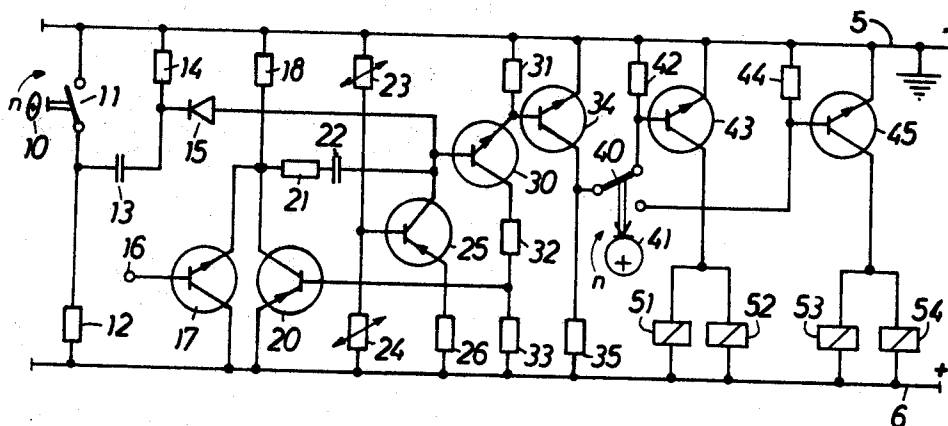


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[33] **Germany**
[31] **1,601,363**

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[54] **FUEL INJECTION ARRANGEMENT FOR**
INTERNAL COMBUSTION ENGINES
15 Claims, 7 Drawing Figs.
[52] U.S. Cl. **123/32,**
123/119, 123/148
[51] Int. Cl. **F02d 5/00**
[50] Field of Search **123/32,**
119, 148E

ABSTRACT: A fuel injection arrangement for internal combustion engines in which the duration is varied as a function of an operating characteristic of the engine. The timing of a monostable multivibrator is varied by varying the resistance values of magnetically-sensitive resistors mounted within a magnetic field which is varied as a function of a desired operating characteristic. A function sensor coupled to either the rotational speed, intake manifold pressure or throttle of the engine, varies the reluctance of the magnetic flux through a magnetic circuit path. The magnetically-sensitive resistors are mounted within the magnetic path so that the resistance values become varied through the function sensor.



