

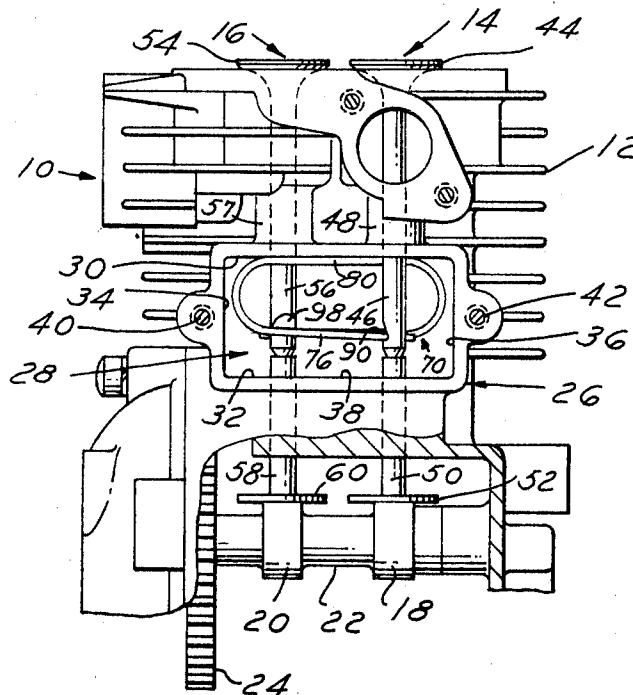
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[45] Patented **Jan. 19, 1971**
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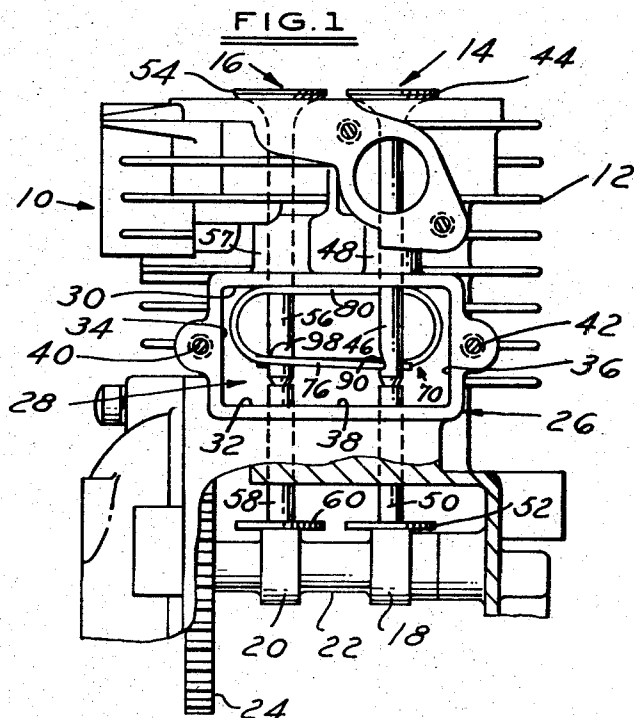
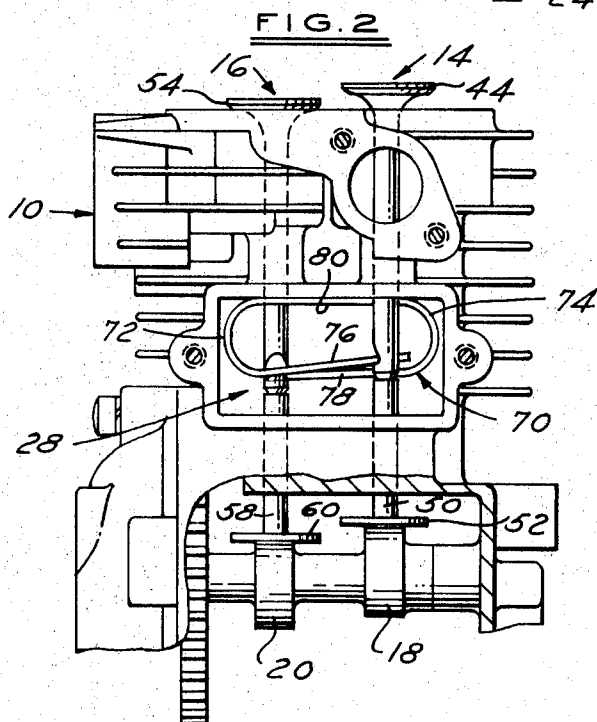
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[54] **VALVE SPRING MECHANISM FOR INTERNAL COMBUSTION ENGINES**
10 Claims, 12 Drawing Figs.
[52] U.S. Cl. 123/90.65,
123/188, 123/191, 123/193, 267/1, 267/57
[51] Int. Cl. F0113/10,
F16f13/00
[50] Field of Search 123/90,
188, 191—L, 193; 267/1, 57

ABSTRACT: A valve mechanism for an internal combustion engine wherein at least one, but preferably both, of the inlet and exhaust valves of the engine are biased into tracking relation with their associated cams by a single split loop or hair-pin-type valve spring.





