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Sattler

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[54] **INTERNAL COMBUSTION ENGINE SPEED LIMITING CIRCUIT**

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[52] **U.S. Cl.** **123/102,** 123/108

[51] **Int. Cl.** **F02m 51/00**

[58] **Field of Search** 123/102

[56] **References Cited**

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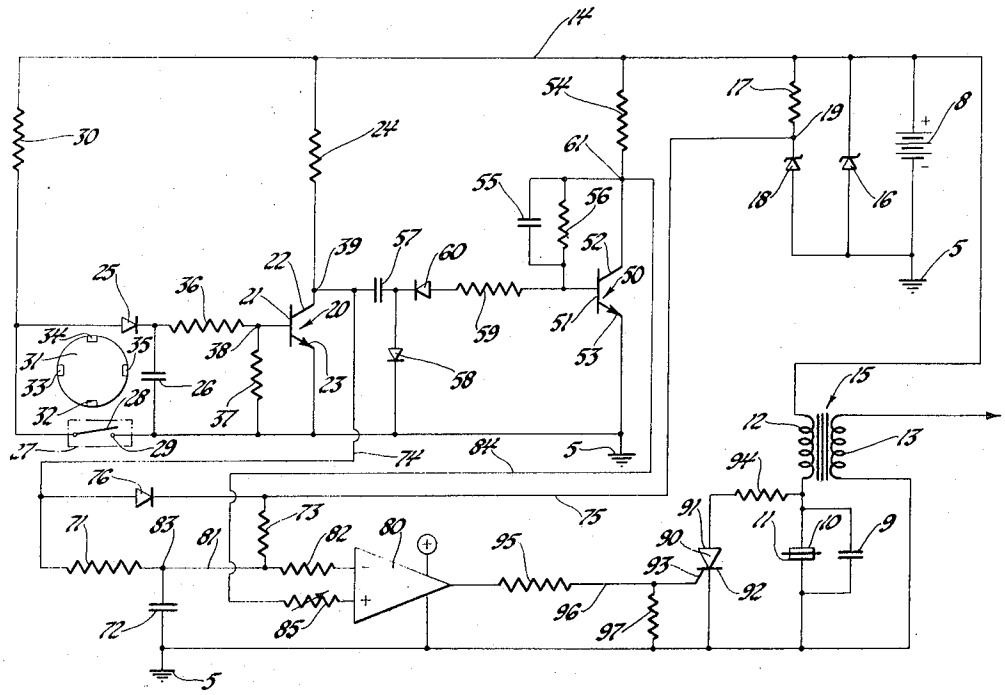
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Attorney, Agent, or Firm—Richard G. Stahr

[57] **ABSTRACT**

An internal combustion engine speed limiting circuit. A direct current sawtooth waveform potential signal having a substantially constant maximum magnitude is applied to the inverting input circuit of a conventional operational amplifier and a direct current engine speed potential signal which increases linearly in magnitude with engine speed is applied to the non-inverting input circuit of the operational amplifier. The operational amplifier produces an output direct current control potential signal while the magnitude of the engine speed potential signal exceeds the magnitude of the sawtooth waveform potential signal which is applied across the gate-cathode electrodes of a silicon controlled rectifier, the anode-cathode electrodes of which are connected in shunt across the conventional ignition distributor breaker contacts.

