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Williams

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[54] **FUEL CONTROL SYSTEMS**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**^{2}...................... **F02B 3/00;** F02M 39/00

[58] **Field of Search**........ 123/32 EA, 139 E, 179 L, 123/179 G; 60/276

[56] **References Cited**

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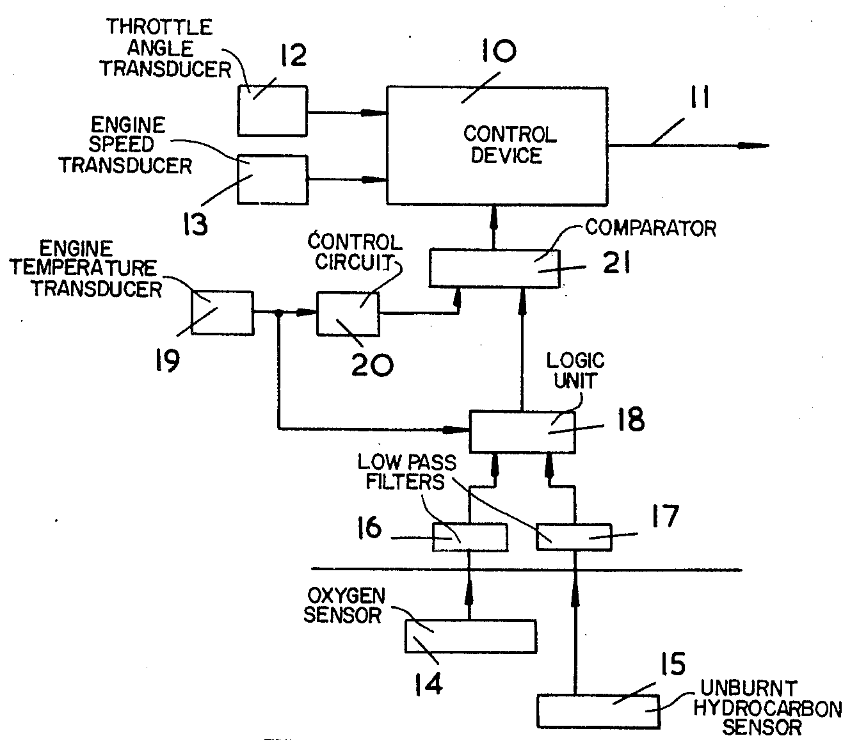
[57] **ABSTRACT**

A fuel control system for an internal combustion engine comprising sensing devices for sensing the quantities of oxygen and carbon monoxide or unburnt hydrocarbons in the engine exhaust emission, a temperature measuring device, a control device for controlling the rate of supply of fuel to the engine in accordance with at least one engine parameter and apparatus controlled by the sensing devices and by the temperature measuring device so as to modify the rate of fuel supply in accordance with the quantity of carbon monoxide or unburnt hydrocarbon in the exhaust emission when the engine temperature is below a predetermined value and in accordance with the quantity of oxygen in the exhaust emission when the engine temperature is above the predetermined temperature.

