United States Patent [19]

Miokovic

[11] **3,888,216**

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[54] **SYSTEM FOR THE CONTROL OF THE INTAKE AND EXHAUST VALVES OF INTERNAL COMBUSTION ENGINES**

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[73] Assignees: **Regie Nationale des Usines Renault; Societe dite: Automobiles Peugot**, France

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[30] **Foreign Application Priority Data**

Dec. 1, 1972 France 72.42860

[52] **U.S. Cl.** **123/90.15**; 123/90.17; 123/90.25; 123/90.27

[51] **Int. Cl.** **F01l 1/34**

[58] **Field of Search** 123/90.15, 90.17, 90.16, 123/90.22, 90.24, 90.25, 90.26, 90.27, 90.44

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[57] **ABSTRACT**

A system for the control of the intake and exhaust valves of internal combustion engines which permits the automatic variation in the valve overlap and the respective open angles during engine operation, is characterized by having two camshafts, one of which serves to open a valve while the other of which serves to close the valve, each shaft having mutually adjustable timing angles, and the rocker arms each have two cam followers one of which contacts a first cam upon one shaft and the other of which similarly contacts a cam upon the other shaft.

4 Claims, 11 Drawing Figures

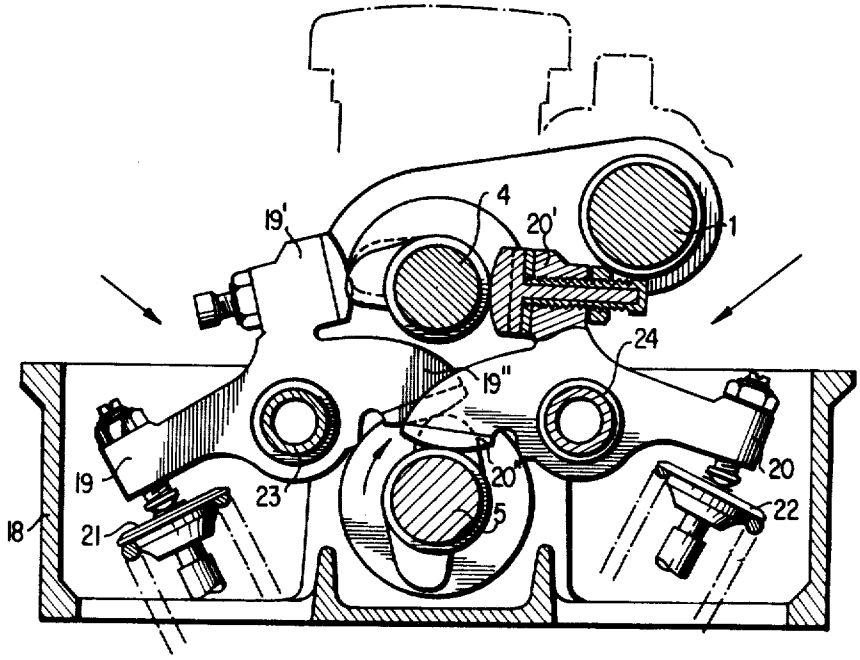


FIG. 1

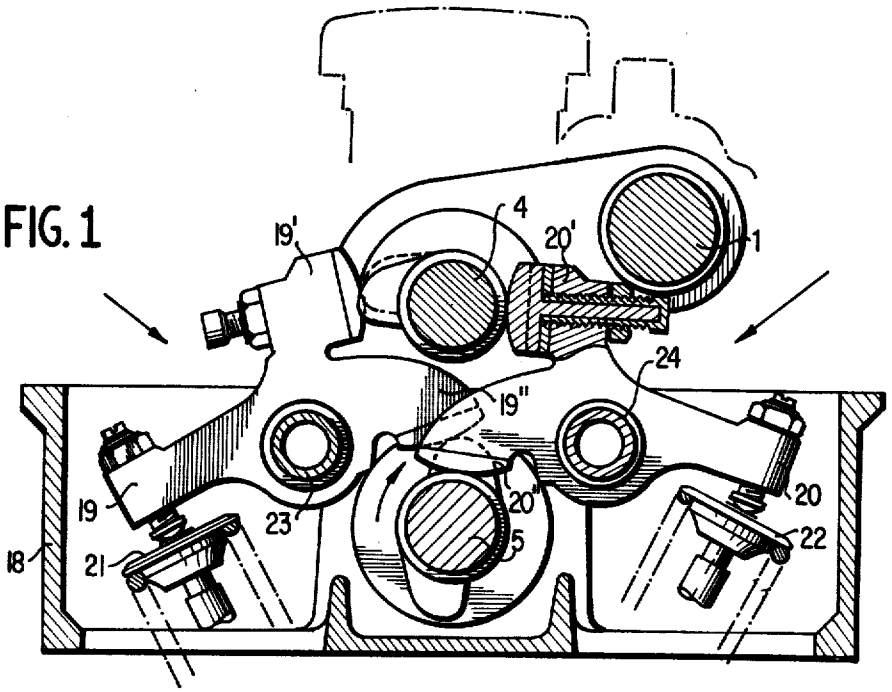


FIG. 2

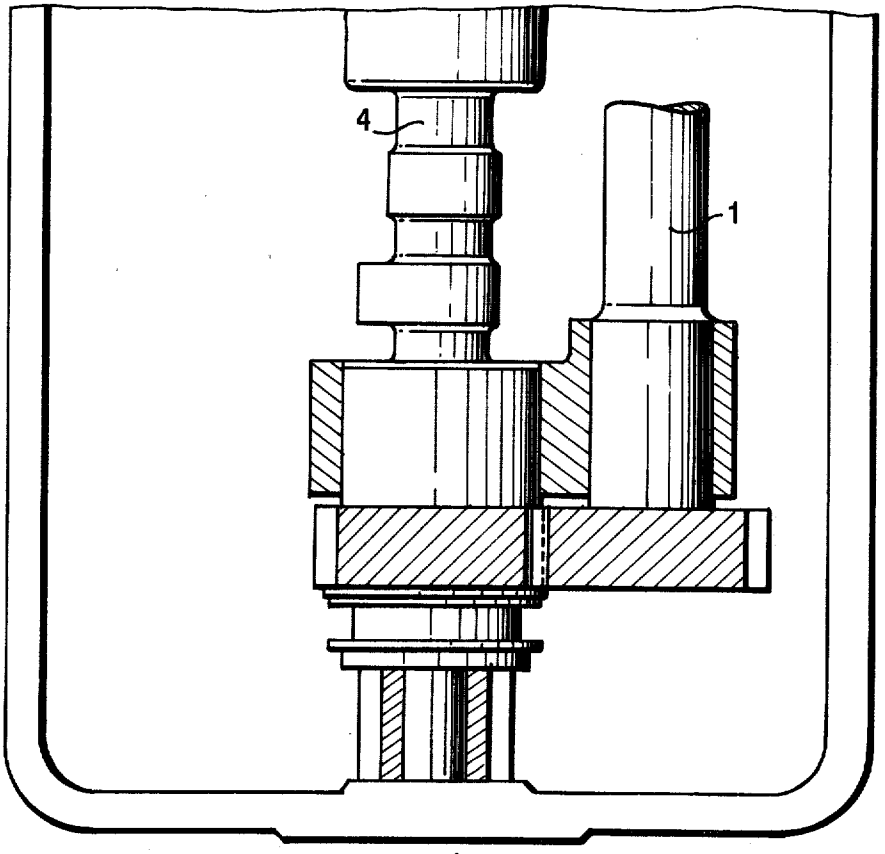
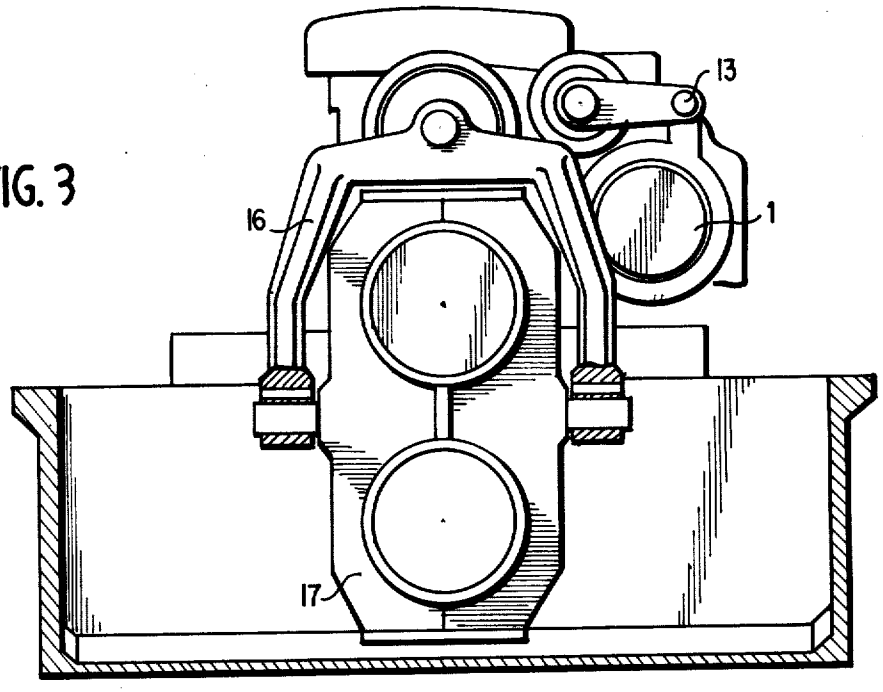


