United States Patent [19]

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[11] **3,902,469**

[45] **Sept. 2, 1975**

[54] **VACUUM DELAY VALVE**

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[22] Filed: **Nov. 7, 1973**

[21] Appl. No.: **413,450**

[52] **U.S. Cl.**.... **123/117 A**; 123/117 R; 123/146.5 R

[51] **Int. Cl.**[2]..... **F02P 5/10**

[58] **Field of Search**..... 123/117 A, 117 R, 146.5 A

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[57] **ABSTRACT**

An improved engine spark timing control device that includes an elastic valve disc cooperating with a valve seat, such elastic valve disc having a fixed orifice therethrough. The control device operates to control the rate of change of application of sparking from the spark port to the servo means associated at the engine distributor. Another aspect of the invention is the improved manner of fabricating the elastic valve disc with a precise small area opening therein.

8 Claims, 5 Drawing Figures

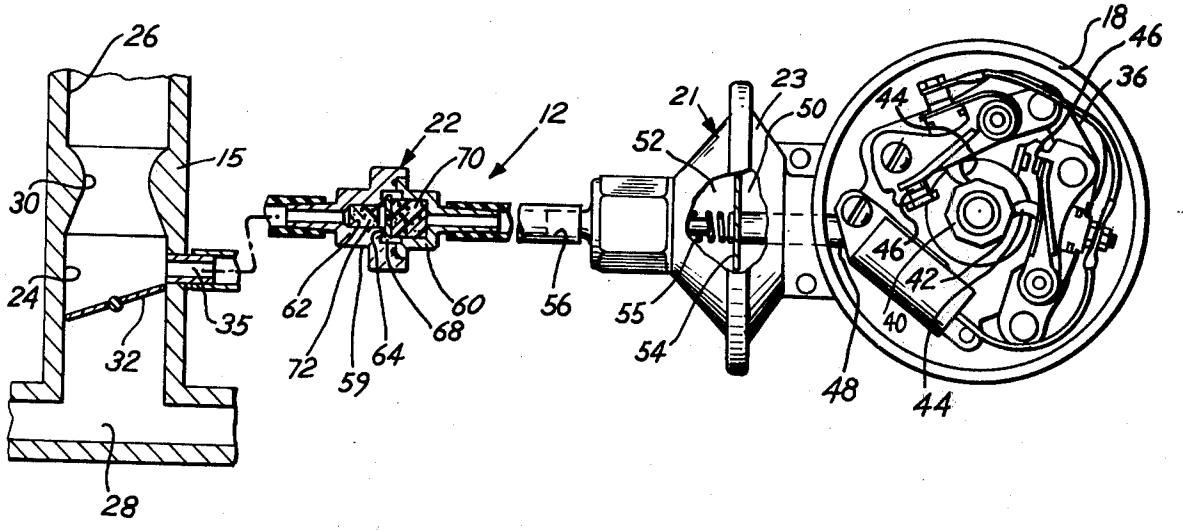


Fig. 1

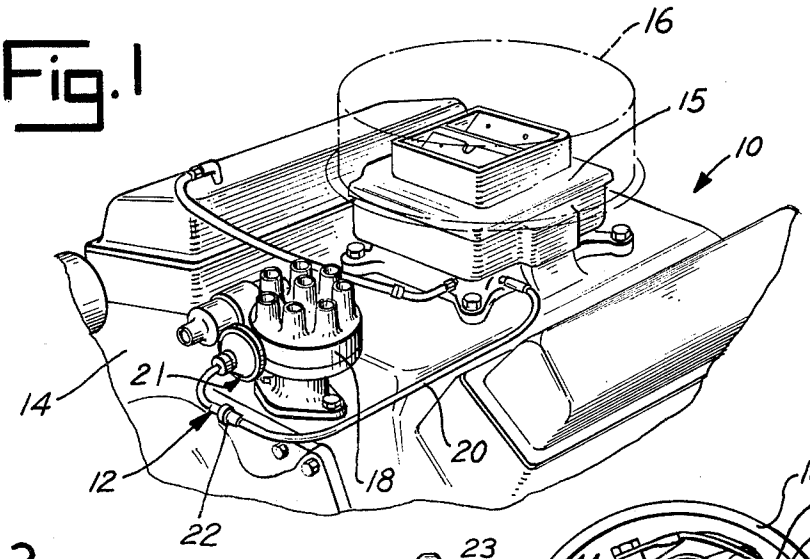


Fig. 2

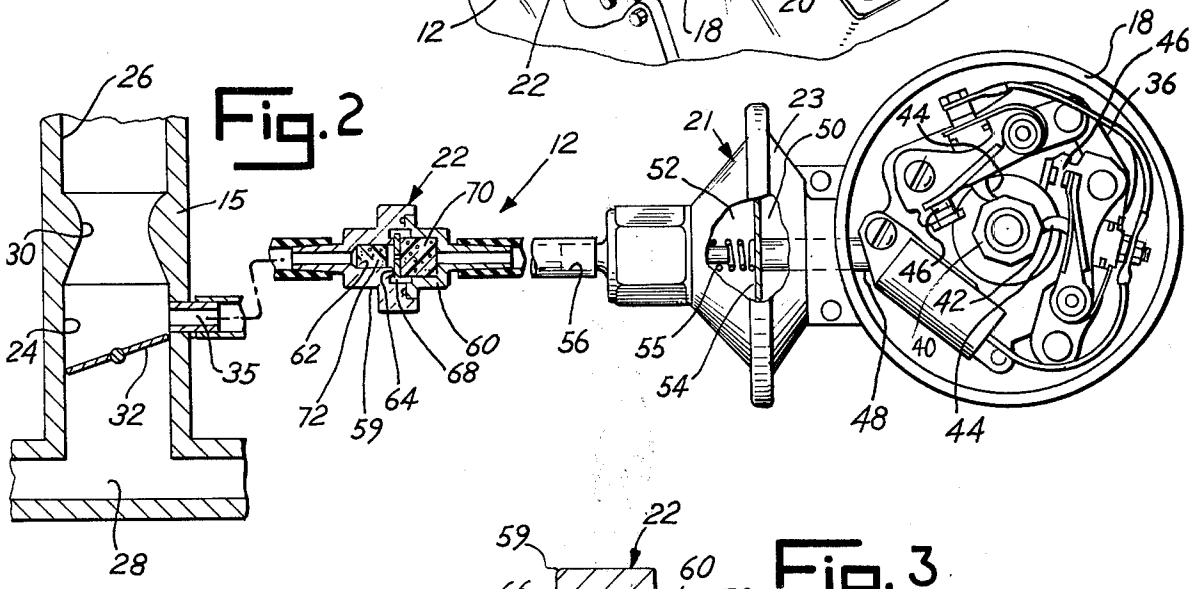


Fig. 3

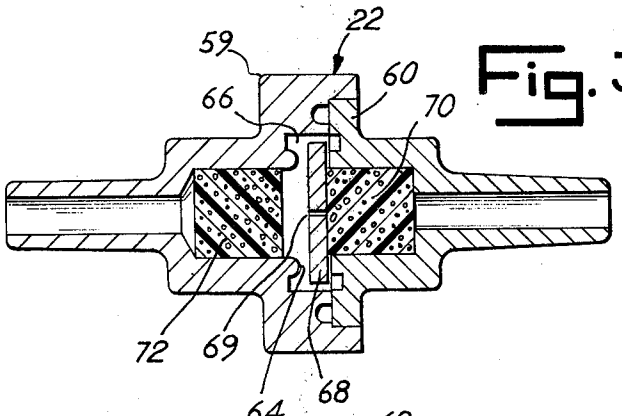


Fig. 4

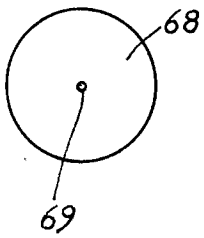
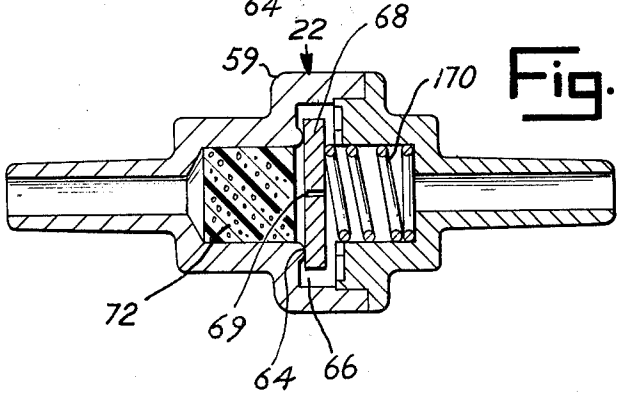


Fig. 5



VACUUM DELAY VALVE

BACKGROUND OF THE INVENTION

This invention relates to an engine spark timing control device, and more particularly, to an improved engine spark timing control device which incorporates an elastic valve disc cooperating with a valve seat, such elastic valve disc cooperating with a valve seat, such elastic valve disc having fixed area orifice means therethrough.

