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[54] **ENGINE RPM CONTROL SYSTEM**

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[51] **Int. Cl.**..... **F02p 9/00;** F02b 77/00

[58] **Field of Search** .. 123/102, 118, 148 E, 198 DC

[56] **References Cited**

UNITED STATES PATENTS

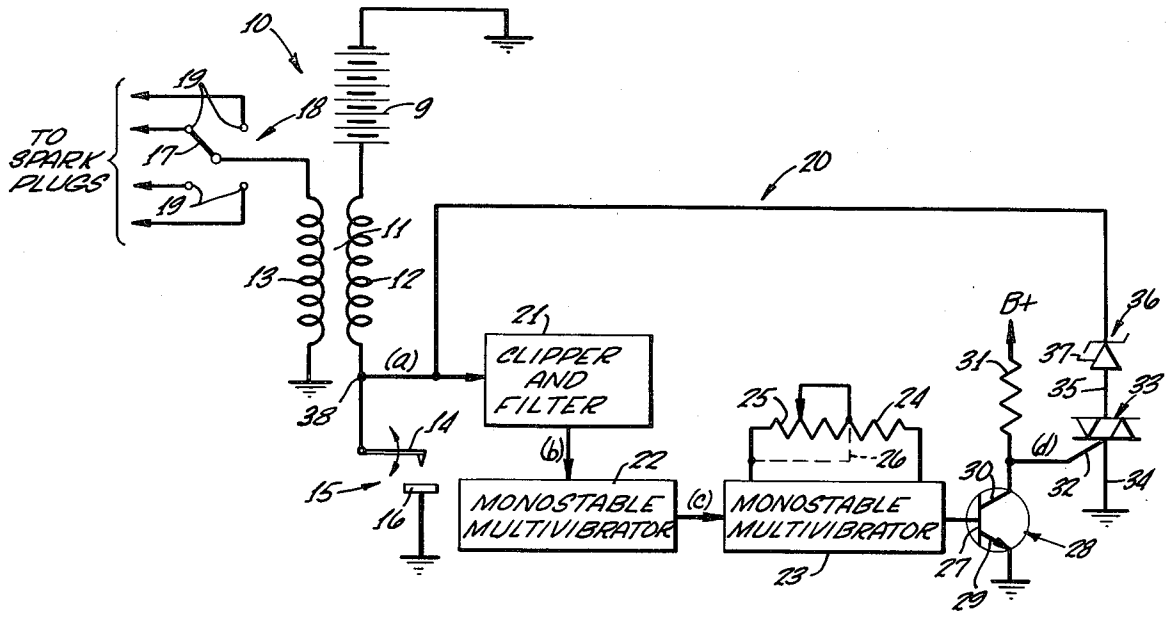
3,563,219	2/1971	Mieras	123/118
3,601,103	8/1971	Swiden	123/102
3,665,903	5/1972	Harris	123/102

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[57] **ABSTRACT**

In an internal combustion engine of the type including an ignition system comprising an ignition coil having primary and secondary windings, a battery, a set of points, and one or more spark plugs, there is disclosed a system for electronically limiting the engine RPM's. The system operates to limit the high voltage spike generated within the primary winding of the ignition coil to a value which is insufficient to cause ignition whenever the time between consecutive point openings is less than a predetermined time interval. By limiting the amplitude of the spike rather than shorting the primary winding, each point opening is examined on an individual basis with respect to its time of occurrence after the previous opening.

