

June 13, 1961

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CONCENTRIC TRIPLE VALVES FOR INTERNAL COMBUSTION ENGINES

Filed March 31, 1959

5 Sheets-Sheet 3

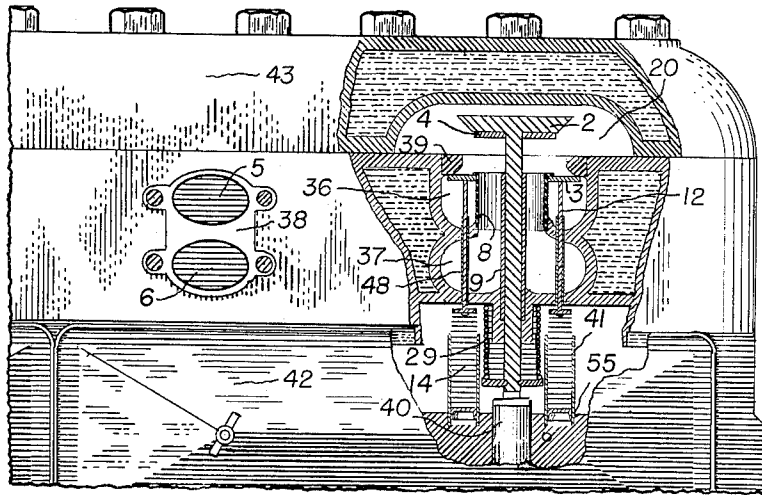


Fig. 3.

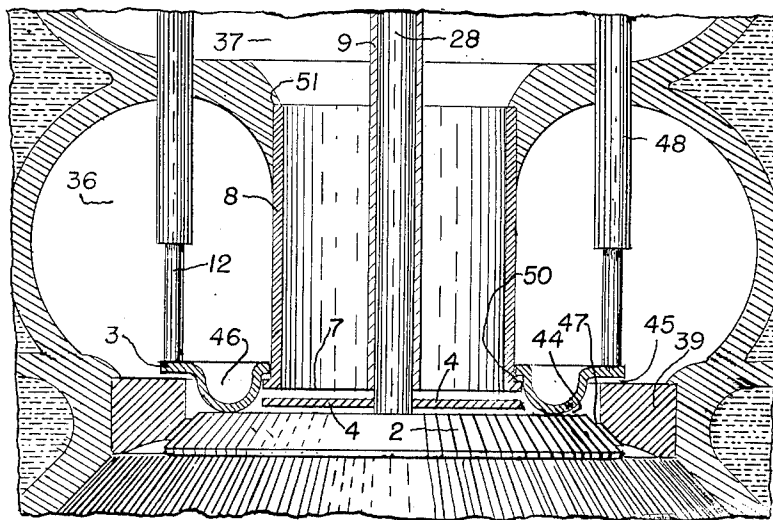


Fig. 4.

