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A. A. ARUTUNOFF ET AL

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VARIABLE VALVE TIMING MECHANISM

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2 Sheets-Sheet 1

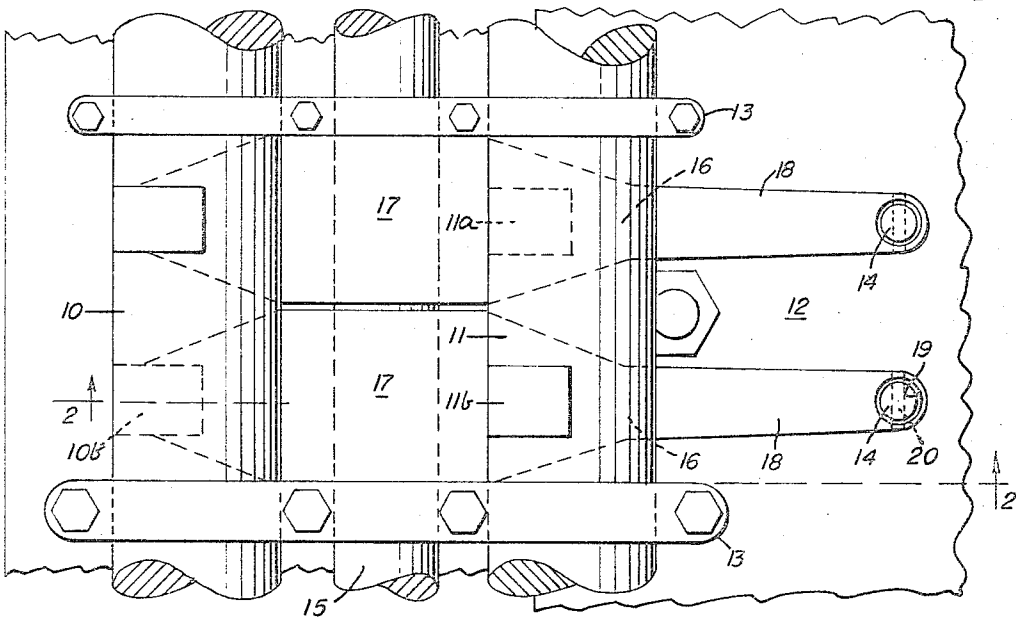


FIG. 1

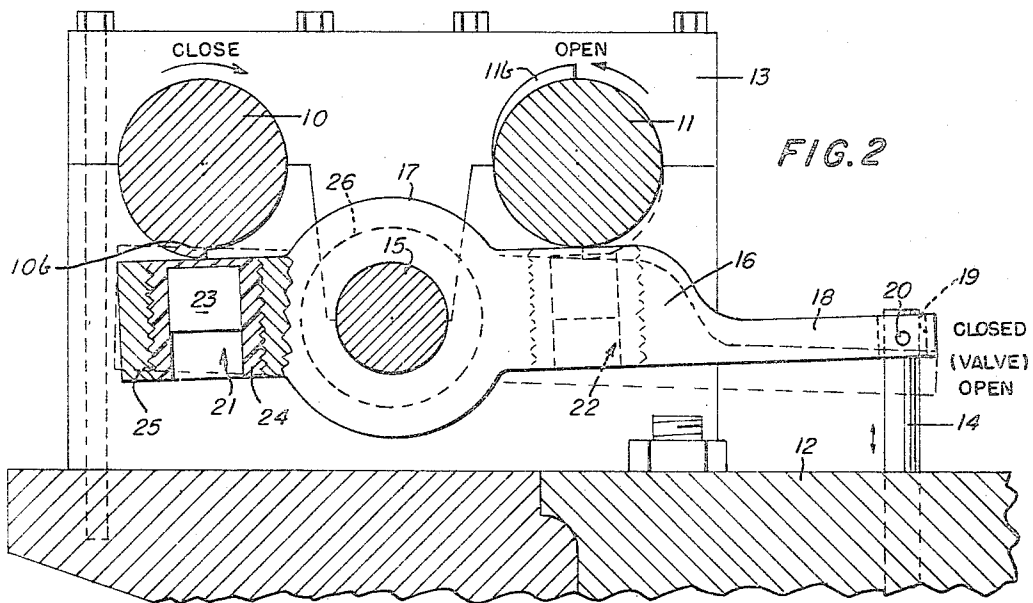


FIG. 2

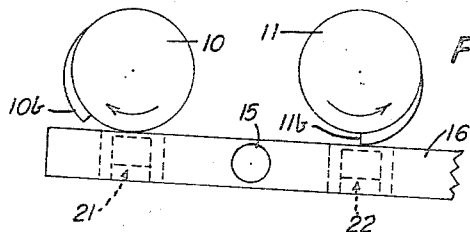


FIG. 3

INVENTORS
ANATOLY A. ARUTUNOFF
HORACE BRYAN CROW

BY *Smallman*

ATTORNEY

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VARIABLE VALVE TIMING MECHANISM