FIG. 3



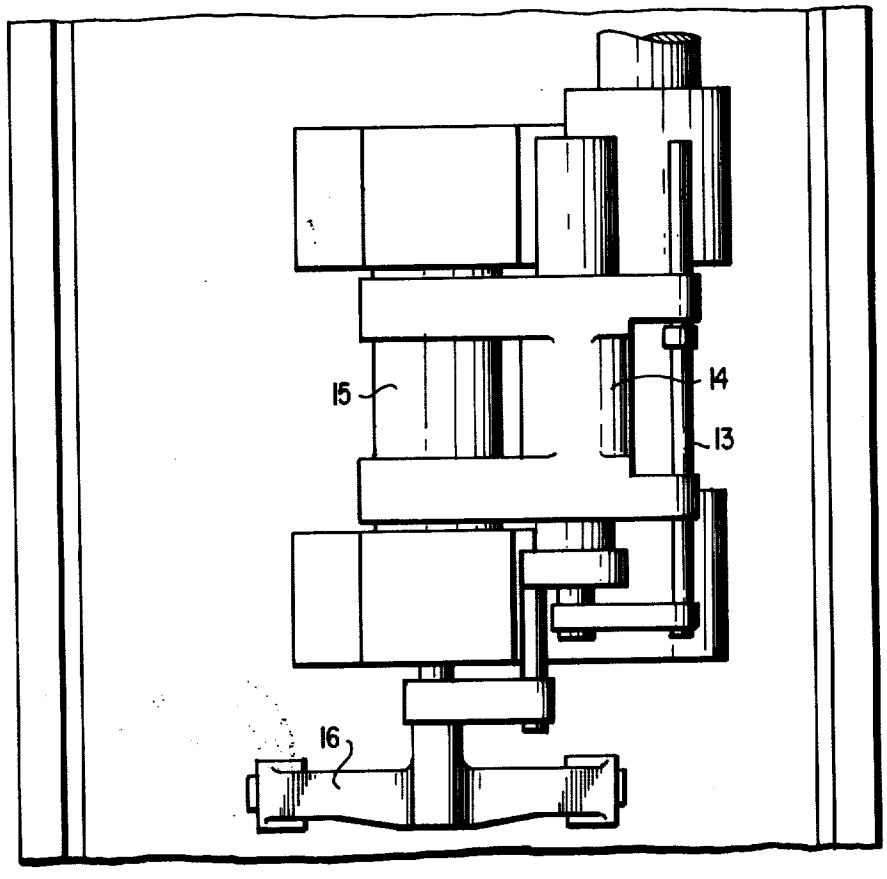


FIG. 4

