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Traisnel

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[45] **May 28, 1974**

[54] **ELECTRONIC FUEL INJECTION CONTROL DEVICES FOR INTERNAL COMBUSTION MOTORS**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ...... **123/32 EA**, 123/179 L, 123/180 R

[51] **Int. Cl.** **F02b 3/00**

[58] **Field of Search** .... 123/32 EA, 179 L, 180

[56] **References Cited**

UNITED STATES PATENTS

3,616,784	11/1971	Barr	123/32 EA
3,628,510	12/1961	Moulds	123/35 EA
3,680,532	8/1972	Omori	123/32 EA
3,683,871	8/1972	Barr	123/32 EA
3,716,034	2/1973	Schmid	123/32 EA
3,734,067	5/1973	Glockler	123/32 EA

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[57] **ABSTRACT**

Control circuits for a fuel injection system for engines in which the engine is provided with a pre-injection and/or supplementary injections of fuel in addition to the normal injections for cold starting conditions.

18 Claims, 11 Drawing Figures

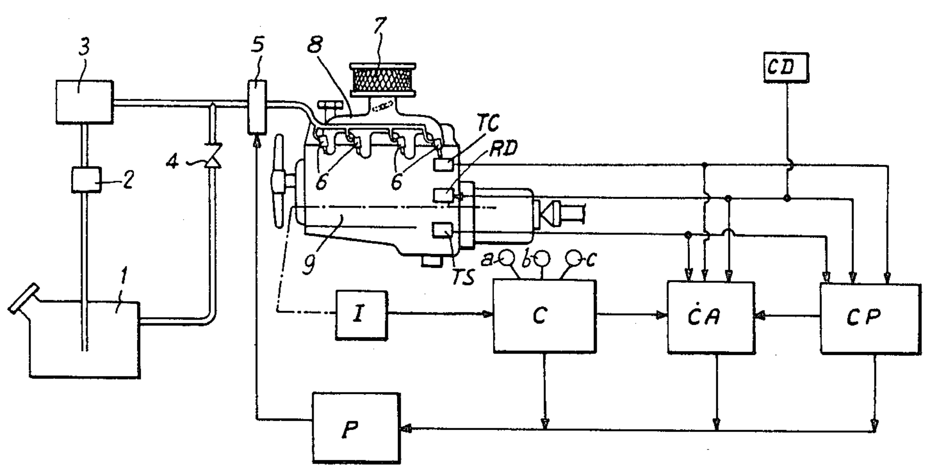
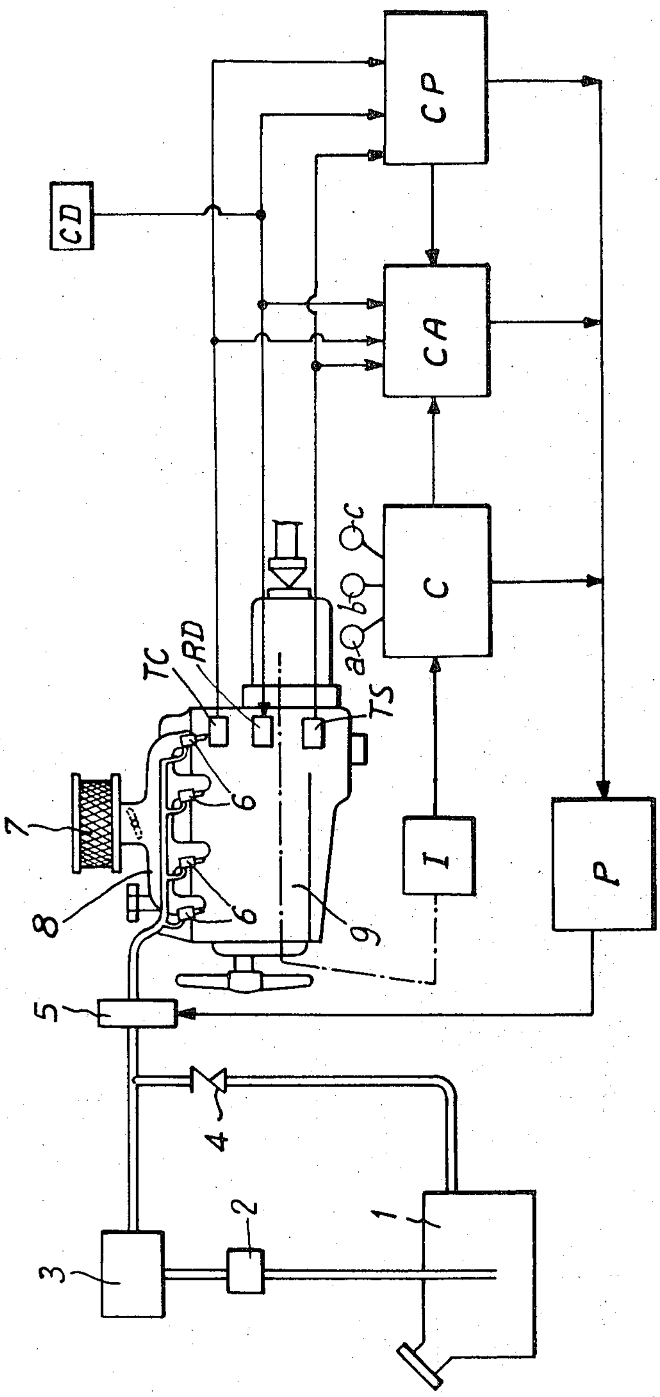


