

[54] METHOD AND APPARATUS FOR ENGINE OPERATION

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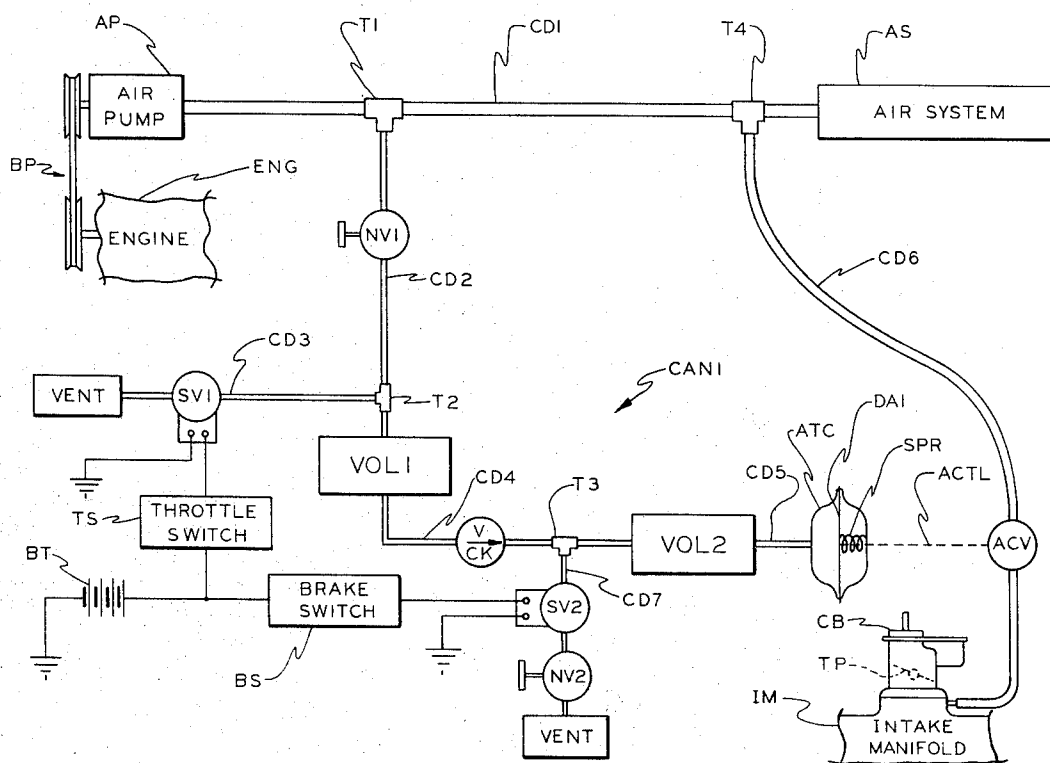
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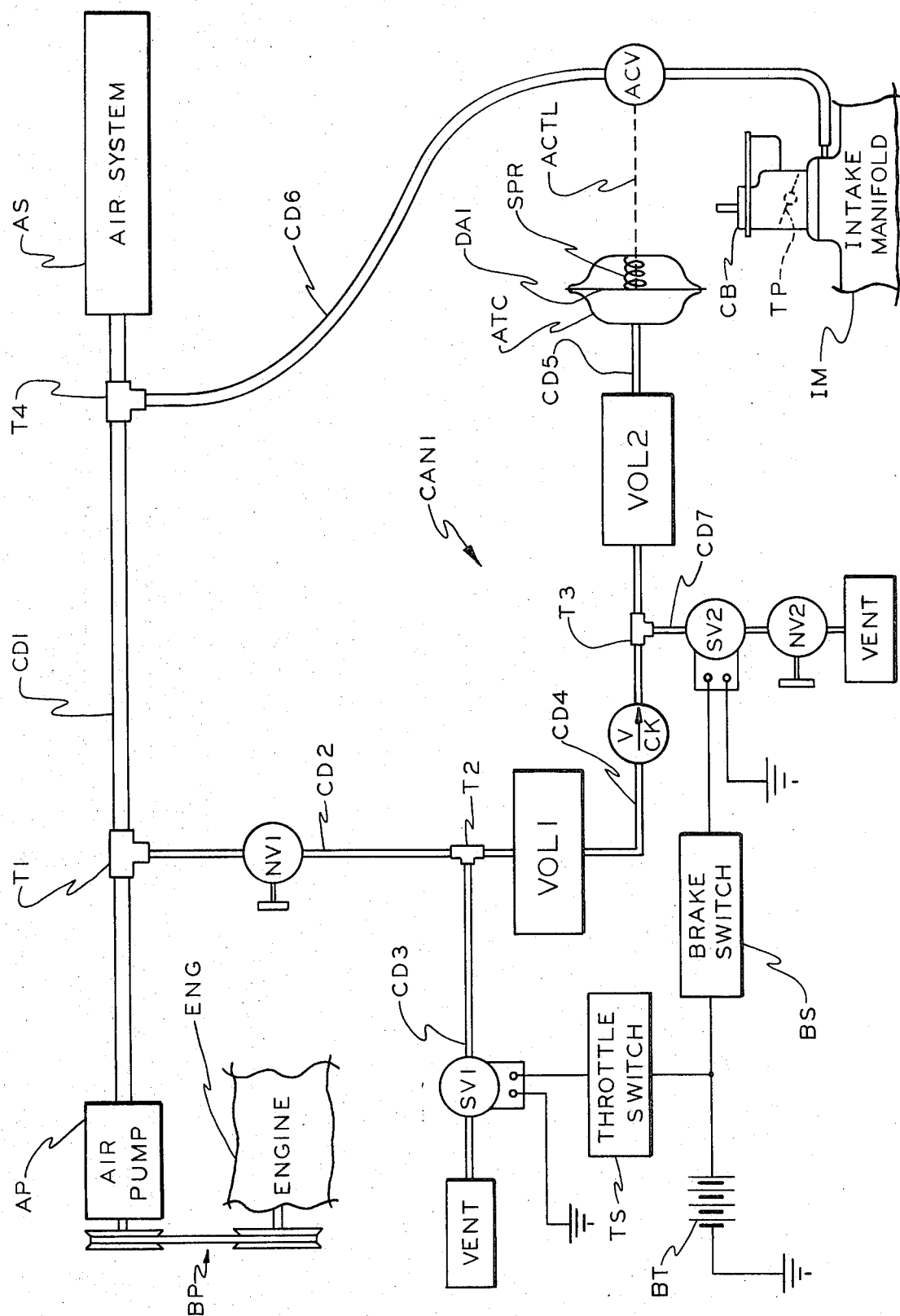
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ABSTRACT

