

## [54] CONTROL SYSTEM FOR EXHAUST GAS RECIRCULATING VALVE

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### Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 445,628, Feb. 25, 1974, which is a continuation-in-part of Ser. No. 320,151, Jan. 2, 1973, abandoned.

[52] **U.S. Cl.**..... **123/119 A**

[51] **Int. Cl.<sup>2</sup>** ..... **F02M 25/06**

[58] **Field of Search**..... 123/119 A

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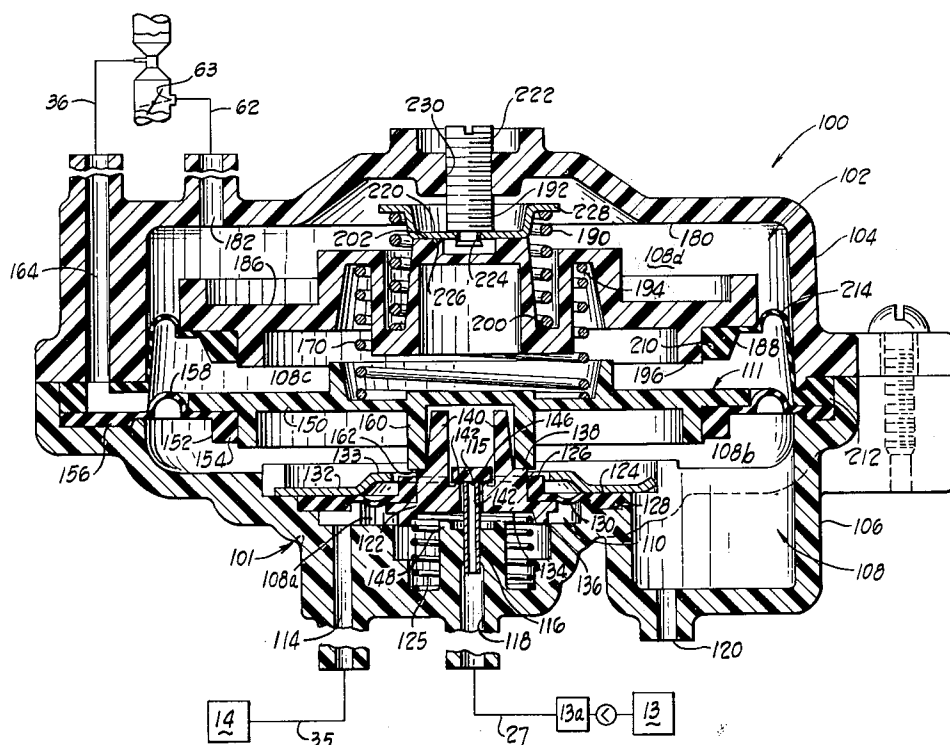
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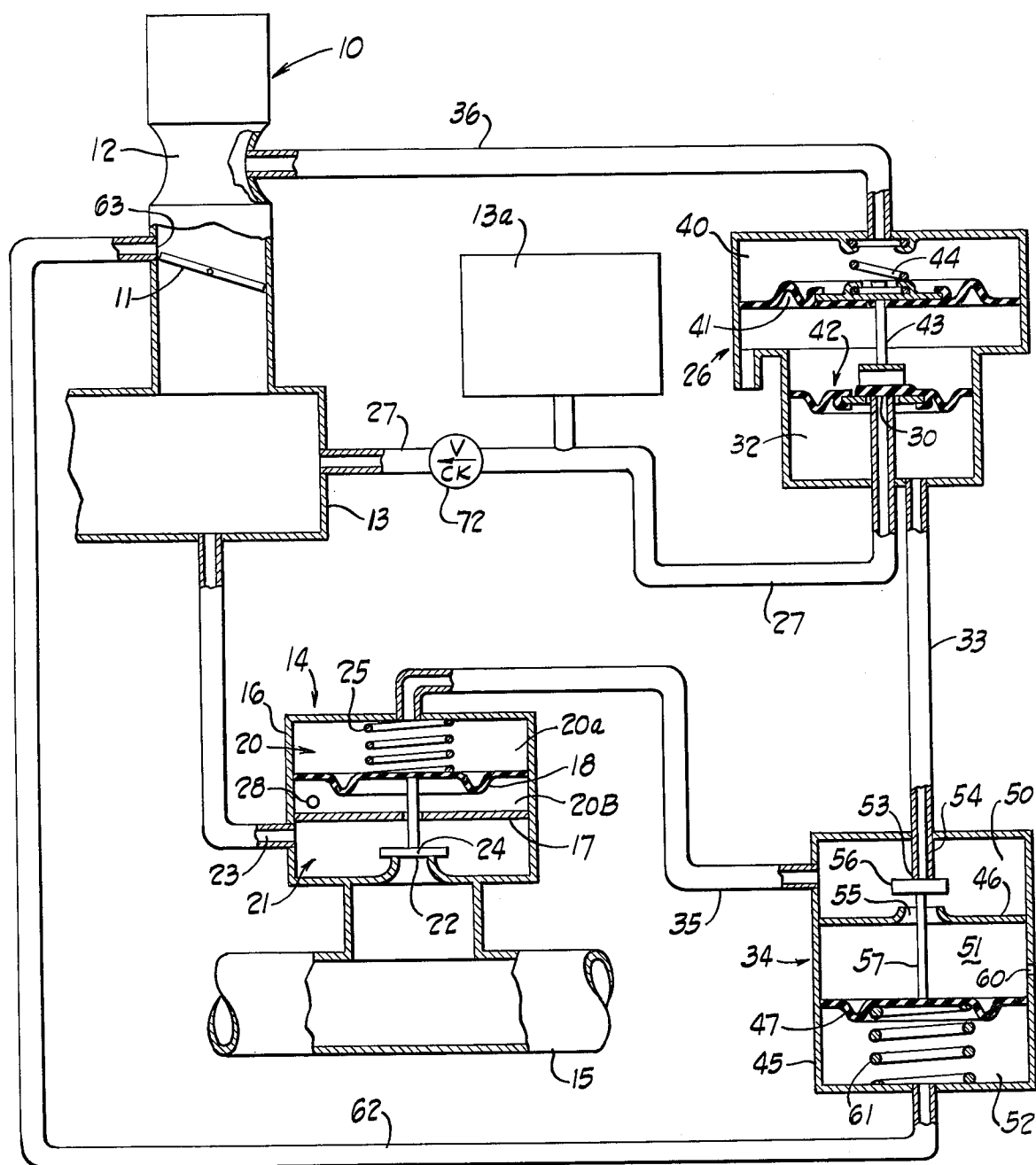
[57] **ABSTRACT**