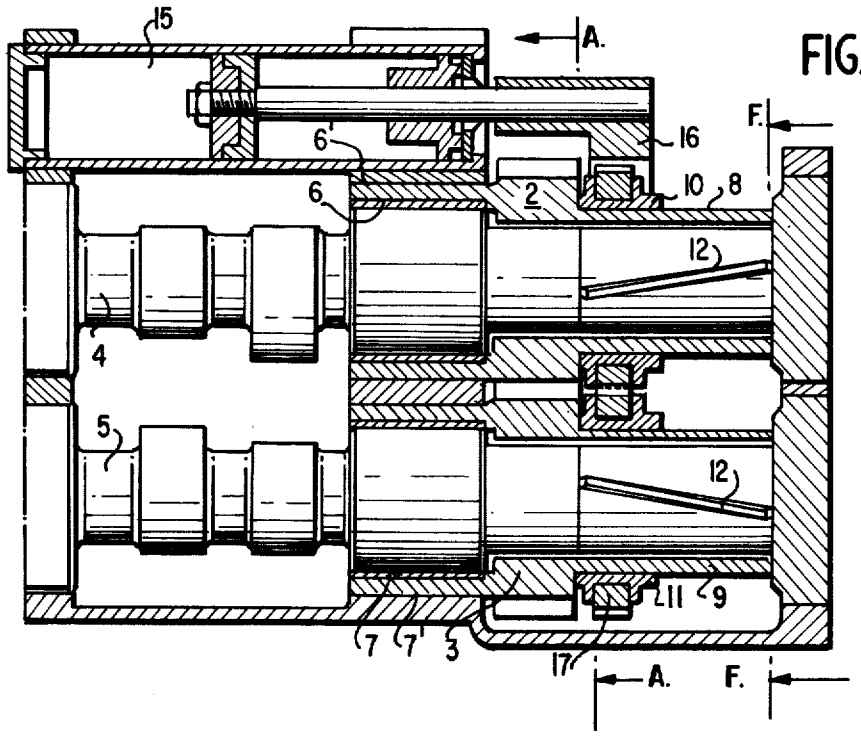
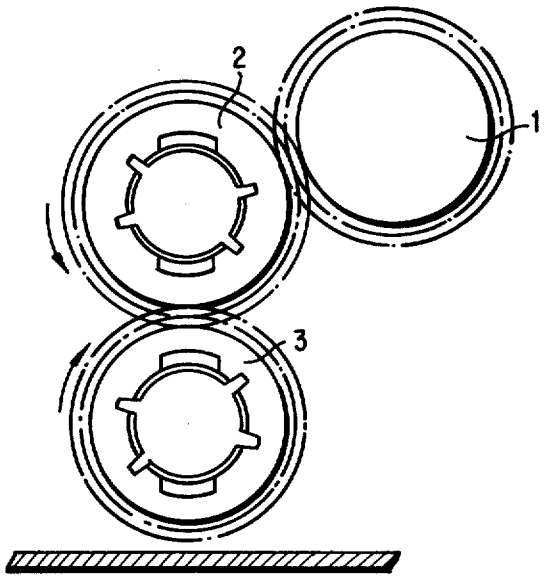