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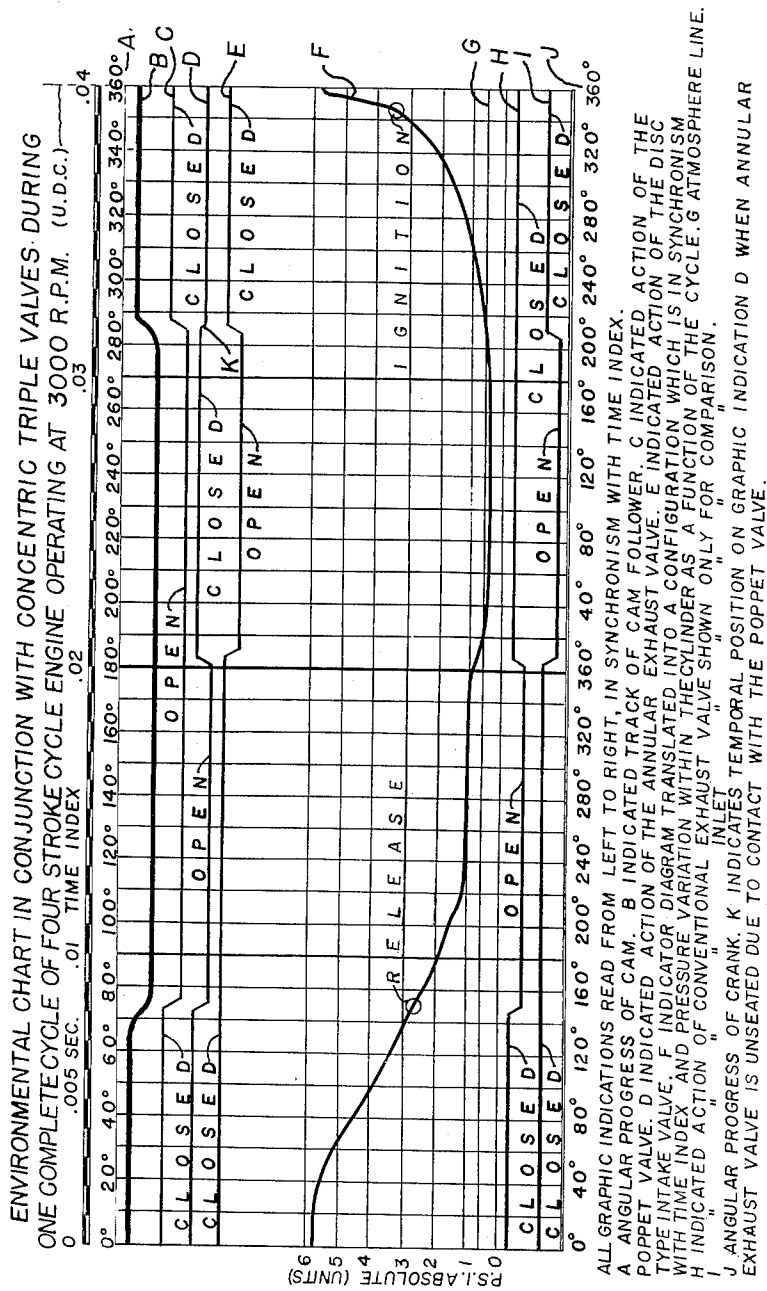


Fig. 5.

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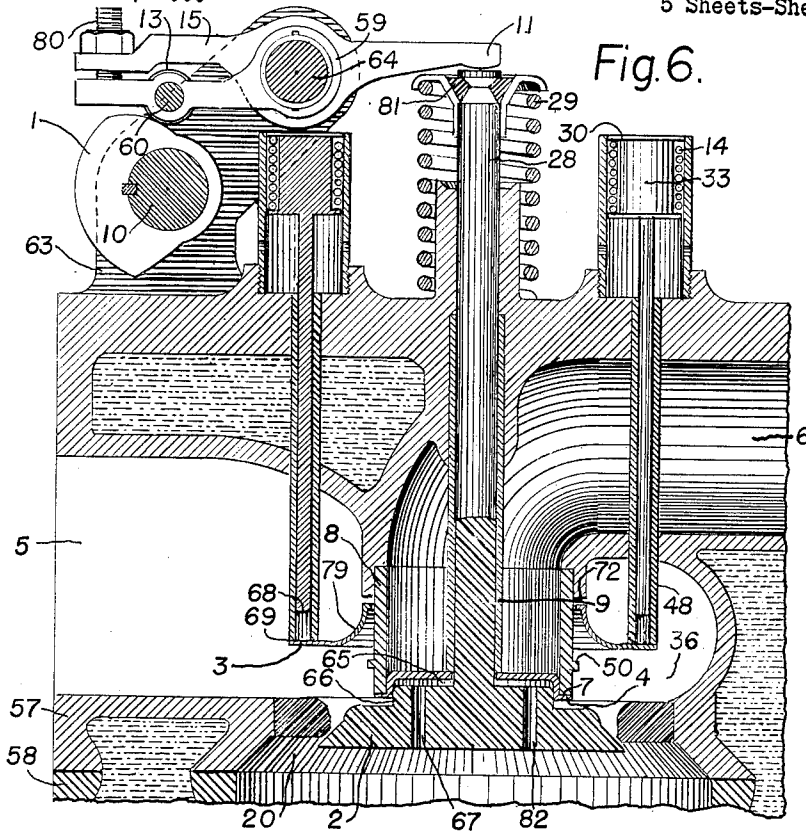


