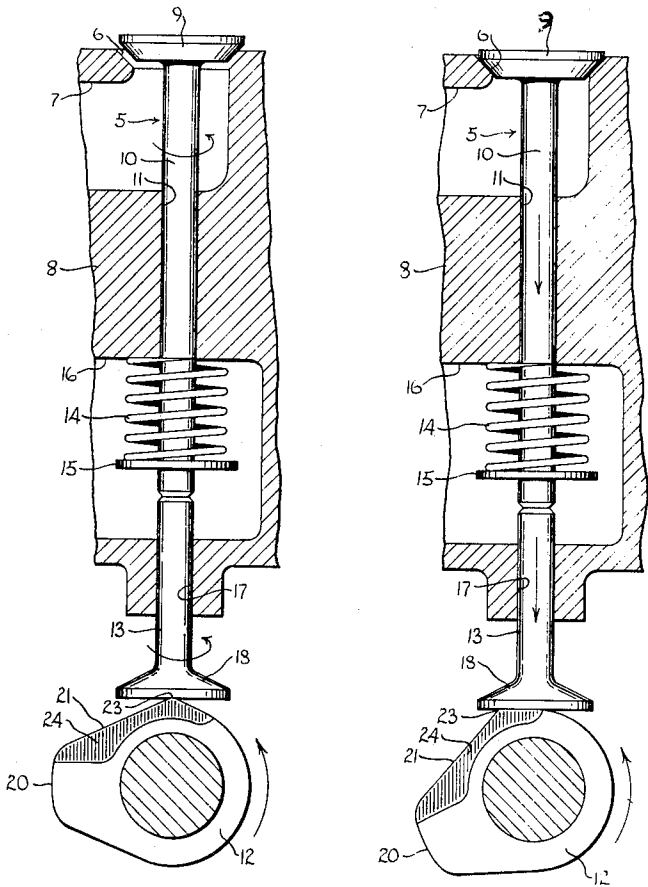


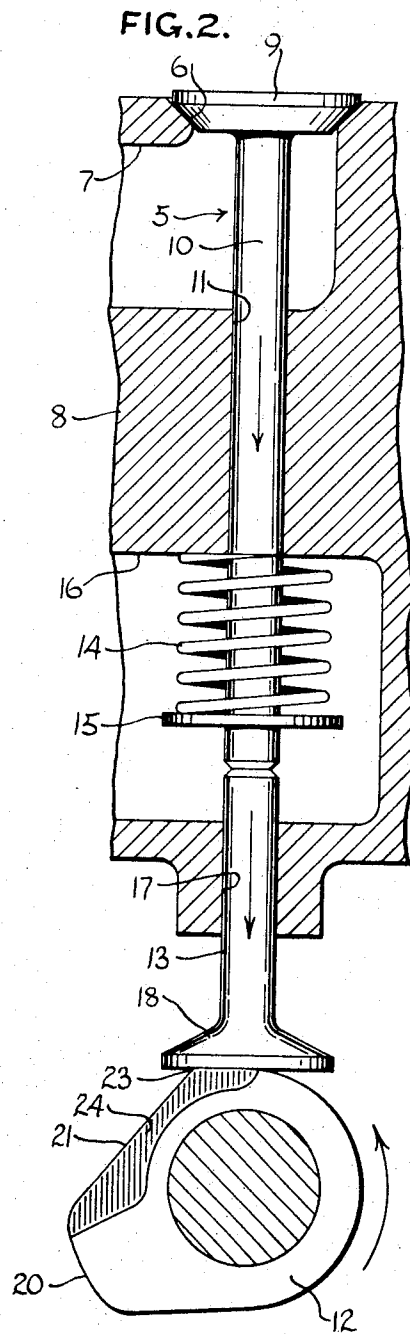
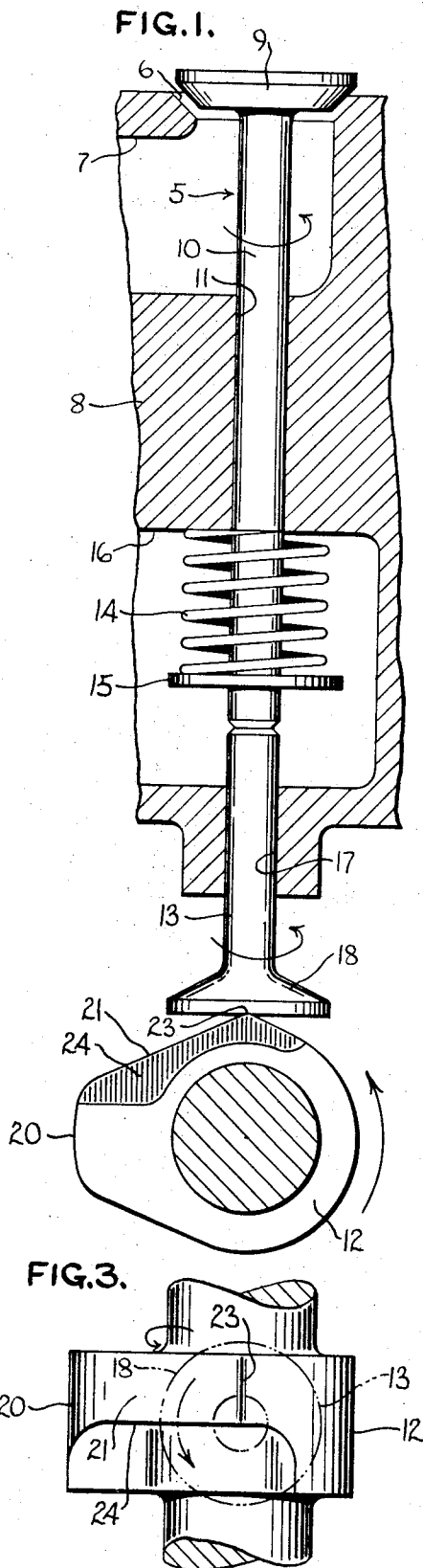
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[54]	GASOLINE ENGINE EXHAUST VALVE ROTATOR		
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		F16K 29/00, F01L 1/08	
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ABSTRACT: The cam for the exhaust valve has a small lobe that momentarily interrupts closing motion of the valve just before it seats, so that the valve slips rotationally relative to its spring under rotational inertia built up during the preceding part of closing motion and induced by rotation of the moving end of the spring. The profiled cam surface is recessed in the neighborhood of said lobe to engage the tappet only at one side of its axis and thus encourage rotation.





