(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 147 678
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 84114676.4

(22) Date of filing: 03.12.84

(51) Int. Cl.⁴: F 02 P 9/00

(30) Priority: 05.12.83 US 557922

(43) Date of publication of application:
10.07.85 Bulletin 85/28

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

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(54) Multiple spark electronic ignition system.

(57) A multiple-spark electronic ignition system producing a timed sequence of a plurality of ignition sparks per cylinder compression cycle of an internal combustion engine. The system includes: a trigger pulse signal source; a control circuit that generates a plurality of timed ignition signals for each of the trigger pulses, preferably 3 to 20 signals, the frequency of the timed ignition signals being a function of the RPM of the engine; and an amplifying circuit which transforms the timed sequence of ignition pulses into a timed series of high energy ignition sparks.

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MULTIPLE SPARK ELECTRONIC IGNITION SYSTEM

FIELD OF INVENTION

This invention pertains to an electronic ignition system and more particularly to an electronic ignition system which provides plurality of individual ignition sparks per each compression cycle of an internal combustion engine.

BACKGROUND OF THE INVENTION

The internal combustion engine is an inherently inefficient device, characterized by less than desirable fuel efficiency and problematic exhaust emissions. Although many factors contribute to these problems, the primary source is the inefficient combustion of the air fuel mixture within the cylinder of the internal combustion engine. It is known that the fuel air mixture in the combustion chamber does not exist in a homogeneous state and thus the mixture's ignition, via an external ignition source, results in uneven and incomplete combustion of the fuel. Incomplete combustion implies a less than stoichiometric conversion of the fuel into energy and increased levels of unburned hydrocarbons in the side-reaction by-products in the exhaust emissions.

Several approaches can be taken in an attempt to improve the combustion efficiency of internal combustion engines. A first approach focuses on the fuel and fuel error mixture and, more particularly, the distribution of the fuel/air mixture within the combustion chamber. Such modifications are the subject of carburetion and fuel injection technology. A second approach focuses on the ignition means utilized to initiate combustion of the fuel/air mixture. Conventional ignition systems, both electronic and mechanical, provide for a single high energy spark per cylinder per compression stroke. Improvements in efficiency are achieved by adjusting parameters such as timing of the spark in relation to the compression stroke, the energy of the spark, duration of the spark, etc. However, these methods of enhancing efficiency are subject to certain limitations. For example, the most efficient point for firing the ignition spark is at top dead center (TDC); however, very high gas temperatures, in excess of 982°C, exist at TDC and results in the production of unacceptable levels of nitrous oxide in the exhaust. This problem is avoided in conventional ignition systems by lowering the compression ratio of the cylinder by firing the ignition spark below TDC, i.e., before TDC. Although there is a significant lost in the efficiency of the fuel to energy conversion, combusion temperatures in the cylinder do not exceed the 982°C level. Improved efficiency is also restricted by the physical limitations of the spark plug electrodes and more significantly, by the stratifications of the fuel/air mixture within the cylinder chamber. This stratification effect occurs when the fuel/air mixture forms layers of varying temperature due to the various temperature regions present in the surrounding cylinder and piston. The effect of stratification on performance is most clearly evident when the engine is cold and the temperature variations are the greatest. Although the consequences of the stratification effect become less noticeable as the engine reaches normal operating temperatures, the stratification effect is still present and contributes to reduced fuel efficiency and increased exhaust emissions.

DESCRIPTION OF THE PRIOR ART

It has been proposed that engine efficiency could be improved by utilizing an ignition system that provides more than one ignition spark per cylinder per compression stroke. While this approach is conceptually sound, prior art attempts at implementing it have had serious drawbacks. One prior art device achieves dual spark ignition by simply duplicating the components of a conventional ignition system. The system employs two spark plugs per cylinder, two distributors, two coils and all_the complicated engine modifications that are necessary to set up such a system.

A second system, set forth in U.S. Patent 3,554,178, Boyer et al., provides a capacitor discharge ignition system which produces two sparks per cylinder per compression stroke in response to each half cycle of alternating current ignition signals. This system merely provides for a switching means by which two capacitors charge and discharge during each one half cycle of the ignition signal cycle. The timing of the ignition signals is fixed by the circuitry and does not adjust with changes in the revolutions per minute (RPM) of the engine.

Other prior art ignition systems provide for multiple spark ignition wherein the number of sparks per cylinder compression stroke varyies directly in number in response to changes in the engine RPM. In these systems the relative relationship between the discrete spark outputs is fixed and the only adjustment is in the number of sparks per compression cycle. Although the prior art systems provide for a second and subsequent ignition sparks for reignition of the residual uncombusted air/fuel mixture, they all lack the ability to adjust the timing relationship between the individual spark signals in response to the rapid changes and fluctuations in the engine operating conditions or RPM.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide a multiple spark electronic ignition system capable of producing a timed sequence of a plurality of ignition sparks per cylinder compression cycle of an internal combustion engine, thus maximizing the percentage of fuel undergoing combustion and minimizing the uncombusted hydrocarbons and reaction by-products thereof in the exhaust emissions.