FIG. 5

FIG. 7



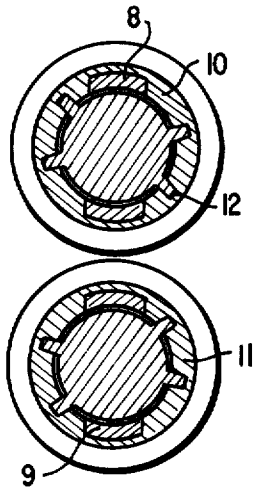


FIG. 6

FIG. 10

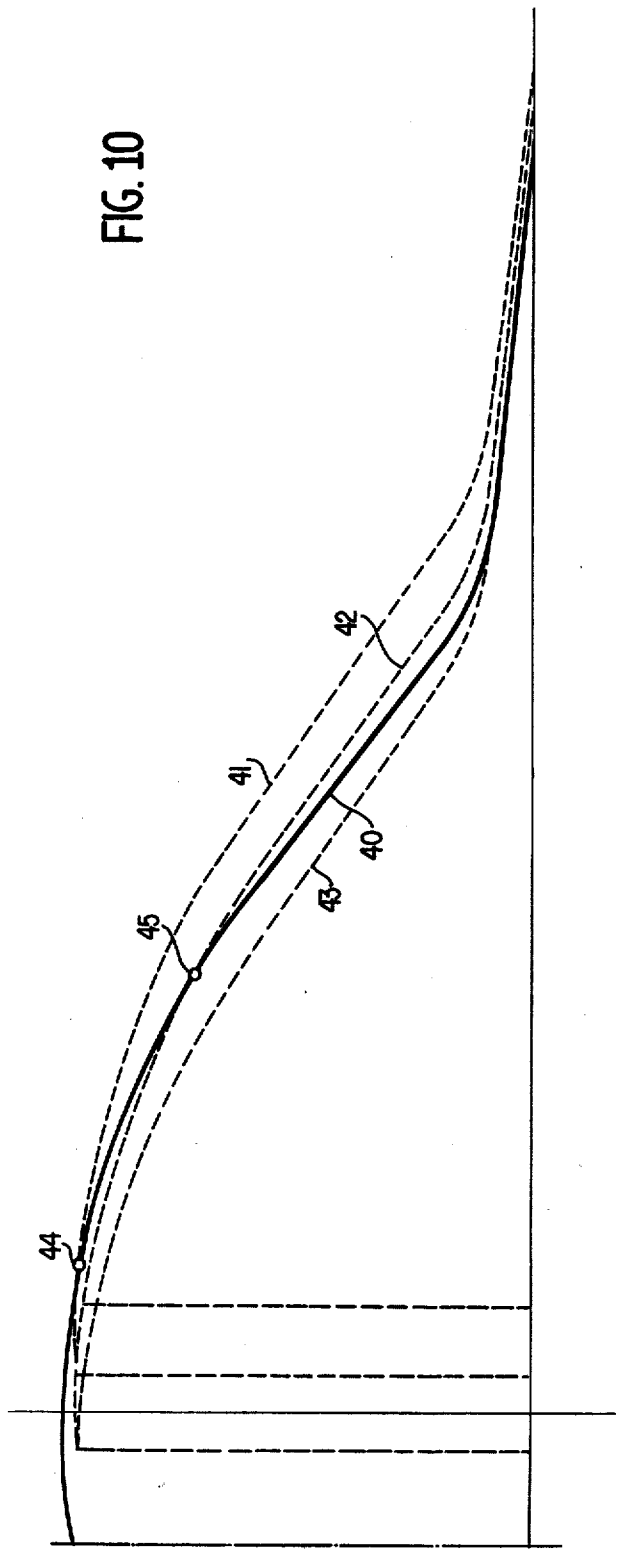
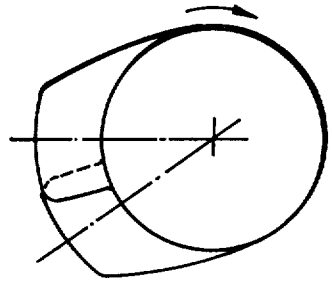