6 Claims, 2 Drawing Figures



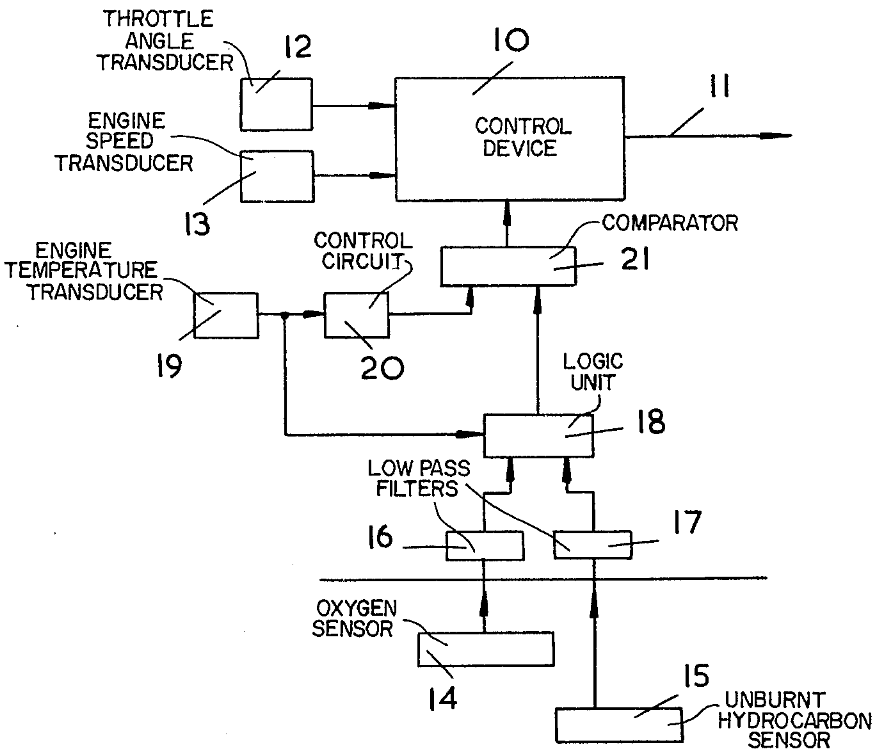

THROTTLE ANGLE TRANSDUCER
12
10
CONTROL DEVICE
11
ENGINE SPEED TRANSDUCER
13
COMPARATOR
21
CONTROL CIRCUIT
ENGINE TEMPERATURE TRANSDUCER
19
20
LOGIC UNIT
18
LOW PASS FILTERS
16
17
OXYGEN SENSOR
14
15
UNBURNT HYDROCARBON SENSOR

FIG.1

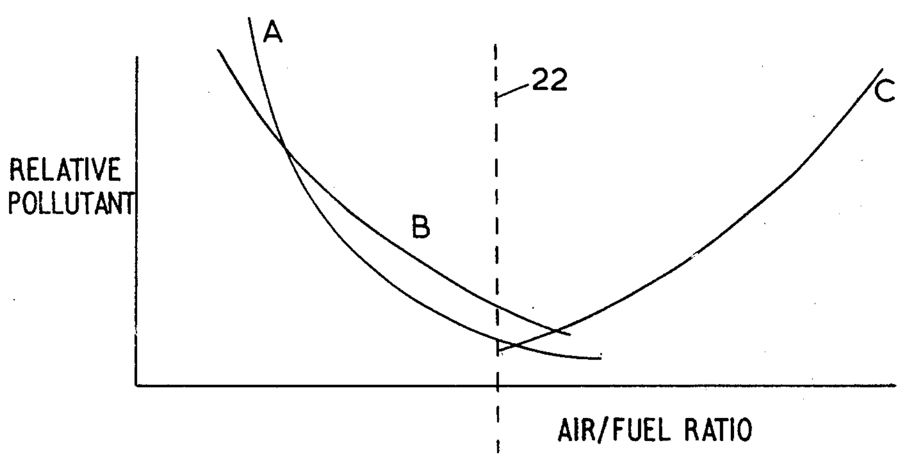

A
22
C
RELATIVE POLLUTANT
B
AIR/FUEL RATIO

FIG.2

FUEL CONTROL SYSTEMS

This invention relates to fuel control systems for use with internal combustion engines and has as its object the provision of such a system in a convenient form.

The invention resides in a fuel control system for use with an internal combustion engine comprising means for sensing the quantity of oxygen within the exhaust emission of the engine, means forsensing the quantity of carbon monoxide or unburnt hydrocarbon within the exhaust emission, means for measuring the temperature of the engine, and control means for controlling the rate of supply of fuel to the engine in accordance with at least one engine parameter and means for modifying the quantity of fuel fed to the engine in accordance with the quantity of carbon monoxide or unburnt hydrocarbon within the exhaust emission when the engine temperature is below a predetermined value and in accordance with the quantity of oxygen within the exhaust emission when the engine temperature is above said predetermined value.

The invention will now be more particularly described with reference to the accompanying drawings wherein:

FIG. 1 is a block circuit diagram illustrating one embodiment of a fuel control system according to the present invention, and

FIG. 2 is a graph of the relative pollutant in the exhaust emission of an engine plotted against the air/fuel ratio of the engine.

Referring to FIG. **1,** the fuel control system shown therein comprises a control device **10** which produces an electrical output pulse on a line **11** to an injector. The length of the electrical output pulse determines the time for which the injector allows fuel to pass from a pump into the engine, and hence the rate at which fuel is fed to the internal combustion engine. The control device **10** is programmed such that the length of the electrical output pulse is dependent upon the values of two engine parameters, namely the throttle angle and the engine speed and to this end a transducer **12** is provided for feeding the signal representative of the throttle angle to the control device **10,** and a transducer **13** is provided for feeding a signal representative of the engine speed to the control device **10.**

