Oct. 2, 1962 I. H. SVENDSEN 3,056,394

VALVE ROTATOR FOR INTERNAL COMBUSTION ENGINES

Filed Sept. 19, 1961 3 Sheets-Sheet 1

Fig. 1.

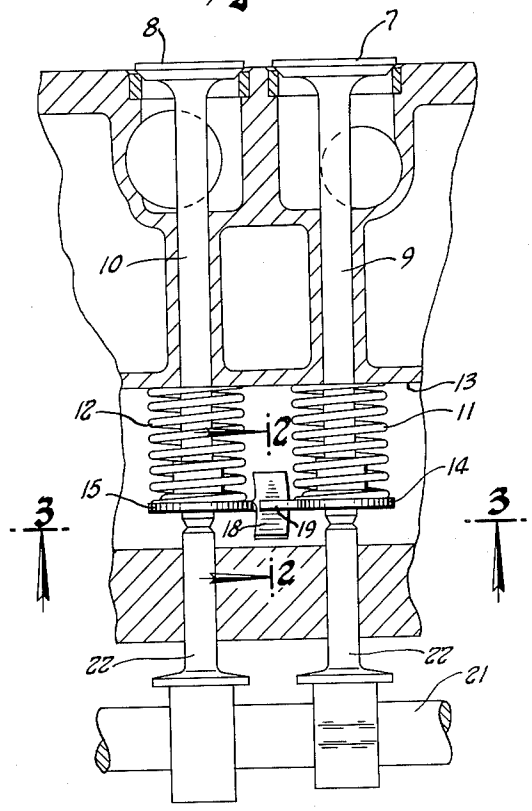
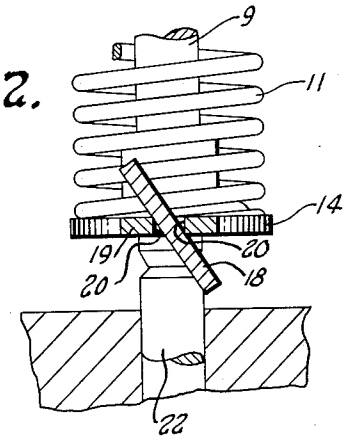


Fig. 2.



Inventor
Ib H. Svendsen
By Dr. Whitton Jones
Attorney

Oct. 2, 1962 I. H. SVENDSEN 3,056,394

VALVE ROTATOR FOR INTERNAL COMBUSTION ENGINES

Filed Sept. 19, 1961 3 Sheets-Sheet 2

Fig. 3.

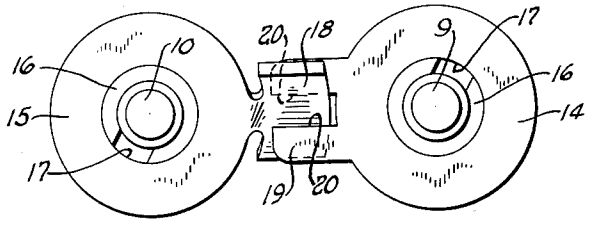


Fig. 4.

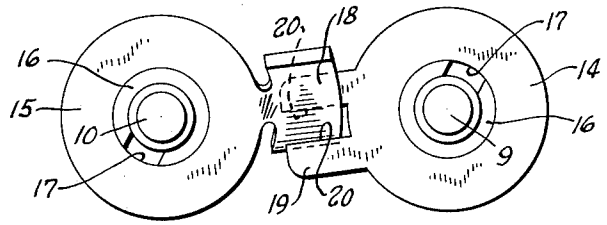


Fig. 5.

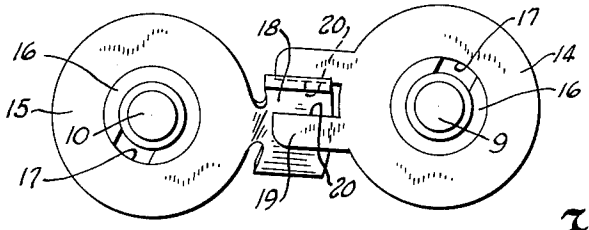


Fig. 6.

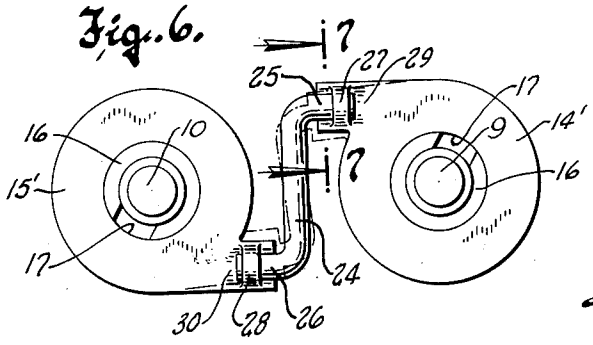
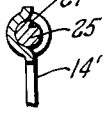


Fig. 7.



