

[54] **ELECTRONIC GOVERNOR HAVING AN OVERSPEED PREVENTING CIRCUIT FOR INTERNAL COMBUSTION ENGINES**

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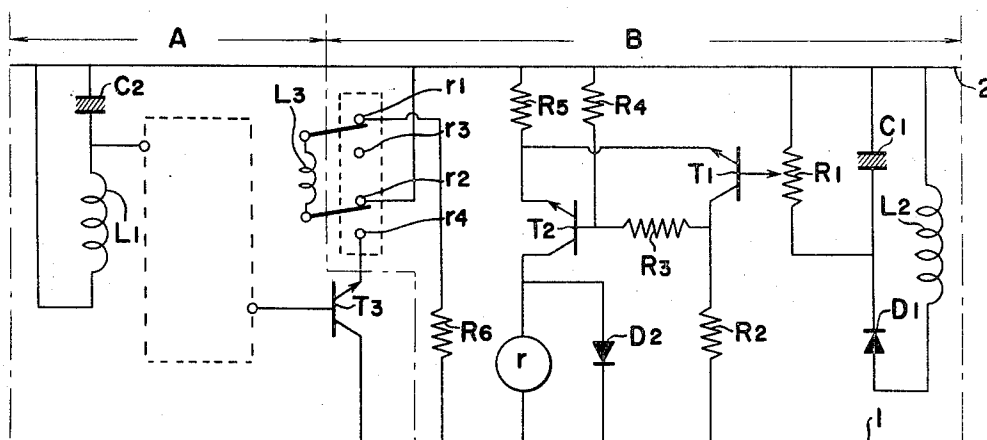
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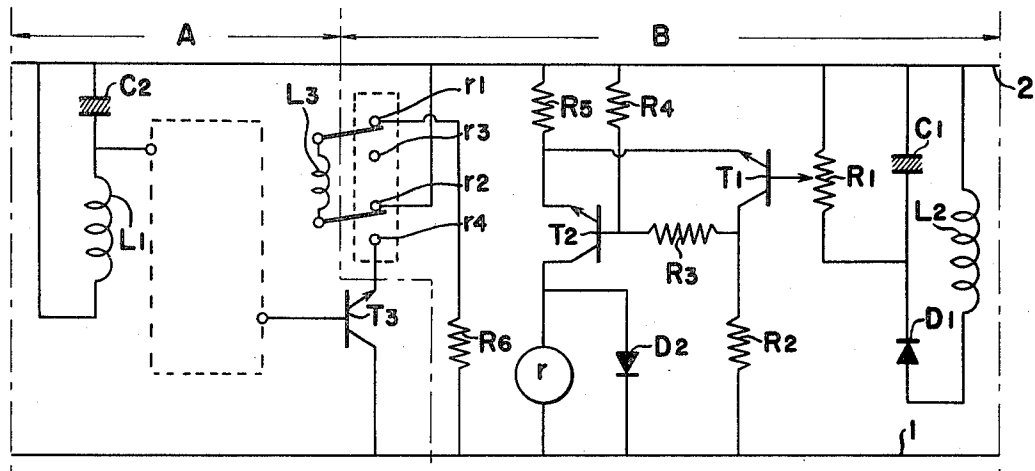
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ABSTRACT

In an electronic governor for internal combustion engines, in which the output voltage of a comparison circuit comparing the output voltage in proportion to the rotative speed of the engine with the output voltage responding to the position of an accelerator lever is conducted to the control coil of a fuel regulating rod in a fuel injection pump, and the position of said fuel regulating rod is electromagnetically controlled by the generated electromagnetic force, there is provided an overspeed preventing circuit arranged to reverse the direction of the electromagnetic force produced in said control coil when the output voltage from another speed sensing circuit exceeds a constant value.

1 Claim, 1 Drawing Figure





ELECTRONIC GOVERNOR HAVING AN OVERSPEED PREVENTING CIRCUIT FOR INTERNAL COMBUSTION ENGINES

This invention concerns an electronic governor for internal combustion engines, in which the quantity of fuel supply is controlled by comparing two output voltages, one being proportional to the rotative speed of the engine and the other being in correspondence with the current position of accelerator lever and by applying the output voltage resulting from said comparison to the control coil of a fuel regulating rod in a fuel injection pump, so that said coil develops an electromagnetic force to position said rod against the counterforce exerted by the governor spring.

Electronic governors of this type began to be developed in recent years because of the potentiality of this type for the excellence of its control performance. There is one drawback inherent in this type, however, in that deterioration in performance of electrical parts, circuit maloperation, or breakage or weakening of such mechanical parts as springs, if any, may prevent said control coil of the fuel regulating rod from getting de-energized, causing an electric current to keep on flowing in said coil to defeat the governor action and thus forcing the engine to overspeed. The probability of such an overspeeding is small but, should it occur once, it would seriously shorten engine life or, worse, destroy the engine beyond repair.

An object of this invention is to eliminate said drawback by detecting the engine speed by means of another speed sensing circuit separate from the one included in the electronic governor network and by controlling the fuel regulating rod according to the detected speed.

In order that this invention may be more readily understood it will now be described, by way of example only, with reference to the accompanying drawing which is a circuit diagram showing an electronic governor for internal combustion engines, equipped with an overspeed preventing circuit according to this invention.

In the diagram shown, "A" is a conventional electronic governor circuit, and "B" is the overspeed preventing circuit having a Schmitt circuit. Elements T_1 , T_2 and T_3 are transistors; elements R_1 through R_6 , inclusive, are resistors; elements C_1 and C_2 capacitors; elements D_1 and D_2 diodes; and elements L_1 and L_2 coils for detecting engine speed. Element L_3 is a fuel regulating rod control coil of a fuel injection pump not shown; element r is a relay, r_1 and r_2 being normally-closed contacts and r_3 and r_4 being normally-open contacts; lines 1 and 2 are a positive and a negative conductor, respectively, in that order.

Coil L_1 of circuit "A" detects engine speed. By this detection, the electromagnetic force developed by control coil L_3 on fuel regulating rod is changed to control the fuel regulating rod, not shown. In circuit "B", normally-closed contacts r_1 and r_2 in relay r are connected to said control coil L_3 . Coil L_2 also detects engine speed, just as does coil L_1 , and develops a corresponding voltage. This voltage is converted by capacitor C_1 and diode D_1 into a DC voltage proportional to the rotative speed of the engine. The Schmitt circuit, comprising transistors T_1 and T_2 and resistors R_2 through R_6 , amplifies the DC voltage. Since transistor T_2 is inverted relative to T_1 in phase relationship, a rise in en-

gine speed causes transistor T_1 to switch on and transistor T_2 to switch off, thereby de-energizing relay r .

In the circuit arranged as above, the overspeed preventing function is performed in the following manner: When engine speed rises due to some malfunctioning occurring in the governor circuit, transistor T_1 becomes conductive, so that transistor T_2 , which has been conducting, becomes non-conductive to de-energize relay r , and normally-closed contacts r_1 and r_2 close. This reverses the flow of current through control coil L_3 on said fuel regulating rod, not shown, and also the magnetic polarity of said coil L_3 relative to a permanent magnet located within itself, so that the fuel regulating rod receives a pull in the direction for decreasing fuel supply, due to two forces, one being that of the governor spring, not shown, and the other being that of coil L_3 , whose reversed magnetic direction coincides with that of the spring force. By this pull, consequently, the fuel regulating rod shifts its position to prevent the engine from overspeeding into the critical range. Even when the governor spring accidentally breaks, the reversed electromagnetic pull of coil L_3 moves the fuel regulating rod in the anti-overspeed direction to avoid the overspeeding of the engine.

The operating point of this circuit, or the engine speed at which the circuit is to start operating as above, can be set by adjusting the potential of the base of transistor T_1 by means of variable resistor R_1 .

As the engine speed falls, relay r becomes energized again, closing normally-open contacts r_3 and r_4 and allowing the fuel regulating rod to move back in the direction for increasing fuel supply, thereby raising engine speed. The operator or driver by this time cannot but realize the abnormal condition and will therefore turn off the power source of the governor to stop the engine for inspection or repair.

It will be obvious from the foregoing description that the electronic governor for internal combustion engines, according to this invention, is a fail-safe device in that the accidental failure, if any, of the governor spring does not defeat the overspeed preventing function and that an open-circuiting of the speed-sensing coil in the governor does not result in loss of said function because the overspeed preventing circuit is independent of the governor circuit and has its own speed-sensing coil. Thus, the governor according to this invention is practical and signifies an improvement.

While this invention has been described in detail with respect to its preferred embodiment it is to be understood that various changes and modifications may be made without departing from the spirit and scope of this invention, and it is intended, therefore, to cover all such changes and modifications in the appended claims.

What is claimed is:

1. An electronic governor for an internal combustion engine comprising a comparison circuit for comparing a first input voltage proportional to the rotational speed of the engine and a second input voltage related to the position of an accelerator operating lever and for producing an output voltage in accordance therewith, means for connecting the output of said comparison circuit to the control coil of a fuel regulating rod of a fuel injection pump so that the position of the fuel regulating rod is electromagnetically controlled in accordance with the electromagnetic force generated by the control coil responsive to the output of said comparison

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son circuit, and an overspeed circuit for preventing engine overspeed including a further, separate voltage generating circuit for generating a D.C. output voltage proportional to the rotational speed of the engine and means for connecting the output of said D. C. voltage generating circuit to said control coil so as to produce an electromagnetic force which acts in an opposite direction to the said electromagnetic force produced by the output of said comparison circuit when the rotational speed of the engine exceeds a predetermined value, said connecting means including means responsive to said D.C. voltage for disconnecting said comparison circuit from said control coil and for connecting said D.C. voltage generating circuit to said control coil when said D.C. output voltage of said voltage generating circuit exceeds a predetermined value, said switching means comprising a relay and first and second pairs of switching contacts controlled by said relay, said first pair of contacts being closed responsive to the energization of said relay to connect the output of said com-

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parison circuit to said control coil and the second pair of relay contacts being closed responsive to the de-energization of said relay to connect said voltage generating circuit to said control coil, and said voltage generating circuit including sensing coil means for sensing the rotational speed of the engine and for producing an output voltage in accordance therewith, means for converting the output voltage produced by said sensing coil means into a corresponding D.C. voltage, and transistor amplifier means including a first transistor, connected to said converting means, which conducts responsive to the said D.C. voltage produced by said converting means exceeding a predetermined value and a second, normally conducting transistor which is rendered non-conducting when said first transistor conducts, and means for connecting said second transistor in series with said relay so that said relay is de-energized when said second transistor is rendered non-conducting.

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