# United States Patent

**Akman**

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[54] **DUAL DIAPHRAGM VACUUM SERVO**


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[52] **U.S. Cl.** ....................**92/49,** 92/64
[51] **Int. Cl.** ....................**F01b 19/02**
[58] **Field of Search** ....................92/48, 49, 64; 123/117.1



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[57] **ABSTRACT**

A vacuum servo construction having two flexible diaphragms in a single housing, with one connected to the other for a limited relative movement between the two, and the movement of one being modulated by changes in the vacuum levels. One of the diaphragms supports a carrier which houses the second diaphragm and, of which the following is a specification.

**2 Claims, 2 Drawing Figures**


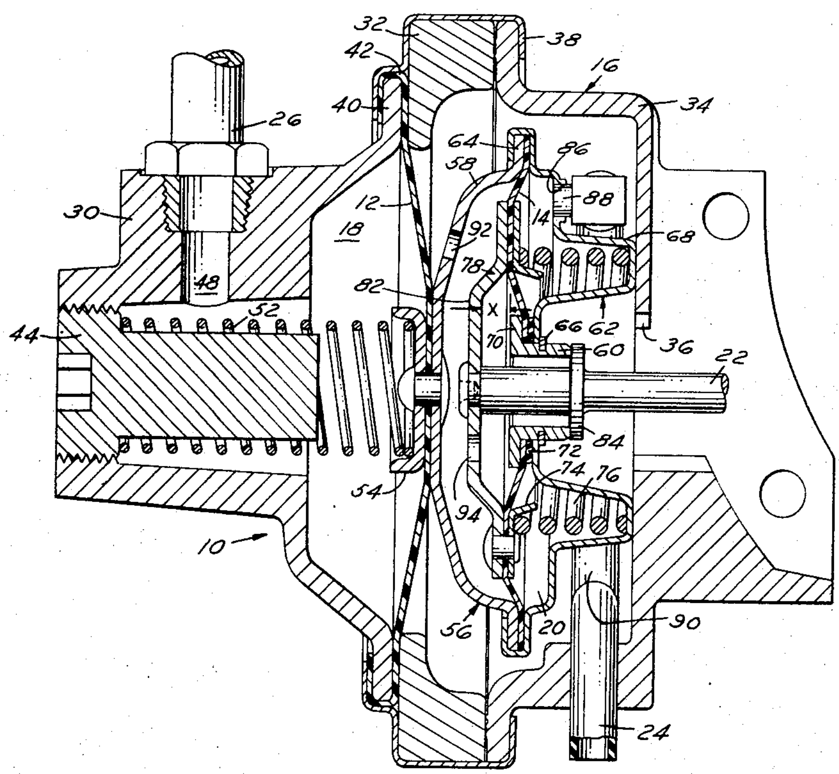

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FIG. 2

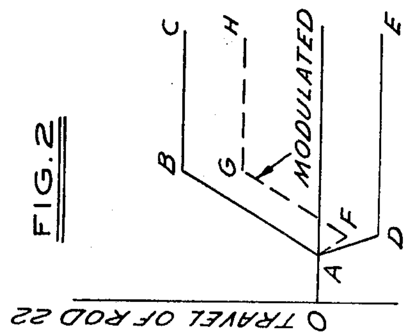
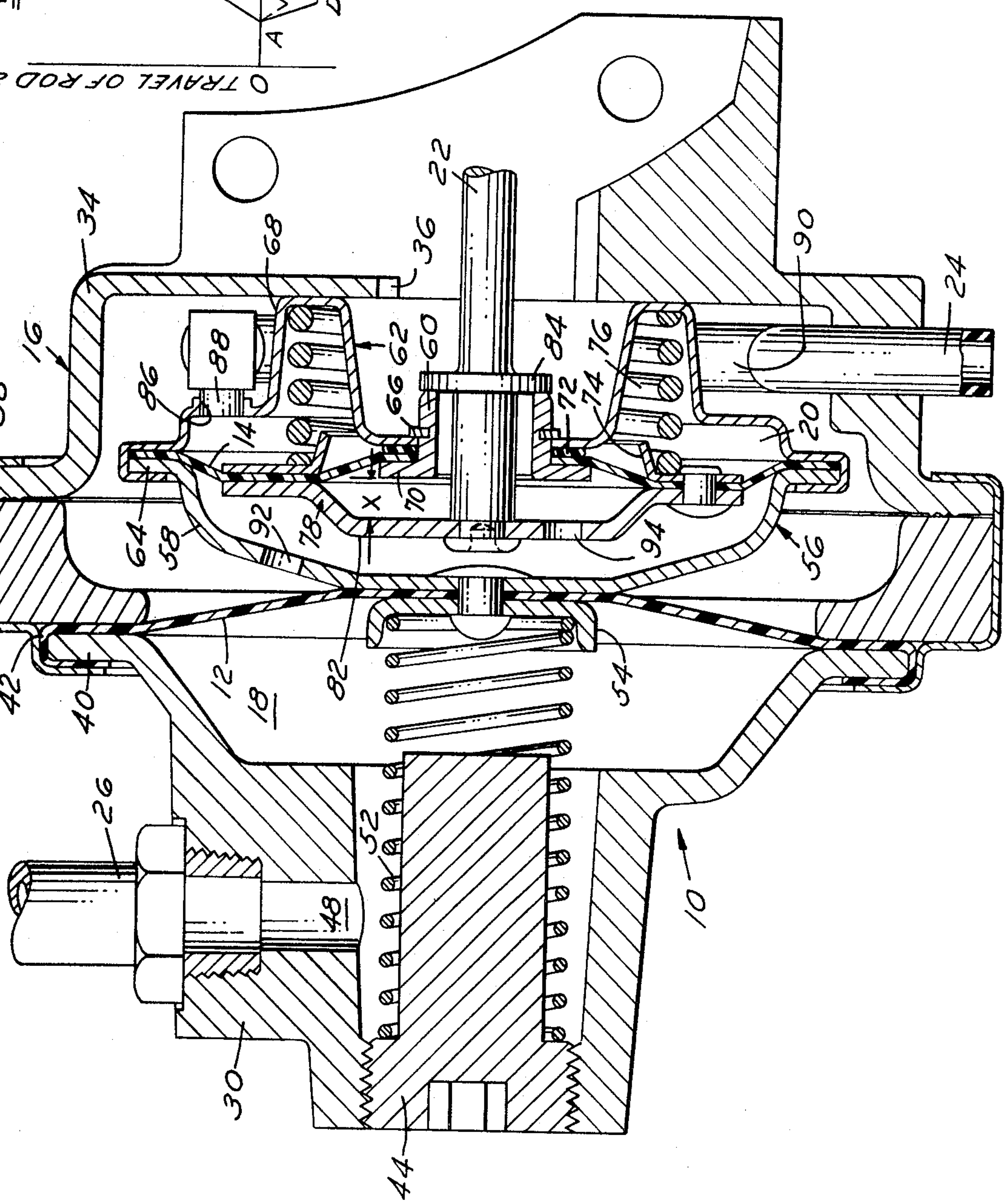



FIG. 1



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## DUAL DIAPHRAGM VACUUM SERVO

This invention relates, in general, to a fluid motor construction. More specifically, it relates to a dual diaphragm vacuum motor assembly contained within a single housing.

This invention in particular is an improvement over the dual diaphragm fluid motor construction of Ser. No. 858,567, Frank M. Kittredge, filed Sept. 11, 1969. As stated in the latter application, anti-smog regulations relating to internal combustion engine exhaust emission controls point out the desirability of selectively controlling the ignition timing at all engine speed and load conditions not only to provide minimum engine exhaust hydrocarbon and other undesirable exhaust emissions, but good engine performance and economy as well.

The dual diaphragm actuator of Ser. No. 858,567 provides, among other things, normal engine ignition advance timing as a function of changes in carburetor spark port vacuum during part throttle engine operation, as described. It does not, however, provide means for modulating the advance as a function of engine load. This may be desirable at times to further control emissions, or for other reasons, such as performance and economy.

This invention, therefore, provides a dual diaphragm fluid motor construction in which the ignition timing advance is capable of being modulated as a function of the change in engine load/vacuum, and the secondary diaphragm is mounted to the primary diaphragm in a unique manner.