Anatoly A. Arutunoff and Horace Bryan Crow, Bartlesville, Okla., assignors to Automobile Racing Club of Oklahoma, Inc., Bartlesville, Okla., a corporation of Oklahoma

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This invention relates to valve-actuating mechanisms for internal combustion engines, and consists more particularly in new and useful improvements in a variable timing mechanism wherein the intake and exhaust valves of respective cylinders are opened and closed by separate complementary cams, actuated in timed relation by the engine crankshaft, each set of cams coacting with common rocker arms operatively connected to the respective valve stems or push-rods.

An object of the invention is to provide a cam-actuated valve mechanism, wherein each valve is opened and closed by a rocker arm which is pivoted intermediate its ends and responsive to a pair of laterally spaced cams, respectively arranged to open and close the associated valves in selectively timed relation.

Another object of the invention is to provide a valve timing mechanism, including means selectively adjusting the relative operating positions of the cams so that the opening and closing of respective valves may be advanced or retarded to accommodate a wide range of speeds of the engine.

A further object of the invention is to provide a valve timing mechanism of this type, wherein the rocker arm has magnetic cam followers arranged in laterally spaced relation on opposite sides of the rocker arm pivot, so that the rocker arm will maintain its position after having been rocked by one cam and the lobe of that cam has proceeded in its cycle, but the lobe of the complementary cam has not yet reached its follower. In other words, the magnet in the closing cam follower, for example, holds the rocker arm in the open position until the closing cam lifts its side of the rocker arm and brings the opposite side and the opening cam follower down onto the heel of the opening cam.

A still further object of the invention is to provide in a valve timing mechanism such as above referred to, a hydraulic damper or the like which insures that the momentum imparted to the rocker arm by the respective cams does not cause it to outrun the cam contour as it tapers off, so as to cause the rocker arm to collide with the opposite cam.

With the above and other objects in view which will appear as the description proceeds, the invention consists in the novel features herein set forth, illustrated in the accompanying drawings, and more particularly pointed out in the appended claims.

Referring to the drawings in which numerals of like character designate similar parts throughout the several views:

FIG. 1 is a fragmentary, top plan view of the valve timing mechanism of the invention;

FIG. 2 is a sectional view taken on line 2—2 of FIG. 1;

FIG. 3 is a diagrammatic illustration of the cams and cam shafts in adjusted relative positions; and

FIG. 4 is a top plan view illustrating the mechanism for selectively adjusting the relative operating positions of the cam shafts.

In the drawings, referring first to FIGS. 1 and 2, 10 and 11 represent a pair of laterally spaced, parallel cam shafts which, as will later appear, are simultaneously rotated in opposite directions through a suitable connection to the engine drive shaft. As shown in the drawings, the cam shaft 10 is rotated in clockwise direction, while shaft

11 is rotated in counter-clockwise direction. These cam shafts are of a length corresponding substantially to the longitudinal extent of the cylinder head 12 and are rotatably supported at spaced intervals by suitable bearing assemblies 13 mounted on the cylinder head, and their respective peripheries are provided with laterally aligned cam lobes which are longitudinally spaced on the respective cam shafts to coincide with the longitudinal spacing of the valve stems of each cylinder of the engine. Thus, the valve closing cam shaft 10 is provided with closing lobes 10a and 10b and the valve opening cam shaft 11 is provided with cam lobes 11a and 11b.

