United States Patent

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[31] **43/72623**

[54] **VACUUM-CONTROLLED SPARK-TIMING DEVICE**
4 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** ..... **123/117 A,** 123/146.5 A
[51] **Int. Cl.** **F02p 5/10**
[50] **Field of Search** 123/117, 117.1; 92/92, 96, 97, 98, 99, 168

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ABSTRACT: A vacuum-controlled spark-timing device for combined use with a contact breaker of a gasoline engine, said device having a rotatable plate mounted for free rotation about a camshaft in a contact breaker housing, said rotatable plate having thereon a fixed contact point and a contact breaker lever pivotably mounted on said rotatable plate, said pivotable lever having thereon a cam follower in sliding contact with the cam surface of said camshaft and a movable contact point adapted to be brought into or out of electrically conductive contact with said fixed contact point upon rotation of said camshaft, a hermetically sealed casing mounted on said contact breaker housing and having a diaphragm dividing the interior of said casing into two chambers, a connecting rod sealingly extending through said casing and having one end pivotably connected to said rotatable plate and the other end secured to said diaphragm, one of said chambers being in communication with an air inlet conduit of said engine at a point upstream of a throttle valve mounted within said conduit and the other of said chambers being in communication with said conduit downstream of said throttle valve, whereby said diaphragm is displaced in one direction by the vacuum exerted to said one chamber during normal operation of said engine to cause said connecting rod to rotate said rotatable plate in one direction for thereby advancing the ignition timing of the engine and said diaphragm is displaced in the opposite direction by the vacuum exerted to said other chamber during idling or deceleration of said engine to cause said connecting rod to rotate said rotary plate in the opposite direction for thereby retarding the ignition timing.