6 Claims, 5 Drawing Figures



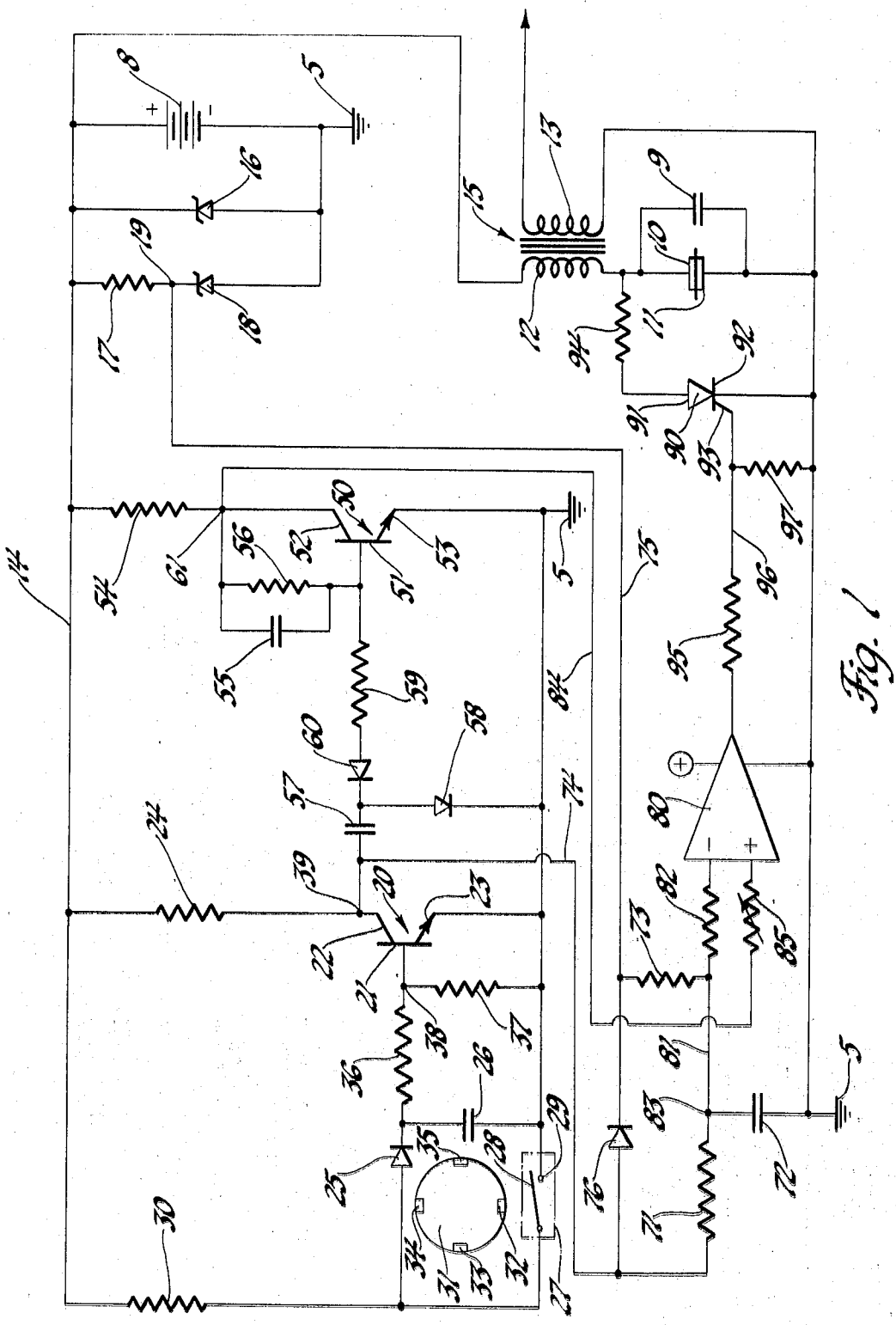


Fig. 1

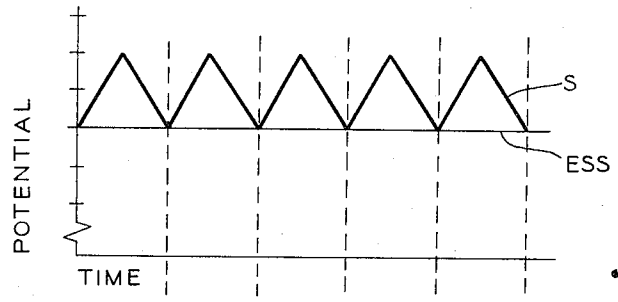


Fig. 2A

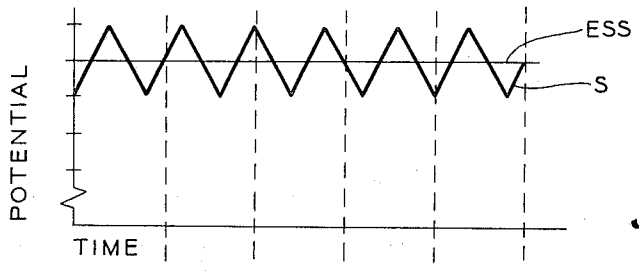


Fig. 2B

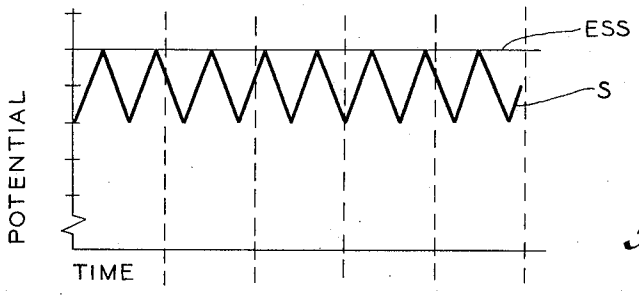


Fig. 2C

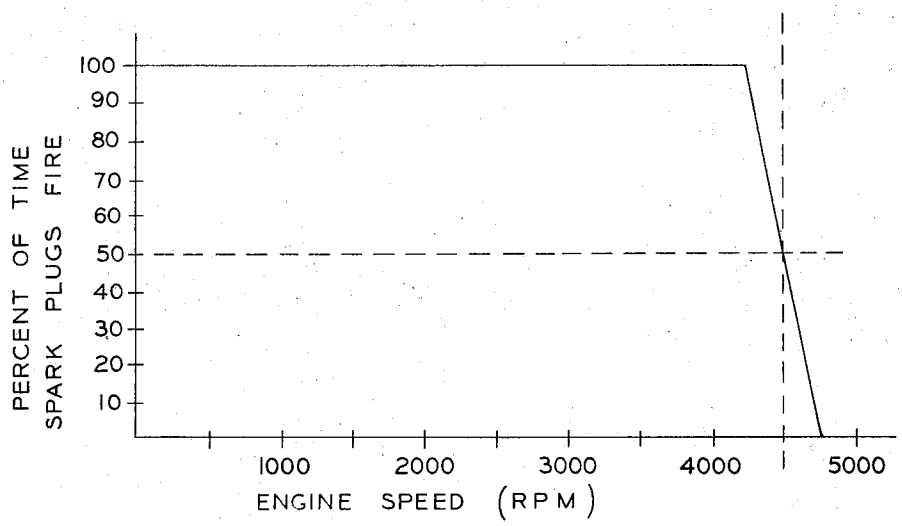


Fig. 2D

INTERNAL COMBUSTION ENGINE SPEED LIMITING CIRCUIT

This invention is directed to an internal combustion engine speed limiting circuit and, more specifically, to an internal combustion engine speed limiting circuit which produces engine spark plug misfire when the engine speed has reached a predetermined maximum.

With certain types of internal combustion engines, for example, high performance automobile engines, the engine may be driven at a rate of speed high enough to destroy the engine. Therefore, a circuit which will limit the engine speed to a predetermined maximum by producing engine spark plug misfire when the engine speed has reached the predetermined maximum is desirable.

It is, therefore, an object of this invention to provide an improved internal combustion engine speed limiting circuit.

It is another object of this invention to provide an improved internal combustion engine speed limiting circuit which produces a engine spark plug misfire when the engine speed has reached a predetermined maximum.

It is another object of this invention to provide an improved internal combustion engine speed limiting circuit which is responsive to a direct current engine speed potential signal, which increases linearly in magnitude with engine speed, and a direct current sawtooth waveform potential signal having a substantially constant maximum magnitude to produce an output signal which will operate a normally open electrical switching device connected in shunt with the ignition distributor breaker contacts to the electrical circuit closed condition while the engine speed potential signal is of a magnitude greater than the sawtooth waveform potential signal.

In accordance with this invention, an internal combustion engine speed limiting circuit for preventing the engine speed from exceeding a predetermined maximum is provided wherein a direct current engine speed potential signal which increases linearly in magnitude with engine speed is compared with a direct current sawtooth waveform potential signal having a substantially constant maximum magnitude to produce an output control potential signal while the engine speed signal is of a magnitude greater than the sawtooth waveform signal which operates a normally open electrical switching device connected in shunt across the ignition distributor contacts to the electrical circuit closed condition.

For a better understanding of the present invention, together with additional objects, advantages and features thereof, reference is made to the following description and accompanying drawing in which:

FIG. **1** sets forth the internal combustion engine speed limiting circuit of this invention in schematic form; and FIGS. **2A**, **2B**, **2C** and **2D** are a set of curves useful in understanding the circuit of FIG. **1**.