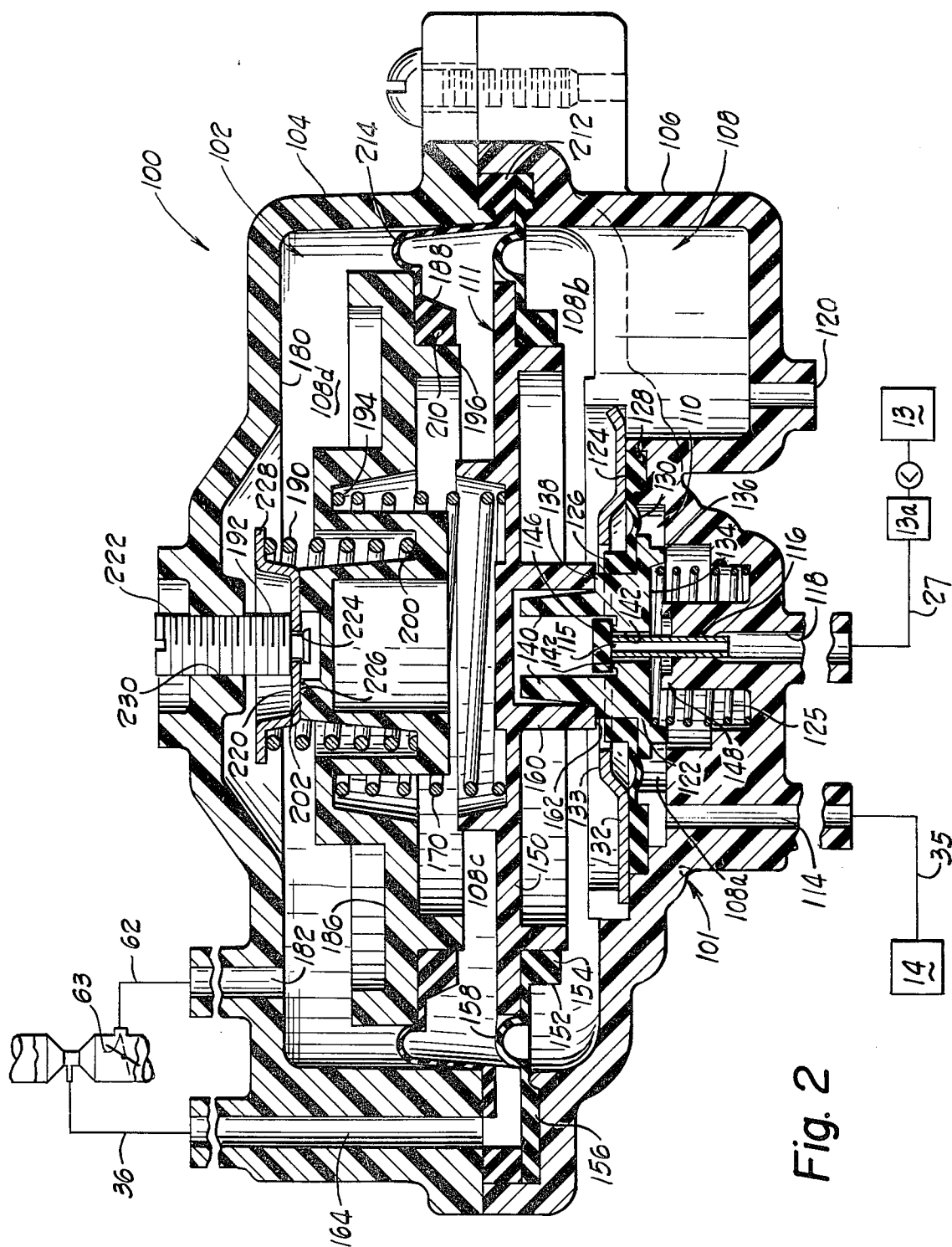
A pressure operated exhaust gas recirculation control valve in an internal combustion engine is operated by pressure from the intake manifold as controlled by a pressure regulator. The regulator responds to a pressure signal which varies as a function of the air intake flow rate into the engine. When the throttle is closed or at an idle position, a controller responsive to the air pressure at a spark port adjacent the throttle plate prevents the regulator from opening the exhaust gas recirculation control valve. The controller also prevents the regulator from opening the exhaust gas recirculation valve when the engine approaches a wide open throttle condition irrespective of the intake air flow rate.

In one disclosed embodiment the controller is associated with the regulator in a single assembly and the controller directly operates the regulator to prevent exhaust gas recirculation when the engine idles and as the engine approaches a wide open throttle condition.

### 16 Claims, 2 Drawing Figures







## CONTROL SYSTEM FOR EXHAUST GAS RECIRCULATING VALVE

### CROSS-REFERENCED APPLICATION

This application is a continuation-in-part of copending U.S. Pat. application Ser. No. 445,628 filed Feb. 25, 1974 by Roland B. Caldwell, entitled CONTROL SYSTEM FOR EXHAUST GAS RECIRCULATION VALVE which was, in turn, a continuation-in-part of U.S. Pat. application Ser. No. 320,151 filed Jan. 2, 1973 by Roland B. Caldwell and entitled CONTROL SYSTEM FOR EXHAUST GAS RECIRCULATION VALVE, now abandoned.

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to improvements in systems for controlling the recirculation of exhaust gases through an internal combustion engine to reduce or eliminate the presence of nitrous oxide in the engine exhaust gases.

#### 2. The Prior Art

Under certain operating conditions internal combustion engines tend to produce exhaust gases having undesirably high levels of nitrous oxide and the prior art has proposed recirculating controlled quantities of exhaust gas to the engine intakes in order to reduce or eliminate the presence of nitrous oxides in the exhaust gases. A vacuum operated exhaust gas recirculation control valve (EGR valve) and a control system for operating the EGR valve to govern the recirculation of engine exhaust gas back into an engine manifold is disclosed in U.S. Pat. No. 3,739,797, issued June 19, 1973 to Caldwell. In that system the vacuum for operating the EGR valve was furnished by the intake manifold and an associated vacuum reservoir through a vacuum regulator which regulated the valve operating vacuum according to the vacuum at a venturi of the engine carburetor. The regulator was constructed to communicate a valve operating vacuum level to the EGR valve which varied as a predetermined multiple, or amplification, of the venturi vacuum pressure. Thus, the vacuum control signal to the regulator varied as a function of air flow into the engine and the output of the vacuum regulator varied as an amplified function of the venturi vacuum so long as the vacuum level provided by the intake manifold and vacuum reservoir remained sufficiently great to produce the amplified valve operating vacuum demanded by the venturi vacuum level.

When engines idle, the exhaust emissions do not contain sufficient nitrous oxides to warrant exhaust gas recirculation and exhaust gas recirculation causes the engine to idle roughly. When engines are operated at wide open throttle the engine performance is also adversely affected by recirculation of exhaust gases. To optimize the performance of engines equipped with exhaust gas recirculation systems, it has been found desirable to positively close the EGR valve in response to movement of the throttle both to its wide open position and to its closed or idle position.

Although exhaust gas recirculation need not occur when an engine idles it is generally required when the engine is operated at low speeds above the idle speed. The pressure at the carburetor venturi is essentially atmospheric pressure when the engine idles because the throttle is substantially closed, and when the engine operates at relatively low speeds the venturi vacuum level

increases only slightly from atmospheric pressure because of the relatively low flow rates of air through the carburetor.

In order to assure exhaust gas recirculation at low engine speeds it was sometimes desirable to preset the regulator to provide an initial, low level, valve operating pressure output when there was no venturi vacuum input pressure to the regulator, i.e. when the throttle was closed. The preset pressure output level was controlled so that it was just insufficient to open the EGR valve in the absence of a venturi vacuum signal. While presetting the regulator tended to assure that sufficient regulator output pressure for opening the EGR valve was available at low level venturi vacuums, the EGR valve was not positively closed when the engine idled and under certain circumstances could remain slightly open during idling, particularly if the initial regulator valve operating output was excessive and/or when replacement parts for the vehicle caused changes in engine operating parameters, e.g. when a replacement muffler or exhaust system caused increased exhaust gas back pressures which tended to open the EGR valve. This caused the engines to idle poorly.

As noted above, some EGR valve controlling systems have employed a vacuum reservoir which was connected between the regulator and the intake manifold so that when the manifold vacuum levels were reduced, the reservoir maintained a relatively large vacuum level for operating the EGR valve via the regulator. These systems thus enabled the EGR valve to remain substantially wide open even though an associated engine was operated for sustained periods under relatively heavy loads at cruising speeds (e.g. when an automobile towing a trailer encountered a long grade). Under these conditions the intake manifold vacuum is reduced to a relatively low magnitude because the throttle is opened substantially but relatively high exhaust gas recirculation flow rates are necessary and, the intake manifold vacuum level itself may not be great enough to open the EGR valve as fully as necessary to provide the required amount of exhaust gas recirculation. The vacuum reservoir provided the necessary pressure to position the EGR valve to provide desirable flow rates of recirculating exhaust gas.

