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May

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[54] **ROTARY DEVICE FOR ELEMENTS SUBJECTED TO AXIAL MOVEMENT, PARTICULARLY FOR VALVES IN INTERNAL COMBUSTION ENGINES**

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[21] Appl. No.: **87,300**

[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **123/90.3**
[51] **Int. Cl.** **F16k 31/00**, F01l 3/10
[58] **Field of Search** ....123/90.3, 90 C

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[57] **ABSTRACT**

Valve rotators for spring loaded engine poppet valves or the like operate during decreasing spring loads on the valve closing cycle to effect valve rotation when the valve head is on or closely adjacent the valve seat. The rotator has a valve spring loaded cover, a valve cap with circumferential inclined grooves each receiving a spring urged rolling member and an axially deflectable energy accumulating spring means between the cap and cover engaged by the rolling members. During the valve opening cycle, the spring means is loaded by the cover, and the rolling members are moved to the shallow ends of the inclined grooves unloading the springs acting thereagainst. During the valve closing cycle, the valve spring load on the cover is decreased and the loaded energy accumulating spring means is released, forcing the rolling elements into the deeper ends of the grooves and effecting rotation between the valve cap and cover to rotate the valve.

10 Claims, 15 Drawing Figures

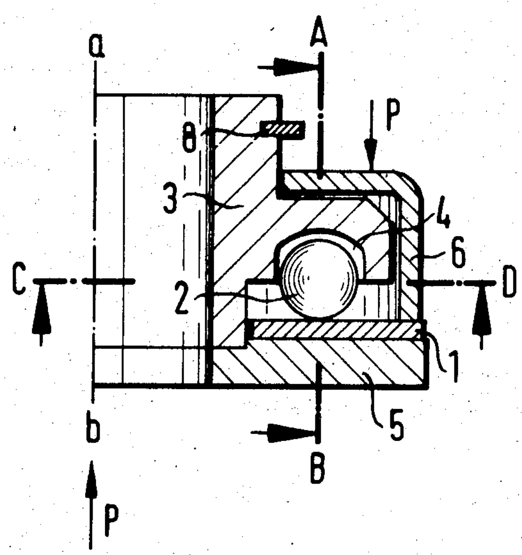

Fig. 1

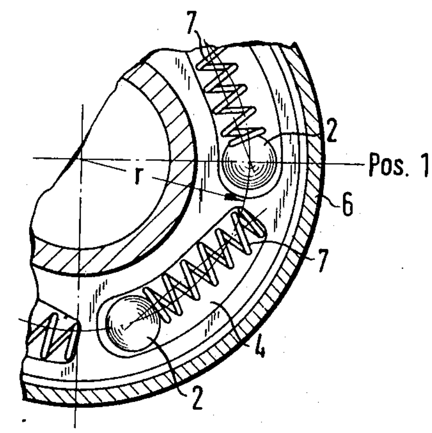

Fig. 1b
C–D

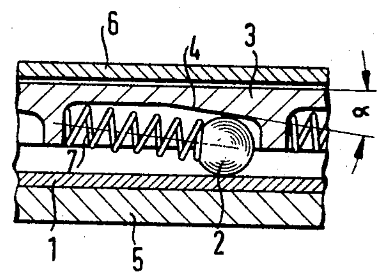

Fig. 1c
A–B

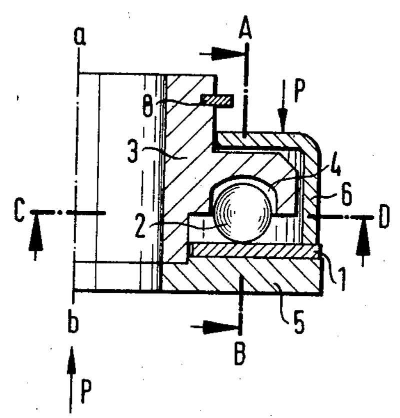

Fig. 1a

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Fig. 2

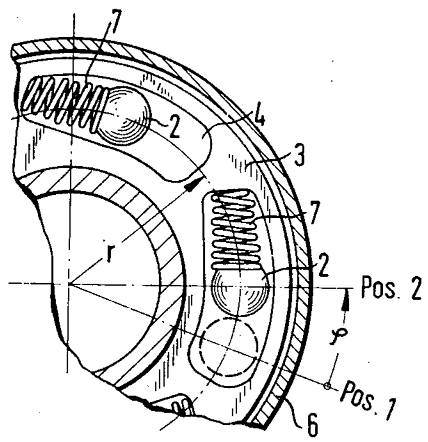
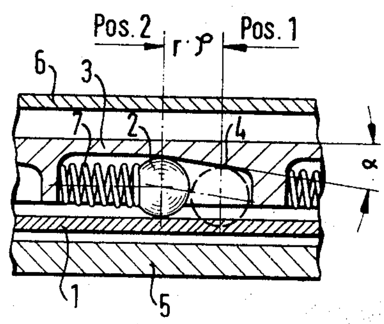