Fig. 1



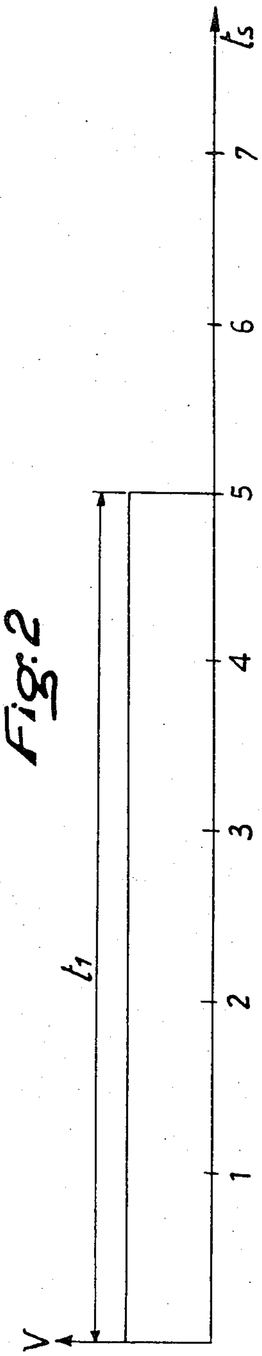


Fig. 2

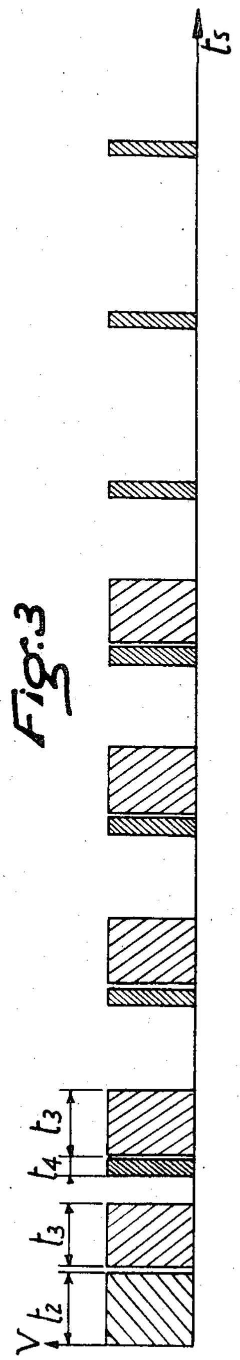


Fig. 3

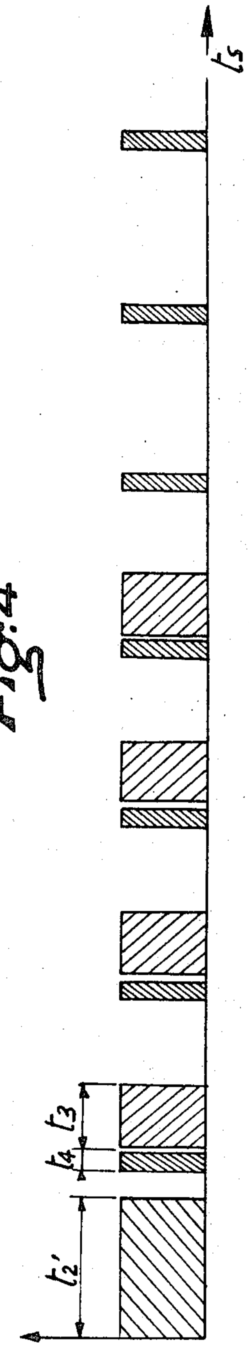
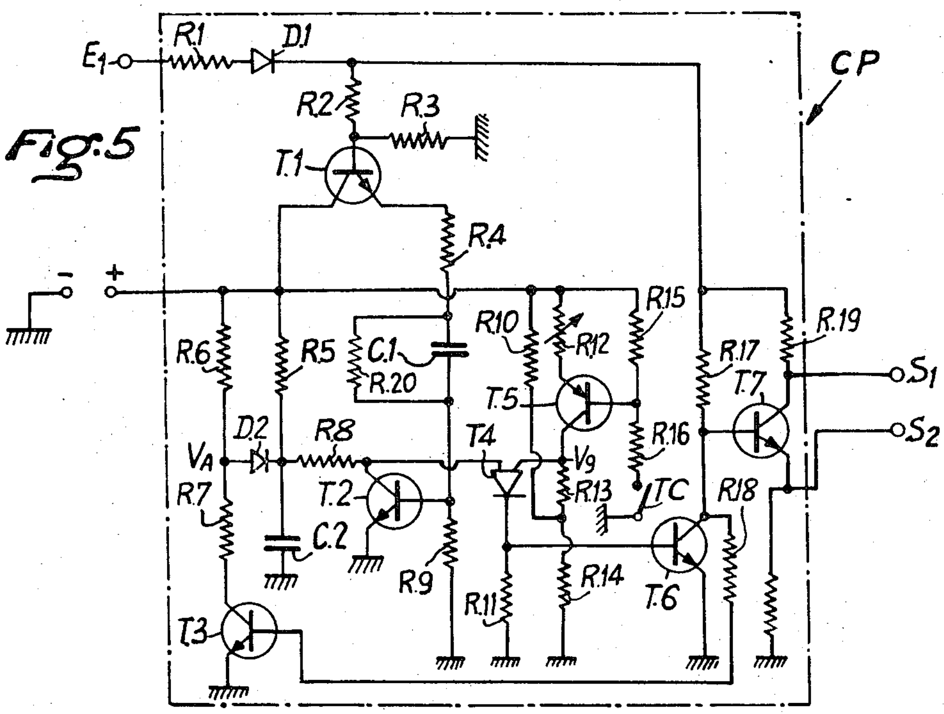


Fig. 4

Fig. 5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D1
R2
R3
T1
R4
CP
- +
R6
R5
C1
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R10
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R17
R19
S1
S2
T5
T7
D2
R8
T4
VA
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R7
T2
R13
TC
R18
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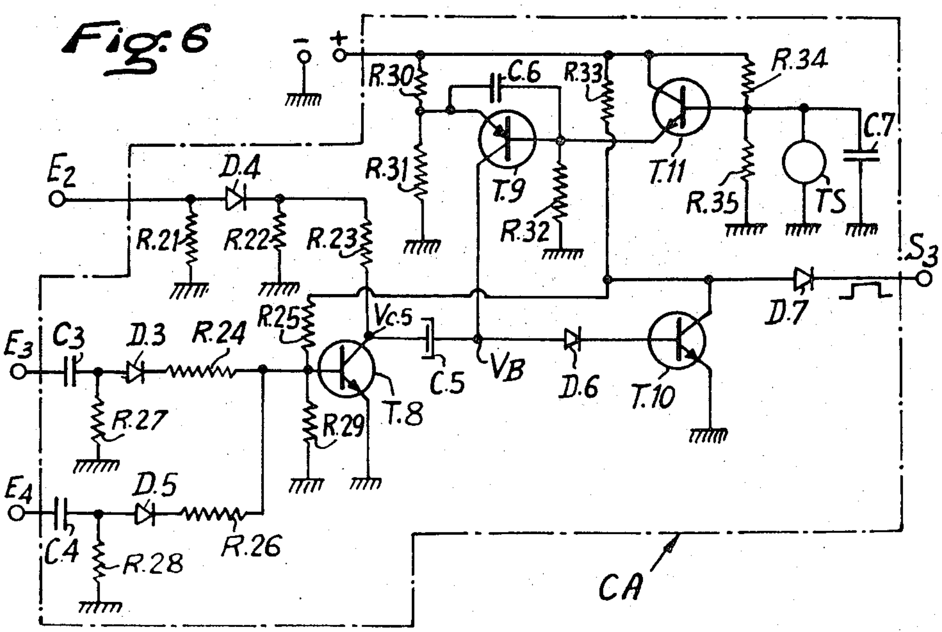
T6
R9
R11
R14
T3