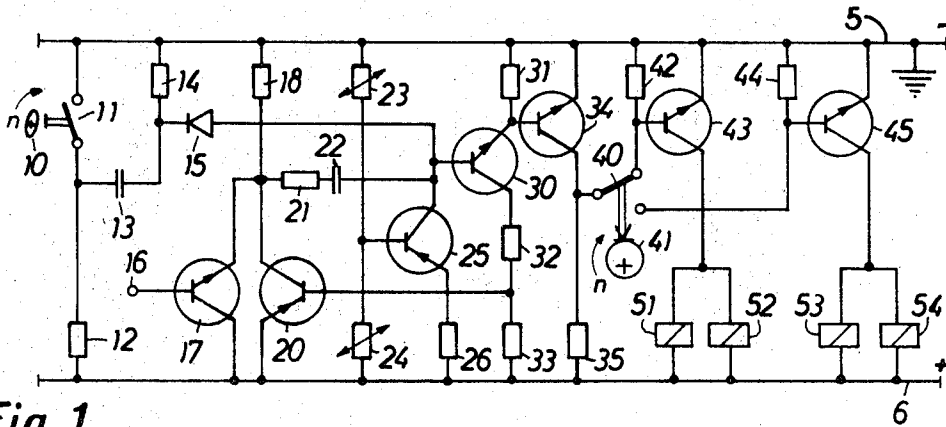


Fig. 1

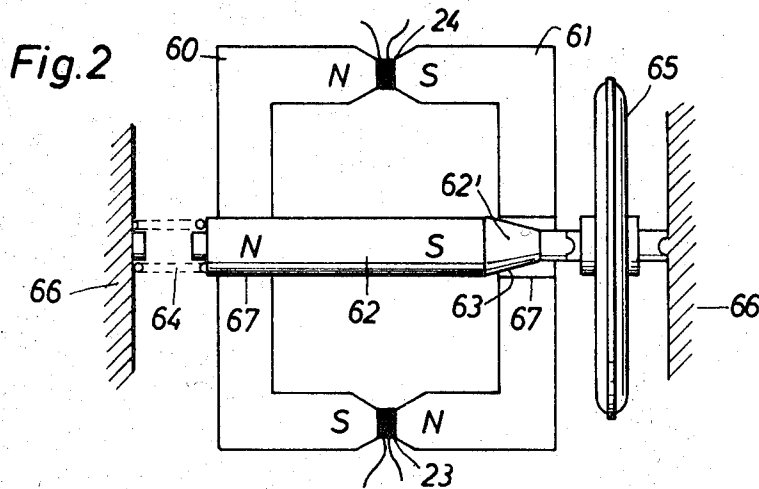


Fig. 2

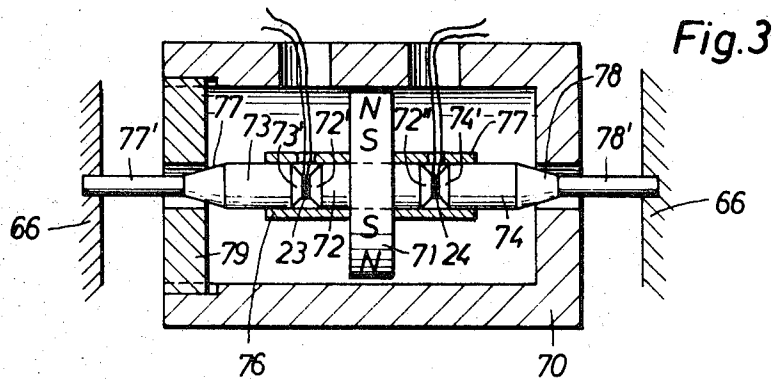


Fig. 3

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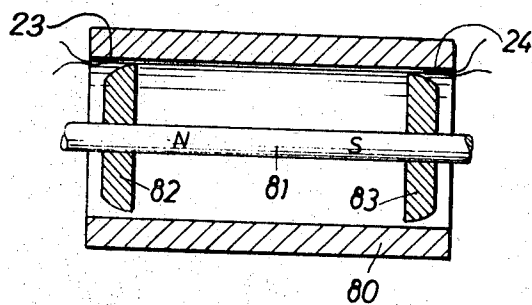


Fig. 4

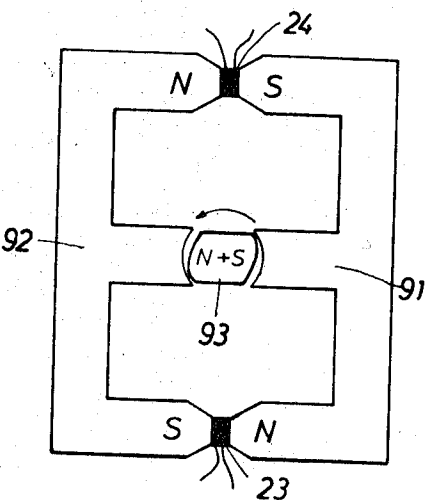


Fig. 5

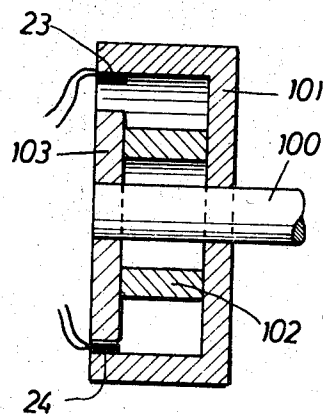


Fig. 6

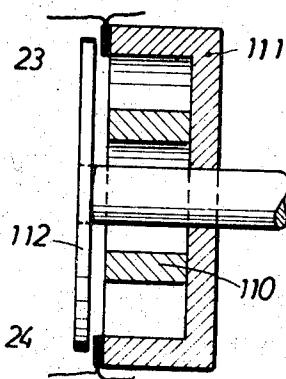
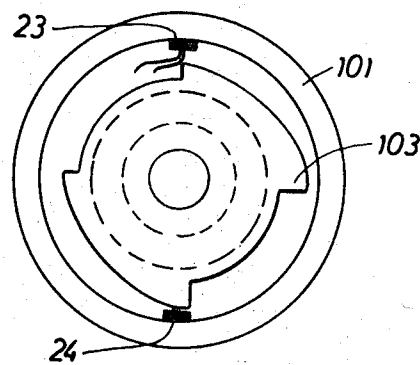
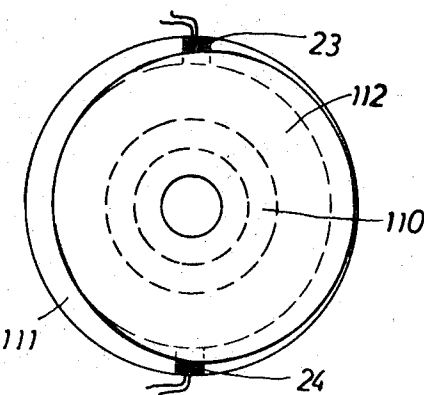