FIG. 9



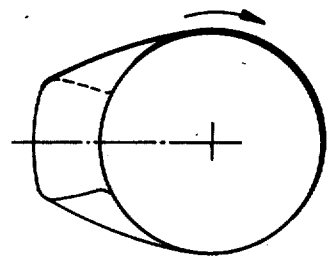


FIG. 8

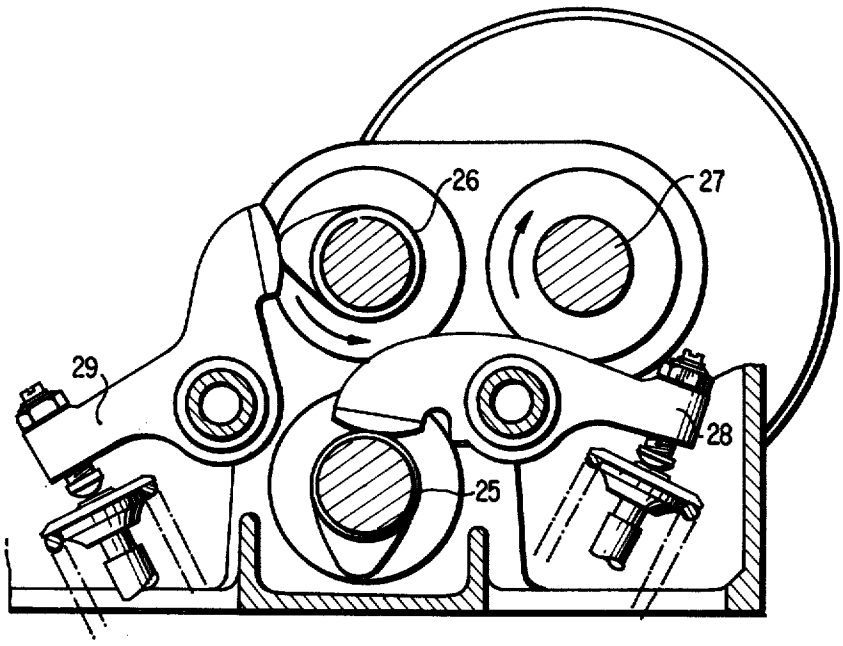


FIG. 11

SYSTEM FOR THE CONTROL OF THE INTAKE AND EXHAUST VALVES OF INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to the intake and exhaust systems of internal combustion engines and more particularly to an arrangement for the control of the intake and exhaust valves so as to permit the automatic variation, during engine operation, of the valve overlap, the angles at which the valves open, and the cyclic periods throughout which the valves remain open.

2. Description of the Prior Art

As is well-known, in internal combustion engines the durations of the intake and exhaust periods, which normally should be limited to the time necessary for the piston to traverse the corresponding strokes, are regularly prolonged so that each valve opens before the piston reaches dead-center and closes after the piston reaches the next dead-center. This prolongation of the intake and exhaust phases is required for several reasons, such as for example, compensation for the losses and recharging of the cylinders due to the passage of the gases around the valves, or the reduction in atmospheric pollution by decreasing the proportion of unburned gas.

Thus, in order to maximize motor efficiency at all speeds and loads it is necessary to vary the intake and exhaust periods which are of course longer, with large advance periods and delay times in valve opening and closing, respectively, for higher engine speeds. Arrangements have in fact already been proposed for varying the advance periods and delay times in the intake and exhaust phases in internal combustion engines as a function of motor speed and load.

One known mechanism provides for the control of the intake and exhaust valves of the internal combustion engine through means of a rotating control shaft which includes means for converting the rotary motion of the control shaft into an oscillatory motion of a cam whose profile includes a lobe disposed upon a circular base, as well as means for varying the width of the cam lobe so as to control the valves as a function of motor speed and load.

Another known timing mechanism for an automobile internal combustion engine, each cylinder of which has intake and exhaust valves actuated by means of a cam shaft which is driven by means of the motor crankshaft, includes a system wherein the camshaft is able to slide within its bearings, integral with the block whereupon the camshaft includes a pair of axially separated cam lobes for actuation of the respective rocker arms of each of the exhaust valves, one lobe being wider than the other, and also includes a piston disposed at one end thereof which tends to be reciprocated within a cylinder integral with the block in one direction by means of a return spring compressed against the camshaft bearing, the piston being actuated in the other direction through means of the admission of fluid, at variable pressure, into the cylinders so as to bring one or the other cam lobe into contact with the respective rocker arm according to engine speed.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention

to provide a mechanism for the control of the intake and exhaust valves of an internal combustion engine which permits the continuous and automatic variation during engine operation, of the overlap and cyclic periods of the valves as a function of engine speed and load.