Fig. 6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S3
R.25
Vc.5
D.7
E3
C3
D.3
R.24
C.5
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R.29
T.8
E4
D.5
C.4
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R.26
CA

Fig. 7

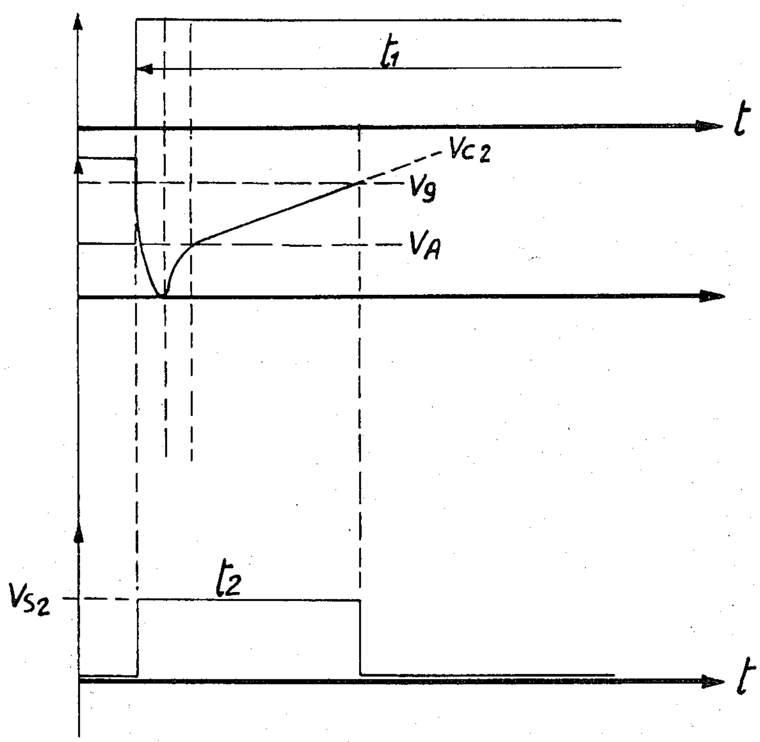
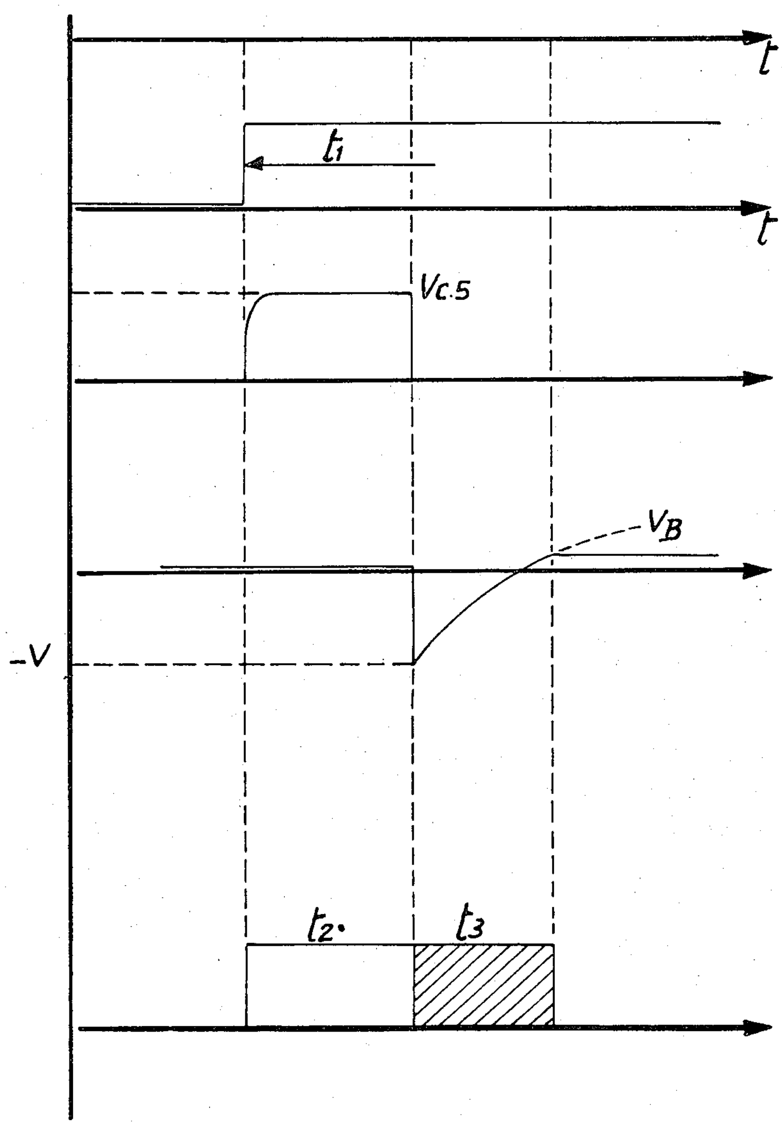