Means are also provided for modifying the length of the electrical output pulse in accordance with the nature of the exhaust emission of the internal combustion engine. Such means comprises an oxygen sensor **14** and an unburnt hydrocarbon sensor **15.** The sensors **14** and **15** produce electrical signals, the amplitude of which are representative of the quantity of oxygen within the exhaust emission and the quantity of unburnt hydrocarbon within the exhaust emission respectively. These signals are fed to low pass filters **16** and **17** respectively, which serve as averaging circuits, and the output of the two low pass filters **16** and **17** are fed to a logic unit **18.** A transducer **19** is provided for producing a signal representative of the engine temperature and this signal is fed on the one hand to the logic unit **18** and on the other hand to a control circuit **20.** The logic unit **18** connects the output from the low pass filter **17** to a first input of a comparator **21** when the output of the transducer **19** is below a predetermined value, representing a set hot engine temperature, and connects the output of the low pass filter **16** to said first input of the comparator **21** when the output of the transducer **19** is above said predetermined value. The control device **20** produces an output which varies in accordance with the engine temperature and which is representative of the required air/fuel ratio of the engine, and this output from the control circuit **20** is fed to a second input of the comparator **21.**

Now referring to the graph shown in FIG. **2,** B is a curve of unburnt hydrocarbon content of the exhaust emission plotted against air/fuel ratio, and C is a curve of oxygen content of the exhaust emission plotted against air/fuel ratio. Thus, it will be seen that when the air/fuel ratio is on the rich side of the stoichiometric line (indicated by the reference numeral **22** in FIG. **2**) a measure of the unburnt hydrocarbon content in the exhaust emission will produce a signal representative of the air/fuel ratio of the engine, and when the air/fuel ratio is on the lean side of the stoichiometric line **22** then the measure of the oxygen content in the exhaust emission will produce a signal representative of the air/fuel ratio of the engine. Now in practice, the air/fuel ratio of the engine will only be on the rich side when the engine temperature is low that is to say during initial warm-up of the engine, and once the engine temperature has achieved its normal operating temperature then air/fuel ratio will be on the lean side of the stoichiometric line **22.** Thus, during engine warm-up the logic unit **18** connects the unburnt hydrocarbon sensor **15** to said first input of the comparator **21** which compares the actual air/fuel ratio of the engine with the required air/fuel ratio of the engine and produces an output which is connected to the control device **10** for modifying the length of the electrical output from the device **10** and thereby adjusting the quantity of fuel fed to the engine. When the engine has reached its normal operating temperature, the logic unit **18** connects the oxygen sensor **14** to said first input of the comparator **21** and once again the electrical output pulse of the device **10** is modified in accordance with the difference between the signals of the two inputs of the comparator **21.**

Finally, it is to be appreciated that instead of using an unburnt hydrocarbon sensor, a carbon monoxide sensor could be used, A being a curve of carbon monoxide content of the exhaust emission plotted against air/fuel ratio.

The invention may also be applied to fuel system in which a variable speed fuel pump continuously injects fuel into the engine air intake at a rate determined by the control system.

I claim:

1. A fuel control system for an internal combustion engine comprising means for sensing the quantity of oxygen within the exhaust emission of the engine, means for sensing the quantity of carbon monoxide or unburnt hydrocarbon within the exhaust emission, means for measuring the temperature of the engine, control means for controlling the rate of supply of fuel to the engine in accordance with at least one engine parameter, and operation means coupled to said engine temperature measuring means and to said control means for modifying the quantity of fuel fed to the engine in accordance with engine temperature and the quantity of carbon monoxide or unburnt hydrocarbon within the exhaust emission when the engine temperature is below a predetermined value and in accordance with the quantity of oxygen within the exhaust emission when the engine temperature is above said predetermined value.

2. A fuel control system as claimed in claim 1 in which said means for sensing the quantity of oxygen and said means for sensing the quantity of carbon monoxide or unburnt hydrocarbon, each comprises a sensing device which produces an electrical output signal the amplitude of which is representative of the quantity of the appropriate gas.

3. A fuel control system as claimed in claim 2 including a low pass filter for each sensing device connected to reject high frequency components in said electrical output signals.

4. A fuel control system as claimed in claim 1 wherein said operation means includes logic means coupled to said engine temperature measuring means and to said oxygen sensing means and the sensing means for carbon monoxide or unburnt hydrocarbons for passing a signal from a selected one of said sensing means depending on whether the engine temperature is above or below said predetermined value.

5. A fuel control system as claimed in claim 4 wherein said operation means further comprises a comparator connected to said logic means for receiving the signal passed thereby, and means coupled to said engine temperature measuring means and to said comparator to provide a second signal to the comparator indicative of the required air/fuel ratio at the particular engine temperature which is measured.

6. A fuel control system as claimed in claim 1 wherein said control means includes means for making the air/fuel ratio relatively rich when engine temperature is low and for making the air/fuel ratio relatively lean when engine temperature is high.

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