Feb. 28, 1967 L. A. BEVACQUA 3,306,272

VACUUM SERVO ADVANCE MECHANISM

Filed April 1, 1965 2 Sheets-Sheet 1

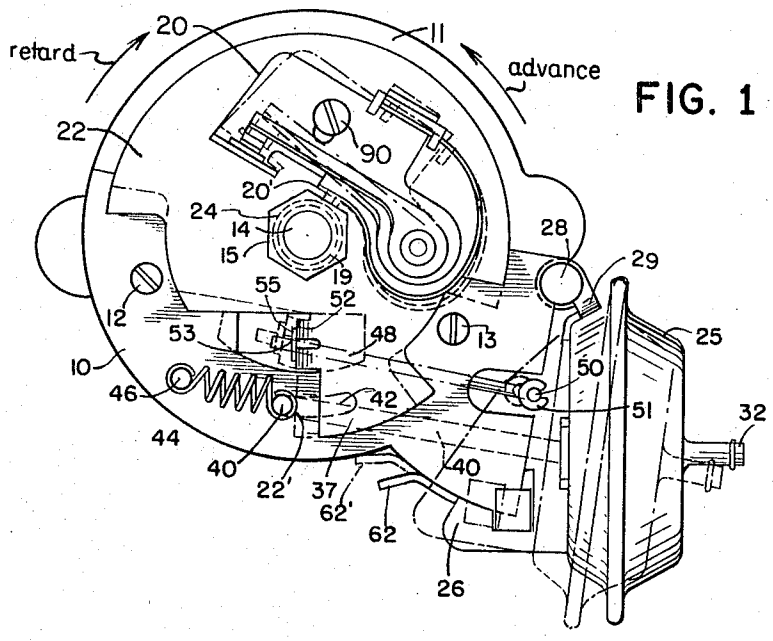


FIG. 1

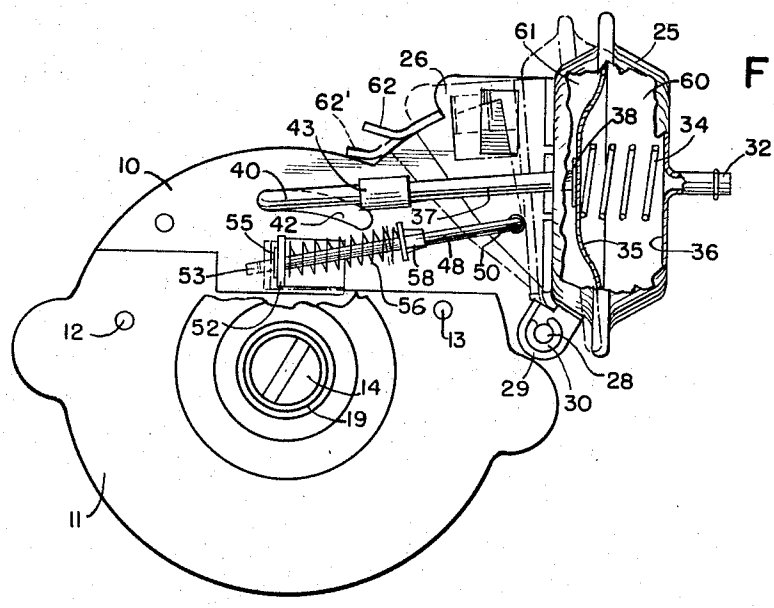


FIG. 2

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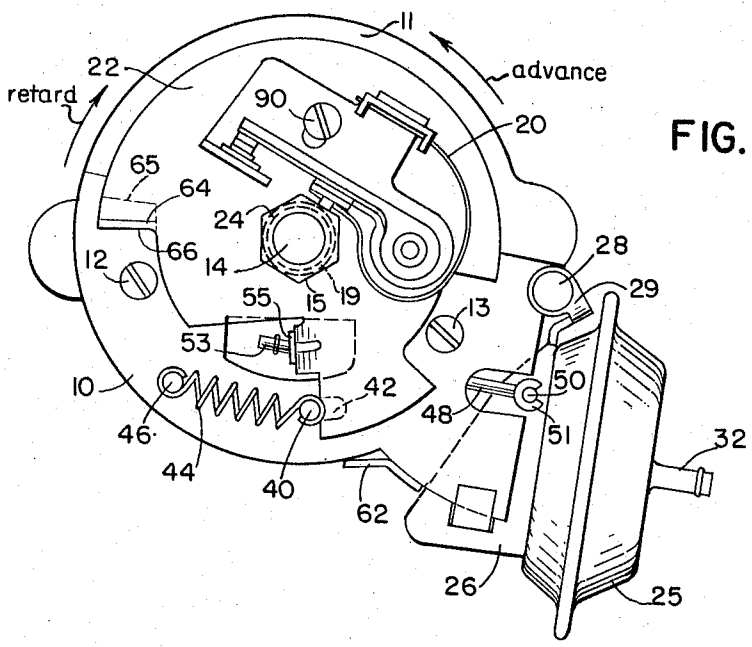


