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Maddocks

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[54] **FLUID CONTROL VALVE**

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[52] **U.S. Cl.** .... **251/61.1,** 123/119 A, 137/100
[51] **Int. Cl.** **F16k 31/145**
[58] **Field of Search** .... 123/119 A; 251/61.1, 61; 137/625.65, 100

[56] **References Cited**

UNITED STATES PATENTS

2,376,918	5/1945	Hughes	251/61.1 X
3,550,629	12/1970	Kreuter	137/625.66

Primary Examiner—Arnold Rosenthal

[57] **ABSTRACT**

A valve for producing an output signal proportional to an input signal, comprising, a pair of chambers having elastomeric diaphragms thereacross, the diaphragms having predetermined proportionally sized areas and the diaphragms spaced from each other and connected by an integral post therebetween, the diaphragms having moveable inner portions flexibly thin about the margins thereof and thickened by said post inwardly of the margins to be relatively rigid therewithin, an input passage communicating with one chamber, and a second input passage and an output passage communicating with the other chamber, said second input passage normally closed by the diaphragm thereadjacent and opened by movement of said diaphragms away therefrom.

15 Claims, 6 Drawing Figures

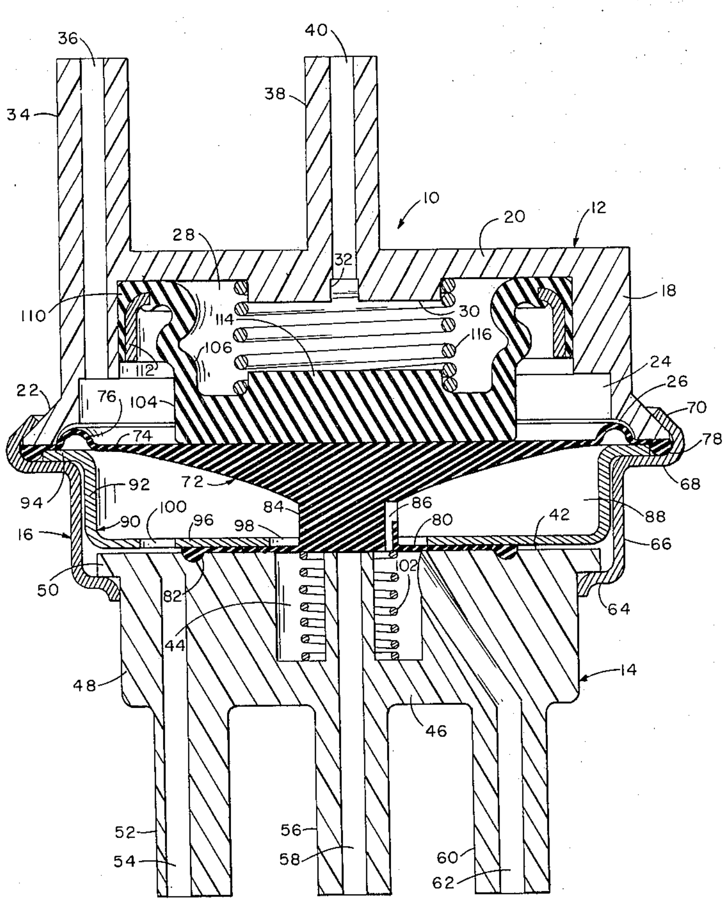


FIG 1

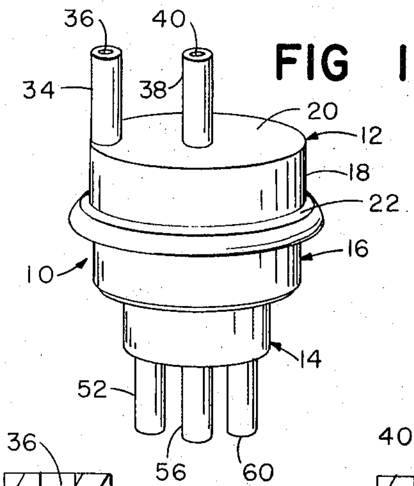


FIG 2

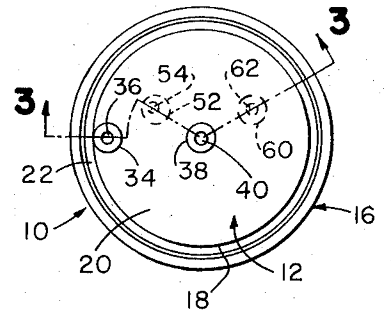


FIG 3

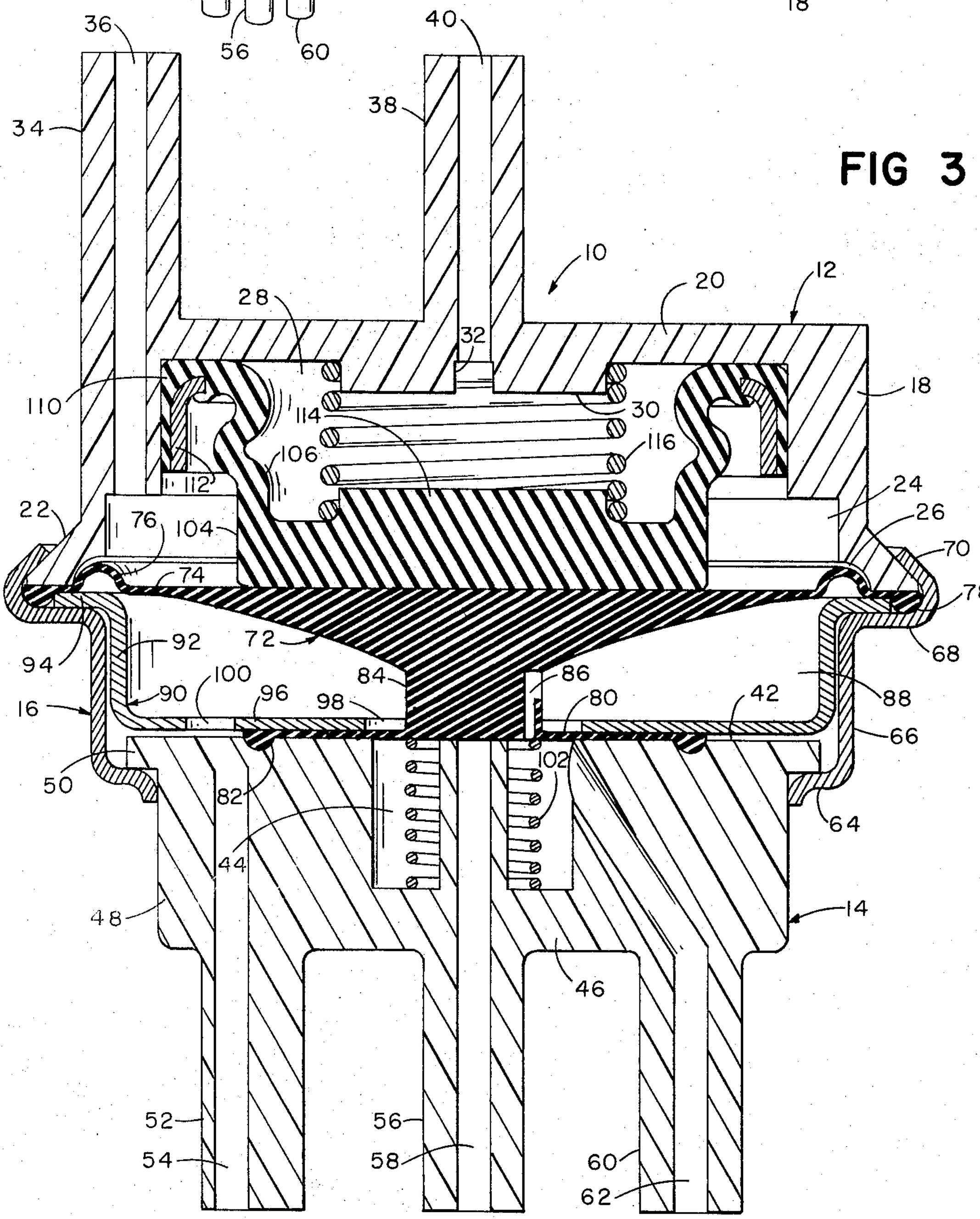


FIG 4

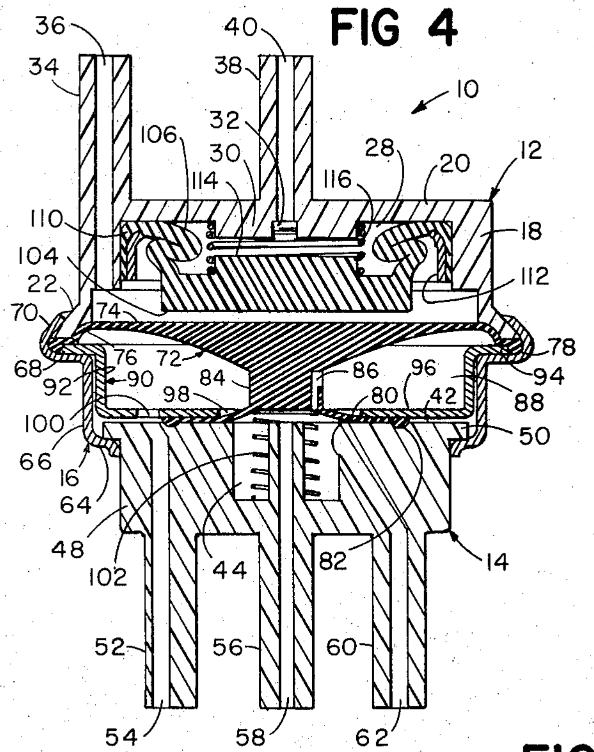


FIG 5

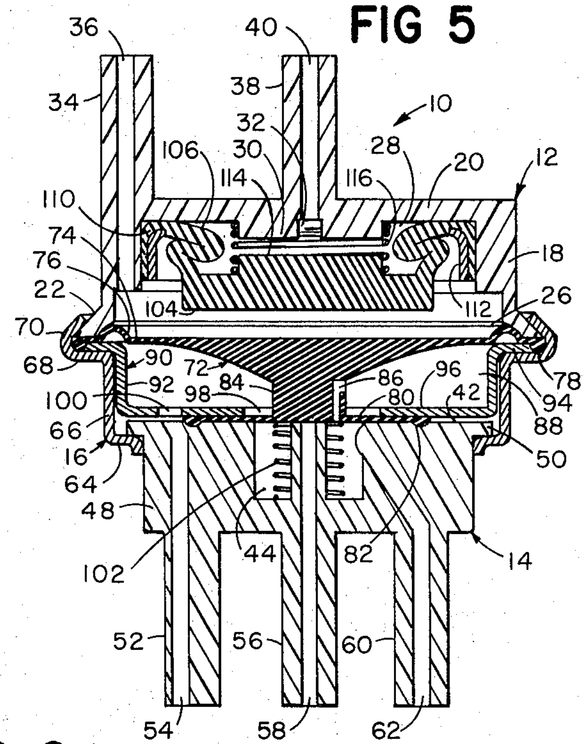
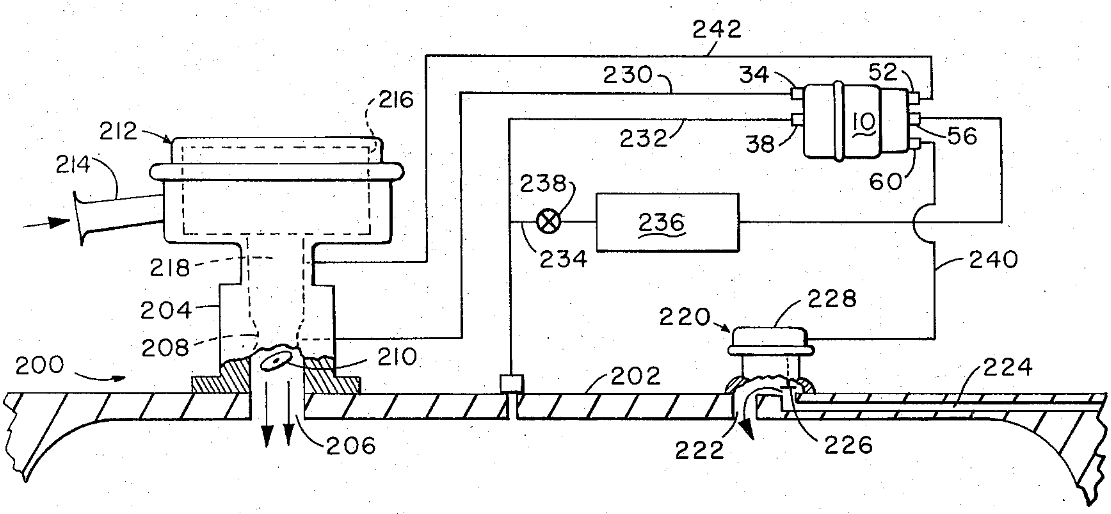


