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INDUCTANCE CONTROLLED MULTIVIBRATOR

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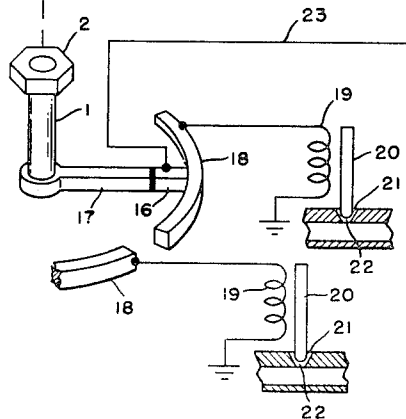
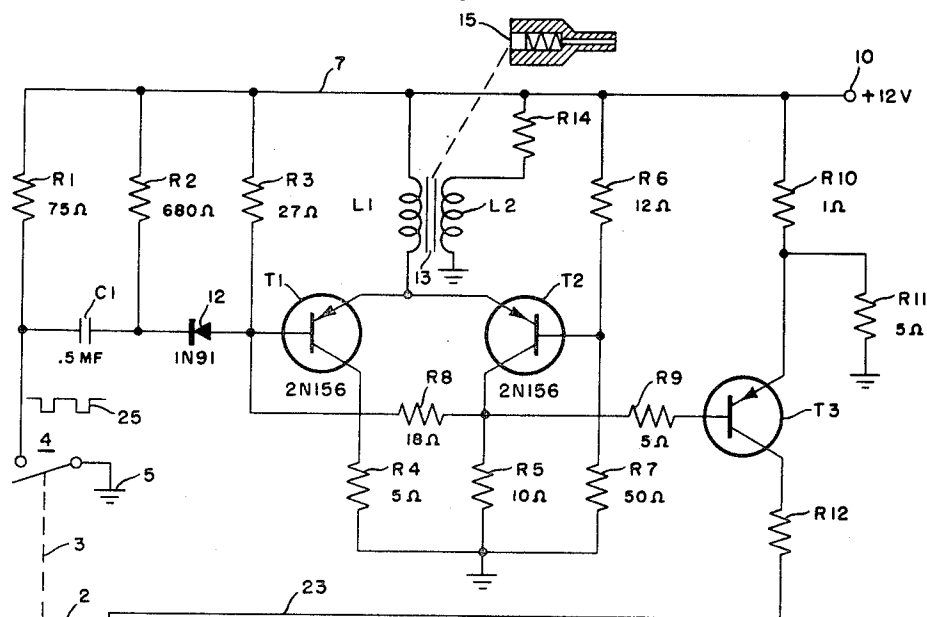


FIG. 1

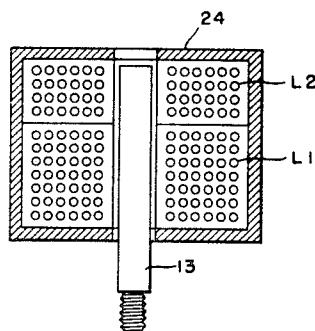


FIG. 2

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INDUCTANCE CONTROLLED MULTIVIBRATOR

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This invention relates to multivibrator circuits of the monostable type and more particularly to such circuits as constructed by the use of transistors.

In certain uses of monostable multivibrators it is desirable to be able to accurately control the duration of the unstable state of the circuit and thus the duration of the output pulse thereof. In the past this has usually been done by the use of a combination of resistance and capacitance in which a capacitor is charged by the operation of the circuit in response to a triggering impulse and discharges through a resistor.

When power transistors are substituted for electron tubes, however, the low impedance of the transistors makes it difficult to utilize a resistance capacitance combination capable of providing an output pulse duration of any considerable value. For this reason only transistors of high impedance and low power handling capabilities can be used and an amplifier chain is required to amplify the multivibrator output to the level needed. Furthermore, the potentiometer necessary for varying pulse duration in the resistance capacitance control circuit has several drawbacks. It is expensive and subject to wear which impairs its life and reliability.

It is an object of the present invention to provide a control for a monostable multivibrator which is adapted for use with the low impedances of power transistors.

It is a further object to provide such a control which is inexpensive, reliable and has a long life.

It is another object to provide a means for compensating for variations in amplitude of the multivibrator output due to variations in supply voltage level.

These and other objects and advantages of the invention are realized by a circuit in which an iron cored inductor is incorporated as a control element, and a separate inductor on the same core varies its saturation as a function of supply voltage level.

In the drawing:

Fig. 1 is a schematic diagram of a circuit embodying the invention; and,

Fig. 2 is a cross-sectional view of one form of control inductor.

By way of illustrating one use for a multivibrator of the type referred to and to disclose a complete system employing the invention, there is shown, in Fig. 1, a schematic representation of a fuel injection system for an internal combustion engine in which fuel is provided by means of a separate solenoid operated fuel injection valve for each cylinder of the engine. The energization of the solenoids is effected by the application thereto of the output pulses of the multivibrator which is triggered in synchronism with the rotation of the engine. The speed of the engine is controlled by the throttle setting which varies the duration of the pulses and which, in turn, varies the open time of the valves.

There is shown in Fig. 1 a shaft 1, which may be the distributor shaft of the engine, and is driven in accordance with engine rotation. The shaft 1 has mounted on it, for rotation therewith, a lobed cam 2 having a lobe for

each engine cylinder. The cam is connected by a mechanical linkage 3 to one contact element of a single pole, single throw switch 4. This contact element is connected to a voltage reference plane shown as ground at 5.

The other contact element of the switch 4 is connected by way of a resistor R_1 and a conductor 7 to a positive terminal 10 of a source of supply voltage. The said other terminal of switch 4 is also connected by way of a condenser C_1 and a diode 12 to the base electrode of a transistor T_1 . The junction of capacitor C_1 and diode 12 is connected to conductor 7 by a resistor R_2 , and the junction of diode 12 and the base electrode of transistor T_1 is connected to conductor 7 by a resistor R_3 .

The emitter electrode of transistor T_1 is connected to the emitter electrode of a second transistor T_2 and their junction is connected by a coil L_1 to conductor 7. The coil has a movable iron core for varying its inductance. The core is indicated by the lines 13 and is connected by a mechanical linkage to a piston 15 driven by manifold vacuum. A second coil L_2 is also wound about the core 13 and has one terminal connected by way of a resistor R_{14} to the conductor 7 and the other terminal connected to a voltage reference plane shown as ground.

The collector electrode of transistor T_1 is connected by way of a resistor R_4 and that of transistor T_2 by a resistor R_5 to the voltage reference plane. The base electrode of T_2 is connected through a resistor R_6 to conductor 7 and through a resistor R_7 to the voltage reference plane.

The base electrode of T_1 is connected through a resistor R_8 to the collector electrode of T_2 and through an additional resistor R_9 to the base electrode of a third transistor T_3 . The emitter electrode T_3 is connected by way of a resistor R_{10} to conductor 7 and by way of a resistor R_{11} to the voltage reference plane.

The collector electrode of T_3 is connected by way of a resistor R_{12} , and a conductor 23 to a wiping contact element 16 carried by and insulated from an arm 17 mounted on the shaft 1 for rotation therewith. The element 16 makes sequential wiping contact with a plurality of contact segments 18, of which one is provided for each cylinder, only two being shown. Each segment 18 is connected to one terminal of a respective solenoid 19 having an armature 20. The armature is a valve stem having a valve element 21 formed on its lower end. The element 21 seats in a seat 22 formed in the intake manifold of the engine close to the fuel intake valve of a respective cylinder. The remaining terminal of each solenoid 19 is connected to the voltage reference plane.

Fig. 2 illustrates a manner in which the coils L_1 and L_2 may be wound about the core 13. The coils are housed in a container 24.

In the operation of the circuit described above, the cam 2 closes the switch 4 and opens it once while the contact element 16 is wiping each segment 18. Closing of the switch causes the undriven contact of the switch to be placed at the potential of the ground reference plane, while opening the switch causes this contact to assume the voltage of the terminal 10. The result is a square waveform as indicated at 25. This waveform is differentiated by the combination of R_1 and C_1 and the negative-going spikes of the resulting waveform are passed by the low impedance of the diode 12 and applied to the base electrode of the transistor T_1 .

In the multivibrator composed of T_1 and T_2 , the transistor T_2 is normally conducting. In this state there will be a drop of about 1.5 volts across the D.C. resistance of the inductor L_1 . There will be a drop of .7 volt from the emitter of T_2 to its collector. The drop across the resistor R_8 is such that the base of T_1 is biased to a

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positive potential with respect to its emitter and T_1 will thus be cut off.