The invention is disclosed herein in method and apparatus for normalizing the exhaust system temperature during normal high engine load conditions. In a specific embodiment, the apparatus may divert air from an air injection system to the intake manifold below the carburetor throttle plate under predetermined conditions so that the air-fuel ratio is leaned out. This allows less combustibles to enter the emission control system and thereby lowers reaction temperatures and improves fuel economy. The method and apparatus for sensing the engine speed or load condition is also novel and includes sensing the pressure of the air supplied by the air pump on an engine to obtain a signal indicating the operating condition of an engine, including engine speed and load. Air under pressure from the air pump is connected to lean out the fuel-air mixture supplied by the carburetor to the engine when an air pump pressure is sensed which provides an indication of a predetermined engine speed and/or load. The sensing of the air pressure may be inhibited in response to a predetermined low throttle setting. The highest engine speed-load signal sensed may be stored and the magnitude of the stored signal reduced in response to application of braking to the vehicle.

35 Claims, 1 Drawing Figure





METHOD AND APPARATUS FOR ENGINE OPERATION

BACKGROUND OF THE INVENTION

The problem of air pollution has become a national concern in recent years. To some extent this problem has been related to the exhaust fumes emitted by vehicles powered by internal combustion engines. Various emission control devices, such as reactors, converters, oxidizing catalytic units, etc. have been devised to reduce the noxious emissions from the exhaust system. However, obtaining optimum operation of such emission control devices has been made somewhat difficult because of the temperatures in the exhaust system which are too high under certain conditions.