FIG 6



FLUID CONTROL VALVE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an improved fluid control valve for producing an output signal proportional to an input signal and, more particularly, to such a control valve for use in amplifying the vacuum signal from a carburator venturi in an internal combustion engine to regulate the recirculation valve of an exhaust gas recirculation system in the engine.

2. Description of the Prior Art

Such valves, having a large area diaphragm across a low vacuum chamber connected to an engine carburator venturi and, spaced therefrom a smaller area diaphragm across a high vacuum chamber connected to the engine's intake manifold, the smaller diaphragm normally closing the passage from the intake manifold and opening the passage on movement toward the low vacuum chamber, have been previously suggested.

Thus, in a prior control valve design, central discs rigidify the larger diaphragm and the smaller diaphragm is sealed to a central rigid member comprising part of a hook washer assembly interconnecting the two diaphragms for common movement thereof. A tension spring for biasing the diaphragms toward the low vacuum chamber is positioned in the low vacuum chamber and is connected on one end to the diaphragm assembly and on the other end to an exteriorly adjustable calibration unit for tension adjustment. The space between the diaphragms is vented, through a filter in a recess in the valve housing, directly to the atmosphere and a valved bleed passage, intermittently operated, communicates through the rigid member, centrally of the smaller diaphragm, from the high vacuum chamber to the space between the diaphragms. An override mechanism is provided in another recess in the valve housing for disabling the control valve when intake manifold vacuum drops below a predetermeined level.

SUMMARY OF THE INVENTION

It is a principal object of this invention to provide an improved fluid control valve which minimizes the number of operating parts and the hysteresis effects inherent in such valves. A further object is to provide such a fluid control valve which eliminates the need for calibration of each unit. Another object is to provide an override mechanism in one of the valve chambers which positively shuts down valve operation under predetermined conditions and which simplifies design. Yet another object is to provide, in such a valve, means for compensating for variations in vacuum caused by the condition of the filter in the air intake. Still another object is to simplify the design of such valves for ease of manufacture and assembly thereof.

In general, the invention features in a fluid control valve an integral elastomeric diaphragm member comprising a pair of diaphragms having predetermined proportionally sized areas, one sealingly spanning each of a pair of chambers, and an integral connector extending between and interconnecting the diaphragms. The diaphragms are flexibly thin about their margins and are thickened inwardly of their margins by the post, thereby centrally rigidifying the diaphragms.

In preferred embodiments the diaphragm member includes a restricted open bleed passage from one chamber, through the diaphragm member, to the space between the diaphragms and a vent passage through the valve housing to the space between the diaphragms. A biasing member in one chamber biases the diaphragm toward the other chamber and in the other chamber a sealed piston is biased in the opposite direction by a biasing member having a greater force than the biasing member in said one chamber.

The control valve is used in an internal combustion engine with: the chamber having the larger area diaphragm connected to the carburator venturi; the other chamber connected, by a passage normally closed by the adjacent diaphragm and opened on movement of the diaphragm member away therefrom, to the engine intake manifold via a vacuum reservoir; an output passage from the said other chamber connected to the engine exhaust gas recirculation valve; the vent passage connected to the air passage ahead of the venturi and after the engine air cleaner filter; and the volume behind the sealed piston connected directly to the intake manifold.

Other objects, features and advantages of this invention will be apparent to those skilled in the art from the following detailed description of a preferred embodiment thereof, taken together with the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of a vacuum control valve embodying the invention;

FIG. 2 is a plan view of the valve shown in FIG. 1;

FIG. 3 is an enlarged, sectional view taken along the line 3—3 of FIG. 1;

FIGS. 4 and 5 are reduced, sectional views, similar to that of FIG. 3, illustrating different operative positions of the valve components; and

FIG. 6 is a schematic view, partly in section, of the valve as used in an internal combustion engine.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIGS. **1** and **2**, the control valve **10** comprises a housing, circular in transverse plane, having cylindrical exterior walls. The housing includes a cap **12**, a base **14** and a metal connector collar **16** therebetween. Cap **12** and base **14** are preferably molded from heat resistant organic plastic material.

