United States Patent

Hill

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[54] EXHAUST GAS RECIRCULATION

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[51] Int. Cl. F02m 25/06

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

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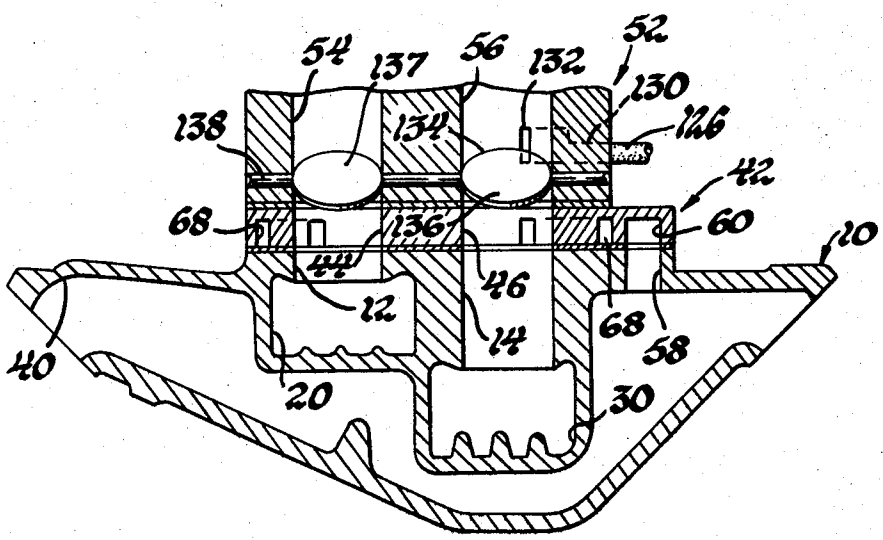
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[57] ABSTRACT

A diaphragm-operated control valve assembly, responsive to vacuum conditions at an induction passage slot traversed by the edge of the throttle, controls recirculation of exhaust gases from the intake manifold exhaust crossover passage to the intake manifold induction passages.

