

1

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VALVE SENSING TRIGGER FOR FUEL INJECTION SYSTEM

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3 Claims. (Cl. 250—27)

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 eliminating a mechanical portion of the synchronization mechanism in such a system.

In one type of such systems, an example of which may be found in U.S. patent application Serial No. 615,079 for "Cold Start Overspeed Control for Fuel Injection System," filed October 10, 1956 in the name of Andrew S. Barclay, fuel under pressure is supplied to a plurality of solenoid actuated valves, each located in the intake manifold adjacent the intake valve of a respective cylinder. The solenoids are sequentially actuated by pulses of electrical energy generated by a circuit such as multi-vibrator. The multivibrator is triggered by the momentary closing of a switch. The switch is closed by a lobed cam on a shaft driven in accordance with engine rotation. This switch may be a set of breaker points similar to those used for ignition and mounted on the distributor shaft.

Distribution of the pulses to the various solenoids is accomplished by a commutator driven in accordance with engine rotation and having a respective fixed contact segment for each solenoid.

Each pulse must, of course, occur during the time in which a commutator segment is in the circuit. At low engine speeds this raises no difficulty. At high engine speeds, however, the problem of insuring that each valve may be opened long enough during each cycle of engine rotation to provide sufficient fuel becomes a difficult one. It is necessary to insure that the full time during which each commutator segment is in the circuit, be fully available and utilized for the application of a pulse, during a period of maximum demand on the engine.

It is an object of the present invention to eliminate the cam driven switch from such a system.

It is a further object of the invention to make possible the accurate utilization of the full period of contact of each commutator segment.

These and other objects and advantages of the invention are realized by an arrangement in which the movable contact element of the commutator is included in one of a pair of parallel circuit branches across the terminals of a D.C. voltage supply source. This branch has a low impedance, while the remaining branch, which includes resistors and a coil, has a high impedance. Intermediate points of both branches are coupled by a diode so poled as to conduct during dead time of said commutator. The voltage across the coil is unilaterally selected and utilized as trigger voltage for the pulse producing circuit.

The single figure of the drawing is a schematic circuit diagram of a triggering arrangement embodying the invention.

Referring more particularly to the drawing, there are shown, by way of example, a pair of valve stems 1, terminating in valve members 2 seating in seats 3 formed

2

in the wall of an intake manifold 4. Each of the valve stems 1 is actuated by the energization of a respective coil or solenoid 5, having one terminal grounded and the remaining terminal connected to a respective fixed contact segment 6 of a commutator 7. The commutator has a rotatable contact 8 driven in synchronism with engine rotation. While only two valves are shown, there will be one per cylinder, thus the usual automobile engine may have four, six or eight valves and an equal number of segments in its commutator. Fuel under pressure is applied by means not shown to each valve, being admitted during the whole time the valve is open.

The rotatable contact element 8 is connected to the positive terminal 10 of a source of D.C. voltage by way of a conductor 11 and a resistor R_1 . A point A on this conductor has applied to it the output of a multi-vibrator type modulator indicated by the box 12 by way of a conductor 13 and resistor R_6 . The point A is connected to ground by way of a capacitor C_1 .

Connected between the terminal 10 and ground is a series arrangement of a pair of resistors R_2 and R_3 and a coil L_1 . Also connected between the terminal 10 and the coil L_1 is a series arrangement of a resistor R_4 and a capacitor C_2 . The junction of R_4 and C_2 is connected by way of a diode CR_2 and a resistor R_5 , in series, to the terminal 10. A diode CR_1 connects the junction of R_1 and C_1 to the junction of R_2 and R_3 .

The circuit described above utilizes the dead space when the movable contact element 8 is between adjacent contact elements 6 to generate a trigger impulse which accurately marks the initiation of contact with the next fixed contact element.

Each time the movable element 8 terminates its contact with one of the fixed elements 6, the potential at point A jumps to some positive value and, upon the occurrence of contact with the next fixed element 6, the potential falls to a value near ground. The rising characteristic of this waveform is not always clear because of noise at the moment the moving element enters the dead space between fixed elements, so C_1 serves to filter undesirable components from this wave portion. The terminal portion of this waveform is usually well shaped with a steep slope.

The dead-space waveform is applied to the anode of CR_1 , the cathode of which is biased by the impedance element string R_2 , R_3 and L_1 . As the point A swings positive on the initial portion of this waveform, CR_1 is biased to conduction and increased current flows in the string R_3 , L_1 . When point A is near ground, CR_1 is biased to non-conduction, and normal current flows in the string R_3 , L_1 .