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GASOLINE ENGINE EXHAUST VALVE ROTATOR

This invention relates to valves for reciprocating internal combustion engines, and more particularly to means for effecting partial rotation of such valves at each actuation thereof.

It has been known for a long time that it is desirable to provide some means for rotating the poppet valves, and particularly the exhaust valves, of a four-cycle gasoline engine as the engine runs. If an exhaust valve is turned through a small fraction of a revolution each time it is opened and closed, both the valve and its seat will stay cleaner and will wear more evenly than if the valve is nonrotating; and consequently an engine with rotating exhaust valves will run more dependably and for substantially longer periods between valve overhauls.

A number of expedients for effecting the desired rotation of gasoline engine exhaust valves have heretofore been proposed. But despite general recognition of the need for an exhaust valve rotator, and a substantial amount of effort devoted to attempts to satisfy this demand, none of these prior rotators has enjoyed any marked degree of commercial success. The vast majority of gasoline engines now available have exhaust valves which maintain a fixed rotational position at every closing.

One valid basis for rejecting many prior valve rotators is their complexity, which not only increases the cost of the engine but tends to increase the cost and frequency of maintenance. By its very nature a complex mechanism tends to be troublesome, and little is gained if the service life of valves is increased at the expense of frequent repairs to the rotator mechanism. Most of the prior devices have been complex; all have been relatively expensive; and some have interfered with normal operation of the engine, particularly in that they involved a distortion of the valve seating springs.

By contrast, the present invention has for its object to provide a valve rotating expedient that is perhaps the ultimate in simplicity and low cost, entailing no parts that are not normally present in a reciprocating internal combustion engine having nonrotating valves, and involving no sacrifice of normal operating characteristics of the engine.

Another object of this invention is to provide a valve rotating expedient that effects rotation of the exhaust valves at a very desirable rate.

Previous valve rotators tended to rotate the valve more rapidly than was desired. Typically the valve was rotated at 30 to 40 r.p.m. when the engine was operating at a standard speed of 3,600 r.p.m., whereas the most desirable speed of valve rotation is on the order of 1 to 5 r.p.m. It has been found that with the expedient of the present invention the speed of valve rotation is on the order of 4 r.p.m., which is nicely within the desired range.

Another object of this invention is to provide an exhaust valve rotator of such extreme simplicity, low cost and compactness as to be particularly suitable for small single-cylinder engines of the type used for powering lawnmowers and the like.

More specifically, it is an important object of this invention to achieve the desired rotation of the exhaust valve in an engine of the character described by means of nothing more than a very simple and inexpensive modification of the conventional cam that comprises the actuating mechanism for the valve.

With these observations and objects in mind, the manner in which the invention achieves its purpose will be appreciated from the following description and the accompanying drawing. This disclosure is intended merely to exemplify the invention. The invention is not limited to the particular structure or method disclosed, and changes can be made therein which lie within the scope of the appended claims without departing from the invention.