19 Claims, 3 Drawing Figures



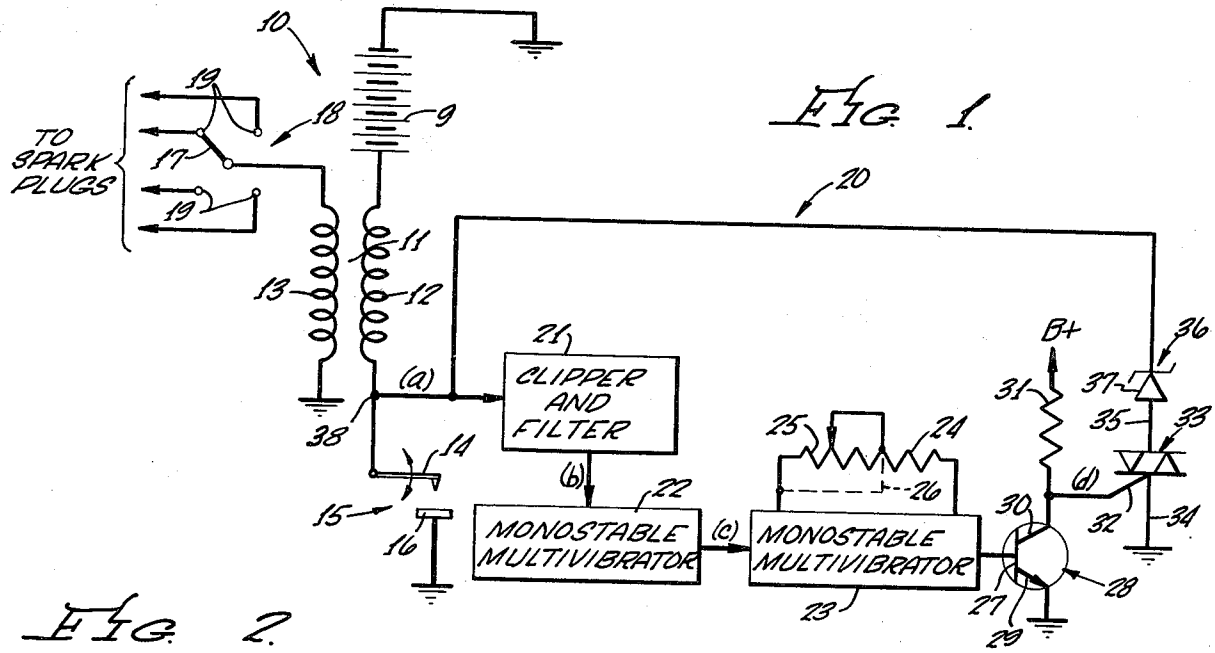
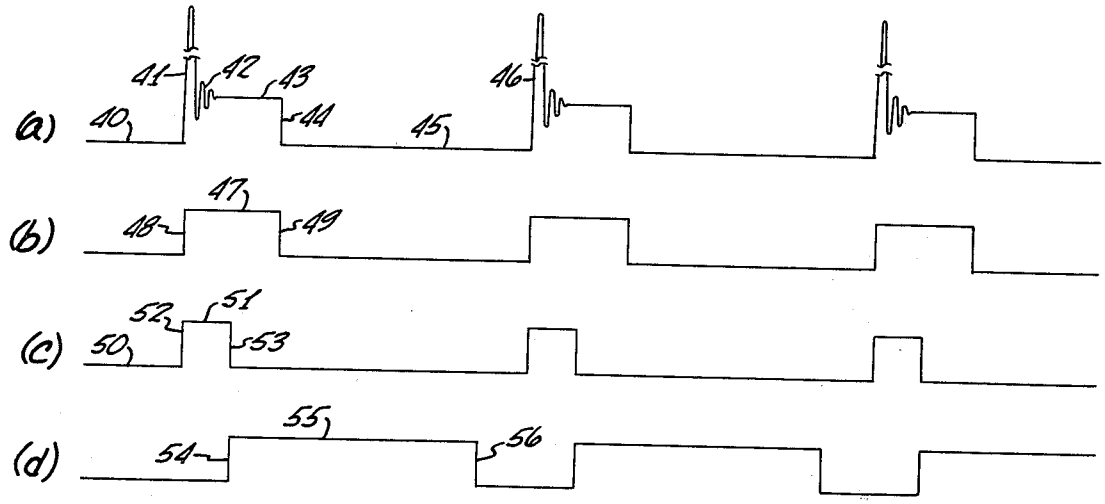