Fig. 8



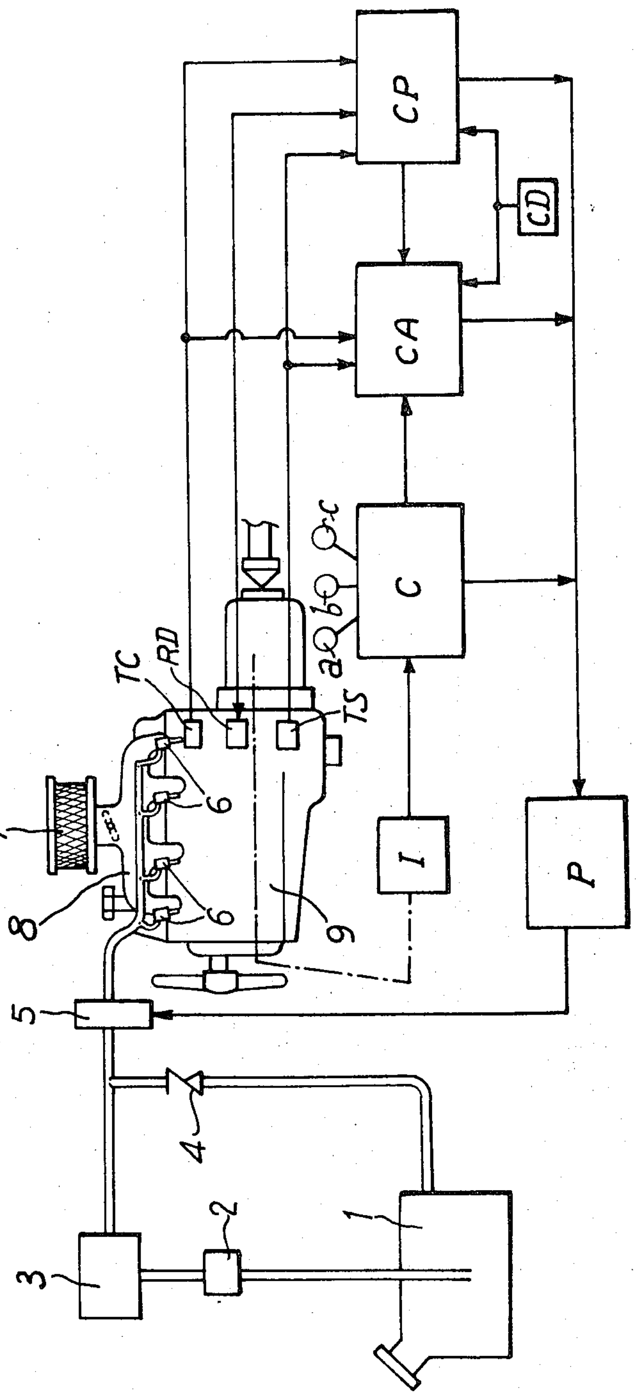


Fig. 9

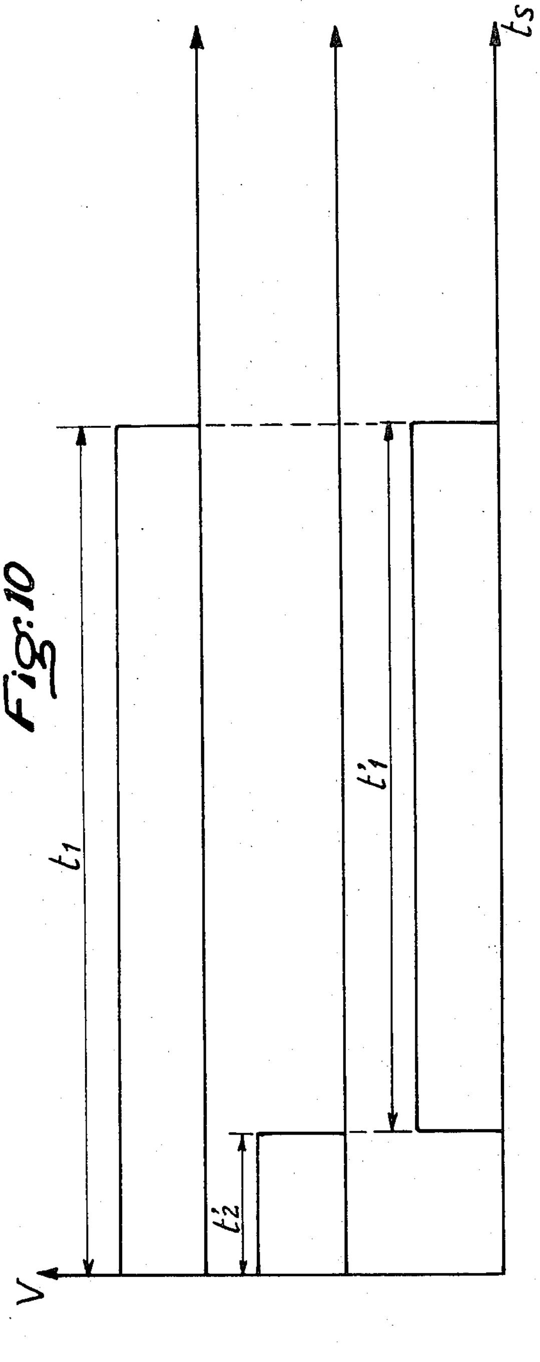


Fig:10

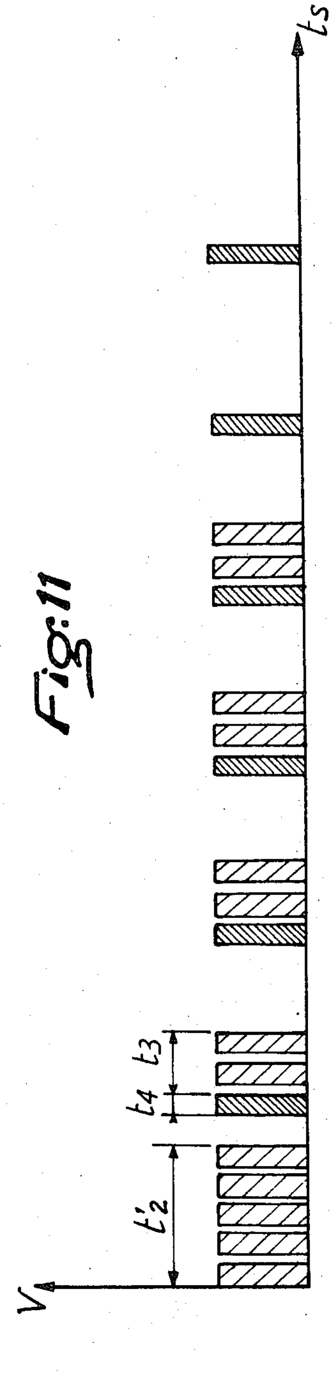


Fig:11

ELECTRONIC FUEL INJECTION CONTROL DEVICES FOR INTERNAL COMBUSTION MOTORS

The present invention relates to improvements in electronic fuel injection control devices for internal combustion motors. It relates, more particularly, to devices designed to produce a pre-injection of fuel before or during the time the starter is actuated, before the normal injections are triggered by the rotation of the motor, which are called normal injections, and an increase in the quantity of fuel injected at the time of each injection, called supplementary injections, in order to facilitate starting under cold conditions.

