

Feb. 25, 1958

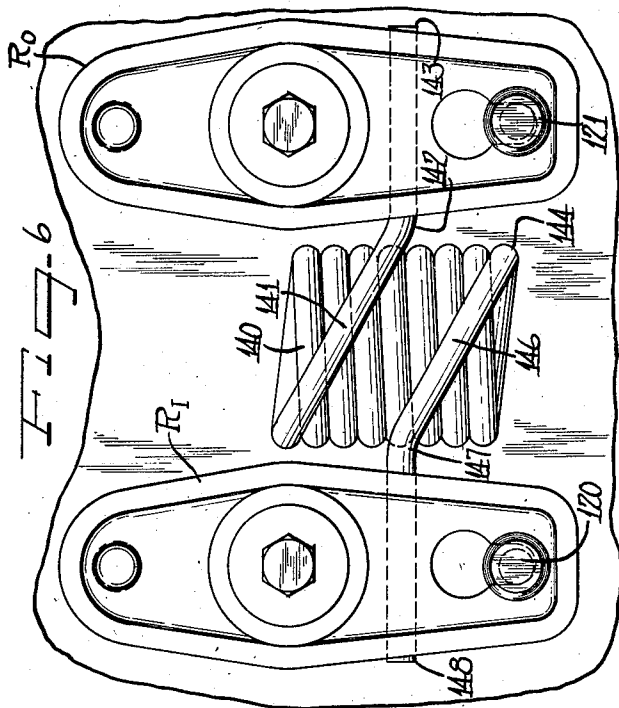
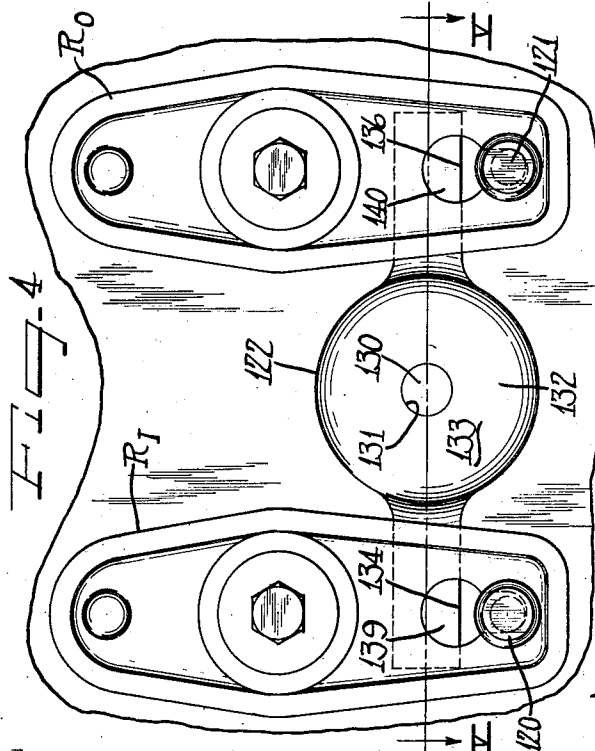
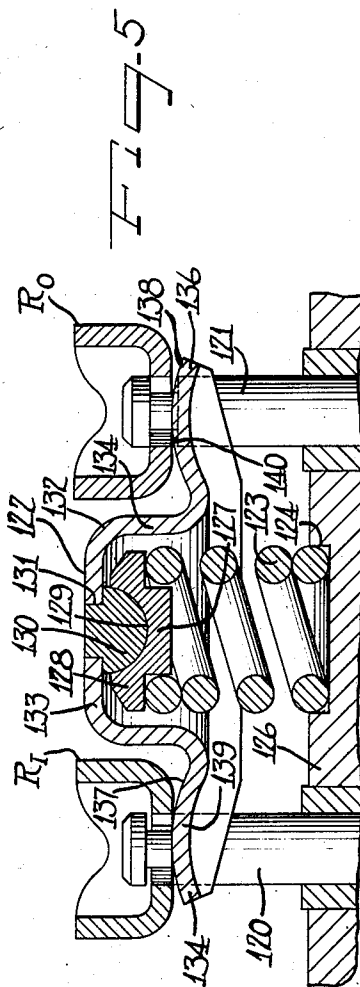
A. C. SAMPIETRO

2,824,554

METHOD AND MEANS FOR ROTATING VALVES

Filed Jan. 31, 1956

5 Sheets-Sheet 2



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Feb. 25, 1958

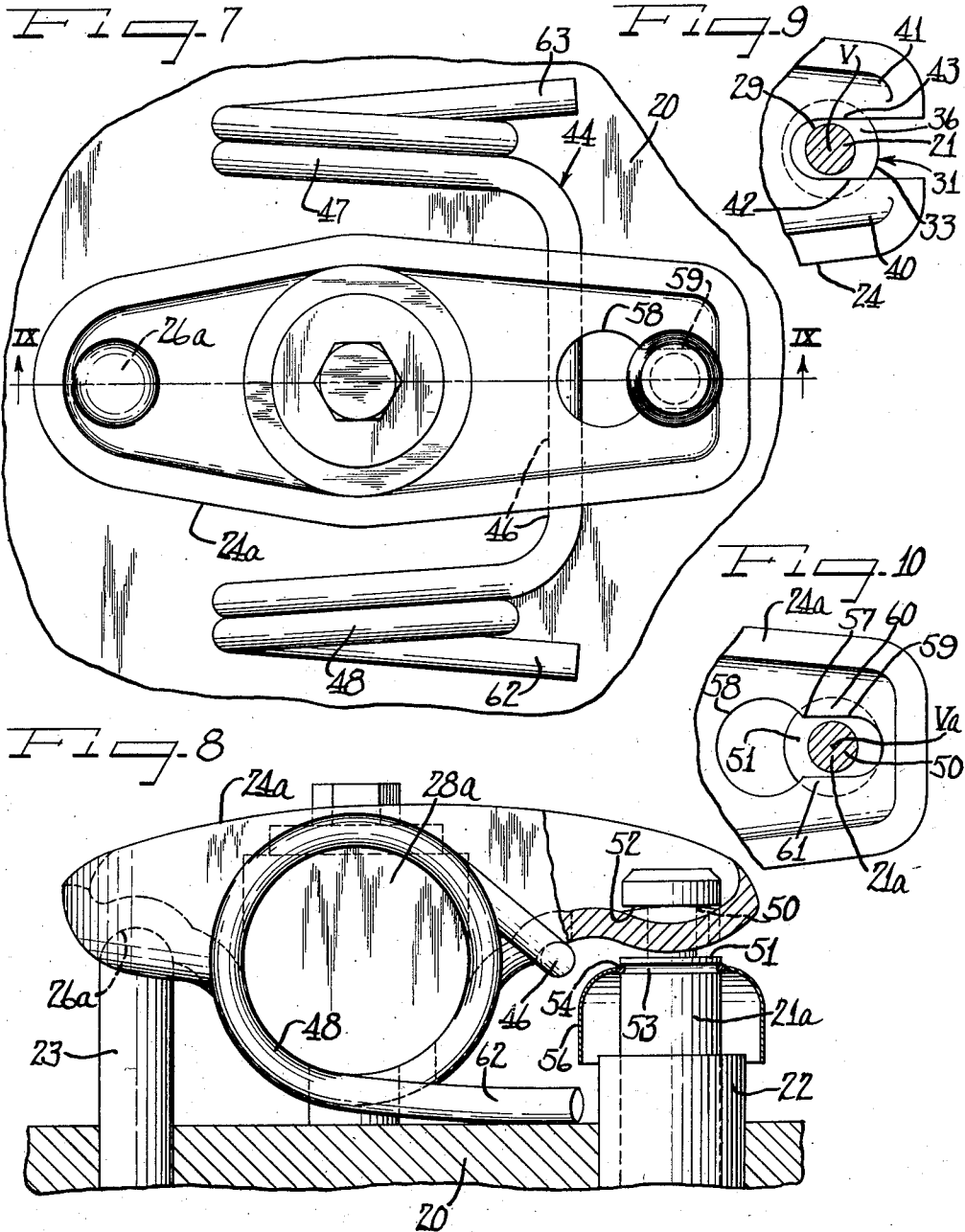
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2,824,554

