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Bigalke et al.

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[54] **SWITCHING DEVICE AND CIRCUIT**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 86,539, Nov. 3, 1970, abandoned.

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

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

[56] **References Cited**

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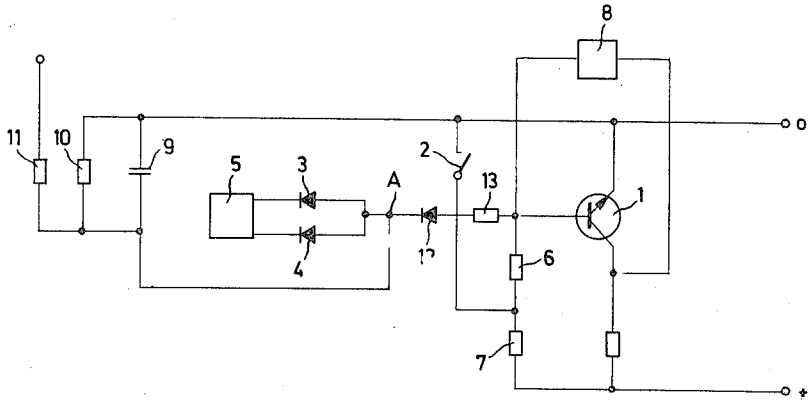
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[57] **ABSTRACT**

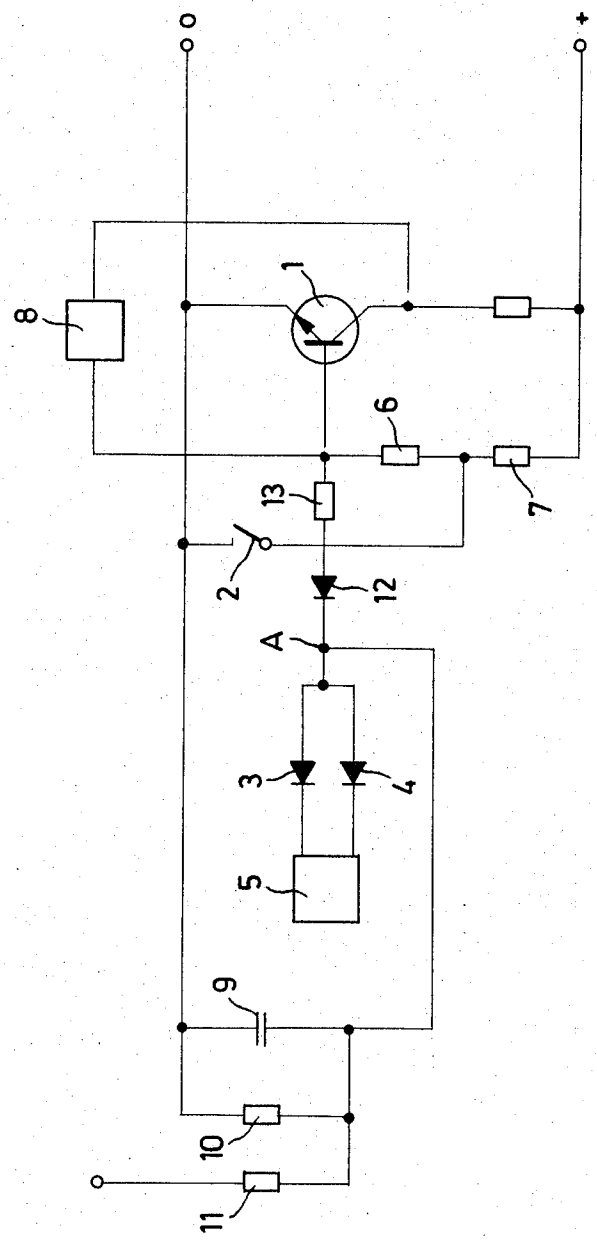
In an electronic fuel control support for supplying fuel to a combustion engine, fuel supply is cut off when the engine r.p.m. during deceleration reaches a predetermined value and is re-supplied to the engine when the engine r.p.m. exceeds a second pre-determined value which exceeds the first pre-determined value. The control circuitry includes an integration network which integrates a signal related to the r.p.m. of the engine for re-establishing the fuel supply.