Some of these systems were constructed to "dump" the vacuum reservoir (i.e., the reservoir was vented to the vacuum level in the intake manifold) when the throttle approached its wide open position in order to enable the EGR valve to close. It should be noted that when the wide open throttle position is approached the intake air flow rates increase towards maximum and the venturi signal to the regulator is maximized. Accordingly the regulator is conditioned to transmit all of the available valve operating pressure from the intake manifold and reservoir to the EGR valve when the throttle is at or substantially at its wide open position. Under these circumstances, even when the reservoir is dumped, low magnitude vacuum pressures are transmitted to the EGR valve and the combination of the low level valve operating pressures and the exhaust gas back pressure acting on the EGR valve tends to prevent the EGR valve from positively closing. Hence some EGR flow may occur which adversely affects the engine performances at wide open throttle.

Moreover, in some systems relatively large volume reservoirs were employed to enable EGR flows during sustained periods of engine operation near wide open

throttle and dumping the large volume reservoirs was undesirable because the reservoir had to be recharged after each dump, and until recharged the reservoir could not always adequately perform its function.

While systems constructed according to the patent referred to were extremely effective in reducing nitrous oxide emissions, since the EGR valve was not always positively closed at wide open throttle conditions and at engine idle speeds the engine performance was not always optimized since some exhaust gas recirculation, under the noted circumstances, could occur.

### SUMMARY OF THE INVENTION

According to the present invention a pressure operated EGR valve is associated with a regulator which governs the communication of EGR valve operating pressure to the EGR valve from an operating pressure source as a function of the flow rate of gas through the engine, and an EGR valve controller functions to effect positive closing of the EGR valve irrespective of the flow rate of gas through the engine when the engine idles and when the engine operates at or substantially at wide open throttle.

In preferred embodiments of the invention the EGR valve operating pressure source is provided by an engine intake manifold and an associated vacuum pressure reservoir. Carburetor venturi vacuum levels are transmitted to the regulator to provide regulator input signals which vary as a function of gas flow rates through the engine. The EGR valve is supplied with vacuum pressure from the regulator to open the EGR valve, while venting the EGR valve to atmospheric pressure closes the EGR valve.

According to the preferred embodiment, the EGR valve controller operates in response to pressure levels at a "spark port" located adjacent a throttle plate in the engine carburetor. When the throttle is closed, or at idle position, the spark port is exposed to atmospheric pressure or, at most, a small magnitude vacuum pressure, and the EGR valve controller functions to prevent the regulator from communicating EGR valve opening pressure to the EGR valve and to condition the EGR valve for positive closing (i.e. by venting the EGR valve to atmospheric pressure). This feature of the invention enables the regulator to be preset to any desirable output pressure level in the absence of a carburetor venturi signal because the EGR valve is positively closed when the engine idles regardless of the theoretical regulator output pressure at idle speed.

When the throttle is partly opened during normal operation of the engine the spark port is exposed to the engine intake manifold pressure and the valve controller is rendered ineffective to govern operation of the EGR valve. When the throttle moves from the engine idle position the spark port is abruptly communicated with the intake manifold pressure and the controller is therefore abruptly rendered ineffective. This permits the regulator to be preset and conditioned to provide for substantial EGR valve operating output pressures to the EGR valve at low engine speeds above the idle speed (low level venturi vacuums) without risk of the EGR valve opening when the engine idles.

When the throttle is at, or substantially at, its wide open position the magnitude of the intake manifold pressure approaches atmospheric pressure and at a predetermined, desired intake manifold pressure the valve controller again operates to prevent the regulator from

supplying operating pressure for opening the EGR valve irrespective of the relatively high level of the input venturi vacuum signal to the regulator. The EGR valve thus tends to positively close regardless of the exhaust gas back pressure.

Because the EGR valve controller operates to vent the EGR valve to atmospheric pressure while blocking the transmission of operating pressure from the regulator to the EGR valve, the pressure level in the vacuum reservoir associated with the intake manifold and the regulator is not substantially depleted, or "dumped," when the engine is operated at wide open throttle. The new system thus permits the reservoir to remain charged during wide open throttle operation of the engine and substantial recharging is not required.

An important object of the present invention is the provision of an EGR valve controlling system wherein a pressure operated EGR valve is controlled by a pressure regulator as a function of the flow rate of gas through the engine and in which an EGR valve controller effects closing of the EGR valve when the throttle is at its idle and its wide open positions irrespective of the flow rate of gas through the engine.

Other objects and advantages of the invention will be apparent from the following description of preferred embodiments of the invention made in reference to the accompanying drawings which form part of the specification.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary schematic view of an internal combustion engine and an exhaust gas recirculating valve and a control system therefore embodying the invention; and,

FIG. 2 is a cross-sectional view showing an alternate construction of part of the EGR valve control system.

### DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIG. 1 of the drawings, an internal combustion engine, only partly illustrated, includes a suitable or conventional carburetor 10 having a throttle plate 11 and a venturi 12; an intake manifold 13, and, an exhaust manifold 15. An exhaust gas recirculation (EGR) control valve 14 is provided for controlling the passage of exhaust gases from the exhaust manifold 15 to the intake manifold 13 for recirculation through the engine.

The EGR valve 14 is preferably fluid operated and is operated from a source of vacuum pressure provided by the intake manifold 13 and an associated vacuum reservoir 13a. Operation of the EGR valve 14 is governed by a pressure regulator 26 and by a valve controller 34 which are disposed between the EGR valve and the operating pressure source. When the throttle 11 is closed or at its idle position, as well as substantially at its wide open throttle position, the controller 34 prevents the EGR valve from opening. During other operating conditions of the engine the EGR valve is opened and controlled as a function of gas flow rate through the engine by the regulator 26.

The EGR valve 14, which is schematically shown, comprises a housing 16 divided by a plate 17 into upper and lower chambers 20, 21. The upper chamber 20 is divided into upper and lower chamber portions 20a, 20b, by a flexible diaphragm 18. The lower chamber 21 has an inlet port 22 communicating with the exhaust manifold 15, and an outlet port 23 communicating with

the intake manifold. A valve member 24 is connected to the diaphragm 18 by a stem which extends through a conforming opening in the plate 17 and is moved by deflections of the diaphragm to close and open the port 22. A spring 25 normally urges the valve member 24 to close the port 22. The valve member 24 is moved from the port 22 when the vacuum pressure level in the upper chamber portion 20a is sufficient to raise the valve member 24 against the force of the spring 25. The lower chamber portion 20b is provided with a port 28 which vents the chamber portion 20b to atmospheric pressure. This permits the diaphragm 18 to flex in accordance with the vacuum level in the chamber 20a with respect to the plate 17.

Valve opening vacuum pressure is communicated to the upper chamber portion 20a from the intake manifold 13 and the reservoir 13a through the regulator 26. A conduit 27 communicates the manifold 13 and reservoir 13a to an inlet port 30 of the vacuum regulator 26, a chamber 32 of the vacuum regulator, a conduit 33 from the chamber 32 to the valve controller 34, and a conduit 35 from the controller 34 to the chamber 20 of the valve 14.