When the switch 4 is closed the negative spike applied to the base electrode of T_1 will cause T_1 to conduct, which will increase the drop across the coil L_1 . This will reduce the conduction of T_2 , applying as a result a negative voltage to the base of T_1 , thus increasing the conduction of T_1 . This regenerative action will terminate in the cut off of T_2 . T_2 will remain cut off until the current build up through the coil L_1 is complete. When the emitter of T_2 is again more positive than the base the reverse action will take place and T_2 will conduct again. The time constant of this action is determined by the inductance of L_1 and the resistance of R_4 . The inductance of L_1 is varied by varying the position of the iron core 13.

The output of the multivibrator is applied through the resistor R_9 to the base electrode of transistor T_3 . It is amplified in a conventional manner and applied by way of resistors R_{12} , conductor 23, contact element 16, and contact segment 18 to the coil 19.

The function of the coil L_2 is to compensate for changes in the amplitude of the pulses in the output of the multivibrator due to changes in the voltage of the supply source. When this source is the battery of an automobile, for example, the voltage is subject to variation and tends to be low when starting and thus to provide a pulse of reduced amplitude. The reduced amplitude results in the injection valves being opened more slowly and an increase in pulse duration is needed to compensate for this effect. The coil L_2 increases the saturation of the core when the supply voltage increases and this results in a reduction in the duration of the pulse. Conversely a reduction in supply voltage decreases the saturation of the core and increases the duration of the pulse. This action is desirable, for example, when starting.

The use of the inductive control means described above makes it possible to use low impedance power type transistors for the multivibrator and to thus effect a reduction in the number of transistors needed for the whole circuit. The circuit illustrated utilizes three power type transistors, whereas with a resistance capacitance type of control circuit power transistors with their low impedances could not be used in the multivibrator and a total of five transistors would be required to provide the desired pulse output.

The component values shown on the drawing are provided solely for the purpose of illustrating typical satisfactory values, and should not be considered as restricting the invention.

What is claimed is:

1. A monostable multivibrator comprising a first transistor and a second transistor, means including a resistor connecting the collector electrode of each of said transistors to a voltage reference plane, means including a resistor connecting the base electrode of said first transistor to the collector electrode of said second transistor, means connecting the emitter electrodes of said transistors, an inductive element connecting said emitters to a terminal of a voltage supply source, said inductive element comprising a first coil, an iron core movable in said first coil for varying the inductance thereof, a second coil wound about said iron core and connected across said voltage supply source, means biasing said second transistor to conduction, the values of said biasing means and said inductive element being such that said conduction cuts off said first transistor, and means triggering said

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first transistor causing said first transistor to conduct and said second transistor to be cut-off for a period of time whose duration depends on the inductance of said inductive element.

2. A monostable multivibrator comprising a first transistor and a second transistor, resisting means coupling the collector electrode of each of said transistors to a voltage reference plane, resistive means coupling the base electrode of said first transistor to said collector electrode of said second transistor, inductive means connected as a common coupling element to the emitter electrodes of said transistors and connecting the same to a terminal of a voltage source, said inductive means comprising a first coil connected to said emitter electrodes and to a terminal of said source, an iron core movable in said coil to vary the inductance thereof and a second coil inductively coupled to said first coil and connected across the terminals of said voltage source, means biasing said second transistor to conduction, the values of said coupling means being such that conduction of said second transistor cuts off said first transistor and means for reversing the conductive states of said transistors for a period of time dependent for its duration on the inductance of said common inductive coupling means.

3. A monostable multivibrator comprising a first and a second transistor, an input circuit for each of said transistors including a pair of electrodes thereof, an output circuit for each of said transistors including one of said pair of electrodes and a third electrode thereof, a first coupling circuit coupling an electrode of said output circuit of said first transistor to an electrode of said input circuit of said second transistor, a second coupling circuit coupling an electrode of said output circuit of said second transistor to an electrode of said input circuit of said first transistor, the values of the impedances of said coupling circuits being such that one of said transistors is normally conducting and the other is cut-off, means for reversing the above mentioned states of conduction of said transistors for a time depending upon the time constant of one of said coupling circuits, said one coupling circuit comprising an inductive element connecting the coupled electrodes of said transistors to a terminal of a source of supply voltage, said inductive element comprising a coil and an iron core movable therein for varying said inductance, and means for compensating for variations in the amplitude of the pulses forming the output of said multivibrator with changes in the level of the voltage of said source, said compensating means comprising a second coil wound about said core and connected across said voltage source whereby the saturation of said core is increased for an increase in the level of the voltage of said source.

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