3 Claims, 1 Drawing Figure



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SWITCHING DEVICE AND CIRCUIT

This application is a Continuation-in-Part of Bigalke et al application Ser. No. 86,539, filed Nov. 3, 1970 and now abandoned.

The invention relates to circuitry for controlling the deceleration fuel cut-off in combustion engines, preferably for engines with electronic fuel injection and more particularly, to circuitry dependent on the r.p.m. in such a way that during deceleration fuel delivery above and below different predetermined engine speeds is prevented.

In modern electronic fuel injection systems, a deceleration fuel cut-off above a certain engine r.p.m. is provided in order to prevent, at least in the range above that r.p.m. during coasting, relatively high portions of harmful gases in the exhaust. However, for a certain r.p.m. range lying above the r.p.m. fuel cut-off value the portion of harmful gas, on the one hand, is inconsequential while, on the other hand, the fuel cut-off may have a very adverse effect on the operation of the motor. For example, where the fuel is cut-off above a certain r.p.m. range, a slight acceleration of the engine may lead to a stalling of the motor and to backfiring thereof. Especially, in the case of critical passing maneuvers, this can considerably impede driving safety. A further disadvantage of the fuel cut-off even in the case of high r.p.m. resides in the fact that in the case of prolonged down-hill travel, the cylinder head will cool off considerably and thereby a resistance with negative temperature coefficient built into the cylinder head as an essential component of the circuit for the electronic fuel injection will assume such values, that in a subsequent idling of the engine, the injection time will be considerably prolonged, that is to say the r.p.m. of the motor drops, possibly resulting in engine cut-off.

It is, therefore, an object of the invention to provide an improvement of the known switching circuitry for deceleration fuel out-off wherein the fuel control circuit permits the feeding of fuel above a certain predetermined r.p.m. of the motor which is higher than a first predetermined r.p.m. at which fuel cut-off was initiated.

The switching circuit according to the invention, therefore, as in the case of the known fuel injection circuit, produces a deceleration fuel cut-off as soon as the r.p.m. exceeds a first predetermined value. However, in contradistinction to the known circuit arrangements, the fuel cut-off is removed again whenever the r.p.m. exceeds a second predetermined value which is greater than the first mentioned r.p.m. This second r.p.m. value lies outside the area which is critical in regard to the portion of harmful gases in the exhaust gas, but is low enough so that the method of operation of the engine will not yet be influenced detrimentally by the fuel cut-off.

A significant feature of the inventive switching system is the use of an integration circuit which includes a capacitor, a discharge resistor lying in parallel thereto, as well as a charging resistor which is fed a signal dependent on the r.p.m. whereby a control electrode of a fuel supply transistor is regulated to achieve the desired results.

While the operation of the switching circuit of the present invention provides for a different type of operation than previously utilized in the operation of fuel injection engines, in constructing the switching circuit for

carrying out such operations, standard circuits which are readily available in the existing technology would be utilized for such construction. In this regard, attention is directed towards the U.S. Patent to W. Reichardt et al, Pat. No. **3,463,130,** which illustrates various circuit arrangements capable of being utilized in the construction of the switching circuit of the present invention for carrying out the desired operation. With respect to this reference, it is noted that while the moments at which the fuel is cut off during deceleration of the engine is different from that provided in accordance with the present invention, the circuit arrangement for carrying out such control procedures would be substantially similar.

The above and other objects and advantages of the invention will be apparent from the following description when considered in connection with the accompanying drawing in which an exemplary embodiment is illustrated.