1 Claims, 4 Drawing Figures



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SHEET 1 OF 2

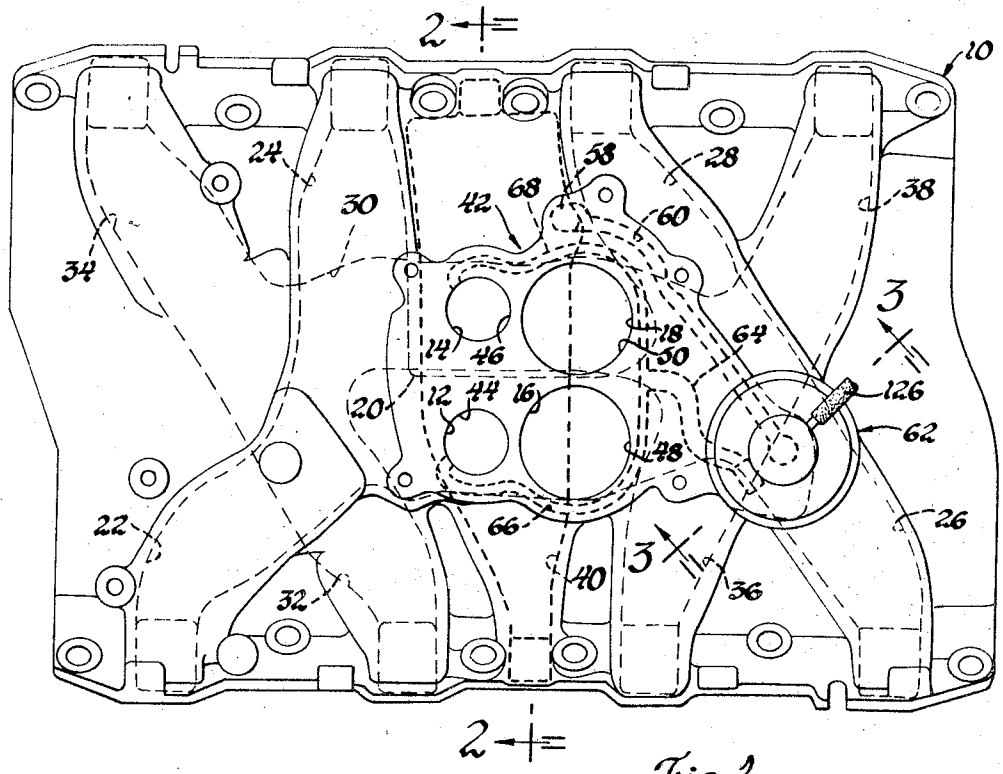


Fig. 1

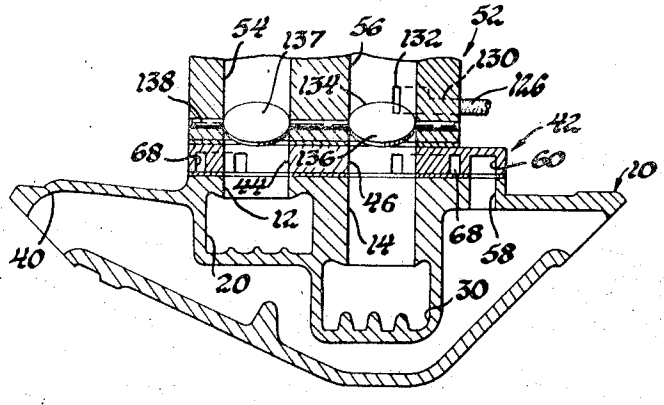


Fig. 2

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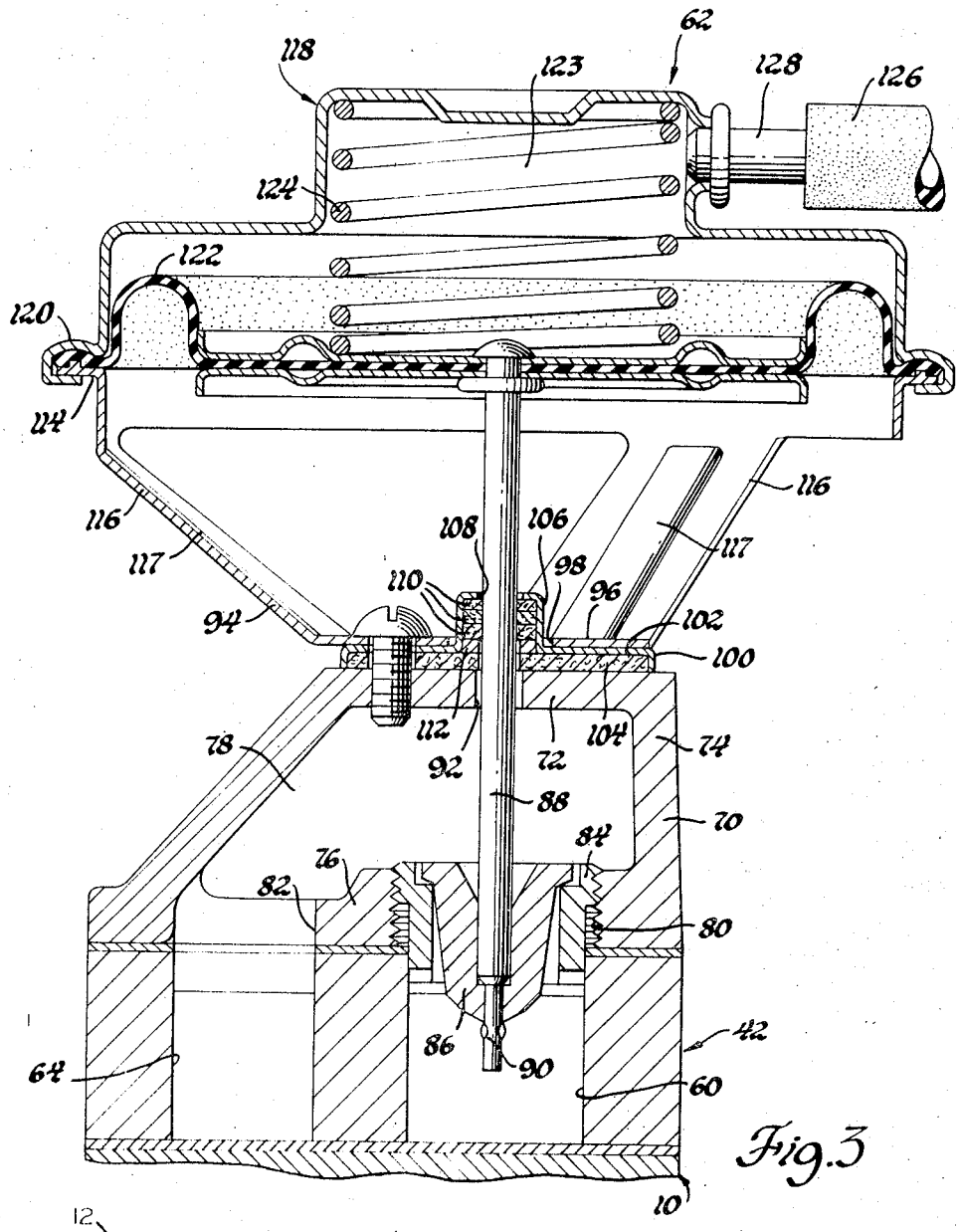