For simplification, only two sets of complementary cams are shown in the drawings, but it will be understood that as many sets of cams are employed as there are valves and valve stems in the engine. The valve stems 13 and 14 are reciprocally mounted in the cylinder head 12 and project upwardly therethrough from their respective valves (not shown). In lateral alignment with each of the valve stems and rotatably supported on a common pivot shaft 15 is a rocker arm 16. The pivot shaft 15 is parallel with the cam shafts 10 and 11 and supported in suitable bearings in the bearing assemblies 13 in downwardly offset relation between the shafts 10 and 11. Each rocker arm 16 is pivoted intermediate its ends on the common pivot shaft 15, by means of a bearing housing 17, and the ends of respective rocker arms adjacent the aligned valve stems are extended as at 18, the extremity of each extension being provided with a suitable slot or opening 19 adapted to receive the projecting end of the adjacent valve stem. These extensions may be connected to the valve stems by any suitable means, such as cross-pins 20, and sufficient clearance is provided in the openings 19 to compensate for the pivotal movement of the rocker arms.

On opposite sides of the pivot shaft 15, each of the rocker arms is provided with magnetic cam followers 21, 22, respectively aligned with the cam lobes on cam shafts 10 and 11. The rocker arms 16 are formed of a suitable non-magnetic material, and in the form shown in the drawings, the magnets 23 are housed in iron or steel followers adapters 24 in the form of inverted cups, threaded into suitable vertical openings 25 in opposite sides of the rocker arms 16 in line for engagement by the respective cam lobes of cam shafts 10 and 11 which are also composed of a magnetic metal.

Thus, as the shafts 10 and 11 rotate in opposite directions, as shown by the arrows in FIG. 2, the engagement of the cam lobe 10b with the magnetic cam follower 21, causes the rocker arm 16 to pivot in counter-clockwise direction which raises the extension 18 and pulls upwardly on the valve stem 14 to close the valve. Likewise, when the continued rotation of the cam shafts 10 and 11 moves the cam lobe 10b out of contact with the magnetic cam follower 21, the opposite lobe 11b of shaft 11 has reached the magnetic cam follower 22, which pivots the rocker arm 16 in clockwise direction to move the valve stem 14 downwardly into open position.

The cam lobes 10b and 11b are contoured for short 180° crankshaft durations, and the contour of the trailing area of the opening lobe 11b and the leading area of the closing lobe 10b are geometrically complementary. Thus, in the adjustment shown in FIG. 2, the opening lobe 11b, after passing the cam follower, will permit that end of the rocker arm to raise at exactly the same rate at which the closing lobe 10b is forcing the opposite end of the rocker arm downwardly to close the valve. It will be apparent that with this adjusted position, the magnetic followers are not relied upon. This particular adjustment provides a minimum duration of valve opening. However, as previously stated, the invention contemplates adjustment of the relative operat-

ing positions of the opposite cams to either extend or retard the operation of the valves, and, under these circumstances, it is necessary that the rocker arm 16 maintain its position after a cam has rocked it, and the lobe has proceeded in its cycle, but before the opposite cam lobe has reached operative position to reverse the rocking movement of the rocker arm.

It is to accomplish this function that the magnetic followers are employed. For example, with the cam shafts adjusted, as shown in FIG. 3, where the opening lobe 11b is about to disengage its cam follower 22 considerably in advance of the time when the leading edge of the closing cam lobe 10b reaches its cam follower 21, the magnetic features become effective. As will be seen in FIG. 3, the opening lobe 11b has forced the rocker arm 16 in clockwise direction, bringing the magnetic cam follower 21 into engagement with the cam shaft 10, and the rocker arm is magnetically maintained in this position with its respective valve open, until the leading edge of closing cam 10b has rotated clockwise to a position where it engages the cam follower 21 to close the valve. The same is true in connection with the operation of the opening cam lobe 11b and its cam follower 22, whereby the opening of the valve is retarded.

Any suitable damper or dashpot arrangement may be employed in the bearing housing 17 of the rocker arm 16, to insure that the momentum imparted to the rocker arm by either one of the cams does not cause it to overrun the cam contour as the latter tapers off and cause the arm to collide with the opposite cam. Such a system is diagrammatically shown in dotted lines at 26 in FIG. 2 and may comprise an oil-filled chamber with coacting blades or fins on the pivot shaft 15 and the walls of the damper. The specific structure of such a damper forms no part of the present invention, as various types can be employed with equal effect.