The output of the vacuum regulator 26, which is communicated to the conduit 33, is controlled according to the vacuum pressure at the venturi 12 of the carburetor 10 which is communicated to the regulator 26 via a conduit 36. The vacuum at the venturi 12 is created by the flow of engine intake air through the venturi, varies as a function of the flow rate of air entering the engine and is generally of small magnitude compared to the vacuum in the intake manifold and the reservoir. The venturi vacuum pressure applied to the regulator is effective to regulate the communication of valve operating vacuum to the regulator output conduit 33 to provide a valve operating vacuum in the chamber 20a which varies as an amplified function of the vacuum at the venturi, provided a sufficiently great valve operating vacuum is available from the intake manifold and the reservoir.

The level of the vacuum pressure produced in the regulator output chamber 32 is thus controlled by the level of vacuum pressure communicated to a chamber 40 of the regulator 26 from the carburetor venturi 12 to the extent sufficient source vacuum pressure is available. One wall of the chamber 40 is formed by a flexible diaphragm 41 which is laterally moved in the chamber 40 in relation to the level of venturi vacuum in the chamber.

Lateral movement of the diaphragm 41 is transmitted to a diaphragm valve 42 by a link 43. The volume between the diaphragm 41 and the diaphragm valve 42 is open to atmosphere so that as the vacuum in the chamber 40 increases in magnitude, the diaphragm 41 is deflected upwardly, as viewed in the drawing. When the magnitude of the venturi vacuum in the chamber 40 is reduced relative to atmospheric pressure, indicating a reduction in the air flow rate into the engine, the diaphragm 41 tends to move downwardly as viewed in the drawing.

Upward movement of the diaphragm valve 42 by the diaphragm 41 tends to communicate the chamber 32 with the conduit 27 to increase the vacuum at the output conduit 33. Downward movement of the diaphragm valve 42 by the diaphragm 41 tends to communicate the output conduit 33 with atmospheric pressure

present in the casing between the diaphragm 41 and the valve 42 to reduce the vacuum at the output 33.

The relative areas of the diaphragm 41 and the diaphragm valve 42 determine the amplification ratio of the regulator. If the pressure area of the diaphragm 41 is extremely large compared to the pressure area of the diaphragm valve 42 the pressure amplification provided by the regulator is great. When the vacuum pressure in the chamber 32 approximates a predetermined multiple of the magnitude of the vacuum in the chamber 40, the forces acting on the diaphragm 41 and the valve 42 are balanced and the diaphragm valve is positioned to seal the chamber 32 from the conduit 27 and atmospheric air pressure and thus provide an output vacuum in the conduit 33 substantially corresponding to a given multiple of the vacuum in the chamber 40.

In the illustrated embodiment of the invention, a light tension spring 44 is disposed above the diaphragm 41 to bias the diaphragm upwardly when no venturi signal is present in the chamber 40. The spring 44 thus establishes a preset, or predetermined, initial vacuum pressure output from the regulator 26. As the air flow rate through the carburetor venturi increases, the vacuum in the chamber 40 increases causing the regulator output vacuum level to increase from the initial output level as an amplified function of the increase in venturi vacuum. Thus when the venturi vacuum level reaches a predetermined level, for example when the engine is operating at a low cruising speed, adequate power for opening the EGR valve 14 from the regulator output is assured.

For a more detailed description of the vacuum regulator 26, reference is made to the disclosures in my co-pending U.S. Pat. application Ser. No. 202,783, now U.S. Pat. No. 3,739,797 and to U.S. Pat. No. 3,125,111.

As mentioned previously, when the carburetor throttle plate 11 is at idle (as shown in the drawing), in which case the throttle plate substantially closes the intake, it is desirable to close the EGR valve 14 to prevent recirculation of exhaust gases. Because of the initial low level vacuum output from the regulator 26, the EGR valve may tend to open slightly when the engine idles and the consequent recirculation of exhaust gas is undesirable.

Likewise, when the engine operates at wide open throttle, exhaust gas recirculation is not desirable, and the valve 14 should be closed notwithstanding the large magnitude venturi vacuum signal provided to the regulator which would theoretically maintain the valve wide open. Where the reservoir 13a is relatively large, the valve 14 would tend to remain open at the wide open throttle condition of the engine until the vacuum in the reservoir 13a is dissipated, for example, by slow leakage of atmospheric air into the reservoir via elements of the system.

The controller 34 is effective to close the EGR valve and to prevent communication of valve operating pressure to the valve via the regulator 26 when the engine idles as well as when the engine operates at wide open throttle. The controller 34 is schematically shown and comprises a casing 45 supporting a rigid transverse internal wall 46 and a transverse diaphragm 47. The wall 46 and the diaphragm 47 are spaced apart to define chambers 50, 51, 52 within the casing. The chamber 50 communicates with the EGR valve chamber 20a via the conduit 35 and is provided with a first port 53 formed

by a stem 54 of the conduit 33 which projects into the chamber 50 and a second port 55 formed in the chamber wall 46 for communicating the chamber 50 with the chamber 51. The chamber 51 is opened to atmosphere by a port 60 in the casing wall.

A valve member 56 is disposed in the chamber 50 and is shiftable between the ports 53, 55 to close one port while opening the other. The valve member 56 is connected to the diaphragm 47 by a valve stem 57 which extends between the valve member and the diaphragm through the port 55. When the diaphragm 47 flexes towards the chamber 50 the valve member 56 closes the chamber port 53 and opens the port 55 to communicate the EGR valve chamber 20a to atmospheric air pressure via the port 60, the chamber 51 and the port 55. The EGR valve is thus closed regardless of the output vacuum pressure level established by the regulator, and the communication of operating pressure to the valve via the regulator is blocked. When the diaphragm 47 flexes in a direction away from the chamber 50 the valve member 56 closes the port 55 and opens the port 53 communicating the EGR valve chamber 20a to the regulator 26. The EGR valve is then controlled according to the output of the regulator 26.

Operation of the valve member 56 is governed by a fluid pressure signal which varies according to engine operating conditions. In the illustrated embodiment of the invention, the valve member 56 is biased toward closing on the port 53 by a compression spring 61 between the lower end wall of the chamber 52 and the diaphragm. The chamber 52 is connected by a conduit 62 with the area of the carburetor intake immediately adjacent and above the throttle plate 11 when the throttle is closed. The conduit 62 is communicated to an opening referred to as a "spark port" 63 formed in the wall of the carburetor.

The pressure at the spark port 63 varies according to engine operating conditions and is transmitted to the controller chamber 52 to govern movement of the valve member 56. When the engine is idling the throttle plate is substantially closed and the spark port is exposed to air substantially at atmospheric pressure because a portion of the spark port opens upstream from the throttle plate. The pressure in the chamber 52 is thus about an atmospheric pressure and the spring 61 forces the valve member 56 to close on the port 53. The force of the valve controller spring 61 is such that when a slight vacuum, e.g. 2 inches Hg. or less, is established adjacent the spark port 63 the spring 61 moves the diaphragm 47 so that the valve member 56 opens the port 55, closes the port 53 and vents the EGR valve chamber 20a to atmospheric air pressure to close the EGR valve.

Hence when the engine idles the valve member 56 blocks communication between the regulator 26 and the EGR valve 14 so that no matter what the preset initial regulator output pressure is, it is not communicated to the EGR valve. The EGR valve 14 is thus positively closed when the engine idles.

When the engine speed is increased from idle speed the controller 34 immediately enables the regulator 26 to control positioning of the EGR valve. As the throttle plate is moved from the idle position the spark port 63 is abruptly exposed to air which is substantially at the intake manifold pressure. The pressure in the controller chamber 52 abruptly changes to about the vacuum

level in the intake manifold, which is greater than 2 inches Hg., and the atmospheric pressure in the chamber 51 above the diaphragm 47 forces the diaphragm to compress the spring 61, opening the valve port 53 and closing the port 55. The EGR valve chamber 20a is then placed in communication with the outlet of the regulator 26 through the conduit 35, chamber 50, port 53 and the conduit 33. The EGR valve is thus positioned according to the carburetor venturi vacuum level via the regulator 26.