Fig. 3

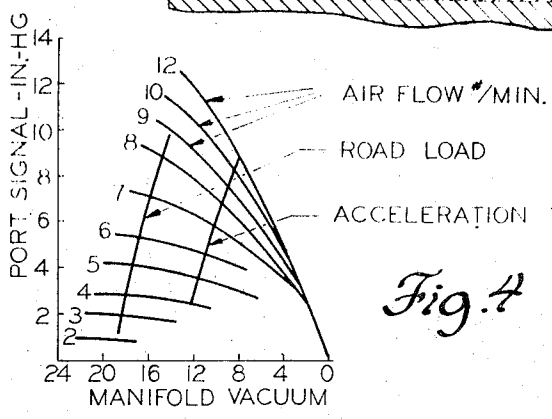


Fig. 4

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EXHAUST GAS RECIRCULATION

SUMMARY OF THE INVENTION

This invention relates to an exhaust-gas-recirculation system and more particularly to such a system in which recirculation of exhaust gases is controlled by a valve assembly responsive to induction passage pressures sensed by an elongated, throttle traversed slot.

It has been well established that the formation of oxides of nitrogen in internal combustion engines and the consequent emission of oxides of nitrogen in the engine exhaust gases may be reduced by recirculating a portion of the exhaust gases back through the engine induction passages to the combustion chambers. It is generally thought that exhaust gases should be recirculated at a rate proportional to the rate of induction airflow over the part throttle range of engine operation and, further, that recirculation of exhaust gases should be prevented during closed throttle, idling operation and during wide open throttle, maximum power operation.

Earlier systems attempted to achieve this control by valves which were linked mechanically to the throttle or valves which were operated by a diaphragm responsive to induction vacuum signals such as those normally used to advance ignition timing. These systems have not been completely satisfactory, in one case because of the complexity of the mechanical linkage required, and in the other case because the vacuum signals known to date do not provide the desired variations in the control signal.

It has now been discovered that exhaust gas recirculation may be controlled in the desired manner by a diaphragm-operated valve responsive to induction vacuum signals sensed by a narrow, elongated slot traversed by the edge of the throttle. The lower portion of the slot extends slightly below the edge of the throttle and is continuously subjected to induction vacuum therebelow, while the upper portion of the slot extends substantially above the edge of the throttle when the throttle is closed and is subjected to the substantially atmospheric pressure existing above the throttle. When the throttle is closed, air bleeds through the slot around the throttle and reduces the induction vacuum sufficiently that the vacuum control signal is insufficient to open the diaphragm-operated control valve; exhaust gas recirculation is thereby prevented during closed throttle, idling operation. As the throttle is opened for part throttle operation, a greater portion of the slot is subjected to the induction vacuum below the throttle and a lesser portion is subjected to the substantially atmospheric pressure above the throttle. The vacuum control signal then delivered to the diaphragm operated valve varies in proportion to induction airflow, and the control valve is thus positioned to recirculate exhaust gases in proportion to induction airflow. As the throttle approaches a wide open position, the induction vacuum below the throttle drops to a very low level, insufficient to actuate the diaphragm operated valve. Recirculation is thus prevented during wide open throttle, maximum power operation.

The details as well as other objects and advantages of this invention are shown in the drawings and set forth in the description of the preferred embodiment.

SUMMARY OF THE DRAWINGS

FIG. 1 is a top plan view of V-8 engine intake manifold containing induction passages and an exhaust crossover passage, together with a carburetor spacer plate containing an exhaust-gas-recirculation passage and carrying an exhaust gas recirculation control valve assembly;

FIG. 2 is a transverse sectional view taken generally along line 2—2 of FIG. 1, showing the induction passage plenums and the exhaust crossover passage in the manifold and the inlet to the exhaust gas recirculation passage in the spacer plate, to which a carburetor throttle body has been added;

FIG. 3 is an enlarged sectional view taken along line 3—3 of FIG. 1, showing the details of the exhaust-gas-recirculation control valve assembly; and

FIG. 4 graphically illustrates the vacuum signal created at different induction airflow rates and induction vacuums.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIGS. 1 and 2, an intake manifold 10 has a pair of vertical primary riser bores 12 and 14 and 1 pair of vertical secondary riser bores 16 and 18. Riser bores 12 and 16 open to an upper horizontal plenum 20 connected forwardly (leftwardly as viewed in FIG. 1) to a pair of transverse runners 22 and 24 and connected rearwardly (rightwardly as viewed in FIG. 1) to another pair of transverse runners 26 and 28. Similarly, riser bores 14 and 18 open to a lower horizontal plenum 30 connected forwardly to a pair of transverse runners 32 and 34 and rearwardly to another pair of transverse runners 36 and 38.