Most automobile engines are today provided with a vacuum mechanism for automatically controlling the advance or retard setting of the engine distributor breaker plate as a function of the carburetor spark port vacuum so as to provide good engine performance, as well as fuel economy during the different operating conditions of the vehicle engine. The vacuum mechanism or servo comprises basically a housing divided into an atmospheric pressure chamber and a vacuum chamber by a flexible diaphragm operatively connected to the distributor breaker plate. The flexible diaphragm and the distributor breaker plate are normally spring biased to the lowest advance or retard spark timing setting, and the carburetor spark port vacuum will normally urge the diaphragm in a spark timing advance direction upon opening of the carburetor throttle valve to increase engine speed.

During rapid accelerations, the drop in vacuum at the carburetor spark port permits atmospheric pressure acting on the opposite side of the servo diaphragm to quickly move the distributor breaker plate to a lower advanced setting to meet engine performance requirements. On the other hand, upon return to normal operation and gradual re-acceleration or deceleration of the engine, an increase in vacuum at the carburetor spark port causes an immediate return movement of the vacuum servo diaphragm to a higher engine spark timing advance setting. This provides a longer burning time for the fuel mixture before the optimum top or near top dead center position of the piston is obtained, generally providing the most desirable operation. However, this longer time permits a built-up to high combustion temperatures and pressures, which are undesirable insofar as the production of nitrogen oxides and other undesirable pollutant elements are concerned.

In the Gropp et al U.S. Pat. No. 3,606,871 there is disclosed an engine spark timing control device that is disposed between the spark port of the carburetor and the vacuum servo of the distributor. Such control device includes a one-way check valve in parallel flow circuit with sintered metal flow restrictions or plugs. The one-way check valve consists of a flapper movable forward or away from relatively large ports in a wall of the housing of the control device. The sintered metal plugs consist of randomly oriented metal particles compacted together under pressure so as to provide openings for fluid flow. The Gropp et al. patent recognized the problems of providing a conventional orifice of a small flow capacity in place of the sintered metal flow restrictions and comments that such could not be feasibly made under production conditions. Gropp et al indicated that a small flow size orifice made in a conventional manner by merely providing a reduced diameter passage would be easily plugged by dirt.

An object of the present invention is to provide an improved engine spark timing control device wherein

the disadvantages and deficiencies of prior known constructions are obviated.

Another object of the present invention is to provide an engine spark timing control means incorporating an elastic disc having fixed orifice means therein that are readily and inexpensively made in production.

A further object of the present invention is to provide an improved engine spark timing control means comprising a vacuum delay valve with a housing having an elastic valve disc therein provided with fixed orifice means therethrough that is self-cleaning in use due to the resilience of the elastic valve disc and which seals against its seat without the need for additional seals.

Yet another object of this invention is to provide an improved method of making an elastic valve disc having a small area opening therein.

These and other object of the present invention will become more apparent hereinafter.

BRIEF DESCRIPTION OF THE DRAWING

There is shown in the attached drawing presently preferred embodiments of the present invention wherein:

FIG. **1** is a perspective view of an engine incorporating the engine spark timing control arrangement of the present invention;

FIG. **2** is a schematic view of the engine spark timing control arrangement showing the vacuum delay valve in cross section;

FIG. **3** is an enlarged cross-sectional view of the vacuum delay valve showing the elastic disc therein in a different operating position from that in FIG. **2**;

FIG. **4** is a plan view of the elastic disc in the vacuum delay valve of FIGS. **2** and **3**; and

FIG. **5** is an enlarged cross-sectional view of a modified vacuum delay valve.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

Referring to FIGS **1** and **2**, there is illustrated an engine **10** embodying the engine spark timing control arrangement **12** of the present invention. The engine, being of conventional design, is shown somewhat schematically. Engine **10** incorporates the usual block **14**, carburetor **15**, air filter **16**, and distributor **18**. The engine spark timing control arrangement **12** incorporates the distributor vacuum line means **20** that communicates the carburetor **15** to the diaphragm **54** of the servo means **21** of the distributor **18** and the slow-fast rate control device **22** disposed within the vacuum line means **20** to control the rate of change of application of vacuum from the spark port of the carburetor **15** to the servo means **21** of distributor **18**.