When the engine is operated at wide open throttle, either at high speed or under extreme load, the pressure in the intake manifold approaches atmospheric pressure and the spark port 63 is exposed to intake air substantially at that pressure level. Accordingly the pressure in the chamber 52 again approaches atmospheric pressure and the spring 61 again urges the valve member 56 into closing engagement with the port 53 to block the regulator output and positively close the EGR valve.

It should be noted that at high engine speeds and/or loads when the port 53 is blocked, the only forces tending to open the EGR valve 14 are the forces exerted on the valve member 24 by the exhaust gas back pressure and the relatively low magnitude intake manifold vacuum in the chamber 21. The spring 25 produces sufficient force for maintaining the valve 24 positively closed on the port 53.

The abrupt increase in detected vacuum pressure at the spark port 63 which occurs when the throttle is opened from its idle position causes a snap motion of the valve member 56 from the port 53 to the port 55. This minimizes the flow of atmospheric air to the regulator from the port 55 as the valve member moves between the ports 53, 55. When the engine approaches the wide open throttle position the valve member 56 also tends to snap move to close on the port 53 due to the differential pressure forces acting on the valve member 56 itself. If desired, the diaphragm 47 and/or the spring 61 can be suitably constructed to provide for snap motion of the valve member 56 in both directions of movement without departing from the invention.

When the engine is operating under load at less than maximum speed with the throttle plate not fully opened, the intake manifold pressure can approach atmospheric pressure. In these circumstances it is desirable to maintain the EGR valve open and the power necessary for maintaining the valve in an open position dictated by the venturi vacuum may not be available directly from the intake manifold. In such circumstances the reservoir 13a supplies the EGR valve operating power.

The vacuum reservoir 13a and an associated check valve 72 are connected in the system to communicate with the intake manifold 13 and the regulator 26. The check valve 72 is connected between the reservoir and intake manifold to permit evacuation of the reservoir by the intake manifold while preventing the reservoir from venting to the intake manifold when the intake manifold vacuum is less than the reservoir vacuum.

When the throttle is moved toward its wide open position sufficiently to create an intake manifold vacuum of, for example, 2 inches Hg or less, the controller 34 functions to block the output from the regulator 26 while venting the chamber 20a of the EGR valve. Thus the controller 34 functions to prevent the reservoir 13a from being vented to atmosphere along with the EGR

valve, and the reservoir maintains a supply of EGR valve operating power while the engine is operated at wide open throttle. If the throttle is then moved gradually closed from its wide open position the reservoir 13a is capable of providing sufficient vacuum power for reopening the EGR valve when the controller has operated to communicate the regulator output to the EGR valve.

Referring now to FIG. 2, an alternate preferred construction of part of an EGR valve controlling system embodying the present invention is illustrated in which a regulator and a coacting valve controller are combined in a single EGR valve controlling unit indicated by the reference character 100. The unit 100 is associated with system components which are identical to those illustrated and described in reference to FIG. 1 and such components are schematically illustrated and referred to by corresponding reference characters in FIG. 2. The unit 100 comprises an EGR valve controlling regulator assembly 101 for governing communication of operating pressure to an EGR valve 14 and a controller assembly 102 cooperatively related to the regulator assembly 101 for overriding the normal regulator operation and preventing the regulator from communicating operating pressure to the EGR valve 14 under predetermined engine operating conditions. The unit 100 preferably includes cup-like housing members 104, 106 each formed of a relatively rigid molded plastic material which are assembled together by suitable screws to define a generally cylindrical internal chamber 108 in which the regulator and controller assemblies are supported.

The regulator assembly 101 normally functions to control the level of the EGR valve operating pressure supplied to the EGR valve 14 in response to the mass flow rate of gas through the engine, as indicated by the level of the carburetor venturi vacuum, and comprises a diaphragm valve assembly 110 and a valve actuator 111. The valve assembly 110 is normally operated by the actuator 111 to provide a controlled EGR valve operating output pressure to the EGR valve via an output chamber portion 108a which is communicable by the valve assembly 110 to a source of EGR valve operating pressure or to an atmospheric air pressure chamber portion 108b. The position of the EGR valving member is thus modulatable between its fully open and its closed positions according to operation of the valve assembly 110 and the actuator 111.

The output chamber 108a communicates with the EGR valve 14 via an output passage 114 formed by the housing member 106 and the conduit 35. As in the embodiment of the invention illustrated in FIG. 1, the source of EGR valve operating pressure is provided by the intake manifold 13 and the associated vacuum reservoir 13a which are communicated to the chamber portion 108a via an input port 115 formed by the projecting end of the input pressure tube 116 which is fixed in the housing member 106. The tube 116 and port 115 communicate with the intake manifold and reservoir via an input pressure passage 118, formed in the housing member 106, and the conduit 27.

The atmospheric air pressure chamber portion 108b communicates with the atmospheric air via a vent port 120 defined in the base of the housing member 106. A suitable air filter (not shown) is supported in the housing member 106 between the vent port 120 and the chamber portion 108b.

The diaphragm valve assembly 110 comprises a generally annular valve body 122 which is supported in the housing member 106 by an annular, air impervious rubber-like diaphragm member 124 and biased away from the chamber portion 108a by a valve spring 125. The diaphragm member 124 forms an air impervious sealed flexible wall which extends from the valve body 122 to the housing member 106 between the chamber portions 108a, 108b and comprises an inner annular sealing flange 126 sealingly engaged about the valve body 122, an outer sealing flange 128 seated on and sealingly engaged with the housing member 106 and a freely flexible wall section 130 disposed between the inner and outer flanges. The diaphragm member thus prevents communication between the chamber portions 108a, 108b about the valve body 122 while enabling the valve body to freely move toward and away from the respective chamber portions 108a, 108b.

The diaphragm member 124 is fixed against the housing member 106 by an annular retainer ring 132 which defines a radially inwardly projecting lip 133 which functions to limit the movement of the valve body 122 away from the chamber portion 108a.

The valve body 122 defines a generally circular base surface 134 facing the chamber portion 108a, an annular spring retaining land 136 projecting from the base 134 for retaining the valve spring 125 in alignment with the surface 134, an annular bearing face 138 engageable with the valve actuator 111, a pair of guide lugs 140 projecting from the bearing face 138 for maintaining the actuator 111 and valve body 122 aligned, a cylindrical through bore 142 extending between the chamber portions 108a, 108b concentric with and spaced from the tube 116, and a valve seat 144 defined about the end of the bore 142 opening at the chamber 108b.

A valving member 146 extends across and is resiliently engaged with the valve seat 144. In the preferred and illustrated embodiment of the invention, the valving member 146 is defined by a strap or tongue integral with the diaphragm member 124 and which extends from the inner sealing flange 126 across the valve body 122 between the lugs 140. In the condition of the regulator valve assembly 110 illustrated in FIG. 2, the valve body 122 is positioned so that the valving member 146 is sealingly engaged with the valve seat 144 as well as being seated on the pressure input port 115 to block pressure communication between the output chamber portion 108a and both the atmospheric air pressure chamber portion 108b and the input pressure passage 118.

When the valve body 122 is moved toward the chamber portion 108b relative to the tube 116, the valving member 146 remains sealingly engaged with the valve seat 144 but is disengaged from the port 115 to communicate the passage 118 to the output pressure chamber portion 108a thus increasing the level of the EGR valve operating pressure in the chamber portion 108a. When the valve body 122 moves toward the chamber portion 108a relative to the tube 116 the valving member 146 engages and seals the port 115 and is disengaged from the valve seat 144 to communicate the atmospheric air pressure chamber 108b with the output chamber 108a thus reducing the level of the valve operating vacuum provided in the output chamber portion 108a. Movement of the valve body toward the chamber portion 108a is limited by engagement between an

abutment projection 148 in the chamber portion 108a and the base surface 134.