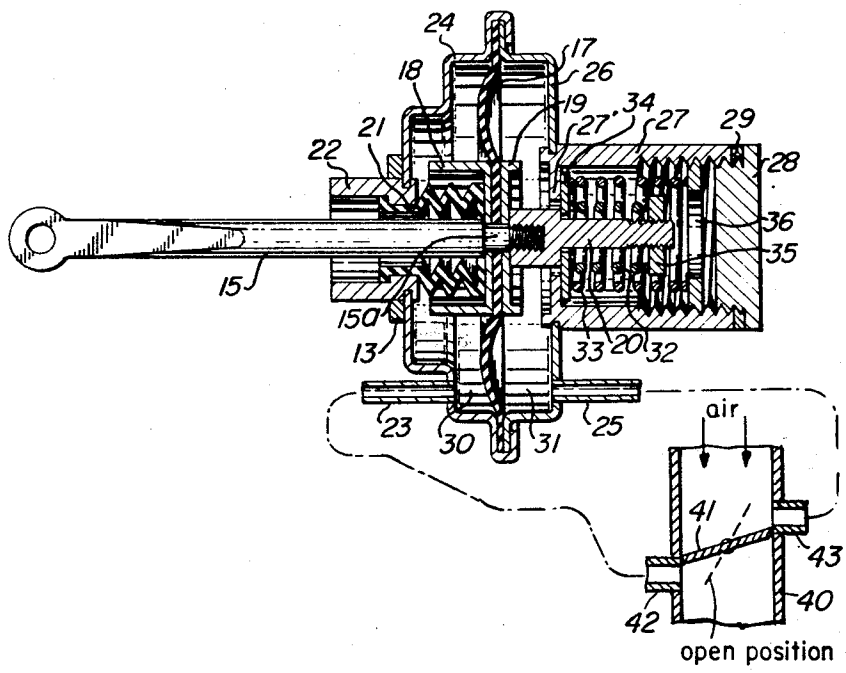


FIG. 1

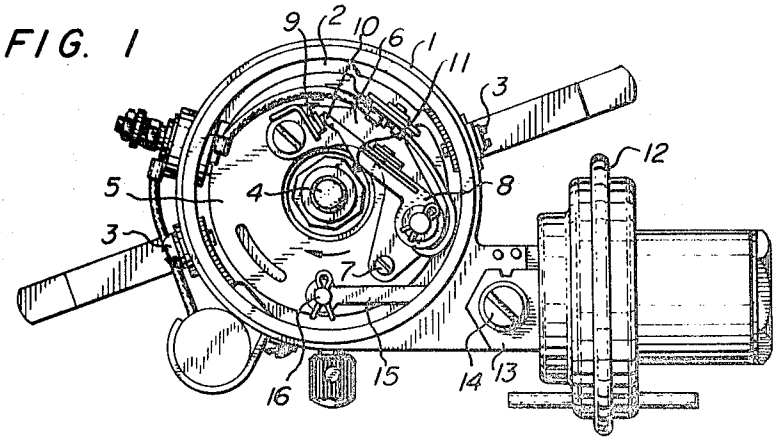


FIG. 2

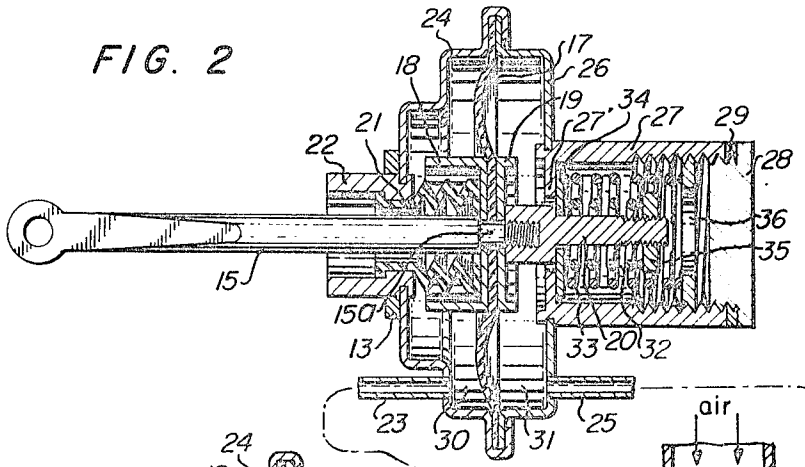
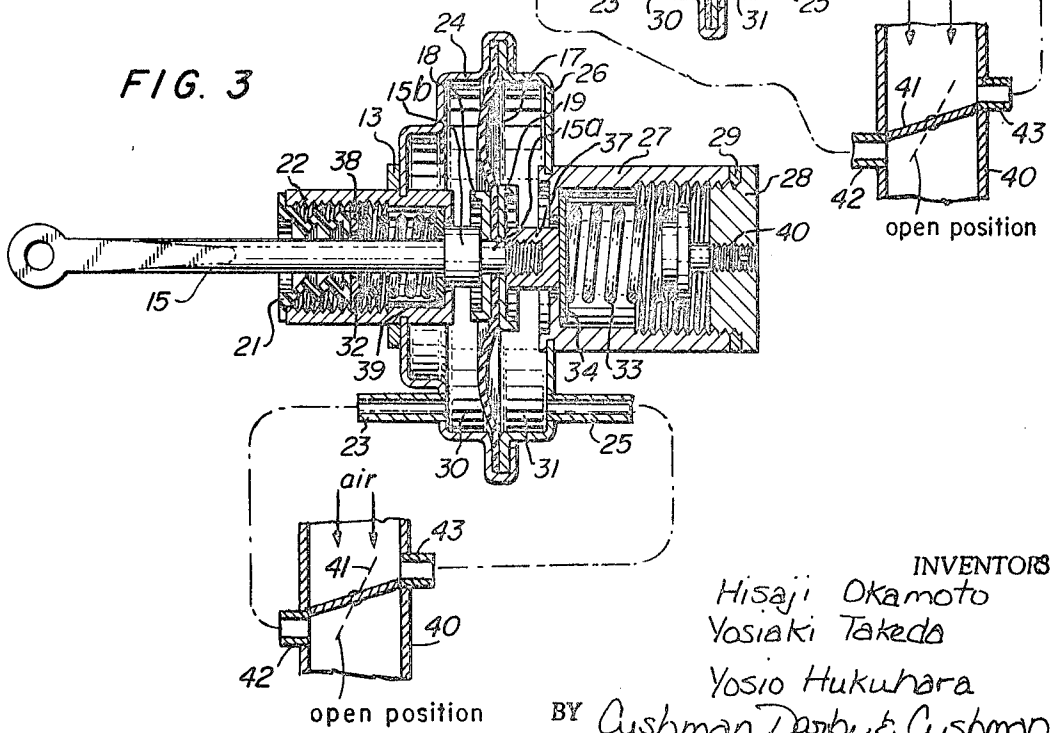