As the point of reference or ground potential is the same point electrically throughout the system, it has been illustrated in FIG. **1** by the accepted schematic symbol and referenced by the numeral **5**.

Referring to FIG. **1** of the drawing, the internal combustion engine speed limiting circuit of this invention for preventing the engine speed from exceeding a predetermined maximum is set forth in schematic form in combination with conventional ignition distributor

breaker contacts **10** and **11** connected in series with the primary winding **12** of an ignition coil **15** across a source of direct current potential, which may be a conventional storage battery **8.** Ignition distributor breaker contacts **10** and **11** are operated to the electrical circuit open and closed conditions in timed relationship with the engine in a manner well known in the automotive art. For this reason and in the interest of reducing drawing complexity, only the ignition distributor breaker contacts have been schematically illustrated in FIG. **1.** The conventional ignition distributor capacitor which is normally connected in shunt across the ignition distributor breaker contacts is referenced by the numeral **9** and the secondary winding of ignition coil **15** is referenced by the numeral **13.** The ungrounded output of secondary winding **13** is connected to the high tension input terminal of the ignition distributor in a manner well known in the automotive art. In FIG. **1,** and without intention or inference of a limitation thereto, the positive polarity terminal of battery **8** is connected to positive polarity bus or lead **14** and to the primary winding **12** of ignition coil **15** and the negative polarity terminal is connected to point of reference or ground potential **5.**

Also provided is circuitry for producing a direct current reference potential of a substantially constant predetermined magnitude, circuitry for producing a series of direct current square waveform potential signals of a substantially constant predetermined magnitude, circuitry for producing a direct current engine speed potential signal which increases linearly in magnitude with engine speed, circuitry for producing a direct current sawtooth waveform potential signal having a substantially constant maximum magnitude, circuitry responsive to the engine speed potential signal and the sawtooth waveform potential signal for producing an output direct current control potential signal while the magnitude of the engine speed potential signal exceeds the magnitude of the sawtooth waveform potential signal and an electrical switching device having normally open current carrying elements connected in shunt across the ignition distributor breaker contacts **10** and **11** which are electrically operable to the electrical circuit closed condition in response to the control potential signal.