Accordingly, it is an object of this invention to provide an improved method and apparatus for operating a vehicle internal combustion engine.

It is a further object of this invention to provide an improved method and apparatus for controlling exhaust system temperatures of a vehicle internal combustion engine.

A still further object of this invention is to provide an improved method and apparatus for normalizing exhaust system temperatures during normal high engine load conditions, thereby lowering emission control device temperatures and improving fuel economy.

SUMMARY OF THE INVENTION

The above objects and features of this invention have been illustrated herein in a preferred embodiment of apparatus for controlling the operation of a vehicle internal combustion engine having a carburetor and a throttle valve supplying a mixed fuel and air flow to the engine, and which further has an air pump driven by the engine to supply output air under a pressure which is related to the speed of and the load on the engine. Means are provided for sensing the pressure of the air supplied by the air pump to determine engine speed and load and for providing a speed signal related in magnitude to engine speed and load. Means are also provided for connecting the air pressure supply to the mixed fuel-air flow supplied by the carburetor. Finally, means responsive to the engine speed-load signal of the air pressure sensing means are provided for controlling the flow of air from the air pump through the connecting means to the engine.

Means are provided further for storing the highest engine speed-load signal sensed. Means responsive to the application of braking to the vehicle carrying the engine reduces the magnitude of the stored signal. Means are further provided for controlling the rate of reduction of the magnitude of the stored signal during the application of braking. In addition means are provided which are responsive to a predetermined low throttle position for inhibiting sensing of engine speed and load by the air pressure sensing means.

In response to a magnitude of the signal which denotes attainment of a predetermined engine speed or load, the flow of air through the connecting means from the air pump is enabled. The flow of air through the connecting means is increased an amount related to an increase in engine speed-load signal above the predetermined engine speed-load signal which enables the initiation of flow through the connecting means.

Means are further provided for delaying application of the pressure build up by the air pump to the air pressure sensing system during an acceleration. A restrictive orifice element may be connected between the air pressure sensing system and the output of the air pump to provide the delay of the pressure build up and also to reduce the effect of transient changes in air pump output in response to changes between acceleration, cruising and deceleration.

The air pressure sensing means may include a housing having movable means dividing the housing into two chambers, one of the chambers being connected to the output of the air pump so that the position of the dividing means in the housing is responsive to the air pressure supplied by the pump. Actuator linkage means is responsive to the position of the dividing means and controls the operation of the air flow controlling device in the connecting means. The movable dividing means is preferably yieldingly biased against movement in response to air pump output pressure until a predetermined output pressure is reached. The biasing means then preferably yields in response to the sensed air pressure an amount which is related to the increase of the sensed pressure above the predetermined output pressure.

The air pressure sensing means may also include canister means connected to be pressurized by output air from the air pump to provide an indication of engine speed and load. The restricted orifice element may be connected intermediate the air pump output and the canister means to reduce transient effects and to delay pressurization as discussed hereinbefore.

The canister means is preferably divided into first and second portions by means including a check valve, which enables a first portion to receive pressurization from the air pump and a second portion to be pressurized from the first portion via the check valve to store and retain air under a pressure related in magnitude to the highest engine speed-load combination sensed. Means responsive to a predetermined low throttle setting are provided for venting the first portion of the canister means to reduce and/or prevent pressurization of the first portion. Means are further provided for venting the second portion of the canister means to reduce pressurization in response to application of braking to the vehicle. The braking responsive venting means advantageously also includes restricted orifice means for controlling the rate of reduction of pressurization.

Other objects, advantages, and features of this invention will become apparent when the following description is taken in conjunction with the accompanying drawing, in which there is shown a schematic diagram of apparatus embodying the teachings of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Previous emission control systems of this general type have sensed exhaust system back pressures to obtain an indication of engine speed or load in order to initiate various control functions. While back pressure sensing has provided an operable signal in most instances, the signal is relatively low and weak.