FIG. 1

FIG. 2



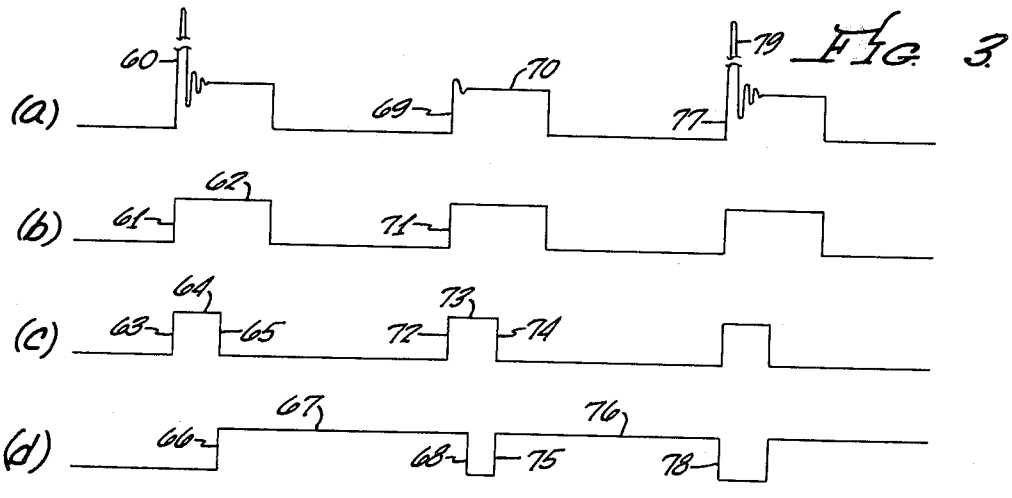


FIG. 3

ENGINE RPM CONTROL SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an engine RPM control system and, more particularly, to apparatus for electronically limiting the revolutions per minute of an internal combustion engine.

2. Description of the Prior Art

The manufacturers of all internal combustion engines specify the maximum number of revolutions per minute that the engine should be subjected to without incurring damage thereto. However, such manufacturers do nothing more than provide recommendations and it is up to the individual operator of the engine to insure that the maximum speed is not exceeded.

While it would seem that the operator of an engine would not exceed the recommended maximum speed, several situations exist where excessive speeds are common. One area is in the case of truck fleets where the truck drivers often have little concern for the life expectancy of the truck engine. In such cases, excessive speeds generally occur when the truck is gaining speed in the lower gears. Such excessive speeds result in frequent and expensive motor overhauls or the replacement of seals that fail due to excessive speeds.

Other examples obviously exist where excessive speeds are prevalent. Owners of taxi cab fleets and rental vehicles also have an interest in preventing excessive engine speeds during break in or thereafter.

The initial attempts at limiting engine RPM's were primarily mechanical and these had numerous disadvantages. Such mechanical governors were not highly accurate, often malfunctioned, and were easily subject to tampering. As a result, various attempts have been made to electronically limit the engine speed. The most typical approach is to short out the primary winding of the ignition coil to thereby prevent ignition voltage for one or more point openings. However, with the primary winding shorted out, it is impossible to measure the time interval between consecutive point openings or closings, due to loss of signal, which causes the engine to "hunt" for a suitable speed. This approach provides for very inexact control and does not allow the engine to perform efficiently at the maximum allowable RPM's. Furthermore, since such devices absorb the energy across the primary winding of the ignition coil, they are generally large and heavy due to the massive heat sink required.

Other problems exist with available electronic engine speed limiters. Some are expensive to manufacture while others are difficult to install or require complicated procedures for adjusting the desired speed of operation. In many cases, the wire length between the unit and the engine ignition system is critical since an excessive wire length creates a voltage drop which the unit is illequipped to handle.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a system for electronically limiting the RPM's of an internal combustion engine which solves the problems discussed above. The present system operates to limit only the high voltage spike generated within the primary winding of the ignition coil to a value which is insufficient to cause ignition whenever the time between consecutive point openings is less than a predetermined time interval. By simply limiting the amplitude of the high voltage spike without shorting the primary winding, the reference signal caused by point opening and closing is not interfered with and it is possible to examine each point opening or closing on an individual basis with respect to its time of occurrence after the previous opening. This allows the engine to speed up to the maximum allowable RPM's before limiting occurs and no hunting of engine speed occurs.

The present control system is inexpensive to manufacture and easy to install in an existing ignition system. Since only the high voltage spike is limited, massive heat sinks are not required and the system may be very small and lightweight. Wire lengths are irrevelant and it is easy to either calculate the fixed component values for a particular engine speed or to adjust the engine speed by means of a potentiometer.