FIG. 3



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VACUUM-CONTROLLED SPARK-TIMING DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a vacuum-controlled spark-timing device adapted to be mounted on an internal combustion engine, that is, to a device for automatically regulating the ignition timing of an internal combustion engine in accordance with the vacuum within the air inlet conduit of the engine.

It is well-known fact that, in the past, a great deal of harmful components such as hydrocarbon was contained in the gas exhausted from a general gasoline engine during idling or deceleration of the engine. Moreover, the contamination of the air due to these exhaust gases has been serious problem to public health for the recent several years and, hence, a consideration has been earnestly made to solve this problem. As a solution of this problem, it has been proposed to retard or defer the ignition timing of an engine during idling or deceleration beyond the ignition timing required by the engine so as to remarkably reduce the hydrocarbon contained in the exhaust gases. For this purpose, various kinds of ignition-timing-retarding devices including vacuum-controlled ignition timers have been devised. However, a vacuum-controlled ignition-timing advancer is conventionally mounted on the contact breaker housing to which ignition-timing retarder of such kind is to be secured. The attachment of such a retarder in addition to the conventional ignition-timing advancer to the contact breaker will not only give rise to an increase in expense but also be very inconvenient in physical viewpoint or, namely, in the viewpoint of space around the engine. Furthermore, independently mounted advances and retarders do not have adequate vibrationproof characteristic to satisfy the requirement in durability.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a vacuum-controlled spark-timing device which, while being of substantially the same size as that of conventional vacuum-controlled ignition-timing advancing device, serves as both ignition-timing advancer and retarder.

It is another object of the present invention to provide a vacuum-controlled spark-timing device of the character as described in the preceding paragraph and which can be manufactured at cost hardly exceeding that of a conventional ignition-timing advancer.

It is a further object of the invention to provide a combined vacuum-controlled spark-timing advancing and retarding device which can conveniently be mounted on a conventional gasoline engine of a given automobile.

It is a further object of the invention to provide a combined ignition-timing advancing and retarding device which can exhibit a good vibrationproof characteristic.

A still further object of the present invention is to provide a vacuum-controlled spark-timing device which may be selectively operable either to advance or to retard the ignition timing of a gasoline engine.

According to the present invention, there is provided a vacuum-controlled spark-timing device for use with a gasoline engine, which includes a single diaphragm adapted to be actuated by vacuum within an air inlet conduit of the engine, said diaphragm having an enclosed ignition-timing advancement chamber on one side of said diaphragm and an enclosed ignition-timing retardation chamber on the other side thereof, spring means within at least one of said chambers for controlling the displacement of said diaphragm caused by the vacuum, and a connecting rod having one end pivotably connected to a rotatable plate in an associated contact breaker housing and the other end secured to said diaphragm. The ignition-timing advancement and retardation chambers have respective vacuum inlet ports which may be connected through tubings to the air inlet conduit at the points downstream and upstream of a throttle valve mounted in the conduit, respectively.

The rotatable plate has mounted thereon a fixed contact point and a pivotable contact breaker lever having thereon a cam follower in sliding contact with the cam surface of a camshaft extending axially through the rotatable plate for free relative rotation with respect to the latter. The contact breaker lever also has thereon a movable contact point in opposite relationship to the fixed contact point so that the movable contact point may be brought into or out of electrically conductive contact with the fixed contact point upon rotation of the cam surface on the camshaft. With the above arrangement, a displacement of the diaphragm in one direction caused by the vacuum exerted to one of the enclosed chambers is transmitted through the connecting rod to the rotatable plate which in turn is rotated in one direction with respect to the camshaft, with the result that the cam follower on the contact breaker lever is shifted relative to the cam surface in a direction opposite to the direction of rotation of the camshaft to advance the contact-breaking operation of the lever for thereby advancing the ignition timing of the engine. The above operation is performed during normal operation of the engine. During idling or deceleration of the engine, the vacuum is applied to the other of the chambers and, thus, the above-mentioned members are actuated all in the directions opposite to the directions in the case of the above ignition-timing-advancing operation and, hence, retardation of the ignition timing is achieved.