FIG. 3

FIG. 4

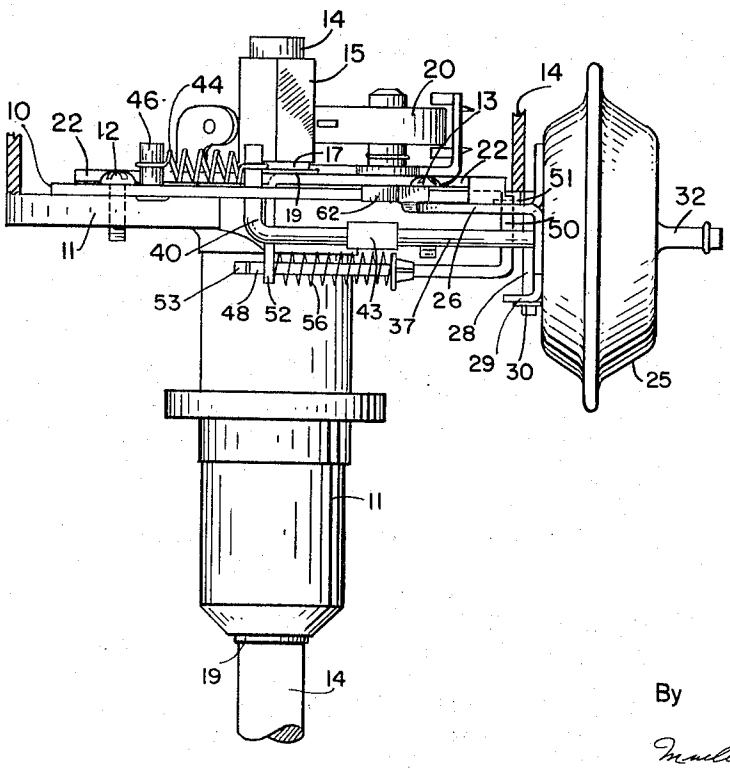
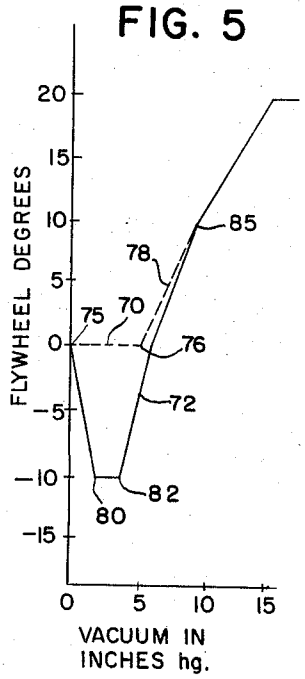


FIG. 5



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United States Patent Office 3,306,272
Patented Feb. 28, 1967

3,306,272

VACUUM SERVO ADVANCE MECHANISM

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Filed Apr. 1, 1965, Ser. No. 444,760
8 Claims. (Cl. 123—117)

This invention pertains generally to a vacuum servo advance mechanism, and more particularly to a vacuum servo mechanism for the ignition timer of an automobile engine which both advances and retards the timer at different engine speeds.

Reduction of smog in large cities has become an increasingly important problem. To meet this problem it is highly desirable that automobile engines be designed to operate so that the hydrocarbons which are emitted in the exhaust from the engines are substantially reduced. One way to reduce this emission of hydrocarbons in the exhaust is by retarding the engine ignition timing during the time that the car is idling, for instance, when stopped in heavy traffic or at a traffic light.