The foregoing and other objects are achieved according to the present invention through the provision of two camshafts, one of which is utilized to raise the valve while the other is utilized to close the valve and which have mutually adjustable timing cycles, a pair of rocker arms, each of which have two cam followers for respectively contacting a cam upon one of the camshafts and a cam upon the other of the camshafts, and means to vary the mutal timing cycle of the camshafts.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other objects, features, and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description when considered in connection with the accompanying drawings, in which like reference characters designate like or corresponding parts throughout the several views, and wherein:

FIG. **1** is an end view, partly in section, of a valve assembly constructed according to the present invention and its cooperative parts, including the two camshafts, the rocker arms having two cam followers and the drive shaft, the control mechanism having been removed;

FIG. **2** is a partial plan view of the assembly shown in FIG. **1**;

FIG. **3** is an end view of the control mechanism of the present invention;

FIG. **4** is a plan view of the control mechanism shown in FIG. **3**;

FIG. **5** is a longitudinal cross-section view taken along a central vertical plane through the control assembly shown in FIG. **4**;

FIG. **6** is a cross-section view of the control mechanism taken along line A–A of FIG. **5**;

FIG. **7** is a view of the drive mechanism taken along the line F of FIG. **5**;

FIG. **8** and **9** are schematic views showing the profiles of the cams for opening and closing the valves and showing the minimum and maximum angular configurations utilized for which the valves can open;

FIG. **10** is a graph showing the angles at which the valves can open as a function of the relative positions of the two cams; and

FIG. **11** is a view similar to that of FIG. **1**, showing however another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and more particularly to FIG. **1** thereof, there is shown a rocker arm casing **18** within which are disposed two sets of rocker arms **19** and **20** which are engaged with the intake and exhaust valves **21** and **22**. The rocker arms **19** and **20** may oscillate about the respective shafts **23** and **24**, and also include a pair of cam followers **19'** and **19''**, and **20'** and **20''**, respectively, cam follower **19'** of rocker arm **19** being in contact with an upper cam shaft **4**, while the other follower **19''** is in contact with a lower camshaft **5**. Similarly, the cam follower **20'** of rocker arm **20** is also in contact with camshaft **4** while follower **20''** is in contact with camshaft **5**. Camshafts **4** and **5** rotate in opposite directions and are driven by means of en-

gine drive shaft **1**, through appropriate gearing, which is of course driven by means of the automobile internal combustion engine, although it should be noted that shaft **1** is not indispensable since the camshafts can be driven directly by means of the engine. However,, as depicted, the use of shaft **1** permits minimum modification of existing engines.

Referring now to FIGS. **5, 6** and **7**, the drive shaft **1** which is driven by means of the engine, transmits the rotary motion to gear-type bushings **2** and **3** which are intermeshed with one another. Bushings **2** and **3** rotate within bearings **6'** and **7'** and serve to support the end bearings **6** and **7** of camshafts **4** and **5** which of course permit rotation of the shafts within the bushings. The right end portions of the bushings **2** and **3**, as seen in FIG. **5**, include partially cut portions which define diametrically opposed tongues **8** and **9**. Upon these tongues are mounted annular gears **10** and **11** which, by means of keyways, are permitted to slide therealong and relative thereto but will be caused to rotate therewith, the sliding gears also engaging the camshafts **4** and **5** which are furnished with spiral fins **12**. When the sliding gears **10** and **11**, which are driven by means of the vehicle engine, are shifted along the tongues **8** and **9** of bushings **2** and **3** so as to mesh with the camshafts, the latter are rotated in opposite directions, and consequently, the timing of the valves with respect to the particular times at which the valves open as well as the duration of the valve overlap may be varied.

The control mechanism will now be described with particular reference being made to FIGS. **3, 4** and **5**. Drive shaft **1** has associated therewith a centrifugal regulator, now shown, and as the engine speed changes, the regulator by means of rod **13**, moves spool valve **14** so as to direct oil into a piston-type actuator **15** in accordance with the engine oil pressure. The actuator **15** is provided with a fork **16** which serves to move the sliding gears **10** and **11** by means of an actuating plate **17** which is secured between flanged members, not numbered, of gears **10** and **11**.

