

[54] **APPARATUS FOR REDUCING HYDROCARBON CONTENT OF EXHAUST GASES DURING DECELERATION**

[75] Inventors: **Yoshio Toda; Mitsutaka Konno**, both of Yokohama; **Masao Nakajima**, Kawasaki, all of Japan

[73] Assignee: **Nissan Motor Company, Limited**, Yokohama City, Japan

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[63] Continuation of Ser. No. 7,005, Jan. 28, 1970, abandoned.

[30] **Foreign Application Priority Data**

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[52] U.S. Cl. **123/97 B**, 123/119 R, 192/0.062, 192/0.084, 74/872, 200/61.91

[51] Int. Cl. **F02m 11/00**

[58] Field of Search 123/97 B, 119; 192/0.046, 0.062, 0.084; 74/860, 872, 873

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Primary Examiner—Benjamin W. Wyche
Attorney—Robert E. Burns

[57] **ABSTRACT**

An air-pollution preventive system to be used in combination with an automotive internal combustion engine having a carburettor with idle and low-speed circuit, which system comprises a deceleration circuit to supply, independently of the idle and low-speed circuit, an air-fuel mixture to the engine in an amount and mixture ratio that are suited for the engine operation during deceleration, the deceleration circuit being closed and opened by valve means which is controlled upon various driving conditions of the motor vehicle particularly upon vehicle speeds, angular positions of the throttle valve (or motions of the accelerator pedal), positions of the clutch pedal, vacuums in the intake manifold of the engine, or combinations of two or more of these variables.