In greater detail, as shown in FIG. **3**, cap **12** has a hollow interior closed on the sides by cylindrical side wall **18** and on the end, remote from base **14**, by circular, transverse, end wall **20** integral with side wall **18.** A lip **22** extends radially outwardly about the periphery of wall **18** at the end thereof opposite end wall **20.** Within the interior of cap **12** a cylindrical low vacuum first chamber **24**, of predetermined cross-sectional area, extends from lip **22** toward end wall **20.** About the periphery of low vacuum chamber **24** and lip **22**, a quarter round recess **26** is provided.

A cylindrical override chamber **28**, of smaller diameter than and coaxial with low vacuum chamber **24**, extends centrally within low vacuum chamber **24** to end wall **20.** Coaxially of end wall **20**, a cylindrical first locating member **30**, having a reduced diameter relative to that of override chamber **28**, extends a short distance into override chamber **28**, member **30** having a groove **32** extending thereacross.

A low vacuum first input tube **34**, located at the peripheral edge of end wall **20** and extending outwardly therefrom, has a first input passage **36** therein communicating with low vacuum chamber **24** through end wall **20** and along and within cylindrical wall **18.** Coaxially of override chamber **28,** another tube, override tube **38,** extending outwardly from end wall **20,** has an override passage **40** communicating through end wall **20** with override chamber **28** at the base of groove **32.**

Base **14** comprises essentially a cylindrical block having a planar surface **42** facing cap **12** and coaxial thereof, base **14** having a diameter only slightly smaller than that of cap **12.** Coaxially of and facing low vacuum chamber **24,** a cylindrical high vacuum second chamber **44** is formed in base **14,** extending from surface **42** to end wall **46.** High vacuum chamber **44** is closed on the end remote from cap **12** by end wall **46** and on the sides by cylindrical side wall **48** integral with end wall **46.** A lip **50** extends radially outwardly about the periphery of wall **48** adjacent surface **42.** High vacuum chamber **44** has a cross-sectional area proportional, in a predetermined relationship, to that of low vacuum chamber **24,** in the preferred embodiment illustrated chamber **44** being smaller than chamber **24.**

A vent tube **52,** located adjacent the peripheral edge of end wall **46** in base **14** and extending outwardly therefrom has a vent pasage **54** extending through base **14** to surface **42,** the portion of passage **54,** adjacent surface **42,** angled outwardly to open through surface **42** just inwardly of lip **50.** Coaxially of high vacuum chamber **44,** a high vacuum second input tube **56** extends outwardly of end wall **46** and extends coaxially within high vacuum chamber **44,** spaced from the side walls thereof, to a position flush with the plane of surface **42,** a second input passage **58** communicating through tube **56.** A signal output tube **60,** spaced from tubes **52, 56** located adjacent the peripheral edge of end wall **46** in base **14** and extending outwardly therefrom, has an output passage **62** extending through base **14** and angled inwardly to communicate with the interior of high vacuum chamber **44** through the side thereof adjacent surface **42** and spaced from high vacuum tube **56.**

The metal connector collar **16** has ana inwardly directed base flange **64** at one end of the integral cylindrical wall **66** thereof, flange **64** engaging the underside of lip **50** of base **14** opposite the surface **42** thereof. An outwardly directed cap flange **68** axially spaced from flange **64** by and integral with wall **66,** underlies the surface of lip **22** of cap **12** facing base **14.** An integral portion **70** of flange **68** is bent around lip **22** to the side thereof opposite base **14.**

An elastomeric diaphragm member **72** is positioned within housing **10.** Diaphragm member **72** includes a first circular, planar diaphragm **74** spanning cap lip **22** across low vacuum chamber **24.** A normally inverted U-shaped, flexibly thin bead **76,** marginally defining an inner movable portion of diaphragm **72,** is provided about the first diaphragm **74** extending toward cap **12,** bead **76** positioned in quarter round recess **26** and having a slightly smaller radius of curvature to form the inverted U-shape than the recess **26.** The peripheral portion of diaphragm **74** extends radially beyond bead **76** to a solid bead seal **78** about the periphery thereof, seal **78** facing base **14** and positioned between the facing surfaces of cap lip **22** and collar flange **68.**

Diaphragm member **72** also includes a second circular, planar diaphragm **80,** parallel to diaphragm **74,** spanning high vacuum chamber **44,** and including a peripheral portion extending beyond high vacuum chamber **44,** across a portion of base surface **42,** to a solid bead seal **82** about the periphery and radially inwardly of passage **54.** Seal **82** faces base **14** and is positioned in an annular groove (not separately numbered) in base surface **42.** Second diaphragm **80** is flexibly thin inwardly adjacent the edge of high vacuum chamber **44,** marginally defining a moveable inner portion of diaphragm **80.** Diaphragm **80** normally is against and closes the passage **58** of tube **56** within high vacuum chamber **44.**

First and second diaphragms **74, 80** are fixedly and rigidly axially spaced from each other and connected together by integral coaxial post **84** extending therebetween. Tube **56** abuts diaphragm **80** opposite post **84.** Spaced radially outwardly of tube **56,** a right angle passage, restricted unobstructed, continuously open bleed hole **86,** extends through second diaphragm **80** and post **84** from high vacuum chamber **44** to the compensator third chamber **88** defined in the space between diaphragms **74, 88.** In the preferred embodiment, bleed hole **86** has a diameter of 0.02 inches opening into high vacuum chamber **44** and a diameter of 0.06 inches opening into compensator chamber **88.**

Post **84** extends as a cylinder from second diaphragm **80** about half-way toward first diaphragm **74** and then flares radially outward blending into first diaphragm **74.** The diameter of post **84** at diaphragm **80** is about two thirds the diameter of high vacuum chamber **44** and at diaphragm **74** post **84** extends substantially thereacross to adjacent bead **76.** Thus, the inner moveable portions of diaphragms **74, 80,** are centrally thickened and rigidified by post **84** inwardly adjacent narrow, flexibly thin annular portions thereof and comprise the major portions of the areas of diaphragms **74, 80.** The flexibly thin portions of diaphragms **74, 80,** and the portion of post **84** flared outwardly, adjacent diaphragm **74,** together comprising a major portion of the area of diaphragm **74,** are exposed to the compensator chamber **88.**