Inventor
Ib H. Svendsen
By Dr. Hutton Jones
Attorney

Oct. 2, 1962 I. H. SVENDSEN 3,056,394

VALVE ROTATOR FOR INTERNAL COMBUSTION ENGINES

Filed Sept. 19, 1961 3 Sheets-Sheet 3

Fig. 8.

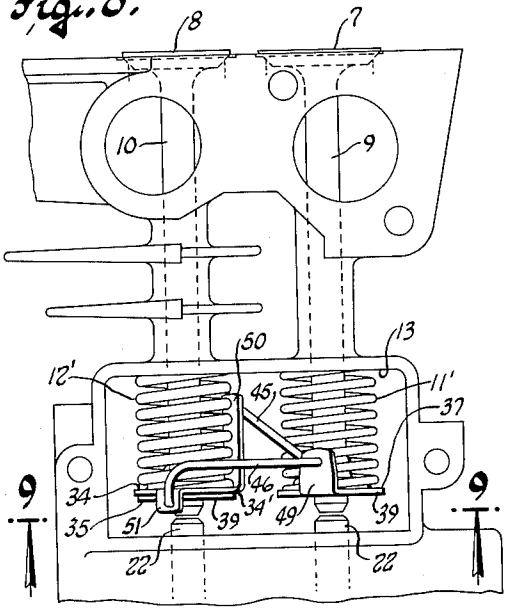


Fig. 9.

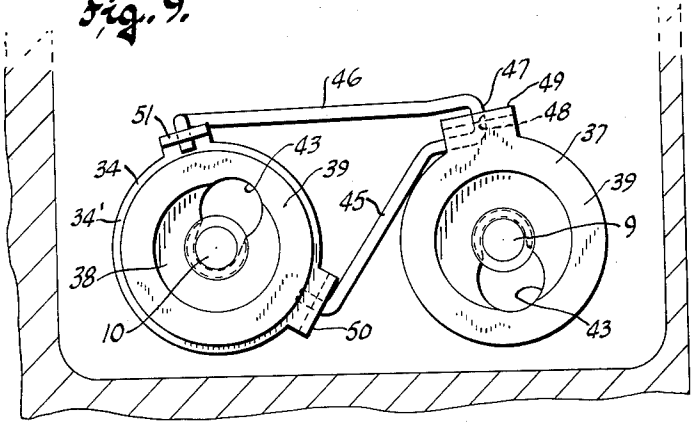


Fig. 11.

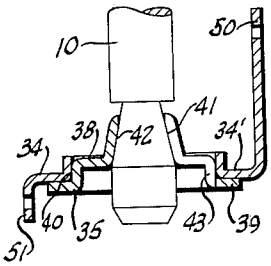


Fig. 10.

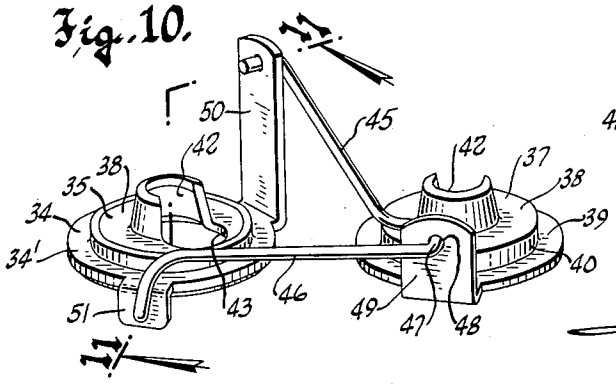
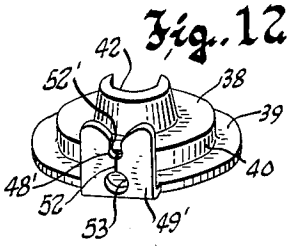


Fig. 12.



Inventor
Ib H. Svendsen
By Dodge, Smith & Jones
Attorneys

United States Patent Office

3,056,394

Patented Oct. 2, 1962

3,056,394

VALVE ROTATOR FOR INTERNAL COMBUSTION ENGINES

Ib H. Svendsen, Milwaukee, Wis., assignor to Briggs & Stratton Corporation, Milwaukee, Wis., a corporation of Delaware

Filed Sept. 19, 1961, Ser. No. 144,808
13 Claims. (Cl. 123—90)

This invention relates broadly to internal combustion engines and, like that of application Serial No. 32,649, now abandoned, of which this is a continuation-in-part, refers more particularly to the intake and exhaust valves of the engine, and has as its purpose and object the provision of improved and simplified means for rotating the valves, and especially the exhaust valve.

