United States Patent [19]

Frederiksen et al.

[11] **3,742,256**

[45] **June 26, 1973**

[54] **FUEL PUMP DRIVER CIRCUIT**

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[22] Filed: **Oct. 15, 1971**

[21] Appl. No.: **189,580**

[52] **U.S. Cl.** ..... **307/254**, 123/32 EA, 307/299, 307/293

[51] **Int. Cl.** **H03k 17/30**

[58] **Field of Search** ..... 307/254, 299, 293; 123/139 EA, 139 E, 139 ST, 119

[56] **References Cited**

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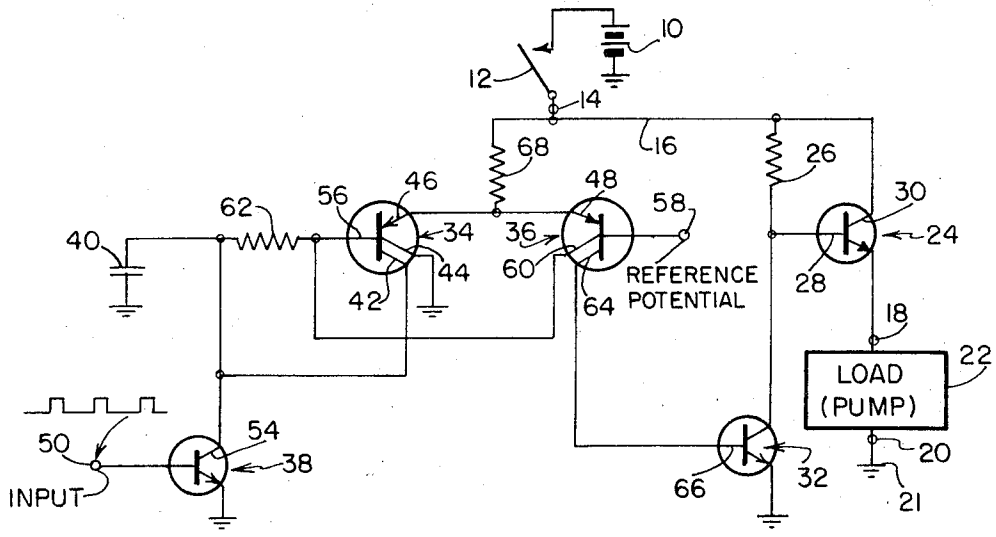
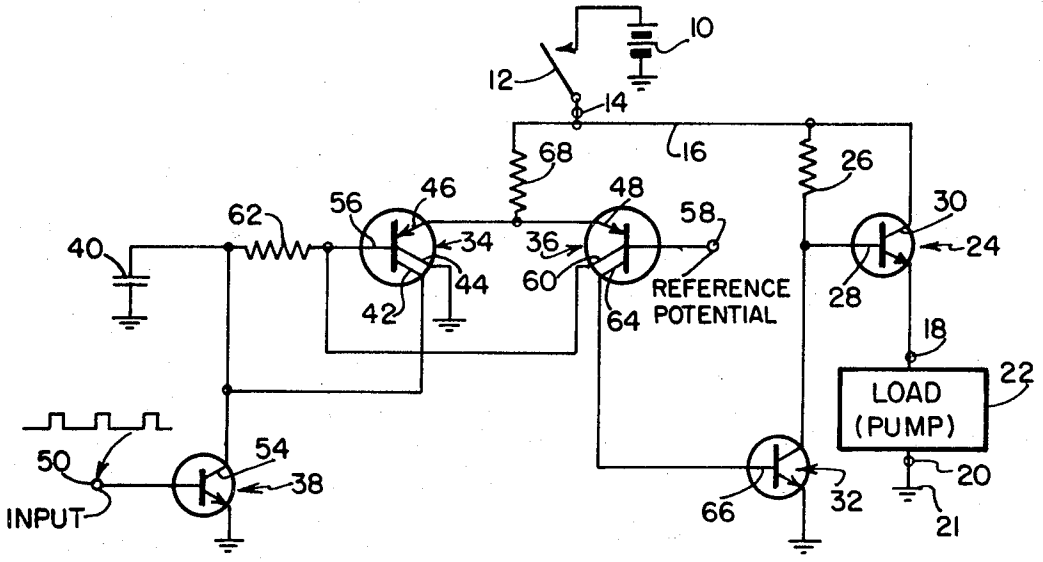
[57] **ABSTRACT**