A metal retainer **90** is positioned in compensator chamber **88.** Retainer **90** includes a cylindrical wall **94** inwardly adjacent and parallel to wall **66** of collar **16.** An integral, outwardly extending flange **94** of retainer **90** extends from one end of wall **92** between collar flnge **68** and fist diaphragm **74** opposite cap lip **22** and abutting the inner periphery of bead seal **78.** At the other end of wall **92** an integral, inwardly extending pierced flange **96** overlies second diaphragm **80,** outwardly from high vacuum chamber **44,** sandwiching second diaphragm **80** between the flange **96** and surface **42** of base **14.** Centrally of flange **96,** an annular opening **98** is provided through which post **84** of diaphragm member **72** extends. Annular opening **98** is substantially the same diameter as high vacuum chamber **44,** in the preferred embodiment 0.02 inches larger, and defines the outer limit of the operative moveable inner portion area of second diaphragm **80** in essentially the same predetermined ratio of area to first diaphragm **74** moveable inner portion area, across the apex of bead **76,** as the ratio of the areas of the low and high vacuum chambers **24, 44.** In the preferred embodiment illustrated the ratio of the areas of the inner moveable portions of diaphragms **80, 74** is about one order of magnitude, e.g., 1:14. Opposite the opening of passage **54** through base surface **42,** an aperture **100** is provided in flange **96** of retainer **90** for communication of passage **54** with compensator chamber **88**.

Retainer **90** functions with collar **16** to fixedly space cap **12** and base **14** a predetermined distance apart, firmly engaging collar flange **64** against base lip **50**. Flange **96**, together with base surface **42** and second diaphragm **80**, including seal **82**, renders high vacuum chamber **44** air tight sealingly engaging the peripheral portion outwardly of opening **98**. Similarly, low vacuum chamber **24** is rendered air tight by retainer flange **94**, and lip **22** sealingly engaging the peripheral portion outwardly of bead **76**, seal **78** against the edge of flange **94**. Compensator chamber **88** is sealed on one side by the same sealing means which renders low vacuum chamber **24** air tight and on the other side is sealed by the collar flange **64** against base lip **50**.

Within high vacuum chamber **44**, a biasing member, compression spring **102**, is provided without about **56**. Spring **102** bears against base end wall **46** and against second diaphragm **80**, opposite post **84** urging second diaphragm **80** away from its normal position closing passage **58** in tube **56**.

Secured in low vacuum chamber **24** is override piston, diaphragm **104**, extending coaxially of and across a substantial portion of the side of first diaphragm **74** opposite post **84**. Override diaphragm **104** includes a generally cylindrical inner wall **106**, integral therewith, extending to cap end wall **20** and having an accordian pleat or rib **108** formed therein to permit axial flexure of inner wall **106** for movement of override diaphragm **104** toward and away from first diaphragm **74**. Adjacent end wall **20**, inner wall **106** is turned outwardly to form an integral cylindrical outer wall **110** against cap side wall **18**, outer wall **110** molded to metal retainer ring **112** which presses outer wall **110** against cap side wall **18** thereby sealingly defining override chamber **28** in low vacuum chamber **24**.

Facing first locating member **30** and coaxially thereof within override chamber **28**, integral with override diaphragm **104**, is short cylindrical second locating member **114** normally spaced from first locating member **30** and having the same diameter thereas. A biasing member, override compression spring **116**, is positioned within override chamber **28** coaxially of and about locating members **30, 114**. Override spring **116** bears against end wall **20** and override diaphragm **104** urging override diaphragm **104** toward diaphragm member **72**. Override spring **116** has a greater spring force than spring **102** in high vacuum chamber **44**.

Control valve **10** is shown in FIG. **6** as used to control the exhaust gas recirculation system of an internal combustion engine **200**. As shown in FIG. **6**, engine **200** includes an intake manifold **202** within which a relatively high vacuum is generated during engine operation.

Carburator **204** is mounted on intake manifold **202** and communicates with the interior thereof via passage **206**. Within carburator **204** is carburator venturi **208** and, downstream thereof a throttle plate **210**. A relatively low vacuum, proportional to the fuel and air mixture entering the engine **200** via intake manifold **202**, is generated during engine operation at the throat of venturi **208**.

Upstream of carburator **204** is air cleaner **212** having an air intake **214** and a filter **216**. Downstream of filter **216**, upstream of venturi **208**, air cleaner **212** has a passage **218**, communicating with carburator **204** and passage **206**, through which filtered air passes to carburator **204**. A small vacuum, due to the pressure drop across filter **216**, is generated during engine operation which increases the vacuum at venturi **208** and in manifold **202**. The vacuum, due to the pressure drop across filter **216**, is not constant, however, increasing as the filter **216** becomes contaminated thereby increasing the pressure drop.

Also mounted on intake manifold **202** is exhaust gas recirculation valve **220**. Recirculation valve **220** communicates with the interior of intake manifold **202** via passage **222**. Recirculation valve **220** also communicates with and connects passage **222** of intake manifold **202** with one end of an exhaust gas passage **224**, within the wall of intake manifold **202**, extending from the engine exhaust manifold (now shown). Recirculation valve **220** includes a valve member **226** for opening and closing exhaust gas passage **224** and also includes a vacuum motor **228** connected to valve member **226** for actuation thereof in response ro a vacuum signal, opening exhaust gas passage **226** in response to a high vacuum signal and closing exhaust gas passage **226** in response to a relatively lower vacuum signal.