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FIG. 3

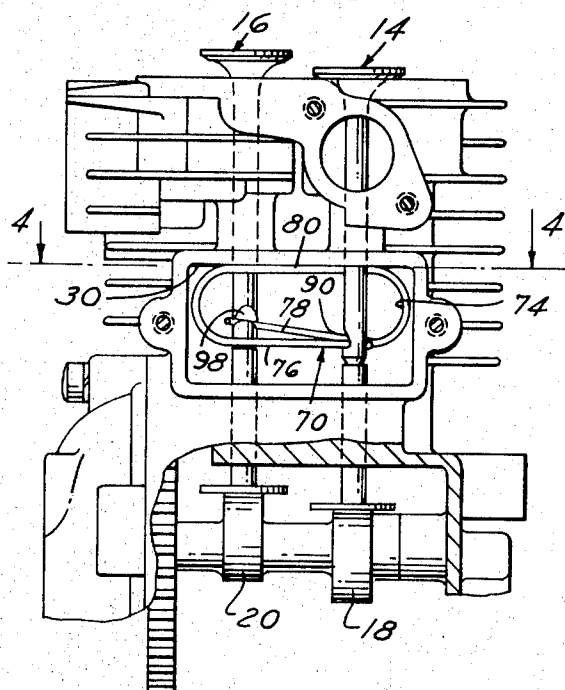


FIG. 6

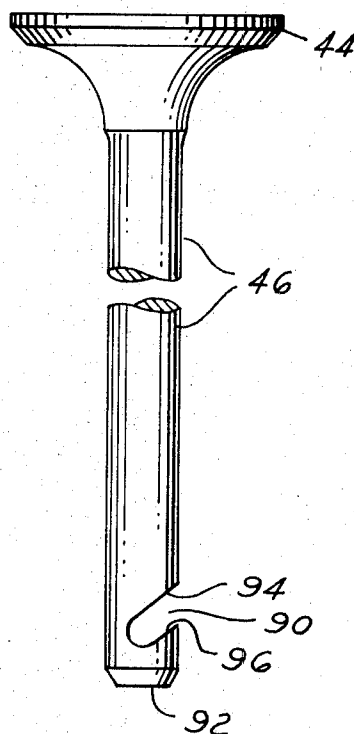


FIG. 4

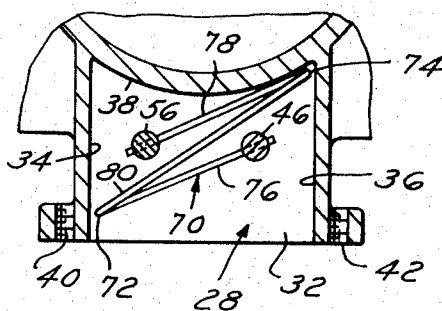
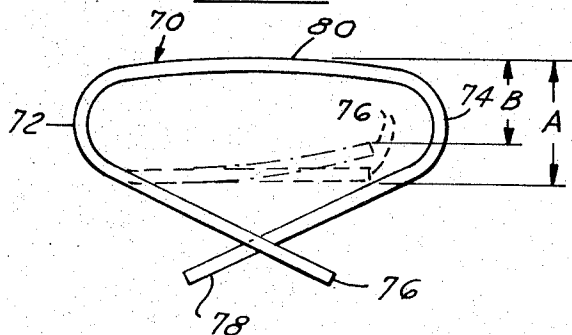