The advantages of rotating the valves are well known. The attainment of a simple reliably functioning valve rotating device, therefore, has claimed the attention of engine manufacturers for years. Many different devices and mechanisms have been employed and proposed in the past to effect this purpose, but heretofore there has never been a successful valve rotating device which possessed the simplicity, low cost and reliability required to make it practicable and economically feasible to incorporate in all small four-cycle single cylinder engines.

The present invention fills this need.

The valves are of course equipped with spring retainers detachably mounted on the stems of the valves, and through which the spring force is applied to the valves to hold them on their seats except when their cams act to lift the valves. These spring retainers have an impositive frictional torque transmitting connection with the stems. Hence, rotation of the retainers will be imparted to the valves when the frictional forces restraining the valves against turning, as when they are seated, are less than the torque frictionally applied to the valve stems by the retainers. At other times the retainers slip and rotate about the stems.

This frictional torque transmitting relationship between the valve spring retainers and the valve stems, together with the fact that the intake valve begins to open before the exhaust valve closes, enables a simple motion translating connection between the valve spring retainers to translate relative axial motion of the retainers into incremental rotation of the valves. The motion translating connection between the spring retainers may take various forms, as long as it definitely imparts rotary motion to the retainer on the stem of the exhaust valve whenever the retainer on the intake valve moves axially. If rotation of the intake valve as well as the exhaust valve is desired, which however is not too important, the connection between the retainers must be such that any relative axial motion between the retainers is always accompanied by rotary motion of both.

In one embodiment of the invention, the motion translating connection between the valve spring retainers comprises a helically shaped cam integral with and projecting from the peripheral edge of one of the laterally adjacent valve spring retainers and a cam follower projecting from the other retainer and having a sliding connection with the cam. Through this connection the relative axial motion or reciprocation of the retainers as the valves are alternately opened positively rotates both spring retainers back and forth through predetermined arcs with both retainers always rotating in a common direction—either clockwise or counterclockwise.

In another embodiment of the invention the motion transmitting connection comprises a pair of rigid links, both having one end thereof pivotally attached to the peripheral portion of the spring retainer on the stem of

the intake valve and the opposite end pivotally attached to the peripheral portion of a ring-like member which may be considered the valve rotator per se, and which has a frictional torque transmitting connection with the spring retainer on the stem of the exhaust valve. The locations of the points of connection between the ring-like rotator and the rigid links with respect to one another and with respect to the point of attachment between the links and the spring retainer on the stem of the intake valve, are such that as the valves are opened and closed the links first impart torque to the rotator in one direction and then in the other. The way in which this is done, of course, will be explained in detail hereinafter.

Merely turning the spring retainers, or the ring-like rotator in the case of the last described embodiment of the invention, back and forth through equal arcs, however, produces no useful effect unless the valves are so timed that the intake valve opens before the exhaust valve seats. This will be clear from a consideration of what takes place if there is no such interval of overlap and instead each valve seats before the other opens. Assume that the exhaust valve is opening and that the intake valve is seated. The resulting relative axial motion between the spring retainers acting through the cam and cam follower or other equivalent motion translating connection therebetween, produces rotary motion of both retainers where the motion translating connection compels simultaneous rotation of both, as it does when the aforesaid cam or cam follower type of connection is used. In the case of the retainer for the exhaust valve, this rotary motion will be imparted to the exhaust valve since it is not seated, but the other retainer will simply slip about the stem of the seated intake valve.

The rotary motion thus imparted to the exhaust valve will be in one direction and through an arc or angle determined by the slope of the cam and the extent of the axial opening motion of the exhaust valve. As the exhaust valve closes, it will turn in the opposite direction and through the same angle, and come to rest upon its seat in the same position of rotation it occupied when it began its opening movement. Nothing will have been accomplished from the standpoint of effecting purposeful rotation of the valve and, of course, the same will hold true for the intake valve. The inability to produce the desired incremental rotation of a valve in this manner has been demonstrated by exhaustive tests.

However, with the intake valve moving off its seat before the exhaust valve seats, the amount of relative axial motion between the two spring retainers during this interval of overlap will be twice that which would occur during this same interval if there were no overlap and the exhaust valve seated before the intake valve left its seat. By virtue of this increased relative axial motion between the spring retainers, the exhaust valve will be turned farther during its final closing motion than would be the case if there were no overlap, so that instead of seating in the position of rotation it occupied when lifted off the seat, it comes to rest in a new position of rotation, which with each cycle is incrementally advanced.

