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Lewis

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[54] **ENGINE EXHAUST GAS RECIRCULATING CONTROL**

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[52] **U.S. Cl.** .... **123/119 A**
[51] **Int. Cl.** **F02m 25/06**
[58] **Field of Search** .... 123/119 A

[56] **References Cited**

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[57] **ABSTRACT**

The engine has a duct connecting the exhaust gas crossover passage to the intake manifold, the duct normally being closed by a valve that is opened by manifold vacuum connected thereto past an air-bleed device that normally is closed and opened against a spring force by manifold vacuum above a predetermined level so that the gas recirculating valve opening signal force varies directly with manifold vacuum below the predetermined level and inversely above the level to prevent recirculation during engine idle and cruising and wide-open throttle operations while providing controlled operation in the range between.

9 Claims, 2 Drawing Figures

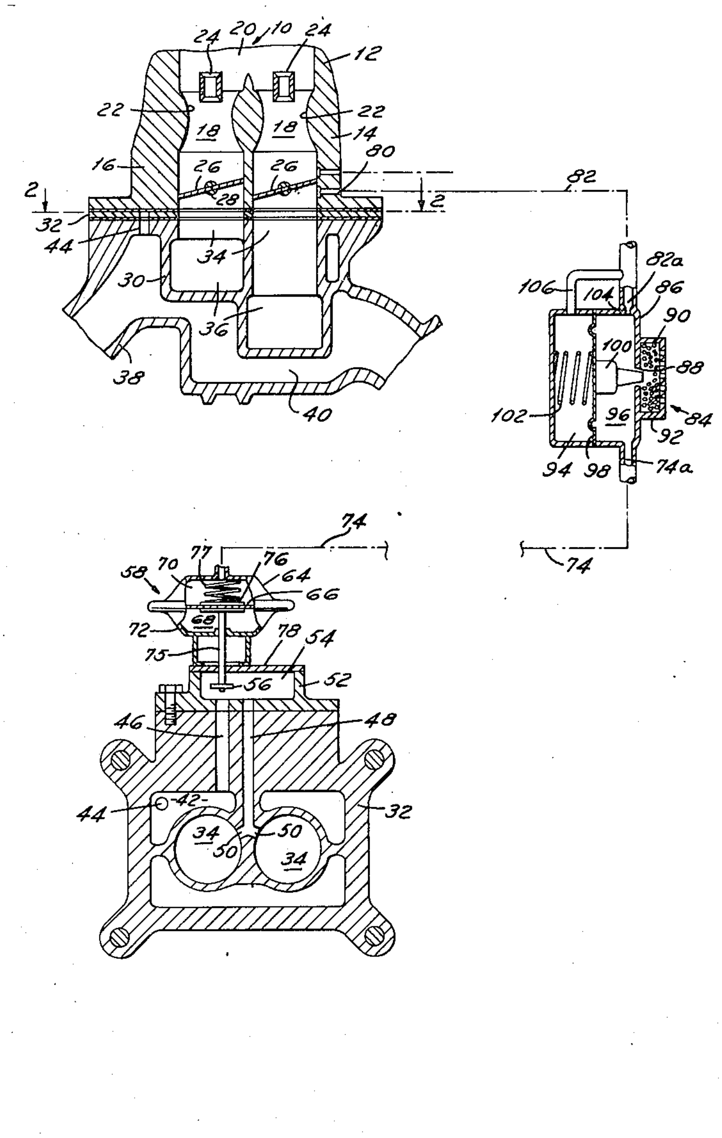

FIG.1

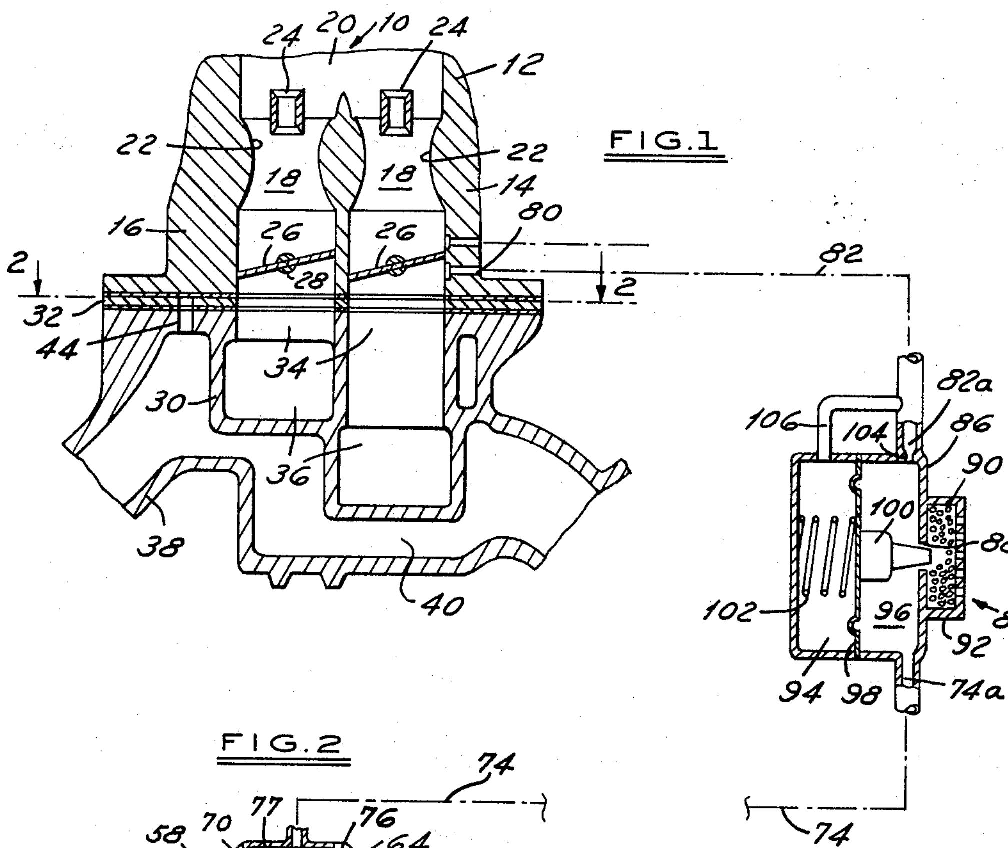
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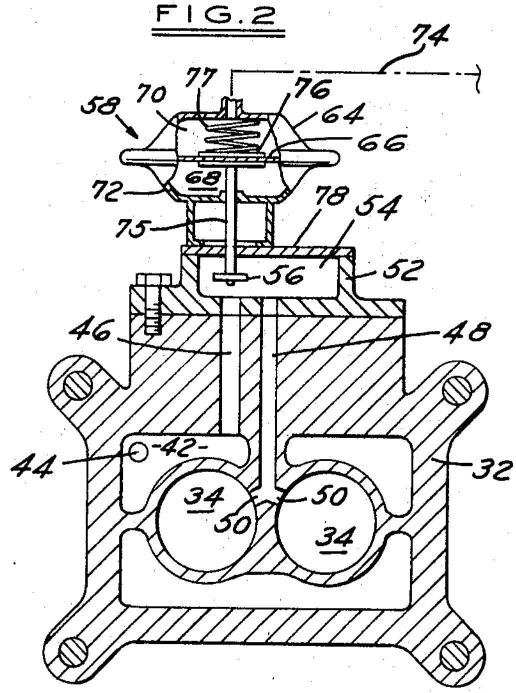
FIG.2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ENGINE EXHAUST GAS RECIRCULATING CONTROL

This invention relates, in general, to an internal combustion engine. More particularly, it relates to a system for controlling the recirculation of exhaust gases back into the engine through the intake manifold.