An exhaust crossover passage 40 extends transversely from the left-hand side of manifold 10 beneath plenums 20 and 30 and receives a portion of the exhaust gases discharged from the engine combustion chambers. Exhaust crossover passage 40 may be blocked at the right-hand side if desired.

An insert plate 42 is secured on mainfold 10 and has primary riser bores 44 and 46 and secondary riser bores 48 and 50 which meet, respectively, riser bores 12, 14, 16, 18 of manifold 10.

A carburetor 52 is secured on insert plate 42 and has primary throttle bores 54 and 56 which meet, respectively, primary riser bores 44 and 46 of insert plate 42. Carburetor 52 also has secondary throttle bores (not shown) which meet secondary riser bores 48 and 50 of insert plate 42.

A bore 58 in manifold 10 leads upwardly from exhaust crossover passage 40 to the first portion 60 of an exhaust recirculation passage formed in insert plate 42. The first portion 60 of the exhaust recirculation passage leads through a control valve 62 to a second portion 64 of the exhaust recirculation passage. This second portion 64 divides into a pair of branches 66 and 68 which lead to the primary riser bores 44 and 46 in insert plate 42.

Control valve 62 is shown in detail in FIG. 3. It comprises a base member 70 having an upper wall 72, a peripheral wall 74, and a lower wall 76 which define a chamber 78. Chamber 78 has an inlet 80 opening from the first portion 60 of the exhaust gas recirculation passage and an outlet 82 opening to the second portion 64 of the exhaust gas recirculation passage. A valve seat member 84 is threadedly secured in inlet 80.

A valve pintle 86 has a generally conical contour cooperating with valve seat 84 to provide a variable area for flow of recirculated exhaust gases. Valve pintle 86 is retained on a valve stem 88 by staking the end 90 of stem 88. Stem 88 extends upwardly through an opening 92 in the upper wall 72 of base member 70.

A housing member 94 has a central portion 96 provided with an opening 98 receiving valve stem 88.

An intermediate member 100 has an annular, downwardly concave, dished portion 102 disposed between the central portion 96 of housing member 94 and the upper wall 72 of base member 70. An asbestos insulating disc 104 is received in the dished portion 102 of intermediate member 100 and reduces conduction of exhaust heat from base member 70 to housing member 94.

Intermediate member 100 also has a central, downwardly concave, cupped portion 106 with a central opening 108 receiving valve stem 88. A plurality of graphited asbestos sealing discs 110, supported by a steel washer 112, are received in the cupped portion 106 of intermediate member 100 and engage valve stem 88 to guide stem 88 and to reduce airflow into chamber 78 through openings 108 and 92.

Housing member 94 has an outer rim 114 supported by three outwardly and upwardly extending spokes 116 (only two of which appear in the figure). Each spoke 116 has a slightly raised rib 117 for reinforcement. Spokes 116 provide a minimized path for heat conduction from the central portion 96 of housing member 94 to the rim 114 of housing member 94.

A cover member 118 has a rim 120 secured about rim 114 of housing member 94. A diaphragm 122 is clamped between rims 114 and 120 to define an enclosure 123 between diaphragm 122 and cover 118. Diaphragm 122 carries valve stem 88. A spring 124 exerts a downward bias on diaphragm 122, valve stem 88, and valve pintle 86 to engage valve pintle 86 with valve seat 84.

A hose 126, secured to a fitting 128 opening from chamber 123, forms a vacuum signal conduit extending to carburetor 52 as shown in FIG. 2. A passage 130 within carburetor 52 connects hose 126 with a slot 132 opening from throttle bore 56. Slot 132 is disposed adjacent and extends above and slightly below the upstream edge 134 of the carburetor throttle 136 which is rotatably disposed in throttle bore 56 on a throttle shaft 138.