It is another object of this invention to provide a multiple spark electronic ignition system which is capable of producing a plurality of ignition sparks and electronically maintaining their relative relationship to each other as a function of the engine RPM.

It is a further object of this invention to provide a multiple spark electronic ignition system with a control means which proportionally decreases (increases) the time between each individual spark in the timed sequence of sparks as the RPM of the engine increases (decreases) and the actual time of the compression cycle decreases (increases).

It is further object of this invention to provide a multiple spark electronic ignition system with a monitoring means connected to said control means which automatically adjusts the timing between each individual signal in said sequence of timed ignition signals in response to changes in the operating conditions of the engine.

It is another object of this invention to provide a multiple spark electronic ignition system which controls the duration and energy of each individual ignition spark.

It is a further object of this invention to provide a multiple spark electronic ignition system which increases the fuel efficiency of an internal combustion engine.

It is still another object of this invention to provide a multiple spark electronic ignition system which reduces the level of exhaust contaminates and thereby eliminates the need for costly pollution control devices currently used for internal combustion engines.

The above objectives are accomplished by the present invention by employing a control means within the electronic ignition system which is designed to provide a timed sequence of ignition sparks, preferably

3 to 20 sparks, per compression cycle and is also capable of rapidly regulating and adjusting proportionally the timing of each sequence of sparks in response to the dynamic fluctuations in engine RPM. Although the time between each individual pulse in the sequence is adjusted by the control means, all of the timing adjustments are made proportionally so that the relative relationship between pulses remains constant. The number of individual ignitions, for each sequence, is advantageously selected in accordance with one or more operating characteristics of the particular internal combustion engine. Once selected, however, the number of ignition sparks per compression cycle is fixed and the number of sparks per sequence cannot be changed without replacing the control circuit. The timing control circuit operates under the same principle regardless of the number of ignition sparks selected and can regulate the time interval between each individual spark in the timed sequence as detected by changes in the engine RPM.

Although the number of timed ignition signals per sequence is fixed once the control circuit designed, the relative time intervals between each individual ignition signals are separately adjustable. These time intervals can be altered either by manual adjustment of individual potentiometers that determine the relative reference voltage level, or by automatic electronic adjustments of the voltage levels applied to the negative input terminals of the plurality of comparator delays in response to engine operating conditions, i.e., ambient temperature, ambient humidity, engine temperature, exhaust emission composition, etc. The automatic adjustments can be made by an electronic monitoring means which is programmed to alter the relative, not just proportional, timing relationship of the sequence of pulse signals in response to input from sensors of the engine operating conditions.

The ignition system of the present invention includes, but is not limited to the following features. A source of trigger pulse ignition signals produced in timed relation with the RPM of the engine, which can either be a conventional cam/contact points distributor or the so called "electronic ignition" distributors which utilize magnetic induction transducers to provide trigger pulse ignition signals. Either trigger pulse ignition means is acceptable in the present invention.

The present system can best be understood by following a single trigger pulse signal through the circuitry of the present invention. Once the initial trigger pulse is produced, it is feed to a non-inverting voltage comparator and converted into a wave signal. The wave signal is then transmitted to a discrete transistor which is used to isolate the rest of the components of the ignition system and prevent loading of the non-inverting voltage comparator. The wave signal is then fed to three independent components of the ignition system. First, the wave signal is fed to a multiple stage OR gate where the wave signal is converted into a voltage pulse. The voltage pulse is then used to trigger a monostable multivibrator which in turn enables or disables a high voltage/high current switching transistor thus delivering a high energy spark through the ignition coil. The foregoing description represents the first in the timed sequence of sparks.

The second component of the system fed by the initial wave signal is a digital to analog generator. This digital to analog generator is triggered by the wave signal and produces an analog voltage proportional to the frequency of the input wave signal. The frequency of the input wave signal, of course, is a function of the RPM of the engine. The analog voltage is then fed to an inverting amplifier which responds to increasing input voltage with decreasing output voltage.

Therefore, as the frequency of the input wave signal increases, in response to increasing engine RPM, the voltage taken from the inverter amplifier decreases. This inverting relationship and the subsequent use thereof provides the electronic control that regulates the time intervals between sparks and in response to changes in the engine RPM. The inverted voltage is then fed through two or more variable voltage dividers and to the negative input terminals of two or more input comparators. The negative input terminals of the comparators supply the reference voltage which must be exceeded by the positive input terminal voltage to initiate an output voltage. The variable voltage divider is positioned between the inverted voltage and the negative input terminals of the voltage comparators and are independently adjustable so that the reference voltage for each comparator can be set separately, either manually or automatically by a monitoring means.

