United States Patent [19]

Anderson et al.

[11] **3,875,915**

[45] **Apr. 8, 1975**

[54] **CAPACITOR DISCHARGE IGNITION SYSTEM WITH OVERSPEED CONTROL**

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[22] Filed: **Sept. 27, 1973**

[21] Appl. No.: **401,344**

[52] **U.S. Cl.** ..... **123/118;** 123/148 C

[51] **Int. Cl.** **F02p 11/02**

[58] **Field of Search** ..... 123/118, 148 S, 148 C, 123/148 E

[56] **References Cited**

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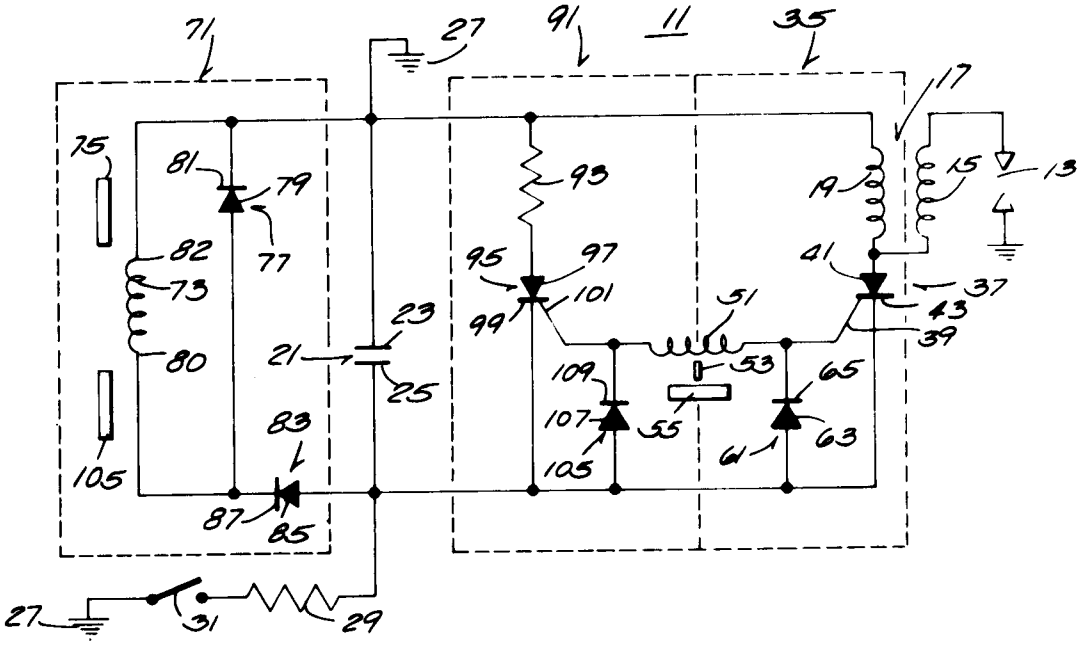
3,581,720	6/1971	Hemphill	123/118
3,703,889	11/1972	Bodig et al.	123/118 X

Primary Examiner—Charles J. Myhre
Assistant Examiner—W. Rutledge, Jr.
Attorney, Agent, or Firm—Michael, Best & Friedrich

[57] **ABSTRACT**

Disclosed herein is a capacitor discharge ignition circuit with engine overspeed control comprising an engine ignition sub-circuit electrically connected to a capacitor and including a primary winding and a normal nonconductive electronic ignition switch connected in series with the primary winding and including a trigger element operative to close the ignition switch ahd thereby to discharge the capacitor through the ignition sub-circuit to effect spark production, together with a speed control sub-circuit connected to the capacitor in parallel with the ignition sub-circuit and including resistor means and a normally nonconductive electronic speed control switch connected in series with the resistor means and including a control element operative to close the speed control switch and thereby to discharge the capacitor through the speed control sub-circuit during a time interval determined by the resistor means and independent of engine rotation, and coil and magnet means rotatable relative to each other in accordance with engine speed and electrically connected to the capacitor, to the control element, and to the trigger element for sequentially charging the capacitor with a speed control charge, generating a speed control pulse and applying the speed control pulse to the control element, charging the capacitor with an ignition charge, and generating a trigger pulse and applying the trigger pulse to the trigger element.