Devices are known for recirculating a portion of the engine exhaust gases back through the engine to control the emission of unburned hydrocarbons and lower the output of oxides of nitrogen. These devices have included valving to prevent recirculation of the exhaust gases at undesired times and generally are controlled by movement of the carburetor throttle valve so that recirculation is prevented during engine idle and wide-open throttle operations. This is desirable because at engine idle, exhaust gas scavenging is inefficient, while at wide-open throttle position, maximum power is limited by the availability of oxygen.

It is an object of this invention to provide an exhaust gas recirculating system that affords a finer control of the recirculation of the gases back into the engine by means of a pilot valve type operation rather than by the single control valve known in the prior art.

Another object of the invention is to provide selective control of exhaust gas recirculating flow of an engine in responses to changes in intake manifold vacuum level, in contrast to control by changes in carburetor spark port vacuum level.

It is a still further object of the invention to provide a valve for opening and closing a duct containing exhaust gases for recirculation into an engine, the valve being moved to open the duct by a force that is directly proportional to changes in manifold vacuum below a predetermined manifold vacuum level, and is inversely proportional to manifold vacuum above the predetermined level so that exhaust gas is not recirculated during engine idle, and wide-open throttle positions.

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

FIG. 1 is a cross-sectional view of a portion of an internal combustion engine and associated carburetor embodying the invention; and,

FIG. 2 is a cross-sectional view taken on a plane indicated by and viewed in the direction of the arrows 2—2 of FIG. 1.