A fuel pump driver circuit for an internal combustion engine includes a voltage supply which energizes the fuel pump through an output or switch transistor. The output transistor is turned off to stop the pump by a control transistor, which is controlled by a differential amplifier or switch. The voltage supply is coupled through the ignition switch of the engine to the circuit, and the differential switch is in the on condition and causes the output transistor to conduct to energize the fuel pump. A capacitor is coupled to the differential switch and is charged thereby to actuate the differential switch to the off condition to turn off the current to the fuel pump. When a signal responsive to the engine turning over is received, an input transistor discharges the capacitor and the differential switch is maintained in the on condition with one transistor thereof conducting and the current supply coupled to the fuel pump. Should the engine signal cease, the capacitor charges so that the differential switch actuates the control transistor to shunt the bias potential from the control electrode of the output transistor which applies the current to the fuel pump.

10 Claims, 1 Drawing Figure

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REFERENCE
POTENTIAL
28
42
64
18
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LOAD
(PUMP)
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38
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INPUT
66
32
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FUEL PUMP DRIVER CIRCUIT

BACKGROUND OF THE INVENTION

Safety devices for all types of internal combustion engines have lead to a number of specific requirements. These include requirements related to the control of fuel supplied to the engine where there has been a collision, or where the engine stalls.

Specifically, one such requirement is the cessation of supplying fuel when the engine fails to start within a designated amount of time. Another, requires the cessation of fuel supply where the engine ceases to operate for a specified time as a result of a collision or some malfunction of the engine. These operations by definition must be automatic.

Where electronic circuitry is utilized in controlling a fuel pump driver circuit, there is the additional problem of maintaining a constant fuel supply to the engine during starting as well as during normal operation, regardless of engine speed.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a safety device to be utilized in connection with the fuel supply for an internal combustion engine.

It is another object of this invention to provide means for uncoupling the driving current from a fuel pump when the engine stops operating for a designated period of time.

It is a further object of this invention to provide means for uncoupling the driving potential from a fuel pump driver after the ignition switch has been turned on, when the engine fails to start in a designated period of time.

A fuel pump driver circuit for an internal combustion engine includes a current supply coupled through the ignition switch to an output transistor which is coupled to the fuel pump. The control electrode of the output transistor is coupled through a resistance to the ignition switch and also to the output electrode of a control transistor. The control transistor is controlled by a differential switch which includes first and second transistors, each having two collector electrodes. A reference potential is coupled to the control electrode of the first transistor and this transistor which fully conducts with the differential switch in the off condition. The first collector of this transistor is coupled to the control electrode of the control transistor, and the second collector is connected to the control electrode of the second transistor, which is fully conducting in the on condition. The control electrode of the second transistor is connected to a storage capacitor and to the output electrode of an input transistor, which input transistor receives a signal when the engine is operating. One collector of the second transistor is also connected to the storage capcitor to charge the same.

With the ignition switch initially turned on, the voltage supply is coupled to the differential switch causing the same to function in the on condition to supply power to the fuel pump driver circuit. With no engine operating signal being received by the input transistor, the storage capacitor charges and turns off the second transistor, whereupon the first transistor conducts fully and the control transistor shunts current to reference ground potential to bias off the output transistor, thus removing power from the fuel pump circuit.

BRIEF DESCRIPTION OF THE DRAWING

The FIGURE is a schematic diagram of the fuel pump driver circuit of the present invention.