Since it is primarily the exhaust valve which should be rotated, the function performed by the intake valve in the attainment of incremental rotation of the exhaust valve could be performed by some other reciprocating member moving in such timed relation that its motion in one direction would begin shortly before the exhaust valve engaged its seat. Also, it is not necessary that the reciprocating member move in a path parallel to the axis of the exhaust valve. Only the described timing and a suitable motion translating connection between the reciprocating member and the spring retainer of the exhaust valve or a part frictionally connected thereto are essential.

Obviously, though, it is expedient to use the intake valve as the reciprocating member, since this entails the least change in the engine, and in addition it provides for rotation of the intake valve as well as the exhaust valve, inasmuch as it too is off its seat during the interval of overlap and hence has an additional increment of rotation imparted to it.

To supplement the foregoing description of the invention, reference will now be made to the accompanying drawings which illustrate three examples of the physical embodiments of the invention constructed according to the best modes so far devised for the practical application of the principles thereof, and in which:

FIGURE 1 is a view in side elevation of a pair of laterally adjacent intake and exhaust valves for an internal combustion engine cylinder, equipped with the valve rotating means of this invention, said view illustrating only so much of the engine as is necessary to orient the essential structure;

FIGURE 2 is a detail cross sectional view through FIGURE 1 on the plane of the line 2—2;

FIGURE 3 is a bottom view of the valve spring retainers and associated structure, said view being taken essentially on the plane of the line 3—3 in FIGURE 1, and showing the parts in the positions they occupy when both valves are closed or seated;

FIGURE 4 is a view similar to FIGURE 3, but showing the valve spring retainers and the valve rotating means thereon in the relative positions they occupy at the instant when the intake valve is fully open;

FIGURE 5 is also a view similar to FIGURE 3, but illustrating the situation at the instant the exhaust valve is fully open;

FIGURE 6 is a view similar to FIGURE 3, but of a modified embodiment of the invention;

FIGURE 7 is a detail sectional view through FIGURE 6 on the plane of the line 7—7;

FIGURE 8 is a front elevational view of a portion of an engine cylinder looking into its valve spring compartment (the cover therefor having been removed) illustrating another embodiment of the invention;

FIGURE 9 is a cross sectional view through FIGURE 8 on the plane of the line 9—9;

FIGURE 10 is a perspective view of the essential elements of that form of the invention shown in FIGURES 8 and 9;

FIGURE 11 is a detail sectional view through FIGURE 10 on the plane of the line 11—11; and

FIGURE 12 is a perspective view of the valve spring retainer for the intake valve in this embodiment of the invention, but illustrating a modified version thereof.

Referring now particularly to the accompanying drawings, the numerals 7 and 8 identify respectively the intake and exhaust valves of an engine cylinder—as, for instance, the latterally adjacent valves of an L-head type single cylinder four-cycle internal combustion engine. The valves have stems designated 9 and 10, respectively, by which the valves are mounted for reciprocating axial motion between open and closed positions along parallel axes, and also for rotation about their respective axes.

The valves are biased to their closed seated positions by compression springs 11 and 12, and are alternately opened against the bias of their springs by the cams of the engine cam shaft 21 acting through valve tappets 22. The springs encircle the valve stems and are located in a valve spring compartment which is part of the engine cylinder casting, and are confined between the top wall 13 of this compartment and valve spring retainers 14 and 15, respectively mounted on the valve stems 9 and 10. The retainers 14 and 15 are held against spring produced axial movement with respect to the valve stems by C-washers 16 embracing grooved portions of the valve stems and snugly seated in downwardly opening circular pockets 17 in the underside of the valve spring retainers. This manner of connecting the valve spring retainers to the valve stems is, of course, conventional, but the fact that the valve spring retainers are not immovably secured to the valve stems and, instead, are capable of rotating about the stems as well as frictionally transmitting torque to the stems and rotating the valves when the latter are not restrained against rotation by being seated is essential to the attainment of the objectives of this invention.

As explained hereinbefore, it is also essential to this invention that the timing of the valves be such that the intake valve 7 leaves its seat and is in motion toward its open position before the exhaust valve 8 seats. Such overlap in timing is conventional with most engine manufacturers, though they may not agree upon the extent of the overlap. For the purposes of this invention, it is desirable to have the overlap as long as possible consistent with good engine performance, since the angle of each increment of rotational advance of the valves, and especially the exhaust valve, is a function of the extent of the overlap.