FIG. 1 illustrates a portion **10** of one-half of a four-barrel carburetor of a known downdraft type. It has an air horn section **12**, a main body portion **14**, and a throttle body **16**, joined by suitable means not shown. The carburetor has the usual air/fuel induction passages **18** open at their upper ends **20** to fresh air from the conventional air cleaner, not shown. The passages **18** have the usual fixed area venturies **22** cooperating with booster venturies **24** through which the main supply of fuel is induced, by means not shown.

Flow of air and fuel through induction passages **18** is controlled by a pair of throttle valve plates **26** each fixed on a shaft **28** rotatably mounted in the side walls of the carburetor body.

The throttle body **16** is flanged as indicated for bolting to the top of the engine intake manifold **30**, with a spacer element **32** located between. Manifold **30** has a number of vertical risers or bores **34** that are aligned

for cooperation with the discharge end of the carburetor induction passages **18**. The risers **34** extend at right angles at their lower ends **36** for passage of the mixture out of the plane of the figure to the intake valves of the engine.

The exhaust manifolding part of the engine cylinder head is indicated partially at **38**, and includes an exhaust gas crossover passage **40**. The latter passes from the exhaust manifold, not shown, on one side of the engine to the opposite side beneath the manifold trunks **36** to provide the usual "hot spot" beneath the carburetor to better vaporize the air/fuel mixture.

As best seen in FIG. 2, the spacer **32** is provided with a worm-like recess **42** that is connected directly to crossover passage **40** by a bore **44**. Also connected to passage **42** is a passage **46** alternately blocked or connected to a central bore or passage **48** communicating with the risers **34** through a pair of ports **50**. Mounted to one side of the spacer is a cup shaped boss **52** forming a chamber **54** through which passages **46** and **48** are interconnected.

As described above, it is necessary and desirable to provide some sort of control to prevent the recirculation of exhaust gases at undesirable times. For this purpose, passage **46** normally is closed by a valve **56** that is moved to an open position by a servo **58**. The servo includes a hollow outer shell **64** containing an annular flexible diaphragm **66**. The latter divides the interior into an air chamber **68** and a signal vacuum chamber **70**. Chamber **68** is connected to atmospheric pressure through a vent **72**, while chamber **70** is connected to a vacuum signal force through a line **74**. The stem **75** of valve **56** is fixed to a pair of retainers **76** that are secured to diaphragm **66** and serve as a seat for a compression spring **77** normally biasing the valve to its closed position. The stem slidably and sealingly projects through a plate **78** closing chamber **54**.

As shown in FIG. 1, the carburetor contains a manifold vacuum sensing port **80** connected by a line **82** and an air-bleed device **84** to the vacuum signal line **74** shown in FIG. 2. Device **84** in this case consists of a can **86** having an opening **88** communicating with the atmosphere through a filter **90** located in a retainer **92**. The can is divided into a pair of chambers **94** and **96** by an annular flexible diaphragm **98**. The diaphragm has secured to it a needle type valve **100** constituting an air-bleed control, the valve being normally moved to close opening **88** by a spring **102**. A line **82*a*** connects one side of chamber **96** to the manifold vacuum line **82** through an orifice **104**, the opposite side being connected by line **74*a*** to the vacuum signal line **74**. A branch line **106** connects manifold vacuum to chamber **94**.

Before proceeding to a description of the operation of the invention, it should be noted that the force of spring **102** is chosen such that below a vacuum force of say 7 inches hg., for example, spring **102** will maintain the bleed valve **100** in a position closing the vent or opening **88**. Spring **77** normally would be a light spring, although it will be clear its force can be varied to vary operation of servo **58**.

In operation, therefore, it is desirous that exhaust gas not be recirculated during engine idle and wide-open throttle conditions of operation, nor during normal cruising operations. The invention accomplishes this by providing a vacuum signal force to servo **58** to open valve **56** that varies directly in proportion to the increase in manifold vacuum, below a predetermined vacuum level of seven inches hg., while above seven inches hg., varying in inverse proportion to increases in manifold vacuum.

After the engine is started, with the throttle valves 26 positioned as shown for idle speed operation, the manifold vacuum level in port 80 will be high and above seven inches hg. Accordingly, manifold vacuum acting in chamber 94 will pull the diaphragm 98 and bleed valve 100 to a position opening vent 88 and allowing air to be bled into chamber 96 so that nearly an atmospheric pressure level will exist. Accordingly, line 74 and chamber 70 of servo 58 will be essentially at atmospheric pressure level allowing spring 77 to maintain valve 56 closing line 46.