Prior art devices of this general type were linked with the motor starter contact so that the pre-injection and the supplementary injections will take place only when the starter contact is actuated. In order to obtain pre-injection, there have already been proposals to mount an auxiliary electromagnetic fuel injector in the intake manifold, this injector being provided in addition to the fuel injectors normally provided for the cylinders, by disposing an independent control circuit to produce pre-injection by means of the auxiliary injector. Since electromagnetic injectors are precision instruments, it is obvious that an auxiliary injector constitutes a complication in the circuit and a higher cost price, this increase being particularly noticeable when the normal injections are produced by lower cost mechanical injectors receiving the fuel to be injected through a single electromagnetic proportioning valve.

In the prior art there have also been proposals to facilitate cold starting by matching each normal injection with another injection of the same duration. It was found, however, that the supplementary quantities of fuel that can be injected in this way are entirely inadequate for satisfactory cold starting. As a matter of fact, at temperatures ranging to −20°C, the supplementary quantities of fuel required to be injected are up to ten times as high as the maximum quantities to be injected during normal operation of the motor. Under these conditions, it is obviously necessary to provide electronically controlled devices which permit, on the one hand, a substantial pre-injection before or during the actuation of the starter, and, moreover, to make supplementary injections immediately following the normal injections.

It is the purpose of the present invention to meet these requirements while avoiding the drawbacks of the prior art solutions mentioned above. Accordingly, its object is improvements in electronically controlled fuel injection devices for internal combustion motors, characterized by the fact that a first electronic control circuit is provided, connected to the starter contact to operate, before and/or during the starting of the motor, to cause a pre-injection of a certain length. A second control circuit is provided, connected to the starter contact and to the circuit computing the durations of the normal injections, to cause one or more supplementary fuel injections immediately following the corresponding normal injection as long as the starter contact is closed.

The pre-injection can be embodied, according to the type of injectors and/or the mode of injection, by one of the following means: a simultaneous opening of all the electromagnetic injectors whether connected to the intake manifold or to each cylinder (direct injection); an alternate opening of the injectors, the speed and duration of the sequence, whether fixed or variable, determining the quantity pre-injected; or one or more openings of an electromagnetic proportioning valve which sends fuel to the mechanical injectors.

On the other hand, the pre-injection can be situated: either before the excitation of the starter relay, the pre-injection beginning when the starter contact is made, the starter relay not being excited until the end of the pre-injection (described with respect to FIG. **10**); or during the excitation of the starter relay, the pre-injection beginning with the excitation of the relay (described with respect to FIG. **11**).

In developing the principles of the invention, there can be provided:

a. A thermal actuated switching contact and/or a thermal responsive resistance on the motor, connected to the first control circuit to vary the length of the pre-injection as a function of the temperature of the motor.

b. A thermal responsive resistance on the motor, connected to the second control circuit to vary the duration of the supplementary injections as a function of the temperature of the motor.

c. A connection between the first and the second control circuit, triggering one or more supplementary injections immediately following the corresponding pre-injection.

d. That the first control circuit comprise a timing device blocking the said first circuit for a certain time to avoid a pre-injection during a second operation of the starter quickly following the first.

Other characteristics will appear in the description which follows, and in the claims, and to facilitate comprehension of the description in this example we have represented in the attached drawings:

FIG. **1** is a diagrammatic view of the control means provided on an internal combustion motor equipped with a proportioning valve and fuel injectors;

FIG. **2** is a diagram showing the length of the period of excitation of the starter;

FIG. **3** is a diagram showing the pre-injection taking place at the start of the excitation of the relay starter, before the first normal injection and the supplementary injections provided during the period of excitation of the starter, the pre-injection of fixed length being followed in this example by a supplementary injection of variable length;

FIG. **4** is a diagram showing a pre-injection of variable length, and the normal injections followed immediately by a supplementary injection during the period of excitation of the starter;

FIG. **5** is an electrical schematic diagram of a pre-injection control device according to the present invention;

FIG. **6** is is a schematic diagram of a device for controlling supplementary injections;

FIG. **7** is a diagram showing the production of voltages at various points in the circuit of FIG. **5**;

FIG. **8** is a diagram showing the production of various voltages developed at certain points in the circuit of FIG. **6**;

FIG. **9** is a diagrammatic view of a variant of the embodiment of the system of FIG. **1** corresponding to the case in which the pre-injection takes place before the excitation of the starter relay;

FIG. 10 is a diagram showing, while the starter contact is closed, the length of the pre-injection and the length of the excitation of the starter relay in the embodiment of the invention of FIG. 9; and

FIG. 11 is a diagram, corresponding to the one of FIG. 4, showing the pre-injection and the supplementary injections being composed by multi-injections.

Referring first to FIG. 1, there is shown an internal combustion motor 9 with an intake manifold 8 and an air filter 7. The branch to each motor cylinder, from the intake manifold, is equipped with a fuel injector 6 which is preferably of a less expensive mechanical type. In the embodiment described, each injector receives fuel under pressure through an electromagnetically controlled proportioning valve 5. A pump 3 is provided to supply fuel at constant pressure to the proportioning valve 5, drawing it from reservoir 1 through a filter 2. A pressure regulator 4 is provided to regulate the pressure of the fuel.

The proportioning valve 5 is periodically operated with the rotation of the motor 9 by a power circuit P which receives, in normal operation, fuel injection control pulses from a computer C which computes the injection durations. Device P is a suitable electrical device for operating the electromagnetic valve 5. The injection durations are a function of various operating parameters of the motor such as motor temperature, oil pressure, speed, etc. detected by suitable sensors *a*, *b* and *c*. The sensor information is supplied to the computer. To insure synchronism of the normal duration fuel injections with the rotation of the motor, a pulse emitter I is connected to the crankshaft of the motor. Each successive pulse from I triggers a calculation in computer C and a fuel injection from P.

The power device P is also operated, when the motor is started, by a pre-injection control device CP, and a supplementary injection control device CA. The device CP receives inputs from a thermo-contact switching element TC and/or a thermally responsive resistance TS which supply signals to CA to determine the characteristics of the pre-injections. The device CA receives inputs from thermo-contact switching element TC and/or thermally responsive resistance TS to determine the characteristics of the supplementary injections. The two devices CA, CP are also connected to a motor starter relay RD. In this example, devices CA and CP are controlled by the motor starter contact CD, and CA, CP and RD are excited only when starter contact CD is operated. Relay RD can, of course, be excited only at the end of the action of the device CP.