Fnally, it is essential to this invention that there be a motion translating connection between the spring retainers 14 and 15 to translate relative axial motion of the retainers into rotary motion. In the structure shown in FIGURES 1 to 5, inclusive, this connection is obtained by the simple addition of a cam 18 to one of the valve spring retainers—in this case the retainer 15 on the exhaust valve—and a cooperating cam follower 19 on the other spring retainer. Both the cam and its follower project laterally from the peripheral edge of their respective retainers and, in each instance, toward the other retainer.

The cam 18 is simply a tab formed integrally with the valve spring retainer 15 and twisted to dispose its opposite parallel faces substantially helically to the axis of the valve 8. The cam follower 19 is a bifurcated arm integral with the spring retainer 14 and projecting laterally therefrom with its furcations embracing the cam, as shown.

The effective height of the cam, i.e. the distance from its bottom edge to its top edge measured along a line parallel to the axes of the valves, is greater than the total relative motion between the valves during their alternate opening and closing. This is important. It is also significant that the inner edges 20 of the furcations constituting the bifurcated arm 19 are parallel and, as best shown in FIGURE 2, are spaced apart a distance such that they snugly though freely slidingly engage the opposite faces of the cam. As will be more fully brought out hereinafter, it is also essential that the adges 20 be as long as the available space will permit.

The manner in which the cam and cam follower translate the relative axial reciprocation of the valve spring retainers into concomitant turning or rotation of both spring retainers in the same or common direction, may be clear from an examination of the drawings alone, but for the sake of completeness, the following explanation is given:

As the spring retainer 14 moves axially upward (as viewed in FIGURE 1) the slope of the cam 18 forces the retainer 14 to rotate, since the cam follower 19 on the retainer 14 embraces the cam. However, because the engagement between the cam follower and the cam is formed by the two line contacts between the inner edges of the furcations 20 and the opposite parallel faces of the cam, and since this engagement, except for necessary running clearance, constrains relative motion between the interengaged cam and cam follower in planes normal to the valve axes to only rectilinear motion parallel to the inner edges 20 of the furcations, it follows that the spring retainer 14 cannot turn about its axis unless the retainer 15 also turns in the same direction about its axis.

Both spring retainers are thus positively rotated through a predetermined angle in a common direction, counterclockwise as viewed from the bottom, to their positions shown in FIGURE 4. At this instant, the intake valve is fully open, and because the height of the cam is greater than the maximum relative axial motion of the valves as they open and close, and because the furcations of the cam follower arm are as long as space will permit, there

is no danger of the cam and cam follower being disengaged as they reach this extremity of the relative motion.

During closure of the intake valve the cam and cam follower effect rotation of both spring retainers in a clockwise direction as viewed from the bottom, back to their respective relative positions shown in FIGURE 3.

As the camshaft now opens the exhaust valve **8** and the retainer **15** moves axially with it, the resulting relative axial motion of the retainers acting through the cam and cam follower positively rotates both spring retainers in the clockwise direction, as viewed from the bottom, to their relative positions shown in FIGURE 5, at which time the exhaust valve is fully open.

It is to be noted that the direction in which the spring retainers rotate during the opening of the exhaust valve, is opposite to the direction they rotate during opening of the intake valve. But, in both cases, providing that the valves are lifted the same axial distance, the angle through which the retainers are rotated is the same.

Again, as in the case of the intake valve, during the closure of the exhaust valve the cam and cam follower act to rotate the retainers back to their position shown in FIGURE 3.

It should now be clear that the motion translating connection between the spring retainers formed by the inter-engaged cam and cam follower, translates relative axial motion between the spring retainers as the valves alternately open, into rotation of both retainers, first in one direction and then the other, and always through the same arc. The valves rotate with the retainers whenever the torque frictionally applied to the valve stems exceeds the friction restraining the valves against turning. Thus a valve that is seated will not be turned by its spring retainer, but by having the frictional grip between the retainer and their respective valve stems strong enough to overcome any other frictional force restraining an unseated valve from turning, assurance is had that as long as a valve is unseated it will turn in unison with its retainer. The retainers thus can be considered rotators.

But this alone, as noted hereinbefore, is not enough to bring about the desired incremental rotational advance of the valves. It is here where the overlap in the timing of the valves plays its part. Because of it, there is an interval when the retainer **14** is moving upward while the retainer **15** is moving downward. This simultaneous axial motion of the two retainers in opposite directions doubles the magnitude of their relative axal motion and, by the same token, increases the arc through which the retainers turn. The important net result is that the exhaust valve turns faster and necessarily farther during its final closing motion than it would if there were not overlap; and in doing so it seats in a different position of rotation than it occupied when first lifted off its seat.