The drawings illustrate one complete example of the physical embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

FIG. 1 is a sectional view through the cylinder body of an internal combustion engine showing an exhaust valve and its actuating mechanism embodying the principles of this invention, the valve being shown in the stage of its motion toward its seat at which its rotation takes place;

FIG. 2 is a view generally similar to FIG. 1 but showing the valve in the last stage of its closing motion, immediately after its rotation; and

FIG. 3 is a fragmentary plan view of a cam embodying the valve rotating expedient of this invention.

Referring now to the accompanying drawing, the numeral 5 designates generally a poppet valve of a four-stroke cycle internal combustion engine, which controls flow of gases through a valve seat 6 that forms the mouth of a gas passage 7 in the body 8 of the engine. The valve 5 can be either the inlet valve or the exhaust valve, but for purposes of specific illustration it will be herein considered and described as the exhaust valve, inasmuch as the exhaust valve is the one that particularly needs to be rotated.

As is conventional, the valve 5 is mushroom shaped, having an enlarged head 9 that cooperates with the valve seat 6 and an elongated coaxial stem 10 that is slidable in a valve guide 11 in the engine body. As is also conventional, the valve is actuated in its opening and closing motion, in timed relation to the engine cycle, by means of an actuating mechanism comprising a rotatable cam 12, a tappet 13 which is normally engaged with both the cam and the valve, and a helical expansion spring 14 that surrounds the valve stem 10 and reacts between a fixed part of the engine body and a keeper 15 on the stem. The valve spring 14 and the keeper 15 are housed in a spring chamber 16 in the engine body 8, and one wall of said chamber receives the reaction of the stationary end of the spring. The bores of the valve guide 11 and of a coaxial tappet guide 17 open to opposite sides of the spring chamber 16, and said bores are of course coaxial with the valve seat 6.

The spring 14 at all times urges the valve in the direction to carry its head 9 towards the seat 6, i.e., towards the valve closed position; while the cam 12, acting through the tappet 13, serves to move the valve in its opening direction against the bias of the spring. At all times that the valve is not fully seated, the biasing force of the spring 14 maintains the base of the valve stem engaged with the head of the tappet and maintains an enlarged foot 18 on the tappet engaged with the cam.

It will be understood that the cam is rotatably driven from the crankshaft (not shown) of the engine, to make one revolution during each cycle of the engine, so that the cam synchronizes the motion of the valve with that of other components of the engine. In this case the cam is assumed to be rotated counterclockwise, as shown. In the course of a cam revolution, a large lobe 20 on the cam passes under the foot of the tappet to lift the valve off of its seat and smoothly but rapidly carry the valve to its open position. The top of the lobe 20 is formed as an arc generally concentric to the cam axis to provide a period of dwell during which the valve remains in its fully open position.

As the cam continues to rotate, a ramp 21 thereon passes under the tappet to permit the spring 14 to propel the valve towards its seat. Since the spring 14 is a relatively stiff one, it maintains the valve stem engaged with the tappet and the tappet engaged with the cam, even though the ramp 21 releases the valve for a very rapid closing motion.

When any expansion spring like the spring 14 is confined between a fixed part and a reciprocating one, the moving end of the spring tends to rotate through a fraction of a turn during each stroke. As the spring is compressed, its free end tends to turn in the direction to tighten its coils, and as the spring is relaxed its free end tends to turn in the direction to open or expand the coils. Thus, as the valve illustrated in the drawings is moved in its opening direction, the end of the spring 14 that is engaged with the keeper 15 tends to rotate clockwise as viewed from the head end of the valve, while during closing motion of the valve said end of the spring turns counterclockwise.

Normally the spring bears so strongly against the keeper that frictional forces between the spring and the keeper, and between the keeper and the valve stem, constrain the valve to rotate with the moving end of the spring. Friction between the abutting ends of the valve stem and the tappet, and between the tappet and the cam, is not great enough to present any significant frictional resistance to such rotation of the valve.

With a conventional cam, the spring induced rotation of the valve during its opening motion is exactly offset by its equal and opposite rotation during its closing stroke, and the valve therefore has no net rotation.

According to the present invention, however, the cam 12 is provided with a small second lobe 23 that adjoins the ramp 21 and serves to effect an abrupt momentary interruption in the closing motion of the valve in a stage thereof just before the valve reaches engagement with its seat 6. When relaxation of the spring is thus momentarily interrupted by the small cam lobe 23, the rotational motion of the free end of the spring 14 is likewise interrupted. But because of the high rotational speed imparted to the valve by the spring during closing motion of the valve prior to this interruption, the valve has a rotational momentum high enough to overcome the friction between it and the spring, and the valve slips rotationally relative to the spring.

As the small lobe 23 passes out from under the tappet, with continued rotation of the cam, the valve resumes its axial and rotational movement under the influence of the spring, and it is brought back onto its seat 6 in a slightly different rotational position than it had when it was initially driven off the seat by the lobe 20 on the cam.