As shown in FIG. **6**, low vacuum tube **34** is connected by tube **230** to venturi **208**, communicating low vacuum chamber **24** therethrough with the throat of carburator venturi **208**. Override tube **38** is connected by tube **232** to intake manifold **202**, communicating override chamber **28** therethrough directly with the interior of intake manifold **202**. High vacuum tube **56** is connected by branch tube **234**, which in turn is connected to tube **232**, to intake manifold **202**, communicating high vacuum chamber **44** therethrough with the interior of intake manifold **202**. Signal output tube **60** is connected by tube **240** to vacuum motor **228** of recirculation valve **220**, communicating high vacuum chamber **44** therethrough with vacuum motor **228**. Compensator tube **42** is connected by tube **242** to air cleaner passsage **218**, communicating compensator chamber **88** to passage **218** downstream of filter **216** and upstream of venturi **208**.

A vacuum reservoir **236** is provided in branch tube **234**, upstream of high vacuum chamber **44**. Upstream of reservoir **236**, in branch tube **234**, is a one way check valve **238** for admitting vacuum to reservoir **236** and for preventing immediate reduction of vacuum therein upon reduction of intake manifold **202** vacuum.

In operation, as shown in FIGS. **4** and **5**, the vacuum from intake manifold **202**, communicated to override chamber **28**, is normally greater than the biasing force of spring **116**, resulting in the movement of override diaphragm **74** toward cap end wall **20**, away from first diaphragm **74**, rendering diaphragm member **72** operative. The opening of passage **40** from override tube **38** into override chamber **28** at the base of slot **32** in locating member **30** prevents the blocking of passage **40** if override diaphragm contacts locating member **30**, thereby maintaining override chamber in constant communication with intake manifold **202**.

First diaphragm **74** is affected by the vacuum in low vacuum chamber **24** and by the pressure in compensator chamber **88**. Second diaphragm **80** is affected by the vacuum in high vacuum chamber **44** and by the pressure in compensator chamber **88**. Due to their rigid interconnection and their relative rigidity centrally, when a vacuum is applied to first diaphragm **74**, the force applied to the first diaphragm **74** is transmitted by post **84** to the second diaphragm **80**. Due to the different areas of diaphragms **74, 80,** equilibrium of forces applied thereto is achieved when the ratio of the vacuum in high vacuum chamber **44** to the vacuum in low vacuum chamber **24** is directly proportional to the area of the first and second diaphragms **74, 80.**

Thus, assuming an initial equilibrium, when the vacuum communicated from carburator venturi **208** to low pressure chamber **24** is increased, upsetting the equilibrium between low and high vacuum chambers **24, 44,** first diaphragm **74** moves toward cap end wall **20,** moving with it second diaphragm **80** and opening high vacuum tube **56** to high vacuum chamber **44,** as shown in FIG. **4.** Intake manifold vacuum from reservoir **236** thereupon enters high vacuum chamber **44** and is communicated through signal output tube **60** to vacuum motor **228** to move valve member **226** to a more open position admitting more exhaust gas through passages **224, 222** to intake manifold **202.** When equilibrium is restored, first and second diaphragms **74, 80** will return to their normal positions, second diaphragm **80** closing tube **56,** as shown in FIG. **5.**

The high vacuum in chamber **44** is continuously bled through bleed hole **86** to compensator chamber **88** which is maintained at a higher pressure, i.e., lower vacuum, than both low and high vacuum chambers **24, 44.** Thus, when equilibrium is attained, it is continually unbalanced by the bleeding of vacuum from chamber **44** causing diaphragms **74, 80** to move and open tube **56** to restore equilibrium, after which diaphragms **74, 80** will move to close tube **56.** Moreover, if the vacuum in low vacuum chamber **24** is reduced to a value lower than the existing equilibrium value, second diaphragm **80** remains closed and vacuum is bled from high vacuum chamber **44** until equilibrium is restored at the lower value reducing vacuum communicated to vacuum motor **228** to move valve member **226** to a more closed position restricting exhaust gas flow to intake manifold **202.** As vacuum is further bled from chamber **44,** diaphragms **74, 80** will move to open and close to maintain equilibrium, as above described.

Spring **102** functions to provide a predetermined minimum vacuum within high vacuum chamber **44.** Thus, with no vacuum in low vacuum chamber **24,** spring **102** will nevertheless move second diaphragm **74** to open tube **56** admitting vacuum to chamber **44** until the vacuum is sufficient to overcome the biasing force of spring **102** moving second disphragm **74** to close tube **56.**

Thus a minimum vacuum value is maintained in high vacuum chamber **44** and communicated to vacuum motor **228.** Above the minimum vacuum, the amount of vacuum in chamber **44** and communicated to vacuum motor **228** is proportional to the vacuum at carburator venturi **208** communicated to low vacuum chamber **24.**

The connection of compensator chamber **88** to passage **218** of air cleaner **212,** downstream of filter **216,** serves two functions. First, it provides a source of clean filtered air for the bleed of vacuum from high vacuum chamber **44.** Second, it applies the vacuum, resulting from the pressure drop across filter **216,** to the exposed sides of diaphragms **74, 80** opposite vacuum chambers **24, 44.** Thus, the vacuum in compensator chamber **88** tends to cancel the effect of the additional vacuum in low vacuum chamber **24** resulting from pressure drop across filter **216,** principally affecting the venturi vacuum and communicated by venturi **208** to chamber **24.** Additionally, this inherently corrects for changes in vacuum, resulting from the pressure drop across filter **216,** as filter **216** becomes dirty thereby increasing the pressure drop. Thus the net force on diaphragms **74, 44** is essentially the true value of the vacuum at venturi **208** and in manifold **222** unaffected by the pressure drop across filter **216.** The change in vacuum in compensator chamber **88** does not substantially affect second diaphragm **80,** because its value is low relative to the vacuum in chamber **44.**

When the vacuum in intake manifold **202** falls, check valve **238** in branch tube **234** closes maintaining vacuum at a high level in vacuum reservoir **236** for use by control valve **10.** Check valve **238** will reopen when the vacuum in reservoir **236** falls to the level of vacuum in intake manifold **202** or when the vacuum in intake manifold **202** is raised to that in reservoir **236.**

If, however, the vacuum in intake manifold **202** falls below the predetermined biasing force of spring **116** in override chamber **28,** override diaphragm **104** will move against first diaphragm **74.** The effective area of first diaphragm **74** in low vacuum chamber **24** is immediately reduced and the force of override spring **116** together with the vacuum in high vacuum chamber **44** moves diaphragm member **72** toward base **14,** closing second diaphragm **80** against tube **56,** as shown in FIG. **3.** Thus, as vacuum in chamber **44** is bled through bleed hole **86,** the signal to vacuum motor **228** is reduced closing valve member **226** to stop circulation of exhaust gas to intake manifold **202.** The same sequence occurs when engine operation is terminated.

