

[72] Inventor **Ralph Wolf Carp**
Baltimore, Md.
[21] Appl. No. **792,204**
[22] Filed **Jan. 10, 1969**
[45] Patented **June 1, 1971**
[73] Assignee **The Bendix Corporation**

FOREIGN PATENTS

1,206,502 4/1959 France 123/97
1,184,395 12/1964 Germany 123/97

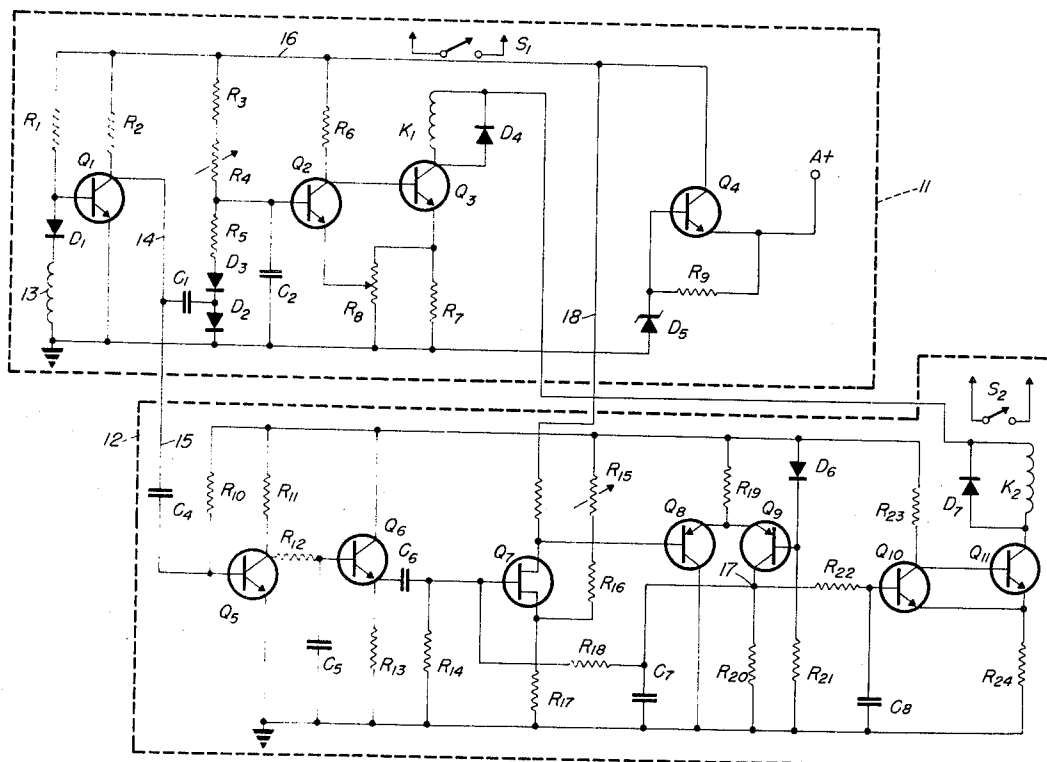
Primary Examiner—Kenneth H. Betts
Attorneys—Plante, Arens, Hartz, Hix and Smith, Bruce L.
Lamb, William G. Christoforo and Lester L. Hallacher

[54] **EXHAUST POLLUTION CONTROL CIRCUIT**
2 Claims, 1 Drawing Fig.

[52] U.S. Cl. **180/82,**
123/97, 123/102, 80/105
[51] Int. Cl. **B60k 13/00**
[50] Field of Search 180/82,
105—109; 123/102, 97 B, 97, 117, 119

[56] **References Cited**
UNITED STATES PATENTS
2,957,463 10/1960 Schnabel 123/97
3,060,602 10/1962 Buttenhoff 123/97X
3,351,811 11/1967 Buckley et al. 317/5
3,381,771 5/1968 Granger et al. 180/105
3,463,130 8/1969 Reichardt et al. 123/97X

ABSTRACT: The invention relates to a circuit for actuating an output load when an input signal above a predetermined level is present. In a particular embodiment the output load is a coil which actuates a linkage to prevent the accelerator pedal of a vehicle from fully closing when it is released by the driver while the vehicle is traveling above a predetermined speed. The input signal is a varying voltage, the frequency of which is representative of the vehicle speed. By so controlling the closing of the accelerator pedal, the expulsion of unburned fumes and gas is minimized. An acceleration responsive circuit is also included. This circuit is actuated when an acceleration above a predetermined rate is reached to prevent an attempt at accelerating the vehicle at a rate beyond its capabilities.