Fig. 6.

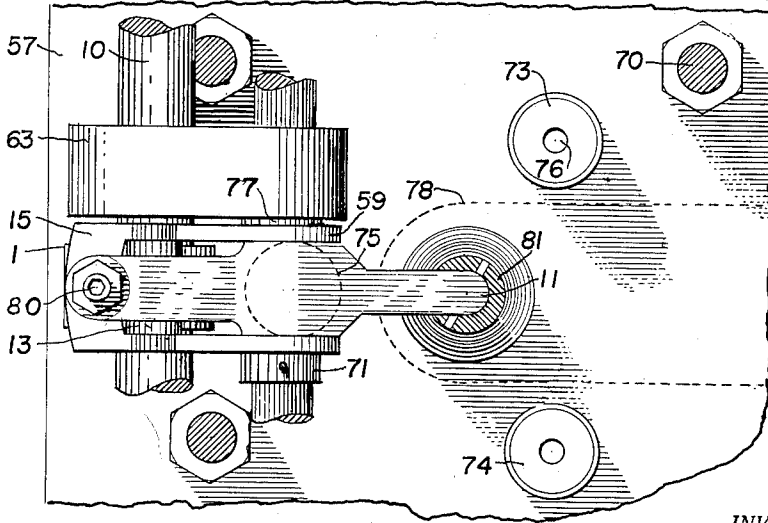


Fig. 7.

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CONCENTRIC TRIPLE VALVES FOR INTERNAL COMBUSTION ENGINES

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Filed Mar. 31, 1959, Ser. No. 803,117

7 Claims. (Cl. 123-79)

My invention pertains to inlet valves and exhaust valves together with cam elements for four stroke internal combustion engines having cam operated valves and being within the reciprocating piston classification.

The primary objective is to provide means to surmount the problem of velocity and acceleration of the cam operated valve elements while maintaining high volumetric efficiency.

Other advantages include elimination of one half of the number of cams per engine, elimination of one half the number of poppet valves per engine, lower temperatures for the valves and valve seats thus increasing valve life while the general design affords the embodiment of a combustion chamber in the shape of a frustum of a cone with the inherent advantages of this type of combustion chamber.

Heretofore the designs and operation of internal combustion engines have been hampered by the prime requisite that cam operated poppet valves must open and close during a small fraction of a second and obviously as the rotative speed of the cam shaft increases there is a decrease in the time interval during which time the cam lobe must displace the cam follower, hold the said cam follower in the "dwell" position for the required time after which the cam lobe moves clear of the said cam follower thus allowing the poppet valve closing spring to move the aforesaid poppet valve to the closed position.

With a conventional engine operating at 3000 r.p.m., the allowable time for this action is approximately .012 second with the result that valves are prone to "float" at extremely high speeds, i.e., the cam rotates while the poppet valve spring is acting to close the valve with the cam lobe arriving at the angular position where the valve should be opening before the valve spring has executed the desired closing action of the said valve, with the present remedy for this malfunction being the use of a more powerful valve closing spring or a decrease in the "dwell" time. To eliminate the necessity for high valve acceleration and velocity in obtaining high valve lift, I have devised means of constructing valve and cam elements wherein the said cam is provided with a lobe which is capable of continually displacing the cam follower during more than 180 consecutive degrees of angular advance of the cam shaft once during each complete cycle of a four stroke cycle engine, thus providing means for the embodiment of low acceleration and velocity of the valve elements while allowing high lift of a conventional poppet valve provided with poppet valve closing spring element.