METHOD AND MEANS FOR ROTATING VALVES

Filed Jan. 31, 1956

5 Sheets-Sheet 3



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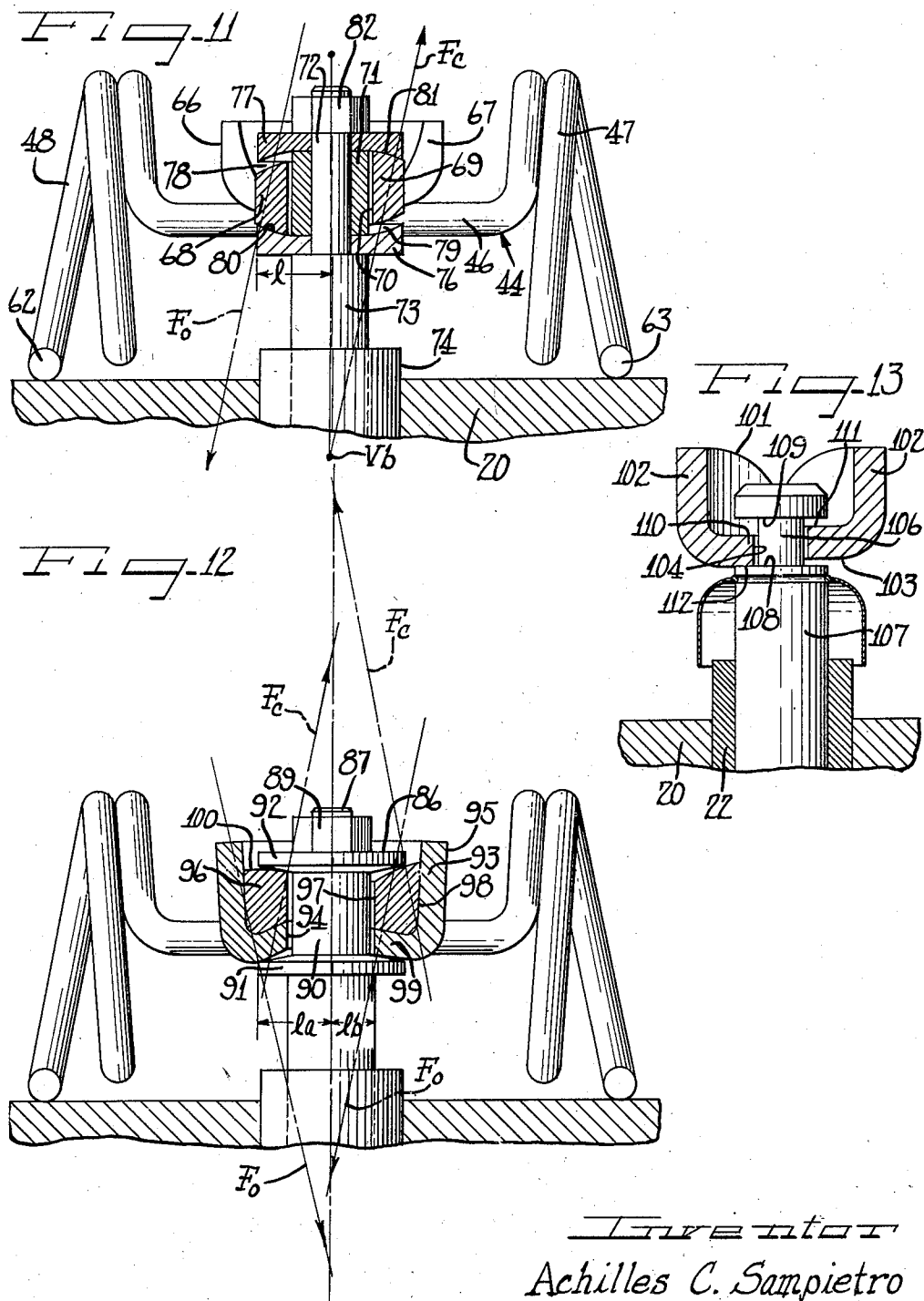
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METHOD AND MEANS FOR ROTATING VALVES

