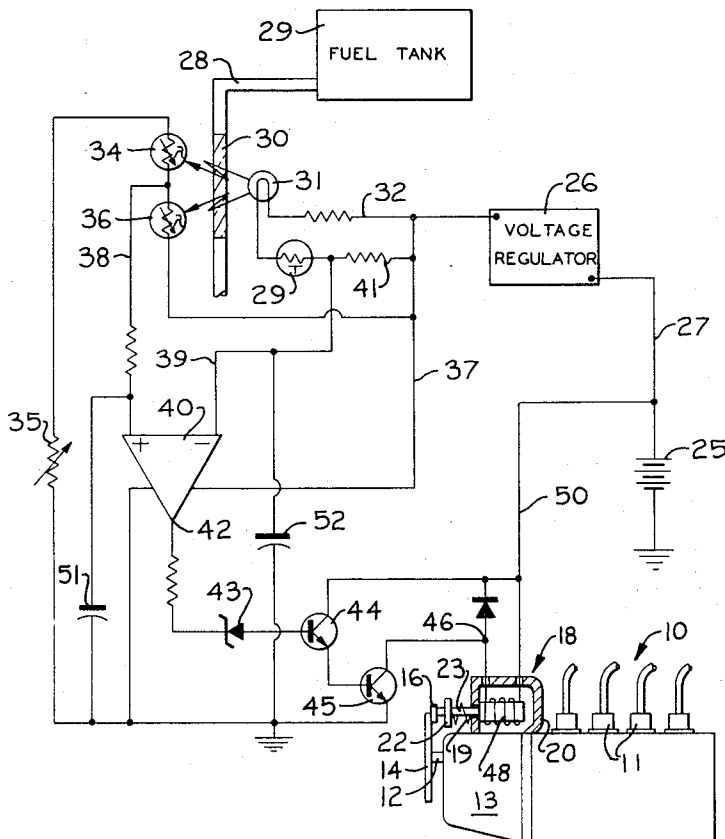
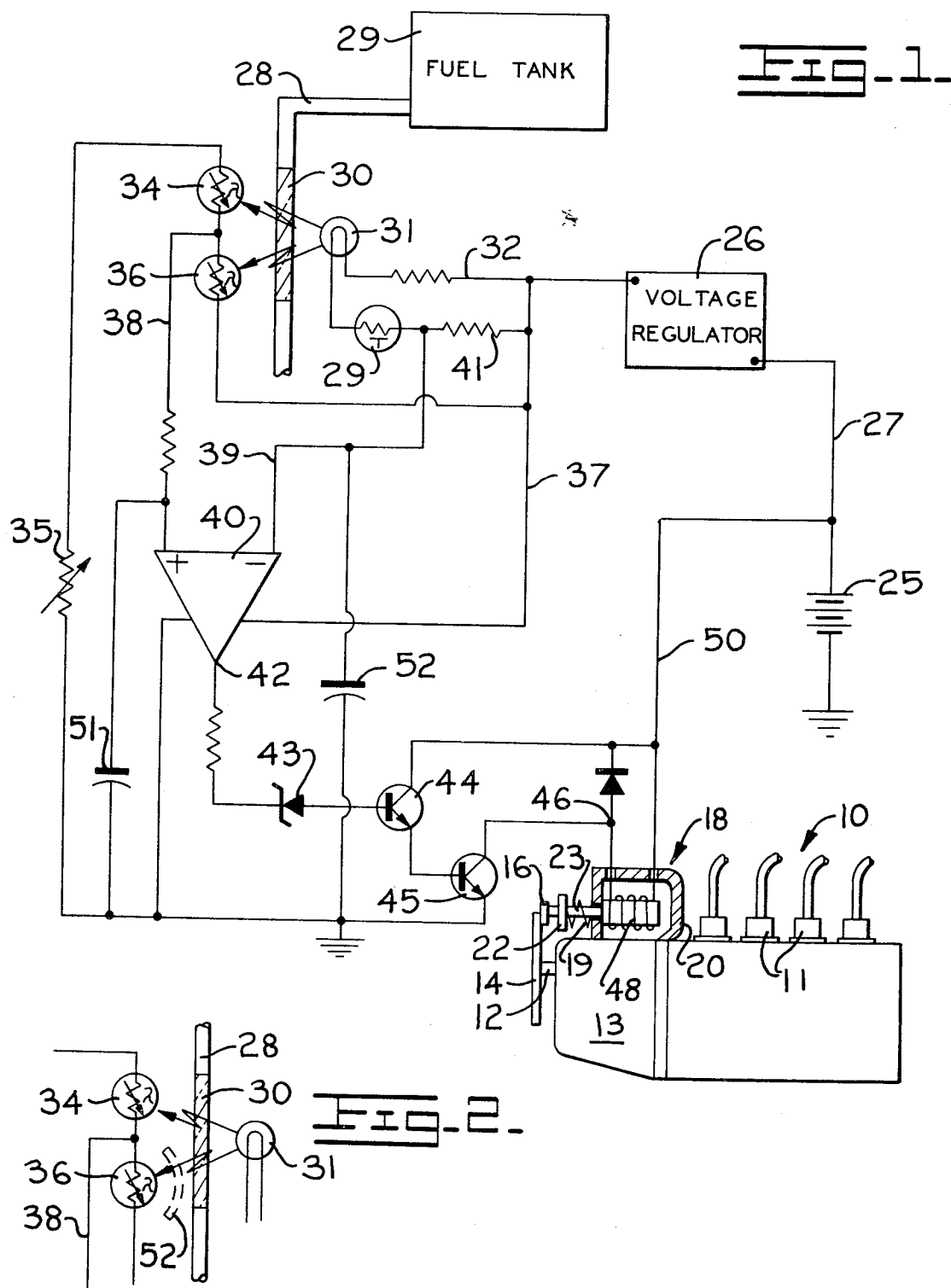