The aforesaid poppet valve opens and closes a port which alternately becomes an inlet port and an exhaust port adjacent to the disc of the aforesaid poppet valve so that during the aspiration action the valve and valve seat are subjected to a cooling effect while relinquishing heat to the incoming gases.

A light weight disc type valve controls the inlet gases, while an annular type light weight valve controls the exhaust gases with these valves being partially opened and closed by pneumatic pressure impulses. At the time the aforesaid poppet valve is closed, it is interposed between the combustion chamber and the aforesaid light weight valves during the combustion action within the cylinder, after which the aforesaid poppet valve opens and remains

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open during the exhaust action and until the termination of the aspirating action.

The poppet valve is the only valve which is subjected to the full working pressure within the engine cylinder.

With a four stroke cycle engine operating at 3000 r.p.m., the time interval between unseating of this poppet valve and reseating of the said poppet valve during one complete cycle would preferably be approximately .023 second although this time may be increased or decreased without departing from the essence of my invention.

In the accompanying drawings constituting a part hereof and in which like reference characters indicate like parts,

FIG. 1 is a fragmentary section of the principal elements of the present invention;

FIG. 2 shows part of the cylinder and the cylinder head of an air-cooled internal combustion engine provided with the device of the present invention;

FIG. 3 is a view of a modification of this invention, partly in section and partly broken away;

FIG. 4 is an enlarged view of a further modification of the present invention;

FIG. 5 is a chart showing graphically the action of the various valves of the present invention, together with other desirable comparative data;

FIG. 6 is a side view partly broken away and partly in section, showing another modification of the present invention, and

FIG. 7 is a plan view of the device shown in FIG. 6.

FIG. 1 is a fragmental view through one cylinder of a liquid cooled four stroke cycle overhead valve internal combustion engine in operation and exhausting products of combustion and provided with a cam at 1, a poppet valve at 2, an annular type exhaust valve shown in the open position at 3, a disc type intake valve shown in the closed position at 4, an exhaust port at 5, an inlet port at 6, while the numeral 7 indicates the outer valve seat for the inlet valve 4 which valve seat is the lower face of a flange on the element 8 which is a flanged tube with one end affixed within the cylinder head which cylinder head is indicated at 57, while the tube 9 provides a valve stem guide for the valve 2 and is affixed within the cylinder head and also provides an inner valve seat for the disc type valve 4 at the pendent end of the said tube 9.

An overhead cam shaft is shown at 10 with a cam firmly affixed to the said cam shaft and indicated at 1 while acting to depress the cam follower element at 11 thus opening the valve 2 as shown during the beginning of the exhaust stroke.

The element indicated at 12 is a push rod provided with a spring similar to that shown at 14 which spring acts to urge the push rod 12 and the annular type exhaust valve 3 in a downward direction so that the said exhaust valve remains closed except when being forced open by pneumatic pressure impulse during the exhaust stroke of the piston 21. A pivoted cam follower pivots on the fixed shaft 17 and comprises a clevis 59 and a rigid element comprising a boss 15 which is integral with a yoke encompassing a cam roller indicated at 13 and terminating to form a valve tappet at 11 with the element 60 functioning as a shaft for the cam roller 13 while the plunger of a conventional hydraulic lash adjuster is indicated at 16.

The shafts indicated at 10 and 17 are retained in the positions shown by suitable bearing pedestals integral with the cylinder head 57 with each of these pedestals being formed as indicated at 18 while a conduit for the accommodation of a spark plug, fuel nozzle or air starting valve is shown at 19.