Briefly, the present engine RPM control system for use in an internal combustion engine of the type including an ignition system having an ignition coil, a battery, a set of points, and one or more spark plugs comprises a clipper and filter circuit coupled to the junction between the primary winding and one of the points of the set of points for generating a first pulse which starts when the points open and terminates when the points close, a first monostable multivibrator coupled to the output of the clipper and filter for generating a timing pulse starting concurrently with point opening and having a fixed time duration, a second monostable multivibrator coupled to the output of the first monostable multivibrator for generating a gating pulse having a time duration which is a function of the desired speed of the engine, a gate circuit having a gate terminal and first and second main terminals, the gate terminal being coupled to the output of the second multivibrator to control conduction between the main terminals during the gating pulse, and a zener diode connected between one of the main terminals of the gate circuit and the before-mentioned junction for establishing a threshold voltage level which exceeds the voltage of the battery, the other of the main terminals of the gate circuit being connected to the other of the points of the set of points, such as via ground, whereby conduction occurs between the main terminals of the gate circuit to short out the high voltage spike generated across the primary winding of the ignition coil only during the gating pulse, thereby indicating excessive speed, and only when the voltage at the junction exceeds the breakdown voltage of the zener so that the entire primary winding is not shorted.

OBJECTS

It is therefore an object of the present invention to provide an engine RPM control system.

It is a further object of the present invention to provide apparatus for electronically limiting the revolutions per minute of an internal combustion engine.

It is a still further object of the present invention to provide an engine RPM control system that operates to limit only the high voltage spike generated within the primary winding of an ignition coil to a value which is insufficient to cause ignition whenever the time between consecutive point openings is less than a predetermined time interval.

It is another object of the present invention to provide an engine RPM control system which is inexpen-

sive to manufacture and easy to install in existing ignition system.

It is still another object of the present invention to provide an engine RPM control system which is small and lightweight.

Another object of the present invention is the provision of an engine RPM control system in which it is easy to calculate fixed component values for a particular engine RPM or in which the desired speed may be readily adjusted by means of a potentiometer.

Still another object of the present invention is the provision of an engine RPM control system in which only the high voltage spike generated within the primary winding of the ignition coil is shorted so that the entire current across the coil does not have to pass through a transistor, diode, or other heat producing device.

Still other objects, features, and attendant advantages of the present invention will become apparent to those skilled in the art from a reading of the following detailed description of the preferred embodiment constructed in accordance therewith, taken in conjunction with the accompanying drawings wherein like numerals designate like parts in the several figures and wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic circuit diagram, partially in block diagram form, of the ignition system of an internal combustion engine showing the connection thereto of the present engine RPM control system; and

FIGS. **2** and **3** are series of waveforms useful in explaining the operation of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and, more particularly, to FIG. **1** thereof, there is shown a typical ignition system, generally designated **10,** for an internal combustion engine, not shown. Ignition system **10** includes an ignition coil **11** having primary and secondary windings **12** and **13,** respectively. One side of primary winding **12** is connected to one terminal of a battery **9,** the other terminal of which is typically connected to ground. Battery **9** may have a nominal voltage of approximately **14** volts. The other side of primary winding **12** is typically connected to the movable point **14** of a set of points **15,** the other point **16** being connected to ground.

One side of secondary winding **13** of ignition coil **11** is normally connected to ground whereas the other side is connected to the rotor **17** of a distributor **18.** Distributor **18** includes a plurality of stationary terminals **19** which are connected to the spark plugs of the engine, not shown.

The high voltage necessary for creating a spark in the spark plugs is obtained from secondary winding **13** of ignition coil **11.** The set of points **15** periodically open, under the control of the distributor cam, and then close under the control of a spring. When points **15** close for the required dwell time, energy is stored in the magnetic field in primary winding **12.** When points **15** open, a high voltage spike of approximately 400 volts peak amplitude and **30** microseconds duration is generated across primary winding **12.** It is this initial spike that is transformed by ignition coil **11** to a voltage of approximately 20,000 volts across secondary winding **13.** This high voltage pulse is directed by distributor **18** across the spark plug gap, causing a spark and ignition.