It has been discovered that a much stronger signal indicating the operating condition of an engine, including engine speed and load, can be obtained and used to ac-

tuate control functions, by sensing the output pressure of an engine-driven air pump or compressor which is supplying air under pressure for other functions such as emission control devices and the like. The output pressure of the pump or compressor is related to and sometimes directly proportional to the speed of and load on the engine driving the air pump.

Referring now to the drawing there is illustrated an engine ENG driving an air pump AP by a belt and pulley system BP. The output of the air pump AP is conducted through conduit CD1 to an air system AS which may utilize the air under pressure for emission control devices and the like.

The output pressure of the air pump AP and the conduit CD1 is sensed by providing a bleed conduit CD2 connected to the conduit CD1 by a tee connection T1. An adjustable needle valve NV1 bleeds air pressure from the conduit CD1 to a canister means CAN1. The canister means CAN1 is preferably divided into a first portion VOL1 and a second portion VOL2. The first and second portions are preferably connected by a conduit CD4 which includes a check valve VCK to prevent air from flowing from the portion VOL2 back to the portion VOL1. The output of the canister means CAN1 is connected via a conduit CD5 to a pressure responsive actuating means ATC.

The pressure responsive actuating means ATC has a movable member therein, such as a diaphragm DA1, which moves in response to the amount of pressure in the canister means CAN1. The diaphragm DA1 is preferably spring biased by a spring SPR to maintain a predetermined position of the diaphragm DA1 until sufficient pressure builds in the canister means CAN1 to overcome the bias, and then to yield in response to pressure increases above the predetermined setpoint in an amount proportional to the increase in pressure. An actuator link ACTL, responsive to movement of the diaphragm DA1, is connected to control the valve ACV which, in turn, controls air flow through conduit CD6.

The conduit CD6 acts as a connecting means between the main supply conduit CD1 through a tee connection T4 and an intake manifold IM of the internal combustion engine. A carburetor CB controls the flow of a mixture of fuel and air by opening and closing a throttle plate TP located in the throat thereof.

The first portion VOL1 of the canister means CAN1 may be vented to the atmosphere via a solenoid controlled valve SV1 located in a conduit CD3 which is connected into conduit CD2 by a tee connection T2. The solenoid valve SV1 is responsive to a throttle switch TS which closes at a predetermined low throttle setting to supply energy from the engine battery BT to energize the solenoid valve SV1 and open the conduit CD2 to the atmosphere via the conduit CD3.

Similarly, the second portion VOL2 of the canister means CAN1 may be vented to the atmosphere through a solenoid valve SV2 located in a conduit CD7 which is connected to the intermediate conduit CD4 between the check valve VCK and the second portion of the canister means CAN1.

The solenoid valve SV2 is energized by a brake switch BS which is responsive to the application of braking to the vehicle to close to supply current from the engine battery BT to the solenoid valve SV2. A needle valve NV2, which may be manually adjustable, is also connected in the vent conduit CD7 to restrict the

flow of air from the second portion VOL2 and thus control the rate of reduction of pressure in the second portion VOL2 of the canister CAN1.

In operation, when the engine is started the air pump AP starts supplying pressure to the conduit CD1. However, a build up of pressure in the canister means CAN1 is prevented since the throttle switch TS is closed during idle and low throttle setting conditions to energize the solenoid valve SV1. Therefore pressurization of the canister means CAN1 is prevented and engine speed and load sensing is inhibited.

When the throttle is advanced during acceleration past the predetermined low throttle setting to which the throttle switch TS is responsive, the throttle switch TS opens to deenergize the solenoid valve SV1 and enable pressurization of the first and second portions of the canister means CAN1. The needle valve NV1 acts as a restricted orifice to delay pressurization of the canister means CAN1. Thus, the amount of pressurization required to move the diaphragm DA1 and the actuator ATC is not reached until a predetermined engine speed or engine load is reached. The needle valve NV1 also acts to eliminate or reduce the effects of transients in air pressure changes in the main supply conduit CD1 which result from alternate acceleration, cruising and deceleration modes of operation.