Present ignition timers have the spark advance set at the manufacturer's recommended position for starting, and then advance the spark with increased engine r.p.m. Therefore, the engine ignition timing is the same during idling as at starting, or slightly advanced with respect to the starting position. To retard the timing further at starting would present the problem of hard starting, loss of power, and overheating at high r.p.m.

It is, therefore, an object of this invention to provide an improved vacuum servo advance mechanism for an automobile ignition timer.

It is another object of this invention to provide a vacuum servo mechanism for an engine ignition timer that permits starting an automobile engine at the optimum timing, retarding the ignition timing below the position for starting while idling, and then advancing the engine timing with increased engine vacuum.

A feature of this invention is the provision of a vacuum servo mechanism having one vacuum actuated diaphragm coupled through a mechanical linkage to provide mechanical motion in two directions.

Another feature of this invention is the provision of a vacuum servo advance mechanism having a first fixed plate, a second plate rotatably mounted with respect to the first plate, and a third plate pivotally mounted to the first fixed plate and supporting a servo body including a vacuum actuated diaphragm. The diaphragm is connected through a mechanical linkage to the second plate and moves the same first in one direction relative to the first plate, and upon increased vacuum in the servo body moves the second plate relative to the first plate in the direction opposite to the one direction.

In the drawings:

FIG. 1 is a plan view of the vacuum servo mechanism for an ignition timer with the position for engine idling shown in dotted lines;

FIG. 2 is a bottom view of the same mechanism of FIG. 1;

FIG. 3 is a plan view of the same mechanism showing the engine running at an r.p.m. greater than at idling;

FIG. 4 is a side view of the mechanism; and

FIG. 5 is a graph illustrating the operation of the mechanism of the invention.

In accordance with this invention, a vacuum servo mechanism for an ignition timer is provided having a first fixed plate, a second plate rotatably mounted with respect to the first plate, and a third plate pivotally mounted to the first plate, and which supports a servo body having a vacuum actuated diaphragm. A first rod is connected from the diaphragm to the second plate by means of a right angle portion that extends through an arcuate slot in the first plate. A first spring connects the right angle extension to the fixed plate and biases the extension from slidably engaging the second plate. A second rod is connected between the second and third plates through a second spring.

Initial vacuum in the servo body actuates the diaphragm which attemps to draw the first rod connected to the diaphragm toward the vacuum side of the diaphragm. However, the tension of the first spring connecting the extension of the rod to the first plate is sufficiently great that the rod remains stationary and the servo body is drawn towards the diaphragm. As the servo body pivots about the fixed plate, the motion is translated through the second rod to move the second plate in a retarding direction relative to the first plate. As the vacuum in the servo body is increased, the pressure differential is great enough for the diaphragm to overcome the first spring tension, so that the extension of the first rod engages the second plate and draws the same against the bias of the first and second springs to move the second plate relative to the first plate in the opposite or advance direction.

The device of the invention is described for use as a vacuum servo advance mechanism for an automobile ignition timer. It should be understood that this device may find utility in other applications where a vacuum servo advance mechanism is desirable.

In FIGS. 1 through 4, a first fixed plate **10** is mounted to housing **11** by screws **12** and **13**. A drive shaft **14** extends coaxially and rotatably within the housing **11**. A cam **15** on the drive shaft **14** has a shoulder **17** which is in rotatable contact with bearing surface or bush **19**. As the drive shaft **14** turns inside the housing **11**, the cam **15** is turned to operate the ignition timing points **20** in the known manner. A second or breaker plate **22** has an aperture **24** through which bush **19** passes. The plate **22** is rotatably and coaxially mounted with respect to plate **10** and housing **11**, and carries the ignition timing points **20** which can be statically adjusted on the plate **22** by screw **90**.

A vacuum servo body **25** is connected to a third plate **26**. This third plate **26** is pivotally mounted to the first fixed plate **10** by pivot post **28** passing through the bracket **29** and secured by crescent lock washer **30**. The servo body **25** has an inlet **32** connected to the vacuum line (not shown) extending from the engine intake manifold as is well known to those familiar with the art. The vacuum in the servo body, therefore, varies in the same sense as the crankshaft r.p.m. of the engine. A spring **34** (FIG. 2) is inserted between the diaphragm **35** and the wall **36** of the servo body **25**. The spring **34** biases the diaphragm **35** to oppose movement of the diaphragm **35** towards the vacuum side **60** of the servo **25**. This spring **34** regulates the advance of the mechanism as will be described.