As noted heretofore, rocker arms **19** and **20** each have two cam followers for respectively contacting the lifting or opening camshaft and the lowering or closing camshaft. The camshafts rotate in opposite directions, the lower shaft **5** rotating in a clockwise direction, while the upper camshaft rotates in a counterclockwise direction. As seen in FIG. **1**, before rocker arm **19** loses contact with the lifting cam upon lower shaft **5**, it is affected by means of the closing cam upon shaft **4**, which will then be at a position noted by the phantom lines.

According to one feature of the present invention, in order to prevent the occurrence of any shocks when the rocker arm cam followers shift contact from the lifting cam to the closing cam, the crests of the cams may have the form of a circular arc the center of which lies upon the cam axis. FIGS. **8** and **9** show the cams having profiles exhibiting the minimum and maximum angular configurations for opening the valves, it being noted that for ease of comprehension the two cams are shown as being superimposed.

It should be noted further in conjunction with the desire to prevent the occurrence of shocks when the cam followers are transferred from one cam to another, that the configurations of the lifting and closing cams may be such that the descending slope of the lifting cam is prolonged so as to intersect that of the closing cam. The intersection is such that passage from one slope to that of the other does not produce abrupt changes in motion, whereby the attendant accelerations remain within acceptable limits. The lifting function of the valves, that is, the angles at which the valve can open, which is dependent upon the relative positions of the cams as well as the profile configurations thereof, is shown in FIG. **10**, curve **40** illustrating the descending curve for the lifting cam while curves **41, 42** and **43** illustrate the descending curves for the closing cam when disposed at three different angular positions. Curve **41** gives the maximum open angle which is derived from the descending curves of the two cams which intersect at point **44**, while point **45** illustrates the maximum open angle which is derived from the descending curves of the two cams which intersect when the closing cam is disposed at a position representative of curve **42**. When the closing cam is disposed at a position represented by curve **43**, valve closure is accomplished entirely upon the descending slope of the closing cam.

Referring now to FIG. **11**, another embodiment of the present invention may be used in which only the overlap of the intake and exhaust valves, and not their open angles, is made to vary automatically. Two camshafts **25** and **26**, which are respectively provided for initiating intake and exhaust, are driven by means of the engine drive shaft **27**. The rocker arms **28** and **29** for intake and exhaust, respectively, each have a single cam follower in contact with their respective cams, and the angular displacement of one camshaft with respect to the other shaft, which thereby varies the valve overlap, is done automatically by means of a mechanism similar to that discussed heretofore in connection with the embodiment of FIG. **1**.

Obviously, many variations and modifications of the present invention are possible in light of the above teachings. It is to be understood therefore that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A system for the control of the intake and exhaust valves of internal combustion engines which permits the automatic variation, during engine operation, of valve overlap and the respective open angles thereof comprising, in conjunction with engine intake and exhaust valves:

two camshaft means for respectively lifting and closing said engine intake and exhaust vauves;

said camshafts having mutually adjustable timing means for adjusting the timing angles of said valves; and

a pair of rocker arms operated by said camshafts, and each of said rocker arms having two cam follower means thereon for respectively contacting cam means upon each of said camshafts.

2. A system as set forth in claim **1**, wherein said means for adjusting the timing of said valves during engine operation comprises:

two bushings intermeshed with one another and within which said camshafts respectively rotate;

the end portions of said bushings defining diametrically opposed tongue members;

gear means disposed upon said tongue members for longitudinal movement thereto;

sprial fin means disposed upon said camshafts for interengaging recess means within said gear means; and

hydraulic actuator means for moving said gear means relative to said tongue members.

3. A system as set forth in claim 1, wherein:

said cam means have arcuate crest portions, the center of which lies upon the axes of said cam means,

whereby shocks are prevented from occurring during passage of said rocker arms from said lifiting cam to said closing cam.

4. A system as set forth in claim 1, wherein:

said lifting cam has prolonged descending slope configuration which is compatible with the slope of said closing cam,

whereby at the points of intersection of said two cams no abrupt changes in movement occur so as to thereby maintain accelerations within acceptable limits and to prevent the occurrence of any shocks during passage of said rocker arms from said lifting cam to said closing cam.

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