In FIG. **1,** the output potential of battery **8** is shown to be regulated by a Zener diode **16.** It is to be specifically understood that this potential regulating arrangement is not absolutely necessary for the practice of this invention.

To produce a direct current reference potential signal of a substantially constant predetermined magnitude, the series combination of a resistor **17** and a Zener diode **18** may be connected across battery **8** through positive polarity bus or lead **14** and point of reference or ground potential **5.** Zener diode **18** is selected to have an inverse breakdown potential of a magnitude equal to the selected predetermined magnitude. Consequently, the direct current reference potential appearing across junction **19** and point of reference or ground potential **5** remains substantially constant at a magnitude equal to the inverse breakdown potential of the Zener diode selected as Zener diode **18.** In one specific embodiment of the internal combustion engine speed limiting circuit of this invention, the selected Zener diode corresponding to Zener diode **18** had an inverse breakdown potential of seven volts.

One method for producing a series of direct current square waveform potential signals of a substantially constant magnitude may be circuitry including type NPN transistor **20** having the collector electrode **22** and the emitter electrode **23** thereof connected across the positive and negative polarity terminals, respectively, of battery **8** through collector resistor **24** and positive polarity bus or lead **14** and through point of reference or ground potential **5**; the parallel combination of diode **25** and capacitor **26** in series and the normally open contacts **28** and **29** of a magnetically operated reed switch **27** connected across battery **8** through current limiting resistor **30** and positive polarity bus or lead **14** and through point of reference or ground potential **5.** Member **31** may be any member which may be conveniently rotated at a speed equal to or porportional to engine speed which is arranged to carry a plurality of permanent magnets, four of which are illustrated in FIG. **1** and referenced by the numerals **32, 33, 34** and **35.** For example, member **31** may be a drum mounted upon the engine crankshaft; it may be a member mounted upon the engine flywheel, or a member mounted upon any other vehicle part which is rotated at a speed equal to or porportional to vehicle or engine speed. It is only necessary that the permanent magnets rotated thereby are in operative relationship with the normally open contacts **28** and **29** of reed switch **27** to operate these contacts to the electrical circuit closed condition at a frequency porportional to vehicle speed by passing in close proximity thereto in a manner well known in the art. While the contacts **28** and **29** of reed switch **27** are open, circuit flows from the positive polarity terminal of battery **8** through positive polarity lead **14,** current limiting resistor **30,** diode **25,** resistors **36** and **37** in series, and point of reference or ground potential **5** to the negative polarity terminal of battery **8.** This flow of current through resistor **37** produces a potential drop thereacross which is of a positive polarity upon junction **38,** to which the base electrode **21** of type NPN transistor **20** is connected, of a positive polarity upon junction **38** with respect to point of reference or ground potential **5.** As this is the proper polarity relationship to produce base-emitter current flow through type NPN transistor **20,** this device is triggered conductive through the collector-emitter electrodes thereof. While transistor **20** is conducting through the collector-emitter electrodes, the potential upon junction **39** is substantially ground potential. While contacts **28** and **29** of reed switch **27** are closed, base drive current for transistor **20** is shunted to ground, consequently, transistor **20** extinguishes. With transistor **20** extinguished, the potential appearing across junction **39** and point of reference or ground potential **5** is of a magnitude substantially equal to the magnitude of the potential of battery **8** and of a positive polarity upon junction **39** with respect to point of reference or ground potential **5.** From this description, it is apparent that a series of direct current square waveform potential signals of a substantially constant magnitude appear across junction **39** and points of reference or ground potential **5** of a frequency porportional to engine speed.

To produce a direct current engine speed potential signal which increases linearly in magnitude with engine speed, circuitry including type NPN transistor **50** operating as a class A amplifier having the collector electrode **52** and emitter electrode **53** thereof connected across the positive and negative polarity terminals, respectively, of battery **8** through collector resistor **54** and positive polarity potential lead **14** and point of reference or ground potential **5,** respectively; the parallel combination of capacitor **55** and resistor **56** connected across the collector electrode **52** and the base electrode **51** of type NPN transistor **50,** capacitor **57** and diode **58.** During the periods that type NPN transistor **20** is not conducting, that is, when the direct current square waveform potential signal appearing across junction **39** and point of reference or ground potential **5** is of a maximum magnitude with the polarity of junction **39** being positive with respect to point of reference or ground potential **5,** capacitor **57** charges through collector resistor **24** and diode **58.** During the periods that transistor **20** is conductive, that is, the time between each square waveform potential signal, a circuit is established through the collector-emitter electrodes thereof for the discharge of capacitor **57.** Discharging capacitor **57** reduces the positive polarity potential upon the base electrode **51** of type NPN transistor **50,** thereby decreasing the collector-emitter conduction therethrough as a class A amplifier. Capacitor **55** charges through the relatively low value resistors **54** and **59** and diodes **60** and **58** and discharges through high resistance **56** or much more rapidly through the collector-emitter electrodes of type NPN transistor **50,** depending upon the degree of its conductivity. The more frequently transistor **20** goes not conductive with increases of engine and vehicle speed, the lower the degree of conduction through type NPN transistor **50.** As capacitor **55** discharges more slowly with a decrease of conduction through transistor **50,** the direct current engine speed potential signal appearing across junction **61** and point of reference or ground potential **5** increases in magnitude. Consequently, this direct current engine speed potential signal is of a magnitude porportional to vehicle or engine speed and is of a positive polarity upon junction **61** with respect to point of reference or ground potential **5.**