The third component of the ignition system fed by the initial wave signal is a sweep voltage ramp generator which converts the wave signal into a sweep voltage. A ramp voltage is an example of a sweep voltage. The sweep voltage is fed to the positive input terminals of the previously mentioned voltage comparators. The sweep voltage ramp is thus the triggering source for the voltage comparators and as the reference voltage level of each comparator is reached by the sweep voltage the comparators are sequencially triggered. The triggered output of each comparator is fed to the second and subsequent terminals of the previously discussed OR gate and follow in timed sequence the path of the initial square wave through the OR gate, amplifier, monostable multivibrator, and output switching amplifier to produce the second and subsequent high energy ignition sparks.

Unlike other ignition systems which provide for a untimed multiple spark ignition, the present invention provides the electronic control means for producing a plurality of timed ignition signals from each of the trigger pulses. A timed sequence is produced by adjusting the real time (microseconds) between each of the ignition signals in said sequence; the adjustments are made in response to fluctuations in the engine RPM. As the RPM of an engine increases (decreases) the compression cycle time frame is decreased (increased) and therefore the time interval between the first, second and subsequent ignition sparks must be decreased (increased) in order to achieve completion of the timed sequence of sparks and maximum combustion of the air/-fuel mixture. The present invention achieves this result by providing an ignition system which generates second and subsequent ignition sparks from the sequential firing of a plurality of comparator delays which are characterized by having individually adjustable reference voltages that are inversely proportional to the engine RPM and positive input voltages in the form of a sweep voltage that is proportional to the engine RPM.

BRIEF DESCRIPTION OF THE DRAWINGS

Further objects, feastures, and advantages of the present invention will become more clear from the following description of the drawings, wherein;

Fig. 1 is a simplified block diagram of the multi-spark ignition system of the present invention and shows the various operational components of a triple spark ignition system;

Fig. 2, is a schematic diagram of one of the preferred emobodiments of the present invention and provides for a triple spark ignition system.

Fig. 3 (a-k), is a series of voltage verses time plots at different junctions within the multiple spark electronic ignition system.

DETAILED DESCRIPTION OF THE INVENTION

There is shown in Fig. 1 a multiple spark ignition system 20 according to the present invention, including, a pulse means 3 for producing a plurality of trigger pulse signals; a control means 21, responsive to said trigger pulses, for generating a plurality of timed ignition signals for each of said trigger pulses and for controlling the frequency of said plurality of timed ignition signals as a function of engine RPM; an amplifying means 15 for transforming said sequence of timed ignition signals into a timed series of high energy ignition sparks. Pulse means 3 and control means 21 can be used without amplification means 15, if the output sequence of timed ignition signals is of sufficient voltage to negate the need for further amplification.

More specifically, Fig. 1 shows a trigger pulse source 2 and power supply 4, which may be the usual automobile battery. Input comparator 6 converts the trigger pulse into square waves and feeds them to isolator amplifier 8, the output of which is divided and fed to OR gate 10, digital to analog generator 12, and ramp generator 14. OR gate 10 converts the square wave from isolator amplifier 8 into an ignition pulse which is fed to amplifier 16 which converts each wave form from OR gate 10 into an output pulse. The output pulse is fed to monostable multivibrator 18 which is normally in the off state but is triggered into a conductive state by the pulse signal from amplifier 16. The conduction at monostable multivibrator 18 cuts off the normal current flow in output switching amplifier 20 and the primary ignition coil current rapidly decreases to 0 volts. As the current through output switching amplifier 20 decreases, a high voltage high current spark is generated in the secondary coil 22 and upon discharge provides a high energy ignition spark.

The divided square wave of isolator amplifier 8 is also fed to digital to analog generator 12 which converts the digital square wave form into an analog voltage signal. The analog voltage is then inverted by inverter amplifier 24. The inverted analog voltage is fed to the negative or reference terminals of voltage delay 26 and 28. The third path for the square wave of isolator amplifier 8 is to ramp generator 14 which, converts the input square wave into a positive logarithmic ramp voltage. The ramp voltage is then fed to the positive or triggering terminals comparator delays 26 and 28. The reference voltage of comparator delays 26 and 28 can be independently adjusted even though it comes from the same source, inverter amplifier 24. Accordingly, comparator delay 26 is adjusted to provide a lower reference voltage than comparator delay 28; therefore comparator delay 26 is the first to be triggered by the raising ramp voltage from ramp generator 14. The output from comparator delay 26 is fed to OR gate 10 and through the amplification and switching means provided by amplifier 16, monostable multivibrator 18 and output switching amplifier 20 to produce the second high energy ignition spark. Soon thereafter, the ramp voltage from ramp generator 14 reaches the somewhat higher reference voltage of comparator delay 28 changes state, feeds its output signal to OR gate 10 and on to produce the third high energy ignition spark.