The actuator 111 normally bears on the valve body 122 and effects movement of the valve body to alter the pressure in the output chamber portion 108a, in accordance with the vacuum pressure level at the carburetor venturi. The actuator 111 preferably comprises an actuator body formed by a generally disc-like imperforate rigid plastic member 150 which is supported within the chamber 108 by an air impervious rubber-like annular actuator diaphragm member 152. The diaphragm member 152 comprises an inner sealing flange 154 which is tightly disposed about and sealed against the actuator member 150, an outer sealing flange 156 which is seated on and sealed against the housing member 106 and an intermediate flexible wall portion 158 extending between the flanges. The actuator member 150 and diaphragm 152 extend completely across the chamber 108 and form a flexible upper chamber wall of the chamber 108b. The actuator member 150 defines a central cup-like hub 160 having a projecting annular bearing face 162 which is engageable with the valve body bearing face 138. The lugs 140 extend into the hub 160 to guide the bearing face 162 into engagement with the face 138 in the event of relative movement between the valve body 122 and the actuator member 150.

The actuator 111 is effective to position the valve body 122 to control the pressure in the output chamber portion 108a in response to an input pressure signal provided from the carburetor venturi. Accordingly an input pressure chamber portion 108c is defined within the unit 100 above the actuator 111 and which communicates with the carburetor venturi via a signal passage 164 defined by the housing member 104 and the conduit 36. As the level of the carburetor venturi vacuum increases relative to atmospheric pressure the actuator 111 tends to shift away from the chamber portion 108b, while reductions in the magnitude of the carburetor venturi vacuum result in a tendency for the actuator to shift toward the chamber portion 108b. The valve spring 125 urges the valve body against the actuator 111 so that the valve body follows movement of the actuator 111 away from the chamber 108b. When the actuator 111 moves towards the chamber 108b the valve spring 125 is compressed by the valve body 122.

The positions of the diaphragm valve 110 and the actuator 111 are governed by coacting spring and pressure forces. The actuator member 150 is biased toward the chamber portion 108b by a helical actuator spring 170 disposed in the chamber portion 108c. The force exerted on the actuator member 150 by the actuator spring 170 is opposed by the force exerted by the valve spring 125 on the valve body 122.

In addition to the spring forces operating on the actuator member 150 and the valve body 122, differential pressure forces are applied to these respective components to enable the establishment of a preset, initial regulator output pressure level in the chamber portion 108a as well as to enable the output pressure level to vary as an amplified function of the input pressure in the signal pressure chamber portion 108c throughout a predetermined range of input signal levels. The differential between the output vacuum pressure in the chamber 108a and the atmospheric pressure in the chamber 108b creates a differential pressure force which urges the valve body 122 toward the chamber

portion 108a in opposition to the force of the valve spring 125.

Assuming that the engine is operating above its idling speed (i.e., the EGR valve controller 102 is ineffective) but the venturi vacuum level is substantially at atmospheric pressure, the actuator member 150 and the valve body 122 are acted on by the opposed springs 125 and 170, with the valve spring 125 being effective to shift the valve body 122 towards the chamber portion 108b to open the input pressure port 115 and increase the magnitude of the vacuum output pressure in the chamber portion 108a. The output chamber pressure is stabilized at a predetermined level when the differential pressure force applied to the valve body 122 balances the opposed spring forces and the valve body is positioned as illustrated by FIG. 2 with the valving member 146 seated on both the port 115 and the valve seat 144.

As the throttle plate is opened further, the level of the vacuum pressure in the signal input chamber 108c increases from atmospheric pressure resulting in pressure increases in the output chamber 108a from the initial pressure level which correspond to a predetermined multiple of the change in the input signal pressure. The increase in the venturi vacuum level creates a differential pressure between the chamber portions 108b, 108c resulting in a pressure force being exerted on the actuator member 150 in opposition to the actuator spring 170. The resulting unbalanced force enables the spring 125 to shift the valve body 122 towards the chamber 108b thus opening the port 115 to the chamber portion 108a while the valving member 146 remains engaged on the valve seat 144.

The pressure amplification ratio between the pressure input signal and the output chamber pressure level is determined by the ratio of the areas of the actuator 111 and the diaphragm valve 110. In the preferred embodiment, the pressure area of the actuator assembly 111 (i.e. the combined area of the actuator member 150 and the diaphragm 152 exposed to the chamber portion 108c) is about 10 times the effective pressure area of the diaphragm valve 110 (i.e. the combined area of the valve body 122 and the diaphragm 124 exposed to the chamber portion 108a). Therefore the amplification ratio of the regulator is 10:1 and for every incremental pressure change in the chamber portion 108c, the magnitude of the pressure level in the output chamber portion 108a is changed by an amount equal to 10 times the incremental signal pressure change.

When the magnitude of the pressure in the chamber 108c reaches a predetermined level the EGR valve is wide open and the regulator output pressure chamber 108a remains communicated to the reservoir 13a. The regulator output is therefore at a maximum and no further increases in EGR valve operating pressure can be furnished as a direct result of further increases in the input signal level. As noted previously, the retainer ring flange 133 limits movement of the valve body 122 towards the chamber portion 108b. When the input signal chamber pressure level has reached a predetermined magnitude the output pressure from the regulator 101 is maximum and the valve spring 125 maintains the valve body 122 at the limit position established by the flange 133. Accordingly, further increases in the input signal level cause the actuator member 150 to move from bearing engagement with the valve body

122 and the lugs 140 maintain the valve body 122 and the member 150 aligned for proper re-engagement.

When the flow rate of gas through the engine is reduced, as evidenced by the magnitude of the venturi vacuum being reduced, the pressure forces acting on the diaphragm valve 110 and the actuator 111 become unbalanced causing the valve body 122 to shift toward the chamber portion 108a so that the valving member 146 closes the port 115 and is disengaged from the seat 144. Pressure from the chamber portion 108b is thus communicated to the chamber portion 108a to reduce the magnitude of the pressure in the chamber 108a which in turn causes the EGR valve to operate toward its closed condition. When the reduction in magnitude of the pressure in the chamber portion 108a is 10 times the reduction in magnitude of the venturi vacuum signal the pressure forces acting on the valve 110 and the actuator 111 are again balanced and the pressure level in the chamber portion 108a is stabilized since the valving member 146 engages both the seat 144 and the port 115.

The controller assembly 102 is disposed in the chamber 108 between the chamber portion 108c and end wall 180 of the housing member 104 remote from the valve assembly 101, and is effective to override the actuator 111 for preventing the regulator valve assembly 110 from providing an EGR valve operating output pressure when the engine idles as well as when the engine is operated substantially at wide open throttle. The controller assembly 102 cooperates with the regulator valve assembly 110 so that the vacuum reservoir is isolated from atmospheric pressure when the controller assembly operates and the charge in the reservoir 13a is therefore maintained at all times during operation of the controller assembly.

In the preferred embodiment of the invention the controller assembly 102 is operable in response to spark port pressure levels which are established when the engine idles and when the engine is operated substantially at wide open throttle, and is ineffective at all other times during operation of the engine. The assembly 102 forms an air impervious upper wall of the chamber portion 108c and defines, with the housing member 104, a spark port pressure chamber portion 108d at the end of the chamber 108 remote from the valve assembly 110. The pressure at the spark port 63 is communicated to the chamber portion 108d via the conduit 62 and a passage 182 formed in the housing member 104.