Assume that the period of excitation of the motor starter during a cold start extends over a time period $t1$. As shown in the diagram of FIG. 3, according to one embodiment of the invention, there is provided, for this period, a pre-injection from CP of duration $t2$, followed immediately by a supplementary injection from CA of duration $t3$. The supplementary injection has a duration $t3$ which depends upon the temperature of the motor. For the next several injection cycles, to the end of $t1$, there are normal duration injections of time $t4$ followed by the supplemental injection of time $t3$.

As shown in FIG. 4, as an alternative to this, there can be provided a pre-injection from CP of a longer time $t2'$, which varies as a function of the temperature of the motor, this pre-injection, in this example, preceding the first normal duration injection of time $t4$ in the motor. The first normal duration injection of length $t4$ which follows the pre-injection of duration $t2'$ is triggered when the starter is energized, and the normal injection duration is increased by a supplementary injection of duration $t3$ from CA, this duration likewise being determined as a function of the temperature of the motor.

As shown in both FIGS. 3 and 4, as soon as the motor has started and the starter is no longer excited, that is at the end of time $t1$, the supplementary injections are cut off and the motor is running with injections of normal duration $t4$. The length of the normal injections is, of course, a function of the temperature of the motor as controlled by computer C.

The pre-injection control device CP shown in FIG. 5 has an input E_1 connected to the motor starter contact, an output S_1 connected to the supplementary injection control device CA, and an output S_2 connected to the power device P controlling the proportioning valve 5. The pre-injection control device CP is essentially of a monostable circuit with a programmable, uni-junction transistor T.4. The control electrode of T.4 is fixed at a certain potential, on the one hand by a voltage divider formed by resistors R.10 and R.14 connected between the voltage source and the ground, and on the other hand by a current generator formed by transistor T.5. These two sources set a potential Vg at the control electrode of T.4.

The emitter of T.5 is connected through a variable resistor R.12 to the voltage source and the collector is connected to the control electrode of the programmable uni-junction transistor T.4, as well as to the middle point of the voltage divider R.10, R.14 through a resistor R.13. The base of transistor T.5 is fixed at a certain potential by a voltage divider formed by resistors R.15 and R.16 connected in series with thermally actuated switch TC, the whole network being connected between the voltage source and ground. Transistor T.5 is blocked (non-conductive) when the thermal switch TC is open, and it delivers a constant current when switch TC is closed. If it is desired to vary the current produced by the current generator T.5 as a function of the temperature of the motor, a thermally responsive resistor (not shown) can be placed in parallel with resistor R.16 and switch TC.

Uni-junction transistor T.4 has its anode connected to one of the terminals of a capacitor C.2 through a resistor R.8. The other terminal of the capacitor C.2 is connected to ground. Capacitor C.2 is charged from the voltage source by a voltage divider comprising resistors R.5 and R.6 connected in parallel, but separated by a diode D.2, and a resistor R.7 connected to ground through the collector-emitter circuit of a transistor T.3.

The input E_1 of the pre-injection control device CP is connected to the monostable circuit described, by a resistor R.1 and a diode D.1 connected to the base of a transistor T.1 through a resistor R.2. The base of T.1 is connected to ground through a resistor R.3. The collector of transistor T.1 is directly connected to the voltage source, while its emitter is connected to the base of transistor T.2 through a resistor R.4 and a capacitor C.1, the base of the transistor T.2 also being connected to ground through resistor R.9.

The collector-emitter circuit of transistor T.2 is connected between the anode of the programmable uni-junction transistor T.4 and ground.

The input E_1 of the device CP is also connected, again through resistor R.1 and diode D.1, to the base of a transistor T.7 by means of another resistor R.17. The collector of transistor T.7 is also connected to the resistor R.17 by a resistor R.19. The collector of transistor T.7 constitutes the output S_1 of device CP while the emitter constitutes the output S_2 thereof. A transistor T.6 is also provided, its base being connected to the cathode of the uni-junction transistor R.4, and its emitter to ground. The collector of T.6 is connected to resistor R.17 and the base of the transistor T.7, and also to the base of transistor T.3 through a resistor R.18.

The device CP is described below. Assuming that a voltage is applied to the monostable circuit by the voltage source, but the starter contact is not closed and there is no E_1 input, transistors T.1, T.2, T.3 are blocked. T.6 is conductive so that T.7 is blocked and no signal can appear at outputs S_1, S_2. At this time, the uni-junction transistor T.4 is conductive since as the supply voltage is applied to its anode by R.6, D.2 and R.8 and the voltage Vg applied to its control electrode, as determined by the voltage divider constituted by resistors R.10 and R.14 is sufficient to make it conductive. The voltage drop across R.11 when T.4 is on creates the forward bias at the base of T.6 to turn on the latter.

When the starter is excited by closing its contact, a control signal voltage is applied to input E_1, which is of sufficient magnitude to make transistors T.1, T.7 and T.3 conductive, this control signal being applied directly to the respective base electrodes of these transistors. In addition, transistor T.2 is made conductive transitorily since a pulse is applied to its base from capacitor C.1 which was fully discharged, as T.1 conducts. As T.2 conducts, capacitor C.2 is completely discharged through resistor R.8 and the collector-emitter circuit of transistor T.2. This lowers the voltage at the anode of programmable uni-junction transistor T.4 and it is blocked.

The excitation of the starter relay by closing the starter contact causes the blocking of programmable, uni-junction transistor T.4 which in turn causes the appearance of a current at the output S_2 to initiate the start of a pre-injection. This occurs since when T.4 is non-conductive, there is no voltage drop across R.11 and T.6 is non-conductive, causing a rise in the voltage at the base of T.7 which makes it conductive. This produces a current flow through T.7 and, therefore, outputs at S_1 and S_2.

The starter contact is engaged only momentarily when it is released, the input voltage at E_1 is removed and T.1 is blocked. This also blocks T.2. As soon as transistor T.2 is blocked again, when the started contact is released, capacitor C.2 is quickly charged through resistors R.5 and R.6 to the voltage VA, the voltage at the junction of R.6, R.7 and D.2. Then resistor R.5 alone insures the charging of condenser C.2 since diode D.2 is polarized in the opposite direction and eliminates, from the voltage divider, the resistors R.6 and R.7. The voltage at the terminals of capacitor C.2 then evolves more slowly, as indicated in FIG. 7, up to the time when voltage VC.2, which is the voltage at the anode of T.4 when T.2 is blocked, reaches a certain value with respect to the voltage Vg applied to the control electrode of the uni-junction transistor T.4, making it conduct abruptly due to the avalanche effect. As a result, a voltage is applied from across R.11 to the base of transistor T.6, making it conduct, so that the bases of transistors T.3 and T.7 are essentially grounded, which blocks them. At this time, the current at output S_2 disappears and the pre-injection ceases since P has no input, while a higher voltage now appears at output S_1. This higher voltage at S_1 is transmitted to the E_3 input of device CA for controlling supplementary injections, if it is desired that the pre-injection of established length be immediately followed by a supplementary pre-injection controlled by device CA.