The system described by Fig. 1 provides for a triple spark ignition sequence, however, additional comparator delays can be incorporated into the circuit to produce any number of ignition sparks in sequence.

Fig. 2 is a complete schematic diagram of a multi-spark ignition system which provides a timed sequence of three ignition sparks per cylinder compression cycle.

The system illustrated by Fig. 2 is comprised of integrated circuits 2 and discrete components. The trigger pulse 2 generated by either distributor cam/contact point or a magnetic induction transducer is sensed by comparator 4 at the positive (+) input terminal 6 through resistor 8. The negative (-) input terminal 10 of comparator 4 is ground referenced so that as the trigger pulse 2 voltage decreases from a negative potential, passing through zero voltage, then increases to its positive potential (See Fig. 3b), comparator 4 responds by rapidly changing its output state as the input voltage positive terminal 6 exceeds the reference voltage at negative terminal 10. Resistors 8, 12, and 14 are fixed, as dictated by the operating requirements of comparator 4. Resistor 16, on the other hand, is a variable voltage divider provided for the purpose of fine tuning of distributor position relative to its advance/retard requirements. The output wave form of comparator 4 is sensed at the base of transistor 18 through resistor 20, a current limiting resistor. Upon sensing this positive voltage, transistor 18 is driven into conduction and a replica of the input wave form is reproduced between the emitter of transistor 18 and resistor 22 (See, Fig. 3b). The function of transistor 18 is to provide isolation between comparator 4, capacitor 24, capacitor 26, and resistor 28. From the emitter of transistor 18 the wave form is fed to capacitor 24, capacitor 26, and resistor 28. Upon passing through current limiting resistor 28, the wave form is sensed at the positive (+) terminal 30 of ramp generator 32. At the negative (-) terminal 33 of ramp generator 32 a reference voltage is produced from between voltage dividers, resistors 34 and 36. Resistor 38 is fixed as dictated by the operating requirements of ramp generator 32. As the input wave form voltage at the positive (+) terminal 30 of ramp generator 32 exceeds the reference voltage at the negative (-) terminal 33, the output of ramp generator 32 rapidly changes state. For example, a change from a zero voltage level to ramp generator 32 supply voltage level, i.e., 11.6 volts. Capacitor 40 starts an exponential charge through 42, producing a positive logarithmic voltage ramp (See Fig. 3d) which in turn is connected to resistors 44 and 46. The wave form produced at the emitter of transistor 18 is fed to capacitor 24, resistor 48, then to the input terminal 49 of digital to analog generator 50. Resistors 52, 54, 56, 58, capacitors 60, 62, 64, and diode 66 provide the necessary biasing as dictated by the operating requirement of digital to analog generator 50. Resistor 56 is adjusted for different voltage output, as determined by the number of cylinders of the internal combustion engine. For example, a 4 cylinder engine would require one value, while a 6 cylinder engine another, and an 8 cylinder engine yet another. The wave form to the input terminal of digital to analog generator 50 produces a voltage at its output 68 that is directly proportional to the frequency of the input wave forms. For example, a 6 cylinder engine has a idling RPM of 600. The input wave forms frequency at this RPM would be approximately 30 pulses per second. The output at this frequency would be approximately 30 pulses per second. The output at this frequency would be approximately +.25 volts. Then as the frequency of the input wave forms increase to 75 pulses per second (an engine RPM of 1500), the output voltage would increase to approximately +1.5 volts. At 3000 RPM or 150 pulses per second, the output voltage would be approximately +3. volts. Digital to analog generator 50 works somewhat like a pump; the greater the input pulse frequency, the higher the output voltage.

The resulting output voltage of digital to analog generator 50 is fed to the inverting transistor 70 and the biasing network resistor 72, resistor 74, resistor 76. Resistors 78 and 80 form a voltage divider that sets the level of transistor 70 output voltage swing. The inverted output voltage produced from between the collector of transistor 70 and resistor 80 is fed to two separate variable voltage dividers resistor 82 and resistor 84, which function as potentiometers, to 86 and then to ground. Varying these potentiometers reduces or increases the level of voltage produced by digital to analog generator 50 and inverted by transistor 70. This voltage is then fed to the negative (-) terminals 88 and 89 of comparator delay 90 and comparator delay 92 and is thereby used as a variable reference voltage. The positive logarithmic ramp voltage produced by ramp generator 32, resistor 42, and capacitor 40 is fed to the positive (+) terminals 94 and 96 of comparator delays 90 and 92 through current limiting resistors 44 and 46. Resistors 98, 100, 102, and 104 provide the necessary biasing as dictated by the operating requirements of comparator delays 90 and 92. Potentiometers, resistors 82 and 84, are adjusted to set specific reference levels at the negative (-) input terminals 88 and 89 of comparator delay 90 and comparator delay 92, so that as the logarithmic ramp voltage exceeds these reference levels, comparator delay 90 and comparator delay 92 will change states in sequence. Consequently, as the engine RPM increases or decreases, comparator delay 90 and comparator delay 92 will change states because the reference voltage levels shift up and down, but will always maintain a fixed relationship to each other due to the potentiometer settings, resistors 82 and 84. The logarithmic ramp voltage then provides the trigger voltage and the constant time relationship between the first, second, and third pulse is preserved. (<u>See</u>, Figs. 3b, 3d, 3e, and 3f.)