To produce a direct current sawtooth waveform potential signal having a substantially constant maximum magnitude in response to the series of square waveform potential signals appearing across junction **39** and point of reference or ground potential **5,** the square waveform potential signals are applied across the series combination of resistor **71** and capacitor **72** and the reference potential appearing across junction **19** and point of reference or ground potential **5** is applied across the series combination of resistor **73** and capacitor **72** through respective leads **74** and **75.** To limit the magnitude of the sawtooth waveform potential signals to a preselected maximum, a diode **76** is provided. The square waveform potential signals are applied to the anode electrode of diode **76** and the reference potential is applied to the cathode electrode of diode **76,** as indicated. Diode **76** is selected to have a forward potential drop thereacross, which remains substantially constant regardless of current flow therethrough, of a magnituide slightly greather than the selected magnitude of the reference potential. In a practical application of the circuit of this invention, the diode therein corresponding to diode **76** had a forward potential drop of 7.7 volts. Consequently, the square waveform potential signals have a substantially constant maximum magnituide equal to the forward potential drop across diode **76.** While transistor **20** of the square waveform

generating circuit is not conducting, that is, while the square waveform potential signals are of the maximum magnitude, capacitor **72** charges through series resistor **71** and while transistor **20** is conducting, that is, between each of the square waveform potential signals, capacitor **72** discharges through resistor **71** and the collector-emitter electrodes of transistor **50.** As capacitor **72** charges with each square waveform potential signal and discharges between each square waveform potential signal, the potential across capacitor **72** increases to a maximum magnitude as determined by the forward potential drop across diode **76** and decreases to a magnitude determined by the time constant of the discharge circuit with a minimum magnitude substantially equal to the magnitude of the reference potential. The value of capacitor **72** and resistor **71** are selected to provide one time constant at the frequency of the square wave potential signals where speed limiting is to begin. The direct current sawtooth waveform potential signals are superimposed upon the reference potential as shown in FIGS. **2A, 2B** and **2C.**

To produce a direct current control potential signal in response to the engine speed potential signal and the sawtooth waveform potential signal while the magnitude of the engine speed potential signal exceeds the magnitude of the sawtooth waveform potential signal, a convetional operational amplifier **80,** having an inverting input circuit and a non-inverting input circuit, operating in the open loop mode may be employed. When operating in the open loop mode, operational amplifiers function as an extremely sensitive and rapidly operating electrical switch which produces an output signal of a positive polarity upon the output terminal thereof with respect to point of reference or ground potential **5** when a positive polarity potential is applied to the inverting input circuit of a magnitude less than the positive polarity potential applied to the non-inverting input circuit and produces an output signal of substantially ground potential when a positive polarity potential is applied to the inverting input circuit of a magnituide greater than the positive polarity potential applied to the non-inverting circuit. The sawtooth waveform potential signal is applied to the inverting input circuit of operational amplifier **80** through lead **81** and resistor **82** connected between junction **83,** between resistor **71** and capacitor **72,** and the inverting input circuit of operational amplifier **80.** The engine speed potential signal is applied to the non-inverting input circuit of operational amplifier **80** through lead **84** and resistor **85,** which may be variable to provide calibration and adjustment, connected between junction **61** and the non-inverting input terminal of operational amplifier **80.**

To provide for engine misfire when the speed of the engine reaches the predetermined maximum, an electrical switching device having normally open current carrying elements connected in shunt across the ignition distributor breaker contacts **10** and **11** and a control element responsive to an electrical signal for operating the normally open current carrying elements to the electrical circuit closed condition is provided. This electrical switching device may be a conventional silicon controlled rectifier **90** having an anode electrode **91** and a cathode electrode **92,** the current carrying elements, connected in shunt across the ignition distributor breaker contacts **10** and **11** through current limiting resistor **94** and point of reference or ground potential **5** and a control element, gate electrode **93,** responsive to an electrical signal for operating the normally open current carrying elements, the anode-cathode electrodes, to the electrical circuit closed condition. The control potential signal produced by operational amplifier **80** is applied to the control element, gate electrode **93,** of silicon controlled rectifier **90** through resistor **95** and lead **96.** That is, the control potential signal produced by operational amplifier **80** is applied across the gate-cathode electrodes of silicon controlled rectifier **90** in the proper polarity relationship to produce gate current flow therethrough. Resistor **97** is connected across the gate-cathode electrodes of silicon controlled rectifier **90** to improve the di/dt characteristics of the device.