In operation, an air-fuel mixture, or air alone in the case of a fuel-injected engine, will be drawn into the engine through the induction passage defined by carburetor throttle bores 54 and 56, insert plate riser bores 44, 46, 48, 50 and manifold riser bores 12, 14, 16 and 18, manifold plenums 20 and 30, and manifold runners 22, 24, 26, 28, 32, 34, 36, 38. When throttles 136 and 137 are closed as shown in FIG. 2, the substantially atmospheric pressure in throttle bore 56 above throttle 136 bleeds into the upper portion of slot 132 and reduces the induction vacuum sensed by the lower portion of slot 132. The resultant vacuum signal delivered through passage 130 and hose 126 to chamber 123 is insufficient to raise diaphragm 122 against the bias of spring 124. Valve pintle 86 is thereby maintained in engagement with valve seat 84 to prevent recirculation of exhaust gases through control valve chamber 78.

As throttles 136 and 137 are opened to a part throttle position, the upstream edge 134 of throttle 136 traverses slot 132 and a greater portion of slot 132 is subjected to the induction vacuum below throttle 136 while a lesser portion of slot 132 is subjected to the substantially atmospheric pressure above throttle 136. The resultant vacuum signal transferred through passage 130 and hose 126 to chamber 123 raises diaphragm 122 against the bias of spring 124. Valve pintle 86 is then lifted away from valve seat 84 to recirculate exhaust gases from exhaust crossover passage 40 through bore 58, passage 60, inlet 80, chamber 78, outlet 82, passage 64, and branches 66 and 68 to riser bores 44 and 46.

The rate at which exhaust gases are recirculated through control valve 62 is determined by the contour of pintle valve 86 and by the lift of valve 86, the pressure differential between exhaust crossover passage 40 and insert plate primary riser bores 44 and 46 being sufficient to maintain flow through control valve 62 at or near sonic velocity. The lift of valve 86 is determined by the vacuum signal created by slot 132 which, as shown in FIG. 4, is proportional to the rate of induction airflow. The precise value of the vacuum signal may be controlled by the contour of slot 132 and its orientation with respect to throttle 136.

As throttles 136 and 137 approach wide open position, the induction vacuum below the throttles becomes insufficient to hold diaphragm 122 against the bias of spring 124. Valve pintle 86 thereupon reengages valve seat 84 to prevent recirculation of exhaust gases.

An additional advantage in the design of valve 62 also should be noted: no elaborate seals are required to assure against leakage about valve stem 88. Because chamber 78 is connected through passage 64 directly to the induction system below throttles 136 and 137, chamber 78 is maintained at subatmospheric pressures. Thus any leakage past valve stem 88 is only atmospheric air entering from within housing member 94, and the potential for deposits around valve stem 88 is minimized.

I claim:

1. In an internal combustion engine having an induction passage for airflow to the engine, a throttle disposed in said passage and rotatable between closed and open positions for controlling airflow therethrough, and an exhaust passage for exhaust gas flow from the engine, means for recirculating exhaust gases from said exhaust passage to said induction passage comprising:

a recirculation passage extending from said exhaust passage to said induction passage, and a valve assembly disposed in said recirculation passage,

said valve assembly having a valve seat and a generally conically contoured valve pintle reciprocable with respect to said valve seat, said valve pintle cooperating with said valve seat to provide a variable area for exhaust gas flow through said valve assembly from said exhaust passage to said induction passage,

said valve assembly further having spring means biasing said valve pintle into engagement with said valve seat and pressure responsive means connected to said valve pintle for overcoming the bias of said spring means and selectively positioning said valve pintle relative to said valve seat,

said induction passage having an elongated vacuum signal port in the form of a slot disposed adjacent and extending both above and slightly below the upstream edge of said throttle when said throttle is in closed position and traversed by the upstream edge of said throttle as said throttle is rotated between closed and open positions, whereby said vacuum signal port is simultaneously subjected both to the vacuum in said induction passage downstream of said throttle and to the substantially atmospheric pressure in said induction passage upstream of said throttle to thereby provide a vacuum signal which varies from a minimum value when said throttle is closed to a maximum value when said throttle is rotated to a partially open position and back to a minimum value when said throttle is further rotated to a fully open position,

and a vacuum signal conduit connecting said vacuum signal port to said pressure-responsive means whereby said spring means will maintain said valve pintle in engagement with said valve seat when said throttle is in closed and fully open positions and whereby said pressure-responsive means will overcome said spring means and selectively position said valve pintle relative to said valve seat when said throttle is in partially open positions to thereby control recirculation of exhaust gases through said valve assembly from said exhaust passage to said induction passage.

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