The wave form from between the emitter of 18 and resistor 22 is fed to the integrating network, capacitor 26 and resistor 106, then to the diode 108, through the biasing network, resistors 110 and 112, to the base of the amplifier configuration of transistors 114 and 116. This wave form will initiate the first of the three sparks. (See, Fig. 3g). Meanwhile, the output wave forms from comparator delay 90 and comparator delay 92 are fed through the integrating network, capacitor 118, and resistor 120, capacitor 122 and resistor 124, to the diodes 126 and 128, through the biasing network, resistors 110 and 112, to the base of the amplifier configuration of transistors 114 and 116. See, Figs. 3h and 3i). The OR gate network of diode 108, 126, 128, and resistors 110 and 112 provide three paths for the first, second, and third spark initiating components.

The output pulses are then taken from between the emitter of transistor 116 and resistor 130, through coupling capacitor 132 to the base of transistor 134 biased by resistors 136 and 138. The circuit transistors 134, 140, resistors 136, 138, 142, 144, 146, 147, capacitor 148 and diode 150 form a monostable multivibrator in which transistor 134 is normally off and transistor 140 is normally conducting the supplying current to the ignition coil through transistor 152. A positive pulse from between the emitter of transistor 116 and resistor 130 fed through coupling capacitor 132 to the base transistor 134 causes transistor 134 to conduct for a period of time determined by resistor 146 and capacitor 148. While transistor 134 conducts, transistor 140 and 152 are cut off and the ignition primary coil current rapidly decreases to zero volts. As the current decreases, a high voltage, high current spark is generated in the secondary. The voltage supplied to 134 is held constant by zener diode regulator 154 and resistors 156 and 158. An anti-ringing zener 160 is connected between the collector of transistor 152 and ground to prevent this transistor's VCE rating from being exceeded due to a high voltage ring out after each spark is generated.

The features disclosed in the foregoing description, in the following claims and/or in the accompanying drawings may, both separately and in any combination thereof, be material for realising the invention in diverse forms thereof.

I CLAIM:

1. A multiple-spark electronic ignition system producing a timed sequence of a plurality of ignition sparks per cylinder compression cycle of an internal combustion engine, comprising:

a pulse means for producing a plurality of trigger pulse signals; and

a control means, responsive to said trigger pulses, for generating a plurality of timed ignition signals for each of said trigger pulses and for controlling the frequency of said plurality of timed ignition signals as a function of engine RPM.

2. The multiple-spark ignition system of claim 1, further comprising,

an amplifying means for transforming said sequence of timed ignition signals into a timed series of high energy ignition sparks.

3. The multiple-spark electronic ignition system of claim 1, further comprising,

a monitoring means, connected to said control means and responsive to said trigger pulses, for adjusting the frequency of said plurality of timed ignition signals as a function of the operating conditions of the engine.

4. The multiple-spark electronic ignition system producing a timed sequence of a plurality of ignition sparks per cylinder compression cycle of an internal combustion engine, comprising,

a first means for producing trigger pulse signals in timed relation with the RPM of said engine;

a second means, connected to said first means, for generating a first wave output signal in timed relation to said trigger pulse signal;

a third means, connected to said second means, for converting said wave into a sequence of two or more wave output signals, including, a means for maintaining the relative relationship of said sequence of wave output signals by monitoring the variations in the operating conditions and RPM of said engine and making the corresponding electronic adjustments to vary the time between the initiation of said first wave output signal and said second and subsequent wave output signals;

a fourth means connected to said second and third means for converting said sequence of wave output signals into a corresponding sequence of pulse ignition signals; and

a fifth means, connected to said fourth means for amplifying and maintaining the relative relationship of each pulse in said sequence of ignition signals to produce a timed series of a plurality of high energy ignition sparks per cylinder compression cycle.

5. The multiple-spark ignition system of claim 4, wherein, said first means is a conventional cam and contact points distributor system

6. The multiple-spark ignition system of claim 4, wherein, said first means is a magnetic induction transducer.

7. The multiple-spark ignition system of claim 4, wherein said second means comprises a input comparator and an isolator amplifier.