It is an object of the invention, therefore, to provide a dual diaphragm vacuum motor actuator in which the movement of the actuator is determined as a function of the changes in a plurality of sources of vacuum operatively acting on the actuator.

It is another object of the invention to provide a dual diaphragm vacuum servo construction in which one of the diaphragms is secured to the other in a unique manner.

Other objects, features and advantages of the invention will become more apparent upon reference to the succeeding detailed description thereof, and to the drawings illustrating the preferred embodiment thereof, wherein;

FIG. 1 is a cross sectional view of a vacuum servo mechanism embodying the invention; and

FIG. 2 graphically illustrates a typical travel movement of one of the parts shown in FIG. 2 with changes in vacuum level.

Ser. No. 858,567 shows and describes an engine ignition timing system of the type in which the present invention could be used. However, it will become apparent that it will have many other uses wherever a servo control of the type to be described is desired. Therefore, only the servo control per se will be described.

In general, the vacuum motor assembly 10 shown in FIG. 1 includes two flexible diaphragms 12 and 14 mounted in a housing 16 and defining separate vacuum chambers 18 and 20 to provide various control movements of an actuating rod 22. Chamber 20 is connected by a hose or line 24 to a first source of varying vacuum, such as, for example, the vacuum of an engine intake manifold. The other chamber 18 is connected by a hose or line 26 to a source of vacuum that alternates from essentially zero level to a maximum.

No controls are shown for varying the vacuum levels in chambers 18 and 20 since they can be conventional, can be manually or automatically operated, and the details and operation thereof are believed to be unnecessary for an understanding of the invention. Furthermore, reference may be had to Ser. No. 858,567 describing one such system changing the vacuum levels.

More specifically, vacuum motor 10 has an outer housing 16 that includes a sleeve portion 30, a central ring portion 32, and a torus-shaped portion 34, the latter having a central opening 36. The three portions are held in the assembled position shown by an annular spring-like clamp 38.

Sleeve portion 30 has a lip flange 40 around which is wrapped the outer edge 42 of the primary or first annular flexible diaphragm 12. The latter extends across the hollow space of housing 10, and is clamped in a sealing manner between ring 32 and lip flange 40, as shown. The end of sleeve portion 30 is blocked by an adjustable plug 44, which together with diaphragm 12 defines a first or primary vacuum chamber 18. The latter is connected by a bore or passage 48 to conduit 26 that contains any suitable source of vacuum that can be varied from essentially zero or an atmospheric pressure level to a maximum.

Plug 44 seats one end of a spring 52 that biases diaphragm 12 to the right, as shown, for a purpose to be described. Plug 44 also acts as an adjustable stop to limit movement of diaphragm 12 in a leftward direction. Spring 52 is seated at its opposite end in a retainer 54 riveted to a central portion of diaphragm 12.

Also riveted to the diaphragm is an annular, essentially crescent-shaped, carrier or support 56. The latter movably supports and mounts the secondary diaphragm 14, and together they define the secondary vacuum chamber 20.

More specifically, carrier 56 includes an outer annular dish shaped part 58 riveted to diaphragm 12, an inner flanged sleeve 60, and an annular closure part 62. The latter is spring-clamped at its outer edge over the outer lip flange 64 of part 58, and has its inner edge located axially against a snap ring 66. Closure part 62 is formed with an annular projecting portion 68 that abutts housing 16 at times to act as a stop for movement of diaphragm 12 in one direction.

Secondary annular diaphragm 14 has a washer like shape, with its outer edge clamped between carrier parts 64 and 62. Its inner edge is wedged axially against flange 70 of sleeve 60 by a rubber O-ring 72.

A spring retainer 74 is riveted to one side of diaphragm 14, and seats one end of a preloaded compression spring 76. Also riveted to a central portion of the diaphragm is a disc 78 whose inner edge is staked at 80 to the end of actuating rod 22. The disc is formed with an offset 82 to provide an axial clearance space "*x*" between the disc and flange 70, for a purpose to be described later. Rod 22 has an annular radial projection or abuttment 84 adapted to abutt or be abutted at times by the right end of the hub of sleeve 60.