When the cruise condition is reached, as controlled by the needle valve NV1 and the volumes of the first portion VOL1 and the second portion VOL2 of the canister means CAN1, the output from the canister means CAN1 in conduit CD5 is sufficient to overcome the bias supplied by the spring SPR against the diaphragm DA1. The diaphragm DA1 may then move to the right as shown on the drawing, to open the valve ACV via link ACTL to enable flow of air through conduit CD6 from the main supply conduit CD1 to the intake manifold IM of the engine. As the pressure in the canister means CAN1 increases the diaphragm DA1 is preferably moved an amount proportional to the increase to enable a proportionally greater flow through the control valve ACV and conduit CD6 to the intake manifold. This will lean out the air-to-fuel ratio in the intake manifold and cause the emission devices to see less combustibles and therefore run cooler. Fuel economy will also be improved. The reaction temperatures for the emission control devices will be reduced.

It should also be noted that, although the check valve VCK in conduit CD4 causes the second portion VOL2 to retain the highest pressure sensed and thus to store an indication of the highest engine speed and/or load sensed to maintain the setting arrived at for the control valve ACV, there is an additional amount of control available because the conduit CD6 is directly connected to the output of the air pump AP. That is, even though the brakes are not applied to the vehicle during the cruising condition but the vehicle is allowed to proceed without touching the brakes, the air pump AP will slow down as the engine slows down thus reducing the pressure of the air available for the connecting conduit CD6 and thus enriching the air-to-fuel ratio during this condition.

Assume that a braking of the vehicle is required after cruise conditions are reached, but that a complete stop is not required. The brake switch BS energizes the solenoid valve SV2 opening the vent conduit CD7 to the atmosphere. However, the inclusion of the needle valve NV2 in the conduit CD7 prevents a sudden loss of pres-

sure in the second portion VOL2 of the canister means CAN1. Thus, when acceleration is again resumed after the brake is released, as in turnpike driving, the time required to repressurize the second portion VOL2 of the canister means CAN1 is considerably shortened, thus enabling more rapid response of the control system to this set of conditions.

It should also be noted that if the foot is taken completely off of the gas pedal or accelerator, thus permitting the throttle switch TS to close and open the solenoid valve SV1, that the first portion VOL1 of the canister means CAN1 is vented to the atmosphere and the pressure reduced to ambient. However, the pressure in the second portion VOL2 of the canister means CAN1 is maintained by the check valve VCK between the first and second portions. This again enables a more rapid response of the control system when acceleration is again resumed.

When the vehicle is being brought to a complete stop, both the throttle switch TS and the brake switch BS are closed. The throttle switch TS enables the complete venting of the first portion VOL1 of the canister means CAN1 to ready the control system for resetting for operation whenever the vehicle is started up again. Similarly, the solenoid valve SV2 opens and permits a venting of the second portion VOL2 of the canister means CAN1 through the conduit CD7. Although the reduction of pressurization of the second portion VOL2 is slower than the reduction of pressurization in the first portion VOL1, because of the inclusion of the needle valve NV2 in the conduit CD7, the application of braking power sufficient to bring the vehicle to a complete stop will be long enough to enable a reduction of pressurization of the second portion VOL2 of the canister means CAN1 to a level which enables the control apparatus to be reset for operation from a standing start.

Although the canister means CAN1 has been shown as divided into a first portion VOL1 and a second portion VOL2 which are separated by a check valve VCK, it is to be understood that a single canister means may be utilized but that the system will not operate as effectively as when a canister system having two portions is provided. Similarly, means other than the needle valve NV1, such as a time delayed opening valve, may be utilized to effect the time delay required to prevent complete pressurization of the canister means CAN1 before cruise conditions are reached. However, the needle valve NV1 not only effects the time delay but also is advantageous in that it eliminates the transient changes in air pressure in the conduit CD1 in response to alternate acceleration, cruising and deceleration conditions for the engine ENG.