Filed Jan. 31, 1956

5 Sheets-Sheet 4



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Feb. 25, 1958

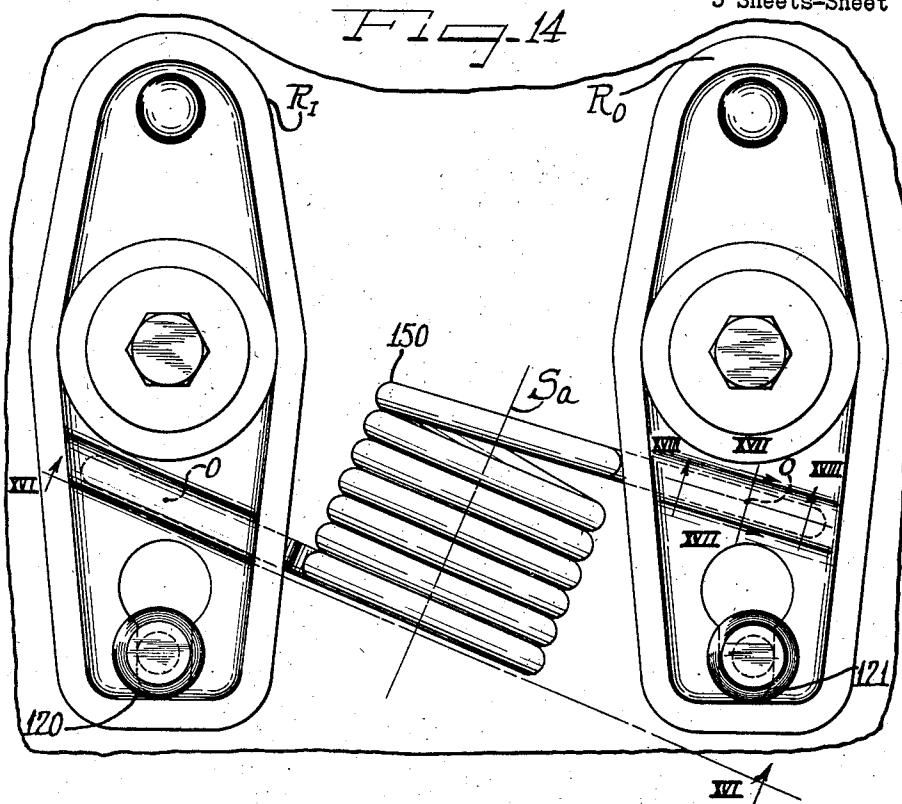
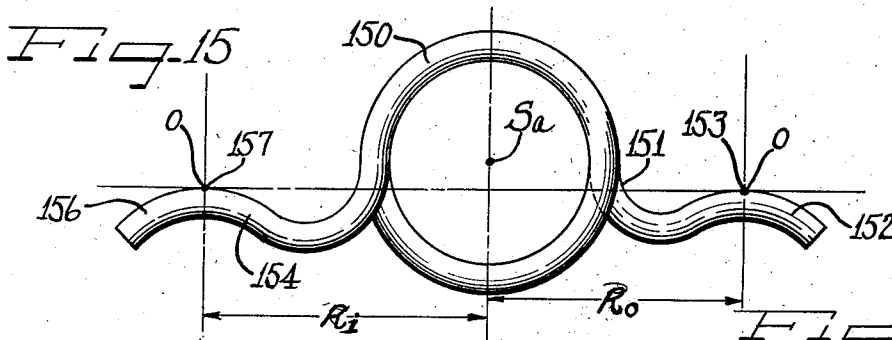
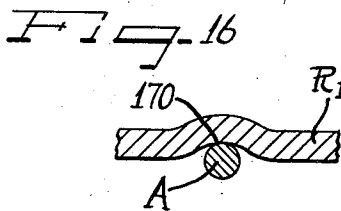
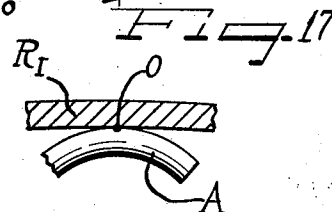
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2,824,554

METHOD AND MEANS FOR ROTATING VALVES

Filed Jan. 31, 1956

5 Sheets-Sheet 5



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2,824,554

METHOD AND MEANS FOR ROTATING VALVES

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Application January 31, 1956, Serial No. 562,423

23 Claims. (Cl. 123—90)

This invention relates generally to valve-rotating devices and more particularly relates to a method and means for rotating two axially adjacent parts by cyclically loading and unloading the parts with a generally axially directed resultant force having a lateral component which is converted into unidirectionally acting torque moments operable to rotatably drive the parts with respect to one another.

Although the principles of the present invention are of general utility, a particularly useful application is found in connection with the provision of valve-rotating devices. It is highly desirable to provide means for rotating engine valves since cyclic rotation of the valves during the course of operation thereof assists in eliminating valve burning as well as wearing, pitting and stem-galling and scoring.

In one form of valve-actuating mechanism, a spherically pivoted rocker arm is combined with a torsion spring and operates as a load-transmitting means between an engine part and a reciprocable valve assembly.

According to the principles of the present invention, a light fast valve gear of the rocker arm type is constructed to effect automatic rotation of the valve concurrently with the reciprocation thereof. Briefly described, the present invention contemplates the utilization of a rocker arm having spaced laterally-separated bearing areas engageable with a valve on opposite sides of the valve axis. Means are provided to render the first and second bearing surfaces thus provided alternately dominant and evasive. Accordingly, whenever force is transmitted to the valve by the rocker arm assembly, a lateral component of force will be exhibited even though the loading and unloading forces applied to the valve are directed in the direction of the valve axis. Accordingly, a scrubbing action occurs which is attributable to the lateral component of force. This phenomenon is exploited in accordance with the principles of the present invention since the lateral component of force is converted in both loading and unloading directions into unidirectionally applied torque moments which rotatably drive the valve.

It is an object of the present invention, therefore, to provide a light fast valve gear construction having a minimum moment of inertia and a lighter than normal spring force and which will effect valve rotation during the opening and closing movements of the valve.

Another object of the present invention is to provide a valve gear which is ideally suited for conventional open clearance lash operation and is fully usable with valve gear assemblies incorporating automatic lash adjusters located anywhere in the valve gear train.

Yet another object of the present invention is to provide a rocker arm valve assembly which will cause valve rotation both in the opening and closing portion of the valve cycle.

A further object of the present invention is to pro-

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vide a rocker arm actuating mechanism for a valve wherein separate keying devices are not required.

A still further object of the present invention is to provide a multiple valve arrangement wherein a single spring can be employed with multiple poppet-type valves.

Another object of the present invention is to provide means for applying a generally axially directed force having a scrubbing component in lateral direction relative to a valve and incorporating means for converting the lateral scrubbing component into unidirectional torque moments for rotatably driving a valve member.

Many other features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheets of drawings in which preferred embodiments of the present invention are illustrated by way of example only. The methods of the present invention will best be understood from an understanding of the structures provided herein for practicing the steps of the method.