In FIG. **2** there is better illustrated the engine spark timing control of the present invention. The carburetor **15** (shown schematically) is of the down draft type which includes the usual air-fuel induction passage **24** with an atmospheric air inlet **26** at one end and connected to the engine intake manifold **28** at the other end. Passage **24** contains the usual fixed area venturi **30** and a throttle valve **32**. The throttle valve **32** is rotatably mounted on a part of the carburetor body across the passage **24** in a manner to control the flow of the air-fuel mixture into the intake manifold **28**. Fuel would be inducted in the usual manner from a nozzle (not shown) projecting into or adjacent the venturi **30** in a known manner.

The throttle 32, shown in its engine idle speed position essentially closing the induction passage 24, is rotatable to a nearly vertical position essentially unblocking the passage 24. A spark port 35 is provided at a point just above the idle position of the throttle valve 32, to be transversed by the throttle valve 32 during its opening or part throttle movement. This will change the vacuum level in the spark port 35 as a function of the rotative position of the throttle valve 32, with the spark port 35 reflecting essentially atmospheric pressure in the air inlet 26 upon closure of the throttle valve 32.

The source of vacuum can be from the carburetor through a spark port (as shown) or alternatively, there could be a carburetor connection below the throttle valve or a connection directly from the intake manifold to communicating line 20.

When communicating line 20 is connected directly from distributor serve means 21 to intake manifold 28, the vacuum pressure in the intake manifold willl be transmitted to the servo at a slow rate when increasing and at a fast rate when decreasing. The result is a delay in the application of higher vacuum to the servo means to advance the spark timing, with no delay in the reduction of vacuum in the servo to retard the timing when the vacuum decreases in the intake manifold.

The distributor 18 includes a breaker plate 36 that is pivotally mounted at 36 on a stationary portion of the distributor 18, and movable with respect to cam 40. The cam 40 has eight peaks 42 corresponding to the number of cylinders in engine 10, each peak 42 cooperating with the follower 44 of a breaker points set 46 to make and break the spark connection in a known manner, each one eighth (in this case) rotation of cam 40. Pivotal movement of breaker plate 36 is counterclockwise spark retard setting direction, or in a clockwise spark advance setting direction, is provided by an actuator 48 operatively connected to diaphragm 54 in the housing 23 of vacuum servo housing 21.

The vacuum servo 21 may be of conventional construction incorporating hollow housing 23, whose interior is divided into an atmospheric pressure chamber 50 and a vacuum chamber 52 by an annular flexible diaphragm 54. The diaphragm 54 is fixedly secured to the actuator 48 and is biased to the right as viewed in FIG. 2 to a retard direction by a compression spring 55. Chamber 50 has an atmospheric or ambient pressure vent (not shown) while the chamber 52 is connected by a bore 56 to the line 20.

During engine-off and other operating conditions to be described, atmospheric pressure exists on both sides of the diaphragm 54, permitting the spring 55 to force the actuator 48 to the lowest advance or a retard setting position. Application of vacuum to chamber 52 moves the diaphragm 54 and the actuator 48 toward the left as viewed in FIG. 2 to an engine spark timing advance position, by degree responsive to the change in vacuum level.

Disposed within the line 20 is the vacuum delay valve 22 of the present invention. The vacuum delay valve 22 comprises a housing formed of two parts or cup-shaped portions 59 and 60 that are preferably molded from plastic and bonded to one another. Extending through the housing body part 59 is a passage 62 having a valve seat 64 defined adjacent an end thereof. Disposed in the chamber 66 within the housing formed by the body part 59 and cover part 60 is a resilient or elastic valve disc 68 that is adapted to seat against the valve seat 64. The elastic valve disc 68 is biased toward the closed seating position against valve seat 64 by spring means 70, which as shown may be fabricated from polyurethane foam. In this case, the spring means 70 would also function as a filter. Disposed in the passage 62 between the spark port and the elastic disc 68 is a filter 72, made from a suitable medium that will filter out particles that might otherwise impede operation of the vacuum delay valve.