If, however, without interfering with the normal signal across primary winding **12,** this high voltage spike is limited to a relatively low value, such as 20 volts, a corresponding reduction occurs in the voltage across secondary winding **13.** In the example given, the voltage across secondary **13** would be limited to 1,000 volts and this is not sufficient to cause ignition. Thus, the theory of operation of the present invention is to measure the time interval between consecutive openings of points **15.** When such time interval becomes shorter than a predetermined time interval, indicating that the maximum allowable speed has been exceeded, the present control system, generally designated **20,** operates to clip the high voltage spike to a value which is insufficient to cause ignition. As a result, the spark plug is not fired and there is insufficient energy created in the engine to permit the speed to continue at such rate. The engine immediately slows down and as soon as the timing between consecutive point openings becomes longer then the predetermined time interval, normal ignition occurs.

Still referring to FIG. **1,** engine RPM control system **20** comprises a clipper and filter **21** coupled to the junction **38** between primary winding **12** of ignition coil **11** and point **14** of set of points **15.** Clipper and filter **21** limits the excursions of the voltage across points **15** and filters out the high frequency oscillations. The resultant output of clipper and filter **21** is a squarewave which alternates between the voltage of battery **9** and ground level.

The output of clipper and filter **21** is applied to the input of a first monostable multivibrator or one-shot **22** which is triggered on the leading edge of the pulse from clipper and filter **21** and generates a timing pulse having a fixed time duration. This timing pulse is applied to the input of a second monostable multivibrator or one-shot **23** which is triggered on the trailing edge of the timing pulse from one-shot **22** and generates a gating pulse having a time duration which is a function of the desired speed of the engine. As is well known in the art, the time duration of a multivibrator may be adjusted by simply varying the value of one of the resistors in the circuit thereof. Thus, one-shot **23** may include a resistor **24** connected in series with a variable resistor **25** for those cases where the engine speed is to be adjustable. Alternatively, variable resistor **25** may be shorted, as shown dotted at **26,** whereby the value of resistor **24** controls the desired engine speed.

The output of one-shot **23** is applied to the base **27** of a transistor amplifier **28,** the emitter **29** of which may be connected to ground and the collector **30** of which may be connected via a resistor **31** to a suitable source of reference voltage included within RPM control system **20.** Collector **30** of transistor **28** is also connected to the gating terminal **32** of a gating means, generally designated **33,** which also has first and second main terminals **34** and **35.** As shown in FIG. **1,** gating means **33** may be a triac or, alternatively, may be a silicon controlled rectifier (SCR). Gating means **33** may be any other type of device for permitting conduction between main terminals **34** and **35** whenever a suitable signal is applied to gating terminal **32.**

Terminal **34** of gating means **33** is connected to point **16** of set of points **15,** such as by connecting terminal **34** to ground. The other terminal **35** of gating means **33** is connected to junction **38** via a means, generally des-

ignated 36, for establishing a reference voltage level or predetermined voltage across main terminals 34 and 35. In other words, means 36 prevents conduction between terminals 34 and 35 unless the voltage across points 15 exceeds the reference or threshold voltage level established thereby. Means 36 may comprise a battery but preferably comprises a zener diode 37 having a breakdown voltage which exceeds the voltage of battery 9. In the present example, the breakdown voltage of zener diode 37 is chosen to be approximately 20 volts.

OPERATION

The operation of engine RPM control system 20 may be best understood with reference to FIGS. 2 and 3 wherein waveforms (*a*) in each of FIGS. 2 and 3 show the voltage at junction 38 between primary winding 12 of ignition coil 11 and point 14 of set of points 15, waveforms (*b*) in both figures show the output voltage of clipper and filter 21, waveforms (*c*) show the output voltage of one-shot 22, and waveforms (*d*) show the output voltage of transistor amplifier 28 which is an amplified version of the output voltage of one-shot 23.

Consider first the operation of engine RPM control system 20 when the associated engine is operating below the maximum speed established by resistor 24 and/or 25 of one-shot 23. The appropriate waveforms are those of FIG. 2 where it is seen that when points 15 are closed, the voltage at junction 38 is at ground level, as shown at 40. After points 15 have been closed for the required dwell time and energy is stored within primary winding 12 of ignition coil 11, points 15 open under the control of the distributor cam, causing an energy spike 41 of approximately 400 volts peak amplitude and 30 microseconds duration. Initial spike 41 is transformed up to about 20,000 volts by secondary winding 13 to cause ignition of the spark plug. The voltage at junction 38 then decays at 42, in an oscillatory manner, to the voltage of battery 9, at 43. Junction 38 remains at this voltage until points 15 close, at which time the voltage thereat is reduced to ground level 45, at 44. The voltage remains at ground level 45 until the next voltage spike 46 which occurs upon opening of points 15, whereupon the cycle repeats.