The transistor **1** controls the fuel cut-off during deceleration or releases the supply of fuel by means of load elements, not shown, respectively in accordance with its non-conductance or conductance, and constitutes an essential component of the electronic fuel injection circuit. The transistor **1** is nonconductive and, consequently, the deceleration fuel cut-off is effective whenever, with throttle valve **2** closed, its base potential is lowered. This is accomplished by means of diodes **3** and **4,** which are connected with r.p.m. controlling network **5** in such a way that diodes **3** and **4** are made conductive at respective r.p.m. values which define a desired r.p.m. range for fuel cut-off. If, however, throttle valve switch **2** is opened, then transistor **1** is made conductive by means of resistors **6** and **7** or, insofar as no negative potential is connected to diodes **3** and **4,** by the regenerative coupling network **8.** The control of transistor **1** by regenerative coupling network **8** and resistors **6** and **7** is well known to those skilled in electronic controlled fuel injection systems and forms no part of the present invention.

R.P.M. controlling network **5** generates control signals to actuate diodes **3** and **4** at respectively different engine r.p.m. values to define the desired r.p.m. range during which deceleration fuel cut-off takes place. For example, diode **3** may be forward biassed by r.p.m. controlling network **5** between 1800 and 3000 r.p.m. when the r.p.m. go up and between 3000 and 1000 r.p.m. when the engine speed decreases. This is established in the network **5** by differentiating and integrating circuits for the fuel injection control impulses in a manner known in the art. Diode **4** is connected to an element which is sensitive for the temperature of the engine in order to vary said r.p.m. ranges with temperature. This, of course, does not constitute part of the invention. As is evident from the circuit illustrated in the FIGURE, the closing of switch **2** provides a bias to the base of transistor **1** which is determined by resistors **6** and **7.** When either diode **3** or **4** is energized, the base of transistor **1** is driven sufficiently negative to render it non-conductive cutting off supply of fuel to the engine.

As is apparent from a consideration of the circuit, the potential at junction A is the controlling factor as diode **12** can be back-biassed if the potential at junction A is sufficiently positive. In accordance with the invention the potential at junction A is controlled by an integration circuit so that diode **12** is back-biassed at an ele-

vated r.p.m. whereby transistor **1** is no longer controlled by diodes **3** and **4** and is again rendered conductive by the bias provided via switch **2** and resistors **6** and **7**. In such a case the conduction of transistor **1** reestablishes supply of fuel to the engine. The integration circuit comprises capacitor **9** and resistor **11** which is connected to a source that generates a signal dependent on the engine r.p.m. Resistor **10** acts as a discharge resistance for capacitor **9**. The signal fed to resistor **11** and capacitor **9** are selected so that diode **12** is back biassed at a desired engine r.p.m. such as, for example, **3000** r.p.m.

Thus, the supply of fuel is restored at 3000 r.p.m. after having been cut-off at engine r.p.m's exceeding 1800 r.p.m. and is also restored when the engine speed again goes down below 1000 r.p.m. by the operation of r.p.m. controlling network **5** and diodes **3** and **4**.

What is claimed is:

1. An electronic fuel control circuit for controlling the supply of fuel to a combustion engine, comprising:

throttle switch means for controlling the fuel supply;

means for deceleration fuel cut-off additionally controlling the fuel supply in accordance with the rpm of the engine whereby the fuel supply is cut off at a predetermined rpm of said engine with said throttle switch means closed; and

additional means for further controlling the fuel supply in response to the rpm of said engine whereby fuel is supplied to said engine when the engine rpm exceeds a second predetermined value greater than said predetermined rpm.

2. An electronic fuel injection control circuit as in claim **1** wherein said additional means for controlling comprises an integration network including a capacitor and a parallelly connected discharge resistor and a charging resistor connected to said capacitor and discharge resistor and fed responsive to the r.p.m. of said engine.

3. An electronic fuel injection control circuit as in claim **2** further comprising for use in controlling the supply of fuel a transistor for blocking and unblocking the supply of fuel.

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