

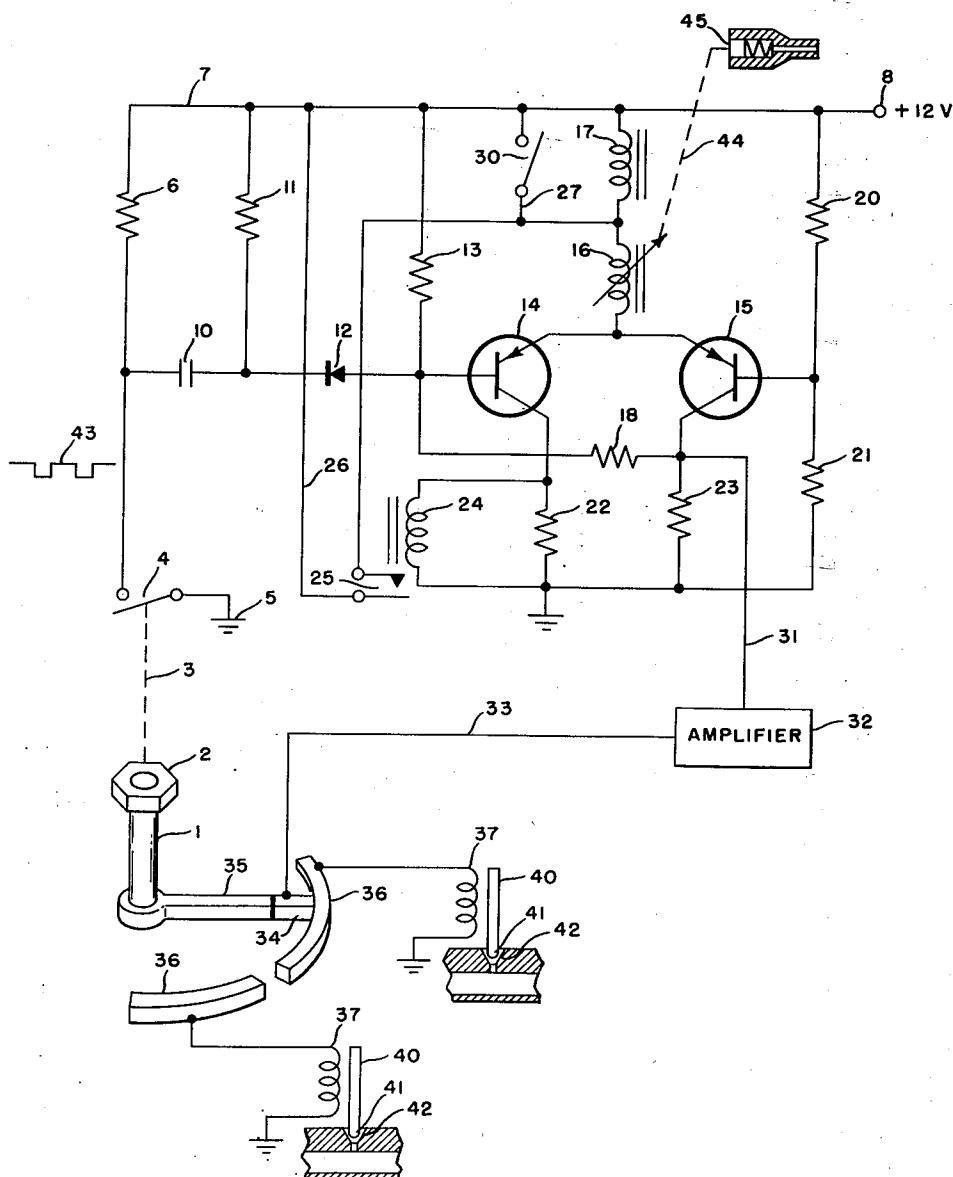
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COLD START OVERSPEED CONTROL FOR FUEL INJECTION SYSTEM

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COLD START OVERSPEED CONTROL FOR FUEL INJECTION SYSTEM

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3 Claims. (Cl. 123—32)

This invention relates to a system for injecting measured amounts of fuel into the cylinders of an internal combustion engine in synchronism with the operation thereof and more particularly to a means for preventing faulty operation of the system under cold weather conditions.

The invention has reference to a system in which fuel under constant pressure is supplied to a plurality of solenoid operated injection valves of which there is one for each cylinder of the engine and the amount of fuel fed is controlled by varying the time during which each valve is held open by its solenoid in response to operation of the air throttle. The solenoids are activated by having applied thereto in sequence the output pulses of a monostable multivibrator triggered in synchronism with the operation of the engine. The application is made by means of a commutating device.