It is most desirable to use the leading edge, such as at 41 and 46, of the waveform at junction 38 to trigger the remaining components of engine RPM control system 20 since the opening of points 15 occurs quite precisely under the control of the distributor cam. Closing is caused by a spring and since bouncing occurs, the trailing edge of waveform (*a*), such as at 44, is less exact. It is also desirable to eliminate the high voltage spike at junction 38 as well as the high frequency oscillations 42 before further proceeding in control system 20. Thus, circuit 21 contains standard components for limiting the excursions of the voltage at junction 38 and for filtering out the high frequency oscillations to provide a squarewave 47 having a leading edge 48 which coincides with the opening of points 15 and a trailing edge 49 which coincides with the closing of points 15.

The squarewave output pulse of clipper and filter 21 is applied to first one-shot 22, the output of which is normally at a first voltage level 50. The output of one-shot 22 rises to a second voltage level 51, at 52, whenever the output of clipper and filter 21 goes positive, such as at 48. The length of the pulse output of multivibrator 22 is fixed, independently of the width of the output of clipper and filter 21. This fixed timing pulse, which may be adjusted to be approximately two milliseconds, is provided to prevent interference by system 20 with the generation of the high voltage pulse within ignition coil 11, as will appear more fully hereinafter.

The output of one-shot 22, waveform (*c*), is applied to second one-shot 23 which is triggered on the trailing edge of the timing pulse therefrom to provide a gating pulse, the width of which is set for the particular speed limit desired. Thus, on the trailing edge of waveform (*c*), at 53, the output of one-shot 23 goes positive, at 54, producing a gating pulse 55 which lasts for a time period determined by the internal components of one-shot 23, such as resistor 24 and/or 25. When the gating period of one-shot 23 is over, its output returns to a reference level, at 56.

The output of one-shot 23 is amplified in transistor amplifier 28 and applied to gating terminal 32 of triac 33. Thus, triac 33 is turned on for the duration of the pulse output of one-shot 23 and will conduct whenever a voltage appears across main terminals 34, 35. Zener diode 37 prevents such conduction until the voltage at junction 38 exceeds the breakdown voltage of zener diode 37. In the present example, and assuming an ideal 20 volt zener diode 37, no current flows through triac 33 unless the voltage between junction 38 and ground is in excess of 20 volts. The only time this occurs is during the high voltage spike across primary winding 12 of ignition coil 11 since at other times, the voltage at junction 38 alternates between ground and the value of battery 9, essentially 14 volts. Thus, in the example given, engine RPM control system 20 does not interfere with the normal operation of ignition system 10.

Consider now the case when the speed of the engine associated with ignition system 10 reaches and exceeds the maximum desired speed. The appropriate waveforms are those of FIG. 3 where it is seen that the opening of points 15 generates a first voltage spike, at 60, which produces the leading edge 61 of a pulse 62 at the output of clipper and filter 21. Leading edge 61 of pulse 62 triggers one-shot 22 causing its output to go positive, at 63, generating a timing pulse 64. When pulse 64 returns to its reference level, at 65, one-shot 23 is triggered to produce the leading edge 66 of a gating pulse 67. At the end of the timing cycle established by one-shot 23, gating pulse 67 returns to the reference level, at 68. However, since the engine has reached the maximum speed, the second opening of points 15 occurs before the termination of gating pulse 67, at 68. Therefore, as soon as the leading edge 69 of the voltage at junction 38 reaches 20 volts, triac 33 conducts since all of the conditions for conduction simultaneously exist. More specifically, the voltage across main terminals 34 and 35 exceeds the breakdown voltage of zener diode 37 and a gating voltage, namely the output of one-shot 23, is present at gating terminal 32. Thus, the excursion of the voltage at junction 38 is limited to 20 volts, thereby limiting the voltage across secondary winding 13 to 1,000 volts, a value which is insufficient to cause ignition. Since the spark plugs now fail to ignite, the engine immediately begins to slow down.