Fig. 7



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FUEL INJECTION ARRANGEMENT FOR INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

The present invention relates to a fuel injection arrangement for internal combustion engines in which the injected quantity depends upon at least one operating parameter of the engine as, for example, the rotational speed, the intake manifold pressure, or the throttle position. Control is exercised with the aid of a monostable multivibrator which determines the time interval for the fuel injection as a function of the controlling parameters.

Arrangements are known in the art in which the parameters to be measured are applied to an electronic control circuit. In particular, such arrangements apply these operating parameters to the timing network of a monostable multivibrator which determines the injection duration. The parameters are applied to the monostable multivibrator, in this manner, through functional sensors or transducers. Such transducers are in the form of mechanically positioned potentiometers. In motor vehicles designed for driving large mechanical loads, such potentiometers are subjected to, for example, shock and vibration as well as contamination. These undesirable environmental conditions diminish the operational reliability of the arrangement.

In accordance with the present invention, therefore, at least one resistor is provided in which the resistance value is made variable by varying the characteristic of a magnetic field as a function of an operational parameter. The variation of the resistor affects the timing network of the arrangement.

In addition to avoiding the aforementioned disadvantages, the embodiment of the present invention also affords the possibility to envelope any desired function with sufficient rapidity.

SUMMARY OF THE INVENTION

A fuel injection arrangement in which the duration of fuel injection into the engine is varied as a function of one of the operating characteristics of the engine. The operating characteristic may be selected as the rotational speed, the intake manifold pressure, or the throttle position, for example. The unstable time interval of a monostable multivibrator circuit is used to establish the injection duration of the engine. The timing network of the monostable multivibrator is directly connected to a magnetically-sensitive resistor subjected to a magnetic field which is made to vary in intensity as a function of the selected operating characteristic. The intensity of the magnetic field to which the magnetically-sensitive resistor is subjected to, may be varied in turn, by varying the reluctance of the magnetic path of field. This is accomplished by moving a ferromagnetic member, for example, as part of the core associated with the field as a function of the selected operating characteristic, by mechanically linking the ferromagnetic member to the engine at the location at which the operating characteristic is realizable. By varying the resistance value of the magnetically-sensitive resistor through variation of the magnetic field, in this manner, the timing network of the monostable multivibrator, and hence the duration of the unstable state of the monostable multivibrator becomes varied as a function of the selected operating characteristic. Accordingly, the duration of injection as determined by the unstable state of the monostable multivibrator is affected as a function of the selected operating characteristic.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an electronic circuit diagram of the control arrangement for fuel injection in internal combustion engines, in accordance with the present invention;

FIG. 2 is a sectional diagrammatic view of an intake manifold pressure sensor used in connection with the arrangement of FIG. 1;

FIG. 3 is a sectional view of another embodiment of an intake manifold pressure sensor of FIG. 2;

FIG. 4 is a sectional view of a still further intake manifold pressure sensor;

FIG. 5 is a sectional view, in diagrammatic form, of a throttle position sensor used in conjunction with the arrangement of FIG. 1;

FIG. 6 is a plan view and a sectional side view of another embodiment of a throttle position sensor for the arrangement of FIG. 1; and