INVENTORS
JOHN L. HOFFMAN
GERALD E. WHITEHURST

BY
Fryer, Ginnard, Feix, Phillips & Lemus
ATTORNEYS

AUTOMATIC ADJUSTMENT FOR FUEL RACK STOP

BACKGROUND OF THE INVENTION

The present invention relates to multi-fuel engines, and pertains more particularly to control means to vary the quantity of fuel delivered to the combustion chambers and an engine automatically, in response to the light transmission characteristics of fuel.

In many engine uses, especially Military uses, it is desirable that the engine be capable of operating on several different types or grades of fuel, such as combustion, ignition, turbine engine fuel referred to as CITE and diesel engine fuel. Since the heat value of these different fuels vary, for a given volume, it is necessary that the volume of fuel injected into the engine be adjusted when changed from CITE to diesel or vice versa in order to get the optimum efficiency from the engine. Failure to properly adjust the fuel can result in loss of power or in excess heat being generated which may damage the engine.

For this reason means are often provided on multi-fuel engines to effect a different setting at the fuel injection pumps which permit the injection of more or less fuel to maintain the maximum output regardless of the type of fuel used. These adjusting means may be either manual or automatic. Manual means are not always desirable because it permits the operator the option of using a normally low heat value fuel setting with a relatively higher heat value fuel which permits the engine to run at a power level higher than is desirable for proper engine operation and life. Automatic adjusting means which sense the heat value of fuel for a given volume are often expensive to manufacture and complex in their construction and operation.

SUMMARY AND OBJECTS OF THIS INVENTION

A primary object of the present invention is to provide means which is responsive to color variations of different fuels such as CITE and diesel fuel for automatically altering the quantity of fuel injected into the engine.

Another object of the present invention is to provide simple and reliable means which operate in response to light transmission characteristics of fuel for altering the adjustment of fuel injection systems to thereby alter the quantity of fuel injected in the engine.

A further object of the present invention is to provide means which is responsive to light transmission characteristics of fuel for altering the adjustment of a fuel injection system for an engine.