FIG. 5



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FIG. 7

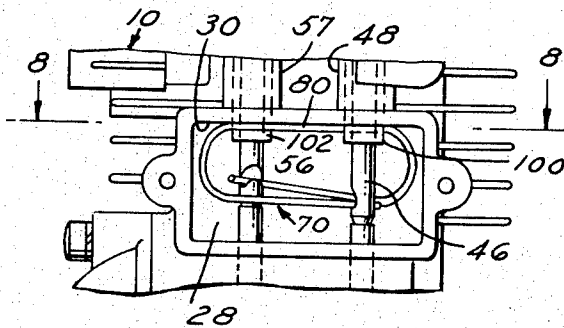


FIG. 8

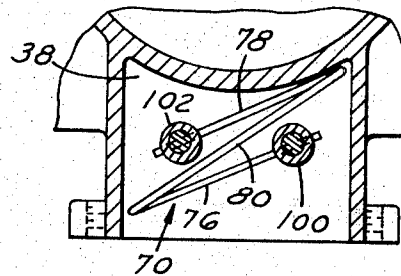


FIG. 9

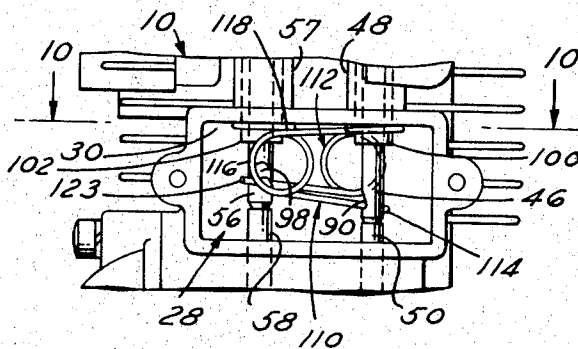


FIG. 10

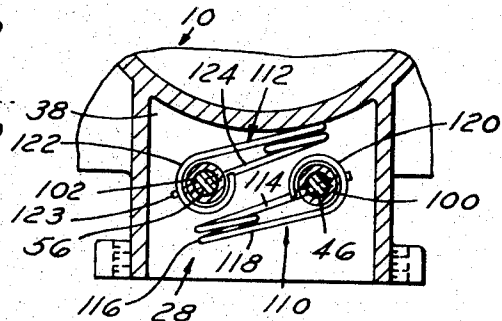


FIG. 11

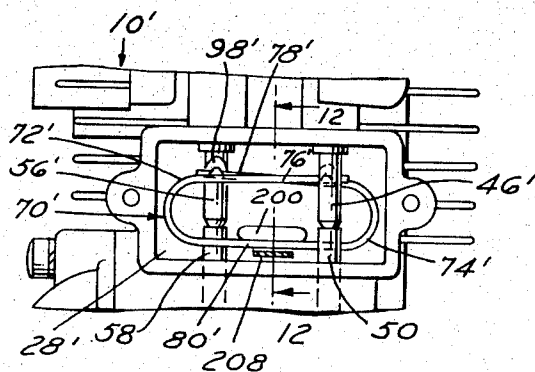
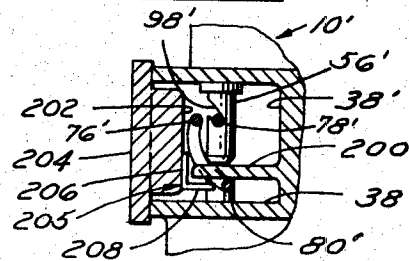


FIG. 12



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VALVE SPRING MECHANISM FOR INTERNAL COMBUSTION ENGINES

An object of the present invention is to provide an improved valve mechanism for an internal combustion engine which utilizes a very simple and economical valve spring for biasing one or both of the inlet and exhaust valves toward closed position and for biasing the lifter of the associated valve train into tracking relation with the associated cam.

Another object is to provide a valve mechanism of the above character which cooperates with the existing valve chamber of an L-head internal combustion engine to provide a mounting arrangement for the valve spring which requires a minimum of parts and labor to assemble the spring in operative position.

Still another object is to provide a single valve spring of the above character adapted to conjointly act on both the inlet valve train and exhaust valve train of the engine, which contains an absolute minimum of material that can be safely stressed to provide the necessary valve closing forces, and which insures better following of the valve train on the valve cam at high engine speeds.

Other objects as well as features and advantages of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a fragmentary side elevational view of a portion of a single cylinder four-stroke cycle internal combustion engine incorporating the valve mechanism of the present invention, the inlet and exhaust valves both being shown in closed position.

FIG. 2 is a view similar to FIG. 1 but illustrating the intake valve in raised, open position and the exhaust valve in lowered, closed position.

FIG. 3 is a view similar to FIGS. 1 and 2 but illustrating the exhaust valve in raised, open position and the inlet valve in lowered, closed position.

FIG. 4 is a fragmentary horizontal sectional view taken on the line 4-4 of FIG. 3.

FIG. 5 is a side elevational view of the improved valve spring of the invention shown by itself in its relaxed, free state condition.

FIG. 6 is a fragmentary side elevational view of an inlet valve of the engine shown by itself.

FIG. 7 is a fragmentary side elevational view of a portion of a single cylinder four-stroke cycle internal combustion engine incorporating a modified valve guide arrangement for the valve spring of FIGS. 1-5.

FIG. 8 is a horizontal sectional view taken on the line 8-8 of FIG. 7.

FIG. 9 is a fragmentary side elevational view of a portion of a single cylinder four-stroke cycle internal combustion engine incorporating a modified dual valve spring mechanism of the present invention.

FIG. 10 is a horizontal sectional view taken on the line 10-10 of FIG. 9.

FIG. 11 is a fragmentary side elevational view of a portion of a single cylinder four-stroke cycle internal combustion engine incorporating a third embodiment of a valve spring mechanism of the present invention.

FIG. 12 is a fragmentary vertical section on the line 12-12 of FIG. 11.

Referring in more detail to the accompanying drawings, FIGS. 1, 2 and 3 illustrate the improved valve mechanism of the invention incorporated in a conventional single cylinder four-stroke cycle internal combustion engine 10 which is only partially shown and is of the air cooled L-head type having a finned cylinder block 12, the usual cylinder head not being shown. The inlet and exhaust ports (not seen) of the engine are respectively controlled by an inlet valve train 14 and an exhaust valve train 16 reciprocatingly driven by an inlet cam 18 and an exhaust cam 20 respectively. These cams are fixed on a camshaft 22 which in turn is rotatably driven at half engine speed by a timing gear 24 which meshes with a gear (not shown) mounted on the crankshaft of the engine.

The side of block 12 has an integrally cast rectangular box 26 which forms a valve chamber 28 identical to that usually provided to house a pair of coil-type valve springs and mounting washers, one for each of the valve trains 14 and 16. As best seen in FIGS. 1 and 4, chamber 28 is defined by a flat, parallel top and bottom walls 30 and 32, parallel sidewalls 34 and 36 and a convex back wall 38 (the outer surface of the cylinder of the engine). Chamber 28 is closed at its outer end by a removable cover plate (not shown) secured by suitable mounting studs received in threaded holes 40 and 42.

The inlet valve train 14 includes a poppet-type inlet valve 44, a cylindrical valve stem 46 integral with valve 44 and slidably guided for reciprocation in a guide portion 48 of block 12, and a valve lifter 50 abutting the lower end of stem 46 and having a flatfooted follower 52 disposed in sliding tracking relation on the periphery of cam 18. Exhaust valve train 16 is substantially identical to train 14 and likewise has a poppet valve 54 integrally joined to the upper end of a valve stem 56 guided for reciprocation in guide 57 which in turn abuttedly contacts the upper end of a valve lifter 58 having a flatfooted follower 60 slidably tracking on cam 20.