A first rod **37** has one end thereof connected through an aperture in the servo body **25** to the face of the diaphragm **35** at **38**. A second end has a right angle extension **40** connected to it by coupling **43**. The right angle extension **40** extends through an arcuate slot **42**, and a spring **44** connects the extension **40** to a projection **46** on the first fixed plate **22**. A second rod **48** has one end, a right angle extension **50**, that is inserted through an aperture in plate **26** and secured to that plate by crescent lock washer **51**. The second end **53** is inserted through an aperture in a tab **52**, that was cut from plate **22** and bent into position. A crescent lock washer **55** prevents the end **53** from slipping out of the tab **52**. A spring **56** encircles the rod **48** and has one end butted against the tab **52** and the other end butted against shoulder **58** that is pinched to the rod **48**.

The full lines in FIGS. 1 and 2 indicate the position of the device with the engine stopped. At this point the

timing is set at the manufacturer's recommended position for starting. After the engine has started and begins to idle, the components are rotated as indicated in the dotted lines to retard the spark. When the engine is idling, for example, between 300 to 600 r.p.m., the vacuum side **60** of the servo **25** is subjected to a pressure of approximately two inches of mercury. The other side **61** of the servo is open to atmospheric pressure, so that when the vacuum is drawn the diaphragm **35** tends to move toward the vacuum side **60** in an attempt to equalize the pressure. This motion is resisted by spring **34**. The pressure of the spring **34** is reduced somewhat from the standard diaphragm return spring generally used in the art, in order to permit motion of the diaphragm at a lower than normal vacuum. As the diaphragm **35** moves, it attempts to carry rod **37** with it, however, the tension of spring **44** is greater than the pressure differential at idling speeds, with the result that the entire servo body **25** rather than the diaphragm **35** moves about pivot **28** to equalize the pressure. This motion of the servo body **25** connected to plate **26** is transmitted through rod **48** and tab **52** to move breaker plate **22** clockwise. This clockwise movement of the plate **22** moves the points **20**, which are mounted on the plate **22**, in a similar fashion to retard the spark, for example, 10° as shown by the dotted line **20'**. The rotation of the body **25** about pivot post **28** is limited by stop **62** meeting plate **10**, as shown by dotted line **62'** and the simultaneous meeting of plate **22** with extension **40**, as shown by the dotted and dashed line **22'**.

When the engine r.p.m. is increased above idling, the vacuum increases thereby increasing the pressure differential on either side of the diaphragm **38**. When this pressure differential is great enough to overcome the tension of spring **44**, spring **56** and spring **34**, the diaphragm **35** will move toward the vacuum side **60** of the body **25** and draw rod **37** with it. This motion of rod **37** causes extension **40**, which had been biased by spring **44** from slidably engaging plate **22**, to slide in arcuate slot **42**. Since extension **40** was in contact with plate **22** at **22'** (FIG. 1), as previously stated, this sliding action of the extension **40** will move the breaker plate **22**, hence points **20**, in a counter clockwise fashion to advance the spark.

FIG. 3 shows the points advanced with the engine running at some r.p.m. greater than at idle. Dotted lines show the relative position of the breaker plate **22**, at starting **64** and in the retarded position while idling **65**. The advance position **66** is shown in solid.

It should be noted that once the vacuum gets to approximately two inches of mercury the servo body **25** will rotate until the stop **62** hits the fixed plate **10** and will remain in this position, even when the breaker plate **22** is advanced, until the vacuum decreases below approximately two inches of mercury. In addition, the combined tension of springs **44**, **56** and **38** is substantially equal to the normal tension of a standard diaphragm return spring commonly used in the art. This insures that the timing will be advanced when the engine r.p.m. is increased above idling speeds in accordance with the manufacturer's recommendations.

The operation of this invention may be better understood by referring to the graph of FIG. 5. The change in flywheel degrees is plotted against the change in vacuum in inches of mercury, with the dotted line **70** indicating the standard advance recommended by the manufacturer, and the solid line **72** indicating the advance and retarding action of the structure of this invention.

Using a standard ignition advance mechanism, the engine of the vehicle is started with the advance as indicated at **75** and remains at the recommended starting position during the entire idling range, or until the vacuum is about five inches, as indicated at **76**. At this point the timing is advanced by the increased vacuum in the same sense as the engine r.p.m., along the line **78**.