The cylinder block is indicated at 58 while the combustion chamber is shown at 20 with the cylinder shown

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at 49, piston at 21, wrist pin at 22, connecting rod at 23, crank at 24 and crankpin at 25 with a clockwise direction of rotation of the crank and cam.

FIG. 2 is a fragmental view through the cylinder head and upper portion of the cylinder of an air cooled four stroke cycle engine equipped with triple valves positioned so that they are concentric with the poppet valve stem indicated at 28 as are all the valve groups shown in the various drawings. In this FIG. 2 all valves are closed, and valve displacing elements are not shown.

The poppet valve closing spring is shown at 29, a stop abutment is shown at 30 and firmly affixed within a spring retainer of cylindrical shape attached to the element 31 which in turn is affixed to a cooling fin by rivets as at 32 while 35 indicates a cooling fin.

The space indicated at 36 is a continuation of the exhaust conduit indicated at 5 and is enlarged and completely around and adjacent to the periphery of the element 39 to provide additional space for receiving exhaust gases while the space indicated at 37 is also an accumulator space for incoming gases passing through inlet conduit 6. The element indicated at 39 is an inserted valve seat with its upper side providing an outer valve seat for the exhaust valve 3 as indicated at 26 and 27 with the inner valve seat formed for the said exhaust valve by the upper face of the flange of the flanged tube 8 as indicated at 50 while the lower side of the said flange forms an outer seat for the disc type valve 4 as indicated at 7 with the inner seat of the said valve 4 formed by the pendent end of the valve stem guide tube 9 as shown at 61.

A small antechamber is shown at 62 above the poppet valve 2 and below the valves 3 and 4 wherein residual gases may be trapped when all valves are closed as shown in this FIG. 2. Therefore it is essential that the design be such as will embody the least amount of space within this chamber by employment of such means as changing the shape of the valve 3 from a flat valve to one having an intervening annular valley between the inner and outer seats which is shown in FIG. 4 at 46 and there may also be changes in the contours of the poppet valve for the same purpose.

In FIG. 2 it will be noted that there are guide tubes provided for the push rods as at 48 which tubes would preferably be affixed within the cylinder head as at 52 and 53 by the "freezing" method as would be the flanged tube 8 at 51 and the valve stem guide tube 9 at 54, although any or all of these tubes may be threaded and screwed into tapped holes.

The enlarged portion of the push rod 12 which is indicated at 33 is to form a spring abutment for a compression spring such as the spring shown at 14 and to increase the total mass of the element 12 so that opening of the poppet valve and the release of exhaust gas will blast the exhaust valve 3 upward to a position where the said exhaust gas valve contacts the tube 48 at the point indicated at 34 where the valve 3 stops. While the element 12 due to its momentum will consume extra time and overtravel until the element 33 is forced to stop at the abutment 30 after which the push rod spring returns the push rod 12 to the position shown, thus forcing the valve 3 within close proximity of the valve seat while at this time the piston 21 is beginning the aspirating action by moving away from the cylinder head thus creating a void space into which the gaseous contents of the space indicated at 37 are expanded through the flanged tube 8 while forcing the disc type inlet valve 4 downward until the said disc type valve 4 rests on the inner face of the already open poppet valve which poppet valve remains open until the spring 29 is allowed to return the said poppet valve to the closed position shown in this drawing when the said aspirating action has been completed.

In this version of my invention, the push rods are of such length as to be incapable of contacting the annular type exhaust valve 3 while the said valve is in the closed

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position as the element 33 rests upon the exterior of the engine cylinder head while the push rod 12 is of insufficient length to contact the valve 3 as is indicated at 56.

This feature may be embodied within the design of multi cylinder engines when a partial vacuum is maintained within the space 37 due to low pressure effects emanating from the action of additional cylinders operating from an intake manifold which is common to all engine cylinders.