It should be particularly noted that only the high voltage spike is clipped by system 20 and the normal pulse 70 is still generated at junction 38. Thus, leading edge 69 causes a corresponding leading edge 71 at the output of clipper and filter 21 which again triggers one-

shot 22, at 72, generating a timing pulse 73. The trailing edge of timing pulse 73, at 74, again triggers one-shot 23 which generates the leading edge 75 of the next gating pulse 76. If the engine has not slowed down sufficiently before the next opening of points 15, causing a leading edge 77 at junction 38, the voltage spike at junction 38 will again be limited to 20 volts and no ignition occurs. However, if the engine slows down sufficiently, the next opening of points 15, which causes voltage spike 77 occurs after gating pulse 76 has ended, at 78, and the voltage spike 79 can occur normally, permitting ignition.

It should be particularly noted that engine RPM control system 20 operates to limit only the high voltage spike generated within primary winding 12 of ignition coil 11 to a value which is insufficient to cause ignition whenever the time between consecutive openings of points 15 is less than a predetermined time interval. By simply limiting the amplitude of the high voltage spike without shorting winding 12, the reference signal generated at junction 38 and caused by the opening and closing of points 15 is not interfered with and it is possible to examine each opening of points 15 on an individual basis with respect to its time of occurrence after the previous opening. This allows the engine to speed up to the maximum allowable RPM's before limiting occurs and no hunting of engine speed results.

It should be noted that it is possible to trigger one-shot 23 on the trailing edge of the output of filter 21, thereby eliminating the necessity for one-shot 22. However, it is desirable to operate on the opening of points 15 since this occurs quite precisely under control of the distributor cam. Closing is caused by a spring and bouncing usually occurs. Therefore, if one-shot 23 were to trigger on the closing of points 15, its triggering would be sufficiently jittery to cause as much as 20percent uncertainty in the speed control limit. In other words, system 20 would start cutting in during the last 20percent of speed before the maximum RPM was reached.

On the other hand, triggering one-shot 23 on the opening of points 15 necessitates the use of one-shot 22 so that the generation of the gating pulse by one-shot 23 is delayed for a time sufficient to permit normal operation of ignition coil 11.

It can therefore be seen that in accordance with the present invention, there is provided a system 20 for electronically limiting the RPM's of an internal combustion engine which solves all of the problems discussed previously. With system 20, since only the high voltage spike is limited, massive heat sinks are not required and system 20 may be very small and lightweight. System 20 is inexpensive to manufacture and easy to install in existing ignition systems. Most importantly, wire lengths are not critical as in some existing units. Were it not for zener diode 37, the turning off of triac 33 would be dependent on the voltage across main terminals 34 and 35 of triac 33. Thus, the voltage drop in the wires connecting triac 33 to points 15 would have to be low enough to allow the current to be carried by them, rather than triac 33, thus allowing triac 33 to turn off. With zener diode 37 imposed in the circuit, the current through triac 33 is immediately reduced to zero as soon as the voltage at junction 38 goes below 20 volts, thereby insuring the complete turn off of triac 33.

A triac is preferred for gating means 33 since it is more difficult to turn on by commutating voltages across it and requires a higher gate current to turn it on, thus giving a degree of immunity from false triggering caused by radio frequency interference.

While the invention has been described with respect to the preferred physical embodiment constructed in accordance therewith, it will be apparent to those skilled in the art that various modifications and improvements may be made without departing from the scope and spirit of the invention. Accordingly, it is to be understood that the invention is not to be limited by the specific illustrative embodiment, but only by the scope of the appended claims.

I claim:

1. In an internal combustion engine of the type including an ignition system comprising an ignition coil having primary and secondary windings, the primary winding being connected in circuit with a battery and a set of points and the secondary winding being connected in circuit with one or more spark plugs, the improvement comprising means for limiting the revolutions per minute of said engine, said means comprising:
   - means operatively coupled to said ignition system for generating a gating pulse which starts a fixed time interval after opening of said points and has a time duration which is a function of the desired speed of said engine;
   - gating means having a gating terminal and first and second main terminals, said gating terminal being operatively coupled to receive said gating pulse, said gating means permitting conduction between said main terminals during said gating pulse; and
   - threshold switching means connected between one of said main terminals of said gating means and one side of said primary winding of said coil for preventing conduction between said main terminals unless the voltage across said threshold switching means and said main terminals exceeds a predetermined threshold voltage whereby said gating means shorts said primary winding during said gating pulse when the voltage thereacross exceeds said predetermined threshold voltage.