On the drawings:

Figure 1 is a force diagram indicating schematically the theory of operation of the principles of the present invention;

Figure 2 is a fragmentary cross-sectional view taken generally on line II—II of Figure 3 but showing parts in elevation;

Figure 3 is a plan elevational view of the valve gear illustrated in Figure 2;

Figure 4 is a plan elevational view of an alternative form of valve gear;

Figure 5 is a fragmentary cross-sectional view with parts shown in elevation taken generally on line V—V of Figure 4;

Figure 6 is a plan elevational view of an alternative form of valve gear;

Figure 7 is a plan elevational view of an alternative form of valve gear;

Figure 8 is a cross-sectional view with parts shown in elevation taken generally on line IX—IX of Figure 7;

Figure 9 is a fragmentary cross-sectional view; and

Figure 10 is a similar fragmentary cross-sectional view illustrating alternative forms of connections provided on the end of a valve rocker arm in accordance with the principles of the present invention;

Figures 11 and 12 are generally similar views and illustrate valve gear constructions corresponding generally to the assembly of Figures 7 and 8, however, different forms of coupling connections are illustrated in accordance with the principles of the present invention between the load-transmitting means and the valve stem;

Figure 13 is a fragmentary cross-sectional view with parts in elevation illustrating yet another form of coupling connection between the load-transmitting means and the valve stem in accordance with the principles of the present invention;

Figure 14 is a fragmentary plan elevational view showing yet another embodiment of the present invention;

Figure 15 is an end view of the spring 150 of Figure 14 in the plane of line XVI—XVI on Figure 14 to illustrate details of the construction of the spring;

Figure 16 is a fragmentary cross-sectional view taken generally on line XVII—XVII of Figure 14; and

Figure 17 is a cross-sectional view taken generally on line XVIII—XVIII of Figure 14.

As shown on the drawings:

Although the principles of the present invention are of general utility, a particularly useful application is made to valves for internal combustion engines. Accordingly,

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it is contemplated that the usual engine part is provided which is indicated generally at 20 and which will be ported to provide passages for fluids moving within the cavities of the engine part. The ports thus provided are controlled by one or more valves, each valve including a stem 21 carried for reciprocation and rotation by a valve stem liner 22 supported by the engine part 20,

Actuating means are also provided to operate the valves in correlation with the movement and positioning of the engine components. Accordingly, an actuating member indicated at 23 is provided and it will be understood that the movement of the actuating member 23 is controlled by the usual timing gear incorporated in an internal combustion engine.

Load-transmitting means are interposed between the valve stem 21 and the engine part 20, thereby to cyclically load and unload the valve stem 21 in accordance with the movements of the actuator member 23. According to the principles of the present invention, a rocker arm indicated generally at 24 is formed with a curved indentation 26 at one end thereof adapted to seat and engage against a correspondingly curved surface formed on the end of the actuating member 23.

The rocker arm 24 is spherically pivoted for pivotal movement relative to an axis 26, the rocker arm 24 including an intermediate body portion 27 pivotally connected to a mounting member 28 carried in firm assembly with the engine part 20.

As shown on Figure 2, the valve stem 21 is provided with a reduced diameter end portion 29 providing a shoulder 30 against which a collar member 31 abuts. The collar member 31 is retained in assembly with the valve stem 21 by means of a fastener 32 threaded onto the end of the reduced section 29 of the valve stem 21. The collar member 31 includes a lower flange 33 and an upper flange 34, thereby to provide axially spaced shoulders each of which being inwardly crowned as at 36 and 37, respectively, to form annular bearing faces or surfaces which confront one another.

Relating the force diagram of Figure 1 to the structure thus far described in connection with Figures 2 and 3, it will be noted that the heavy line corresponds to the rocker arm 24 pivoted for rotation around the pivot axis 26 and having an end portion 36 movable in a generally vertical plane of movement to impart opening and closing thrusts to the valve stem 21 movable on an axis of valve movement indicated by the letters A, B.

Because the rocker arm 24 is confined for pivotal movement around the axis 26, it will be appreciated that a true trace of the end of the rocker arm 36 would lie on an arcuate path shown extended in Figure 1 between the points C and D.

With the rocker arm 24 in the position with the end of the arm 36 located at point E, it will be assumed that the valve gear is at the closed valve position corresponding to the beginning of a typical valve cycle.

The rocker arm is actuated and accelerates the valve stem by the application of a force which is an opening force indicated by the character F_o . At the point E and with the application of the force F_o , it will be noted there is a small component of laterally-directed force extending towards the right in the orientation of Figure 1, which lateral component of force is indicated at FO_1 .

At the instant when F_o reaches its maximum value, then it should act in line with the linear movement of the valve and no lateral component of force is exhibited. Past this point of maximum force value, however, there is a substantial lateral component of force acting towards the left, according to the orientation of Figure 1, which component is indicated in Figure 1 at FO_2 . It will be understood that the relative values of FO_1 and FO_2 are dependent upon the relationship between the axis 26 and the axially spaced shoulders 36 and 37 in a horizontal direction. In other words, as shown in Figure 1, greater move-

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ment below the center point is contemplated and, accordingly, the value of FO_2 is indicated as being greater.

When the valve is fully open, the end 36 of the rocker arm 24 has moved, as indicated in Figure 1, to the point indicated at G. At this point, the accelerating force changes sign and a closing force is applied to the valve stem 21, the closing force being indicated by F_c . At the point G, the closing force F_c indicates a horizontal component or lateral component of force indicated at FC_1 .

It will be understood that if both the force F_o and the force F_c were to be applied to the center line of the valve stem 21, the horizontal components or lateral components of force only effect would be to create side thrust. If applied to the valve stem 21 at some point offset from the center line axis of the valve, however, a torque moment is produced which is a function of the lateral component of force.

Moreover, if the force F_o and the force F_c are applied at the same point on the same side of the center line valve axis, the torque moment thus produced would merely tend to oscillate the valve stem 21.

In accordance with the principles of the present invention, the application of the opening force and the closing force occurs on opposite sides of the center line valve axis, thereby producing unidirectionally acting torque moments which will rotatably drive the valve stem 21 in the same direction.

It will be understood that the force diagram of Figure 1 greatly exaggerates the amount of relative movement for the sake of clarity and understanding. In practicing the present invention, it is contemplated that a sufficient lateral component of force is produced to effect a so-called "scrub" between the components of no more than just a few thousandths of an inch. The lateral component of force which produces the scrubbing action, however, is exploited in accordance with the principles of the present invention by converting the lateral component of motion as exhibited during loading and unloading to produce unidirectional torque moments for rotatably driving the valve. Several different embodiments of the invention exploiting the phenomena thus far described are disclosed herein.

As shown in Figures 2, 3 and 9, the rocker arm 24 has a recess 26 engaging the actuating member 23 on one side of the fulcrum provided by the spherical pivot mounting member 28 and the arm portion of the rocker arm 24 on the other side of the fulcrum is adapted to operatively engage the valve stem 21. More specifically, the rocker arm 24 is shown as including a bifurcated end portion providing spaced apart leg portions 40 and 41 separated a distance sufficient to freely receive the reduced end section 29 of the valve stem 21. The arm portion 40 thus provides a bearing area 42 lying on one side of the center line valve axis indicated at V (Figure 9) and the arm portion 41 provides a bearing surface or area indicated at 43 lying on the opposite side of the valve axis V, the bearing surfaces or areas 42 and 43 comprising first and second bearing surfaces for engaging and cooperating respectively with the axially spaced shoulders 36 and 37 on the collar 31 firmly assembled to the valve stem 21.