While specific circuit arrangements and devices have been herein set forth for producing the direct current reference potential, the direct current square waveform potential signals, the direct current engine speed potential signal, the direct current sawtooth waveform potential signal and the direct current control potential signal and the electrical switching device, it is to be specifically understood that alternate circuit arrangements and switching devices may be substituted therefor without departing from the spirit of the invention.

To limit engine speed, the novel circuit of this invention causes the spark plugs to misfire during a selected limiting range of engine speed, the percentage of spark plug misfires increasing as the speed of the engine increases within the range until there is a 100 percent misfire at the upper extreme of the limiting range. Therefore, at all speeds below the liniting range, the output of operational amplifier **80** is substantially ground potential, consequently, there is no direct current control signal to trigger silicon controlled rectifier **90** conductive. At engine speeds above the limiting range, the output of operational amplifier **80** is continuous and of a positive polarity with respect to ground to provide a constant gate signal across the gate-cathode electrodes of silicon controlled rectifier **90,** consequently, silicon controlled rectifier **90** is triggered conductive through the anode-cathode electrodes each time the anode electrode becomes more positive than the cathode electrode, a condition which produces 100 percent spark plug misfire. At speeds within the limiting range, the output of operational amplifier **80** is essentially a square wave of frequency identical to the sawtooth wave which is porportional to engine speed.

For purposes of this specification, it will be assumed that the engine speed limiting range is between 4,250 r.p.m. and 4,750 r.p.m. That is, at engine speeds below 4,250 r.p.m., the engine operates normally; at an engine speed of 4,250 r.p.m., the circuit of this invention begins to produce spark plug misfire, the percentage of spark plug misfires increasing between engine speeds of 4,250 r.p.m. and 4,750 r.p.m. and provides 100 percent spark plug misfire above 4,750 r.p.m. This is graphically shown in FIG. **2D** wherein the percent of time spark plugs fire is plotted against engine speed in r.p.m.'s.

Assuming that the engine is running at or slightly below 4,250 r.p.m., the magnitude of the direct current engine speed potential signal is of a magnitude proportional to engine speed as indicated by the straight line ESS of FIG. **2A.** So long as the engine is operating constantly at this speed, the magnitude of the direct current engine speed signal never exceeds the lowest mag-

nitude of the direct current sawtooth waveform potential signal S of FIG. 2A. Should the engine attain the constant speed of 4,500 r.p.m., the magnitude of the direct current engine speed potential signal increases with this increase of speed, the straight line ESS of FIG. 2B. At this constant 4,500 r.p.m. speed, it may be noted in FIG. 2B that the magnitude of the direct current engine speed potential signal is greater than the magnitude of the direct current sawtooth waveform potential signal S substantially one-half the time, a condition which produces a 50 percent spark plug misfire, as is best seen in the curve of FIG. 2D. As the engine speed increases, the magnitude of the direct current engine speed potential signal increases in magnitude, consequently, this signal is greater than the direct current sawtooth waveform potential signal a greater percentage of the time to produce a greater percentage of spark plug misfire until at 4,750 r.p.m. the spark plug misfire is 100 percent, FIG. 2C.

Assuming that the associated internal combustion engine, not shown, is operating at a speed less than 4,250 r.p.m., the contacts **28** and **29** of reed switch **27** are being operated by the magnets upon rotating member **31**. Each time contacts **28** and **29** open, base-emitter drive current is supplied to transistor **20** from the positive polarity terminal of battery **8**, through positive polarity potential lead **14**, resistor **30**, diode **25**, resistor **36**, the base-emitter electrodes of transistor **20** and point of reference or ground potential **5** to the negative polarity terminal of battery **8** to trigger transistor **20** conductive through the collector-emitter electrodes. Each time contacts **28** and **29** of reed switch **27** are closed, base drive current is diverted from transistor **20** therethrough to point of reference or ground potential **5** to extinguish transistor **20**. This switching action of transistor **20** produces a square waveform potential signal across junction **39** and point of reference or ground potential **5** of a frequency porportional to engine speed. Capacitor **26** acts as a filter capacitor to filter out any transients which may be produced by contact bounce within reed switch **27**.

While the direct current square waveform potential signals appear across junction **39** and point of reference or ground potential **5**, transistor **50** is operating as a class A amplifier. Upon each positive polarity excursion of the direct current square waveform potential signals, capacitor **57** charges through a circuit which may be traced from the positive polarity terminal of battery **8**, through positive polarity potential lead **14**, resistor **24**, capacitor **57**, diode **58** and point of reference or ground potential **5** to the negative polarity terminal of battery **8** and capacitor **72** charges from a circuit which may be traced from the positive polarity terminal of battery **8**, through positive polarity potential lead **14**, resistor **24**, lead **74**, resistor **71**, capacitor **72** and point of reference or ground potential **5** to the negative polarity terminal of battery **8**. Between each of the direct current square waveform potential signals while transistor **20** is conducting through the collector-emitter electrodes, capacitors **57** and **72** tend to discharge therethrough. The discharge of capacitor **57** reduces the degree of conduction through transistor **50** operating as a class A amplifier and the discharge of the charge of capacitor **72** produces the direct current sawtooth waveform potential signal. With these conditions, the magnitude of the direct current engine speed potential signal appearing across junction **61** and point of reference or ground potential **5** does not exceed the magnitude of the sawtooth waveform potential signal, as shown in FIG. 2A. Consequently, operational amplifier **80** does not produce an output direct current control signal to trigger silicon controlled rectifier **90** conductive and the engine operates normally.