The functioning of the small lobe 23 is not understood in full detail, but it seems that the abrupt deceleration of the valve that it produces, acting in conjunction with the elasticity of the valve and of the components of its actuating mechanism, causes a small rebound between the valve and the movable end of the spring, which rebound, although of extremely small magnitude and brief duration, is nevertheless sufficient to relieve the frictional connection between the valve and the spring and permit the valve to turn in response to its rotational momentum.

To encourage rotation of the valve, the cam has an axial cutout or recess 24 in the neighborhood of the small lobe 23, so that the profiled surface of the cam is engaged with the tappet only at one side of the tappet axis. The eccentric force thus imposed upon the tappet, due to sliding friction between the cam and the tappet, tends to turn the tappet in the direction of valve rotation, and the tappet, in turn, tends to transmit such rotation to the valve during the brief critical period in which rotational slipping of the valve relative to the spring is permitted.

It has been found that provision of the recess 24 in the cam materially promotes rotation of the valve when the actuating mechanism includes the small lobe 23 on the cam, although without that small lobe the recess 24 seems to bring about little or no rotation of the valve. Again, the reason for the effectiveness of the recess 24 only when the lobe 23 is provided is not completely understood, but it seems to be related to some sort of bounce or rebound of the parts of the mechanism for which the lobe 23 is responsible.

Of course the valve turns through only a very small fraction of a revolution (approximately 0.8°) at each actuation, but this is sufficient to provide a desirable rotation rate of about 4 r.p.m. when the engine is running at 3,600 r.p.m.

It will be apparent that the very short interruption of valve closing movement that is produced by the lobe 23 on the cam in no way interferes with normal operation of the engine, especially since it occurs in the latter part of closing motion of the valve.

From the foregoing description taken with the accompanying drawings it will be apparent that this invention provides a very simple, compact, dependable and efficient valve rotator for reciprocating internal combustion engines,

requiring no parts other than those normally present on such an engine and therefore extremely inexpensive. It will also be apparent that the valve rotator of this invention is especially well suited to small single-cylinder engines, and that it lends itself satisfactorily to retrofitting inasmuch as it requires only replacement of the conventional camshaft by one embodying the principles of this invention.

I claim:

1. A reciprocating internal combustion engine having a poppet valve which is urged axially toward its seat by a helical expansion spring that reacts between a keeper on the stem of the valve and a fixed part of the engine, and which valve is moved off of its seat by a rotatable cam in cooperation with a tappet that is coaxial with the valve stem, said engine being characterized by:

A. the cam having a large lobe with a tappet engaging surface which is of increasing radius in the direction opposite to that of cam rotation to effect motion of the valve away from its seat;

B. the cam also having a ramp with a cam engaging surface which extends from that of said large lobe in the direction opposite to that of cam rotation and which is of steadily decreasing radius in said direction to permit the spring to accelerate the valve rapidly towards its seat; and

C. the cam further having a small lobe, the cam engaging surface of which extends from that of said ramp in the direction opposite to that of cam rotation and is of such rapidly increasing radius in said direction that said small lobe effects an abrupt and brief deceleration of the valve in the latter part of its motion towards its seat to cause a momentary cessation of the rotational force which the spring imparts to the valve as a component of spring expansion, during which cessation the valve continues to turn under its own rotational momentum and slips rotationally relative to the spring.

2. The internal combustion engine of claim 1, further characterized by:

that portion of the cam which defines said small lobe having its tappet engaging surface axially relieved at one side of the tappet axis so that the remaining tappet engaging surface of the small lobe cooperates with the tappet in frictionally inducing rotation of the tappet in the direction of said rotational slipping of the valve.

3. Mechanism in an internal combustion engine for actuating a poppet valve that has a stem and a coaxial head at one end of the stem and which is movable to and from engagement of its head with a valve seat, said mechanism comprising a cam follower at the other end of the stem for imparting axial motion thereto, a rotatable cam which has a surface engageable with the cam follower and which propels the valve in its opening motion and releases it for closing motion, and a helical expansion spring reacting between a keeper on the stem and a fixed part of the engine to propel the valve in its closing motion, said mechanism being characterized by:

the cam being formed with:

1. a portion of its said surface having a radius which decreases steadily in the direction opposite to that of cam rotation to provide for rapid spring propelled acceleration of the valve towards its seat; and

2. a portion of said surface which extends from the last-mentioned portion thereof in said direction and which has a radius that increases so rapidly in said direction as to provide for an abrupt momentary interruption of spring propelled valve closing motion in a later stage thereof, just before the valve seats, so that during said interruption the valve rotates relative to the spring under its turning momentum built up during the preceding stage of valve closing motion as the valve followed the keeper engaging end of the spring in its rotational component of spring expansion.