DETAILED DESCRIPTION

Referring to the FIGURE, the fuel pump driver circuit is energized by a current supply **10** which may be energized by a battery, and which is connected through the ignition switch **12** to terminal **14.** Output or load terminals **18** and **20** are provided for connection to the load, i.e., fuel pump **22,** with terminal **18** being connected by output transistor **24** to terminal **14,** and terminal **20** being connected to the reference ground potential **21.** Resistor **26** is connected between terminal **14** and base **28** of output transistor **24.** With the circuit energized, base **28** is biased with respect to collector **30** and transistor **24** conducts, supplying current to the pump to drive the same so that fuel is supplied to the engine.

The conduction of transistor **24** is controlled by NPN control transistor **32** which has its collector connected to base **28** of transistor **24,** its emitter connected to ground reference potential, and its base **66** connected to collector electrode **64** of transistor **36.** Transistor **32** is initially in a state of nonconduction, and is controlled by the differential switch including multiple collector transistors **34** and **36.** With transistor **36** fully conducting, the differential switch is in the off condition and causes the control transistor **32** to conduct to turn off the output transistor **24.** Capcitor **40** is connected to the base of transistor **34** of the differential switch, and when the voltage supply **10** is initially coupled to the driver circuit, capacitor **40** is in a discharged condition and transistor **34** conducts. Accordingly, the differential switch is in the on condition. In such condition, the collector **42** of transistor **34** supplies charging current to capacitor **40.** The time necessary for the capacitor **40** to charge, and thus, the time before power is disconnected from the load, with no input signal, is a function of the collector ratios of transistor **34** and the bias current supplied through resistor **68** to the emitters **46** and **48** of the respective PNP transistors **34** and **36.** When the engine is turning over, a signal which may comprise recurring pulses is produced and applied through input terminal **50** to the base of transistor **38** to cause the same to conduct. A magnetic sensor or some other device may produce such a signal dependent upon the engine turning over.

The pulses at terminal **50** periodically turn on transistor **38** to cause the same to conduct, to reduce the potential at the collector **54,** resulting in the discharge of capacitor **40** through transistor **38** to the ground. This causes a reduction in the potential at the base electrode **56** of transistor **34.** As a consequence, transistor **34** conducts to drop the emitter potential to reference ground potential, thus shunting the bias current from the emitter **48** of transistor **36.** With the differential switch in the on state, i.e., transistor **34** conducting and transistor **36** conducting, current is applied to the pump **22** through transistor **24.** As long as transistor **34** continues to conduct, the coupling of the voltage supply **10** to the load **22** continues.

The absence of an input signal at input terminal **50,** indicating that the engine is not turning over, removes the shunt across capacitor **40** provided by transistor **38.** Capacitor **40** therefore charges and the potential of

base 56 increases to the value of the reference potential applied to the base terminal 58. With the potential at base 56 equal to the reference potential, the output from collector 60 of transistor 36, which is coupled to base 56, charges the capacitor 40 through resistor 62, thus providing a regeneration voltage across resistor 62 which tends to drive the transistor 34 further off and transistor 36 further on.

With transistor 36 being further turned on, collector 64 thereof supplies current to base 66 of transistor 32 to turn on the same. This completes the path for current from terminal 14 through resistor 26 to provide a voltage across resistor 26 which turns off transistor 24 to uncouple power from the load.

The circuit time delay in uncoupling the voltage supply from the pump 22 can be varied by utilizing different values of bias resistance 68. The particular circuit shown in the diagram has the collector 44 coupled to the reference ground potential to increase the time delay of the circuit. The provision of the two collectors 42 and 44 in transistor 34 is necessary for geometrically matching the transistors 34 and 36 as closely as possible for balancing the differential switch.

Transistors of the opposite conductivity type may be substituted for those of the schematic diagram shown in the diagram provided appropriate changes are made to the other circuit elements and the voltage supply. Also, the circuit just described could be incorporated in an integrated circuit chip. The chip could be produced in conventional processes which are well known in the art, and along with other chips may be utilized in a fuel injection system for an internal combustion engine or other system requiring selective coupling and uncoupling of a power supply to a load in response to an external signal.