As the speed of the engine is increased, the magnets carried by rotating member **31** operate contacts **28** and **29** of reed switch **27** more rapidly to the electrical circuit closed condition to increase the frequency of the direct current square waveform potential signals, a condition which decreases the degree of conduction through transistor **50**. A reduced degree of conduction through transistor **50** results in the retention of a charge of increased magnitude upon capacitor **55** as it is not as rapidly discharged through conducting transistor **50**. Consequently, as the engine continues to increase in speed, the direct current engine speed potential signal appearing across junction **61** and point of reference or ground potential **5** continues to increase in magnitude until it exceeds the magnitude of the direct current sawtooth waveform during at least a portion of each cycle of the sawtooth waveform as is best seen in FIG. 2B. Each time the magnitude of the direct current engine speed potential signal exceeds the magnitude of the direct current sawtooth waveform potential signal, operational amplifier **80** produces an output direct current control potential signal of a positive polarity with respect to point of reference or ground potential **5**. This control potential signal, applied across the gate-cathode electrodes of silicon controlled rectifier **90**, triggers silicon controlled rectifier **90** conductive to provide a current path in shunt with the ignition distributor breaker contacts **10** and **11** even though they may be open at the time. With silicon controlled rectifier **90** conducting while ignition distributor breaker contact points **10** and **11** are open, there is an insufficient potential induced in secondary winding **13** to fire the next spark plug, hence the spark plug misfires, a condition which tends to reduce the speed of the engine.

As the speed of the engine continues to increase, the magnitude of the direct current engine speed potential signal continues to increase for reasons previously described, consequently, operational amplifier **80** produces an output direct current control signal for a greater portion of each cycle of the direct current sawtooth waveform potential signal as determined by the percentage of time the magnitude of the direct current engine speed potential signal exceeds the magnitude of the direct current sawtooth waveform potential signal. With a control signal maintained for a longer period of time, silicon controlled rectifier **90** is conductive for a longer period of time to produce more spark plug misfires, a condition which tends to reduce even further the speed of the engine.

When the engine speed has exceeded the predetermined maximum, silicon controlled rectifier **90** is triggered conductive substantially 100 percent of the time, a condition which results in 100 percent spark plug misfire, a conditon which reduces the engine speed regardless of the throttle setting.

While a preferred embodiment of the present invention has been shown and described, it will be obvious to those skilled in the art that various modifications and substitutions may be made without departing from the spirit of the invention which is to be limited only within the scope of the appended claims.

What is claimed is:

1. An internal combustion engine speed limiting circuit comprising in combination with conventional ignition distributor breaker contacts connected in series with the primary winding of an ignition coil across a source of direct current potential and operated to the eletrical circuit open and closed conditions in timed relationship with the engine, means for producing a direct current engine speed potential signal which increases linearly in magnitude with engine speed, means for producing a direct current sawwooth waveform potential signal having a substantially constant maximum potential, means responsive to said engine speed potential signal and said sawtooth waveform potential signal for producing an output direct current control potential signal while the magnitude of said engine speed potential signal exceeds the magnitude of said sawtooth waveform potential signal, electrical switch means having normally open current carrying elements connected in shunt across said ignition distributor breaker contacts and a control element responsive to an electrical signal for operating said normally open current carrying elements to the electrical circuit closed condition, and means for applying said control potential signal to said control element of said electrical switch means.

2. An internal combustion engine speed limiting circuit comprising in combination with conventional ignition distributor breaker contacts connected in series with the primary winding of an ignition coil across a source of direct current potential and operated to the electrical circuit open and closed conditions in timed relationship with the engine, means for producing a direct current engine speed potential signal which increass linearly in magnitude with engine speed, means for producing a direct current sawtooth waveform potential signal having a substantially constant maximum potential, an operational amplifier responsive to said engine speed potential signal and said sawtooth waveform potential signal for producing an output direct current control potential signal while the magnitude of said engine speed potential signal exceeds the magnitude of said sawtooth waveform potential signal, electrical switch means having normally open current carrying elements connected in shunt across said ignition distributor breaker contacts and a control element responsive to an electrical signal for operating said normally open current carrying elements to the electrical circuit closed condition, and means for applying said control potential signal to said control element of said electrical switch means.