Provided in the elastic valve disc 68 are orifice means of predetermined fixed area. Whereas it has been suggested in the prior art that an orifice means of a fixed small flow capacity could not feasibly be made under production conditions, applicant has discovered that utilization of a resilient valve disc having fixed area opening means formed therein can be made under production conditions in an economical fashion. Because of the elasticity or resiliency of the disc it will properly seat against the valve seat 64 and the flexibility thereof in use will help to free or unclog particles that might otherwise tend to accumulate in the fixed orifice mean therein.

In operation of the system, in engine-off, as well as engine idle speed and deceleration conditions, the engine spark port 35 will be at atmospheric pressure, as will both the chambers 50 and 52 of the vacuum servo 21. Therefore, the distributor breaker plate 36 will be placed in its lowest engine spark timing advance or retard position by the servo spring 55 acting through actuator 48.

During part throttle engine operations, during normal depression of the vehicle accelerator pedal (not shown), rotation of throttle valve 32 will communicate the vacuum in engine intake manifold 28 to the spark port 35 so that the passage 62 will be at a pressure level lower than that on the opposite side of the elastic disc 68. As the elastic valve disc 68 is seated, equalization of the pressures between the opposite sides of the valve disc will be obtained only through the fixed orifice means 69 in the valve disc 68. Thus, only a slow build up in vacuum will be transmitted to the vacuum servo chamber 52, resulting in only a slow change in the vacuum advance setting of the distributor breaker plate 36. This is a slower response than the conventional engine spark timing control system and the results in a lower advance setting than conventional for the same vacuum level in spark port 35, thereby producing lower peak combustion temperatures and pressures. The delayed ignition also causes the mixture to continue burning into the exhaust system and thereby provides more complete combustion. The end result is a lower output of undesirable engine exhaust elements.

If the engine throttle valve is suddenly moved toward wide open throttle position or rapid acceleration condition of operation, the sudden decay in vacuum in the engine intake manifold 28 is communicated immediately through the spark port 35 to the passage 62 to the left of the elastic valve disc 68. The vacuum level in the line 20 to the right of the elastic valve disc 68 is at a vacuum level previously attained at the spark port 35 and therefore, is at a lower absolute pressure than that in the passage 62. This immediately unseats the elastic valve disc 68 (FIG. 3) and allows a quick equalization of the pressures on opposite sides of the disc valve. Accordingly, the immediate change in vacuum level in spark port 35 is promptly communicated to the servo

chamber 52 and the braker plate 35 is immediately pivoted to a lower advance setting more appropriate to an accelerating condition of operation.

As soon as equalization occurs, the slow increase in vacuum in the spark port 35 permits the higher pressure in the chamber to the right of the elastic valve disc 68 to seat the elastic valve disc 68 and provide continued advance at a delayed rate because of the restricted flow through the orifice means 69. For each vacuum level of an engine, there is a corresponding desirable engine spark timing setting that is best for the particular engine to provide optimum performance.

If the vehicle throttle valve 32 now is permitted to return toward or to its idle speed position, from the rapid acceleration position previously attained, the vehicle then begins driving the engine and the spark port vacuum immediately decays to a lower value than normal (a higher absolute pressure than previously and higher than in the servo chamber 52). This immediately opens the check valve 68 and permits a quick equalization of the vacuum servo chamber 52 pressure to that of the spark port pressure level to reduce the advance setting of the distributor to a lower engine operating setting. Once the pressure levels are equalized, the check valve 68 will again be seated.

There has been provided by the present invention an engine spark timing control arrangement incorporating a vacuum delay valve that quickly and automatically provides the desired spark timing setting for engine performance and yet reduced the output of undesirable exhaust pollutants by delaying normal advance timing during gradual part throttle engine accelerating conditions of operation.