Each valve train 14 and 16 also includes means for yieldably biasing the lifter into tracking relation with the associated cam and the valve toward closed position, which biasing means preferably takes the form of a single unitary valve spring 70. Referring to FIG. 5, spring 70 is shown in its relaxed free state condition and consists of a single piece of spring steel wire bent back upon itself at 72 and 74 so that the wire after forming comprises a pair of generally straight arms 76 and 78 which cross over one another near their free ends and which are respectively connected by bends 72 and 74 with an intermediate bight portion 80 extending generally between bends 72 and 74.

For purposes of illustration and not by way of limitation, in one successful embodiment of the present invention, spring 70 was constructed as shown to scale in FIG. 5 from valve spring quality steel wire, oil tempered, containing 0.6-0.7 percent carbon and having a diameter of 0.094 inches. Also, the distance between bends 72 and 74 was 2.44 of bends 72 and 74 was 0.30 inches. Arms 76 and 78 were both 1.75 inches in length and the angle of these arms with a horizontal center line drawn between bends 72 and 74 as viewed in FIG. 5 was about 25°. Thus bends 72 and 74 in forming are bent through an angle about 155°. The perpendicular distance between arms 76 and 78 taken in the plane of the drawing in FIG. 4 in the free state condition of spring 70 was approximately 0.25 inches. The spring-loading characteristics of spring 70 constructed per the foregoing is illustrated in phantom in FIG. 5 wherein arm 76 is shown deflected to its valve closed position by dash lines. The distance between bight 80 and arm 76 at this deflection is indicated by the dimension A and was 0.844 inches, and the applied loading to so compress the spring was 10 pounds, plus or minus 1 pound. Similarly, when arm 76 was further deflected to the valve opened position shown in dash-dot lines in FIG. 5, wherein the distance indicated by dimension B was 0.656 inches, the applied loading to so compress the spring was 17 pounds, plus or minus 1 pound. It is to be understood that the above exemplary specifications for spring 70 apply to a particular single cylinder engine as illustrated to scale in FIGS. 1, 2 and 3 wherein valve and stem part 44-46 measures about 3 inches in length and the stem is about 0.250 inches in diameter.

With the above example in mind, it is believed that the material and configuration of spring 70 of the present invention may be varied by those skilled in the art to suit the requirements of a particular application, considered in the light of the present disclosure.

As shown in FIG. 6, valve stem 46 has a notch 90 formed in the side thereof near the lower end 92 of the valve stem, preferably by a simple grinding operation. Notch 90 is oriented with its flat parallel upper and lower sides 94 and 96 extending upwardly toward valve 44 at an angle of approximately 50° relative to the axis of stem 46. The lower end of

slot 90 is spaced about 0.12 inches from the lower end 92 of stem 46 and the distance between sides 94 and 96 of the notch measured perpendicular thereto is about 0.12 inches. The notch extends at its inner end to within about 0.08 inches of the diametrically opposite surface of stem 46. Stem 56 likewise has a notch 98 formed in an identical manner to notch 90.

One important feature of spring 70 is its structural simplicity and apparent economy of material and manufacture. Another feature is the ease with which spring 70 can be mounted in operative assembled relation with the valve train. After the components of valve trains 14 and 16 have been assembled in the engine as illustrated in FIGS. 1—3, spring 70 may be readily installed by manually inserting the same endwise, end 74 first, into the open valve chamber 28, feeding the spring between stems 46 and 48 and then swerving end 74 to the right as viewed in FIG. 4 until end 74 is disposed in the right-hand rear corner of chamber 28 (FIGS. 3 and 4). The free end of arm 78 is then stressed upwardly and dropped into notch 98, thereby pressing bight 80 of spring 70 against top wall 30 of the spring chamber. The other arm 76 is then likewise deflected upwardly and its free end dropped into notch 90. As best seen in FIG. 4, the free ends of arms 76 and 78 project beyond the respective stems 46 and 48 by a distance about equal to the clearance between ends 74 and 72 of spring 70 so that should endwise movement of spring 70 occur, it is limited by walls 34 and 36 so as to prevent arms 76 and 78 from falling out of the associated stem notches. The valve chamber cover (not shown) may then be secured over the opening of chamber 28 as described previously to complete the entrapment of spring 70 in the valve chamber. The foregoing assembly procedure is preferably performed when valve trains 14 and 16 are both lowered to their port closing position as shown in FIG. 1 to minimize the deflection of the spring arms required during assembly.

In operation, spring 70 will be stressed throughout its entire length by the assembly preloading to exert a constant biasing force on valve trains 14 and 16 which tends to draw valves 44 and 54 downwardly toward their respective seats, and through the associated stems, to push followers 50 and 58 downwardly into tracking relation with the peripheries of the associated cams 18 and 20. The reaction support for the spring merely comprises the top wall 30 of the valve chamber against which bight 80 abuts, the spring being stable in the assembled position due to the spaced relationship, vertically and horizontally, of wall 30 relative to the free ends of arms 76 and 78 riding in the upwardly inclined juxtaposed notches 90 and 98. Thus when the inlet valve train 14 is raised from its FIG. 1 position to its FIG. 2 position to open the inlet port in response to rotation of cam 18, arm 76 will be deflected upwardly to the position shown in FIG. 2. This stresses arm 76 in a manner of a cantilever beam and imparts a bending stress to bend 72 which in turn is exerted as a bending moment on bight 80, causing it to bend downwardly slightly away from wall 30 in the portion thereof near bend 72. However, no significant deflection occurs in the opposite bend 74 or in the other arm 78 as a result of this upward deflection of arm 76. As cam 18 rotates further from the FIG. 2 position toward the FIG. 3 position thereof, spring 70 forces valve train 14 toward closed position as illustrated in FIG. 3.