The modified embodiment of the invention illustrated in FIGURE 6, though perhaps not as practicable as the one just described, will also produce the desired results. In it, the motion transmitting connection between the two spring retainers **14'** and **15'** comprises a crank-like link **24** having oppositely extending trunnions or crank pins **25—26**, the axes of which are parallel. These trunnions or crank pins are respectively journalled in bearings **27—28** formed in lateral projections **29—30** on the peripheral edges of the spring retainers **14'** and **15'**.

The specific form of the bearings **27—28** is of no consequence. In the present case they are formed by oppositely directed loops pressed into the lateral extensions **29—30**, as best seen in FIGURE 7. The important consideration is that, as noted before, the axes of the trunnions or crank pins **25—26** are parallel and that they have only a rotary and axial motion in their respective bearings. This prevents relative rotation of the spring retainers except when they are moving axially with respect to one another, and then the crank **24** constrains them to concomitant rotation in the same direction, either clockwise or counterclockwise, depending upon which valve is opening.

In principle, therefore, the structure shown in FIGURE 6 is the same as the cam and cam follower of the previously described embodiment of the invention. In both cases, the connection between the laterally adjacent spring retainer includes a part fixed with respect to one of the spring retainers and having spaced surfaces symmetrically disposed at opposite sides of an axis extending laterally from the periphery of the retainer and towards the other retainer.

In the modified form of the invention illustrated in FIGURE 6, this part may be considered one of the bearings—say the bearing **27**. Diametrically opposite portions of the inner surface of this bearing are, of course, symmetrically disposed at opposite sides of the axis of the bearing. In the other embodiment of the invention, this part may be considered the bifurcated arm or cam follower **19**, the inner edges **20** of which, being parallel, are symmetrically disposed on opposite sides of the axis which longitudinally disects the bifurcated arm.

The connection between the two spring retainers is completed in each of these two forms of the invention by a part carried by the other spring retainer fixed against movement out of a predetermined angular relationship with respect to that retainer and having spaced surfaces symmetrically disposed at opposite sides of an axis extending laterally from the periphery of the retainer.

In the FIGURE 6 embodiment this second part of the connection is the crank arm **24** and the bearing **28** on the retainer **15'**. Since the crank pin **26** can only slide and turn in the bearing **28**, this part of the connection is restrained against movement out of a predetermined angular relationship with respect to the retainer **15'**. In other words, the crank arm **24** cannot be swung angularly with respect to the retainer **15'**. The surfaces which are symmetrically disposed at opposite sides of an axis extending laterally from the periphery of the retainer **15'** are the diametrically opposite sides of the crank pin **25** which is journalled in the bearing **27** of the retainer **14'**. In the first described embodiment of the invention, this second part of the connection is, of course, the cam **18**, the opposite faces of which are symmetrically disposed at opposite sides of an axis extending laterally from the periphery of the retainer **15**.

Also in both structures, the designated surfaces of the connection between the two spring retainers are parallel to one another and engaged with one another, to at all times hold the spring retainers in positions of relative rotation at which the laterally extending axes are substantially parallel. And, of course, in each of the two structures, the coacting parts of the connection between the two retainers are provided with means to cause the retainers to rotate through a predetermined arc with each instance of relative reciprocation between the valves.

Bearing in mind that the function of the motion translating connection between the valve rotators which, as shown, may be the spring retainers, is to translate relative reciprocatory motion of the valve stems into back and forth oscillation of the rotators to the end that the exhaust valve at least will be incrementally advanced through a slight angle with each cycle of operation due to the overlap in timing between the valves, it follows that the specific nature and construction of this motion translating connection, once the essentials of the invention are known, may take any form the ingenuity of the designer may produce; and in FIGURES 8–11, inclusive, there is illustrated a motion translating connection which is quite different in structure from the two forms of the invention already described.

In this embodiment of the invention about to be described, the rotator **34** for the exhaust valve is separate from its spring retainer **35**, but for the intake valve the spring retainer **37** performs the function of the rotator as it did in the other embodiments of the invention. Both

retainers are preferably stampings. Both have a circular, dished shape with a flat central portion 38 bounded by an offset peripheral flange 39. The junction between the flange 39 and the flat central portion 38 forms a circular shoulder 40. In the case of the retainer 37 for the intake valve, this shoulder fits the adjacent end of the intake valve spring 11' to center it, and the spring seats directly upon the flange 39.

On the retainer 35 for the exhaust valve, the shoulder 40 is smaller in diameter and fits inside the rotator 34 to hold the same rotatably assembled with the retainer. The rotator is essentially a ring with a flat peripheral flange 34' that seats upon and is pressed against the flange 39 of the spring retainer 35 by the spring 12'.