There has thus been disclosed a normal operating temperature control system which utilizes air pressure bleeding through a needle valve into canister means having predetermined volumes VOL1 and VOL2 which are sized to enable pressurization at a desired cruise condition to operate the pressure responsive actuating means ATC. Similarly, a mechanically equivalent element may be employed for the actuator ATC, such as an air cylinder having a piston therein movable in response to air pressure.

Further, although the solenoid valves SV1 and SV2 are shown as being located in separate vent conduits, other forms of solenoid valves are available for connection directly in conduits CD2 and CD4, respectively,

and have separate vent outlets which are opened when the valves are energized.

In conclusion, it is pointed out that while the illustrated examples constitute practical embodiments of my invention, I do not limit myself to the exact details shown, since modification of these details may be made without departing from the spirit and scope of this invention.

I claim:

1. Apparatus for controlling operation of a vehicle internal combustion engine having a carburetor and a throttle valve supplying a mixed fuel and air flow to said engine, comprising
 - a. an air pump to be driven by an engine and supply air under a pressure which is related to the operating condition of the engine including the speed of and the load on the engine,
 - b. means for sensing the pressure of the air supplied by said air pump to determine said operating conditions and for providing a signal related in magnitude thereto,
 - c. means for connecting said air pressure supply to said mixed fuel-air flow supplied by said carburetor, and
 - d. means responsive to said signal from said air pressure sensing means for controlling the flow of air from said air pump through said connecting means.
2. Apparatus as defined in claim 1 which further includes means for storing the highest signal sensed.
3. Apparatus as defined in claim 2 which further includes means responsive to application of braking to the vehicle carrying the engine for reducing the magnitude of said stored signal.
4. Apparatus as defined in claim 3 which further includes means for controlling the rate of reduction of the magnitude of said stored signal during application of braking.
5. Apparatus as defined in claim 1 which further includes means responsive to a predetermined low throttle position for inhibiting sensing of said engine operating condition by said air pressure sensing means.
6. Apparatus as defined in claim 1 in which said air flow control means includes means responsive to a magnitude of said signal which denotes attainment of a predetermined engine operating condition for enabling flow of air through said connecting means from said air pump.
7. Apparatus as defined in claim 6 in which said air flow control means further includes means for increasing the flow of air through said connecting means an amount related to an increase in said signal above said predetermined signal.
8. Apparatus as defined in claim 7 which further includes means responsive to reduction of engine speed to a predetermined low throttle setting for inhibiting operation of said air pressure sensing means.
9. Apparatus as defined in claim 8 in which said pressure sensing means further includes means for storing and maintaining the highest signal sensed before operation of said low throttle inhibiting means.
10. Apparatus as defined in claim 9 in which said pressure sensing means further includes means responsive to application of braking to the vehicle for reducing the magnitude of said stored signal.
11. Apparatus as defined in claim 10 in which said stored signal reducing means includes means for con-

trolling the rate of reduction of the magnitude of said stored signal during application of braking.

12. Apparatus as defined in claim 1 which further includes means for delaying application of a pressure buildup by said air pump to said air pressure sensing system.

13. Apparatus as defined in claim 1 which further includes a restricted orifice element connected between said air pressure sensing system and the output of said air pump to reduce the effect of transient changes in air pump output.

14. Apparatus for controlling exhaust system temperatures of a vehicle internal combustion engine having a carburetor and a throttle valve supplying a fuel and air mixture to an intake manifold, and also having an air pump driven by the engine to supply output air under a pressure which is related to the operating condition of the engine including the speed of and the load on the engine, comprising

- a. means for sensing the pressure of air supplied by the air pump,
- b. means for connecting the air pump to the intake manifold of the engine, and
- c. means responsive to the sensed air pressure for controlling air flow through said connecting means.

15. Apparatus as defined in claim 14 in which said air pressure sensing means includes a housing having movable means dividing the housing into two chambers, one of said chambers being connected to the output of the air pump so that the position of the dividing means in the housing is responsive to the air pressure supplied by the pump.