In accordance with the present invention, control means which are responsive to the variations in the color of fuel when color is an indication of the heat value for a given volume of the fuel are provided which is responsive to such variations for initiating a signal which is effective to control a setting of a fuel injection system.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic view of the light transmission sensitive system of the present invention shown operatively connected to a fuel injection mechanism of an internal combustion engine; and

FIG. 2 is an alternate embodiment of a light transmission sensitive element of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and in particular to FIG. 1, there is illustrated a schematic layout of the present invention in combination with a fuel injection system for an internal combustion engine. The present invention is shown in conjunction with a fuel injection pump assembly 10 of the type having a plurality of pumps 11 which are driven in a conventional manner to provide fuel to each of a plurality of engine cylinders (not shown). A rack bar 12 operatively connects the pumps 11 to a governor 13. The control rack 12 has an extension 14 which is adapted to engage a moveable stop 16 which is positioned in a manner hereinafter described, to prevent an excessive amount of fuel to be delivered to the engine. The moveable stop 16 is operatively connected to control means such as a solenoid 18 and is extended or biased to its leftward or full load position by means such as a spring 19 disposed between housing 20 and a shoulder 22 of control rod 23. This leftward, full load position, is a maximum power output setting for the engine when a particular fuel such as a relatively dark, high heat value fuel such as diesel fuel is being used. When a different heat value fuel is being used, for example, a relatively clear, lower heat value fuel such as CITE fuel, the stop position would be moved to the right to allow a larger amount of fuel to be delivered to the engine cylinders to obtain an equivalent power output. This setting is obtained automatically by means of the light transmitting sensitive response control means as will be described below.

Means for controlling the above-described linkages comprise an electrical circuit having means responsive to light transmission characteristics of fuels for initiating a signal which is then used to alter the position of the rack stop. The circuit includes a suitable electrical source 25 connected by a suitable conductor 27 to a voltage regulator 26. A fuel line 28 is operatively connected for conducting a fuel from a suitable tank 29 to the pump assembly 10. The fuel line 28 includes a suitable transparent portion or section 30 through which the fuel must flow. A suitable light source 31 is supplied with current from a conductor line 32 from regulator 26 and radiates light through the transparent section or portion 30 of the fuel line 28. The light waves which pass through the fuel are then detected by photo sensors 34 and 36, each having a different spectral response and positioned on the opposite side of transparent portion 30 from the light source 31. The photo cells 34 and 36 form part of a bridge whose output is through a conductor line 38 and communicates with a differential amplifier 40 which acts as a comparator. A conductor 39 is connected to regulator 26 and includes the resistor 41 for enabling a reference voltage to be established at comparator 40. The comparator 40 may be a suitable operational amplifier of a well known type and is connected by means of a conductor 37 to a suitable power supply. A suitable variable resistor 35 is provided in the bridge circuit between photo cell or sensor 34 and ground for the purpose of balancing the circuit. The reference voltage through 39 is taken from between a pair of resistors 29 and 41 with resistor 29 being preferably temperature compensated. The photosensitive elements 34 and 36 may preferably be of the electrical resistance type that vary the resistance with the amount of light or to different light rays so as to

alter the bridge circuit in response to changes in light received.

The output at 42 of the amplifier 40 is connected through a Zener diode 43 which is in turn connected to the base of a driver transistor 44. The driver transistor 44 has one terminal of the emitter collector circuit to electrical source 25 to the other terminal connected to the base of a transistor 45. The emitter collector circuit of transistor 45 has one terminal connected to one terminal of the circuit of solenoid 18 and the other terminal connected to the ground so that when a transistor 45 is activated the solenoid circuit including conductor 50 from electrical source 25 is completed thereby energizing the solenoid 18. When the coils 48 of the solenoid 18 are energized the control rod for stop 16 is moved to the right permitting the rack 12 to adjust the pumps 11 for delivery of the increased fuel to the engine.

When a colorless fluid such as CITE fuel flows through line 28 through transparent section 30, light from the source 31 is transmitted over a broad range of the optical spectrum which encompasses the spectral peaks of both photo cells 34 and 36. With such a relatively clear fluid flowing through the lines 28 a conductance through sensor 36 is greater than through resistance 41 so that the output 42 of the comparator 40 is positive. A positive voltage at output 42 causes a current flow through the Zener diode 43 triggering transistor 44 which in turn activates transistor 45 permitting the ground to be completed to terminal 46 of solenoid windings 48 which are supplied current from the line 50 of battery 25. This activates the solenoid 18 which in turn moves rack stop 16 to the right permitting rack 12 to move to the right to adjust the pumps 11 for greater fuel input into the engine.