In accordance with conventional four-stroke cycle engine timing practice, the opening and closing movement of inlet valve train 14 will be followed by a similar cycle of movement of exhaust valve train 16. Exhaust valve train 16 thus will then be lifted by cam 20 against the downward bias exerted thereon by spring 70 through arm 78 of the spring, causing arm 78 to deflect upwardly to the position illustrated in FIG. 3. During this motion arm 78 is likewise stressed in a manner of a cantilever beam, causing arm 78 to exert a bending stress through bend 74 on bight 80 so that the working stress is distributed well back into the spring. Due to the out-of-phase or alternating reciprocation of valve trains 14 and 16 relative to one another during engine operation, spring 70 never sees a "dou-

ble load" nor does the compression of the spring by one valve train affect the biasing force exerted by spring 70 on the other valve train.

From the foregoing description it will now be apparent that the embodiment of the present invention shown in FIGS. 1—6 inclusive provides several advantages over the conventional prior art coil spring arrangements. Only one spring is required to bias both the inlet and exhaust valve trains as compared to the two separate coil springs and associated washer retainers of the prior art. In addition, assembly of the spring may be performed after installation of the valve trains in the engine block, and in a very quick and simple manner as described previously. No special end forming is required on the spring as it merely rides in the ground angular notches 90 and 98 of stems 46 and 56, which represents a twofold saving from a cost standpoint.

From the performance standpoint additional advantages are obtained. With most multiturn engine valve spring arrangements of the prior art, whether they be conventional compression coil springs or multiturn mousetrap-type springs, a certain amount of motion continues to take place in the turns of this spring even during the portion of the valve-engine cycle when the associated valve train or valve trains are at rest. In order to prevent unnecessary stresses from being produced by these random spring motions, many such prior art springs are specially formed to have a nonstandard spacing on one or more of the coils or convolutions of the spring in order to obtain a self-damping effect. However, with spring 70 of the present invention no evidence of any random spring motion has been detected. Thus not only are spring coils obviated but the special forming thereof required by the prior art is also eliminated. The present invention thus provides a spring 70 which contains an absolute minimum amount of material that can be safely stressed to provide the necessary valve closing forces.

It is to be noted that the aforementioned lateral spacing between arms 76 and 78, as best seen in FIG. 4, results in a side clearance between bight 80 of spring 70 and stems 46 and 56. Test results have shown that during engine operation spring 70 tends to center itself between the two valve stems, thereby preventing bight 80 from rubbing against either of the reciprocating valve stems. However, even when spring 70 was deliberately forced during assembly against one or the other of the valve stems 46 and 56, it was found that the spring reoriented itself to a position which caused no damage. For example, in one test after several hundred hours of operation with a deliberately misoriented spring, only a small spot appeared on the spring and a corresponding line appeared on the valve stem, indicating that the contact of these parts was very light and that no significant wear resulted.

It has also been found that a spring 70 constructed according to the specifications described previously for use in a small horsepower, lightweight engine appears to insure better following of the valve train in tracking relation with the associated valve cam at higher engine speeds as compared to conventional coil springs, a feature which is particularly advantageous in small engines designed to operate at unusually high speeds where valve flutter or bounce often is a serious problem.

As shown in FIGS. 7 and 8, the engine may be modified to extend valve guides 48 and 57 downwardly into the chamber so as to provide integral cast bosses 100 and 102 which project axially a short distance below top wall 30 of the chamber 28. Bosses 100 and 102 are thus disposed on opposite sides of the center bight portion 80 of spring 70 and are made somewhat longer axially than the diameter of bight 80 so that they serve as locating bosses for spring 70. Thus should bight 80 of spring 70 tend to wander toward one or the other of the valve pins 46 and 56 during operation of the engine, bight 80 will come against one or the other of the stationary bosses 100 and 102 instead of rubbing against the moving valve stems 46 or 56.

It is to be understood that the present invention also encompasses a single valve train biased by spring 70, in which case one of the spring arms will ride in a notch of the valve stem as

described herein, but the other spring arm need only bear against wall 32 of the valve chamber to help maintain the position of the spring in the valve chamber. Alternatively, the spring arm not engaged with the valve train may be deleted and spring 70 modified by, for example, deleting arm 78 and bend 74, so that a simple U-shaped spring is formed consisting merely of arm 76, bend 72 and bight portion 80. Moreover, if desired in applications requiring higher spring loads, bend portions 72 and/or 74 may consist of one or more convolutions coiled on about the same radius as bends 72 and 74 and disposed to interconnect the adjacent ends of bight 80 with arms 76 and 78.

For example, as shown in FIGS. 9 and 10, the aforementioned variations may be embodied in a pair of hairpin-type springs 110 and 112 which operate individually on valve stems 46 and 56 respectively. Springs 110 and 112 are identical and therefore only spring 110 will be described in detail. Spring 110 has a straight arm portion 114, the free end of which rides in notch 90 of stem 46. Arm 114 is connected by a full turn coil 116 with an upper bight or straight arm portion 118 which extends back above and at a slightly diverging angle relative to arm 114, portion 118 terminating in a 270° loop 120 which encircles three-quarters of the circumference of boss 100 adjacent top wall 30 of chamber 28. Spring 110 is preloaded and deflected during assembly to the mounted position shown in FIGS. 9 and 10 so that loop 120 retains one end of spring 110 while the other end of the spring is retained by notch 90.