Fig. 2b
G–H

Fig. 2c
E–F



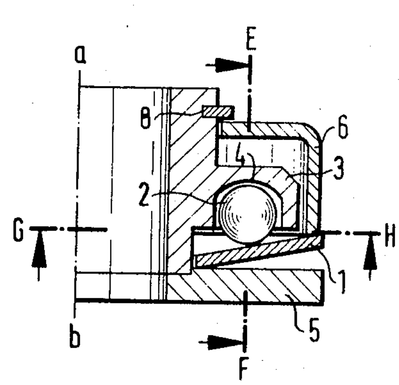


Fig. 2a

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Fig. 3

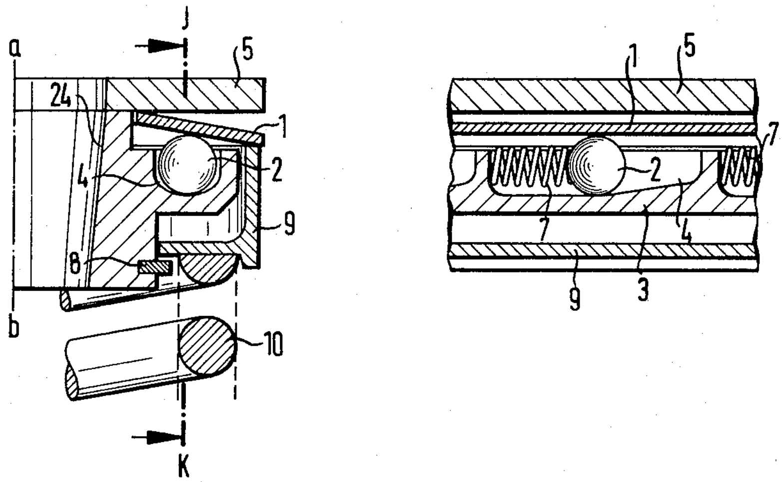

Fig. 4

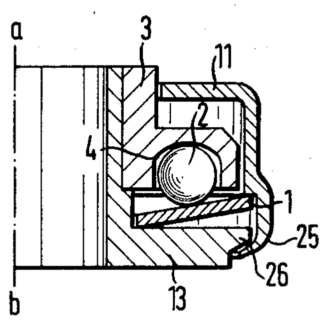

Fig. 5

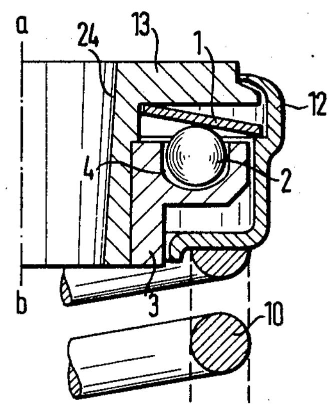

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Fig. 6

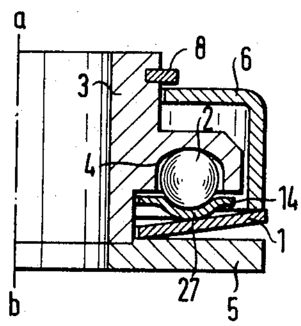


Fig. 7

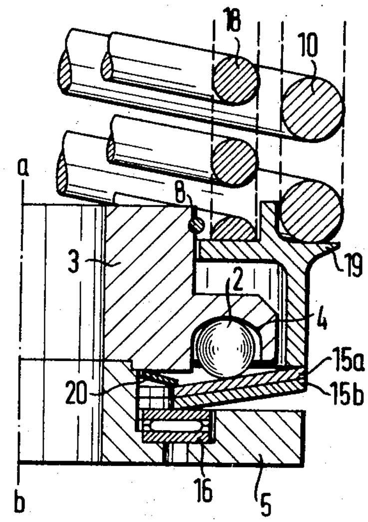


Fig. 8

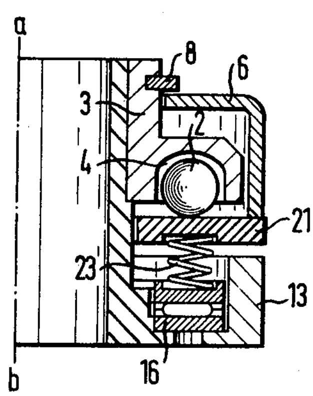
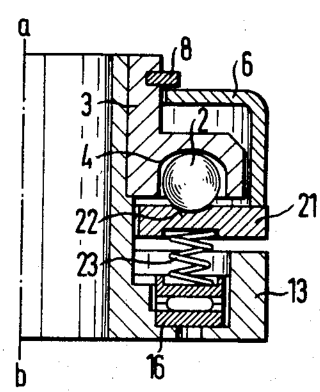


Fig. 9



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ROTARY DEVICE FOR ELEMENTS SUBJECTED TO AXIAL MOVEMENT, PARTICULARLY FOR VALVES IN INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to devices for rotating valves or similar elements with axial movement.

2. Prior Art

It is old in the art to use devices for rotating valves of internal combustion engines such as gasoline and diesel engines. Such devices normally utilize the increased valve spring load which acts axially during lifting of the valve to produce the rotation. With such devices, the valve rotates for a given circumferential degree during the lifting period, but no rotation is provided during the closing period in order to avoid wear at the valve seat. In diesel engines, running with low-grade fuel, however, it is advantageous to rotate the valves during the closing period when they are touching the valve seats in order to remove glazing deposits. This is not possible with valve rotaters constructed according to the prior art, which are operated by the valve spring load.

SUMMARY OF THE INVENTION

It is therefore a principle object of this invention to provide a valve rotating device which restricts, by its special design, the formation of deposits on valves, especially with diesel engines running with low-grade fuels.

The solution is accomplished by means effecting rotation during the closing period of the valves, by the valve spring load.