When a fuel such as diesel fuel flows from tank 29 through line 28 its darker coloring will block transmission of short wave lengths but allow longer wave lengths to pass through the sensor 34. A greater conductance then takes place through sensor 34 than through sensor 36. With the increase in resistance in sensor 36, the bridge balance is changed so as to have a greater voltage drop between 39 and 38 causing the comparator 40 to switch polarity so that the output at 42 is negative. With this change in polarity a current flow no longer takes place through diode 43, thus no activating current reaches driving transistor 44 or transistor 45. This opens the ground circuit of the solenoid windings 48 releasing the solenoid and urging the rack 12 leftward to a decreased fuel or diesel position. Suitable capacitors 51 and 52 may be provided in the circuit to protect against transient voltage fluctuations.

Referring now to FIG. 2, there is illustrated a modification of the light transmission sensing means in which suitable means such as a filter 52 is placed between one of the photosensitive elements such as 36 and the source of light 31 so as to modify the response of the system to the fuel used. Thus the filter 52 operates to shield the photosensitive element 36 from a portion of the light which is permitted to pass through the transparent section 30 of the fuel line. Thus it is clear that the present invention operates on the principle that fuels having different heat values per volume relative to their coloring will likewise have different light transmitting characteristics.

This principle applies whether the color or light transmitting qualities occur naturally or are artificially

induced. It is well known, for example, that aviation fuels and some auto fuels are color coded to indicate grade or octane rating. It may be necessary in each case to calibrate the control system for a given class of fuels.

As can be seen from the above description there is disclosed a fuel control system comprising means responsive to the coloring or transparency of a fuel which means is responsive to initiate a signal. The signal being used to activate a control circuit for the adjusting of the fuel setting for an engine.

We claim:

1. Control means for controlling the amount of fuel supplied to an internal combustion engine in accordance with the heat value of said fuel, said control means comprising:

means for measuring said heat value of said fuel, said measuring means including:

- a. a source of light energy;
- b. means for directing light from said source through at least a sample of fuel to be supplied to said engine;
- c. means responsive to said light transmitted through said fuel to initiate a signal; and, means responsive to said signal to energize adjusting means to adjust the amount of fuel supplied to said engine.

2. The system of claim 1 wherein said light responsive means comprises a photosensitive cell.

3. The system of claim 1 wherein said light responsive means comprises a pair of photosensitive cells; each of said cells are operative to alter one branch of an electrical bridge circuit in response to said light, and

said bridge circuit is operatively connected to control means for energizing stop positioning means for a fuel control rack.

4. The system of claim 3 wherein said stop positioning means comprises a solenoid.

5. The system of claim 3 wherein each of said photosensitive cells has a different spectral response.

6. The system of claim 3 comprising a filter positioned between one of said cells and said light source to alter the response of said cell.

7. A fuel control system for controlling the amount of fuel supplied to an internal combustion engine, said control system comprising:

- a source of fuel;
- means for supplying a quantity of said fuel to an engine;
- means for measuring the heat value of said fuel, said measuring means comprising:

- a. a source of light energy;
- b. means for directing light from said source through at least a sample of said fuel supplied to said engine; and,
- c. means comprising a photosensitive cell responsive to said light transmitted through said fuel to initiate a signal proportional to said light; and, means responsive to said signal to energize adjusting means to adjust the amount of said fuel supplied to said engine.

8. The fuel control system of claim 7 wherein said light responsive means comprises a pair of photosensitive cells, each having a different spectral response; each of said cells are operative to alter one branch of an electrical bridge circuit in response to said light; and

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said bridge circuit is operatively connected to control means for energizing stop positioning means for a fuel control rack.
9. The fuel control system of claim 8 wherein said stop positioning means comprises a solenoid.

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10. The fuel control system of claim 9 comprising a filter positioned between one of said cells and said light source to alter the response of said cell.
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