Spring 112 is similarly mounted at one end by a three-quarter turn loop 122 encircling boss 102 and by having the free end 123 of its straight arm portion 124 riding in notch 98 of stem 56. Should spring 112 tend to pivot about the axis of stem 56 during operation of the engine, such pivotal movement will be limited by wall 38 of the valve chamber and loop 120 of spring 110 which serve as stops to define the end limits of this pivotal movement. Likewise, similar pivotal movement of spring 110 is limited by loop 122 of spring 112 at one extreme and by the cover (not shown) of the valve chamber 28 at the other extreme.

In operation of the dual spring embodiment of FIGS. 9 and 10 upward movement of stem 46 during engine operation deflects arm 114 upwardly as viewed in FIG. 9, a portion of this deflection also occurring in convolution 116 which in turn contributes to the load applied by spring 110 to stem 46 to bias the associated valve of train 14 towards closed position and the associated follower 50 into tracking relation with its associated cam. Spring 112 operates in like manner but independently of spring 110 relative to exhaust valve train 16. As with the previous single spring 70, the dual springs 110 and 112 are easily assembled and mounted in operative relation with the valve train parts and are protectively housed in the easily accessible valve chamber 28. Also, like spring 70, they utilize notches 90 and 98 in the associated valve stems to mount the spring and rely on preloading during assembly to maintain the spring in operative position.

It is also to be noted that in all embodiments of the invention disclosed herein notches 90 and 98 in the respective valve stems 46 and 56 do not impair the performance of stems since these valve stems are, as is customary, actually made larger in diameter than would be necessary considered only from the standpoint of the strength required to transmit stresses axially of the valve train. This "oversize" diameter of valve stems 46 (and 56) provides enough sliding area between the portion of the valve stem received in the bore of valve guide 48, and also provides sufficient surface area between stem 46 and the bore wall to provide adequate heat transfer area for cooling the valve. Thus by locating notch 90 at the lower end of stem 46 in a portion of the stem where the aforementioned heat transfer and sliding area requirements are of no consequence, the removal of the material from the stem to form the notch does not compromise the aforementioned mass and area requirements of the valve stem.

Also, it is to be noted that the force exerted by the end of spring 70 and spring 70' described hereinafter, and likewise by

the free ends of springs 110 and 112, through their engagement with the associated notches of the valve stems is essentially axial due to the limited divergence of the upper and lower arms of the springs so that the plane of the spring arms is inclined only slightly to the axes of the stems, and also due to the limited deflection of the straight arm portions of the springs. Accordingly, there is little or no wear of the valve stem because side thrust forces exerted by the spring are minimized.

Although springs 70, 110 and 112 as disclosed herein are designed to operate in a manner analogous to a compression spring, it is to be further understood that good results may also be obtained by reversing the position of the spring so that the same operates as a tension spring. For example, in FIGS. 11 and 12 a modified engine 10' is shown similar to engine 10 described previously but which is modified to receive such a modified tension spring 70' of the invention. Chamber 28' of engine 10' has a ledge or abutment 200 which projects outwardly from the back wall 38' of the valve chamber (FIG. 12) and between followers 50 and 58. Ledge 200 terminates outwardly of the followers but short of the inner wall 202 of the removable chamber cover 204 (FIG. 12). Ledge 200 is spaced above floor 38 of the valve chamber by a distance greater than the diameter of the wire of spring 70' to permit the central bight portion 80' of the spring to be slipped under the ledge. Spring 70' is quite similar to spring 70 described previously except that the arms 76' and 78' thereof in the free state condition in the spring are inclined toward the bight portion 80 instead of away from the bight portion. Also, the retaining notches 90' and 98' provided in stems 46' and 56' respectively are reversed compared to notches 90 and 98 in that they open upwardly instead of downwardly. Notches 90' and 98' also are formed slightly higher up on the associated stems 46' and 56' but are still located in the area of the stem which remains within the confines of valve chamber 28' during reciprocation of the valve stems.

During assembly of spring 70', end turn 74' is slipped in behind stem 46' bight portion 80' under ledge 200, and the free ends of arms 76' and 78' are then deflected upwardly and then dropped into notches 90' and 98' respectively, thereby preloading spring 70' in a "tension" mode, i.e., in the opposite sense from the manner in which spring 70 is loaded. Ledge 200 serves to resist the upward pull of this preloading and thus serves as an abutment similar to top wall 80 of chamber 28 relative to bight 80 in the previous embodiment. Although bight portion 80' of spring 70' will tend to remain centered between followers 50 and 58 as in the case of spring 70, bight portion 80' is positively prevented from slipping out from under ledge 200 by an L-shaped right angle bracket 205 (FIG. 12) having a vertical leg 206 fixed to wall 202 of cover 204 and having a horizontal leg 208 which projects under ledge 200. Spring 70' operates in a manner similar to spring 70 except that the stresses are reversed in the spring. Other variations will undoubtedly occur to those skilled in the art in light of the present disclosure without departing from the scope of the invention as defined in the appended claims.