For this purpose, a spring element which is deformable in its axial direction is flattened by the valve spring force during its lifting period. In this manner, rolling or sliding elements, running in grooves of the retainer cap, are caused to roll into the shallow ends of the grooves by the influence of tangentially arranged springs. Thereafter, during the closing period of the valve spring, the spring element releases, activating a force on the rolling or sliding elements, moving those elements to the deeper ends of the grooves. Thereby the spring element moves in relation to the rolling or sliding planes. The inclined races are arranged circumferentially and concentric to an axis so that the movement of the spring element leads to a rotation around the axis.

The devices of this invention can be positioned between the valve spring and the engine body to rotate the valve spring which in turn rotates the valve, or can be positioned between the valve spring and the valve stem where it will directly rotate the valve. In the first embodiment, the valve spring is compressed between a cover of the device and a separate retainer cap locked to the valve stem. In the second embodiment, the valve spring is compressed between the engine body and the cover of the device which has its retainer cap locked to the valve stem. The spring means of the device is loaded when the valve spring load on the cover of the device increases during the valve opening cycle, thereby relieving load on the rolling or sliding elements so that the tangential springs may urge these elements into the shallow ends of the grooves in the retainer cap. Then during the valve closing cycle, the valve spring load on the cover of the device is relieved, the spring means of the device exerts an axial load on the rolling or sliding elements causing them to move into the deeper ends of the grooves, and this movement rotates either the cover or the retainer cap to effect rotation of the valve during the valve closing cycle.

The inclination of the grooves must be of sufficient degree so that all the forces preventing rotation can be overcome by circumferential forces, generated by the spring element from the axial forces.