The duration of the pre-injections, that is, the time S_2 has an output, can be regulated by the variable resistor R.12 in the collector of T.5 which determines the control voltage Vg for making conjunction T.4 conduct in accordance with the rise in its anode voltage across C.2. A temperature dependency on the motor can be introduced either by the thermo-contact switch TC, as represented in the base of T.5, or by a thermal sensitive resistor (not shown) in its stead, or by the two devices simultaneously, with provision of a parallel hookup. The switch TC and/or the thermal responsive resistor are connected to the base of T.12 and would thereby also control Vg.

It should be noted that the particular hookup of the capacitor C.1, in particular its discharge circuit, makes it possible, in an extremely simple way, to prevent the circuit CP from producing another signal at S_2 to operate P to produce another pre-injection in the course of operation of the starter immediately following the first. As a matter of fact if, at the end of the first period of excitation of length $t1$ of the starter, as indicated in FIG. 2, the motor has not started, it is, of course, necessary to operate the starter a second time. In this case, however, a fresh pre-injection of fuel is no longer needed, it having been made previously, and on the contrary it should be avoided in order not to flood the motor with excess fuel. With the circuit of FIG. 5, capacitor C.1 can discharge but very slowly through leak resistor R.20, the discharge period being much longer than the period of excitation $t1$ of the starter. Thus, a second signal at E_1 occurring before C.1 discharges will not be passed to the base T.2 to make it non-conductive and thereby block the uni-junction T.4.

The supplementary injection control device CA, represented in FIG. 6, includes in this example an input E_2 connected with the motor starter contact. There is also an input E_3 connected, where the case applies, to the output S_1 of the pre-injection control device CP of FIG. 5. An input E_4 is connected to the normal injection time computer C. The output S_3 of device CA is connected to the power control P of the proportioning valve to control its opening during the times of the supplementary injections.

Inputs E_3 and E_4 are connected to the base of a transistor T.8 by means of a capacitor C.3, a diode D.3 and a resistor R.24, and through capacitor C.4, diode D.5 and resistor R.26 respectively. The junction points of capacitor C.3 and diode D.3, and of capacitor C.4 and diode D.5, respectively, are connected to ground through the respective resistors R.27 and R.28. The emitter of transistor T.8 is connected to ground while its collector is connected on the one hand to input E_2 through diode D.4 and resistor R.23, and on the other hand to one of the terminals of a capacitor C.5. The anode and cathode of the diode D.4 are connected, respectively, to ground through resistors R.21 and R.22.

The second terminal of capacitor C.5 is connected to the base of a transistor T.10 by a diode D.6 as well as to the collector of a transistor T.9 which forms part of a current generator. The current generator also includes a voltage divider formed by resistors R.30 and R.31 connected between the voltage supply and ground, the junction point of this voltage divider being connected to the emitter of transistor T.9. A capacitor C.6 is connected between the emitter of the said transistor T.9 and its base and the base is also connected to ground through a resistor R.32 and to the emitter of another transistor T.11. The collector of transistor T.11 is connected directly to the supply voltage while its base is connected to the junction point of a voltage divider formed by resistors R.34 and R.35 which are connected between the supply voltage and ground. A thermal sensitive resistor TS and a capacitor C.7 are connected in parallel with resistor R.35.

The collector of transistor T.10 is connected to the supply voltage through a resistor R.33 and to the output S_3 through a diode D.7. In addition, there is a connection between the collector of transistor T.10 and the base of transistor T.8 through a resistor R.25. The base of transistor T.8 is also connected to ground through a resistor R.29.

The device CA works as described below. When the circuit CA is energized from the supply voltage, the current generator, which comprises transistors T.9 and T.11, delivers a certain current which is a function of the temperature of the motor as a result of the disposition of thermal sensitive resistor TS in the base circuit of transistor T.11. T.9 and T.11 set the voltage V_B at the second terminal of capacitor C.5. Resistor TS has a negative temperature coefficient. Thus, as the motor temperature is higher, the resistance value of TS is lower. A decrease in the value of TS reduces the voltage dropped across R.35 and the forward bias on the base of T.11, making it less conductive. The emitter of T.11 feeds the base of T.9 which is of opposite conductivity type. Thus, as the conductance of T.11 increases (motor colder), the conductance of T.9 decreases and the voltage at point V_B is higher. Conversely, when T.11 decreases in conductivity (motor warmer), the conductance of T.9 increases and the voltage at point V_B is lower. The voltage at V_B is sufficient to make T.10 conductive and ground the output S_3.

When the starter contact is closed for time $t1$ (see FIG. 8), a voltage appears during the period of excitation $t1$ at input E_2 of device CA, rapidly charging capacitor C.5 at point $V_{C.5}$ (collector of T.8) to the voltage of the starter which is as great as the supply voltage. This charge has no influence on transistor T.10 which remains conductive due to the voltage V_B. When, at the end of either a pre-injection $t2$ (see FIG. 8) or a normal injection $t4$, a signal appears at input E_3 (from CP) or E_4 (from C) respectively, transistor T.8 is made conductive and the voltage $V_{C.5}$ returns to zero. As a result, the voltage at point V_B falls to the negative voltage of the supply voltage with respect to ground. Transistor T.10 is now blocked, with the result that a positive signal appears at output S_3, provoking the start of a supplementary injection.

As explained previously, capacitor C.5 is charged by the current generator comprising transistors T.9 and T.11 by a current which is a function of the temperature of the motor which is served by TS. At the end of a certain time which is a function of this temperature, the voltage at point V_B reaches a higher voltage than the one corresponding to the voltage drop through diode D.6 and transistor T.10 (about 1.4 v), and transistor T.10 begins to conduct, grounding output S_3 and thus provoking the discontinuance of the supplementary injection.

