a full period of more than one revolution of the crank shaft which is equivalent to more than two strokes of the engine.

It is understood that the eccentric ring shown is the preferred form of embodiment but I do not limit the invention specifically to the specific form shown.

It is understood that various parts may be variously constructed within the judgment of the manufacturer for facilitating the assembling of the parts and such changes as may be deemed advisable as mechanical expedients for that purpose may be made at pleasure by the constructor.

Different forms of solid cams with their respective tappets and other parts, may also be used interchangeably with each other by making changes that are within the skill of a mechanic.

Particular attention is directed to the advantages obtained by providing an engine with means whereby there is given a longer period of time during which the inlet valve is opened to its fullest capacity. The result of this improvement is an increased volume of gas consumed at each explosion; and attention is further directed to the combination in the engine of inlet and exhaust valves, both operating upon this same principle so that maximum discharge may take place in the quickest possible manner.

The wiper limb 22 extends on both sides of the limb 25 of the grooved cylindrical body so that when the slotted eccentric ring is fully shifted to the right as in Fig. 9, and the slot of said ring accommodates the limb 25, the rider rides on the wiper portion on both sides of the cylindrical limb 25; thus to give an even support to the rider while the same is moving the ring from closed to open and from open to closed position according to whether the wiper is acting on the follower or the rider.

I claim.

1. The combination with a four stroke internal combustion engine cylinder, piston, connecting rod and crank shaft, and intake and exhaust valves for said cylinder; of cams connected to the crank shaft for synchronous revolution therewith at the rate of one to one with said crank shaft; eccentric rings operably connected to the cams and said valves respectively; said cams being arranged to revolve on an axis for successive but like operation of said eccentric straps and each comprising concentric minor and major cylindrical portions to hold the eccentric ring in valve closed position, a wiper limb having a face drawn to the radius and axis of the minor cylindrical portion, and a face drawn to the axis of the cylindrical portions and to a radius equal in length to the radius of the minor cylindrical portion plus the lift of the valve to which it pertains; and means for shifting the eccentric ring to and from the wiper.

2. In an internal combustion engine the combination with the valves and the cam shaft of the engine; of cams on said shaft; eccentric ring shiftable along said cams respectively; means connecting said eccentric rings to their respective valves; said cams being arranged for successive operation of the rings and respectively comprising a cylindrical portion to hold the valve in closed position, a wiper limb having a face drawn to the axis of the cylindrical portion and to a radius equal in length to the radius of the cylindrical portion plus the lift of the valve; and means for shifting the eccentric rings to and from their wipers, respectively.

3. In an engine a valve; an eccentric ring operably connected to said valve; a cam comprising a wiper having a major cylindrical face and a minor cylindrical face, and inclined valve opening and closing faces between said major and minor cylindrical faces; said major cylindrical face being adapted and arranged to allow the eccentric ring to hold the valve in closed position; said minor cylindrical face drawn to the radius and axis of said major cylindrical face, and said major cylindrical face drawn to the axis of said minor cylindrical face and to a radius equal in length to the radius of the minor cylindrical face plus the lift of the valve; and means for shifting the eccentric link to and from the wiper.

4. In an engine a valve; an eccentric ring operably connected to said valve; a cam comprising a wiper having a major cylindrical face and a minor cylindrical face, and inclined valve opening and closing faces between said major and minor cylindrical faces, said major cylindrical face being adapted and arranged to allow the eccentric ring to hold the valve in closed position; said minor cylindrical face drawn to the radius and axis of said major cylindrical face, and said major cylindrical face drawn to the axis of said minor cylindrical face and to a radius equal in length to the radius of the minor cylindrical face plus the lift of the valve; and means for shifting the eccentric link to and from the wiper, said major cylindrical face forming an arc having a chord equal to the diameter of said

wiper, and said valve opening and closing faces being tangent to said faces that are drawn to the radii of the cylindrical portions, said tangent faces being drawn to a radius equal in length to said chord.

5. The combination with a poppet valve, of a guide connected to said poppet valve and provided with a slideway; a slide shiftable along said slideway and adapted to operate the guide to move the poppet valve to and from closed position; an eccentric strap connected to the slide and provided with a rider and a follower spaced apart; and a cam provided with a cylindrical rider support and a wiper, and being adapted to hold the rider in valve closed position throughout the major portion of two revolutions of the cam shaft, and being grooved to accommodate the follower, and to guide the same for the purpose of shifting the eccentric strap along the cylindrical eccentric strap supporting portion of the cam, and for the purpose of accommodating the eccentric strap when the wiper acts upon the follower.

6. The combination with a cam having a peripherally grooved cylindrical portion, of an eccentric strap on said cam, said strap being provided with a slotted rider and with a follower; said follower adapted to run in the grooves of the cam, and said rider adapted to ride upon the cylindrical portion of the cam throughout the major portion of two revolutions of the cam, said cam being provided with a wiper adapted to act upon said follower to open the valve during a minor portion of one revolution of the cam and said rider being accommodated in the groove of said cam throughout a major portion of two revolutions of the cam.

7. Valve operating mechanism substantially set forth comprising a cam, having a cylindrical limb and a wiper; an eccentric strap mounted on said cam and adapted to be carried by said limb to hold the valve closed, and to be reciprocated by said wiper to open the valve; said eccentric strap being slotted to accommodate said limb when the wiper moves the eccentric strap to open the valve.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 5th day of January, 1923.

GALEN H. PETERS.

Witness:
JAMES R. TOWNSEND.