FIG. 7 is a plan view and a sectional side view of a still further embodiment of a throttle position sensor, in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawing, FIG. 1 shows an injection arrangement adapted, for example, for a four-cycle internal combustion engine with four cylinders. The four electromagnetically actuated injection valves 51, 52, 53 and 54 are arranged in two groups 51-52 and 53-54. The operating coils of these injection valves have one terminal connected to the positive line 6, and the other terminal leading to the negative potential line 5, by way of the collector-emitter path of NPN transistors 43 and 45. The opening duration of the valves 51, 52, 53 and 54 is determined from a monostable multivibrator which contains a PNP transistor 20 and a NPN transistor 30 as the principle operating components. The transistor 20 is connected directly to the positive potential line 6 through its emitter, whereas the collector of the transistor 20 leads to the negative supply line 5, by way of the resistor 18. The collector of the transistor 30 is connected to a voltage divider consisting of resistors 32 and 33 which, in turn, is connected to the positive supply line 6. The emitter of the transistor 30, on the other hand, is connected to the negative supply line 5, through the resistor 31. The capacitor 22 which determines the injection time interval and which functions as the storage component in this monostable multivibrator circuit, is connected between the base of the transistor 30 and a resistor 21 which, in turn, is connected to the collector of the transistor 20. The base of the transistor 20 is connected to the junction between resistors 32 and 33 forming a voltage divider.

In order to influence or affect the discharge time of the capacitor 22 and thereby the injection duration, the collector of a PNP transistor 25 is connected to the base of the transistor 30. A resistor 26 is connected between the emitter of the transistor 25, and the positive supply line 6. The control current for this transistor 25 is determined by a voltage divider consisting of resistors 23 and 24. These two resistors have values dependent upon the intensity of a magnetic field, and their junction is connected to the base of a transistor 25. This voltage divider of resistors 23 and 24 is connected across the positive and negative supply lines 6 and 5, respectively. The diode 15 is, furthermore, connected to the base of the transistor 30. This diode 15 is connected to the junction of a capacitor 13 and resistor 14 which forms a differentiating network. The differentiating network, is, in turn, connected to a switch 11 operated by a cam. The fixed or stationary contact of the switch 11 is connected directly to the negative supply line 5, whereas the movable contact of the switch 11 leads to the positive voltage supply line 6, by way of the resistor 12. An NPN transistor 34 is connected to the emitter of the transistor 30 for the purpose of amplifying the signals produced by the monostable multivibrator circuit. The emitter of this transistor 34 is directly connected to the negative voltage line 5, whereas the collector of this transistor 34 leads to the positive voltage

line 6, through the resistor 35. The collector of the transistor 34 is, furthermore, connected to the movable contact of a switch 40 which is actuated or operated by the cam 41. The fixed or stationary contacts of this switch are arranged so that one contact leads to the base of the transistor 43, while the other contact leads to the base of the transistor 45. The base of the transistor 43 leads to the negative voltage line 5 through the resistor 42, and the base of the transistor 45 leads to the negative voltage line 5 through the resistor 44.

In operation, the transistors 20 and 30 are conducting in the quiescent state. The two end or terminal transistors 43 and 45 are turned off in the quiescent state, and the injection valves are thereby closed. The capacitor 22 becomes charged through the limiting resistor 21, the collector-emitter path of the transistor 20, and the base-emitter paths of the transistors 30 and 34.

The cam 10 actuates the switch 11 twice for every rotation of the cam shaft, and when the switch 11 becomes thus closed, the negative pulse appearing at the switch 11 becomes differentiated. The differentiated pulse or signal is transmitted to the base of the transistor 30, through the diode 15. As a result, the transistor 30 as well as the transistor 20 become turned off. The monostable multivibrator is then situated in its unstable state. During the duration of this unstable state, the monostable multivibrator maintains open either the valves 51 and 52 or the valves 53 and 54, depending upon the position of the transfer switch 40. The negative voltage rise appearing at the collector of the transistor 20 when the latter becomes turned off, maintains the transistor 30 turned off, until the capacitor 22 has been discharged. This condition prevails even after the differentiated pulse has been passed over the capacitor 22. This capacitor becomes discharged with constant current in this embodiment. This constant discharged current results through the transistor 25, and the valve of magnitude of the current is determined through the resistor 26 and the potential line at the emitter for the base of the transistor 25. The base potential is dependent upon the magnetic-sensitive resistors 23 and 24. Through variation of the magnetic field linking these resistors, the resistance values of these resistors are varied so that favorable operation as a function of temperature is realized.