1 Claim, 18 Drawing Figures

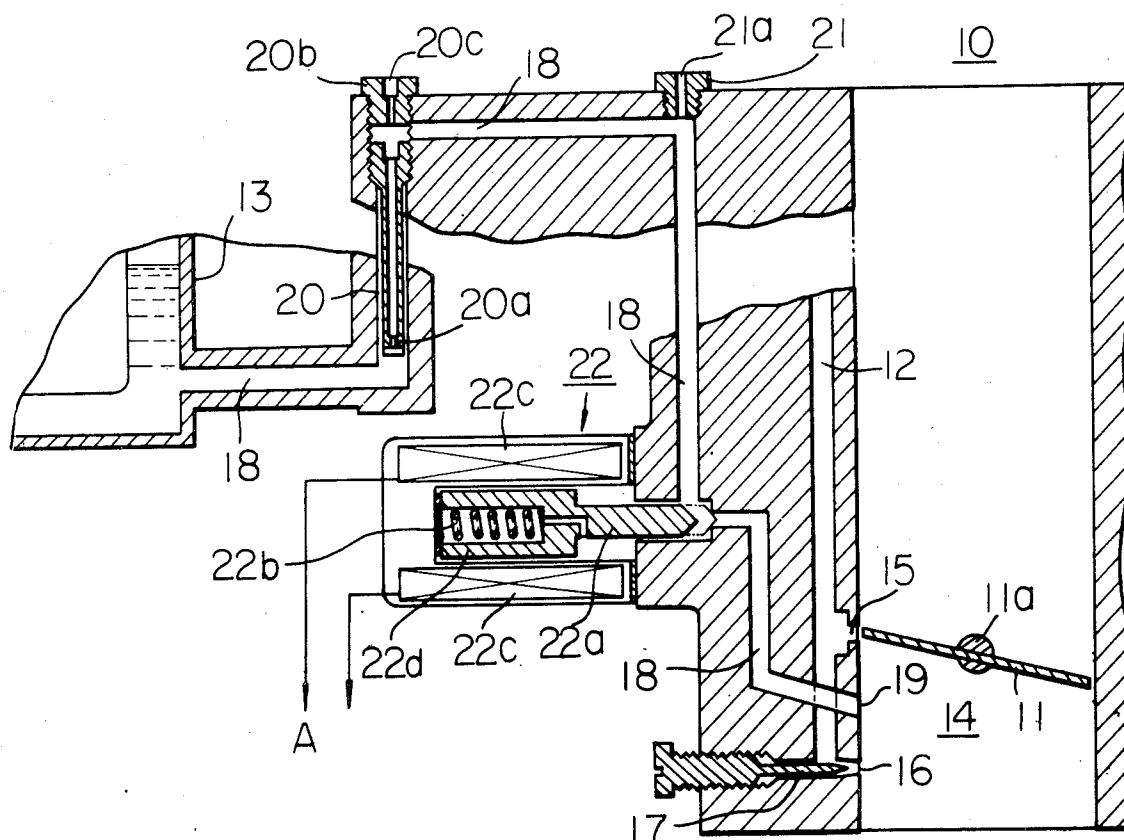


Fig. 1

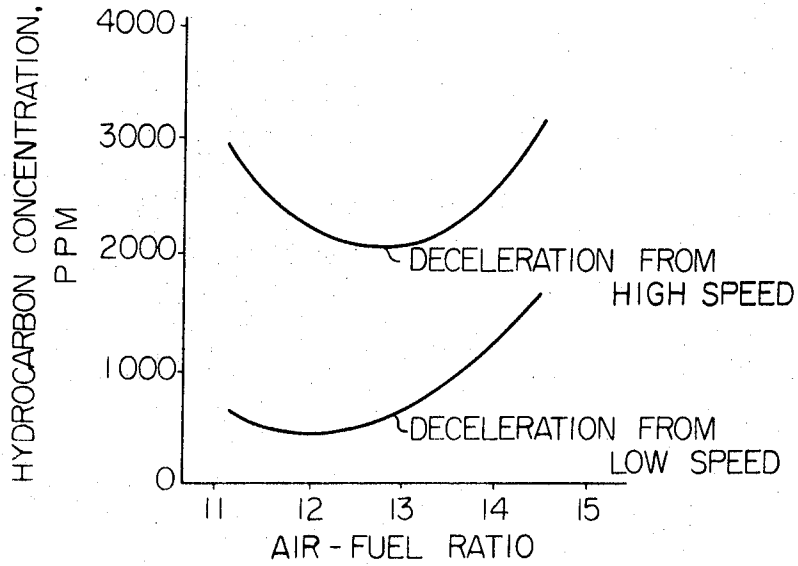


Fig. 2

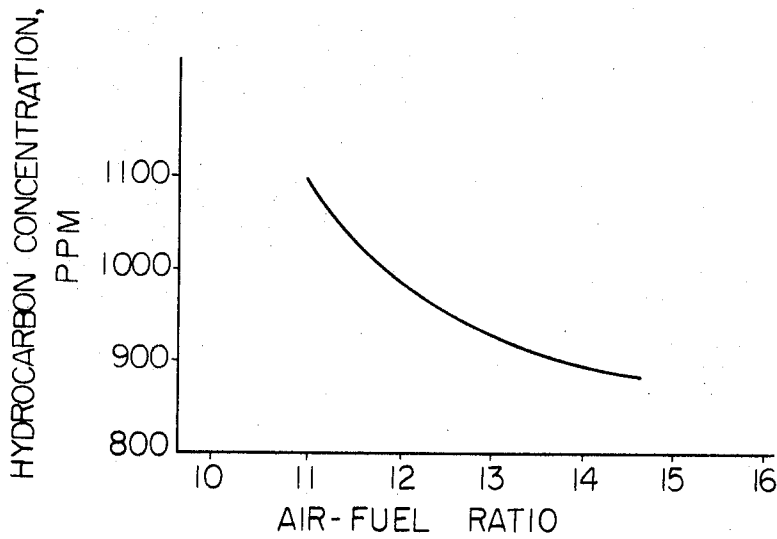


Fig. 3

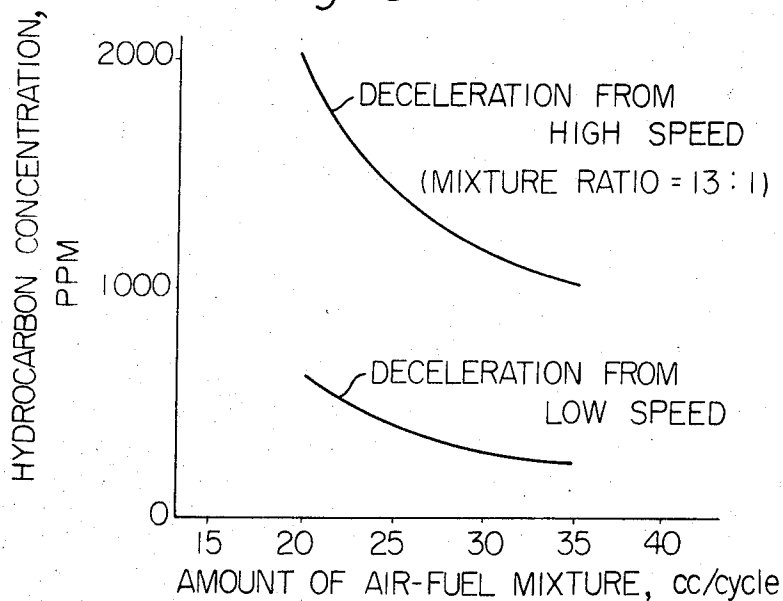


Fig. 4

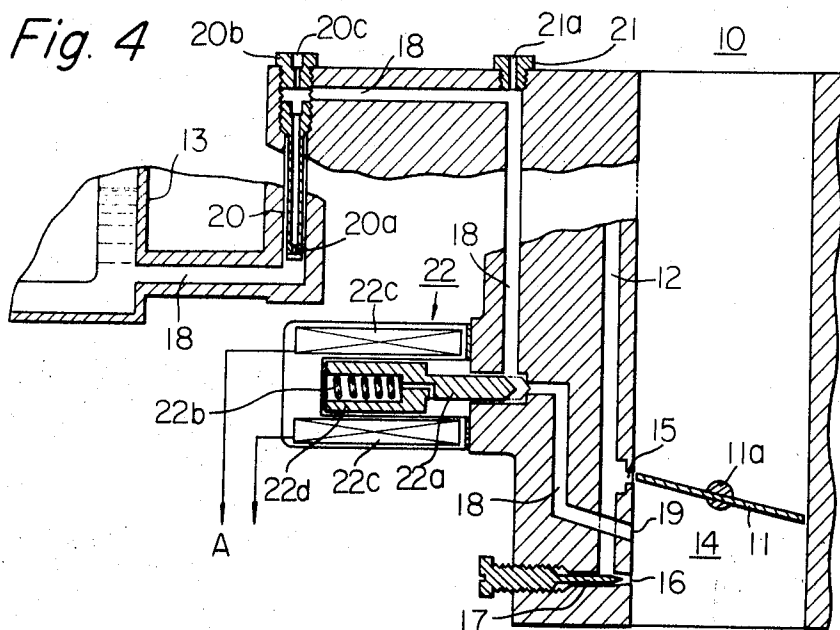


Fig. 5

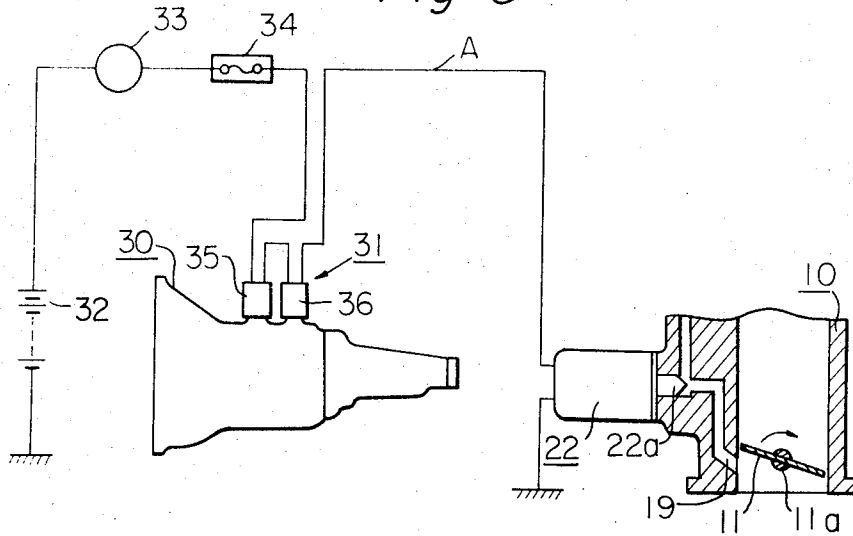


Fig. 6

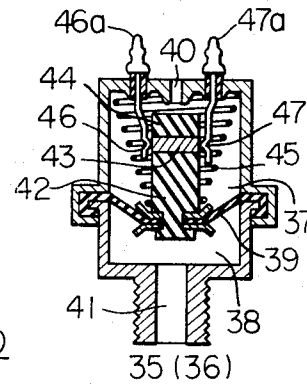


Fig. 7

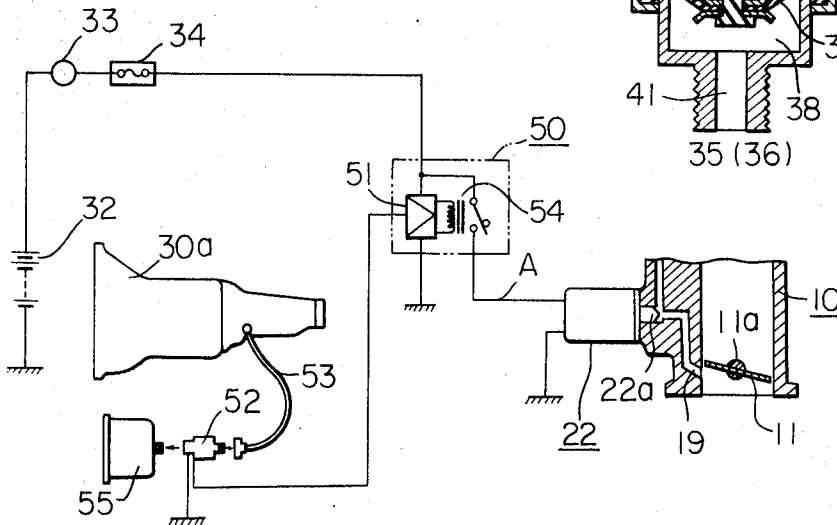


Fig. 8

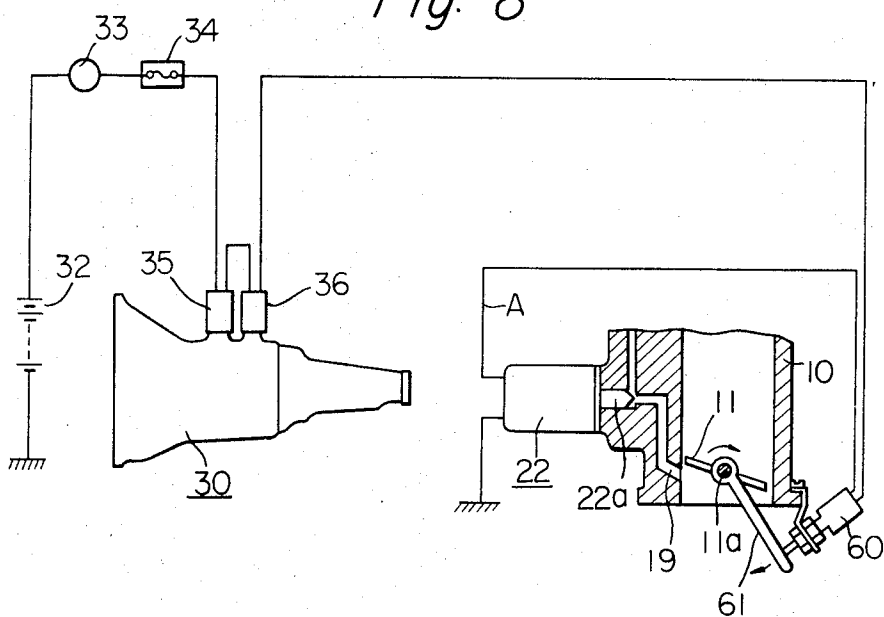


Fig. 9

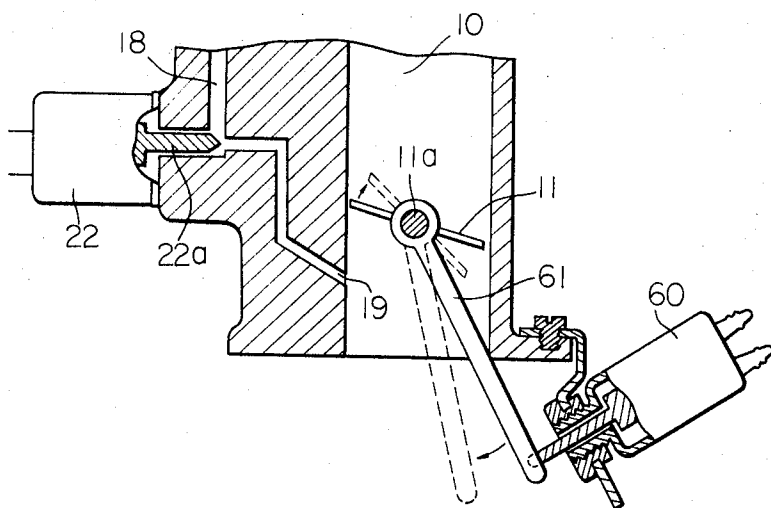


Fig. 10

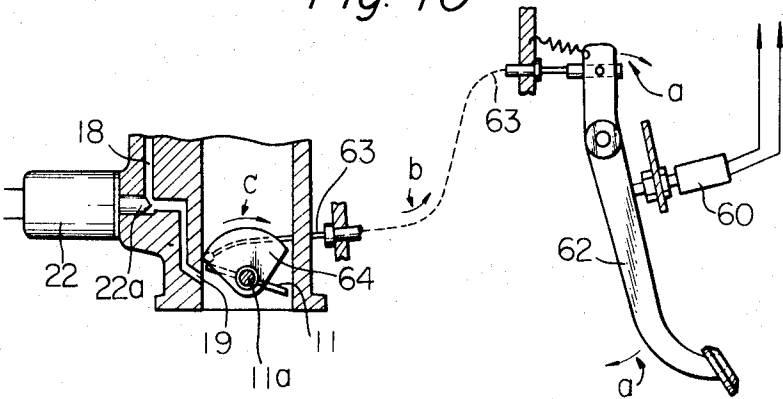


Fig. 11

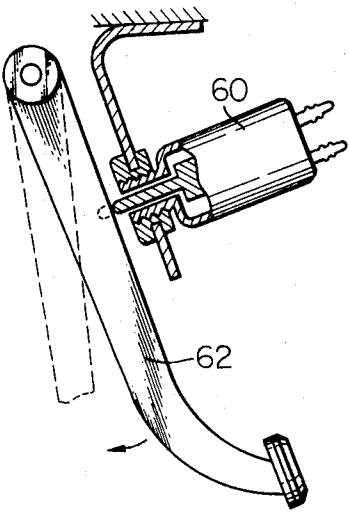


Fig. 12

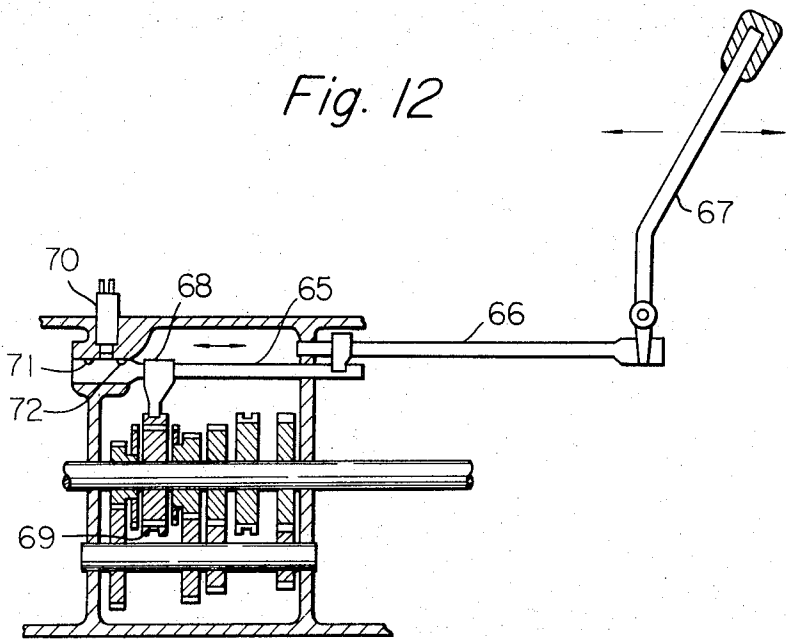


Fig. 13

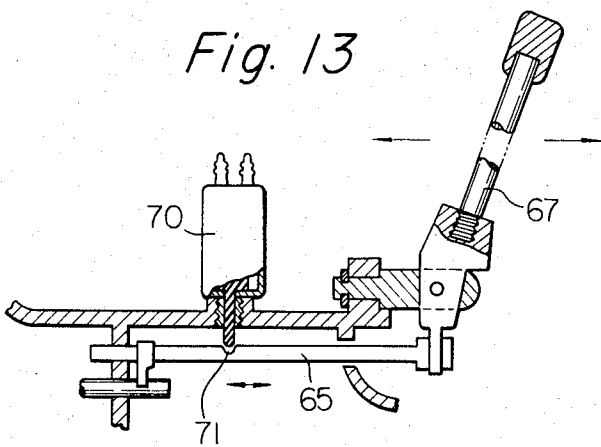


Fig. 14

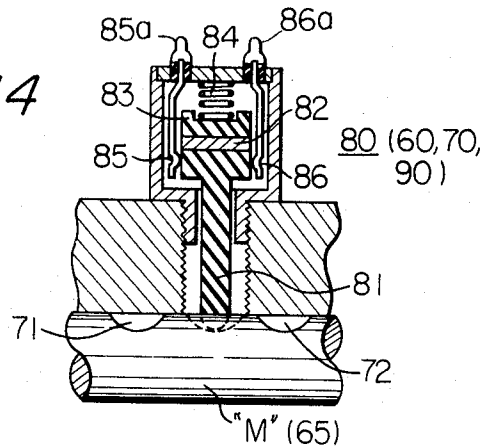


Fig. 15

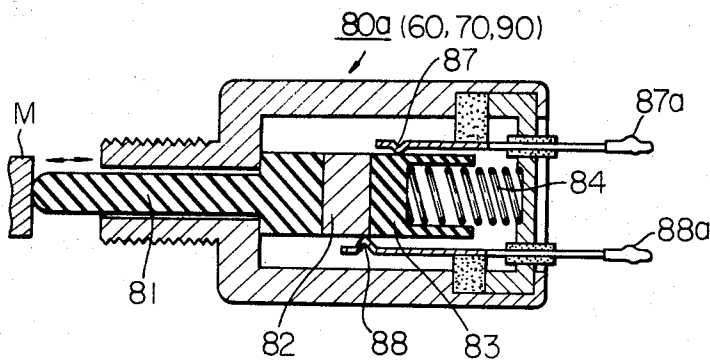
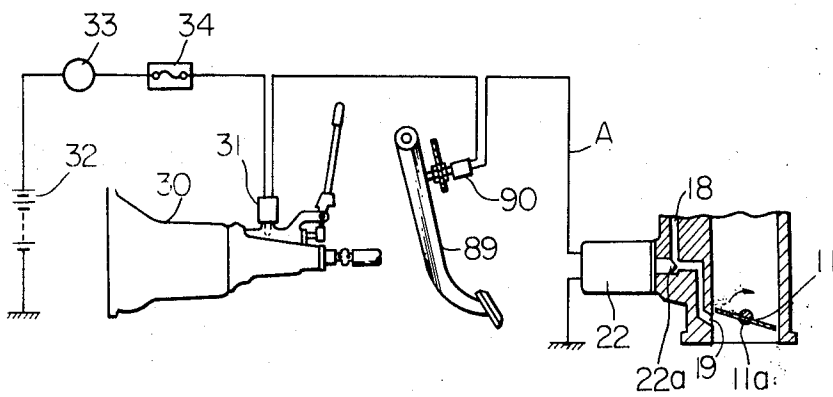


Fig. 16



APPARATUS FOR REDUCING HYDROCARBON CONTENT OF EXHAUST GASES DURING DECELERATION

This application is a continuation of application Ser. No. 7,005, filed Jan. 28, 1970, and now abandoned.

This invention relates to a vehicular air-pollution preventive system for use with an automotive gasoline-powered internal combustion engine and, more particularly, to an air-pollution preventive system to be combined with an automotive internal combustion engine having an idle and low-speed circuit, which system is adapted to reduce the concentration of the unburned content of the exhaust gases emitted from the engine during deceleration.

During deceleration of the motor vehicle when the throttle valve of the carburettor is substantially closed, the flow of air-fuel mixture is practically shut off at the throttle valve to cause the vacuum in the intake manifold to rise abruptly. An additional mixture circuit, called the idle and low-speed circuit, is therefore provided to supply an air-fuel mixture to the engine during deceleration and an amount and mixture ratio that are predetermined. The amount and mixture ratio of the air-fuel mixture are usually determined to suit the idling operation of the engine. The engine is thus supplied during deceleration with an air-fuel mixture which is calibrated to enable the engine to operate satisfactorily during the idling, not the decelerating, operation. This is reflected by degraded combustion efficiency and misfiring in the combustion chamber of the engine during deceleration so that a certain amount of unburned content which is largely hydrocarbons is emitted from the engine to the open air.