PATENTED JUN 1 1971

3,581,839



EXHAUST POLLUTION CONTROL CIRCUIT

The problem of air pollution has become of 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. In this environment, the expulsion of air-polluting fumes can be considered as a twofold problem. The first difficulty stems from the expulsion of fumes which are created by the partial, or incomplete, burning of the fuel. This occurs when an excess of fuel is supplied to the engine. In this instance the engine does not receive a sufficient supply of air to completely burn some of the fuel. The result is the expulsion of polluting fumes which are harmful to the health of living organisms which intake the fumes.

The second aspect stems from the expulsion of completely unburned fuel. Two attempted uses of the engine can result in a complete failure to burn some of the fuel injected into the engine. The first of these is the complete and sudden release of the fuel control mechanism. This occurs when the vehicle is traveling at a high speed and the accelerator pedal is fully released, as for example, when the brakes are applied. In this instance the natural slow down of the engine is much less than that occasioned by the braking action. Also, the natural engine slow down exceeds the decrease of fuel input to the engine. These two factors add together and result in the expulsion of unburned fuel.

The other action which causes a large oversupply of fuel to the engine is an attempt to accelerate the engine beyond its capability. This occurs when the driver suddenly fully depresses the accelerator pedal. In such instances fuel is injected into the engine at a rate determined by the accelerator pedal angle. Some of the additional fuel will be fully burned and cause the engine speed to increase. Another portion of the fuel will be partially burned and cause a slight increase in engine speed. However, the load on the engine and the inherent engine characteristics will not permit the engine to accelerate at a rate sufficient for all the fuel to fully or partially burn. The excess is expelled in raw form along with that only partially burned. Both of these ingredients in the exhaust are detrimental to the health of any living organism which intakes them.

Several attempts have been made to minimize the percentage of unburned and partially burned fuel in exhaust fumes. One of the better known attempts consists of recirculating the exhaust fumes through the engine to permit a second opportunity to completely burn the fuel. There are several disadvantages of such systems. The exhaust fumes are very contaminated and therefore cause the engine to become dirty and decrease its efficiency. As the engine deposits become larger, the performance is decreased until the problem is magnified instead of corrected. Also, the recirculation system becomes contaminated and filled with deposits. Consequently the recirculation of the exhaust is greatly hampered and ultimately the system is practically useless.

These problems can be overcome only by frequent and regular maintenance of the engine and recirculation system. Because most vehicle owners are somewhat negligent in proper maintenance and are reluctant to suffer its expense, the existing systems are of little practical value.

It is therefore evident that the approach of treating the exhaust fumes is not the answer to the problem. A much better approach is found in the prevention, and minimization, of the expulsion of unburned and partially burned fuel. A system which prevents the full closing of the accelerator pedal when it is released and injection of excess fuel when the accelerator is fully opened is required to solve the air pollution problem. Such a system must be responsive to both the speed of, the changes in speed, of the vehicle. The control necessary from the system can be realized by controlling the accelerator pedal or the fuel control on the carburetor. Consequently, although in the following description of the inventive system reference is made to control of the accelerator pedal, it should be understood that the carburetor fuel control can also be used. For this reason, no mechanical linkage is described. Such a description is omitted because the necessary linkage is a func-

tion which can be accomplished in any of many ways within the purview of a skilled artisan.

In the design of such a system several important functions must be contemplated. Firstly, the system must automatically respond when a preselected velocity is reached. Also, the system must automatically release control when a velocity below the actuation velocity is returned to. The hysteresis resulting from different "cut in" and "cut out" velocities prevents the cutting in and out of the system which would occur at the preselected velocity in the absence of the hysteresis feature. The system must also respond to acceleration levels above a preselected level. The preselected level will depend upon the capabilities of the engine and the characteristics of the vehicle into which the system is incorporated.

Because of the dependence of both features of the system upon velocity, the system must contain a means of measuring this parameter. Several devices capable of doing this are available. Some of the available devices yield an output which has an amplitude which is proportional to speed. Other devices yield an output which has a frequency proportional to speed. The inventive system is designed to operate with the latter of these. Several such devices are available and therefore a full description need not be presented here.

It is therefore an object of this invention to provide a system which automatically responds to the velocity of a vehicle when it reaches a preselected level.

It is another object to provide such a system which automatically deactivates when a lower preselected velocity is returned to.

It is another object to provide such a system which automatically responds to the acceleration of a vehicle when it reaches a preselected level.

It is another object to provide such a system which responds to signals having a frequency proportional to the velocity of the vehicle.