In the embodiment of Figure 2, a torsion spring is provided which functions as a continuous biasing means preloading the rocker arm 24 and hence the valve of which the valve stem 21 is a part towards closed position. The torsion spring is indicated generally at 44 and has a cross bar 46 which extends transversely of the rocker arm 24 and underlies and engages a portion of the rocker arm 24 on one side of the fulcrum or pivot axis 26. As shown in Figure 2, the rocker arm 24 may be provided with an embossment 48 seating the cross bar 46.

At opposite ends of the cross bar 46 and on opposite sides of the rocker arm 24, a pair of coiled loops are provided. It is contemplated, according to the principles

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of the present invention, that the loops herein indicated at 47 and at 48, respectively, both be wound in such a direction as to exert a biasing force against the rocker arm 24 in the same direction, however, it is further contemplated that the spring rate of the loop 47 will vary from the spring rate of the loop 48 in sufficient amount to characterize one of the loops 47, 48 as dominant and the other of the loops 47, 48 as evasive. Thus, the cross bar 46 is made dominant on one side of the rocker arm 24 and evasive on the other side of the rocker arm 24. This characteristic will, in turn, cause a sufficient twisting of the rocker arm 24 to effect a similar dominant and evasive arrangement between the bearing areas or surfaces 42, 43 (Figure 9) and the axially spaced shoulders 36 and 37. Thus, when the rocker arm 24 is subjected to increased load greater than the predetermined preloading effected by the torsion spring 44 and in sufficient amount to apply a generally axially directed force to the valve stem 21, the load will be transmitted through one of the bearing and surface areas 42 and 43 and the lateral component of force will be converted into a torque moment equal to the amount of the lateral component of force multiplied by the length of the moment arm extending from the axis V to the point of application of the force.

Because of the dominant and evasive characteristics of the valve gear, however, upon unloading the valve stem 21, the other of the bearing surfaces or areas 42 and 43 will engage the opposite shoulders 36 and 37 on the other side of the valve axis V, thereby producing a second torque moment arm which is acting in the same direction as the torque moment arm first produced.

In other words, by making the cross bar of the spring dominant on one side of the rocker and evasive on the other, the rocker is twisted to touch the upper flange of the collar on the valve stem on one side and the lower flange on the other. Then as the rocker arm foreshortens as it rotates in opening, it will cause the valve to turn one way. Likewise, it forelengthens on closing and becomes oppositely dominant and evasive due to the inertia of the valve changing direction and favors rotation in the original direction. Thus rotation is caused in the same direction whether the valve is being opened or closed.

In addition to facilitating the rotating action, the bifurcated ends of the rocker arm 24 enveloping the flanges 33 and 34 on the collar 31 are caused to be twisted up and down to take up clearance at all times, thereby keeping looseness out of the valve gear to avoid noise and also permitting positive seating of the valve when operated with open clearance lash. Thus, the mechanism of the present invention is not only ideally suited for conventional open clearance lash operation but also with automatic lash adjusters located anywhere in the valve gear train.

The embodiment of Figures 7, 8 and 10 is generally similar to that already described in connection with Figures 2, 3 and 9, however, a different form of coupling connector is provided between the valve stem and the load-transmitting means. In describing the embodiment of Figures 7, 8 and 10, like reference numerals are applied to like parts wherever possible. In this form of the invention, the rocker arm is indicated at 24a and is pivotally mounted to a mounting member 28a carried on the engine part 20. An actuator recess 26a engages the actuating member 23. A valve stem 21a slidably mounted in a valve stem liner 22 carried in the engine part 20 has a reduced neck indicated at 50, thereby to provide a pair of axially spaced shoulders indicated at 51 and 52, respectively. Adjacent the shoulder 51 is an annular groove 53 seating a retaining bead 54 formed on a dust cover 56 carried by the valve stem 21a.

The end of the rocker arm 24a adjacent the valve stem 21a is particularly characterized by the formation therein

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of a keyhole slot 57 which includes an enlarged generally circular aperture 58 and a somewhat reduced axially extending slot 59 of sufficient width to freely pass the reduced neck 50 of the valve stem 21a. There is thus provided on opposite sides of the valve stem axis indicated at V_a first and second bearing surfaces or areas indicated by the reference numerals 60 and 61, respectively, which are located on opposite sides of the valve axis V_a for co-operative engagement with corresponding axially spaced shoulders 51 and 52.

In assembly, the valve stem 21a passes through the enlarged hole 58 whereupon the rocker arm 24a is then pulled so the reduced portion of the valve stem, as indicated at 50, is trapped in the rocker slot neck or slot 59. The bearing surfaces or areas 60 and 61 then cooperate with the shoulders 51 and 52 so that the valve stem 21a must move up and down in following the movements of the rocker arm 24a.

With the embodiment of Figures 7, 8 and 10, the continuous biasing means taking the form of a spring, as already described in connection with Figures 2 and 3, is employed. Accordingly, like reference numerals have been applied to the corresponding structural features of the spring means illustrated in Figures 7 and 8.

It may be noted in connection with the spring 44 that the free end of the loop 48 and indicated at 62 is bottomed against the engine part 20. In like manner, the free end of the loop 47 as indicated at 63 is likewise bottomed against the engine part 20. The spring 44 is thus operatively interposed between the engine part 20 and the rocker arm 24 or 24a in order to preload the valve towards a closed position.

With the arrangements thus far described, it will be noted that the force to be transmitted is only a fraction of what is normally transmitted through the collar fitted to a valve stem. At no time is the sum of the inertia load and the valve spring load transmitted. During the cycle, only the inertia load of the valve itself has to be handled by the surfaces in contact between the rocker arm and the valve stem, or a portion of the valve spring force. When the valve is seated, the full force of the valve spring has to be transmitted through such surface and the valve stem.