To solve the vehicular air-pollution problem to be traced to such emission of unburned toxic content of engine exhaust gases, the air-pollution system proposed by this invention is constructed and arranged in such a manner that an air-fuel mixture of optimum amount and mixture ratio is fed during deceleration to the engine through a mixture circuit which is independent from the idle and low-speed circuit. The independent mixture circuit is herein referred to as "deceleration circuit" because it is operable only during deceleration.

It is thus an object of the invention to provide a vehicular air-pollution preventive system for use with an automotive internal combustion engine to reduce the concentration of unburned content of the engine exhaust gases emitted during deceleration.

It is another object of the invention to provide an air-pollution preventive system to be combined with an automotive internal combustion engine to supply the engine with an air-fuel mixture of an amount and mixture ratio that are specifically suited for the deceleration in addition to the air-fuel mixture fed to the engine through the existing idle and low-speed circuit.

In order to achieve these objects, the air-pollution preventive system according to the invention is controlled on the vehicle speeds, intake manifold vacuums, or combination of the two. Where the vehicle speed, in particular, is to be utilized, it may be represented by a selected gear ratio or, more specifically, by the position of the speed selector lever if the timing system is used together with a manually controlled transmission system and by the hydraulic pressures applied to the front and rear clutches if the system is used with an automatic transmission system.

In the drawings:

FIGS. 1 and 2 show as typical examples the variations of the concentration of unburned hydrocarbons in the engine exhaust gases in terms of the mixture ratio of an air-fuel mixture during deceleration and during vehicle operations excepting the deceleration, respectively;

FIG. 3 shows also as a typical example the variations of the concentration of unburned hydrocarbons in the engine exhaust gases in terms of the amount of an air-fuel mixture to be supplied to the engine during deceleration;