Thus, in normal engine operation, control valve **10** puts forth a signal to exhaust gas recirculation valve **220,** above a predetermined minimum value, which is proportional to the vacuum at carburator venturi **208.** The flow of exhaust gas to intake manifold **202** is, therefore, proportional to the flow thereto of fuel air mixture. The signal is unaffected by most variations in vacuum in intake manifold **202.** Hence, during engine idling or deceleration, when vacuum in intake manifold **202** is at its highest levels but venturi vacuum is low, the signal to recirculation valve **220** is attenuated to reduce the flow of exhaust gas to intake manifold **202.** However, when manifold pressure falls below a predetermined value, as during full throttle acceleration when venturi vacuum is high, the override diaphragm will operate to shut down the system and close recirculation valve **220.**

Hysteresis is minimized in the control valve by virtue of the integral diaphragm member design minimizing the number of operative and connecting parts. The continuously open bleed passage contributes to the minimizing of hysteresis effects. The design further eliminates the need for unit calibration. The override mechanism, in the low vacuum chamber, provides a simple and positive means for disabling the valve. Compensation for variations in venturi vacuum caused by the filter condition is provided. The simplified valve design eases the manufacture and assembly thereof.

Other embodiments of this invention will occur to those skilled in the art which are within the scope of the following claims.

What is claimed is:

1. In a fluid control valve comprising:

a housing enclosing a volume and defining, therewithin, a pair of spaced apart chambers opening toward each other, the first of said chambers at one end of and the second of said chambers at the other end of said enclosed volume;

a first diaphragm across said first chamber and a second diaphragm across said second chamber, said diaphragms spaced apart, connected to each other and having predetermined proportionally sized areas;

a first input passage communicating through said housing with said first chamber and spaced from said first diaphragm; and

a second input passage and a separate output passage, each communicating through said housing with said second chamber, said output passage spaced from said second diaphragm and said second input passage extending to said second diaphragm and normally closed thereby, said second input passage open with said second diaphragm moved toward said first chamber;

that improvement characterized in comprising:

an integral elastomeric diaphragm member positioned between and closing said chambers, said diaphragm member comprising said first and second spaced apart diaphragms, each said diaphragm spanning one of said chambers and having an outer peripheral portion fixedly and sealingly secured peripherally to one of said chambers and each said diaphragm having a moveable inner portion and a flexibly thin portion about the margin thereof adjacent said outer peripheral portion, said flexibly thin portion marginally defining said moveable inner portion and integrally connecting said inner and outer portions and said moveable inner portion moveable toward and away from said chambers, and said diaphragm member also comprising a connector post extending between and integrally connected to and connecting said diaphragms on the adjacent sides thereof, said post extending transversely across each said diaphragm moveable inner portion from inwardly adjacent said flexibly thin portion, said post thickening and rigidifying said moveable inner portion inwardly adjacent said flexibly thin portion, said control valve further including a vent passage communicating through said housing with a third chamber defined within said housing by said housing and the space between said diaphragms and further including a bleed passage extending through said diaphragm member from said second chamber to said third chamber at a position spaced from said second input passage.

2. In the control valve claimd in claim **1**, the improvement further characterized in comprising a biasing member in said second chamber contacting the said second diaphragm and biasing said diaphragm member toward said first chamber.

3. In a fluid control valve comprising:

a housing enclosing a volume and defining, therewithin, a pair of spaced apart chambers opening toward each other, the first of said chambers at one end of and the second of said chambers at the other end of said enclosed volume;

an integral elastomeric diaphragm member positioned between and closing said chambers, said diaphragm member comprising first and second spaced apart diaphragms, said disphragms respectively spanning said first and second chambers and having an outer peripheral portion fixedly and sealingly secured peripherally to one of said chambers and each said diaphragm having a moveable inner portion and a flexibly thin portion about the margin thereof adjacent said outer peripheral portion, said flexibly thin portion marginally defining said moveable inner portion and integrally connecting said inner and outer portions and said moveable inner portion moveable toward and away from said chambers, and said diaphragm member also comprising a connector post extending between and integrally connected to and connecting said diaphragms on the adjacent sides thereof, said post extending transversely across each said diaphragm moveable inner portion from inwardly adjacent said flexibly thin portion, said post thickening and rigidifying said moveable inner portion inwardly adjacent said flexibly thin portion, the area of said first diaphragm inner moveable portion greater than the area of said second diaphragm inner moveable portion;

a first input passage communicating through said housing with said first chamber and spaced from said first diaphragm; and

a second input passage and a separate output passage, each communicating through said housing with said second chamber, said output passage spaced from said second diaphragm and said second input passage extending to said second diaphragm and normally closed thereby, said second input passage open with said second diaphragm moved toward said first chamber;

that improvement characterized in comprising:

a piston in said first chamber extending transversely of siad moveable inner portion of said first diaphragm to a position inwardly spaced from said flexibly thin portion of said first diaphragm, a tubular, axially flexible wall sealingly connected at one end thereof to said piston and at the other end thereof, remote from said first diaphragm, to said housing, thereby defining, with said piston and said housing, an override chamber, an override biasing member in said override chamber contacting said piston, said override biasing member biasing said piston toward said first diaphragm, and an override passage communicating through said housing with said override chamber.