The spring element, preferably a coned spring washer such as a Belleville spring, is an accumulator for the energy consumed by the rotative movement, in contrast to its function in conventional valve rotators where it is used as a transformer of forces. The member introducing the force is not necessarily a valve spring, but may be a rigid member movable in an axial direction which, just as the valve spring, additionally takes the function of an element transmitting the rotation of the non-rotatable support.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the invention will be readily apparent from the following description of certain preferred embodiments thereof, taken in conjunction with the accompanying drawings, although variations and modifications may be effected without departing from the spirit and scope of the novel concepts of the disclosure, and in which:

FIG. 1 illustrates a preferred embodiment of the valve rotator when subjected to an upward force with FIG. 1*a* being a fragmentary cross-sectional view of the rotator taken along the indicated line of FIG. 1*b*, which is a fragmentary plan cross-sectional view of the rotator, and FIG. 1*c* is a fragmentary cross-sectional view taken along the line A–B of FIG. 1*a*;

FIG. 2 illustrates the device of FIG. 1 when subjected to circumferential rotation from the position of FIG. 1;

FIG. 2*a* being a view similar to FIG. 1*a*, illustrating the rotated elements of the rotator in angular displaced position from FIG. 1;

FIG. 2*b* is a view similar to FIG. 1*b*, illustrating the rotational movement;

FIG. 2*c* is a view similar to FIG. 1*c*, illustrating the movement of the roller element in the inclined groove;

FIG. 3 illustrates a modified form of the invention of FIGS. 1 and 2 in views similar to 2*a* and 2*c*;

FIG. 4 illustrates yet another embodiment of the rotator of this invention;

FIG. 5 is a view similar to FIG. 4 and FIG. 1*a*, illustrating yet another embodiment of this invention;

FIG. 6 is a view similar to FIG. 1*a*, illustrating a modified form of this invention with a ball race interposed between rolling elements and the spring element;

FIG. 7 is a view similar to FIG. 1*a* illustrating yet another modified form of this invention;

FIG. 8 is a view similar to FIG. 1*a* illustrating a spring-urged modified form of this invention;

FIG. 9 is a view similar to FIG. 8, illustrating the use of a raceway in the spring-urged disk.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows the rotator with the valve in fully-opened position with spring element 1 under tension, and the rolling elements are shown in the utmost position before rotation starts. The grooves **4**, inclined under angle ζ, machined in the retainer cap **3**, are shown as a sectional view in FIG. **1***a*, as a plan view in FIG. **1***b*, and as a tangential unrolling in pitch-line with radius *r* in FIG. **1***c*. The spring element **1** is supported at the base plate **5** which is fixed to the retainer cap **3** and axially loaded by cover **6**. The tangential springs **7** having pushed balls **2** into the minimal attainable depth of the inclined grooves **4** so said balls **2** come into contact with spring element **1** and with grooves **4**.

If the concentric axial force P applied by the valve spring is reduced or completely removed during the closing period of the valve, the spring element **1**, being under tensional forces, introduces forces on balls **2**, which according to these forces and according to components of forces in peripheral direction, roll in grooves **4** and transfer their rolling action onto spring element **1**, which makes twice the travel of balls **2** and rotates around axis *a–b* of retainer cap **3**. Using sliding elements instead of rolling elements, spring element **1** will just have the same travel as the sliding elements.

FIG. **2** shows the position when rotation has ended. Balls **2** are situated in the maximal attainable depth of grooves **4**. They have been rolled from position **1** in FIG. **1***b* to position **2** in FIG. **2***b*, thereby making rotation covering the angle ζ, on the rolling radius *r* or as shown in FIG. **2***c* a rolling distance $r \cdot \zeta$, so that spring element **1** theoretically has been rotated for 2ζ and covered the rolling distance $2\zeta r$.

If no axial force acts any longer on the cover **6**, this cover is supported by the safety ring **8**, and balls **2** come in contact with grooves **4** and with spring element **1** in proportion to the tangential spring forces. This position is also obtainable if cover **6** is still axially loaded so that spring element **1** has to exert a corresponding counterforce action.