In Figure 11 a modified form of coupling means is shown. The rocker arm is indicated at 66 and includes a generally trough-shaped element having upstanding side wall portions 67. At the valve stem, the rocker arm 66 has enlarged bearing portions indicated at 68 and 69, respectively. The bearing portions 68 and 69 together form a cylindrical inner periphery 70 having clearance with respect to a bearing ring 71 encircling a reduced diameter portion 72 formed on the end of a valve stem 73 supported for reciprocation and rotation by a valve liner 74 carried in the engine part 20. A lower washer member 76 underlies the bearing ring 71 and the bearing portions 68 and 69 and an upper washer member 77 overlies the same parts. The washer member 76 and the lowermost portions of the bearing portions 68 and 69 are formed with confronting curved bearing surfaces as are the upper parts of the bearing portions 68 and 69 and the upper washer 77. Moreover, the bearing portion 68 and the bearing portion 69 are relatively longitudinally or axially offset to provide clearances indicated at 78 and 79, respectively. The coiled loops 47 and 48 are arranged to be appropriately dominant and evasive so that the opening force F_o is directed between the bearing surfaces indicated at 80 between the lower washer 76 and the bearing portion 68 and the closing force F_c is transmitted through the bearing surfaces indicated at 81 between the bearing portion 69 and the upper washer 77. It will be understood that the rocker arm 66 together with the upper and lower washers 76 and 77, the bearing ring 71 and the bearing portions 68 and 69 are retained in stacked assembly by an appropriate fastener 82 connected to the reduced end 72 of the valve stem 73.

The length of the moment arm is measured from the axis of the valve stem V_b to the point of application of the forces at the bearing surfaces 80 and 81 and in Figure 11 the moment arm is indicated at 1.

In the form of the invention illustrated in Figure 12, a spool member 86 is retained on a reduced diameter portion 87 formed on a valve stem 88 by means of a fastener 89. The spool member 86 has a central hub portion 90 and upper and lower flanges, indicated at 91 and 92, each flange 91 and 92 being provided with curved or tapered bearing surfaces which are axially or longitudinally spaced and which face one another.

The rocker arm is indicated generally at 95 and includes upstanding side wall portions 93. A suitable opening 94 is formed in the rocker arm 95 and has clearance with respect to the hub portion 90 of the spool member 86. The thickness of the rocker arm 95 is considerably less than the axial spacing dimension between the flanges 91 and 92. Accordingly, a ring member 96 is carried within the rocker arm 95 between the wall portions 93. The inner diameter of the ring member 96 provides a peripheral surface 97 having a clearance spacing relationship relative to the hub portion 90 of the spool 86 and is of considerably less diameter than the outer diameter of the flanges 91 and 92. The outer diameter of the ring member 96, as indicated at 98, is formed to coincide with the inside dimension of the upstanding wall portions 93 on the rocker arm 95.

The application of an opening force to the valve results in contact between bearing surfaces on the lower flange 91 and the lower wall portions 99 of the rocker arm 95, as indicated by the double arrows F_o , F_o . Upon closing, the closing force is applied between the bearing surfaces provided by the upper curve portion 100 of the ring member 96 and the upper flange 92, as indicated by the double arrows F_c , F_c . It will be noted that the ring member 96 and the lower wall portions 99 of the rocker arm 95 are suitably offset so that the torque moments will be applied unidirectionally. In this connection, it will be noted that the respective lengths of the torque moment arms are indicated in Figure 12 at L_a and L_b .

In the embodiment of Figure 13, the rocker arm is indicated at 101 and includes upstanding side walls 102 on opposite sides of a bottom wall portion 103. The bottom wall is slotted, as in Figure 9, or is key-slotted, as in Figure 10, to provide an opening 104 cooperating with a reduced diameter portion 106 on a valve stem 107. The reduced diameter portion 106 is bounded by a lower shoulder 108 and an axially or longitudinally spaced upper shoulder 109. The bottom wall 103 on opposite sides of the opening 104 is offset to provide a first bearing portion 110 and a second bearing portion 111. Thus, in opening the valve, the forces are applied or transmitted through the engaging bearing surfaces indicated at 112 formed between the shoulder 108 and the bearing portion 110, whereas in closing, the forces are applied or transmitted through the bearing surfaces provided between the bearing portion 111 and the shoulder 109.

In Figures 4, 5 and 6 and in Figures 14-17, the principles of the present invention are illustrated in connection with a double element combination. For example, an inlet valve is indicated at 120 and an outlet valve is indicated at 121 connected to a rocker arm R_i and a rocker arm R_o , in accordance with the structural arrangement already described. A beam member 122 is interposed between the rocker arms R_i and R_o . Only a single coiled spring 123 is provided having its coils at one end seated in a recess 124 formed in an engine part 126. The coils of the spring 123 at the opposite end surround a pilot portion 127 formed on a spring retainer member 128.

The upper surface of the spring retainer member 128 is particularly characterized by the provision of a spherically-shaped recess 129 seating a spherically-shaped ball

member 130 carried in firm assembly with the beam member 122 at an opening indicated at 131.

More specifically, the beam member 122 has a central embossed body portion providing a substantially cylindrical or cup-shaped portion 132 providing a top wall 133 and upstanding side walls 134. The side walls 134 surround the spring 123. At the extremities of the side walls 133, there are provided oppositely extending arms including a first arm 134 and a second arm 136. The upper surface of the arms 134 and 136 is curved as at 137 and 138, respectively, thereby to provide a curved bearing surface for engaging against a substantially flat bearing surface 139 or 140 confronting one of the corresponding curved bearing surfaces 137 and 138.

As will be evident, the tension of the spring 123 tends to keep both of the valves 120 and 121 closed. Each respective valve stem is trapped in the coupling means of a corresponding rocker arm and it will be understood that the motion of the rocker arm is transmitted to the corresponding valve stem in both opening and closing directions.

As the parts are never perfectly in line, each corresponding rocker arm R_i or R_o will turn on its corresponding ball seat, as previously described, until its flank touches the stem of the valve, and it will touch either on the left or the right side, according to the direction of the resultant force. That is to say, it will be touching on the left side or on one side when the valve is opening, and on the right side or on the other side when the valve is closing.

Because each respective rocker arm R_i and R_o is moving on a circle and the valve stem 120 or 121 associated therewith is confined for movement along a straight line, there is a difference or vectorial velocities and there will be a tendency to pull the stem around. The difference of velocities changes sign, however, by changing the side of the valve axis on which the force is applied at the same time the direction of force is changed, unidirectional torque moments are insured so that unidirectional rotation is effected.

Furthermore, by using the single coil spring 123 as a continuous biasing means for both of the inlet and outlet valve parts, it will be appreciated that the difference in opening times between the inlet and outlet valves will result in the biasing force being rendered dominant and evasive through the beam member 122.

Figure 6 illustrates an arrangement similar to Figures 4 and 5, however, in this form of the invention, a single helically wound coil spring is indicated at 140. One end of the spring is bent back, as at 141, to approximately the mid point of the coiled loop. The bent portion 141 is angularly offset as at 142 to provide an arm portion 143 underlying the rocker arm R_o and engaging therewith.