Closure part 62 has an opening 86 that receives a hose fitting 88 having an internal passage connected to an annular vacuum manifold 90. The latter is adapted to be connected by line 24 to any suitable source of vacuum, such as engine intake manifold vacuum or sparkport vacuum, or alternating, for for example, that varies in level from zero or essentially atmospheric pressure to a maximum, much in the same manner as the vacuum in chamber 18.

To complete the construction, carrier outer part 58 is formed with a pressure equalizing hole 92, as is disc 78 with hole 94, to provide atmospheric or ambient pressure conditions against the right and left sides, respectively, of diaphragms 12 and 14. The ambient pressure conditions will exist by virtue of the annular clearance space between the sleeve 60 and rod 22.

It will be clear that the preloads of primary and secondary springs 52 and 76 can be chosen to suit the particular results desired, as will be explained in connection with FIG. 2, for example. Also, the distance "X" between disc 78 and sleeve flange 70 can be varied, as can the axial extent of stops 68 and 84. Also, changing the inclination of part 58 of carrier 56 will change the characteristics of operation of the servo.

FIG. 2 illustrates graphically typical changes in travel distance of rod 22 for changes in vacuum level. Assume, for example, the vacuum level in chambers 18 and 20 initially is zero, or at atmospheric pressure. The parts then will be positioned as shown. The preload of primary spring 52 positions carrier 56 against the housing 16 and 68. The preload of secondary spring 76 moves diaphragm 14 to the left and abutts stop 84 against sleeve 60 to provide the maximum clearance "X" between the sleeve and disc 78. Thus rod 22 has an initial position at O in FIG. 2.

Assume now that vacuum is applied only to chamber 18. Until the preload of primary spring 52 is overcome, an increase in vacuum produces no movement of rod 22. This is represented by the horizontal line OA in FIG. 2. Upon increase in vacuum, once the preload of spring 52 is overcome, diaphragm 12 then will begin moving to the left, as will carrier member 56. Rod 22 likewise will move to the left under the influence of the secondary spring 76 abutting flange 84 against sleeve 60. Thus, as the vacuum in the primary chamber increases, the rod 22 will move progressively between the points A and B in FIG. 2. Point B represents the position of diaphragm 12 when the spring seat 54 has bottomed against the end of plug 44. Further increases in vacuum, therefore, produce no further leftward movement of the rod 22. This is represented by the horizontal line BC in FIG. 2.

Conversely, assume that there is no vacuum (atmospheric pressure) in chamber 18 and that we begin applying vacuum to chamber 20. Until the preload of secondary spring 74 is overcome, rod 22 will remain stationary. Again, this is represented by the horizontal distance OA in FIG. 2. As the vacuum increases above the preload of the spring, secondary diaphragm 14 will be drawn rightwardly to decrease the distance "X" between the disc 78 and sleeve 60, which is bottomed against the housing portion 16. This is represented by the line or curve AD in FIG. 2. Increasing vacuum will continue to move rod 22 to the right until the disc 78 bottoms against the sleeve flange 70, at which time further movement of the rod 22 in the rightward direction will be prevented. This is represented by the point D on the curve in FIG. 2. From this point on, further increases in vacuum will not cause a further travel of rod 22. This is represented by the horizontal line DE.

Assume now, therefore, that vacuum is applied in a controlled manner to both vacuum chambers 18 and 20 in a varying manner. It will be clear from a consideration of FIG. 2 that the two curves ABC and ADE will be combined because of the modulating action of the vacuum in the secondary chamber 20 on the action of the vacuum in primary chamber 18, and vice versa. Accordingly, assuming a vacuum existing in both chambers, of different values, until the preloads of the springs 52 and 76 are overcome, no travel of rod 22 in either direction will occur. Again this is represented by the distance OA in FIG. 2.

Now, with vacuum in both chambers, assume that the vacuum level in secondary chamber 20 increases to where it overcomes the preload of spring 76. If, at the same time, the vacuum in chamber 18 overcomes the preload of spring 52, then vacuum in chamber 18 will be moving the carrier 58 and sleeve 60 to the left at the same time that vacuum in chamber 20 is moving rod 22 to the right relative to carrier 58. The modulating movement results in the dotted line curve AFG. AF represents the rightward movement of rod 22 relative to sleeve 60, and FG represents the leftward movement of diaphragm 12 and carrier 58 and the resultant leftward movement of rod 22. Once the primary diaphragm 12 has bottomed against plug 44, further leftward movement of rod 22 will be prevented. This is represented by line GH.