I claim:

1. In an internal combustion engine having first and second valve trains respectively including first and second valve stems and first and second valves connected respectively thereto for controlling the exhaust and intake ports of the engine respectively, cam means for imparting reciprocating opening motion to said valves via the associated valve train, said engine having a valve chamber through which said valve trains pass, and means for biasing said valves closed and said valve trains into tracking relation with said cam means, the improvement wherein said biasing means comprises a wire spring housed in said valve chamber and having a bight portion extending transverse to said direction of reciprocation of said valve train and adjacent said valve stems, a first bent portion extending from one end of said bight portion and curved through an angle of more than 90° with respect to said bight portion, a first arm portion extending from said first bent portion

generally in the direction of said bight portion, each of said stems having a notch therein disposed in said chamber, said first arm portion being received in said notch of said first valve stem at a point spaced from said first bent portion, said spring comprising a second bent portion extending from an opposite end of said bight portion and a second arm portion extending from said second bent portion in the direction of said bight portion, said second arm of said spring being received in said notch of said second valve stem at point spaced from said second bent portion, said arm portions extending oppositely and generally parallel to one another and at an angle to a plane defined by said first and second valve stems, and an abutment in said valve chamber stationarily fixed to said engine and engaging said bight portion of said spring and positioned to maintain said spring stressed in all positions of said valve trains such that said spring urges said valve trains toward said cam means, said bight portion of said spring extending along said abutment of said valve chamber and between said valve stems, said chamber having a pair of sidewalls flanking said valve stems and spaced therefrom, said bent portions being disposed one adjacent each of said sidewalls but with clearances therebetween adapted to limit endwise movement of said spring to that of said clearances, said arms each having a free end projecting from the associated notch by a distance at least about equal to the clearance between its associated bent portion and the sidewall adjacent said associated bent portion.

2. In an internal combustion engine having first and second valve trains respectively including first and second valve stems and first and second valves connected respectively thereto for controlling the exhaust and intake ports of the engine respectively, cam means for imparting reciprocating opening motion to said valves via the associated valve train, said engine having a valve chamber through which said valve trains pass, and means for biasing said valves closed and said valve trains into tracking relation with said cam means, the improvement wherein said biasing means comprises a wire spring housed in said valve chamber and having a bight portion extending transverse to said direction of reciprocation of said valve train and adjacent said valve stems, a first bent portion extending from one end of said bight portion and curved through an angle of more than 90° with respect to said bight portion, a first arm portion extending from said first bent portion generally in the direction of said bight portion, each of said stems having a notch therein disposed in said chamber, said first arm portion being received in said notch of said first valve stem at a point spaced from said first bent portion, said spring comprising a second bent portion extending from an opposite end of said bight portion and a second arm portion extending from said second bent portion in the direction of said bight portion, said second arm of said spring being received in said notch of said second valve stem at point spaced from said second bent portion, said arm portions extending oppositely and generally parallel to one another and at an angle to a plane defined by said first and second valve stems, and an abutment in said valve chamber stationarily fixed to said engine and engaging said bight portion of said spring and positioned to maintain said spring stressed in all positions of said valve trains such that said spring urges said valve trains toward said cam means, said abutment comprising a ledge projecting outwardly between said valve stems in said chamber and spaced from said notches in the direction of force exerted by said spring on said valve trains, said bight portion of said spring extending along and against the side of said ledge disposed remote from said notches, said spring being preloaded in tension and tending to pull said bight portion against said remote side of said ledge, said ledge terminating short of an outwardly facing opening of said valve chamber, said valve chamber having a cover closing said opening and having means thereon projecting inwardly in overlapping relation with said ledge adjacent said remote side thereof to serve as a retaining abutment for said bight portion of said valve spring.

3. In an internal combustion engine having first and second valve trains respectively including first and second valve stems and first and second valves respectively connected thereto for controlling the exhaust and intake ports of the engine respectively, cam means for imparting reciprocating opening motion to said valves via the associated valve train, said engine having a valve chamber through which said valve trains pass, and means for biasing said valves closed and said valve trains into tracking relation with said cam means, the improvement wherein said biasing means comprises a wire spring housed in said valve chamber and having a bight portion extending transverse to said direction of reciprocation of said valve train and adjacent said valve stems, a first bent portion extending from one end of said bight portion and curved through an angle of more than 90° with respect to said bight portion, a first arm portion extending from said first bent portion generally in the direction of said bight portion, each of said stems having a notch therein disposed in said chamber, said first arm portion being received in said notch of said first valve stem at a point spaced from said first bent portion, said spring comprising a second bent portion extending from an opposite end of said bight portion and a second arm portion extending from said second bent portion in the direction of said bight portion, said second arm of said spring being received in said notch of said second valve stem at a point spaced from said bent portion, said arm portions extending oppositely and generally parallel to one another and at an angle to a plane defined by said first and second valve stems, said valve chamber having a top wall engaging said bight portion of said spring and positioned to maintain said spring stressed in all positions of said valve trains such that said spring urges said valve trains toward said cam means, said bight portion of said spring extending along said top wall of said valve chamber and between said valve stems, said notches being disposed for reciprocating travel within a range of movement spaced from said top wall in the direction of said cam means, said valve chamber having first and second bosses projecting from said top wall thereof and respectively encircling said first and second valve stems, said bight portion of said spring extending between said bosses.

4. In an internal combustion engine having a valve train including a stem and a valve connected to said stem and controlling one of the exhaust and intake ports of the engine, a cam for imparting reciprocating opening motion to said valve via said valve train and a spring for biasing said valve closed and said valve train into tracking relation with said cam, said engine having a valve chamber through which said valve train passes, the improvement wherein said spring comprises a hair-pin-type wire spring housed in said valve chamber having a bight portion extending transverse to said direction of reciprocation of said valve train and adjacent said valve train, a bent portion extending from one end of said bight portion and constituting at least one convolution, and a straight arm portion extending from said convolution of said bent portion generally in the direction of said bight portion, said stem having a notch receiving the free end of said arm portion of said spring at a point spaced from said bent portion, said notch being disposed at an angle relative to the axis of said stem and inclined toward said valve, an abutment in said valve chamber stationarily fixed to said engine and engaging said bight portion of said spring and positioned to maintain said spring stressed in all positions of said valve train such that said spring urges said valve train toward said cam, and a boss encircling said valve stem and said bight portion having an end turn wrapped at least partially around said boss.