It is another object to provide an electrical system which is used in conjunction with a system for minimizing the expulsion of unburned and partially burned fuel into the air by a vehicle powered by an internal combustion engine.

Further objects, features and advantages of the invention will become apparent from the following description and claims when read in view of the accompanying drawings, wherein like numbers indicate like parts and in which:

The FIGURE shows a preferred embodiment of the instant invention.

The circuit shown in the FIGURE is separated into two portions. A first portion, identified by reference numeral 11, is responsive to the velocity of the vehicle in which it is mounted. A second portion, identified by reference numeral 12, is responsive to the acceleration of the vehicle in which the system is mounted.

Velocity-sensitive circuit 11 includes a speed sensor 13. Sensor 13 as shown is merely a coil which yields an output signal to transistor Q_1 through diode D_1 . In an actual embodiment the speed sensor includes a magnet which rotates at a rate directly proportional to the velocity of the vehicle. An alternating current is therefore induced into coil 13. The frequency of the current is directly proportional to vehicle speed and is used to actuate the circuit 11, as will be more fully described hereinafter. The output from sensor 13 is coupled to the base of transistor Q_1 through a temperature-compensating diode D_1 . Transistor Q_1 is connected to operate as a limiter-amplifier. Its output is therefore a square wave having a frequency equal to that of the output of sensor 13.

The collector of transistor Q_1 is connected to capacitors C_1 and C_2 through lines 14 and 15, respectively. Capacitor C_1 is connected to the junction of diodes D_2 and D_3 . A capacitor C_2 is connected across the serial combination of resistor R_5 and diodes D_2 and D_3 . The parallel combination is connected to the A+ supply line 16 through biasing resistors R_3 and R_4 .

As the input to transistor Q_1 changes from positive to negative the collector of Q_1 varies from a low level to a much higher voltage level. Capacitor C_1 therefore receives a positive

square voltage from the collector of transistor Q_1 . Capacitor C_2 is continuously changed positively through resistors R_3 and R_4 . When the collector of transistor Q_1 is less positive, capacitor C_1 discharges through diode D_2 . When the collector becomes more positive capacitor C_1 charges through diode D_3 . The charging current is received from capacitor C_2 . When the collector becomes less positive again capacitor C_1 discharges and capacitor C_2 recharges through resistors R_3 and R_4 . When the frequency of the square wave from transistor Q_1 is low the charging of capacitor C_2 exceeds its discharge and the base of transistor Q_2 is held positive. Transistor Q_2 is then conducting and transistor Q_3 is held non-conducting by the negative potential on its base.

When the speed of the vehicle reaches the point where the discharging of capacitor C_2 exceeds the charging, the base of transistor Q_2 goes negative. The current in transistor Q_2 begins to decrease. The base of transistor Q_3 receives a positive current through resistor R_6 and consequently the current in transistor Q_3 begins to increase. The current of transistor Q_2 through resistor R_7 is limited by resistor R_6 when transistor Q_2 is conducting. The voltage across resistor R_7 is therefore very small. However, when transistor Q_3 begins to conduct the increased current raises the voltage drop across resistor R_7 . The emitter of transistor Q_2 is pulled positive and Q_2 is switched off. Transistor Q_3 is therefore switched on. Transistor Q_3 will remain on until transistor Q_2 is switched back on.

When transistor Q_3 is on current flows through coil K_1 . This coil then actuates a switch S_1 and the speed responsive portion of the system is in operation. It should be noted that switch S_1 merely represents the linkage between coil K_1 and the fuel control of the vehicle. Coil K_1 could also be used to operate a mechanical linkage connected to the accelerator pedal on the carburetor fuel control. These are features which can be added according to the desired use of the system and therefore need not be fully explained herein.

When the speed of the vehicle decreases to the speed required to turn transistor Q_2 off, transistor Q_2 would ordinarily turn back on because the base voltage is again sufficient to turn that transistor back on. However, transistor Q_2 will not conduct until the voltage on capacitor C_2 exceeds the total of the turn-on voltage and the voltage present on the emitter of transistor Q_2 . The emitter voltage is obtained from the tap of resistor R_8 which is in parallel with resistor R_7 . It should be noted that resistor R_8 can be eliminated and the value of resistor R_7 will accomplish the same purpose. The current of transistor Q_3 flows through this parallel combination and therefore serves to cause the cut-in voltage of the system to exceed the cutout voltage. The system therefore has a built-in hysteresis which prevents the system from jumping in and out when the vehicle is traveling near the cut-in speed. The differential in the "cut-in" and "cutout" speeds can be adjusted by the setting of resistor R_8 or the value of resistor R_7 if R_8 is eliminated. The cut-in speed can be adjusted by regulating the charging rate of capacitor C_2 . This can be done by changing the setting of resistor R_4 .