Means may be provided on a hermetical casing for adjusting the action of the spring means within one or both of the enclosed chambers to thereby precisely control the displacement of the diaphragm caused by the vacuum introduced from the air inlet conduit, said casing comprising a pair of unitary joined casing members which cooperate with the diaphragm to define the enclosed two chambers.

Other objects and features of the present invention will be made clear from the following description with reference to the accompanying drawings.

DESCRIPTION OF DRAWINGS

FIG. 1 is a plan view of a contact breaker having mounted thereon a vacuum-controlled spark-timing device according to the present invention,

FIG. 2 is a longitudinal sectional view illustrating a first embodiment of the device of the invention, and

FIG. 3 is a longitudinal sectional view illustrating the second embodiment of the device of the invention.

Referring first to FIG. 1 and FIG. 2 which illustrate the first embodiment of the device of the present invention, numeral 1 indicates a contact breaker housing within which a fixed baseplate 2 is rigidly mounted by means of screws 3. A camshaft 4 is disposed within the housing 1 and is operatively connected to an engine (not shown) so as to be rotated thereby in the direction indicated by an arrow shown in FIG. 1. A rotatable plate 5 is supported on the fixed baseplate 2 for free rotation about the camshaft 4. On the rotatable plate 5 is rigidly mounted a supporting plate 6 by means of screws 7, which supporting plate has a breaker rod 8 pivotably connected thereto by means of a pivot pin and an electrically insulating sleeve therearound. The rotatable plate 5 has a fixed contact point 9 mounted on the supporting plate 6 in opposite relationship to a movable contact point 10 mounted on the forward end of the breaker rod 8. The latter has mounted thereon a slider or cam follower 11 which will follow the rotational movement of the cam surface of the camshaft 4 so as to move the movable contact point 10 away from the fixed contact 9 for thereby breaking or shutting off the primary current in the ignition coil (not shown) when the cam follower 11 rides on each of the projections or rises on the cam surface.

Numeral 12 indicates a vacuum-controlled spark-timing device according to the present invention. The device 12 is

secured through a mounting plate 13 to the housing 1 of the contact breaker by means of a screw 14. The device includes a connecting rod 15 having one end pivotably connected to the rotatable plate 5 of the contact breaker by means of a pin 16. The connecting rod 15 has a reduced-diameter portion 15*a* adjacent the other end of the rod with a shoulder formed between the portion 15*a* and the major portion of the rod 15. The connecting rod portion 15*a* extends through the center of a circular diaphragm 17 and through the centers of a pair of cup-shaped washers 18 and 19 disposed on the opposite sides of the diaphragm 17. The reduced-diameter portion 15*a* has a threaded forward end on which a bar 20 having a threaded recess is threadable mounted to fasten the washers 18 and 19 and the sandwiched diaphragm 17 against the shoulder on the connecting rod 15.

A diaphragm 21 closely and sealingly surrounds the peripheral surface of the connecting rod 15 adjacent the shoulder. The diaphragm 21 has its outer end sealingly bonded to an inner periphery of a supporting sleeve 22 which is adapted to be fitted into the housing 1 of the contact breaker. The other or inner end of the diaphragm 21 is also sealingly bonded to the bottom of the cup-shaped washer 18.

A generally cup-shaped casing member 24 having a vacuum inlet port 23 is sealingly secured at the inner peripheral edge of central opening to the outer periphery of the supporting sleeve 22. At the side opposite to the casing 24 with respect to the diaphragm 17, a cup-shaped casing member 26 having a vacuum inlet port 25 is sealingly secured at the inner peripheral edge of central opening to a sleeve member 27 having a closure 28 threadably fitted into the outer end of the sleeve 27 with a packing ring 29 interposed therebetween. The casing members 24 and 26 have their outer peripheries firmly secured or connected together with the outer periphery of the diaphragm 17 firmly held between the connected peripheries of the casing members, the casing members 24 and 26 and the diaphragm 17 cooperating to define a pair of enclosed chambers 30 and 31 on the opposite sides of the diaphragm 17.