With the vacuum servo mechanism of this invention, however, the vehicle is started at the manufacturer's recommended position for starting **75**, but as the vacuum increases to about two inches during idling, the ignition timing is retarded 10° in the manner previously described and as shown at **80** on the graph. The curve between points **80** and **82** is relatively flat representing the period where the vacuum is increased from the idling range but is still not great enough to overcome the tension of spring **34** to advance the timing. However, because the tension of spring **34** is reduced from that of the standard spring, a slight increase in vacuum (point **82**) from the idling range causes the ignition timing to be rapidly advanced. This is shown by line **72** which continues to rise rapidly until the combined tensions of spring **44**, spring **56** and spring **34** cooperate to regulate the timing advance. At the point **85**, the two curves merge, and the timing is advanced from that point in accordance with the manufacturer's recommendation.

It is possible during heavy engine loads and deceleration to eliminate the retarding of the timing. This could be done by reducing the vacuum below one inch during the periods that the elimination of the retarding of the timing was desired thereby permitting the servo body to return to its stop position. Vacuum could be reduced by throttle settings, relays and other known methods.

What has been described, therefore, is an improved vacuum servo advance mechanism which uses only one diaphragm to provide mechanical motion in two directions. This makes it possible to start an engine at the manufacturer's recommended timing, then retard the ignition timing below that of the manufacturer's recommended position while idling, and then advance the engine timing with the increased engine vacuum in accordance with the manufacturer's recommendations.

What is claimed is:

1. A vacuum servo advance mechanism including in combination, a first fixed plate, a second plate rotatably mounted with respect to said first plate, vacuum means to rotate said second plate relative to said first plate including a vacuum actuated diaphragm, pivotal means supporting said vacuum means on said first plate and linking means coupling said diaphragm and said pivotal means to said second plate, said diaphragm being responsive to an initial vacuum and acting through said linking means to move said second plate in one direction relative to said first plate, said linking means being responsive to increased movement of said diaphragm to move said second plate relative to said first plate in a direction opposite to said one direction.

2. A vacuum servo advance mechanism for use with an automobile engine ignition timer and for actuation by vacuum taken from the automobile engine which varies in the same sense as the engine r.p.m., the combination including a first fixed plate, a breaker plate rotatably mounted with respect to said first plate, vacuum means to rotate said breaker plate relative to said first plate to advance and retard the engine ignition timing including a vacuum actuated diaphragm, pivotal means supporting said vacuum means on said first plate and linking means coupling said diaphragm and said pivotal means to said breaker plate, said diaphragm being responsive to the vacuum taken from the engine at idling r.p.m. and acting through said linking means to move said breaker plate in one direction relative to said first plate to retard the ignition timing, said linking means being responsive to increased movement of said diaphragm with increased engine r.p.m. above said idling r.p.m. to move said breaker plate relative to said first plate in the direction opposite to said one direction to advance the ignition timing.

3. A vacuum servo advance mechanism including in combination, a first fixed plate, a second plate rotatably mounted with respect to said first plate, a third plate pivotally mounted to said first fixed plate, vacuum means to rotate said second plate relative to said first plate including a servo body having a vacuum actuated dia-

phragm, said servo body being mounted to said third plate, linking means coupling said diaphragm and said third plate to said second plate, and spring means coupled between said first plate and said diaphragm, said linking means being responsive to initial vacuum applied to said diaphragm for moving said second plate in one direction relative to said first plate, said linking means being responsive to increased vacuum for moving said second plate relative to said first plate in a direction opposite to said one direction, with said spring means preventing said motion in said direction opposite to said one direction until the limit of said motion in said one direction is reached.

4. A vacuum servo advance mechanism including in combination, a first fixed plate having an arcuate slot therein, a second plate rotatably mounted with respect to said first plate, servo means including a vacuum actuated diaphragm, pivotal means supporting said servo means on said first fixed plate, linking means including a first rod coupled to said diaphragm and slidably engageable with said second plate and a second rod coupled between said pivotal means and said second plate, with initial vacuum in said servo means actuating said diaphragm to cause said pivotal means to pivot with respect to said first plate thereby causing said second rod to move said second plate in one direction relative to said first plate, and increased vacuum in said servo means causing said diaphragm to move said first rod thereby moving said second plate relative to said first plate in a direction opposite to said one direction.