The assembly 102 preferably comprises an operating member 186, a diaphragm 188 supporting the member 186 for movement towards and away from the housing end wall 180, a controller spring 190 urging the member 186 towards the valve assembly 110, and an adjustable stop mechanism 192 for limiting motion of the member 186 towards the housing end wall 180. The member 186 is preferably a rigid disc-like member which is constructed to provide a fixed wall of the chamber portion 108c when the engine is operated between its idle speed and its substantially wide open throttle conditions. The side of the member 186 facing the chamber portion 108c defines an annular seat 194 for the actuator spring 170 and an annular abutment 196 which projects towards the actuator member 150 for limiting relative movement of the actuator member 150 and the controller member 186 towards each other. The side of the member 186 facing the spark

port pressure chamber portion 108d defines an annular seat 200 for the controller spring 190 and an annular shoulder 202 for engaging the stop mechanism 192 and limiting movement of the member 186 towards the housing end wall 180.

The diaphragm member 188 allows the controller member 186 to freely move towards and away from the housing end wall 180 under the influence of the controller spring 190 and differential pressure forces which effectively act on the member 186. The diaphragm member 188 comprises an inner sealing flange 210 which is tightly engaged about the periphery of the member 186, an outer sealing flange 212 which is in sealing engagement with the housing member 104 and an intermediate flexible wall portion 214 continuous with the flanges 210, 212 for enabling the aforementioned movement of the controller member 186.

In the preferred embodiment the outer sealing flange 212 is clamped against the outer sealing flange 156 of the diaphragm 152 between the housing members 104, 106 and, as illustrated in FIG. 2, a portion of the venturi signal passage 164 extends through part of the outer sealing flange 212.

The adjustable stop mechanism 192 comprises a generally annular stop member 220 which is supported in the chamber portion 108d by an adjustable screw 222 which extends through the housing end wall 180. The stop member 220 defines a central opening 224 which is loosely received on the projecting end of the screw 222, an annular bearing face 226 which extends radially away from the opening 224 and a spring seating flange 228 which extends peripherally about and is offset from the plane of the bearing face 226 against which the spring 190 seats.

The screw 222 is preferably disposed in a tapped hole 230 extending through the housing end wall 180 with the threads of the hole 230 and screw 222 being engaged tightly to prevent leakage of atmospheric air into the chamber portion 108d.

During operation of the engine when the throttle plate is away from its closed, or idle, position but not at or substantially at the wide open throttle position, the chamber portion 108d communicates with a vacuum level at, or substantially at, the intake manifold vacuum level via the spark port 63, the conduit 62, and the passage 182. Under these conditions the vacuum pressure level in the chamber portion 108d is substantial and the member 186 is urged upwardly against the stop member 220 in opposition to the controller spring 190. This condition of the controller assembly 102 is illustrated in FIG. 2.

When the engine is operating at a cruising speed the controller member 186 is in engagement with the abutment member 220 the actuator spring 170 biases the actuator member 150 away from the controller member 186 towards the atmospheric chamber portion 108b to operate the regulator valve assembly 110 as described previously.

As the throttle plate opens further to increase the engine speed or accommodate a greater load at the cruising speed the venturi vacuum magnitude increases. When the venturi vacuum magnitude reaches a predetermined level such as, for example, one inch of mercury, the actuator spring 170 is compressed sufficiently that the actuator member 150 engages the abutment 196 on the controller member 186. When this occurs the actuator spring 170 is, in effect, removed from the

system and the actuator member 150 and controller member 186 function is a unit. As noted previously, in this condition of operation, the diaphragm valve assembly 110 is wide open since the valve body 122 maintained in engagement with the retainer ring flange 133 by the valve spring 125 and maximum available EGR operating pressure is communicated to the EGR valve.

If the throttle plate is opened still farther toward its wide open position the vacuum level in the spark port pressure chamber 108d is reduced towards atmospheric pressure sufficiently that the controller spring 190 moves the controller member 186 and the actuator member 150 towards the valve assembly 110. Since the actuator member 150 and the controller member 186 function as a unit, movement of the members 186, 150 towards the valve member is determined by the pressure differential between the chamber portions 108b and 108d and the force of the controller spring 190.

When the actuator member 150 re-engages the valve body 122, the valve spring 125 begins to oppose further movement of the members 186 and 150 while the pressure in the chamber portion 108a creates a pressure force on the diaphragm valve 110 tending to oppose the valve spring 125. The valve spring 125 is compressed which tends to reduce the pressure in the output chamber portion 108a and operate the EGR valve 14 toward its closed position. It should be noted in this connection that the controller spring 190 is substantially stronger than the valve spring.

When the pressure in the spark port chamber portion 108d reaches a desired level, e.g. approximately two-three inches of mercury, the action of the controller spring 190 operates the diaphragm valve assembly 110 to communicate atmospheric air from the chamber portion 108b directly to the EGR valve 14. This vents the EGR valve 14 causing that valve to be positively closed. It should be noted that venting of the EGR valve 14 occurs while the valving member 146 is seated on the port 115 and thus the reservoir 13a is not vented to atmosphere even though the EGR valve 14 is so vented.

When the engine speed or load is reduced and the throttle plate is moved away from its substantially wide open position, the member 186 moves toward the housing end wall 180 resulting in the regulator 101 again supplying operating pressure to the EGR valve 14. It should be apparent that even if the movement of the throttle plate away from its substantially wide open position is accomplished quite gradually, since the reservoir 13a is not vented when the EGR valve is closed at the wide open throttle condition, sufficient power is available from the reservoir for operating the EGR valve 14 from its closed position as the throttle plate is moved towards its closed position.

When the engine is idling the throttle plate is substantially closed and the spark port, since it is communicated with atmospheric air pressure upstream from the closed throttle plate, maintains the spark port chamber portion 108d at substantially atmospheric pressure. Under this condition of operation of the unit 100 the small mass flow rate of air into the engine is such that there is substantially no venturi vacuum signal and the chamber portion 108c is accordingly effectively at atmospheric pressure. When these conditions exist the controller spring 190 overcomes the force of the actuator spring 170 causing the controller member 186 to engage the actuator member 150 and consequently

urge the valve body 122 towards the chamber portion 108a so that the EGR valve 14 is vented to atmosphere via the bore 142 in the valve member 122 and the chamber portion 108b. The diaphragm valve 110 is thus prevented from communicating any operating pressure to the EGR valve 14. The controller spring 190 overcomes the forces produced by the actuator and valve springs 170, 125 and operates the diaphragm valve 110 to its zero output pressure condition notwithstanding the fact that the diaphragm valve 110 is preset to produce an initial output pressure in the absence of an input signal.

As soon as the throttle plate moves slightly away from its idle position, the spark port is effectively exposed to the engine intake manifold pressure, which is substantially in excess of 3 inches of mercury, causing the member 186 to abruptly compress the controller spring 190 and move into engagement with the abutment member 220. The actuator spring 170 becomes effective to force the members 150, 186 apart and the position of the actuator member 150 is controlled by the actuator spring 170, the venturi vacuum signal level present in the chamber portion 108c and the valve spring 125. Accordingly the valve body 122 is shifted to produce at least the preset initial output pressure level in the chamber portion 108a. The output pressure is thereafter determined by the signal input pressure as described previously.

Proper operation of the unit 100 requires selection of the springs 125, 170 and 190 so that the controller spring 190 provides a greater force than both of the other two springs as it moves to its fully extended condition. The controller spring 190 must also be related to the controller assembly so that when the spark port vacuum level exceeds a predetermined low level, e.g. 3 inches of Mercury, the controller spring 190 is compressed sufficiently to enable the member 186 to engage the abutment 220. The valve spring 125 is selected to provide force which is slightly in excess of the force provided by the actuator spring 170 so that the initial preset output vacuum level can be established in the chamber 108a in the absence of venturi vacuum pressure.