In order to apply a correction voltage which is preferably dependent upon the rotational speed, an NPN correction transistor 17 is connected in parallel with the emitter-collector path of the transistor 20. The correction voltage or signal is applied to the circuit and to the base of the transistor 17, through the input terminal 16. The capacitor 22 charges to the full battery voltage, independent of the voltage line at the base of the transistor 17. In this manner, the base-emitter path of the transistor 17 is biased in the turned-off direction. When the monostable multivibrator is transferred in state, a step voltage appears at the collector of the transistor 20. The magnitude of this step voltage is limited by a voltage prevailing at the base of the transistor 17. As a result of this step voltage, the time interval during which the monostable multivibrator circuit is in its unstable state, is diminished.

Upon subsequent discharge of the capacitor 22, the transistor begins to conduct, as well as the transistor 20. The monostable multivibrator then transfers back to its stable state in closing the valves 51 to 54.

In accordance with the arrangement of FIG. 2, the two magnetic-sensitive resistors 23 and 24 are built into an arrangement which serves as a sensor for the pressure within the intake manifold. Two U-shaped permanent magnets 60 and 61 are arranged so that they are situated opposite to each other with poles of opposite polarity facing one another. The magnetic-sensitive resistors 23 and 24 are secured within the air gaps between the poles of the magnets. Each of the two U-shaped magnets 60 and 61 has a bore 67 lying longitudinally along the symmetrical axis of the magnet. A permanent magnet 62 which is rod shaped is slidable within the bore 67. At one end 62' of the rod shaped permanent magnet 62, is a control cam contour 63. This cam contour 63 is shown in the em-

bodiment in the form of a tapered portion or trapezoid of revolution. This cam contour can, however, be of a different shape as required for fitting to another desired function of the magnetic field variation. The displacement of the magnet 62 results through a ciphon diaphragm 65 which abuts against the wall of a housing 66 shown only in partial form. On the other side or end of the permanent magnet 62, is a spring 64 which abuts the opposite wall of the housing. The housing 66 is sealed against the external air or environment, and is connected with the intake manifold of the internal combustion engine through a hose connection, not shown. In this manner, the diaphragm member 65 is subjected to the pressure of the intake manifold and is thereby pressed together more or less. When the magnet 62 is displaced in the longitudinal direction, the cam contour 63 produces a varying air gap within the bore 67. Through this variation in the air gap, the magnetic field strength between the pulse of the magnets becomes varied correspondingly. The arrangement is such that when the resistance value of one of the magnetic-sensitive resistors increases, the resistance value of the other resistor decreases.

The intake manifold pressure sensor shown in another embodiment of the FIG. 3, has a cylindrical-shaped enclosure 70 and a disc-shaped magnet 71 which is radially polarized and is situated within the interior of the enclosure. The disc-shaped magnet 71 has a central bore in which a cylindrical soft iron bar or rod 72 is secured. This soft iron rod 72 is tapered at both of its ends 72' and 72''. A soft magnetic bolt member 73 is secured to one end of the rod-shaped member 72, through means of a sleeve 76 which is made of nonmagnetic material. This same sleeve also secures a similar bolt member 74 of soft magnetic material to the other end of the rod 72. These two bolt members 73 and 74 also have tapered ends 73' and 74' facing the ends of the rod-shaped member 72. A magnetic field-sensitive resistor 23 is located or situated between the rod member 72 and the bolt member 73, whereas another magnetic-sensitive resistor 24 is similarly located between the rod member 72 and the bolt member 74. Transition portions 77 and 78 prevail between the bolt members 73 and 74 and guide pins 77' and 78', respectively. These transition portions 77 and 78 are trapezoidal shaped. The guide pins 77' and 78' are secured in the wall of the housing 66. The guide pins maintain the trapezoidal sections 77 and 78 concentric with the bores in the base or bottom of the enclosure 70, as well as in the cover 79. When the enclosure is displaced as a function of the intake manifold pressure, the air gap between the portion 77 and the enclosure 70 varies in an opposite sense to the air gap between the portion 78 and the enclosure 70. As a result, the field linking the resistors 23 and 24 is correspondingly varied with their accompanying resistance values.

A further embodiment for the sensor of the pressure within the intake manifold is shown in FIG. 4. A bar magnet 81 becomes displaced as a function of the manifold pressure, through a ciphon diaphragm. Two discs 82 and 83 are secured to the bar magnet 81 and have identical shapes or contours on their rims or circumferences. The magnetic rod 81 as well as the discs 82 and 83 move within a cylindrical sleeve 80. The magnetic-sensitive resistors 23 and 24 are secured to the inner wall of the sleeve near the respective ends thereof. When the bar magnet 81 is displaced with the discs 82 and 83 longitudinally in relation to the sleeve 80, the resistance values of the resistors 23 and 24 become oppositely varied. In this design, the sleeve 86 can also be made of magnetic material instead of the bar member 81.