8. The multiple spark ignition system of claim 4, wherein said third means comprises:

a sweep voltage generator connected to said second means;

a digital to analog generator connected to said second means;

an inverter amplifier connected to said digital to analog generator; and a plurality of comparator delays each connected to said sweep voltage generator and said inverter amplifier.

9. The multiple-spark ignition system of claim 4, wherein said fourth means is a multiple input OR gate.

10. The multiple-spark ignition system of claim 4, wherein said fifth means comprises:

an amplifier;

a monostable multiple vibrator; and

an output switching amplifier.

11. The multiple-spark ignition system of claim 4, wherein said wave is a square wave.

12. The multiple-spark ignition system of claim 4, wherein said sweep voltage generator converts said first wave into a positive logarithmic voltage ramp;

said digital to analog generator converts said first wave into a proportional analog voltage signal, which is inverted by said inverter amplifier;

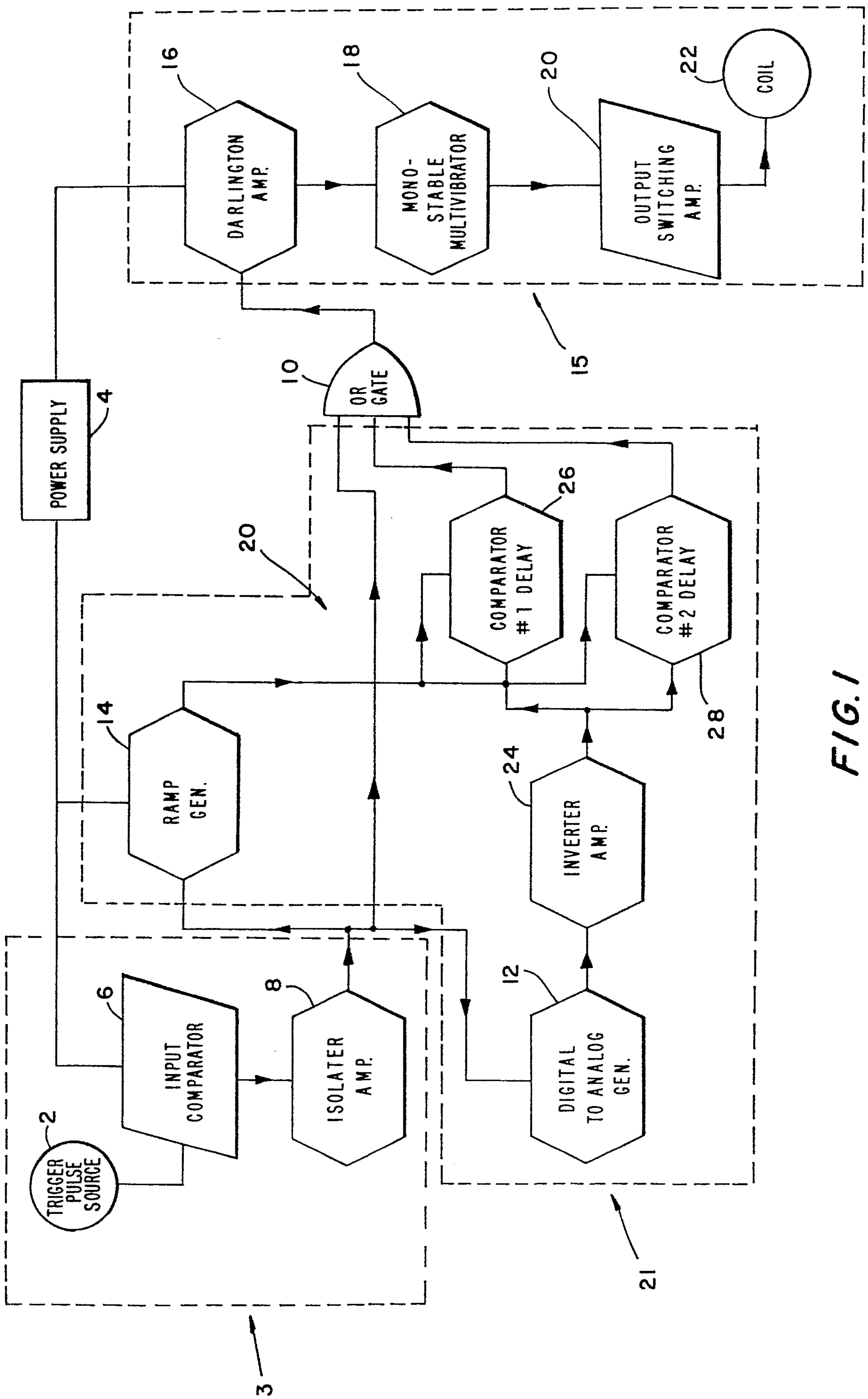
said inverted analog voltage is individually adjusted for each comparator delay;

said adjusted voltage is used to set specific reference levels at the negative input terminals of the plurality of comparator delays;

said logarithmic sweep ramp voltage is fed to the positive terminals of the plurality of comparator delays; and

each of said comparator delays changes state in succession as the logarithmic sweep ramp voltage exceeds set reference voltages.