The detachable connections between the two retainers and their respective valve stems are alike. Each consists of a steep frustoconical shoulder 41 near the end of the valve stem seated in a correspondingly tapered socket 42 in the retainer. The sockets 42 are formed by central protrusions of the retainers, and engagement and disengagement between the retainers and the valve stems is made through keyhole-shaped openings 43 in the retainers, the small end of which is concentric to the retainer and coincides with the small diameter end of the tapered socket, and the large end of which accepts the full diameter of the valve stem outwardly of its frustoconical shoulder. Essentially, this form of separable connection between the valve stems and the spring retainers is like that illustrated in the Holdsworth Patent No. 2,523,570.

From the standpoint of this invention, the important feature of the connection between the spring retainers and the valve stems is its ability to frictionally transmit torque from the retainer to the valve stem. To this end, the component of friction resisting relative rotation between the spring retainers and the valve stems offered by this connection should be sufficient to overcome any resistance to rotation of the valve other than that which results from the engagement of the valve with its seat; but in the case of the exhaust valve, all rotation of its rotator 34 is not necessarily accompanied by rotation of the spring retainer 35. This follows from the fact that the friction at the flat surface-to-surface engagement between the flanges 34' and 39 is considerably less than it is between the valve stem and the retainer 35. Hence, relative reciprocation of the valve stems is translated into back and forth rotation of the spring retainer 35 only when the exhaust valve is unseated. At other times, the rotator 34 turns with respect to the retainer 35.

The motion translating connection is between the spring retainer 37 and the rotator 34. It comprises two links 45 and 46, which preferably are the legs of a generally hairpin-shaped length of wire. The bend 47 which connects the two links is pivotally received in a hole 48 punched in a tongue 49 projecting up from the marginal edge portion of the intake valve spring retainer 37. The outer ends of the links 45 and 46 have inturned end portions received in holes in the outer ends of a pair of angularly spaced arms 50 and 51 which project axially in opposite directions from the periphery of the rotator 34. The spring tension of the connected links 45 and 46 imparts an inward bias thereon and thus holds the ends of the links attached to their respective arms.

The angular spacing of the arms 50 and 51, and hence of the points of attachment of the links to the rotator, though not critical, should be as great as space will permit. In actual practice it is 135°, which is about the maximum that can be accommodated.

The axial spacing of the points of attachment between the links 45 and 46 and the rotator 34, again should be as great as possible, but more important, these points should be higher and lower than the common point of attachment 47, and preferably the latter, should be at a height midway between that of the other two when both valves are seated. Accordingly, since the tongue 49 and the arm 50 project axially in the same direction, this arm is longer than the other one. With this relationship, when the intake valve is lifted and the common attachment point 47 moves upward, the link 45 is placed in compression and the link 46 in tension, to thereby impart equal and opposite forces to the rotator at substantially opposite sides of its axis. By the same token, when the exhaust valve is lifted, a pull is exerted on the link 46 and a push on the link 45, which forces reacting against the common connection 47 cause the links to impart an opposite torque to the retainer 34. In this manner, the relative reciprocation of the valve stems is translated into back and forth arcuate motion of the rotator 34 without imposing objectionable side thrust thereon; and since part of this arcuate motion takes place during the overlap period when neither valve is seated, it results in the desired incremental angular advance of the exhaust valve.

During that part of the arcuate motion imparted to the rotator by the links 45 and 46 which takes place when the exhaust valve is seated, the rotator slides on the spring retainer 35 because, as noted hereinbefore, the component of friction between the rotator and the spring retainer, though sufficient to impart rotary motion to the latter, and hence to the valve stem when the valve is off its seat, is insufficient to do so when the valve is seated. In this manner, the desired action is obtained without imposing too severe a strain upon the wire links 45 and 46.

The attachment of the common end 47 of the two links to the retainer 37 may be effected simply by "threading" one of the links through the hole 48; or, if desired, the modified form of connection illustrated in FIGURE 12 may be used. In this case, the tongue 49' is bifurcated by a slit 52, the outer portion of which provides a throat through which the loop or bend 47 may be forced and snapped into the hole 48'. To give the furcations into which the tongue is divided the needed resilience, the slit extends from the hole 48' to a hole 53.

From the foregoing description taken in connection with the accompanying drawings, it will be readily apparent to those skilled in this art that this invention provides an extremely simple and highly reliable and effective way of rotating the poppet valves of an internal combustion engine; and that by virtue of its simplicity, the invention lends itself especially well to use in small, single cylinder internal combustion engines.