FIG. 4 is a sectional view of an embodiment of the air-pollution preventive system according to the invention;

FIG. 5 is a schematic view showing a preferred arrangement of control means for use in the system illustrated in FIG. 4, the control means being operative responsive to changes in the vehicle speed;

FIG. 6 is a sectional view showing, on an enlarged scale, a preferred construction of combined detector and switch means for use in the control means of FIG. 5;

FIG. 7 is a schematic view similar to FIG. 5 but showing a modified form of the control means;

FIG. 8 is a schematic view similar to FIG. 5 but showing a modification of the control means, which is operative responsive to not only the changes in the vehicle speed but angular positions of the throttle valve of the carburettor;

FIG. 9 is a sectional view showing, on an enlarged scale, the detailed arrangement of the combined throttle detector and switch means used in the control means of FIG. 8;

FIG. 10 is a schematic view showing a modified form of the combined detecting and switch means for use in the control means of FIG. 9, the detecting and switch means being responsive to the motion of an accelerator pedal;

FIG. 11 is a view showing the detailed arrangement of the detecting and switch means of FIG. 9, which arrangement is also applicable to the control means of FIG. 7;

FIGS. 12 and 13 are sectional views showing preferred constructions of speed detector means to be used in the control means of FIG. 8;

FIGS. 14 and 15 are sectional views showing, on an enlarged scale, preferred constructions of switch means for use in the detector and switch means of FIGS. 6 and 7, the switch means being also applicable, as they are, to some of the modified control means to be illustrated in the subsequent figures;

FIG. 16 is similar to FIG. 5 but shows a still another modification of the control means, which is operative responsive to both the changes in the vehicle speed and the motion of a clutch pedal;

FIG. 17 is also similar to FIG. 5 but shows a still another modification of the control means, which is operative responsive to the changes in the vehicle speed, angular position responsive the throttle valve and motion of the clutch pedal; and

FIG. 18 is similar to FIG. 4 but shows a modified embodiment of the system according to the invention.