In an eight cylinder engine operating around five thousand R. P. M. there is a maximum time, during which each fuel injection valve may be open, of about two milliseconds. At low speeds, however, it is possible to increase this time and for cold weather starting it is desirable to do so. For this purpose means may be provided by which an operator may switch an impedance element into the input circuit of the multivibrator so that the valve open time may be increased to as much as five milliseconds.

If this is done, however, and the operator races the engine in warming it up, speeds may be reached at which the duration of the output pulses of the multivibrator is greater than the period of dwell of the commutating device for each cylinder. This results in sparking at the commutator.

It is an object of the invention to provide a means for automatically removing the added impedance element from the input circuit of the multivibrator when such overspeed conditions are imminent.

It is another object to provide such a means which is simple and reliable.

The single figure of the drawing is a schematic diagram of a fuel injection system embodying the invention.

Referring more particularly to the drawing, there is shown a shaft 1 which may be the distributor shaft of the engine rotating in synchronism with the operation thereof. Mounted on the shaft 1 for rotation therewith is a lobed cam 2 having one lobe for each cylinder of the engine. The cam 2 drives one contact element of a switch 4 by means of a mechanical linkage 3. The driven contact element of the switch 4 is connected to a voltage reference plane illustrated as the ground 5. The remaining contact of the switch is connected through a resistor 6 and a conductor 7 to the positive terminal 8 of a voltage supply source which may be the battery of an automobile.

Said other contact is also connected to one terminal of a capacitor 10, the other terminal of which is connected by way of a resistor 11 to the conductor 7 and also to the cathode of a diode 12. The remaining ter-

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minial of the diode 12 is connected through a resistor 13 to a conductor 7 and also to the base electrode of a transistor 14. The emitter electrode of transistor 14 is connected to the emitter electrode of the transistor 15 and also through a pair of coils 16 and 17 in series to the conductor 7. The base electrode of the transistor 15 is connected by way of a resistor 20 to the conductor 7 and by way of a resistor 21 to the voltage reference plane.

The collector electrodes of the transistors 14 and 15 are connected through respective resistors 22 and 23 to the voltage reference plane. The collector electrode of transistor 15 is also connected through a resistor 18 to the base electrode of transistor 14. The collector of the transistor 14 is also connected to the voltage reference plane through a relay coil 24. The armature of this relay operates a switch 25 formed in a conductor 26, one terminal of which is connected to the conductor 7 and the other terminal of which is connected to the junction of coils 16 and 17. This junction is also connected to the conductor 7 by way of a conductor 27 and a switch 30.

The collector electrode of transistor 15 is also connected by way of a conductor 31 to an amplifier 32, the output of which is applied by way of a conductor 33 to a wiping contact element 34 carried by and insulated from an arm 35 mounted on the shaft 1 for rotation therewith. The contact element 34 makes sequential wiping contact with a plurality of contact segments 36, one of which is provided for each cylinder of the engine and only two of which have been shown. Each of the segments 36 is connected to one terminal of a respective solenoid coil 37. The armature of each of these solenoids is a valve stem 40, terminating at its lower end in a valve element 41, seating in a seat 42 formed in the intake manifold of the engine adjacent a respective one of the cylinders thereof and in communication therewith. Fuel under constant pressure is supplied to these valves by means not shown.

In the operation of the system described above the rotation of the shaft 1 causes the switch 4, driven by the cam 2, to be opened once and closed once while the wiping contact element 34 is in contact with each of the segments 36. When the switch is open the undriven contact element thereof is at the voltage of the terminal 8 and when the switch is closed this element is at the voltage of the voltage reference plane 5. This results in the presence at this contact element of a square waveform such as indicated at 43. This waveform is differentiated by the elements 10 and 11 and the negative-going spikes thereof are applied by way of the low impedance of the diode 12 to the base electrode of the transistor 14.