13. The multiple-spark ignition system of claim 12, wherein there are two of said comparator delays.


TRIGGER PULSE SOURCE
INPUT COMPARATOR
ISOLATER AMP.
POWER SUPPLY
RAMP GEN.
DIGITAL TO ANALOG GEN.
INVERTER AMP.
COMPARATOR #1 DELAY
COMPARATOR #2 DELAY
OR GATE
DARLINGTON AMP.
MONO-STABLE MULTIVIBRATOR
OUTPUT SWITCHING AMP.
COIL
2
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28

FIG. 1

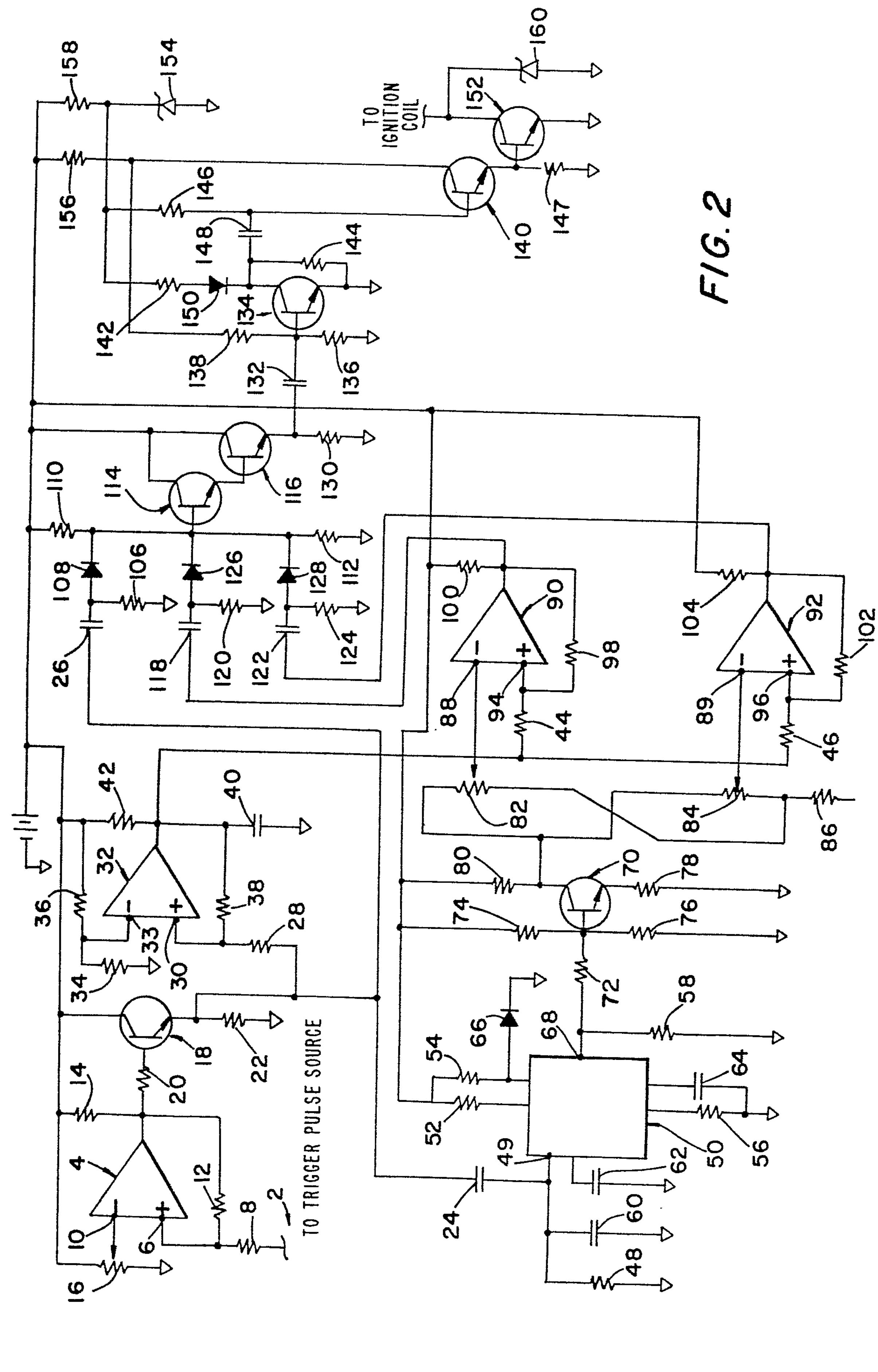

FIG. 2

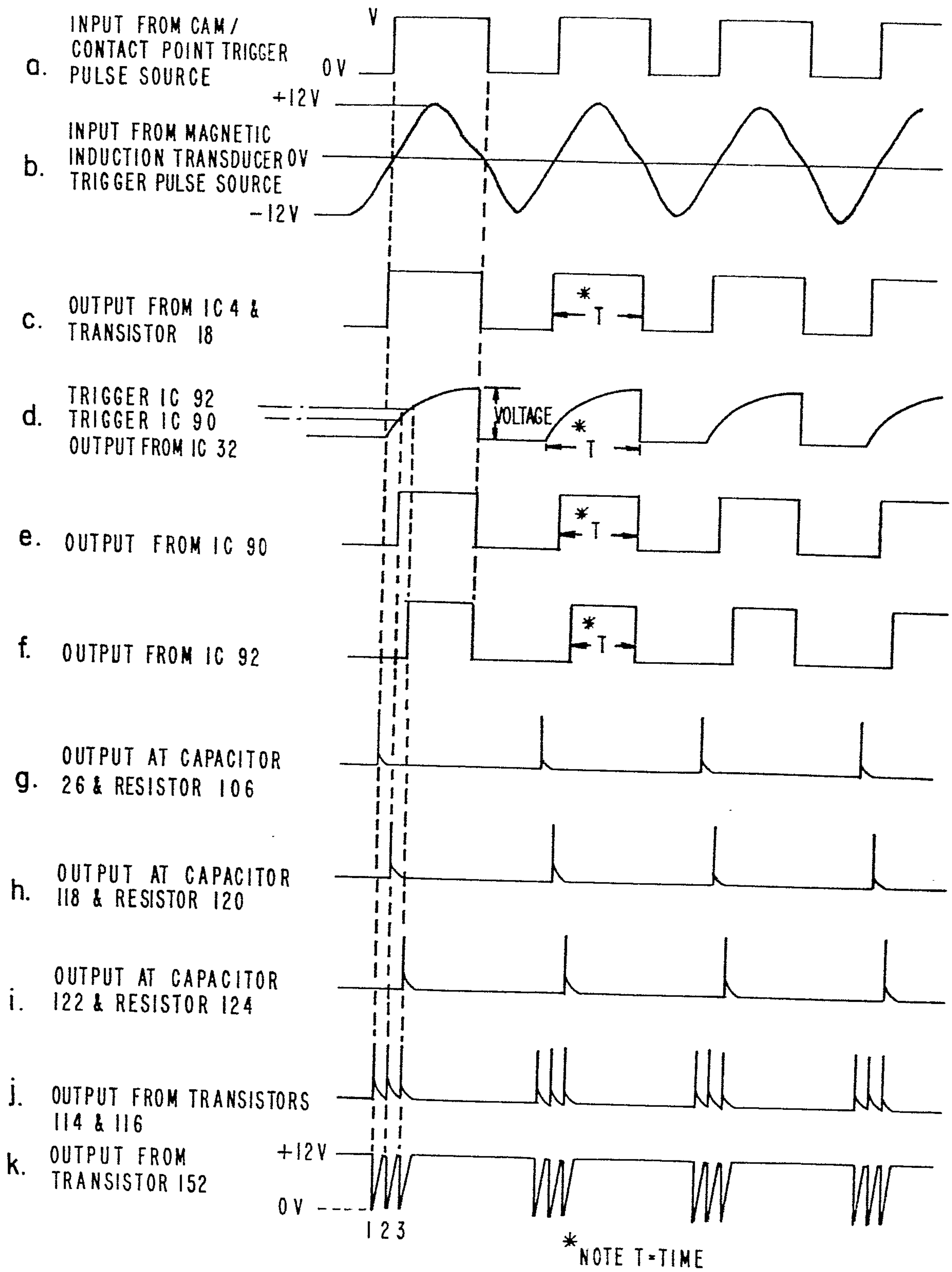
a. INPUT FROM CAM / CONTACT POINT TRIGGER PULSE SOURCE
V
0 V
+12V
b. INPUT FROM MAGNETIC INDUCTION TRANSDUCER TRIGGER PULSE SOURCE
0V
-12V
c. OUTPUT FROM IC 4 & TRANSISTOR 18
* T
d. TRIGGER IC 92
TRIGGER IC 90
OUTPUT FROM IC 32
VOLTAGE
* T
e. OUTPUT FROM IC 90
* T
f. OUTPUT FROM IC 92
* T
g. OUTPUT AT CAPACITOR 26 & RESISTOR 106
h. OUTPUT AT CAPACITOR 118 & RESISTOR 120
i. OUTPUT AT CAPACITOR 122 & RESISTOR 124
j. OUTPUT FROM TRANSISTORS 114 & 116
k. OUTPUT FROM TRANSISTOR 152
+12V
0V
1 2 3
*NOTE T=TIME

FIG. 3