The concentration of unburned hydrocarbons in the exhaust gases, as is well known, varies markedly with the mixture ratio of an air-fuel mixture to be fed to the engine during deceleration from either high speed or low speed driving, a typical graphical representation

being illustrated in FIG. 1. It will be observed from FIG. 1 that a range of air-fuel mixture ratio does exist in which the concentration of unburned hydrocarbons is reduced significantly. The range may preferably be between about 12:1 to 13:1.

It is, on the other hand, also known that the concentration of unburned hydrocarbons decreases as the air-fuel mixture supplied to the engine becomes leaner, i.e., the mixture ratio becomes greater during the operations except for deceleration. This will be ascertained from the illustration of FIG. 2 which shows the variation of the aggregated amount of unburned hydrocarbons emitted with air-fuel mixtures of different mixture ratios supplied to the engine. The idle and low-speed circuit in a conventional carburettor is, for this very reason, arranged to supply the engine with an air-fuel mixture of 10:1 to 14:1 mixture ratio during idling and deceleration.

It is thus apparent that the concentration of hydrocarbons remaining unburned in the exhaust gases will be reduced throughout the varying driving conditions of the motor vehicle if the engine is supplied with a richer air-fuel mixture during deceleration.

Another important factor affecting the emission of unburned hydrocarbons is, as seen in FIG. 3, the amount of air-fuel mixture to be supplied to the engine. During deceleration when the throttle valve of the carburettor is substantially closed with the engine still operating at a high speed, a decreased amount of air-fuel mixture is drawn to the combustion engine and, on top of this, the mixture drawn to the combustion chamber is leaned out with the exhaust gases, impairing the ignition efficiency. This is a major cause of the incomplete combustion and misfiring as experienced during deceleration. Thus, it will be advantageous for reducing the concentration of unburned hydrocarbons in the exhaust gases to have the engine supplied with an increased amount of air-fuel mixture during deceleration.

With these in mind, the invention proposes to provide an additional mixture circuit in the carburettor having, as customary, an idle and low-speed circuit, whereby an additional richer air-fuel mixture is supplied to the engine during deceleration.

FIG. 4 illustrates a preferred embodiment of the system according to the invention to achieve such an end.

The air-pollution system of the invention is, as shown, used in combination with a carburettor of known construction. The carburettor, which is generally denoted by numeral 10, has a throttle valve 11 and idle and low-speed mixture circuit 12. The throttle valve 11 is mounted on a rotary shaft 11a and is herein shown as substantially closed to effect the deceleration of the motor vehicle. The idle and low-speed mixture circuit 12, which is led from a float bowl 13 although not so illustrated, is opened into the throttle chamber 14 through a slow port 15 and idle port 16. Designated by numeral 17 is an idle adjustment screw for adjusting the flow of air-fuel mixture through the idle port 16.

According to the invention, an additional deceleration circuit 18 is provided leading from the float bowl 13 and opened into the throttle chamber 14 through a deceleration port 19 which is shown, by way of example, to be located intermediate between the slow port 15 and the idle port 16. An atomizer 20 is provided in the deceleration circuit 18 immediately downstream of the float bowl 13. The atomizer 20 has formed at its bottom a jet nozzle 20a and at its top a first air bleed

20b having an air vent 20c vented from the atmosphere. Downstream of the first air bleed 20b is provided a second air bleed 21 having an air vent 21a which is also vented from the atmosphere.

The flow of air-fuel mixture through the deceleration circuit 18 is controlled by a solenoid valve assembly 22. The solenoid valve assembly 22 has a valve head 22a which extends movably into the deceleration circuit 18 downstream of the second air bleed 21 and upstream of the deceleration port 19. The valve head 22a is usually held in a protruded position by the action of a compression spring 22b to keep the deceleration circuit 18 closed. The solenoid valve assembly 22 also has, as usual, a solenoid coil 22c and core 22d. The core 22d is shown, by way of example, to be integral with the valve head 22a. The solenoid coil 22c, when excited, forces the core 22d in a direction in which the valve head 22a retracts from the deceleration circuit 18 against the action of the compression spring 22b. The solenoid coil 22c is electrically connected through lines A and B with control means of the construction to be described later and is excited only when the motor vehicle slows down.

The first and second air bleeds 20b and 21, respectively, are so calibrated as to pass air from the atmosphere at desired flow rates and the jet nozzle 20a to pass liquid fuel from the float bowl 13 at a desired rate, so that an air-fuel mixture in desired amount and mixture ratio can be delivered to the engine through the deceleration circuit 18.

With the deceleration circuit 18 and solenoid valve assembly 22 thus constructed and arranged, the valve head 22a is normally held in a position to close the deceleration circuit 18 with the solenoid coil 22c kept unexcited, thereby shutting off the flow of air-fuel mixture through the deceleration circuit 18. When, however, the solenoid coil 22c becomes excited through a line A in response to the deceleration of the motor vehicle, then the valve head 22a is moved against the action of the spring 22b in a direction to open the deceleration circuit 18, thus permitting the air-fuel mixture to be pulled by the vacuum in the intake manifold (not shown) over to the throttle chamber 14 through the deceleration port 19.

The control means to excite and unexcite the solenoid coil 22c may be constructed and arranged in different manners depending upon the control factors selected to govern the timings of the air-fuel mixture being delivered to the engine through the deceleration circuit 18.

Although a variety of control factors may be conceivable, the invention proposes to use, as preferable, any of vehicle speeds, intake manifold vacuums, angular positions of the throttle valve or combinations of these.

Where the vehicle speed, in particular, is to be utilized, it may be preferable to have the control means constructed to be responsive to vehicle speeds within a predetermined range in which the motor vehicle slows down. If, in this instance, the air-pollution preventive system according to the invention is to be used together with an automatic transmission system, the control means may be controlled either by the fluid pressure in the hydraulic circuits in the transmission system or by electrically detecting the speeds selected by the transmission system. If, on the other hand, transmission system is of manually operated type, the vehi-

cle speed will be indexed as the positions of the clutch pedal and of the fork rod in the power train.

FIG. 5 illustrates a preferred example of the arrangement of such control means for use with an automatic transmission system which is sketchily indicated by numeral 30. The control means as used in this arrangement is constructed essentially as a combined speed detector and switch means 31 of which construction is to be described and shown later.

The control means is electrically connected at one terminal with the line A connected with the solenoid coil 22c and at the other with a power source 32 preferably through an ignition switch 33 and fuse 34.

The concentration of unburned hydrocarbons in the engine exhaust gases is higher during deceleration from high speeds than from low speeds, as will be understood from the plots of FIGS. 1 and 3. Since higher gear ratios are usually selected during the high speed driving, it will be beneficial for the reduction of the concentration of unburned hydrocarbons to have the solenoid valve assembly 22 actuated especially in the deceleration from high speed driving. It is desirable for this very reason that the combined detector and switch means be constructed in a manner to excite the solenoid valve assembly only when the motor vehicle is decelerated from higher speeds, for example, from the third or fourth driving speed in a four-shift transmission system or from the third driving speed in a three-shift transmission system.

The combined detector and switch means to achieve this purpose may be operated in accordance with changes in the fluid pressures in the hydraulic control circuit of the transmission system. The fluid pressures occurring at the actuating elements of the brakes and clutches of automatic transmission system are known to vary with the speed range as tabulated in Table 1. In Table 1, the sign "o" refers to an occurrence of fluid pressure ranging between 3 and 10 kg/cm² and the sign "x" to an occurrence of fluid pressure lower than 0.5 kg/cm².