The sleeve 27 has a bottom or inner wall 27′ formed with a central aperture through which the rod 20 extends into the interior of the sleeve. Within the latter and around the rod 20 is disposed a pair of inner and outer coiled compression springs 32 and 33 having their one ends urging a flat washer 34 against the bottom 27′ of the sleeve member 27. The inner compression spring 32 is retained at the other end by a nut 35 threadably mounted on the forward end of the rod 20. Also, the outer compression spring 33 is retained at the other end by a plate 36 threadably fitted into the sleeve 27 and centrally apertured for the reasons which will become apparent later.

The vacuum inlet ports 23 and 25 of the casings 24 and 26 are connected to the air inlet conduit 40 of an associated engine at points downstream and upstream, respectively, of a throttle valve 41 in the conduit.

The device of the present invention having the aforestated construction operates in the following manner: Since the throttle valve of the engine is opened during ordinary operation of the engine, there exists atmospheric pressure within the air inlet conduit 40 at the point of connection of a tubing 42 from the vacuum inlet port 23 to the air inlet conduit whereas vacuum is produced within said air inlet conduit at the point of connection of another tubing 43 from the vacuum inlet port 25 to said air inlet conduit, which vacuum is exerted through said another tubing 42 and the vacuum inlet port 25 to the enclosed chamber 31 to suck or bias the diaphragm 17 rightwards. This displaces the diaphragm 17 to a position at which said vacuum is balanced with the flexibility of the compression spring 33. This displacement of the diaphragm 17 is transmitted through the connecting rod 15 and the pin 16 to the rotatable plate 5 of the contact breaker for rotating the rotatable plate in the direction opposite to the direction indicated by the arrow shown in FIG. 1, with the result that the time at which the cam follower 11 is reached by projections on the cam surface of the camshaft 4 is advanced. Thus, an advancement of ignition timing is achieved.

The throttle valve is completely closed at idling or deceleration of the engine. In this condition of the engine, atmospheric pressure is abruptly exerted to the enclosed chamber 31 while the other chamber 30 is supplied with vacuum, so that the diaphragm 17 is biassed or displaced leftwards to a position at which said vacuum is balanced with the flexibility of the compression spring 32. This displacement of the diaphragm 17 rotates the rotatable plate 5 in the direction opposite to the direction in the above-described instance, that is, in the direction indicated by the arrow in FIG. 1. This rotation, therefore, achieves a retardation of ignition timing.

FIG. 3 illustrates the second embodiment of the present invention. The device of the instant embodiment operates in the same manner as in the first embodiment. In this embodiment shown in FIG. 3, the parts similar or identical to those in the first embodiment are denoted by identical numerals. The greatest difference in structure of this embodiment from the device of the preceding embodiment is that while in the first embodiment the compression springs 32 and 33 are both disposed within the enclosed chamber 31, the compression spring 32 in the instant embodiment is disposed within the enclosed chamber 30 and the compression spring 33 is provided within the enclosed chamber 31. In addition, the threaded rod 20 in the first embodiment is replaced by a capnut 37 which urges cup-shaped washers 18 and 19 against a shoulder defined by an enlarged portion 15*b* on the connecting rod 15, said washers being disposed in contact with the opposite sides of the diaphragm 17 in the central portion thereof. A threaded plate 38 is substituted for the nut 35 in the first embodiment, the plates 38 being threadably fitted into the supporting sleeve 22 to retain the compression spring 32 at its one end. A flat washer 39 is disposed around the connecting rod 15 between the other end of the compression spring 32 and another shoulder on the enlarged portion 15*b* formed on the side opposite to the above-mentioned shoulder. A spring retainer 40 corresponding to the threaded plate 36 in the first embodiment is threadably mounted on the closure 28 of the sleeve 27 to retain the compression spring 33 at its outer end.