Transistor Q_4 , resistor R_9 and Zener diode D_5 are used to assure a regulated supply voltage. It should be noted that because the actuation voltage of transistor Q_2 is dependent upon the output of transistor Q_1 and because both of these transistors are subjected to the same biasing voltages as the charging and discharging capacitors, a regulated supply is not required for circuit 11. However, a regulated supply is preferable for the acceleration-responsive circuit 12.

It should be noted that in the absence of a requirement for an acceleration responsive circuit, velocity responsive circuit 11 can be used independently. This circuit will prevent the immediate full closing of the fuel control and thereby substantially decrease the expulsion of partially burned and unburned fuel. This is so because the coil K_1 and its associated linkage keep the engine running at a rate sufficient to burn the fuel injected into it but insufficient to interfere with the braking and normal slow down characteristics of the engine.

The speed at which velocity circuit 11 deactivates coil K_1 is above the speed at which the control attempts to hold the car. Consequently, the vehicle slows down normally even though the fuel control is not suddenly completely closed. When the cutout speed is reached, the velocity responsive circuit 11 is deactivated and the vehicle continues to slow down at its normal rate.

The operation of acceleration-responsive circuit 12 is also dependent upon the output of sensor 13, which it receives through transistor Q_1 and capacitor C_4 via line 15. The application of the square wave present on the collector of transistor Q_1 to the base of transistor Q_5 through capacitor C_4 results in a series of positive and negative pulses as an input to the base of transistor Q_5 . The output of transistor Q_5 is therefore a series of positive pulses having a width corresponding to the width of the input pulses. This width is a function of the decay time of capacitor C_4 and is therefore dependent upon the value of resistor R_{10} .

The output pulses from transistor Q_5 are of constant width and amplitude but have a frequency proportional to the speed of the vehicle. These pulses are fed to the base of transistor Q_6 through an integrator formed of resistor R_{12} and capacitor C_5 . The input to transistor Q_6 is therefore a DC voltage which has a level proportional to the speed of the vehicle. When the speed is above a selected level, for example, 15 m.p.h. transistor Q_6 is turned on and the acceleration-responsive portion is operative. The emitter of transistor Q_6 will follow the changes in the base voltage as it responds to speed changes. Consequently, the voltage drop across resistor R_{13} changes in direct proportion to the speed changes. This voltage is coupled to amplifying transistor Q_7 and resistor R_{18} through differentiating capacitor C_6 . The differentiated speed signal is, of course, proportional to the vehicle acceleration. This voltage tends to charge capacitor C_7 negative and is also amplified by field effect transistor Q_9 .

Initially, the base of transistor Q_8 is positive and, therefore, the current in transistor Q_8 is small. The junction 17 of resistor 20 and transistor Q_9 is positive because of transistor Q_9 current. The base of transistor Q_{10} is therefore also positive and it is conductive. Transistor Q_{11} is not conductive and coil K_2 is unenergized.

As the speed increases the signal coupled by capacitor C_6 increases. The greater the acceleration (rate of change of speed) the greater the signal. This signal is amplified by transistor Q_7 and increases transistor Q_8 current. Transistor Q_9 current decreases and the junction 17 of its collector and resistor 20 goes negative. This makes the base of transistor Q_{10} go negative and it turns off, resulting in current flow in transistor Q_{11} . Current then flows in coil K_2 and it actuates the linkage indicated generally as S_2 .

Transistors Q_{10} and Q_{11} are connected the same as transistors Q_2 and Q_3 . However, resistor R_{24} is selected such that the hysteresis band is held to a minimum.

Resistor R_{22} and capacitors C_7 and C_8 form a filter to desensitize the amplifier to wheel accelerations occasioned by poor road conditions. The acceleration-sensitive circuit 12 is biased by the A+ source through line 18. The circuit therefore receives a regulated voltage.

Diodes D_4 and D_7 , which parallel coils K_1 and K_2 , respectively provide a discharge path when the coils are deenergized.

Although this invention has been described with respect to particular embodiments thereof, it is not to be so limited, as changes and modifications may be made therein which are within the spirit and scope of the invention as defined by the appended claims.

The invention I claim is:

1. A system for minimizing the emission of unburned and partially burned fuel from a vehicle internal combustion engine having a fuel control comprising:

means for generating a signal proportional to the velocity of said vehicle;

a capacitor;