TABLE 1

Speed Range	Front Clutch Piston	Rear Clutch Piston
Parking	x	x
Reverse	o	x
Neutral	x	x
Drive	3rd	o
	2nd	x
	1st	o

In order to detect the third driving speed selected, therefore, the combined speed detector and switch means may be constructed in such a manner as to be responsive to changes in the fluid pressures carried to the front and rear clutch pistons.

For this purpose, the combined speed detector and switch means 31 may be made up of two switch elements 35 and 36 connected in series with each other. The switch elements 35 and 36, herein termed the front and rear clutch piston switches, respectively, are constructed similarly to each other and, hence, only one of them is illustrated in FIG. 6.

Referring to FIG. 6, the front clutch piston switch element 35 has two chambers 37 and 38 which are separated from each other by a diaphragm member 39. The chamber 37 is an atmospheric chamber which is vented to the open air through an aperture 40 while the chamber 36 is a fluid chamber which communicates with the

piston chamber of the front clutch piston (not shown) through a conduit 41. A moving member 42, which is made of an insulating material, is mounted on the diaphragm member 39 and extends into the atmospheric chamber 37. The moving member 42 is connected at its leading end with a moving contact 43 of conductive material, which moving contact 43 is, in turn, connected at its opposite end with an insulating member 44, as shown. The diaphragm member 39 is usually forced toward the fluid chamber 38 by the action of a compression spring 45. The switch element 35 also has a pair of stationary contacts 46 and 47 connected with lead wires 46a and 47a. The stationary contacts 46 and 47 are positioned in such a manner that they are usually in an abutting engagement with the insulating member 44 when the diaphragm member 39 is forced toward the fluid chamber 38 overpowering the fluid pressure present in the fluid chamber 38. Thus, the lead wires 46a and 47a are usually kept disconnected from each other to maintain the solenoid coil 22c (FIG. 4) deenergized. When, however, an increased fluid pressure is carried into the fluid chamber 38, then the diaphragm member 39 is moved against the action of the compression spring 45 toward the atmospheric chamber 37 so that the moving contact 43 integral with the moving member 42 is brought into a position in which it is seized by the stationary contacts 46 and 47. The lead wires 46a and 47a are thus interconnected with each other and as the consequence the solenoid coil 22c of the solenoid valve assembly 22 is excited.

The rear clutch piston switch element 36 is constructed and arranged entirely similarly to the front clutch piston switch element 37 except that the fluid pressure communicates with the piston chamber of the rear clutch piston (not shown) and, hence, discussion of construction and operation is herein omitted.

With the front and rear clutch piston switch elements 36 and 37 combined in series with each other, "ON" and "OFF" signals representing the high and low fluid pressures, respectively, are made available as shown in table 2.

Table 2

Speed Range	Clutch Piston Switch Elements		Combination of Two Elements
	Front	Rear	
Parking	OFF	OFF	OFF
Reverse	ON	OFF	OFF
Neutral	OFF	OFF	OFF
Drive	3rd	ON	ON
	2nd	OFF	ON
	1st	OFF	ON

It will be appreciated from the above Table that the combined speed detector and switch means 31 made up of the front and rear clutch piston switch elements 35 and 36 constructed as discussed above can be closed and the solenoid valve assembly 22 actuated only when the third driving speed is detected by the means 31. The concentration of the unburned hydrocarbons in the exhaust gases emitted from the engine during deceleration can be thus reduced significantly as already discussed with reference to FIG. 4.

By the control means thus constructed, the solenoid valve assembly 22 will be actuated also during acceleration and normal cruising. The throttle valve 11 of the carburettor 10 in this instance is partly open to permit the passage of air-fuel mixture therethrough and the vacuum in the intake manifold is far lower than the vacuum built up during deceleration. The amount of air-

fuel mixture to be drawn to the engine through the deceleration circuit is practically negligible as compared with the amounts of air-fuel mixtures to be supplied through the main supply passage and idle and low-speed circuit of the carburettor.

As an alternative to the combined speed detector and switch means 31, the control means may be constructed as a switch of the nature which is responsive to the vehicle speed detected electrically from the output shaft of the transmission system, an example being illustrated in FIG. 7.

In FIG. 7, the switch of such nature is generally indicated by numeral 50 which is shown to be combined with a transmission system 30a. The transmission system 30a to which the switch 50 is to be applied may be either automatic or manually controlled type.

The switch 50 per se may be constructed and arranged in some suitable manners inasmuch as the intent of operating on predetermined vehicle speeds is maintained and the construction arrangement as shown and described is presented solely for illustrative purposes.

The switch 50 as shown has a vehicle speed detector 51 which is connected with an operated by a vehicle speed sensor 52 through a speed meter cable 53. The speed sensor 52 is so arranged as to constantly supply the speed detector 51 with a voltage corresponding to the vehicle speed selected in the transmission system 30a. The speed detector 51 is connected to a relay switch 54. The relay switch 54 is constructed in a manner to remain open normally and to be closed once the voltage which the speed detector 51 receives from the speed sensor 52 of the transmission system exceeds a predetermined level, say about 20 km/hr. for example. Designated by numeral 55 is a speed meter which visually displays the speed selected in the transmission system 30a.

The switch 50 thus constructed, the control means in this arrangement acts to keep the solenoid coil 22c of the solenoid valve assembly 22 (FIG. 4) when the vehicle is driven at a speed higher than the predetermined level of 20 km/hr., for example, so that an air-fuel mixture is continuously supplied to the engine through the deceleration circuit. When, therefore, the motor vehicle starts to slow down with the carburettor throttle valve 11 kept substantially closed, the engine can still receive an air-fuel mixture of an amount and mixture ratio that are determined to best suit the deceleration of the motor vehicle, as previously discussed. In this example, too, an air-fuel ratio is invariably supplied to the engine through the deceleration circuit during acceleration and normal cruising of the motor vehicle. The amount of the air-fuel mixture to be passed through the deceleration circuit is practically negligible for the same reason as mentioned in connection with FIG. 5.

In operations at a vehicle speed lower than the predetermined level (20 km/hr. for example) including the parking or standing, the relay switch 51 remains open so that the solenoid valve assembly 22 is maintained inoperative; the engine operation at idle is as the consequence performed in a manner entirely similar to the conventional carburettors.

FIG. 8 illustrates another example of the control means for use in the air-pollution preventive system according to the invention. The control means as shown is constructed as the combination of a vehicle speed detector and switch means and a throttle detector and switch means cooperating with the former.

The vehicle speed detector and switch means may be constructed entirely similarly to the corresponding means used in the control means of FIGS. 5 and 7 and, hence, detailed description on the construction and operation thereof are herein omitted. Where the speed detector and switch means is constructed similar to means 31, then it will be operative only when the front and rear clutch piston switch elements 35 and 36, respectively, thereof are closed concurrently with the third driving speed selected in the transmission system. Where, on the other hand, it is desired to use the switch 50 used in the control means of FIG. 7, then the speed detector and switch means will be operative only when the vehicle speed is in excess of a predetermined level of, for instance, 20 km/hr.

The throttle detector and switch means to be used in the control means of FIG. 8, on the other hand, is electrically connected in series with the speed detector and switch means thus constructed and operates on the angular positions of the throttle valve 11 of the carburettor 10. The detailed construction of this throttle detector and switch means is illustrated in FIG. 9.