In FIG. 4 there is shown a plan view of an elastic valve disc 68 incorporating a single fixed area opening 69. The opening 69 is formed with precision and in one embodiment of the invention the opening is on the order of 0.0025 inch in diameter. The opening 69 is preferably formed by tensioning or compressing the material of disc 68 to reduce the effective thickness at the center thereof, forming the hole (or holes) using an oversized punch, drill or laser beam of predetermined size, and then releasing the tension or compression to permit the disc material to return to its unstressed state to provide a hole (or holes) of the desired area for the particular engine requirements with which the vacuum delay valve is used. Tensioning can be accomplished by clamping the edges peripherally and drawing the edges outwardly. The disc material can be compressed in dies and then punched, drilled, or lasered through a suitable opening in a die. By use of oversized means for forming the opening of predetermined size, greater precision is possible. This method results in an elastic disc with a precision formed small area opening that is able to be produced consistently in production in an economical fashion.

With reference to FIG. 5 there is illustrated a modification of the present invention, which functions in all respects like the embodiment of FIGS. 2 and 3, but wherein the spring means 70 is in the form of a conventional coil spring 170 rather than the polyurethane spring of the embodiment of FIGS. 2 and 3.

Preferably the vacuum delay valve 22 of the present invention is fabricated from inexpensive components, such as plastic, so that after a predetermined operational use, the vacuum delay valve can be discarded and a new valve substituted therefor.

One or more openings 69 may be provided in elastic disc 68. Further a different sized fixed orifice (or orifices) 69 may be provided in the elastic disc 68 to accomodate the requirements of different engines. The method of manufacture described herein produces a superior elastic disc product that can be made with consistancy and uniformity in production.

While I have shown presently preferred embodiments of the present invention, it will be obvious that other embodiments may be made within the scope of the appended claims.

What is claimed is:

1. In a spark timing control system comprising an engine carburetor having an induction passage containing a spark port located above the idle speed position of a throttle valve controlling flow through the induction passage and subject to the depression in the carburetor as a function of the movement of the throttle valve from its idle speed position, an engine distributor having a breaker plate typically movable in opposite directions to advance and retard the spark timing, vacuum-controlled servo means connected to said breaker plate for moving the same, and slow-fast rate control means between said spark port and servo means to control the rate of change of application of vacuum from said spark port to said servo means, said control means including faster flow rate means operable in response to a change in the depression at said spark port to a lesser depression than at said servo means to quickly equalize the pressure level at said servo means to that at the spark port, and slower flow rate means operable in response to a change in the depression at said spark port to a greater depression than at the servo means to delay the equalization of the pressure level at the servo means to that at the spark port to delay the spark timing change, said control means including conduit means connecting said spark port to said servo means, said control means comprising a vacuum delay valve in said conduit means having a passage therethrough with an annular seat, said faster flow rate means comprising an elastic disc cooperating with said annular seat and said slower flow rate means comprising fixed orifice means in said elastic disc, said fixed orifice means comprising at least one opening through the elastic disc to provide a controlled delay in pressure change to the servo means, said opening being self-cleaning in use because of the resiliency of the elastic disc and the movement thereof in use.

2. The mechanism of claim 1 wherein a filter is disposed in the vacuum delay valve between the spark port and the elastic disc.

3. The mechanism of claim 1 including spring means for biasing the elastic disc into engagement with the annular seat.

4. The mechanism of claim 3 wherein the spring means comprises resilient plastic.

5. The mechanism of claim 3 wherein the spring means is disposed between the elastic disc and the engine distributor.

6. The mechanism of claim 1 wherein the vacuum delay valve comprises a housing comprised of a body and a cover, a filter in the housing between the spark port and the elastic disc, and spring means associated with the elastic disc for biasing the elastic disc toward the annular seat.

7. The mechanism of claim 6 wherein the fixed orifice means in the elastic disc comprises at least two

fixed area openings the openings being self-cleaning because of the movement of the elastic disc and the resiliency thereof.

8. In a spark timing control system comprising an engine distributor having a breaker plate movable in opposite directions to advance and retard the spark timing and communicating with an engine source of vacuum, vacuum-controlled servo means connected to said breaker plate for moving the same, and control means between said engine source of vacuum and servo means to control the rate of change of application of vacuum from the engine source of vacuum to said servo means, said control means including a conduit connecting said engine source of vacuum to said servo means and a vacuum delay valve in said conduit means having a passage therethrough with an annular seat, an elastic disc cooperating with said annular seat and movable toward and away therefrom to control flow through the passage, and fixed orifice means of predetermined size in said elastic disc, said fixed orifice means comprising an opening through the elastic disc that is self-cleaning in use because of the movement of the elastic disc and the resiliency thereof.

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