Thus, from the above, it will be seen that by varying the level of vacuum in the secondary vacuum chamber in a selective manner as the vacuum varies in chamber 18, and/or varying the preloads of the primary and secondary springs 52 and 76, and/or varying the spring rate of springs 52 and 76, and/or varying the axial distance "X" between disc 80 and sleeve flange 70, and/or the other adjustable changes previously described, that the dotted line shown in FIG. 2 can be made to assume a number of different shapes to provide a particular desired movement of rod 22 in either or both directions.

From the above, therefore, it will be seen that the invention provides a movement of one diaphragm by vacuum in one direction modulated by the action of vacuum in the secondary chamber, the modulating action varying as a function of the selection of the spring rates and preloads and adjustable stop distances.

While the invention has been illustrated in its preferred embodiment in the drawings, it will be clear to those skilled in the arts in which it pertains that many changes and modifications may be made thereto without departing from the scope of the invention.

I claim:

1. A fluid motor assembly comprising, a housing, first and second flexible diaphragm members in said housing defining first and second vacuum chambers, first and second means connecting said first and second chambers to separate sources of fluid varying from a maximum essentially atmospheric pressure level to a minimum sub-atmospheric pressure or vacuum level for reciprocable movement of said first and second members as a function of the changes in vacuum acting thereon, first and second spring means respectively biasing said first and second diaphragm members towards each other, movable actuating means connected to said second diaphragm member for movement therewith, carrier means secured to said first member and extending adjacent said second member and said housing, means mounting said second diaphragm member on said carrier means, said actuating member and said carrier means having a straddled interengagement permitting a limited relative movement therebetween in opposite directions, said second spring means biasing said carrier means and actuating members apart whereby movement of said first diaphragm member upon application of vacuum to said first chamber moves said first and second diaphragm members and actuating member in one direction, the application of vacuum to said second chamber modulating the movement of said first diaphragm member by urging relative movement between said carrier means and said actuating member, said carrier means comprising an annular hollow housing, said carrier means housing having radially spaced portions mounting the inner and outer edges of said second diaphragm member, said latter member having a washer-like shape, said actuating member being axially movable within the inner portion of said carrier means housing and having axially spaced portions thereon extending radially on opposite sides of said carrier means inner housing portion to define stops for relative axial movement therebetween.

2. A fluid motor assembly comprising, a housing, first and second flexible diaphragm members in said housing defining first and second vacuum chambers, first and second means connecting said first and second chambers to separate sources of fluid varying from a maximum essentially atmospheric pressure level to a minimum sub-atmospheric pressure or vacuum level for reciprocable movement of said first and second members as a function of the changes in vacuum acting thereon, first and second spring means respectively biasing said first and second diaphragm members towards each other, movable actuating means connected to said second diaphragm member for movement therewith, carrier means secured to said first member and extending adjacent said second member and said housing, means mounting said second diaphragm member on said carrier means, said actuating member and said carrier means having a straddled interengagement permitting a limited relative movement therebetween in opposite directions, said second spring means biasing said carrier means and actuating members apart whereby movement of said first diaphragm member upon application of vacuum to said first chamber moves said first and second diaphragm members and actuating member in one direction, the application of vacuum to said second chamber modulating the movement of said first diaphragm member by urging relative movement between said carrier means and said actuating member, said carrier means comprising a hollow essentially crescent shaped support having an axially projecting portion engagable at times with said housing to stop movement of said first diaphragm member in one direction, the said support having an inner sleeve portion, said means mounting said second diaphragm between a radially outer portion of said support and said sleeve portion to define said second chamber between said support and second diaphragm, said actuating member being secured to a radially median portion of said second diaphragm permitting relative axial movement between one axial edge of said sleeve portion and said actuat-

ing member, and stop means projecting radially from said actuating member beyond the opposite edge of said sleeve portion to limit relative axial movement between said latter member and sleeve portion.

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