As long as the starter is energized and a signal appears at E_2, the operation of CA is repetitive. That is, a supplementary injection is triggered every time that a normal injection is terminated and the computer produces a signal at E_4 for as long as the period of excitation of the starter lasts. This is shown in FIGS. 3 and 4. Furthermore, in certain cases, as shown in FIG. 3, we can provide, as mentioned above, a supplementary injection following a pre-injection, by providing a connection between the S_1 output of device CP and the E_3 input of device CA. We can also note that the length of the supplementary injections can be as much as ten times as long as the length of the normal injections by suitably selecting the values of the circuit components.

The result is, in the arrangement according to the invention, that it is possible to provide a starting sequence comprising a pre-injection, and a supplementary injection added to each normal injection during the action of the starter, which makes it possible to obtain an enrichment proportional to the speed of the motor without risk of flooding, and to provide the motor with a mixture which is always of the same richness regardless of the starting speed of the motor, regardless of the time required for the motor to start, and regardless of the moment at which the starter ceases to act.

In the example of embodiment in FIG. 9, the closing of the contact CD directly controls only the devices CP and CA. When the pre-injection is terminated, the device CP controls the excitation of starter relay RD. This can be accomplished, for example, by having the S_1 output of the circuit of FIG. 5 permit the starter relay RD to receive current after a delay corresponding to the duration of the pre-injection. To accomplish this, for example, the output S_1 of the circuit of FIG. 5, which appears at the end of the pre-injection pulse, can be used.

The corresponding timing diagram for the FIG. 9 arrangement is shown in FIG. 10 where $t1$ represents the length of time the starter contact CD is closed, $t2'$ the duration of the pre-injection, and $t1'$ the actual time of the excitation of starter relay RD.

FIG. 11 shows a diagram of the times of the pre-injection and of the supplementary injections in the case where multi-injections are used during each period. The timing diagram corresponds generally to that of FIG. 4 with the exception of the use of the multi-injectors.

What is claimed is:

1. In an electronic fuel-injection system of the type for a motor energized by a starter circuit means including a switch contact which is actuated for a time to produce a starting signal to operate a means for starting the motor, said fuel injection system including injection means for supplying fuel to the motor and computer means for controlling the duration of normal injections supplied by said injection means during the turning of the motor, the improvement comprising first control circuit means responsive to the starting signal for operating said injection means to supply a pre-injection of

fuel of a predetermined duration to the motor prior to its starting and the application of the normal injections, and second control circuit means responsive to the starting signal for operating said injection means to supply supplementary injections of fuel to the motor in a predetermined time relationship with the normal injections for a duration not to exceed the production of the starting signal.

2. The system of claim 1 wherein said second control circuit means operates for a period of time substantially equal to that for which the starting signal is produced.

3. The system of claim 1 wherein said first control circuit means operates said injection means to supply the pre-injection of fuel to the motor substantially coincident with the production of the starting signal and prior to the operation of said means for starting the motor.

4. The system of claim 1 wherein said first control circuit means operates said injection means to supply the pre-injection of fuel to the motor a predetermined time after the starting signal is produced.

5. A system as in claim 1 further comprising means connected to said first control circuit means and responsive to the temperature of the motor to control the duration of the fuel pre-injection.

6. A system as in claim 1 further comprising means responsive to the temperature of the motor and connected to said second control circuit means to vary the duration of the supplementary fuel injections.

7. A system as in claim 1 wherein said first and second control circuit means includes means for controlling said injection means to produce a supplementary fuel injection immediately following a pre-injection.

8. A system as in claim 1 wherein said first control circuit means includes means for disabling said first control circuit means for a predetermined time to prevent a pre-injection of fuel during a subsequent operation of the starter switch contact.

9. A system as in claim 1 wherein said first control circuit means includes an input for receiving said starting signal, first transistor means having an output electrode at which the control signal for causing the pre-injection is produced and a control electrode, controllable transistor means having a control electrode, an anode and a cathode, circuit means for producing a control potential for said control electrode, a capacitor connected to the anode of said controllable transistor means, charging circuit means for supplying a potential to said capacitor to establish the anode potential with respect to the control electrode potential of said controllable transistor means, output means connected to said controllable transistor for supplying a control signal to said control electrode of said first transistor means, said controllable transistor means becoming conductive in response to a potential on said capacitor which exceeds the potential at the control electrode by a certain value, said controllable transistor means when conductive producing a control signal across said output means which operates said first transistor means to terminate the production of the pre-injection control signal.

10. A system as in claim 9 wherein said circuit means for producing the control potential for said controllable transistor means includes means responsive to the temperature of the motor for determining the control potential of the uni-junction transistor means.

11. A system as in claim 9 wherein said charging circuit means for said capacitor includes a voltage divider means having a first impedance means in parallel with a portion thereof and being connected to the voltage divider by a diode, the capacitor charging up to the voltage determined by the voltage divider in a rapid manner at a slower rate through the said first impedance means which is isolated from the voltage divider by said diode.

12. A system as in claim 9 further comprising second transistor means connected to said capacitor to discharge the same, a second capacitor connected in the control electrode circuit of said second transistor and responsive to the starting signal produced by the first closing of the starter switch contact to operate said second transistor means to discharge said first capacitor, said second capacitor preventing the operation of said second transistor means to discharge said first capacitor for a predetermined time.

13. A system as in claim 1 wherein said second control circuit means comprises a first input for receiving the starting signal and a second input for receiving a normal fuel injection signal from said computing means and means responsive to the occurrence of said starting signal and a normal fuel injection signal for producing a supplementary fuel injection signal.

14. A system as in claim 13 wherein said second control signal means also includes a third input for receiving a pre-injection signal from said first control circuit means and produces a supplementary fuel injection signal in response to the pre-injection signal and the starting signal.

15. A system as in claim 13 wherein said second control circuit means includes first transistor means including an output electrode at which said supplementary fuel injection control signal is produced and a control electrode, and timing means responsive to the normal injection signals from said computing means for periodically operating said first transistor means to produce the supplementary fuel injection control signals.

16. A system as in claim 15 wherein said timing means includes capacitor means, charging circuit means for charging said capacitor means to a first voltage level which operates said first transistor means to terminate the production of a said supplementary fuel injection control signal.

17. A system as in claim 16 wherein said timing means also includes means responsive to the temperature of the motor for controlling the charging time of said first capacitor means to said first voltage level.

18. The system of claim 1 wherein said first control circuit means operates said injection means to supply the pre-injection of fuel to the motor during the operation of the means for starting the motor.

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