If now the vehicle is lightly accelerated, rotation of throttle valve 26 will cause a decay in manifold vacuum. This will cause closing of bleed valve 100 if the vacuum level is below 7 inches hg., and direct the manifold vacuum level through chamber 96 to servo chamber 70. The valve 56 therefore will open to a degree dependent upon the force of spring 77 and the level of manifold vacuum to recirculate gases into risers 34 to flow to the intake manifold.

When the vehicle has reached its cruising condition, the throttle valves will be operating at slightly off idle position or slightly opened from the positions shown. The manifold vacuum, however, will be essentially at a maximum value and cause a complete opening of air bleed valve 100. This will provide essentially atmospheric pressure in the servo chamber 70 and maintain valve 56 closing passage 46. Similarly, during a wide-open throttle condition of operation, a rapid opening of the throttle valves to their wide-open position indicating demand for maximum torque, will drop the manifold vacuum level essentially to zero permitting complete closure of the air-bleed valve 100. However, since the manifold vacuum at this time is essentially zero, the servo 58 will maintain valve 56 closed and no recirculation of exhaust gases will occur until the vacuum level again builds up.

From the foregoing, it will be seen that the invention provides a selective control of exhaust gas recirculation through the use of a pilot valve controlled by manifold vacuum changes. While the invention has been described and illustrated in its preferred embodiment, it will be clear to those skilled in the arts to which it pertains that many changes and modifications may be made thereto without departing from the scope of the invention.

I claim:

1. An exhaust gas recirculating system for an internal combustion engine, comprising, a duct connecting the exhaust gases to the engine intake manifold, a valve normally closing the duct to prevent recirculation and movable by a signal vacuum connected thereto to an open position, and means operable to provide a signal vacuum to the valve that varies in direct proportion to manifold vacuum changes below a predetermined manifold vacuum level while above the predetermined level varies the signal vacuum in inverse proportion to manifold vacuum changes.

2. A system as in claim 1 including means connecting manifold vacuum to the means operable to provide a signal vacuum to operate the means operable.

3. A system as in claim 1, including a vacuum servo connected to the valve having spring means biasing the valve to a position closing the duct, the means operable comprising manifold vacuum controlled means to convert manifold vacuum to a signal vacuum varying as indicated in claim 3.

4. A system as in claim 1, the means operable including a line connecting manifold vacuum to a signal vacuum passage connected to the valve, and an air bleed valve movable by manifold vacuum above a predetermined manifold vacuum level to variably bleed air into the line as a function of manifold vacuum increases.

5. A system as in claim 1, the means operable including a line connecting manifold vacuum to a signal vacuum passage connected to the valve, and an air bleed device in the line to control the signal vacuum in the manner indicated in claim 1, the air bleed device including an air bleed opening in the line, a valve movable by intake manifold vacuum out of the air bleed opening, and spring means biasing the air bleed valve closed below a predetermined intake manifold vacuum level.

6. An exhaust gas recirculating system for an internal combustion engine having intake and exhaust manifolding and a carburetor with an induction passage connected to the intake manifold and having a throttle valve movable across the passage to open and close the passage to control the flow therethrough, a duct connecting the intake and exhaust manifolding for recirculating the exhaust gases back into the engine, a second valve movable between alternate positions to open and close the duct, a servo connected to the second valve and having spring means biasing the second valve to one position, a vacuum signal line connected to the second valve for moving the same to the other position, a second passage connecting manifold vacuum to the signal line, and air bleed means in the second passage controlling the vacuum signal force in the signal line, the air bleed means including a vent in the second passage, an air bleed control valve movable into and out of the vent to close or open the same to control the level of transfer of manifold vacuum to the signal line, spring means biasing the air bleed valve closed, and manifold vacuum operated servo means connected to the bleed valve for moving it to an open vent position whereby the vacuum signal force in the signal line varies directly with changes in intake manifold vacuum at manifold vacuum levels below the force of the spring means, and varies inversely with the changes in manifold vacuum at manifold vacuum levels above the force of the spring means, whereby the exhaust gases are not recirculated when the throttle valve is near or at idle or wide open throttle position and is recirculated at other positions.

7. A system as in claim 6, the duct connecting exhaust gases from the engine exhaust gas crossover passage that passes beneath the carburetor riser bores to the riser bores through a spacer between the carburetor and intake manifold.

8. A system as in claim 6, the air bleed valve having a tapered surface cooperating with the vent to progressively vary the bleed of air to the signal line with changes in manifold vacuum.

9. A system as in claim 6, including an orifice in the second passage upstream of the vent to minimize bleeding of manifold vacuum from the source.

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