3. An internal combustion engine speed limiting circuit comprising in combination with conventional ignition distributor breaker contacts connected in series with the primary winding of an ignition coil across a source of direct current potential and operated to the electrical circuit open and closed conditions in timed relationship with the engine, means for producing a direct current engine speed potential signal which increases linearly in magnitude with engine speed, means for producing a direct current sawtooth waveform potential signal having a substantially constant maximum potential, an operational amplifier responsive to said engine speed potential signal and said sawtooth waveform potential signal for producing an output direct current control potential signal while the magnitude of said engine speed potential signal exceeds the magnitude of said sawtooth waveform potential signal, a silicon controlled rectifier having anode and cathode electrodes connected in shunt across said ignition distributor breaker contacts and a gate electrode, and means for applying said control potential signal across said gate-cathode electrodes of said silicon controlled rectifier.

4. An internal combustion engine speed limiting circuit comprising in combination with conventional ignition distributor breaker contacts connected in series with the primary winding of an ignition coil across a source of direct current potential and operated to the electrical circuit open and closed conditions in timed relationship with the engine, means for producing a series of direct current square waveform potential signals of a substantially constant predetermined potential, means for producing a direct current engine speed potential signal which increases linearly in magnitude with engine speed, means responsive to said series of square waveform potential signals for producing a direct current sawtooth waveform potential signal having a substantially constant maximum potential, an operational amplifier having an inverting input circuit and a non-inverting input circuit responsive to said engine speed potential signal and said sawtooth waveform potential signal for producing an output direct current control potential signal while the magnitude of said engine speed potential signal exceeds the magnitude of said sawtooth waveform potential signal, means for applying said sawtooth waveform potential signal to said inverting input circuit of said operational amplifier, means for applying said engine speed potential signal to said non-inverting input circuit of said operational amplifier, a silicon controlled rectifier having anode and cathode electrodes connected in shunt across said ignition distributor breaker contacts and a gate electrode, and means for applying said control potential signal across said gate-cathode electrodes of said silicon controlled rectifier.

5. An internal combustion engine speed limiting circuit comprising in combination with conventional ignition distributor breaker contacts connected in series with the primary winding of an ignition coil across a source of direct current potential and operated to the electrical circuit open and closed conditions in timed relationship with the engine, means for producing a direct current reference potential of a substantially constant predetermined magnitude, means for producing a series of direct current square waveform potential signals of a substantially constant potential, means for producing a direct current engine speed potential signal which increases linearly in magnitude with engine speed, means responsive to said series of square waveform potential signals for producing a direct current sawtooth waveform potential signal having a substantially constant maximum potential, first and second resistors, a capacitor, means for applying said square waveform potential signals across the series combination of one of said resistors and said capacitor, means for applying said reference potential across the series combination of the other one of said resistors and said capacitor, an operational amplifier having an inverting input circuit and a non-inverting input circuit responsive to said engine speed potential signal and said sawtooth waveform potential signal for producing an output direct current control potential signal while the magnitude of said engine speed potential signal exceeds

the magnitude of said sawtooth waveform potential signal, means for connecting the junction between said capacitor and said two resistors to said inverting input circuit of said operational amplifier, means for applying said engine speed potential signal to said non-inverting input circuit of said operational amplifier, a silicon controlled rectifier having anode and cathode electrodes connected in shunt across said ignition distributor breaker contacts and a gate electrode, and means for applying said control potential signal across said gate-cathode electrodes of said silicon controlled rectifier.

6. An internal combustion engine speed limiting circuit comprising in combination with conventional ignition distributor breaker contacts connected in series with the primary winding of an ignition coil across a source of direct current potential and operated to the electrical circuit open and closed conditions in timed relationship with the engine, means for producing a direct current reference potential of a substantially constant predetermined magnitude, means for producing a series of direct current square waveform potential signals of a substantially constant potential, means for producing a direct current engine speed potential signal which increases linearly in magnitude with engine speed, means responsive to said series of square waveform potential signals for producing a direct current sawtooth waveform potential signal having a substantially constant maximum potential, first and second resistors, a capacitor, means for applying said square waveform potential signals across the series combination of one of said resistors and said capacitor, means for applying said reference potential across the series combination of the other one of said resistors and said capacitor, a diode having anode and cathode electrodes, means for applying said square waveform potential signals to said anode electrode of said diode and said reference potential to said cathode electrode of said diode, an operational amplifier having an inverting input circuit and a non-inverting input circuit responsive to said engine speed potential signal and said sawtooth waveform potential signal for producing an output direct current control potential signal while the magnitude of said engine speed potential signal exceeds the magnitude of said sawtooth waveform potential signal, means for connecting the junction between said capacitor and said two resistors to said inverting input circuit of said operational amplifier, means for applying said engine speed potential signal to said non-inverting input circuit of said operational amplifier, a silicon controlled rectifier having anode and cathode electrodes connected in shunt across said ignition distributor breaker contacts and a gate electrode, and means for applying said control potential signal across said gate-cathode electrodes of said silicon controlled rectifier.

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