In the devices of the first and the second embodiments, any one of advanced and retarded ignition-timing characteristics may be obtainable by replacing the compression springs 32 and 33 with springs of different spring constant. Furthermore, a precise regulation of advanced and/or retarded ignition-timing characteristics after the completion of mounting of the devices may be carried out by appropriately adjusting the positions of the nut 35 and the threaded plate 36 in the first embodiment and of the threaded plate 38 and the spring retainer 40 in the second embodiment. In addition, the device of the present invention may be operable either as a device only for advancing ignition timing in which case the vacuum inlet port 23 is always opened to atmosphere, or as a device only for retarding ignition timing in which instance the vacuum inlet port 25 is always opened to atmosphere.

As has been described in detail, the device of the present invention comprises a pair of enclosed chambers, one for the advancement of ignition timing and the other for the retardation of the ignition timing, formed on the opposite sides of a single diaphragm which is actuated or driven by the vacuum present within the air inlet conduit of an engine. In addition, springs are mounted within at least one of the enclosed chambers to control the displacement of the diaphragm. Moreover, the latter is connected to a connecting rod for driving the rotatable plate in the contact breaker housing. The present invention, therefore, provides an advantage that ignition-timing advancing and retarding effects can be achieved with a single device by introducing the vacuum from the interior of the air inlet conduit into the enclosed ignition-timing advancement chamber during normal operation of the engine and by introducing the vacuum into the enclosed ignition-timing retardation chamber during idling or deceleration of the engine. It is further pointed out that the device of the present invention may be of substantially equal size as that of conventional vacuum-controlled spark-timing-advancing device, with the

result that the device can easily and conveniently be mounted onto a given automobile. Moreover, since the ignition-timing advancing and retarding sections are united together into a single unit, a better vibrationproof characteristic may be obtained. According to the present invention, a still further advantage is also obtainable that the device of the invention may be independently used either as an ignition-timing advancer or as an ignition-timing retarder by selectively exposing any one of the ignition-timing advancement and retardation chambers to atmosphere.

The present invention has been described and illustrated hereinabove with reference to preferred embodiments. It should be understood that the above embodiments are only for illustrative purpose and the invention is not limited to these embodiments buy may have various modifications and changes within the spirit and the scope of the invention defined in the annexed claims.

What is claimed is:

1. A vacuum-controlled spark-timing device for use with an internal combustion engine of the type that utilizes at least one ignition plug, said device comprising a casing, a diaphragm dividing the interior of said casing into two chambers, a first chamber which has a first vacuum inlet port communicating with an air inlet conduit of said engine downstream of a throttle valve mounted in said conduit, and a second chamber which has a second vacuum inlet port communicating with said air inlet conduit upstream of said throttle valve, a connecting rod having one end pivotally connected to a rotary plate in an associated contact breaker housing and the other end secured to said diaphragm, and a pair of independent compression spring means provided within at least one of said chambers and arranged such that only one of said spring means acts on said connecting rod when said rod is moved in one direction while only the other spring means acts thereon when said rod is moved in the opposite direction, whereby said diaphragm is biassed in one direction by the vacuum drawn through said second vacuum inlet port on said second chamber during normal operation of said engine to cause said connecting rod to rotate said rotary plate in one direction for advancing the spark timing of said engine whereas said diaphragm is biassed in the other direction by the vacuum drawn through said first vacuum inlet port on said first chamber during idling or deceleration operation of said engine to cause said connecting rod to rotate said rotary plate in the opposite direction for thereby retarding the spark timing of said engine.

2. A vacuum-controlled spark-timing device as claimed in claim 1 wherein means are provided on at least one casing member for precisely adjusting the spring forces of said spring means.

3. A vacuum-controlled spark-timing device as claimed in claim 2 wherein said spring means are a pair of compression coil springs disposed within one of said chambers, the forces of said coil springs being adjustable by adjustable spring retainers, one of said retainers being threadably mounted on said casing while the other of said retainers is threadably mounted on said connecting rod.

4. A vacuum-controlled spark-timing device as claimed in claim 2 wherein said spring means are a pair of compression coil springs one spring being disposed within each of said chambers, the forces of said coil springs being adjustable by a pair of adjustable spring retainers each threadably mounted on said casing.