The increase in current flow in L_1 during the early portion of this interval produces an increase in its magnetic field, and when CR_1 ceases to conduct the field collapses to produce a negative-going self-induced pulse.

Since the increase of current flow was accompanied by a positive pulse, the waveform at the junction of R_3 and L_1 is made up of a positive pulse followed by a negative pulse, the positive pulse occurring when contact with one fixed element 6 is terminated and the negative pulse occurring when contact with the next following fixed element is initiated. The waveform at this junction is capacitively coupled by C_2 to the network composed of R_4 , CR_2 , and R_5 , which selects the negative pulse and injects it by means of capacitor C_3 into a suitable point in the modulator 12 to trigger the initiation of a new valve duty pulse.

Selection of the biasing network voltage at the junction of R_2 and R_3 permits a selective clipping of the signal at A, and by this means, any tendency toward auto regeneration of the modulator, due to positive feedback of its own output, is eliminated.

3

It can be seen that the above described circuit insures that the triggering of each valve actuating pulse coincides accurately with the initiation of contact between the element 8 and one of the fixed elements 6. By this means the whole period of contact with each fixed element is available for use so that the duration of valve actuating pulses is only limited by the dwell of each contact.

What is claimed is:

1. In a system having a multisegment fixed contact commutator with a movable contact and means for moving said movable contact to successively contact said fixed contacts, means for applying a pulse of electrical energy to the movable contact element of a commutator coincident with the dwell of said movable contact element on each of the fixed contact elements of said commutator comprising a pulse generating circuit, a source of supply voltage and means connecting each of said fixed contact elements to one terminal of said source; means for triggering said pulse generating circuit, said triggering means comprising means including said movable contact element forming a first circuit path across said source, means including an inductor forming a second circuit path across said source, said second path having a greater resistance than said first path, a unilaterally conductive means coupling the potential appearing at said movable contact element across said inductor when said movable contact element is not in contact with any of said fixed contact elements, and means selectively coupling the voltage appearing across said inductor coincident with the initiation of contact between said movable element and each of said fixed elements to said pulse generating circuit as triggering voltage.

2. In a system having a multisegment fixed contact commutator with a movable contact and means for moving said movable contact to successively contact said fixed contacts, means for applying a pulse of electrical energy to the movable contact element of a commutator coincident with the dwell of said movable contact element on each of the fixed contact elements of said commutator comprising a pulse generating circuit, a source of supply voltage and means connecting each of said fixed contact elements to one terminal of said source; means for triggering said pulse generating circuit, said triggering means comprising means connecting another terminal of said source to said movable element whereby the last named means and said movable element, when in contact with any of said fixed elements, complete a first circuit path across said source, means

4

including an inductor connected between said terminals of said source and constituting a second circuit path therebetween, said second circuit path having greater resistance than said first circuit path, unilateral conductive means connecting said movable contact element to a point on said second circuit path, whereby interruption of contact between said movable element and said fixed elements will generate across said inductor a first voltage impulse and the initiation of contact between said movable element and the next following one of said fixed contact elements will generate across said inductor a second voltage impulse of the opposite sense to said first impulse, unilateral means selectively recovering said second voltage impulse and means coupling said recovered second voltage impulse to said pulse generating circuit as triggering voltage.

3. In a system having a multisegment fixed contact commutator with a movable contact and means for moving said movable contact to successively contact said fixed contacts, means for applying a pulse of electrical energy to the movable contact element of a commutator coincident with the dwell of said movable contact element on each of the fixed contact elements of said commutator comprising a pulse generating circuit, a source of supply voltage and means connecting each of said fixed contact elements to the negative terminal of said source; means for triggering said pulse generating circuit, said triggering means comprising means connecting the positive terminal of said source to said movable element whereby the last named means and said movable element, when in contact with any of said fixed elements, complete a first circuit path across said source, means including an inductor connected between said terminals of said source and constituting a second circuit path therebetween, said second circuit path having greater resistance than said first circuit path, unilateral conductive means connecting said movable contact element to a point on said second circuit path, whereby interruption of contact between said movable element and said fixed elements will generate across said inductor a positive-going voltage impulse and the initiation of contact between said movable element and the next following one of said fixed contact elements will generate across said conductor a negative-going voltage impulse, unilateral means selectively recovering said negative-going voltage impulse and means coupling said recovered second voltage impulse to said pulse generating circuit as triggering voltage.

No references cited.