FIG. **3** shows a version of rotator installed at tip-end of valve. Bore of retainer cap **3** is a taper **24** to fit the retainer locks. Retainer cap **3** rotates against spring element **1** which is in contact with cover **9**. Said cover **9** forms the support for valve spring **10** and is fixed against rotation by said valve spring **10**.

FIG. **4** shows a device similar to FIG. **1** and FIG. **2** whereby a beaded flange **25** of cover **11** around a shoulder **26** of part **13** replaces safety or retainer ring **8**.

FIG. **5** shows a version which combines elements of FIG. **3** and FIG. **4**. The beaded cover **12** acts also as a support for valve spring **10**. Base plate **5**, FIG. **1** and FIG. **2**, is replaced by the flange of part **13** having a taper **24** to fit the retainer locks.

FIG. **6** shows a ball race **14** between rolling elements **2** and spring element **1**, said ball race **14** reducing the contact pressure at spring element **1** as said spring element **1** now supports on a bulge **27** with linear contact.

FIG. **7** shows a design especially suitable if a high torque of the rotator is required. Two spring washers **15a** and **15b** act as one spring element, said spring washers loading the base plate **5** indirect over anti-friction bearing **16**. The loads for the spring washers **15***a* and **15***b* are applied by one or a plurality of valve springs **10** and **18** and cover **19** acting as a spring support. The friction between baseplate **5** and spring element **1** being reduced by the antifriction bearing **16** makes it sometimes necessary to install an additional brake disk **20** between spring element **1** and retainer cap **3**, to prevent uncontrolled rotation of the spring element **1** against retainer cap **3** in the loading period.

FIG. **8** shows said spring element **1** consisting of a disk **21** into which a raceway **22** might be machined (See FIG. **9**), said disk **21** supported by an antifriction bearing **16** and coil springs **23** or any other elastical members. The overall height of part **13** is so dimensioned as to limit the axial movement of disk **21** to a predetermined size.

Although the teachings of my invention have herein been discussed with reference to specific theories and embodiments, it is to be understood that these are by way of illustration only and that others may wish to utilize my invention in different designs or applications.

I claim as my invention:

1. A rotator adapted for rotating spring loaded engine poppet valves during the valve closing cycle which comprises a cap having circumferential grooves with inclined bottoms, rolling elements received in said grooves, springs urging the rolling elements toward the shallow ends of the grooves, a base plate on the cap, a cover adapted to be loaded by the valve spring, a spring means between the base plate of the cap and the cover loaded in the direction of the valve axis during the valve opening cycle, said rolling elements engageable with said spring means and urged by the springs acting thereagainst into the shallow ends of the grooves when the spring means is loaded during the valve opening cycle and said rolling elements being subject to increased load when the load on the spring means is decreased during the valve closing cycle thereby effecting relative rotation between the cap and the cover.

2. The rotator of claim 1 wherein the the base plate is fixed to the cap, the spring means rests on the base plate, the spring means rotates relative to the cap and the cover is rotated by the spring means to rotate the valve spring and valve.

3. The rotator of claim 1 wherein the spring means rotates the cap and the cap is locked on the valve stem to transfer rotation to the valve stem.

4. The rotator of claim 2 including anti-friction means between the spring means and the base plate.

5. The rotator of claim 1 including a flange on a sleeve connected to the retainer cap.

6. The rotator of claim 1 wherein the spring means is a Belleville washer.

7. The rotator of claim 1 wherein the spring means is a flat disc having a plurality of coil springs acting thereagainst.

8. The rotator of claim 7 wherein an anti-friction bearing is provided between the coil springs and the base plate.

9. The rotator of claim 1 wherein a conical washer is placed between the spring means and the retainer cap.

10. A rotator for rotating a spring loaded engine poppet valve during the valve closing cycle which comprises a first part to be loaded by the valve spring, a second part axially shiftable relative to the first part, an energy accumulator spring means urging the first and second parts into axially extended relationship and biased during the valve opening cycle, said second part having axially inclined circumferential grooves, rolling elements seated in said grooves, spring means urging the rolling elements into the shallow ends of the grooves during the valve opening cycle, and said rolling

elements being driven circumferentially by release of energy from the energy accumulator spring means during the valve closing cycle to effect relative rotation of the first and second parts.

* * * * *