The purpose of providing the clearance indicated at 56 is to allow the outgoing exhaust gas to automatically control the final closing of the valve 3 which valve in this case momentarily becomes independent of the influence of the push rods with automatic variation of the final closing time of the valve 3 being in unison with the variation of engine speed and engine load while the final closing time of the said valve 3 is determined by pneumatic pressure impulse rather than by the action of springs such as shown at 14.

It should be noted that the push rod springs may be endowed with substantial power without seriously robbing the engine of power output as the springs such as shown at 14 will be compressed as the poppet valve opens before the crank arrives at the lower dead center while the retraction of the push rod 12 beyond the point indicated at 34 renders the valve 3 independent of the push rod during this overtravel action and elapsing time period, therefore the expulsion of the products of combustion is completed as the valve 3 approaches its valve seats.

FIG. 3 is a fragmental drawing of a liquid cooled four stroke cycle L head engine in operation during the aspirating action of number one cylinder with the cylinder head indicated at 43, side cover plate at 42, combined exhaust and intake manifold gasket at 38 which gasket seals conduits 5 and 6 leading to number two cylinder which is not shown. The combustion chamber of number one cylinder is shown at 20 with the poppet valve 2 shown in the open position while the disc type intake valve 4 is held upward and in contact with the inside face of the poppet valve 2 by the pneumatic impulse action of incoming gases passing from the accumulator space 37, through the flanged tube 8 and into the combustion chamber 20.

A cam follower element is shown at 40 which element is actuated by a cam which is not shown while one of the tubular spring retainers is shown at 41 with the said spring retainers firmly affixed to the cylinder block within suitable sockets as at 55, while the remaining elements are similar to the elements described in reference to FIG. 1 and FIG. 2 with the exception of the position of the complete valve assembly which is inverted for use in an L head engine as against an overhead valve type engine where the poppet valve opens in a downward direction.

FIG. 4 is a fragmental view through part of the head of a four stroke cycle overhead valve type engine with natural aspiration and carburetion showing part of the intake conduit at 37, exhaust conduit at 36 with the poppet valve at 2 and in the act of closing at the completion of the aspirating action with the said poppet valve in close proximity to the poppet valve seat at 39 as indicated at 47.

The annular type valve 3 is here provided with an annular valley formed as shown at 46 with the outer radius of the curve of the said valley contacting the poppet valve as indicated at 44 while the said valve 3 is being unseated from its inner seat and its outer seat as indicated at 50 and 45 while the disc type intake valve 4 is approaching and in close proximity of the valve seat 7 at which time some of the products of combustion are enabled to pass from the space indicated at 36 and into the flanged tube 8 as the disc type valve 4 is completing the closing action, thus forcing the greater portion of residual intake gases occupying the space described as an antechamber and described in relation to FIG. 2 and designated by the number 62.

With solid injection engines it is immaterial as to what

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disposition would be made of any air in the antechamber, so this particular embodiment would produce no advantage.

In FIG. 5 this chart provides an easy means for the extrapolation of the behavior of my invention in comparison with conventional devices within the same classification.

The p.s.i. absolute (units) are assumed to be approximately of twenty pounds each, while the letter K on the graphic indication D refers to the valve action described in relation to FIG. 4.

FIG. 6 is a fragmental view through the upper part of the cylinder and cylinder head of a liquid cooled four stroke cycle overhead valve engine in operation and in the act of beginning the exhaust stroke.

This engine is suitable for driving a racing automobile and may be classed as embodying one extreme variation of my invention, wherein it is desired to obtain the greatest volumetric efficiency by the use of large inlet and exhaust conduits with an oversized poppet valve which oversized poppet valve would require a prohibitive amount of power for the opening of such a valve without assistance to the cam during engine operation. Therefore I have provided means for deducting a large area of the said poppet valve from the unequal pressure action of the pent up products of combustion within the engine cylinder by allowing a minute amount of the said pent up gases to impart an equal pneumatic pressure upon a substantial area of the inside surface of the said poppet valve so that it is only required that the force applied to the cam in order to open the said poppet valve be only sufficient to overcome the holding force of that area of the poppet valve which is subject only to unequal pneumatic pressure, plus friction, spring force, and inertia.