To calibrate the operation of the unit 100, the chamber portion 108d is evacuated to a level which seats the controller member 186 against the abutment member 220. In this condition the controller spring 190 is ineffective to exert forces on the actuator member 150 or the valve body 122. The input pressure passage 118 is communicated to a suitable source of vacuum pressure which is capable of supplying vacuum to the valve 110 at a greater magnitude than the desired preset initial output level from the chamber portion 108a. A slight vacuum pressure, e.g. about 0.1 inches of mercury it then supplied to the venturi signal chamber 108c and the screw 222 is advanced or retracted from the housing member 104 until a desired valve operating pressure level is established in the output chamber 108a.

This condition of the unit 100 duplicates the condition of the unit 100 when the engine is operated at a low speed cruise just above idle speed and enables the desired opening of the EGR valve 14 to be established under such conditions.

While two preferred embodiments of the present invention have been illustrated and described herein in considerable detail the present invention is not to be

considered limited to the precise constructions shown. Various adaptations, modifications and uses of the invention will occur to those skilled in the art to which the invention pertains. The intention is to cover all such adaptations, modifications and uses which come within the scope or spirit of the appended claims.

What is claimed is:

1. An exhaust gas recirculating system for an engine in which a fluid pressure operated exhaust gas recirculating valve has an open condition to enable engine exhaust gas to mix with engine intake gas and a closed condition, a fluid pressure regulator communicating valve operating pressure from a pressure source to the valve in relation to gas flow through the engine and valve controller means for effecting operation of the valve to the closed condition and preventing said regulator from communicating operation pressure to said valve in response to predetermined engine operating conditions irrespective of the gas flow rate through the engine.

2. An exhaust gas recirculating system as claimed in claim 1 wherein said valve controller comprises a fluid signal producing means communicating with engine intake air to produce fluid signals which vary in magnitude in dependence on engine speed and load and a controller member movable in response to fluid signals of a predetermined level to effect closing of said valve.

3. A system as claimed in claim 2 further characterized in that said signal producing means comprises a port in an engine intake air duct, a pressure signal transmitting conduit extending from said port and a movable throttling member in said intake air duct, said throttling member having a given throttling position in which said port is communicated with air substantially at atmospheric pressure and movable from said throttling position to communicate said port with engine intake manifold pressure, said signal producing means effecting operation of said valve to the closed condition when said throttling member is in said throttling position.

4. A system as claimed in claim 1 wherein said valve controller comprises a movable member which is positioned to effect closing of said valve when the engine is idling.

5. A system as claimed in claim 1 wherein said valve controller comprises a movable member which is positioned to effect closing of said valve when the engine is operating under substantially wide open throttle conditions.

6. A system as claimed in claim 1 wherein said fluid pressure regulator comprises a regulator valve means including a valve body movable between a first position wherein valve operating pressure is communicated from said pressure source to said exhaust gas recirculating valve for opening said valve, a second position wherein communication from said pressure source to said valve is blocked and atmospheric air pressure is communicated to said exhaust gas recirculating valve for closing said valve and a third position wherein communication of atmospheric air pressure and valve operating pressure to said valve is blocked so that the condition of the valve is stabilized, actuator means for positioning said valve body in response to the flow rate of gas through the engine to change the condition of said valve in response to changes in the rate of gas flow through the engine, said controller means comprising a controller member operable to move said valve body

to said second position when the engine idles and when the engine operates substantially at a wide open throttle condition.

7. A system as claimed in claim 6 wherein said controller means further comprises biasing means for urging said controller member towards a position in which said valve body is in said second position.

8. A system as claimed in claim 6 wherein said actuator means comprises an actuator member for engaging and moving said valve body, said controller member defining a surface portion engageable with said actuator member, and said controller means further comprising force applying means for urging said controller member into engagement with said actuator member for moving said valve body to said second position.

9. In an exhaust gas recirculation control system for an internal combustion engine having an air intake duct containing a movable throttle, a pressure operated exhaust gas recirculation control valve openable to permit recirculation of exhaust gas from an engine exhaust duct to an engine intake duct, pressure source means providing a source of operating pressure for the valve, a pressure regulator between said pressure source and said valve for governing communication of operating pressure between said valve and said pressure source, signal means providing an input signal to the regulator which varies in magnitude in relation to gas flow through the engine, said regulator controlling communication of operating pressure between said source means and said valve in response to said input signal, and valve controller means for blocking communication of operating pressure from said source means to said valve when the engine is operated at idle speed and at wide open throttle.

10. A system as claimed in claim 9 wherein said valve controller means comprises second signal means for producing a fluid pressure signal which varies in accordance with positioning of the throttle and engine loading, a pressure operated assembly in communication with said fluid signal and movable from a first position to a second position in response to increases in magnitude of the second signal beyond a predetermined level relative to atmospheric pressure said assembly comprising a controller member movable between a position wherein communication between said pressure source means and said valve is blocked and said valve is communicated to pressure which is ineffective to open the valve and a second position wherein said valve and said pressure source means are in communication via said regulator.

11. A system as claimed in claim 10 wherein said pressure source means comprises an engine intake manifold, a pressure reservoir communicating with said intake manifold and said regulator, and a check valve between said reservoir and said intake manifold to enable said reservoir to be charged from said intake manifold and prevent the charge in said reservoir from being dissipated to said manifold, said controller member effective to communicate said valve to atmospheric pressure in said first position while blocking communication of said reservoir to atmospheric pressure whereby said reservoir is maintained charged.

12. In an exhaust gas recirculation system for an engine having an air induction system, an exhaust system, a pressure operated exhaust gas recirculation control valve for communicating said induction and exhaust systems, and means defining a source of valve operat-

ing pressure; a control unit for governing operation of said exhaust gas recirculation control valve comprising:

- a. a regulator valve means between said pressure source and said exhaust gas recirculation valve comprising a valve body movable to variably govern the communication of pressure from said source to said exhaust gas recirculation control valve and thereby control the position of said control valve;
- b. pressure responsive actuator means for effecting movement of said valve body in relation to pressure signal levels which vary according to the flow rate of gas through the engine; and,
- c. controller means cooperatively related with said actuator means for effecting movement of said valve body to block communication of pressure from the source to the control valve when the engine idles and is operated substantially at a wide open throttle condition.

13. The system claimed in claim 12 wherein said actuator means comprises a chamber communicable with a fluid signal pressure source means which varies according to changes in the flow rate of gas through the engine, and an actuator member supported for movement in response to changes in said fluid signal pressure to move said valve body, said controller means comprising a second chamber communicable with a second fluid signal pressure source means for producing fluid signals having less than a predetermined magnitude with respect to atmospheric pressure when the engine

idles and is operated substantially at wide open throttle and a controller member supported for movement in response to establishment of fluid pressures in said second chamber less than said predetermined magnitude, said controller member biased to engage said actuator member and said valve body to block communication from said source to said control valve.

14. The sytem claimed in claim 13 wherein said controller member is biased to engage said actuator member by first spring means, and further including second spring means biasing said actuator member to resiliently oppose movement therefor in response to variations in pressure signal levels resulting from detected changes in gas flow rate through the engine.

15. The system claimed in claim 14 further including third spring means biasing said valve body in opposition to movement thereof by said actuator member.

16. The system claimed in claim 15 wherein said second and third spring means are cooperatively related with said actuator member and said valve body, respectively, in opposition to movement of said actuator member and said valve body by said controller member, said first spring means effective to overcome the biasing forces of said second and third spring means and effective movement of said valve body to said blocking position when said second fluid pressure signal source means produces a pressure signal less than said predetermined magnitude.

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