Referring to FIG. 9, the throttle detector and switch means has a switch element 60 which is controlled in accordance with the angular position of the throttle valve 11 through an arm 61 secured at one end to the rotary shaft 11a of the throttle valve 11. The switch element 60 may be constructed in different manners inasmuch as it is closed at full-throttle (during deceleration) and open at part- or open-throttle (during operations excepting deceleration).

It will be appreciated that the control means constituted by these vehicle speed detector and switch means and throttle detector and switch means is operable when, and only when, the two means connected in series are made concurrently operative and consequently that the solenoid valve assembly 22 (FIG. 5) is actuated only when the vehicle speed is limited within a predetermined range or in excess of a predetermined lower limit and when the carburettor throttle valve is substantially closed. If at least either of the two means remains inoperative, then the solenoid valve assembly 22 is kept at rest so that no air-fuel mixture is passed over to the engine through the deceleration circuit. When the motor vehicle is operating at idle, for example, the throttle detector and switch means is kept operative with the throttle valve virtually closed but gear ratios are selected in the transmission system to provide the parking or neutral range or the first speed of the driving range (i.e., not the third driving speed) so that the speed detector and switch means is kept inoperative, thereby keeping the solenoid valve assembly 22 unexcited. When, on the other hand, the throttle valve is partly or fully open to effect the normal cruising or acceleration, then the throttle detector and switch means remains inoperative, also keeping the solenoid valve assembly 22 at rest.

The deceleration of the motor vehicle may be, if preferred, detected through utilization of the positions of the accelerator pedal in lieu of the throttle valve, since the angular position of the throttle valve follows the motion of the accelerator pedal.

As shown in FIG. 10, the accelerator pedal which is represented by numeral 62 is connected with an accelerator wire 63. A sector drum 64 is securely mounted on and rotated with the rotary shaft 11a of the throttle valve 11 and is operatively connected with the accel-

ator pedal 62 through the accelerator wire 63. The throttle valve 11 is herein shown as substantially closed.

The sector drum 64 rotating complete with the rotary shaft 11a of the throttle valve 11, the throttle valve 11 is substantially closed when the accelerator pedal 62 is released. When, however, the accelerator pedal 62 is depressed and moved in the direction of the arrow *a*, then the accelerator wire 63 is pulled in the direction of arrow *b* and the sector drum 64 and accordingly the throttle valve 11 are rotated in the direction of arrow *c* to increase the effective throttle area. Thus, the angular positions of the throttle valve 11 are dictated by the motion of the accelerator pedal and, for this reason, the deceleration of the motor vehicle can be detected from the motion of the accelerator pedal, if a suitable detector and switch means is used.

Such detector and switch means may be constructed in different manners as far as the same is capable of detecting the displacement in a predetermined range and, hence, the switch element 60 used in the throttle detector and switch means shown in FIG. 9 may be utilized as it is. FIG. 11 illustrates an example of such detector and switch means using the switch element 60 to detect the displacement of the accelerator pedal 62.

Where, now, a transmission system of manually operated type is to be used with the air-pollution preventive system according to the invention, the detection of the speeds selected in the transmission system may be effected with use of modified forms of speed detector and switch means which are illustrated in FIGS. 12 and 13.

In FIG. 12, the transmission system, which is herein shown in its neutral position, has a fork rod 65 which is operatively connected through a striking rod 66 to a speed selector lever 67, as customary. The fork rod 66 is also connected securely to a shifting rod 68 to selectively couple and uncouple the transmission gears (not numbered) through a coupling sleeve 69 as the striking rod 66 is moved back and forth by the selector lever 67.

The speed selected in the transmission system having such elements is detected by a combined speed detector and switch means 70 and, if the transmission system is of four-shift type, two different recesses 71 and 72 formed in the peripheral wall of the fork rod 65 at locations suited to detect the third and fourth driving speeds, respectively, selected. Where a three-shift transmission system is to be used, only one recess may suffice to detect the third driving speed as indicated at 71 in FIG. 13.

The speed detector and switch means 70 is, as will be described in detail, constructed in a manner to detect the movement of the fork rod 65 through mechanical engagement with the recess 71 or recesses 71 and 72 and to become operative when the recess or recesses are seized thereby.

Now, FIGS. 14 and 15 illustrate practical examples of switch elements to be used, as preferable, for detecting the angular position of the throttle valve or displacement of the accelerator pedal (as by the switch element 60 in FIGS. 10 and 11) or the recess or recesses in the fork rod (FIGS. 12 and 13), as the case may be.

First referring to FIG. 14, the switch element which is generally represented by numeral 80 has a moving member 81 made of an insulating material and projecting outwardly toward a moving object M which is actually the arm 61 connected with the throttle valve 11

(FIG. 9), accelerator pedal 62 (FIG. 10) or fork rod 65 (FIGS. 12 and 13). The moving member 81 is securely connected at its innermost end with a moving contact 82 which is electrically conductive. The moving contact 82, in turn, is connected at its end opposite to the moving contact 81 with an insulating member 83, as shown. A compression spring 84 with fixed end is positioned behind the insulating member 83 in a manner to force the moving contact 82 and moving member 81 toward the moving object M as indicated by a dotted line. The switch element 80 also has a pair of stationary contacts 85 and 86 connected with lead wires 85a and 86a. The stationary contacts 85 and 86 are positioned in such a manner that they are usually in abutting engagement with the moving member 81 by the action of the compression spring 84. The lead wires 85a and 86a are usually disconnected from each other so that the solenoid coil 22c (FIG. 4) is kept unexcited. When, however, the moving object M moves toward the leading tip of the moving member 81, then the moving contact 82 is moved against the action of the spring 84 in a direction opposite to the moving object M. The result is that the moving contact 81 is brought into abutting engagement with the stationary contacts 85 and 86 to connect the lead wires 85a and 86a with each other. The solenoid coil 22 of the solenoid valve assembly 22 (FIG. 4) is thereby excited and an air-fuel mixture is permitted to pass into the combustion chamber through the deceleration circuit.

Another form of the switch element is illustrated in FIG. 15, in which the switch element is generally denoted by numeral 80a.

The switch element is essentially similar in construction and function to the switch element 80 and as such like numerals are allocated to corresponding parts. Different from the switch element 80, the switch element 80a has its stationary contacts 87 and 88 located in a manner that one stationary contact which may be 87 is usually located on the moving member 81 and the other contact which may be 88 on the insulating member 83 both by the action of the compression spring 84.

When, now, the moving object M approaches and hits the moving member 81, then the moving contact 81 is moved and brought into contact with the stationary contact 88. In this state, the stationary contact 87 is still abutting to the insulating member 83 so that the lead wires 87a and 88a remain disconnected from each other. As the moving member 81 is further retracted by the moving object M, the moving contact 82 is now permitted to contact the stationary contact 88. The lead wires 87a and 88a are thus connected with each other.

The switch element 80 (FIG. 11) is suited to be closed when the moving object M has moved beyond a predetermined limit while the switch element 80a (FIG. 12) to be closed when the displacement of the moving object M is limited within a predetermined range.

Deceleration of the motor vehicle may be detected, if preferred, from the motion of a clutch pedal 89, as illustrated in FIG. 16.