16. Apparatus as defined in claim 15 which further includes actuator linkage means responsive to the position of said dividing means for controlling said air flow controlling means.

17. Apparatus as defined in claim 15 which further includes means for yieldingly biasing said movable dividing means against movement in response to air pump output pressure until a predetermined output pressure is reached.

18. Apparatus as defined in claim 17 in which said biasing means yields in response to sensed air pressure an amount related to the increase of sensed pressure above said predetermined output pressure.

19. Apparatus as defined in claim 14 in which said air pressure sensing means includes canister means connected to be pressurized by output air from the air pump to provide an indication of the operating condition of the engine.

20. Apparatus as defined in claim 19 in which said air pressure sensing means further includes means connected intermediate the air pump output and said canister means for delaying pressure build up in said canister means.

21. Apparatus as defined in claim 19 in which said air pressure sensing means further includes an element having a restricted orifice connected intermediate the air pump output and said canister means to reduce the effect on pressurization of said canister means by transient changes in engine speed.

22. Apparatus as defined in claim 19 in which said air pressure sensing means further includes means for venting said canister means to reduce and prevent pressurization in response to a predetermined low throttle setting.

23. Apparatus as defined in claim 19 in which said air pressure sensing means further includes means for venting said canister means to reduce and prevent pressurization in response to application of braking to the vehicle carrying the engine.

24. Apparatus as defined in claim 23 in which said braking responsive venting means includes means for controlling the rate of reduction of pressurization of said canister means in response to braking of the vehicle.

25. Apparatus as defined in claim 19 in which said canister means is divided by means including check valve means enabling a first portion to receive pressurization from the air pump and a second portion to be pressurized from said first portion via said check valve means to store and retain air under a pressure related to the highest engine speed and load condition sensed.

26. Apparatus as defined in claim 25 which further includes means connected intermediate the air pump and said first portion of said canister means for delaying pressure build up in said first portion.

27. Apparatus as defined in claim 25 which further includes an element having a restricted orifice connected intermediate the air pump outlet and said first portion of said canister means to reduce the effect on pressurization of said first portion by transient changes in the operating condition of the engine.

28. Apparatus as defined in claim 25 which further includes means for venting said first portion of said canister means to reduce and prevent pressurization of said first portion in response to a predetermined low throttle setting.

29. Apparatus as defined in claim 25 which further includes means for venting said second portion of said canister means to reduce pressurization in response to application of braking to the vehicle carrying the engine.

30. Apparatus as defined in claim 29 in which said braking responsive venting means further includes restricted orifice means for controlling the rate of reduction of pressurization.

31. A method for controlling operation of a vehicle internal combustion engine comprising the steps of

- a. sensing the operating condition of an engine including the speed of and the load on said engine and providing a signal related in magnitude thereto,
- b. inhibiting sensing of engine operating condition in response to a predetermined low throttle setting,
- c. storing the highest signal sensed before engine operating condition sensing is inhibited, and
- d. connecting air under pressure to lean out the fuel-air mixture being supplied to the engine in response to a predetermined magnitude of said signal.

32. A method as defined in claim 31 which further includes reducing the stored signal in response to application of braking to the vehicle.

33. A method for controlling operation of a vehicle internal combustion engine having a carburetor and a throttle valve supplying a fuel-air mixture flow to the engine, and an air pump driven by the engine to supply air under pressure, comprising the steps of

- a. sensing the pressure of the air supplied by said air pump to obtain a signal indicating the speed of and the load on said engine, and

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b. connecting air under pressure from said air pump to lean out the fuel-air mixture supplied by the carburetor to the engine when a pump air pressure is sensed which provides a predetermined magnitude of said signal.

34. A method as defined in claim 33 which further includes inhibiting the sensing of air pressure in re-

sponse to a predetermined low throttle setting.

35. A method as defined in claim 33 which further includes

a. storing the highest signal sensed, and

5 b. reducing the magnitude of stored signal in response to application of braking to the vehicle.

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