In the ordinary operation of the fuel injector system the manual switch 30 is closed, short circuiting the coil 17, and the switch 25 is open. In this state of affairs the duration of the output pulses of the multivibrator is controlled by the variable inductor 16, the iron core of which is connected by a mechanical linkage 44 to a piston 45 which is in communication with the manifold vacuum of the engine. Prior to the application of one of the triggering spikes, by way of the diode 12, the transistor 15 is conducting. There will be a sufficient voltage drop across the inductor 16 and from the emitter to the collector of transistor 15 to bias transistor 14 to cut-off, by virtue of its application to the base thereof through the resistor 18. The application of the negative-going triggering spike to this electrode causes transistor 14 to conduct which increases the voltage drop across the inductor 16. This causes transistor 15 to conduct less, which applies a negative voltage to the base electrode of transistor 14, causing it to conduct more heavily. This regenerative action continues until the transistor 15 is cut off. Transistor 15 remains cut off until the current built

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up through the conductor 16 is complete. When the emitter electrode of the transistor 15 is again more positive than the base the reverse action takes place and transistor 15 conducts again. The resistance of the coil 24 is sufficiently high with respect to that of resistor 22 that the action of the latter is only negligibly effected by the presence of the coil.

For cold weather starting the switch 30 may be either manually or thermostatically opened to insert the coil 17 into the control circuit of the multivibrator. This increases the duration of the pulses in the output of the multivibrator to as much as five milliseconds.

For every position of the air throttle of the engine, voltage across the coil 24 will be substantially the same when the duration of the multivibrator output pulses is equal to the dwell of the contact element 34 on each of the contact segments 36. The characteristics of the relay 24 are so chosen that it will operate at a voltage slightly lower than this maximum safe voltage. Thus, whenever the engine speed becomes too high for any given pulse duration, so that the duration exceeds the dwell of the element 34 on the elements 36, the voltage across the relay 24 increases to a point where it is activated and the switch 25 is closed, temporarily removing the coil 17 from the control circuit of the multivibrator.

What is claimed is:

1. In a system for injecting measured amounts of fuel into the cylinders of an internal combustion engine in synchronism with the operation thereof, in which fuel is supplied under constant pressure to a respective solenoid operated valve for each cylinder, a monostable multivibrator is triggered in synchronism with engine operation and the pulses in the output thereof are applied by way of a commutating device to the solenoids of said valves in sequence to activate the same, the duration of said pulses being controlled by a variable impedance element in an input circuit of said multivibrator, the improvement which comprises: a second impedance element, means operable to switch said second element into an input circuit of said multivibrator in a manner to increase the duration of said pulses, a relay in an output circuit of said multivibrator, and means actuated by said relay to remove said second element from said input circuit while said relay is energized, the characteristics of said relay being so selected that said relay is energized when the duration of said pulses approaches the dwell time of said commutating device for each of said solenoids.

2. In a system for injecting measured amounts of fuel into the cylinders of an internal combustion engine in synchronism with the operation thereof, in which fuel is supplied under constant pressure to a respective solenoid

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operated valve for each cylinder, a monostable multivibrator is triggered in synchronism with engine operation and the pulses in the output thereof are applied by way of a commutating device to the solenoids of said valves in sequence to activate the same, the duration of said pulses being controlled by a variable impedance element in an input circuit of said multivibrator, the improvement which comprises: a second impedance element, means operable to switch said second element into an input circuit of said multivibrator in a manner to increase the duration of said pulses, a relay, means actuated by said relay to remove said second element from said input circuit while said relay is energized, and means applying to said relay a voltage the amplitude of which is a function of the duration of said pulses, the characteristics of said relay being so selected that said relay is energized when the duration of said pulses approaches the dwell time of said commutating device for each of said solenoids.

3. A system for injecting measured amounts of fuel into the cylinders of an internal combustion engine in synchronism with the operation thereof, comprising: a separate solenoid operated valve for each of said cylinders, a monostable multivibrator, said multivibrator comprising a pair of amplifying stages, one of said stages being normally conducting and the other non-conducting, means applying triggering impulses to said multivibrator in synchronism with the operation thereof, each of said applications causing said stages to reverse their conditions of conductivity, an impedance element connected in said multivibrator circuit in a manner to control the duration of said reversal of conductivity, a commutating device, means applying the output of said multivibrator in sequence to said solenoids by way of said commutating device, means driving said commutating device in synchronism with the operation of said engine whereby said commutating device applies the output of said multivibrator during each of said reversals to a respective one of said solenoids, a second impedance element, means operable to switch said second impedance element into said multivibrator circuit in a manner to increase the duration of said reversals of conduction, a relay connected in one of said amplifying stages, said relay having characteristics such that it is energized when the duration of said reversals of conduction approaches the dwell time of said commutating device for each of said solenoids, and means actuated by said relay to remove said second element from said multivibrator circuit while said relay is energized.

No references cited.