What is claimed as my invention is:

1. In combination: a poppet valve member having a stem; means mounting the poppet valve member for axial reciprocation to and from a valve seated position in which the valve member is restrained against rotation by its seat; a spring to bias the valve member to its seated position; a valve rotator frictionally coupled to the valve stem in a manner constraining the rotator to move axially with the valve member and to frictionally transmit rotation in either direction to the valve member when the latter is not restrained against rotation by being seated; a reciprocable member mounted for movement in opposite directions; means to reciprocate said reciprocable member in such timed relation to the reciprocation of the valve member that a portion of the motion of said reciprocable member in one of its directions of motion occurs during a portion of the reciprocating motion of the valve member in one direction, and the remainder of the motion of the reciprocating member in said one direction occurs while the valve member is seated; and means providing a motion translating connection between a point on the valve rotator spaced from the axis of the valve member, and said reciprocable member, whereby motion of each member relative to the other in one of its directions of reciprocation is translated into rotation of the valve rotator in one direction about the axis of the valve member and motion of each member relative to the other in its opposite direction of reciprocation is translated into rotation of the valve rotator in the opposite direction, so that during each cycle of reciprocation of the valve member the valve rotator is rotated first in one direction and then

through an equal angle in the other direction with a portion of the rotation of the rotator in one direction taking place while the valve member is seated so that during such portion of the valve rotator's rotation it slips rotationally with respect to the valve member, but during the remainder of the rotation of the valve rotator the unseated valve member rotates in unison with it.

2. The structural combination of claim 1, wherein the poppet valve member is the exhaust valve of an internal combustion engine cylinder, and the reciprocable member is the intake valve thereof.

3. The structural combination of claim 2, wherein the valve rotator is also a seat against which the spring bears.

4. The structural combination of claim 3, wherein the intake valve has a spring seat mounted on its stem, and a spring bearing upon said seat, and wherein the motion transmitting means comprises a helical cam on the spring seat of one of the valves and a cam follower on the spring seat of the other valve in sliding engagement with the cam.

5. The structural combination of claim 2, wherein the intake valve has a spring retainer mounted on its stem, and a spring bearing upon said retainer, and wherein said motion translating connection comprises a pair of rigid links each having one end pivotally attached to the peripheral portion of the spring retainer and the other end thereof pivotally attached to the valve rotator at a point spaced radially from its axis, the points of connection between said links and the valve rotator being spaced apart angularly and also axially of the rotator.

6. The structural combination of claim 5, wherein the connection between the links and the intake valve is on a plane normal to the axes of the valves and substantially equispaced from the points of connection between the links and the rotator when both valves are seated.

7. The structural combination of claim 1, wherein said motion translating connection comprises a pair of rigid links each having one end pivotally connected with the reciprocating member and the other end pivotally attached to the valve rotator at a point spaced radially from its axis, said points of attachment between the links and the valve rotator being spaced apart angularly and also axially of the rotator.

8. The structural combination of claim 7, wherein said links are the legs of a substantially hairpin-shaped length of wire, the free ends of which are pivotally attached to the rotator and the bend which connects the legs being pivotally connected with the reciprocable member.

9. The structural combination of claim 8, wherein the connection between the reciprocable member and the bend which connects the legs of the hairpin-shaped length of wire comprises a tongue on the reciprocable member having a hole near its outer end of a size to freely receive the diameter of the wire, and a narrow slit leading to said hole and through which said bend may be forced into the hole.

10. The structural combination of claim 7, wherein the connection between the links and the reciprocating member is on a plane normal to the axis of the poppet valve and substantially equispaced from the points of pivotal attachment between the links and the rotator when the poppet valve is seated and the reciprocating member is stationary.

11. The structural combination of claim 1, wherein the coupling of the valve rotator to its valve stem includes a part detachably mounted on the valve stem in a manner constraining said part to move axially with the stem, said part having a peripheral flange concentrically surrounding the valve stem and facing the spring, and wherein the rotator comprises a ring encircling the valve stem and seated upon said flange with the spring bearing on the rotator and holding the same frictionally against the flange.

12. The structural combination of claim 11, wherein the rotator has a pair of angularly spaced arms projecting axially in opposite directions from its periphery, and wherein the motion translating connection comprises a pair of rigid links, one of which has one end pivotally attached to the outer end portion of one of said arms and the other of which has one end pivotally attached to an outer end portion of the other arm, and each of said arms having its remaining end pivotally connected with the reciprocable member.

13. The structural combination of claim 1, wherein the reciprocable member reciprocates along an axis parallel to the axis of the poppet valve.

References Cited in the file of this patent

UNITED STATES PATENTS

1,569,887	Sargent	Jan. 19, 1926
2,766,746	Greer	Oct. 16, 1956