This is more clearly understood by reference to the conduit 67 and the conduit 82 which are simply holes drilled through the poppet valve to place the combustion space 20 in communication with the small cylinder indicated at 65 which cylinder is formed by changing the shape of the intake valve 4 from a flat disc to a shallow cup with a flat flange to cooperate with the valve seat 7, and the shortening of the valve stem guide tube 9 while the operation of the three valves would be as previously described while the boss formed on the poppet valve at 66 functions as a piston provided with conventional circumferential gas seal grooves within the shallow cylinder 65 with the conduits 67 and 82 providing means while the aforesaid poppet valve is closed to equalize pneumatic pressure on opposite sides of the poppet valve over a valve area equal to the area of the diameter of the aforesaid small cylinder indicated at 65.

There is also a slight change in the shape of the annular type exhaust valve wherein the valve seating surfaces are on different planes with the flanged tube 8 having the flange located as shown at 50 and forming an inner valve seat for the annular type exhaust valve while the said exhaust valve is bell shaped as at 79 to cooperate with the valve seat 50 when in the closed position. This construction offers a more unimpeded path for the travel of exhaust gases.

Overtravel of the push rods within the tubes such as 48 is indicated at 68 and 69. As previously stated, this overtravel is to provide a lapse of time during which time the annular type exhaust valve is not subjected to the power of the push rod springs such as shown at 14 while the products of combustion are being exhausted.

FIG. 7 is a topside view of a part of the valve gear and cylinder head which is shown in FIG. 6 with three of the studs which secure the cylinder head to the cylinder block being shown as at 70 and elsewhere while the push rods are in this case three in number and disposed around the periphery of the annular type exhaust valve and spaced one hundred and twenty degrees apart while their spring retainers are designated by the numbers 73, 74 and 75 which is obscured by the valve rocker arm which contacts the poppet valve stem as at 11 in FIG. 6 with the

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broken circle 75 in FIG. 7 indicating the location of the said spring retainer.

The split keeper for the valve spring retainer is indicated at 81 while an adjusting screw is shown at 80 which screw is used for adjusting valve stem clearance while a clevis indicated at 59 is pivotally positioned on the rocker arm shaft between the element 77 which is a spacer washer and the collar 71 which is firmly affixed to the said rocker arm shaft.

The broken line 78 indicates the location of the intake conduit 6 which is shown in FIG. 6. The rocker arm shaft and the cam shaft 10 are positioned within their respective recesses formed in the pedestal indicated at 63 while an air vent is formed in the push rod spring housings to allow free and rapid movement of the element 33, FIG. 6 with one of these air vents indicated at 76, FIG. 7.

Here it may be seen that my invention comprises units of a minimum of three valves cooperating with one cam element of the "long dwell" classification in combination with an intake conduit and an exhaust conduit with the aforesaid conduits amalgamated into one extremely short conduit adjacent to the poppet valve and concentric with the said poppet valve functioning with cooperation of two additional valves to efficiently control the desired pneumatic environment within internal combustion engines to the four stroke cycle classification while utilizing conventional timing gears wherein the cam shaft rotates at one half the speed of the crankshaft, with additional means to relieve the cam elements of a portion of the opposing force which tends to hold conventional poppet valves in the closed position during the combustion action within the engine cylinder, with the said means to relieve being the utilization of pressure equalizing ducts in cooperation with a shallow cylinder wherein a part of the said poppet valve is subjected to an equal pneumatic pressure on a portion of its opposite sides. I have not shown or described any means of lubrication for the moveable elements which may be lubricated by any of the well known means of lubrication.

The fact that the cam shaft is only required to operate one half the number of cams per cylinder, plus the decrease in the required acceleration and velocity of the cam and valve elements provides means wherein the dynamic load imposed upon the cam shaft is much less than would be apparent before careful study of this device.