FIG. 5 shows an embodiment of a throttle position sensor. This device consists of two magnets 91 and 92 having three poles, and arranged so that the poles of one magnet face opposite poles of the other magnet. The magnetic field-sensitive resistors 23 and 24 are situated between the outer opposite poles of the magnet. A cam-shaped magnet 93 is provided in an air gap between the two center poles of the magnet, and is rotated or positioned through the throttle shaft, not shown. Thus, the shaft of the throttle is coupled mechanically to the cam-shaped magnet 93, and as a result the latter becomes an-

gularly positioned in accordance with the position of the throttle. With the rotation of the cam-shaped member 93, in this manner, the magnetic field acting upon the resistors 23 and 24 becomes varied, and the resistance values of these two resistors becomes varied correspondingly.

In the embodiment of FIG. 6, a throttle position sensor is shown in the form of a magnetic ring system. The magnetic-sensitive resistors 23 and 24 are secured at oppositely lying positions on the interior wall of an enclosure 101 in which a ring magnet 102 is secured. A nonmagnetizable shaft 100 becomes driven or positioned with the shaft position of the throttle so that the rotation of the shaft 100 corresponds to the opening of the throttle. The shaft 100 rotates a differential disc 103 made of soft iron. The contour of the rim of the differential disc 103 is made such that it is a function of the desired magnetic field variation. The sensor design is illustrated for a maximum 90° rotation of the shaft 100.

The functional generators in the preceding embodiments operate on the principle that the operational surfaces of the magnetic-sensitive resistances are entirely within a magnetic field, and that the strength of intensity of the field is varied. Another possible arrangement for affecting or influencing the magnetic-sensitive resistors resides in dipping or immersing the resistors more or less within a magnetic field of constant intensity. Such an embodiment is shown in FIG. 7. The throttle position sensor consists, in this embodiment, of a magnetic ring 110 which is arranged within an enclosure or housing 111. Two magnetic-sensitive resistors 23 and 24 are arranged on the rim of the housing or enclosure. A soft iron disc-shaped member 112 is moved over these resistors so that the disc covers the resistors more or less depending upon its position. As a result, the magnetic field linking the magnetic-sensitive resistors 23 and 24 becomes varied, and the resistance values of the resistors vary correspondingly.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of construction differing from the types described above.

While the invention has been illustrated and described as embodied in fuel injection arrangement for internal combustion engines, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

We claim:

1. A fuel injection arrangement for internal combustion engines comprising, in combination, a controllable monostable multivibrator with a timing network for varying the timing of said monostable multivibrator; said timing of said monostable multivibrator determining the fuel injection duration for said internal combustion engine; magnetic means for establishing a magnetic field varying in intensity as a function of at least one operating characteristic of said engine; and magnetically-sensitive resistor means connected to said monostable multivibrator and exposed to said magnetic field, said resistor means varying in resistance value as a function of the intensity of said magnetic field and thereby as a function of said operating characteristic of said engine, whereby said timing of said monostable multivibrator varies as a function of said resistance value of said resistor means and thereby as a function of said operating characteristic of said engine.

2. The fuel injection arrangement for internal combustion engines as defined in claim 1 wherein said operating characteristic is the rotational speed of said engine.

3. The fuel injection arrangement for internal combustion engines as defined in claim 1 wherein said operating characteristic is the intake manifold pressure.

4. The fuel injection arrangement for internal combustion engines as defined in claim 1 wherein said operating characteristic is the throttle position of said engine.

5. The fuel injection arrangement for internal combustion engines as defined in claim 1 including capacitor means in said timing network of said monostable multivibrator; transistor

means with emitter-collector path connected to said capacitor means and applying charge transfer current to said capacitor means; and base voltage means including said magnetically-sensitive resistor means and connected to the base of said transistor means for controlling the magnitude of said charge transfer current to said capacitor means.

6. The fuel injection arrangement for internal combustion engines as defined in claim 5 including means for discharging said capacitor means of said timing network as a function of the rotational speed of said engine.