The opposite end of the spring 140 is angularly offset as at 144 to provide an arm portion 146 extending towards the center of the coiled loop. The arm portion 146 is angularly offset as at 147 to provide an arm 148 which underlies the rocker arm R_i . Both of the arms 148 and 143 are in substantially coaxial alignment and both are arranged to effect a loading of the valves 120 and 121 in a common direction.

The respective arm portions 141 and 146 are bent back preferably to the middle of the coiled loop not only with respect to the middle, as determined in longitudinal direction, but also to lie on the plane intersecting the axis of the coiled spring 140. By virtue of such arrangement, the continuous biasing force exerted upon the inlet and outlet valves 120 and 121 is rendered dominant and evasive in accordance with the principles of the present invention.

In the embodiment of Figures 14 and 15, the coil spring is indicated at 150 and includes a wound coil disposed on an axis S_a which is angularly offset with respect to the longitudinal axis of the rocker arm R_i as well as the longitudinal axis of the rocker arm R_o .

As is more clearly illustrated in Figure 15, one end of the coil spring 150 is brought over the top of the spring as at 151 to provide a laterally extending arm portion. The arm portion 151 is wound sufficiently to extend down towards the plane of the spring axis and is then bent upwardly as at 152 to provide a curved bearing surface indicated at 153.

The opposite end of the spring is brought over the top as at 154 of the coil 150 and is coiled sufficiently to extend upwardly towards the plane of the spring axis, the end of the arm 154 being curved as at 156 to provide a bearing surface 157. It will be understood that the bearing surfaces 153 and 157 underlie the respective rocker arms R_1 and R_2 .

Figures 16 and 17 show the engagement between the rocker arms R_1 and R_2 with the arm portions of the respective springs illustrated in connection with the embodiments of Figures 6 and 14. It will be noted that the rocker arm which in Figures 16 and 17 is indicated at R_1 may be indented as at 170 to seat the arm portion A of either of the springs 150 or 140. It will be understood, however, that the actual bearing surface formed on the wire A may be crowned or curved as described in connection with Figure 15 to effect point contact as at the point O in Figure 17.

From the foregoing, it will be noted that the present invention contemplates the utilization of a rocker arm whereby a scrubbing force will be applied to the valve, the scrubbing force being the manifestation of a lateral component of force applied to the valve during the opening and closing movements thereof. The force is rendered alternately dominant and evasive and is applied away from the axis of the valve to obtain unidirectional torque moments for the express purpose of rotating the valve unidirectionally, thereby affording all of the advantages of valve rotation without requiring an expensive separate valve-rotating mechanism.

Although various minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. The method of rotating two axially adjacent parts with respect to an axis of rotation intersecting one of the parts which includes the steps of cyclically loading and unloading the parts with resultant axially directed forces having axial and lateral components, applying the loading force to one of the parts on one side of said axis of rotation, whereby the lateral component will produce a torque moment acting in one direction, and applying the unloading force to said one of the parts on the opposite side of said axis of rotation, whereby the lateral component will produce a torque moment in the same one direction, whereby to rotatably drive the parts with respect to one another.

2. The method of rotating a valve reciprocable on an axis which includes the steps of alternately and cyclically applying forces to said valve during the reciprocation thereof in transverse direction relative to said axis and on opposite sides of said axis to produce unidirectional torque moments for rotatably driving the valve.

3. The method of rotating a valve reciprocable on its axis which includes the steps of cyclically loading and unloading the valve with generally axially directed forces having a lateral component, and applying loading force to said valve on one side of said axis and the unloading force on the opposite side of said axis to produce torque moments acting in the same direction, thereby to rotatably drive the valve during reciprocation thereof.

4. The method of rotating a preloaded part confined for reciprocation and rotation on a given axis of rotation, which includes the steps of loading the part axially with a resultant minimum continuous biasing force exhibit-

ing a lateral component, applying an increasing greater than minimum load to said part on one side of said axis of rotation to produce a first torque moment acting in one direction, applying a decreasing greater than minimum load to said part on the opposite side of said axis of rotation to produce a second torque moment acting in the same one direction, thereby to rotatably drive said preloaded part.

5. In combination, first and second parts, said first part being rotatable and reciprocable relative to said second part on a given axis, load-transmitting means between the parts engaging and loading said first part on one side of said axis, and engaging and unloading said first part on the opposite side of said axis, and means controlling said load-transmitting means to load said first part with a resultant force having a lateral component producing torque moments on said first part in the same direction of rotation to rotatably drive said first part with respect to said second part.

6. In combination, first and second parts, said first part being rotatable and reciprocable relative to said second part on a given axis, bifurcated load-transmitting means between the parts having a loading portion engaging said first part on one side of said axis and having an unloading portion engaging said first part on the opposite side of said axis, and loading means applying to said load-transmitting means a loading force having a lateral component convertible into a torque moment acting in one direction, and applying to said load-transmitting means an unloading force having a lateral component convertible into a torque moment acting in the same one direction, thereby to rotatably drive said first part during the loading and unloading thereof.

7. In combination, first and second parts being rotatable and reciprocable on generally parallel axes, and means engaging and interconnecting said parts and axially mechanically preloading the parts in one direction, said loading means having a first portion engaging one of said parts under increased load and applying a lateral component of force to said one of said parts at a point offset from one side of a corresponding one of said axes, thereby producing a torque moment acting in one direction, and having a second portion engaging said one of said parts under decreasing load and applying a lateral component of force offset on an opposite side of said corresponding one of said axes, thereby producing a torque moment acting in the same one direction and rotatably driving said one part.

8. The method of rotating a stemmed valve which includes the steps of cyclically loading and unloading the valve with axially directed forces having a lateral scrubbing component to alternately open and close the valve, and applying the loading and unloading forces, respectively, to said valve on opposite sides of its axis to produce torque moments acting unidirectionally to rotatably drive the valve.

9. In combination, an engine part, a stemmed valve part carried for reciprocation and rotation on a given axis by said engine part, and load-transmitting means between the parts comprising a pivoted rocker arm having a fulcrum mounted on said engine part, a continuous biasing means between said rocker arm and said engine part preloading said valve in one direction, said continuous biasing means comprising a spring member having a cross bar extending transversely of said rocker arm and engaging said rocker arm on said one side of said fulcrum, said spring member further including a dominant coiled loop on one end of said cross bar and an evasive coiled loop on the other end of said cross bar, means on said rocker arm on one side of said fulcrum to cyclically open and close the valve, thereby cyclically loading and unloading the valve axially, and means between said valve and said rocker arm on the other side of said fulcrum comprising a collar means providing a loading part engageable with said rocker arm on one side

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of the valve axis during loading and providing an unloading point engaged with said rocker arm on the opposite side of said valve axis, thereby producing torque moments acting unidirectionally to rotatably drive said valve.