4. In the control valve claimed in claim **1**, the improvement further characterized in comprising a restricted open passage forming said bleed passage.

5. In the control valve claimed in claim **1**, the improvement further characterized in comprising said first and second diaphragms, on the sides thereof facing said first and second chambers, respectively, and opposite said post, comprising planar surfaces parallel to each other, the area of the moveable inner portion of said second diaphragm comprising a minor fraction of the area of the movable inner portion of said first diaphragm, said post integral with said diaphragms across said moveable inner portions thereof inwardly of said flexibly thin portions thereof, and said post comprising a first portion extending generally angularly inwardly from said first diaphragm and toward said second diaphragm and having an area, in a plane spaced from said first diaphragm and parallel to said diaphragm surfaces, smaller than the area of said moveable inner portion of said second diaphragm.

6. In the control valve claimed in claim **5** the difference in said areas of said moveable inner portions of said diaphragms being on the order of one order of magnitude.

7. In the control valve claimed in claim **4**, the improvement further characterized in comprising said post having a surface extending generally transversely outwardly adjacent said first diaphragm, the combined transverse areas of the flexibly thin portion of said first diaphragm moveable inner portion and of said transversely extending surface of said post, in a plane parallel to said first diaphragm, being exposed to said third chamber and comprising a major fraction of said area of said first diaphragm inner moveable portion.

8. In the control valve claimed in claim **1**, the improvement further characterized in comprising a cap member and a base member comprising said housing, said members connected together enclosing said volume, said cap member comprising a cap end wall at said housing one end and a cap side wall extending therefrom toward said base member and having an inner annular wall, extending from said cap end wall toward said base member, defining with said cap end wall said first chamber, said base member comprising a base end wall at said housing other end and a base side wall extending therefrom toward cap member and having an inner annular wall, extending from said base end wall toward said cap member, defining with said base end wall said second chamber, said moveable inner portions of said diaphragms substantially coextensive and coaxial with said chamber annular walls.

9. In the control valve claimed in claim **8**, the improvement further characterized in comprising a generally tubular collar connector connected to and joining together said cap and base members said outer peripheral portion of said first diaphragm sealingly secured between said collar connector and said cap side wall.

10. In the control valve claimed in claim **8**, the improvement further characterized in comprising a retainer member having a radially extending pierced flange overlying the outer peripheral portion only of said second diaphragm, outwardly of said moveable inner portion thereof, and overlying said base member under said diaphragm, sandwiching said second diaphragm outer peripheral portion therebetween, and also having a tubular wall extending to and against said first diaphragm opposite the portion of said cap side wall facing said base member and secured thereat, said retainer spacing said cap and base members and sealingly securing said second diaphragm.

11. In the control valve claimed in claim **10**, said first, second and third chambers of generally cylindrical configuration, the improvement further characterized in comprising said first and second diaphragms, on the sides thereof facing said first and second chambers, respectively, and opposite said post, comprising planar surfaces parallel to each other, the area of the moveable inner portion of said second diaphragm comprising a minor fraction of the area of the moveable inner portion of said first diaphragm, said post integral and coaxial with said diaphragms across said moveable inner portions thereof inwardly of said flexibly thin portions thereof, and said post comprising a first portion extending generally angularly inwardly from said first diaphragm and toward said second diaphragm and having an area, in a plane spaced from said first diaphragm and parallel to said diaphragm surfaces; smaller than the area of said moveable inner portion of said second diaphragm.

12. In the control valve claimed in claim **11**, the improvement further characterized in comprising a coil compression spring in said second chamber about said second input passage, extending between said base end wall and said second diaphragm, biasing said diaphragm member toward said first chamber.

13. In the control valve claimed in claim **11**, in which said second input passage comprises a tube coaxial of said second chamber, extending therewithin from said base end wall to said second diaphragm opposite said post, the improvement further characterized in comprising a piston in said first chamber extending parallel to said moveable inner portion of said first diaphragm to a position inwardly spaced from said flexibly thin portion of said first diaphragm, a tubular, axially flexible wall sealingly connected at one end thereof to said piston and at the other end thereof, remote from said first diaphragm, to said housing, thereby defining with said housing an override chamber, an override coil compression spring in said override chamber, extending between said cap end wall and said piston, biasing said piston toward said first diaphragm, and an override passage communicating through said housing with said override chamber.

14. In the control valve claimed in claim **13**, in which said second input passage comprises a tube coaxial of said second chamber, extending therewithin from said base end wall to said second diaphragm opposite said post, the improvement further characterized in comprising a second coil compression spring in said second chamber, about said second input passage, extending between said base end wall and said second diaphragm, opposite said post, biasing said diaphragm member toward said first chamber, the biasing force of said override spring being greater than that of said second spring.

15. In the control valve claimed in claim **14**, the improvement further characterized in comprising a generally cylindrical locating member integral with said cap end wall extending therefrom within said override chamber toward said piston and spaced from said piston, one end of said override spring positioned about said locating member, and a transverse groove extending across said locating member, said override passage opening to the base of said groove.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,861,642 Dated January 21, 1975

Inventor(s) Gerald E. Maddocks

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 3, line 42, "ana" should be --an--.

Col. 4, line 42, "94" should be --92--;

line 46, "flnge" should be --flange--.

Col. 5, line 18, "without about 56" should be --about tube 56--.

Col. 6, line 15, "now" should be --not--;

line 19, "ro" should be --to--.

Col. 9, line 50, "claimd" should be --claimed--.

Col. 10, line 33, "siad" should be --said--.

Signed and sealed this 15th day of April 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks