United States Patent [19]

Aono et al.

[11] 3,735,742

[45] May 29, 1973

[54] **ENGINE OVERRUN PREVENTING DEVICE FOR INTERNAL COMBUSTION ENGINE**

[75] Inventors: **Shigeo Aono; Shyuya Nambu,** both of Yokohama, Japan

[73] Assignee: **Nissan Motor Company, Limited,** Yokohama, Japan

[22] Filed: **Oct. 22, 1970**

[21] Appl. No.: **82,947**

[30] **Foreign Application Priority Data**

Oct. 22, 1969 Japan 44/84431

[52] **U.S. Cl.** ..... **123/102,** 123/32 EA, 123/97 B

[51] **Int. Cl.** **F02d 11/10**

[58] **Field of Search** ..... 123/32, 32 EA, 102, 123/97 B, 119

[56] **References Cited**

UNITED STATES PATENTS

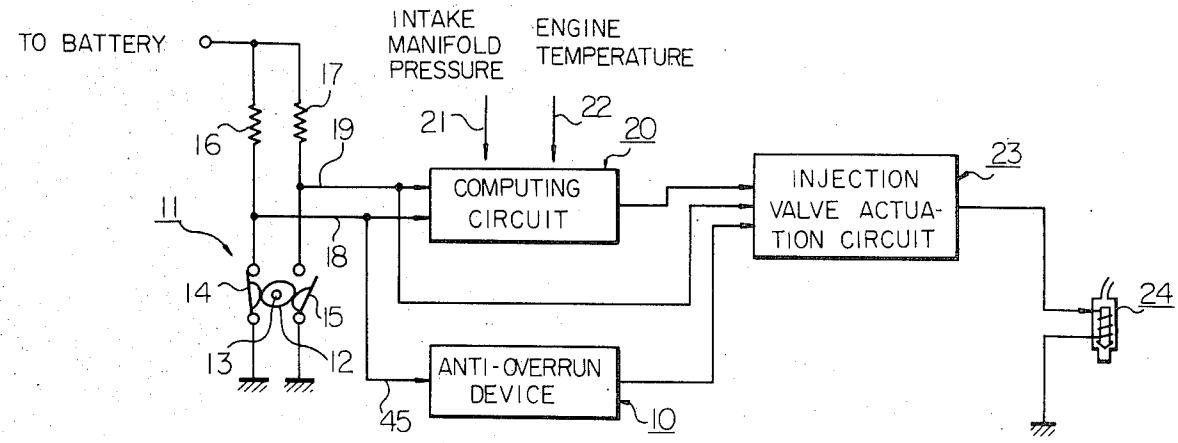
3,570,460	3/1971	Rabus	123/32 EA
3,463,130	8/1969	Reichardt et al.	123/32 EA
3,425,401	2/1969	Lang	123/32 EA
3,455,260	7/1969	Mennesson	123/97 B
3,522,794	8/1970	Reichardt	123/32 EA
3,525,017	8/1970	Rosenberg et al.	123/102 X

Primary Examiner—Laurence M. Goodridge
Attorney—McCarthy, Depaoli, O'Brien & Price

[57] **ABSTRACT**

An engine overrun preventing device adapted to shut off or reduce the fuel supply to the engine cylinders so as to cause engine speed to decrease when "the maximum permissible engine speed" over which the engine tends to overrun has been reached. When applied to a fuel injection system, the overrun preventing device receives a signal indicating engine speed from an engine driven triggering device to generate a fuel shutoff signal when the maximum permissible engine speed has been reached. The fuel shut-off signal is supplied to an injection valve actuation circuit so as to render it ineffective thus preventing the engine from overrunning. When engine speed decreases to a predetermined value lower than the maximum permissible engine speed, the overrun preventing device generates a fuel supply restarting signal which causes the fuel supply system to restart the normal fuel supply to the cylinders.

3 Claims, 5 Drawing Figures

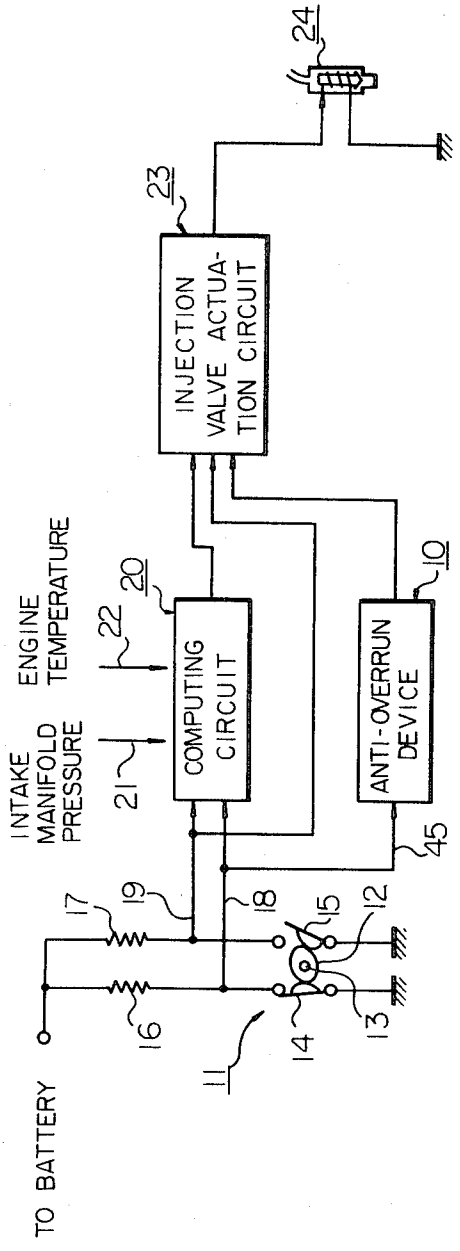


PATENTED MAY 29 1973

3,735,742

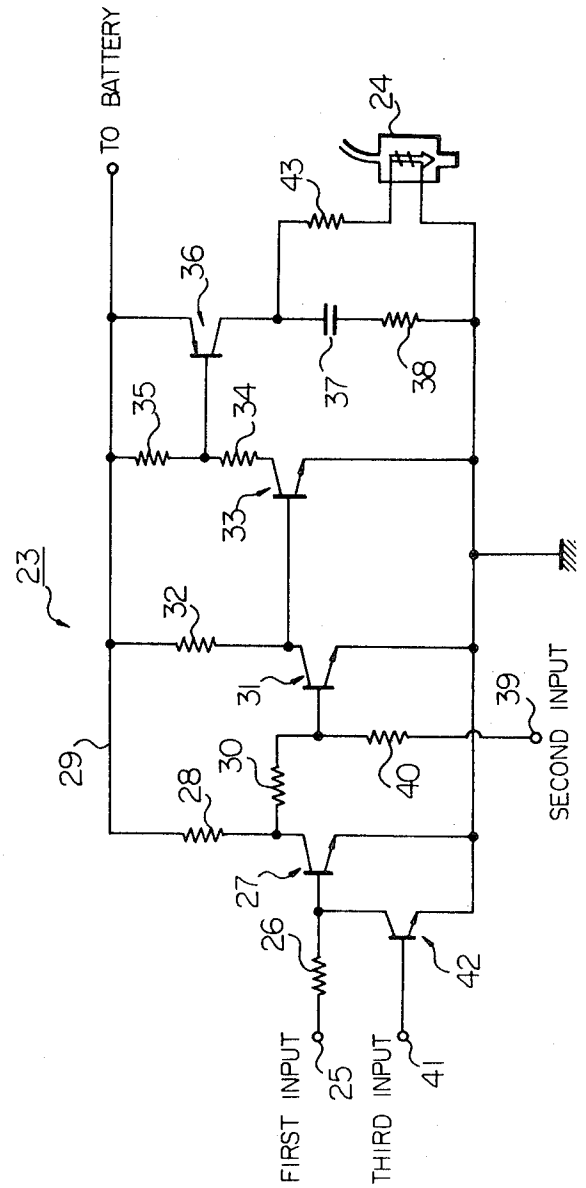
SHEET 1 OF 5

Fig. 1



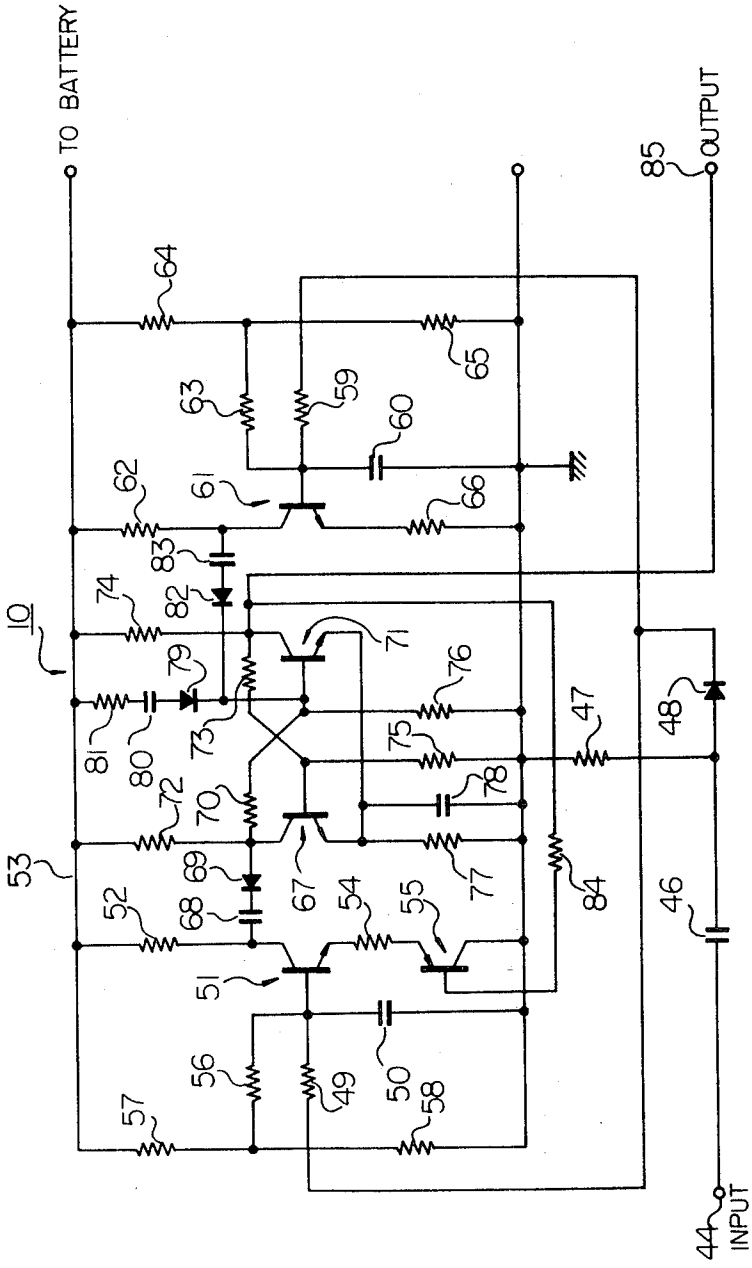
INVENTORS
SHIGEO AONO
BY SHYUYA NAMBU
McCarthy, Depaoli & O'Brien
ATTORNEYS

Fig. 2



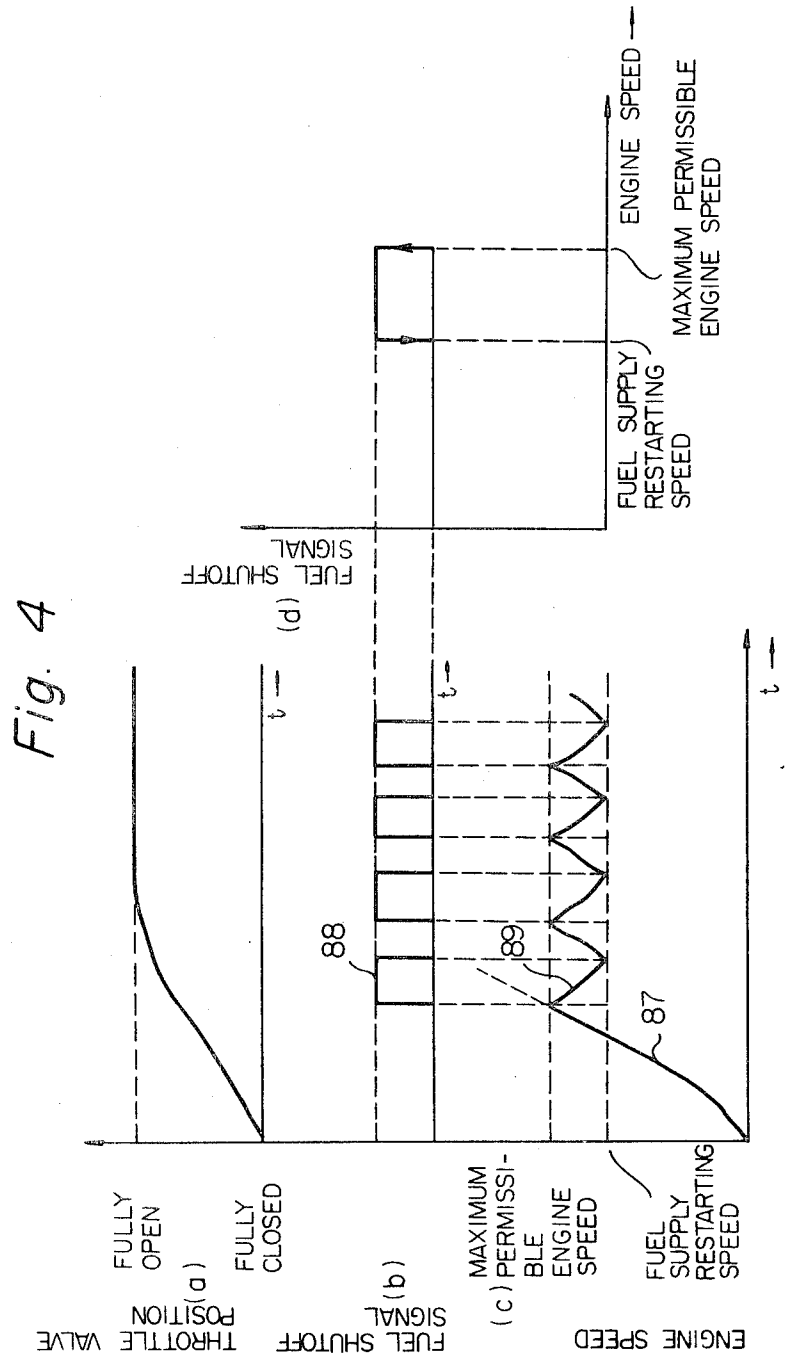
INVENTORS
SHIGEO AONO
BY SHYUYA NAMBU
McCarthy, Depaoli & O'Brien
ATTORNEYS

Fig. 3



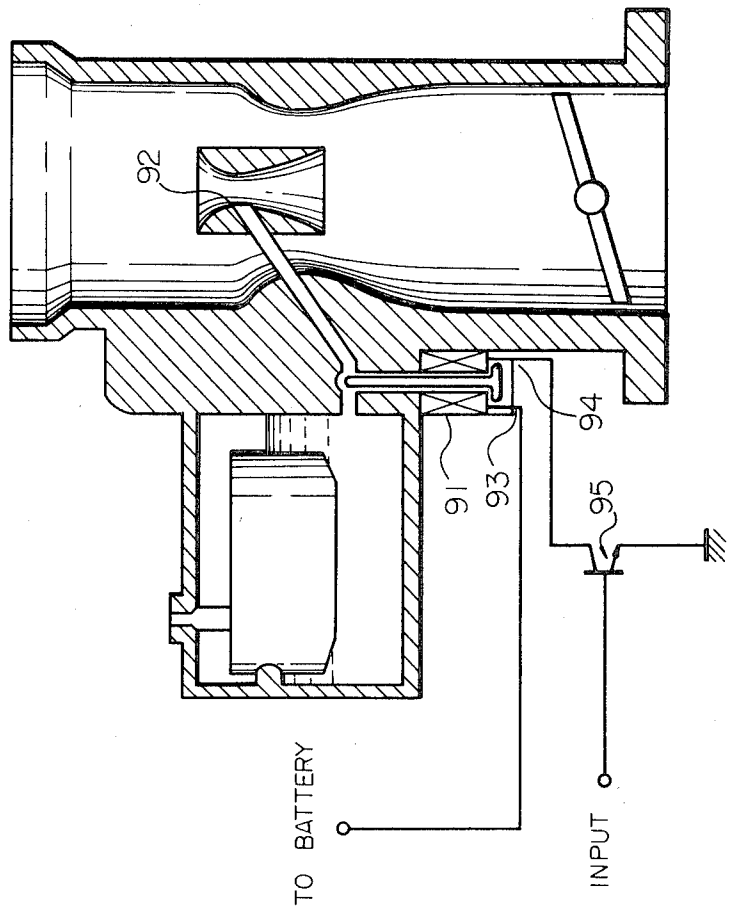
INVENTORS
SHIGEO AONO
BY SHYUYA NAMBU
McCarthy, Lynch & O'Brien
ATTORNEYS

Fig. 4



INVENTORS
SHIGEO AONO
BY SHYUYA NAMBU
McCarthy, Depeah & O'Brien
ATTORNEYS

Fig. 5



INVENTORS
SHIGEO AONO
BY SHYUYA NAMBU
McCarthy, Ogorek & O'Brien
ATTORNEYS

ENGINE OVERRUN PREVENTING DEVICE FOR INTERNAL COMBUSTION ENGINE

This invention relates to an engine overrun preventing device for an internal combustion engine and more particularly to such devices which are adapted to shut off or reduce the fuel supply to the engine cylinders so as to cause engine speed to decrease when "the maximum permissible engine speed" over which the engine tends to overrun has been reached.

It is an object of this invention to provide an engine overrun device adapted for incorporation into a fuel injection system and which is simple in construction.

It is another object of this invention to provide an engine overrun preventing device which renders the injection valve actuation circuit ineffective when the "maximum permissible engine speed" is reached.

It is still another object of this invention to provide an engine overrun preventing device adapted for use with a carburettor type fuel supply system.

It is a further object of this invention to provide an engine overrun preventing device which causes the fuel supply system to restart the normal fuel supply to the engine cylinders when engine speed decreases to "the fuel supply restarting speed" which is lower than the maximum permissible engine speed.

In the drawings:

FIG. 1 is a block diagram showing an engine overrun preventing device incorporated in a fuel injection system according to one embodiment of this invention;

FIG. 2 is a circuit diagram showing an injection valve actuation circuit of FIG. 1;

FIG. 3 is a circuit diagram of the engine overrun preventing device shown in FIG. 1;

FIGS. 4(*a*) through (*d*) are diagrams explaining the operation of the present engine overrun preventing device; and

FIG. 5 is a schematic diagram showing the present engine overrun preventing device incorporated in a carburettor type fuel supply system.

Referring to the drawings and more particularly to FIG. 1, a fuel injection system incorporating an engine overrun preventing device 10 according to one embodiment of this invention is shown. In FIG. 1, numeral 11 designates an engine output shaft driven triggering device incorporated in a distributor housing (not shown). The engine output shaft driven triggering device 11 comprises a cam 12 mounted on an engine output shaft driven shaft 13 and two triggering switches 14 and 15 adapted to be alternately actuated by rotation of the cam 12 in dependence upon engine speed. Both of triggering switches 14 and 15 have a movable contact connected to ground and a stationary contact connected respectively through resistors 16 and 17, respectively, to a battery (not shown). The stationary contacts of the triggering switches 14 and 15 are connected through leads 18 and 19 to a computing circuit 20 so as to transmit thereto a signal indicating engine speed. The computing circuit 20 further receives a plurality of signals indicating engine operating conditions, such as an intake manifold pressure signal 21 and an engine temperature signal 22. In response to these signals, the computing circuit 20 determines a proper time interval during which fuel injection is to take place and generates an injection signal having its pulse width equal to the time interval. This signal is supplied to an injection valve actuation circuit 23 which keeps an injection valve 24 open during a time interval.

FIG. 2 shows an example of the injection valve actuation circuit 23 shown in FIG. 1. This circuit functions to amplify the injection pulse signal to such a level as to actuate the injection valve 24. The injection pulse signal from the computing circuit 20 is applied at a first input terminal 25 which is connected via a resistor 26 to the base of a transistor 27. The transistor 27 has its collector connected via a resistor 28 to a bus line 29 and its emitter grounded. The collector is also connected via a resistor 30 to the base of a transistor 31 whose collector is connected via a resistor 32 to the bus line 29, the emitter thereof being grounded. The collector of the transistor 31 is also connected to the base of a transistor 33 having its emitter grounded. The transistor 33 has its collector connected to the bus line 29 by way of two serially connected resistors 34 and 35, the point between which is connected to the base of a transistor 36 having its emitter connected to the bus line 29. The collector of the transistor 36 is connected to ground by way of a capacitor 37 and a resistor 38. The solenoid actuated injection valve 24 is shown as shunting the series combination of the capacitor 37 and resistor 38.

The injection valve actuation circuit 23 has a second input terminal 39 which is connected via a resistor 40 to the base of the transistor 31. This input terminal 39 is connected to one of the stationary contacts of the engine driven triggering device 11 so as to receive an injection valve discrimination signal associated with the injection valve 24.

The injection valve actuation circuit 23 further includes a third input terminal 41 which is connected to the base of a transistor 42 having its emitter grounded. The collector of the transistor 42 is connected to the base of the transistor 27. The third input terminal 41 is connected to the output of the engine overrun preventing device 10 (FIG. 1), the construction and operation of which will be fully described later.

In the operation of the injection valve actuation circuit 23 shown in FIG. 2, the positive-going injection pulse is supplied from the computing circuit 20 to the first input terminal 25, rendering the transistor 27 conductive, so that the potential at the collector thereof decreases to substantially zero. Under such conditions, if the injection valve discrimination signal applied at the second input 39 is at zero-voltage level, the transistor 31 is kept nonconductive, causing the transistor 33 to become conductive. With the transistor 33 conductive, the transistor 36 is conducting, so that current flows through the transistor 36, resistor 43 and solenoid 24, thus actuating the injection valve. It is to be understood that the solenoid actuated injection valve 24 is actuated in response to the positive-voltage signal applied at the first input terminal 25 if the injection valve discrimination signal is at zero-voltage level.

Reverting to FIG. 1, the signal indicating engine speed is supplied also to the engine overrun preventing device 10, where the signal is converted into a d.c. voltage proportional to the engine speed and is compared with a certain predetermined voltage level so as to detect the conditions in which the engine tends to overrun. Upon detection of such conditions, the engine overrun preventing device 10 applies a fuel shutoff signal to the injection valve actuation circuit 23 so as to render it inactive.

FIG. 3 is a circuit diagram of the engine overrun preventing device 10 shown in FIG. 1. This circuit has an input terminal 44 which is connected to the engine driven triggering device 11 by means of lead 45 (FIG. 1) so as to receive the engine speed signal therefrom. The input terminal 44 is connected to a differentiator comprising a capacitor 46 and a resistor 47, a point between which is connected to a diode 48 which is polarized in a direction to allow only a positive-going pulse to be transmitted therethrough from the input terminal 44 to the following circuit components. The diode 48 is connected to an integrator consisting of a resistor 49 and a capacitor 50, a point between which is connected to the base of a transistor 51. Thus, a d.c. voltage proportional to engine speed develops at the base of the transistor 51. The transistor 51 has its collector connected via a resistor 52 to a bus line 53 and its emitter connected via a resistor 54 to the emitter of a transistor 55, the collector thereof being grounded. The base of the transistor 51 is also connected via a resistor 56 to a voltage divider consisting of resistors 57 and 58 which are connected between the bus line 53 and ground. The resistance values of the four resistors 54, 56, 57 and 58 are adjusted so that the transistor 51 is rendered conductive when the base potential thereof exceeds a value corresponding to the maximum permissible engine speed above which the engine tends to overrun.

The diode 48 is also connected to another integrator comprising a resistor 59 and a capacitor 60, the point between which is connected to the base of a transistor 61. Like the transistor 51, the transistor 61 has its collector connected via a resistor 62 to the bus line 53 and its base connected via a resistor 63 to a voltage divider comprising resistors 64 and 65. The emitter thereof is connected to ground by way of a resistor 66. The values of the four resistors 63, 64, 65 and 66 are adjusted so that the transistor 61 is rendered conductive when the potential at the base thereof rises to a value corresponding to the fuel supply restarting engine output shaft speed which is below the maximum permissible engine speed.

The collector of the transistor 51 is also connected to the collector of a normally nonconducting transistor 67 by way of a capacitor 68 and a diode 69. The diode 69 is polarized in a direction to allow only a negative-going pulse to be transmitted therethrough from the collector of the transistor 51 to that of the transistor 67. The transistor 67 has its collector connected via a resistor 70 to the base of a normally conducting transistor 71 which, together with the transistor 67, forms a flip-flop. The collector of the transistor 66 is also connected to the bus line 53 via a resistor 71. The base of the transistor 67 is connected via a resistor 73 to the collector of the normally conducting transistor 71, which collector is connected to the bus line 53 by way of a resistor 74. The bases of the two transistors 67 and 71 are connected to ground by way of resistors 75 and 76, respectively. The emitters of the two transistors 67 and 71 are connected together to ground through a parallel combination of a resistor 77 and a capacitor 78. The base of the normally conducting transistor 71 is connected to the bus line 53 through a series combination of a diode 79, a capacitor 80 and a resistor 81. The base thereof is also connected to the collector of the transistor 61 by way of a diode 82 and a capacitor 83. The diode 82 is polarized in a direction to allow only a positive-going pulse to be transmitted therethrough from the transistor 61 to the transistor 71. The collector of the transistor 71 is connected to the base of the transistor 55 through a resistor 84.

The output of the engine overrun preventing device 10 is derived from the output terminal 85 connected to the collector of the normally conducting transistor 71. As described above, the output terminal 85 is connected to the third input terminal 41 of the injection valve actuation circuit 23 (FIG. 2).

In the operation of the engine overrun preventing device 10 shown in FIG. 3, the flip-flop is maintained in its first stable state with the transistors 67 and 72 nonconducting and conducting, respectively, since the base of the transistor 71 is connected to the bus line 53 through the series combination of the diode 79, capacitor 80 and resistor 81. Thus, the voltage at the collector of the transistor 71 is at substantially zero level, so that no output signal is developed at the terminal 85. Further, the transistor 55 is conducting since the base is connected to the collector of the transistor 71.

When the fuel supply restarting engine speed is reached, the transistor 61 is rendered conductive, generating a negative-going pulse at the collector thereof. However, the negative-going pulse has no effect upon the flip-flop since the diode 82 prevents the negative-going pulse. When engine speed further increases to the maximum permissible speed, the transistor 51 is rendered conductive, developing at the collector thereof a negative-going pulse which in turn is passed through the capacitor 68, diode 69 and resistor 70 to the base of the normally conducting transistor 71. Consequently, the transistor 71 is rendered nonconductive and the flip-flop is switched to its second stable state. Rendering the transistor 71 non-conductive raises the collector potential to cause an output signal to be fed to the output terminal 85. Further, the transistor 55 is rendered nonconductive because of its connection to the collector of the transistor 71. The output signal is applied to the third input terminal 41 of the injection valve actuation circuit 23 (FIG. 2) to render the transistor 42 conductive, thus connecting the base of the transistor 27 to ground. During the time that the transistor 42 remains conductive, the injection valve 24 is not actuated by the supply of the injection pulse signal at the first input signal 25. Therefore, when the maximum permissible engine speed has been reached, the engine overrun preventing device 10 renders the injection valve actuation circuit 23 ineffective so that the injection nozzle ceases to spray fuel into the intake air entering the engine cylinders, thus preventing the engine from overrunning.

Upon shutoff of the fuel supply to the cylinders, engine speed begins to decrease gradually. When the maximum permissible engine speed is reached, the transistor 51 is rendered nonconductive, generating a positive-going pulse at the collector thereof. However, this pulse is prevented from passing through the diode 69 to the base of the transistor 71. When engine speed decreases further to the fuel supply restarting speed, the transistor 71 is rendered nonconductive, producing a positive-going pulse at the collector thereof. The positive-going pulse, however, can pass through the capacitor 83 and the diode 82 to the base of the transistor 71, rendering it conductive and eventually driving the flip-flop to the first stable state, so that the output signal at the output terminal 85 is zero. When this occurs, the injection valve actuation circuit 23 restores its op-

eration to amplify the injection pulse signal, so that the injection nozzle restarts spraying fuel into the intake manifold or directly into the engine cylinders.