5. A vacuum servo advance mechanism for an engine ignition timer, including in combination, a first fixed plate, a second plate rotatably mounted with respect to said first plate, a third plate pivotally mounted to said first fixed plate, a servo body including a vacuum actuated diagram fixedly mounted to said third plate, linking means including a first rod coupled to said diaphragm and slidably engageable with said second plate and a second rod coupled between said third plate and said second plate, and spring means coupled between said first rod and said first fixed plate, with initial vacuum in said servo body actuating said diaphragm whereupon said diaphragm and said spring means cooperate causing said third plate to pivot with respect to said first plate thereby causing said second rod to move said second plate in one direction relative to said first plate, and increased vacuum in said servo body causing said diaphragm to move said first rod thereby moving said second plate relative to said first plate in the direction opposite to said one direction.

6. A vacuum servo advance mechanism for an engine ignition timer including in combination, a first fixed plate having an arcuate slot therein, a second plate rotatably mounted with respect to said first plate, a third plate pivotally mounted to said first fixed plate, a servo body having a vacuum actuated diaphragm fixedly mounted to said third plate, a first rod having one end connected to said diaphragm and a second end having a right angle extension slidably extending through said arcuate slot and engageable with said second plate, a first spring connecting said right angle extension to said fixed plate and biasing said extension from slidably engaging said second plate, a second rod having one end connected to said third plate and a second end, a second spring connecting said second end of said second rod to said second plate, with initial vacuum in said servo body actuating said diaphragm to cause said third plate to pivot with respect to said first plate thereby causing said second rod to move said second plate in one direction relative to said first plate, and increased vacuum in said servo body causing said diaphragm to move said first rod thereby sliding said right angle extension in said arcuate slot

into engagement with said second plate and moving the same against the bias of said first and second springs relative to said first plate in the direction opposite to said one direction.

7. A vacuum servo advance mechanism having a servo body with a spring return diaphragm for an engine ignition timer, the combination including a first fixed plate having an arcuate slot therein, a breaker plate rotatably mounted with respect to said first plate, a third plate with the servo body being fixedly mounted thereto, said third plate being pivotally mounted to said first fixed plate, a first rod having one end connected to the diaphragm and a second end having a right angle extension slidably extending through said arcuate slot and engageable with said breaker plate, a first spring connecting said right angle extension to said fixed plate and biasing said extension from slidably engaging said breaker plate, a second rod having one end connected to said third plate and a second end, a second spring connecting said second end of said second rod to said breaker plate, with initial vacuum in the servo body actuating the diaphragm to cause said third plate to pivot with respect to said first plate thereby causing said second rod to move said breaker plate in one direction relative to said first plate, and increased vacuum in the servo body causing said diaphragm to move said first rod thereby sliding said right angle extension in said arcuate slot into engagement with said breaker plate and moving the same against the bias of said first and second springs and the diaphragm return spring relative to said first plate in the direction opposite to said one direction.

8. A vacuum servo advance mechanism for use with an automobile engine ignition timer and for actuation by vacuum taken from the automobile engine which varies in the same sense as the engine r.p.m., the combination including a first fixed plate having an arcuate slot therein, a breaker plate rotatably mounted with respect to said first plate, a third plate pivotally mounted to said first fixed plate, a servo body having a vacuum actuated diaphragm fixedly mounted to said third plate, a first rod having one end connected to said diaphragm and a second end having a right angle extension slidably extending through said arcuate slot and engageable with said breaker plate, a first spring connecting said right angle extension to said fixed plate and biasing said extension from slidably engaging said breaker plate, a second rod having one end connected to said third plate and a second end, a second spring connecting said second end of said second rod to said breaker plate, with initial vacuum in said servo body taken from the engine at idling r.p.m. actuating said diaphragm to cause said third plate to pivot with respect to said first plate thereby causing said second rod to move said breaker plate in one direction relative to said first plate to retard the ignition timing and increased vacuum in said servo body taken from the engine at some r.p.m. greater than said idling r.p.m., causing said diaphragm to move with said first rod thereby sliding said right angle extension in said arcuate slot into engagement with said breaker plate and moving the same against the bias of said first and second springs relative to said first plate in the direction opposite to said one direction to advance the ignition timing.

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