Where it is desired to design an engine which is to operate at a constant speed such as required to drive an electric generator, the push rod elements may be completely omitted, with the annular type exhaust valve opening until there is a contact between the said exhaust valve and a fixed stop limit element comprising an element such as a collar firmly affixed to the flanged tube designated by the numeral 8 or a part of the cylinder head casting may be used as an exhaust valve stop for the said annular stop valve such as the shoulder indicated at 72, FIG. 6.

The concept of embodying an element of resonance in the valve operation is not inconceivable for a fixed engine speed combined with valve shape and mass. Obviously this does not refer to the poppet valve.

Without departing from the essence of my invention, there may be changes made in the construction of this device such as the substitution of tension springs for compression springs, reversal or inversion of parts, changes in direction of rotation of parts, or such monomorphic variations as constructing a "built up" cylinder head, installing spring elements for closing the annular type exhaust valve where the said spring elements would be located within the exhaust conduit, changing the bevel seat of the poppet valve to a flat seat, or substituting a "quarter speed" cam shaft with "two lobe" cam elements in lieu of the "half speed" cam shaft and single lobe cam.

Having described my invention, I claim:

1. In an internal combustion engine having a cylinder,

said cylinder having a bore with a piston disposed therein, a cylinder head having an opening alined with said bore, inlet and outlet passages communicating with said cylinder through said opening, the improvement which comprises a first seat facing said bore on the wall of said opening, a poppet adapted to cooperate with said first seat, a second seat facing away from said bore on the wall of said opening, a sealing member adapted to cooperate with said second seat, said member having limited motion and adapted to be unseated by pressure in said cylinder to permit exit gases from said cylinder to enter said outlet, a disk adjacent to said poppet and adapted to cover said inlet, said disk having limited motion and adapted to uncover said inlet by suction in said cylinder, spring means being provided to limit the motion of said sealing member.

2. An engine according to claim 1, characterized in that a tube has one end attached to said inlet and the other end is adjacent to said poppet, said disk adapted to contact said other end to close said inlet.

3. An engine according to claim 2 characterized in that said tube constitutes a guide for said sealing member.

4. An improvement according to claim 1 wherein a portion of said poppet is reciprocatably mounted in a poppet chamber, said chamber being substantially closed at the end thereof furthest from said cylinder, said portion of said poppet fitting into said chamber, at least one passage connecting said cylinder with said chamber.

5. In a four stroke internal combustion engine having at least one cylinder, a piston in said cylinder, an intake between said cylinder and a source of fuel mixed with air, an exhaust from said cylinder to the atmosphere, the improvement which comprises an opening in said cylinder connecting with said exhaust, a poppet in said opening, a poppet stem affixed to said poppet and mounted for

reciprocal motion relative to said opening, a poppet spring urging said poppet against the rim of said opening, said rim constituting a seat for said poppet, a tube smaller than said opening connecting said intake with said cylinder and extending into said opening, said stem passing through said tube, a disc between said one end and said poppet seated on said one end and adapted to reciprocate into and out of sealing relationship with said one end, a sealing member slidably mounted on said tube adjacent said opening and adapted to seal against the rim of said opening, means limiting the motion of said member in a direction out of engagement with said rim, and means synchronized with movement of said piston for actuating said poppet.

6. An improvement according to claim 5 wherein the means limiting the motion of said member comprises at least one push rod mounted on said engine and biasing said member towards engagement with said rim.

7. An improvement according to claim 5 wherein the means synchronized with said piston comprises a rotatable cam shaft geared to the crankshaft, a cam fixed on said cam shaft, a tappet pivotally mounted on said engine and in contact with an end of said poppet stem remote from said poppet, a poppet spring biasing said poppet closed, said cam acting on said tappet causing said poppet to be unseated against the action of said poppet spring.

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