7. The fuel injection arrangement for internal combustion engines as defined in claim 6 including compensating transistor means for applying a limiting voltage for determining the discharge of said capacitor means.

8. The fuel injection arrangement for internal combustion engines as defined in claim 1 including function sensor means with magnetic means having air gaps, said magnetically-sensitive resistor means being arranged within said air gaps, the magnetic field intensity in said air gaps being varied as a function of said operating characteristic and thereby varying the timing of said monostable multivibrator as a function of said operating characteristic.

9. The fuel injection arrangement for internal combustion engines as defined in claim 8 wherein said function sensor is an intake manifold pressure sensor comprising two U-shaped magnets arranged with opposite poles facing each other through two air gaps and having each an opening through which a rod-shaped member is movable; pressure sensing means within the intake manifold of said engine and mounted on said rod-shaped member for moving said rod-shaped member in relation to the pressure prevailing within said intake manifold of said engine, said magnetically sensitive resistor means being two magnetically-sensitive resistors each within one air gap between said U-shaped magnetic members.

10. The fuel injection arrangement for internal combustion engines as defined in claim 8 wherein said function sensor comprises a three-part rod-shaped member including air gaps in which said resistor means is arranged, one of said parts being a disc-shaped magnet; and housing means surrounding said rod-shaped member and slidable as a function of the pressure prevailing within the intake manifold of said engine, whereby the resistance values of said resistor means and thereby the duration of fuel injection is varied as a function of the intake manifold pressure.

11. The fuel injection arrangement for internal combustion engines as defined in claim 8 wherein said function sensor comprises a cylindrical sleeve member with said resistor means being secured to the inner wall at the rim of said cylindrical sleeve member; a rod-shaped magnet arranged longitudinally within said cylindrical sleeve member; and two disc-shaped members mounted on said rod-shaped magnet and movable in relation to the pressure prevailing within the intake manifold of said engine, whereby the resistance value of said magnetically-sensitive resistor means and thereby the duration of fuel injection is varied as a function of the intake manifold pressure of said engine.

12. The fuel injection arrangement for internal combustion engines as defined in claim 8 wherein said function sensor comprises two three-poled magnets each having a center pole and two outer poles arranged so that opposite poles of the two magnets face each other through air gaps between the outer poles of said two magnets, said resistor means being two magnetically-sensitive resistors each arranged within the air gap between the outer poles of said magnets; and a rotatable magnetic member rotatable within an air gap between the center poles of said magnets and mechanically coupled to the throttle of said engine, whereby the resistance values of said magnetically-sensitive resistors are varied as a function of the throttle position of said engine for varying the duration of fuel injection thereby as a function of the throttle position of said engine.

13. The fuel injection arrangement for internal combustion engines as defined in claim 8 wherein said function sensor

comprises a cap-shaped housing; a ring magnet arranged concentric with the axis of said cap-shaped housing and mounted within said housing, said resistor means being secured to the inner wall of said housing; a rotatable shaft coupled to the throttle of said engine and rotatable within said housing concentrically with the axis of said magnetic ring and said housing; and a cam-shaped member mounted on said shaft and varying the air gap between said resistor means and said cam-shaped member, whereby the resistance value of said resistor means and thereby the duration of said fuel injection is a function of the throttle position of said engine.

14. The fuel injection arrangement for internal combustion engines as defined in claim 7 including a function sensor for varying the timing of said monostable multivibrator and comprising a first member upon which said resistor means are mounted within a magnetic field of constant intensity; and a second member varying the overlapping surface between said resistor means and said second member, whereby said second

member is coupled to said engine so that said second member varies said overlapping surface as a function of said operating characteristic and thereby vary the resistance value of said resistor means as a function of said operating characteristic.

15. The fuel injection arrangement for internal combustion engines as defined in claim 14 wherein said first member comprises a cap-shaped housing; a magnetic ring mounted within said housing and concentrically with the axis thereof, said resistor means being mounted on the rim of said cap-shaped housing, said second member comprising a shaft coupled to the throttle of said engine and movable concentrically with the axis of said housing and said ring magnet, said second member including a cam mounted on said shaft and varying the surface of said resistor means covered by said cam, whereby the resistance value of said resistor means and thereby the duration of fuel injection is varied as a function of the throttle position of said engine.

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