Referring to FIG. 16, the control means of the air-pollution system is comprised by a speed detector and switch means 31 and a clutch position detector and switch means 90. The means 31 may be constructed in manners previously described with reference to FIGS. 5, 7 12 and 13. The means 31 and 90 are electrically

connected in series with each other so that the solenoid valve assembly 22 is controlled not only on the vehicle speeds but on the position of the clutch pedal 89.

The clutch position detector and switch means 90 may preferably be constructed as the described switch element 80 or 80a and is arranged to be closed when the clutch pedal 89 is kept released.

If the speed detector and switch means 31 is arranged in such a manner as to become operative when the third or fourth driving speed is selected (in a four-shift transmission system), then the solenoid valve assembly 22 will be excited not only during deceleration but during acceleration and normal cruising with the switch element of the means 90 closed. Since, however, the throttle valve of the carburettor is at least partly open in this instance, the vacuum in the intake manifold is lower than that during deceleration so that the amount of air-fuel mixture to be supplied to the engine is smaller than that during deceleration. As previously pointed out, the amount of the air-fuel mixture to be passed through the deceleration circuit is practically negligible as compared with the amount of mixtures to be supplied to the engine through the main supply passage and idle and low-speed circuit during deceleration.

When the engine is at idle with the transmission gears shifted to the third or fourth driving speed and with the clutch pedal depressed, the switch element of the clutch position detector and switch means 90 is kept open so that the solenoid valve assembly 22 is unexcited. Thus, the air-fuel mixture is not passed through the deceleration circuit and the engine receives through the idle and low-speed circuit an air-fuel mixture in an amount and mixture ratio suited for the idling.

FIG. 17 illustrates an example of the control means in which the control means of FIG. 16 is further combined with the throttle detector and switch means which has been already described with reference to FIGS. 8 and 9.

In this control means, the combined speed detector and switch means 31 may be constituted as a switch element which is so constructed as to be open only when the speed selector lever 67 of the transmission system is in neutral position and closed when the selector lever is held in the remaining positions. An example of such switch element is apparently the switch element 70 used in the control means of FIG. 13.

The clutch position detector and switch means 90 is, similarly to the corresponding means used in FIG. 16, constituted by the switch element 80 or 80a and is kept closed when the clutch pedal 89 remains released and opened with the clutch pedal depressed.

The throttle detector and switch means 60 is, also similarly to the corresponding means in FIG. 8, closed only when the throttle valve 11 is substantially closed.

During deceleration, the engine output shaft is usually coupled with the output shaft of the transmission system for braking the engine. In this instance, the transmission gears are engaged to establish any of the driving range speeds with the clutch pedal kept released and the throttle valve substantially closed. In this condition, all the switch elements of the detector and switch means 31, 90 and 60 are closed and consequently the solenoid valve assembly 22 is energized to pass the air-fuel mixture to the engine through the deceleration circuit.

Although the control means to be used in the air-pollution preventive system of this invention has been discussed as controlled on such variables as vehicle speed, angular position of the throttle valve (or the position of the accelerator pedal), motion of the clutch pedal, or combination of these, the same can be operated in accordance with the vacuum level in the intake manifold of the engine or revolution speed of the engine.

FIG. 18 illustrates an embodiment of the air-pollution system in which the supply of air-fuel mixture through the deceleration circuit is controlled by means of a diaphragm valve assembly which is operable in response to the change in the intake manifold vacuum. The carburettor elements as appearing in FIG. 18 are entirely similar to those in FIG. 4 and, hence, like numerals are assigned to like parts in both figures.

Referring to FIG. 18, the diaphragm valve assembly is generally represented by numeral 91. The diaphragm valve assembly 91 has an atmospheric chamber 92 and vacuum chamber 93 which is separated from the former by means of a diaphragm member 94. A valve member 95 is mounted on the diaphragm member 94 and extends through the atmospheric chamber 92 toward the deceleration circuit 18. A compression spring 96 is mounted in the vacuum chamber 93 to normally force the diaphragm member in a direction in which the deceleration circuit 18 is shut by the valve member 95. The atmospheric chamber 92 is internally maintained at an atmospheric pressure while the vacuum chamber 93 is led to a vacuum conduit 97 which is opened through a vacuum port 98 into the intake manifold of the engine. The compression of the spring 96 is determined in a manner that the spring overpowers the vacuum developing in the intake manifold with the throttle valve 11 partly or fully opened and yields to the increased intake manifold vacuum at full throttle. Designated by 99 is a packing to seal off the clearance between the valve member 95 and the surrounding wall structure.

During vehicle operations excepting deceleration and idling, the throttle valve 11 is more or less opened to supply the engine with an air-fuel mixture through the throttle chamber 14 and idle and low-speed circuit 12. During the idling operation when the throttle valve 11 is substantially closed, the engine is now supplied with an air-fuel mixture through the idle and low-speed circuit 12 as customary. During deceleration when the throttle valve 11 is substantially closed and yet the engine is still operating at a high speed, the intake manifold vacuum increases abruptly. As soon as the vacuum drawn to the vacuum chamber 96 exceeds a level to overpower the compression spring 96, then the diaphragm member 94 is moved toward the vacuum chamber 93 so that the valve member 95 is withdrawn from the deceleration circuit 12, i.e., from the position indicated by a broken line to the position indicated by a solid line. The air-fuel mixture is in this manner passed through the deceleration circuit 12 into throttle chamber 14 downstream of the throttle valve 11, whereby the concentration of unburned hydrocarbons in the engine exhaust gases is reduced significantly.

In this embodiment, too, the amount and mixture ratio of the air-fuel mixture to be passed through the deceleration circuit 12 can be adjusted by varying the flow rates at the first and second air bleeds 20b and 21 and/or the inside diameters of the jet nozzle 20a.

It will now be appreciated from the foregoing description that the air-pollution preventive system according to the invention is advantageous in reducing the concentration of unburned toxic hydrocarbons in the engine exhaust gases during deceleration without affecting the engine performance during the remaining vehicle operations particularly the idling operation.

What is claimed is:

1. In a carburetor for an automotive gasoline-powered internal combustion engine and having a float bowl, a throttle chamber, a throttle valve operatively disposed in said throttle chamber, and an idle and slow speed mixture circuit having an idle port and a slow speed port opening into said throttle chamber for supplying said engine with an air-fuel mixture, a system for reducing the concentration of unburned content of the exhaust gases emitted from said engine during decelerating operation of the automobile, said system comprising a deceleration circuit independent of said idle and slow mixture circuit and provided between said float bowl and said throttle chamber for supplying an air-fuel mixture to said engine in addition to and independent of an air-fuel mixture supplied to said engine through

said idle and slow speed mixture circuit during decelerating operation of the automobile, and a solenoid valve assembly controlling the flow of said air-fuel mixture through said deceleration circuit, said deceleration circuit including an atomizer provided downstream of said float bowl and formed at its bottom a jet nozzle and its top a first air bleed vented to the atmosphere, a second air bleed provided in said deceleration circuit downstream of said first air bleed, and a deceleration port communicating with said deceleration circuit and opening into said throttle chamber at a position downstream of said throttle valve, and said solenoid valve assembly including a valve in said deceleration circuit downstream of said second air bleed and means responsive to a decelerating condition of the automobile to actuate said solenoid valve assembly to open said valve to permit the flow of said air-fuel mixture through said deceleration circuit, whereby said engine is supplied with an air-fuel mixture through said deceleration circuit independently of the air-fuel mixture fed through said idle and slow speed mixture circuit.

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