5. In an internal combustion engine having a valve train including a stem and a valve connected to said stem for controlling one of the exhaust and intake ports of the engine, a cam for imparting reciprocating opening motion to said valve via said valve train and a spring for biasing said valve closed and said valve train into tracking relation with said cam, said engine having a valve spring chamber through which said valve train passes, said spring being housed in said chamber,

the improvement wherein said spring comprises a wire spring having a bight portion extending transverse to the direction of reciprocation of said valve train and adjacent said valve train, a bent portion extending from one end of said bight portion and curved through an angle of more than 90° with respect to said bight portion and a generally straight arm portion extending from said bent portion generally in the direction of said bight portion to a free end of said arm portion, said stem having a notch disposed at angle relative to the axis of said stem and inclined toward said valve, said arm portion of said spring resting in said notch and extending transversely through said stem with said free end of said arm portion protruding from said stem, said notch being open at one end and at the opposite sides thereof whereby said arm may be inserted sideways into said notch via said open end thereof, and an abutment in said chamber stationarily fixed to said engine and engaging said bight portion of said spring and positioned to maintain said spring stressed in all positions of said valve train such that said spring urges valve train toward said cam.

6. In an internal combustion engine having first and second valve trains respectively including first and second valves and first and second stems connected respectively thereto for controlling the exhaust and intake ports of the engine respectively, cam means for imparting reciprocating opening motion to said valves via the associated valve train, said engine having a valve spring chamber through which said valve trains pass with said stems extending side by side in said chamber and each having spring mounting means in said chamber, and spring means for biasing said valves closed and said valve trains into tracking relation with said cam means, said spring means being of the hairpin wire type housed in said chamber, said spring means including bight means extending transverse to the direction of reciprocation of said valve train and adjacent said valve stems, a first bent portion extending from one end of said bight means and curved through an angle of more than 90° with respect to said bight means, a first arm portion extending from said first bent portion generally in the direction of said bight means and being connected to said spring mounting means of said first valve stem at a point spaced from said first bent portion, said second bent portion extending from an opposite end of said bight means and a second arm portion extending from said second bent portion in the direction of said bight means, said second arm of said spring being connected to said spring mounting means of said second valve stem at point spaced from said second bent portion, said arm portions extending oppositely and generally parallel to one another and at an angle to a plane defined by said first and second valve stems, and an abutment in said chamber stationarily fixed to said engine and engaging said bight means of said spring and positioned to maintain said spring means stressed in all positions of said valve trains such that said spring means urges said valve trains toward said cam means, said bight means of said spring extending along said abutment of said valve chamber and between said valve stems.

7. The combination set forth in claim 6 wherein said spring

means comprises a unitary wire spring and said first and second bent portions are each curved through an angle of only about 180° in the operative condition of said spring.

8. The combination set forth in claim 7 wherein said abutment comprises a wall of said chamber extending transverse to the direction of reciprocating travel of said valve trains and said chamber has a side access opening with a removable cover thereover disposed generally parallel to said plane of said valve stems.

9. In an L-head internal combustion engine having first and second valve trains respectively including first and second valve stems and first and second valves connected respectively thereto for controlling the exhaust and intake ports of the engine respectively, cam means for imparting reciprocating opening motion to said valve trains and means for biasing said valves closed and said valve trains into tracking relation with said cam means, said valve trains passing in side-by-side relation through a valve spring chamber located on the side of the cylinder block of said engine, said chamber having a side opening closed by a removable cover providing side access to a notched portion of each of said valve stems disposed in said chamber, the improvement wherein said biasing means comprises a spring wire means disposed in said valve chamber having a first bight portion extending transverse to said direction of reciprocation of said valve trains and adjacent said valve trains, a first bent portion extending from one end of said bight portion and curved through an angle of more than 90° with respect to said bight portion, a first arm portion extending from said bent portion generally in the direction of said bight portion and having a free end resting in said notched portion of said first valve stem at a point spaced from said bent portion, said spring means further comprising second bight, bent and arm portions corresponding to said first bight, bent and arm portions, said second arm portion having a free end resting in said notched portion of said second valve stem, said first and second arm portions extending oppositely and generally parallel to one another and at an angle to a plane defined by said first and second valve stems, said first and second bight portions extending toward one another between said valve stems, and an abutment in said valve chamber stationarily fixed to said engine and engaging said bight portions of said spring means and positioned to maintain said spring means stressed in all positions of said valve trains such that said spring means urges said valve trains toward said cam means whereby said spring means are mountable in said chamber when the cover is removed therefrom by laterally inserting said spring means between said stems and inserting said arm portions sideways in said notched portions while said valve trains are in final assembled position in said engine and extend through said valve chamber parallel to said side opening.

10. The combination set forth in claim 9 wherein said first and second springs are integrally connected by said bight portions thereof whereby said biasing means for both valve trains consists of a unitary wire spring.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,556,062 Dated January 19, 1971

Inventor(s) Edward J. Shermeister

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 40, after "2.44" insert —inches
and the inside radius—

Column 9, line 19, after "urges" insert —said—

Column 10, line 27, after "90°" insert —with—

Signed and sealed this 13th day of July 1971.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents