United States Patent [19]

Bachle

[11] **3,742,924**

[45] **July 3, 1973**

[54] **CONTROL OF AIR-FUEL RATIO**

[75] Inventor: **Carl F. Bachle,** Grosse Pointe Farms, Mich.

[73] Assignee: **Teledyne Industries, Inc.,** Los Angeles, Calif.

[22] Filed: **Feb. 24, 1972**

[21] Appl. No.: **228,943**

[52] **U.S. Cl.** ... **123/119 R,** 123/119 E, 261/DIG. 68

[51] **Int. Cl.** **F02m 7/12,** F02m 7/16

[58] **Field of Search** ..... 123/119 R, 119 E; 73/25, 27; 261/DIG. 67

[56] **References Cited**

UNITED STATES PATENTS

1,702,433	2/1929	Griffon	261/DIG. 67
1,840,279	1/1932	Sturm	261/DIG. 67
1,857,889	5/1932	Sturm	261/DIG. 67
1,984,382	12/1934	Prentiss	261/DIG. 67
1,993,665	3/1935	Holt	73/25
2,023,647	12/1935	Schmid	261/DIG. 67
2,255,551	9/1941	Willenborg	73/27 R
2,752,136	6/1956	Gardner	261/DIG. 67

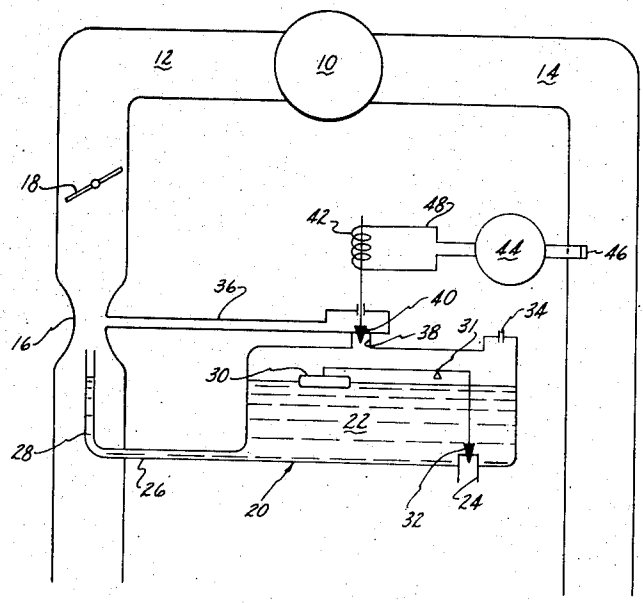
Primary Examiner—Wendell E. Burns

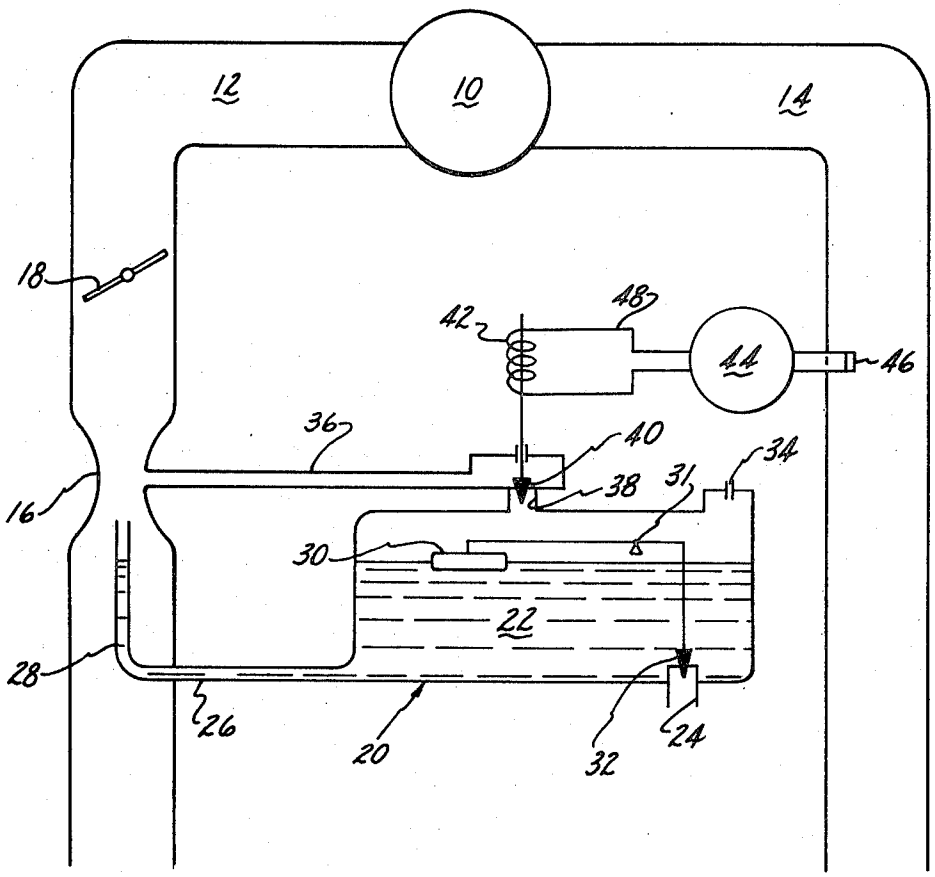
Attorney—Robert C. Hauke, Ernest I. Gifford et al.

[57] **ABSTRACT**

A device for controlling the air-fuel ratio in an internal combustion engine wherein the rate of fuel flow from the float chamber to the air stream in the venturi of a carburetor is modified by a pressure modifying tube joining the float chamber and the venturi, a valve in said tube being responsive to the thermal conductivity of the exhaust gases in the exhaust pipe of the engine.

1 Claim, 1 Drawing Figure




12
10
14
18
42
48
44
46
36
40
34
38
31
16
30
22
28
26
20
32
24

CONTROL OF AIR-FUEL RATIO

BACKGROUND OF THE INVENTION

The extent and control of the combustion which takes place in an internal combustion engine has been the subject of extensive research for more than half a century with a principal objective of achieving high engine efficiency at the lowest possible fuel cost. In recent years ecologists, concerned with air pollution by carbon monoxide and unburned hydrocarbons, have given an added impetus to such research.

Attempts have been made to control the air-fuel ratio in a combustion process by sensors which measure one or more of a number of parameters; temperature, pressure, density of smoke, and the like. By way of example, Pierce, in U.S. Pat. No. 2,562,507, describes the passing of a light beam through the exhaust gases in a flue in order to sense the density of smoke; a high density of smoke effecting the opening of a valve which increases the proportion of air in a combustion chamber. Bollo, in U.S. Pat. No. 2,773,349, describes the sampling of an exhaust gas, the oxidation of the sample, and the analysis of the resulting oxidized exhaust gases in an infrared cell, and further describes the generation of a signal from the analyzer which, via electronic and mechanical means, actuates a valve in a fuel line. Again by way of example, Willenborg in U.S. Pat. No. 2,255,551 describes a sensor which analyzes a gas mixture by measuring its thermal conductivity.

The prior art devices which use sensors to control air-fuel ratios in internal combustion engines are generally characterized by their complexity and "round-about" method of controlling either air flow, fuel flow, or both.

SUMMARY OF THE INVENTION

The present invention takes advantage of the fact that liquid fuel in the typical carburetor flows from the float chamber to a venturi in the air line in response to a pressure differential. Control of fuel flow is achieved in the present invention by modifying the latter pressure differential responsively to changes in the thermal conductivity of, and hence the chemical analysis of, exhaust combustion gases in the exhaust pipe of the engine. Therefore, in an internal combustion engine provided with an exhaust pipe for exhaust gases and provided with a carburetor comprising a venturi and a float chamber, the inventive improvement comprises: (a) a pressure modifying tube joining said venturi and said float chamber, (b) a valve in said tube, said valve being provided with a solenoid for controlling the movement of said valve, and (c) a thermal conductivity sensor positioned in said exhaust pipe and electrically cooperative with said solenoid; wherein the position of said valve and the ratio of air to fuel provided to said engine by said carburetor is responsive to the thermal conductivity of said exhaust gases.

DESCRIPTION OF THE DRAWING

The accompanying drawing illustrates, schematically, a preferred embodiment of the invention. With specific reference to the drawing, an internal combustion engine **10** is provided with an inlet manifold **12** for the supplying of an air-fuel mixture and is provided with an exhaust pipe **14** for the discharge of exhaust combustion gases. A venturi (choke tube) **16** leads into the manifold **12** via a throttle valve **18.**

A carburetor, indicated generally at **20,** comprises a float chamber **22,** an inlet **24** for fuel, and a fuel outlet **26** leading to a fuel jet **28** positioned in a manner to deliver fuel to the venturi **16.** The float chamber **22,** further, is provided with a float **30** which cooperates with a valve **32** in the fuel inlet pipe **24** to maintain fuel at a predetermined level. A bleed orifice **34** is provided for relatively slow adjustment of the pressure in the float chamber **22** to ambient pressure outside the carburetor. A pressure modifying tube **36** joins the venturi **16** with a pressure modifying opening **38** in the float chamber **22.** The latter opening **38** is provided with a valve **40** which is mounted for reciprocal motion in a solenoid **43** responsively to changes in the current in the solenoid.

A sensor; in addition to the usual power source, amplifier, and standard electrical components (not shown); comprises a thermal conductivity cell **46** positioned in the exhaust pipe **14** and comprises an electrical circuit **48** which includes the windings of the solenoid **42.**

DESCRIPTION OF OPERATION

Liquid fuel enters the float chamber **22** of the carburetor **20** via the fuel opening **24.** A float **30** in cooperation with valve **32** via a pivot point **31** controls the level of the fuel. Air is drawn into the manifold **12** via the venturi **16** and past the throttle valve **18** because of the relatively low pressure in the manifold. Liquid fuel is sprayed into the air stream because of the relatively lower pressure in the venturi **16** as compared to the pressure in the float chamber **22.** Combustion of the fuel occurs in the engine **10** and exhaust gases pass through the exhaust pipe **14.**

The sensor **44** is initially calibrated against the thermal conductivity of mixtures of gases normally found in engine exhaust. In this connection it is necessary to measure the thermal conductivity of mixtures from, on the one hand, an exhaust mixture resulting from combustion under very lean conditions to, on the other hand, an exhaust mixture resulting from combustion under very rich conditions. A thermal conductivity sensor such as described in the above mentioned U.S. Pat. No. 2,255,551 or any one of a number available commercially can be used.

The sensor circuit **48** is constructed such that a relatively large current flowing therein reflects the presence of a relatively high proportion of carbon monoxide and unburned hydrocarbons in the exhaust pipe or, in other words, reflects the need for relatively more air in the air-fuel mixture. The current in circuit **48** causes the solenoid to open the valve **40** in the pressure modifying opening **38.** Opening the valve **40** permits modification of; that is, tends to decrease; the pressure differential between the venturi **16** and the float chamber **22.** As the pressure in the float chamber **22** approaches the pressure in the venturi **16,** relatively less fuel is sprayed into the air stream entering the manifold **12.** The resulting air-fuel mixture contains relatively more air and there is a reduction, in the exhaust pipe **14,** of carbon monoxide and unburned hydrocarbons.

Similarily, and if the valve **40** is wide open, the resulting excessively lean conditions will lead to a small, or zero, current in the circuit **48** and the closing of the valve **40.**

The position of the valve **40** (vertically, as shown) can be predetermined such that the valve **40** will be

slightly opened to a point of maximum sensitivity to small changes in thermal conductivity of the exhaust gases at a predetermined optimum analysis of the exhaust gases. In this manner the air-fuel ratio is made responsive to the analysis of the exhaust gases.

It is apparent that changes and modifications can be made in the embodiment described without departing from the spirit or scope of the invention.

I claim:

1. In an internal combustion engine provided with an exhaust pipe for exhaust gases and provided with a carburetor comprising a venturi and a float chamber, the improvement which comprises:

a. a pressure modifying tube joining said venturi with said float chamber,

b. a valve in said pressure modifying tube and provided with a solenoid for controlling the opening and closing thereof, and

c. a current generating, gas thermal conductivity sensor positioned in said exhaust pipe and electrically cooperative with said solenoid;

wherein the position of said valve and consequently the ratio of air to fuel provided to said engine by said carburetor is responsive to the thermal conductivity of said exhaust gases.

* * * * *