FIGS. 4(*a*) to (*d*) are graphs illustrating the operation of the engine overrun preventing device **10** of this invention. Depression of an accelerator pedal (not shown) toward the fully open position of the throttle valve as shown in FIG. 4(*a*) gradually increases engine speed along the curve **87** of FIG. 4(*c*). When the maximum permissible engine speed has been reached, the engine overrun preventing device **10** produces an output pulse **88**, as shown in FIG. 4(*b*), which is applied to the injection valve actuation circuit **23** so as to shut off the fuel supply to the cylinders. Upon fuel shutoff, engine speed begins to decrease as represented by the curve **89** of FIG. 4(*c*). When engine speed reaches the fuel supply restarting speed, the output signal **88** is zero, so that the injection valve actuation circuit **23** is rendered effective to cause the injection nozzle to supply fuel to the cylinders. This process repeats itself so as not to cause engine overrun. FIG. 4(*d*) shows the hysteresis characteristic of the operation of the present engine overrun preventing device **10**. As shown, the fuel shutoff and restarting of fuel supply are effected at different engine speeds.

FIG. **5** schematically shows another embodiment of this invention as applied to a carburettor type fuel supply system. In FIG. **5**, numeral **91** designates a solenoid valve adapted to stop the fuel flow to a main nozzle **92**. The solenoid of the solenoid valve **91** has one terminal **93** connected to a battery (not shown), and the other terminal **94** connected to the collector of a transistor **95**, the emitter thereof being grounded. The base of the transistor **95** is connected to the output terminal **85** of the engine overrun preventing device **10** shown in FIG. **3**. When the engine overrun preventing device **10** applied an output signal to the base of the transistor **95** upon engine speed reaching the maximum permissible value, the solenoid valve **91** is actuated to shut off the fuel flow to the main nozzle **92** whereby engine overrunning is prevented.

What is claimed is:

1. An engine overrun preventing device for an internal combustion engine and adapted for shutting off the fuel supply to the engine to prevent the engine from overrunning said engine overrun preventing device comprising, in combination, an engine driven triggering device having means for producing a pulse signal proportional to the speed of said engine, a differentiating circuit connected to said engine driven triggering device and including a first capacitor connected to said engine driven triggering device and a first resistor connected to said first capacitor, first and second integrating circuits connected to the joint between said first capacitor and said first resistor of said differentiating circuit, said first integrating circuit including a second resistor connected to said differentiating circuit and a second capacitor connected to said second resistor, said second integrating circuit including a third resistor connected to said differentiating circuit and a third capacitor connected to said third resistor, a diode connected between said differentiating circuit and said first and second integrating circuits, said diode being polarized in a direction to allow only pulses of one polarity to be transmitted therethrough from said differentiating circuit to said first and second integrating circuits, first and second switching circuits connected to said first and second integrating circuits respectively, said first switching circuit including first resistor means connected to said engine driven triggering device through said diode and said differentiating circuit and a first transistor connected to said first resistor means and the joint between said second resistor and said second capacitor of said first integrating circuit, said first resistor means having the resistance value to render said first transistor conductive when the base potential thereof exceeds a value corresponding to the maximum permissible engine speed over which said engine tends to overrun, said second switching circuit including second resistor means connected to said engine driven triggering device through said diode and said differentiating circuit and a second transistor connected to said second resistor means and the joint between said third resistor and said third capacitor of said second integrating circuit, said second resistor means having the resistance value to render said second transistor conductive when the base potential thereof rises to a value corresponding to the fuel supply restarting engine speed lower than said maximum permissible engine speed, a flip-flop circuit having first and second inputs connected to said first and second transistors of said first and second switching circuits respectively and having an output, said flip-flop circuit having means for generating a fuel shut off signal when said first transistor is conductive and generating a fuel supply restarting signal when said second transistor is conductive, said means of said flip-flop circuit including a normally conducting transistor connected to said second transistor of said second switching circuit and a normally conducting transistor connected to said first transistor of said first switching circuit, the output of said flip-flop circuit being derived from the collector of said normally conducting transistor, and an injection valve actuation circuit connected to the output of said flip-flop circuit and responsive to said fuel shutoff signal and said fuel supply restarting signal for controlling the fuel supply to said engine thereby to prevent said engine from overrunning.

2. An engine overrun preventing device according to claim **1**, wherein said means of said engine driven triggering device includes a cam mounted on the engine output shaft and two triggering switches adapted to be alternately actuated by the rotation of the cam in dependence on the speed of said engine.

3. An engine overrun preventing device according to claim **1**, wherein said injection valve actuation circuit includes a transistor which is responsive to said fuel shutoff signal to connect the input terminal of said injection valve actuation circuit to ground thereby to render it inactive.

* * * * *