Turning now to FIG. 4 of the drawings which illustrates the cam adjustment feature of the invention, it will be seen that the cam shafts 10 and 11 are extended rearwardly from the cylinder block where they are embraced by tubular sleeves 27 and 28 respectively. The sleeve 28 on shaft 11 carries a double gear 29 having one set of teeth 30 which are engaged by a sprocket chain drive shown in dotted lines at 31 and running to the engine crankshaft (not shown), and a second set of teeth 32 which engage a complementary set of teeth 33 on a second gear 34 on the sleeve 27 of the opposite cam shaft 10. Gear 29 is rotatably supported by suitable bearings 35, and gear 34 is likewise supported in bearings 36. These gears and their bearings are mounted in a suitable housing 37 which is designed to prevent longitudinal movement of the gears with respect to the shafts 10 and 11.

The rear ends of the sleeves 27 and 28 are attached to an adjusting yoke 38 and are rotatably supported therein by bearing assemblies 39 and 40 respectively, and the yoke 38 carries a manual control handle or the like 41 whereby, as will later appear, the yoke and the respective sleeves may be shifted longitudinally on the cam shafts 10 and 11.

The outer periphery of the sleeve 27 and the inner periphery of gear 34 are connected by one or more straight splines 42 and, similarly, the outer periphery of the shaft 10 and the inner periphery of said sleeve 27 are connected by a straight spline 43. Thus, longitudinal movement of the sleeve 27, both with respect to the gear 34 and the shaft 10, which are fixed against longitudinal movement, is permitted by the straight splines 42 and 43. The outer periphery of the sleeve 28 is skew splined to the inner periphery of the gear 29, as shown in dotted lines at 44, and the outer periphery of the shaft 11 is connected to the inner periphery of the sleeve 28 by a straight spline 45. Thus, the longitudinal shifting of the sleeve 28 by manipulating the yoke 38, causes the sleeve 28 to twist with respect to the longitudinally fixed

gear 29 and this twisting movement is transmitted through the straight spline 45, to the cam shaft 11.

It will be apparent that if it is desired to vary the relative operating positions of the cam lobes 10b and 11b to either advance or retard the actions of these respective cams on the rocker arm 16 and the cam followers 21 and 22, this may be accomplished by simply shifting the control handle 41 and yoke 38 longitudinally on the cam shafts 10 and 11 in the desired direction. In the arrangement shown, the only cam which is actually shifted is cam lobe 11b which is rotated with respect to the opposite cam lobe 10b, to thereby regulate the timing of the sequence of cam action on the valves. However, by a generally similar arrangement of skew splines, both cams can be rotatably shifted to effect this same relative adjustment more rapidly.

While the drawings show a hand-actuated control 41, it will be understood that this shifting of the yoke 38 and sleeves may be effected by any suitable means, including a conventional speed sensitive apparatus which is responsive to centrifugal force.

From the foregoing, it is believed that the invention may be readily understood by those skilled in the art without further description, it being borne in mind that numerous changes may be made in the details disclosed without departing from the spirit of the invention as set forth in the following claims.

We claim:

1. A valve timing mechanism for internal combustion engines, including a cylinder head and a series of valves respectively provided with projecting valve tappets; said mechanism comprising a series of rocker arms spaced on said cylinder head corresponding to the spacing of said valve tappets and respectively connected at one end to said valve tappets, said rocker arms being pivoted intermediate their ends and provided with cam followers on opposite sides of their respective pivots, a pair of laterally spaced, parallel cam shafts extending at right angles to said rocker arms, across said cam followers, said cam shafts having peripheral cam lobes spaced for engagement with respective cam followers upon rotation of said cam shafts, said cam followers and cam lobes being magnetically attracted, complementary gear means on said cam shafts, driven by the engine crankshaft and operatively connecting said cam shafts for simultaneous rotation in opposite directions, the cam lobes on one cam shaft being oppositely arranged with respect to the corresponding cam lobes on the other cam shaft, whereby upon the simultaneous rotation of said cam shafts, the respective valve tappets are sequentially operated by said rocker arms to open and close the engine valves.

2. A valve timing mechanism as claimed in claim 1, including means for varying the relative operating positions of said cam lobes.

3. A valve timing mechanism as claimed in claim 1, including means for relatively rotating said cam shafts to thereby vary the relative operating positions of respective cam lobes.

4. A valve timing mechanism as claimed in claim 1, wherein said rocker arms are provided adjacent their pivots with damper means.

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MARK NEWMAN, *Primary Examiner.*

AL LAWRENCE SMITH, *Examiner.*