2. In an internal combustion engine according to claim 1, the improvement wherein the value of said predetermined threshold voltage exceeds the voltage of said battery.

3. In an internal combustion engine according to claim 1, the improvement wherein said threshold switching means comprises:
   - a zener diode connected in series between said one of said main terminals of said gating means and the junction between said primary winding and one side of said points.

4. In an internal combustion engine according to claim 3, the improvement wherein the other of said main terminals of said gating means is connected to the other side of said points.

5. In an internal combustion engine according to claim 3, the improvement wherein the breakdown voltage of said zener diode is greater than the voltage of said battery whereby no current flows through said gating means unless the voltage across said points exceeds said breakdown voltage.

6. In an internal combustion engine according to claim 1, the improvement wherein said gating pulse

generating means is responsive to the opening of said points.

7. In an internal combustion engine according to claim 1, the improvement wherein said gating pulse generating means comprises:

first means responsive to the opening of said points for generating a timing pulse having a duration equal to said fixed time interval; and

second means operatively coupled to the output of said first means and operative upon the termination of said timing pulse for generating said gating pulse.

8. In an internal combustion engine according to claim 7, the improvement further comprising:

means operatively coupled to the junction between said primary winding and said set of points for clipping and filtering the voltage thereat to produce a signal which starts upon opening of said points and terminates upon closing of said points, said signal being applied to said first means, said first means generating said timing pulse upon said start of said signal.

9. In an internal combustion engine according to claim 7, the improvement wherein said first means comprises a first monostable multivibrator and wherein said second means comprises a second monostable multivibrator.

10. In an internal combustion engine according to claim 7, the improvement wherein the time duration of said gating pulse is variable to adjust the desired speed of said engine.

11. In an internal combustion engine according to claim 1, the improvement wherein said gating means comprises:

a triac.

12. In an internal combustion engine according to claim 1, the improvement wherein said gating means comprises:

an SCR.

13. In an internal combustion engine of the type including an ignition system comprising an ignition coil having primary and secondary windings, the primary winding being connected in circuit with a battery and a set of points and the secondary winding being connected in circuit with one or more spark plugs, the improvement comprising means for limiting the revolutions per minute of said engine, said means comprising:

means operatively coupled to the junction between said primary winding and one of the points of said set of points for generating a first pulse which starts when said points open and terminates when said points close;

means operatively coupled to said first pulse generating means for generating a second pulse starting concurrently with said first pulse and having a fixed time duration;

means operatively coupled to said second pulse generating means and operative upon termination of said second pulse for generating a third pulse having a time duration which is a function of the desired speed of said engine;

gating means having a gating terminal and first and second main terminals, said gating terminal being operatively coupled to the output of said third pulse generating means, said gating means permitting conduction between said main terminals during said third pulse;

means connected between one of said main terminals of said gating means and said junction for establishing a threshold voltage level between said primary winding and said one main terminal; and

means for connecting the other of said main terminals to the other of said points of said set of points whereby conduction occurs between said main terminals during said third pulse when said voltage at said junction exceeds said threshold voltage level.

14. In an internal combustion engine according to claim 13, the improvement wherein the value of said threshold voltage level exceeds the voltage of said battery and biases said gating means to prevent conduction between said main terminals until the voltage across said set of points exceeds said threshold voltage level.

15. In an internal combustion engine according to claim 13, the improvement wherein said means for establishing a threshold voltage level comprises:

a zener diode connected in series between said one of said main terminals of said gating means and said junction.

16. In an internal combustion engine according to claim 15, the improvement wherein the breakdown voltage of said zener diode is greater than the voltage of said battery whereby no current flows through said gating means unless the voltage across said points exceeds said breakdown voltage.

17. In an internal combustion engine according to claim 13, the improvement wherein said first pulse generating means comprises a first monostable multivibrator and wherein said second pulse generating means comprises a second monostable multivibrator.

18. In an internal combustion engine according to claim 17, the improvement wherein the time duration of said third pulse is variable to adjust the desired speed of said engine.

19. In an internal combustion engine according to claim 13, the improvement wherein said gating means comprises:

a triac.

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