10. The combination of claim 9, wherein said rocker arm is provided with a bifurcated portion having first and second generally parallel arm portions engaging said collar means on opposite sides of said valve axis.

11. The combination of claim 9 wherein said rocker arm has a slotted portion providing spaced apart first and second bearing portions engaging said collar means on opposite sides of the valve axis.

12. In combination, an engine part, a stemmed valve part carried for reciprocation and rotation on a given axis by said engine part, and load-transmitting means between the parts comprising a pivoted rocker arm having a fulcrum mounted on said engine part, a continuous biasing means between said rocker arm and said engine part preloading said valve in one direction, means on said rocker arm on one side of said fulcrum to cyclically open and close the valve, thereby cyclically loading and unloading the valve axially, said rocker arm having means on the other side of said fulcrum forming spaced bearing areas engaging said valve on opposite sides of the valve axis, said bearing areas being operatively offset axially to be dominant and evasive, respectively, during unloading and loading of said valve, thereby to apply unidirectional torque moments for rotatably driving said valve.

13. In combination, an engine part, a valve part carried for reciprocation and rotation in said engine part on a given axis, said valve part having a cylindrical stem, means on the end of said stem providing axially spaced first and second annular shoulders, and load-transmitting means between the parts comprising a rocker arm, means to cyclically apply force to one end of said rocker arm, said rocker arm having laterally spaced first and second bearing areas on the other end of said rocker arm for engaging corresponding ones of said first and second annular shoulders, and means between an intermediate portion of said rocker arm and said engine part forming a fulcrum confining said rocker arm for pivotal movement, whereby said rocker arm will deliver forces to said valve stem having a lateral component, and means rendering said first and second bearing areas, respectively, dominant and evasive, thereby to utilize said lateral component of force to develop unidirectional torque moments between said valve and said rocker arm to rotatably drive the valve part in the engine part.

14. In the combination of claim 13, said means rendering said first and second bearing areas respectively dominant and evasive comprising an axial offset formed in said rocker arm between said first and second laterally spaced bearing areas.

15. In the combination of claim 13, said means rendering said first and second bearing areas respectively dominant and evasive comprising a spring member having a cross bar extending transversely of said rocker arm and engaging said rocker arm on said other end of said rocker arm, said spring member further including a dominant coiled loop on one end of said cross bar and an evasive coiled loop on the other end of said cross bar.

16. In the combination of claim 13, said means rendering said first and second bearing areas respectively dominant and evasive, comprising a cross bar extending transversely of said rocker arm and engaging said rocker arm at said other end of said rocker arm, said cross bar comprising one end of a coiled spring, the opposite end of said spring being spaced transversely of said rocker arm and being confined to effect a continuous spring-loading of said rocker arm through said cross bar.

17. In the combination of claim 13, said means rendering said first and second bearing areas, respectively, 75

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dominant and evasive comprising a cross bar extending transversely of said rocker arm and engaging said rocker arm at said other end of said rocker arm, said cross bar comprising the common end of a pair of coiled springs on opposite sides of said rocker arm.

18. In the combination of claim 13, said means rendering said first and second bearing areas, respectively, dominant and evasive comprising a cross bar extending transversely of said rocker arm and engaging said rocker arm at said other end of said rocker arm, said cross bar comprising a lever arm extending transversely of said rocker arm and having one end engaging said rocker arm at said other side of said fulcrum, a coil spring seated on said engine part, a spring retainer between said lever arm and said coil spring, said lever arm and said retainer having spherically-shaped bearing surfaces formed therebetween, and means confining the other end of said lever arm.

19. In combination, an engine part, valve means carried for reciprocation and rotation in said engine part, collar means on said valve means providing axially spaced first and second annular shoulders offset from the valve axis, and load-transmitting means between said engine part and said valve means comprising rocker arm means having laterally spaced first and second bearing areas at one end for engaging corresponding ones of said first and second annular shoulders, means between intermediate portions of said rocker arm means and said engine part confining the rocker arm means for pivotal movement about a fulcrum axis, means at the other end of said rocker arm means for cyclically applying loading and unloading forces to said rocker arm means, thereby to, in turn, deliver generally axially directed forces to said valve means but having a lateral component of force, and means rendering said first and second areas, respectively, dominant and evasive to utilize said lateral component of force to develop unidirectional torque moments on the valve means to rotatably drive said valve means.

20. In the combination of claim 19, said valve means comprising a pair of spaced side-by-side valves and said means rendering said first and second areas, respectively, dominant and evasive, comprising spring means preloading both of said rocker arms towards closed position.

21. In the combination of claim 20, said spring means comprising a cross bar forming a lever arm extending transversely of said rocker arm and having one end engaging said rocker arm at said one end of said rocker arm, a coil spring seated on said engine part, a spring retainer between said lever arm and said coil spring, said lever arm and said retainer having spherically-shaped bearing surfaces formed therebetween, and means confining the other end of said lever arm.

22. In the combination of claim 20, said spring means comprising a coiled spring having an end portion forming a cross bar extending transversely of said rocker arm and engaging said rocker arm at said one end of said rocker arm, the opposite end of said spring being spaced transversely of said rocker arm and being confined to effect continuous spring-loading of said rocker arm through said cross bar.

23. In a valve actuator, a pivoted rocker arm having a lever arm portion for engaging a valve stem and applying a generally axially directed force exhibiting a scrubbing component in lateral direction relative to the valve, first and second valve bearing surfaces formed thereon, and spaced on opposite sides of the valve axis, and means rendering said first and second bearing surfaces alternately dominant and evasive, whereby the lateral scrubbing component will be converted into unidirectional torque moments for rotatably driving the valve.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,824,554

February 25, 1958

Achilles C. Sampietro

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the grant, lines 1 to 3, for "Achilles C. Sampietro, of Detroit, Michigan," read -- Achilles C. Sampietro, of Detroit, Michigan, assignor to Thompson Products, Inc., of Cleveland, Ohio, a corporation of Ohio, --; line 12, for "Achilles C. Sampietro, his heirs," read -- Thompson Products, Inc., its successors --; in the heading to the printed specification, line 3, for "Achilles C. Sampietro, Detroit, Mich." read -- Achilles C. Sampietro, Detroit, Mich., assignor to Thompson Products, Inc., Cleveland, Ohio, a corporation of Ohio --.

Signed and sealed this 29th day of April 1958.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

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Commissioner of Patents