The fuel pump driver circuit described operates to auto-matically disconnect the supply voltage from the load when no signal is received during a designated period of time, thus preventing the supply of the fuel to create a dangerous condition when the engine is not operating.

We claim:

1. In a driver circuit for a fuel pump for an internal combustion engine, which engine produces a signal indicating engine operation, the combination including:
first means for receiving the signal from the engine,
capacitor means,
current supply means,
circuit means including a load terminal and second means coupling said current supply means to said load terminal for controlling the application of current thereto, and
control means coupled to said first means and to said capacitor means and including means for discharging said capacitor means in response to a signal indicating engine operation, said control means including means for charging said capacitor means and being coupled to said second means and operating in response to the voltage across said capacitor means produced in the absence of a singal indicating engine operation to control said second means to uncouple said load terminal from said supply means.

2. The combination according to claim 1 including switch means coupling said current supply means to said circuit means and having on and off conditions.

3. The combination according to claim 1 wherein said circuit means and said control means are provided as an integrated circuit chip.

4. The combination according to claim 1 wherein said second means includes a switch transistor having control, common and output electrodes, said common electrode being coupled to said current supply means, said output electrode being coupled to said load terminal, and means coupled between said control means and said control electrode to control said transistor for causing the same to selectively supply current to said load terminal.

5. The combination according to claim 1 wherein said capacitor means forms energy storage means for delaying the action of said control means to uncouple said current supply means from said load terminal.

6. The combination according to claim 1 wherein said control means includes a control transistor having control, output and common electrodes, said common electrode being coupled to reference ground potential, and said output electrode being coupled to said second means, and a differential switch coupled between said first means for receiving signals from the engine and said control electrode of said control transistor, said differential switch having on and off conditions, and being in said off condition to render said control transistor conducting in the absence of a signal from the engine by said signal receiving means.

7. A driver circuit for an electrically operated device associated with apparatus which produces a signal indicating that the apparatus is operating, including in combination:
current supply means,
load terminal means;
an output transistor having control, common and output electrodes said common electrode being coupled to said current supply means, said output electrode being coupled to said load terminal means;
differential switch means including first and second transistors of the same conductivity type, each having control, common and first and second output electrodes, said common electrode of each of said first and second transistors being coupled to said current supply means, means providing a reference potential connected to said control electrode of said first transistor, said first output electrode of said first transistor being coupled to said control electrode of said second transistor;
means coupling said second output electrode of said first transistor to said control electrode of said output transistor;
a capacitor coupled between said input electrode of said second transistor and the ground reference potential, means connecting said first output electrode of said second transistor to said capacitor for charging the same, said second output electrode of said second transistor being connected to a reference potential;
an input transistor having control and output electrodes, means applying the signal indicating operation of the apparatus to said control electrode, means connecting said output electrodes across said capacitor for discahrging the same in response to the operation signal;
said capacitor charging to render said first transistor conducting in the absence of the operation signal

to hold said differential switch in the off condition, and render said output transistor nonconducting to disconnect said current supply means from said load terminal means.

8. A driver circuit in accordance with claim **7** including resistance means connected between said first output electrode of said first transistor and said capacitor means for charging said capacitor means in the absence of the operation signal, said capacitor providing a predetermined time to charge to thereby delay the conduction of said first transistor and the disconnection of said current supply means from said load terminal means.

9. A driver circuit in accordance with claim **7** wherein said means coupling said second output electrode of said first transistor to said control electrode of said output transistor includes a control transistor having control, common and output electrodes, said common electrode being coupled to the reference ground potential, said output electrode being coupled to said control electrode of said output transistor to control the conductivity of said output transistor to control the supply of current to said load terminals, and means connecting said second output electrode of said first transistor to said control electrode of said control transistor.

10. The driver circuit in accordance with claim **9** further including resistance means connecting said control electrode of said output transistor to said current supply means.

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