9 Claims, 2 Drawing Figures



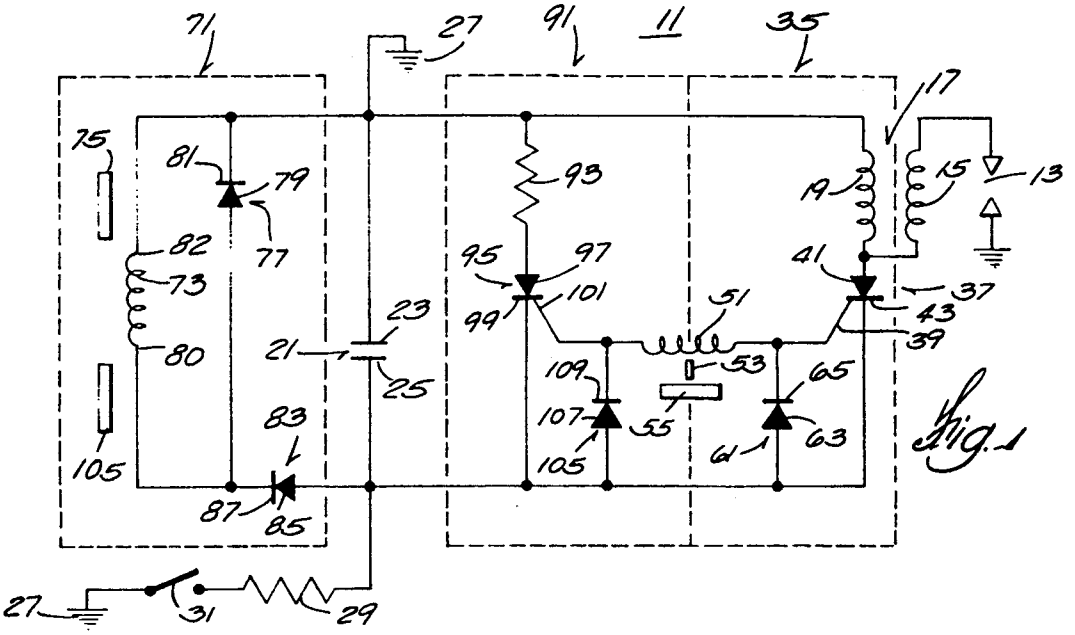

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Fig. 1

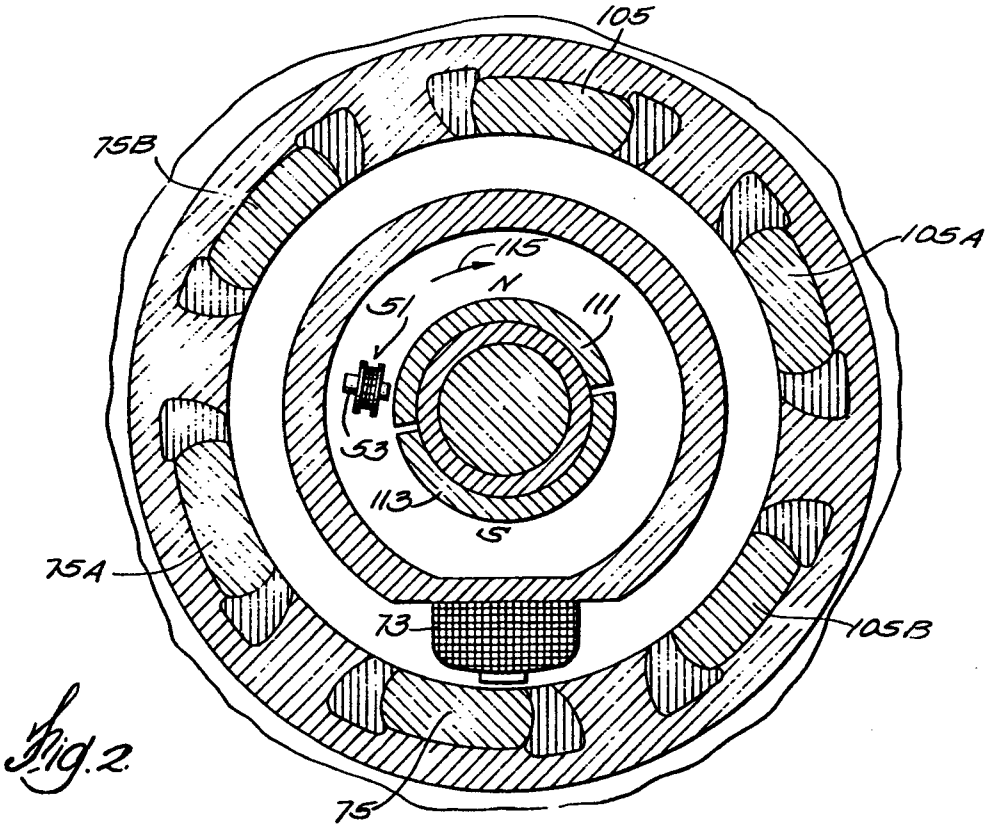

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75B
105A
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N
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111
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113
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75A
73
105B
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Fig. 2

CAPACITOR DISCHARGE IGNITION SYSTEM WITH OVERSPEED CONTROL

BACKGROUND OF THE INVENTION

The invention relates generally to capacitor discharge ignition circuits and, more particularly, to capacitor discharge ignition circuits with engine overspeed control, i.e., to circuits which discontinue ignition operation in the event of attempted engine rotation above a predetermined speed.

Attention is directed to the following U.S. patents which disclose capacitor discharge ignition circuits with overspeed control:

Hemphill, U.S. Pat. No. 3,581,720 issued June 1, 1971;

Bodig, U.S. Pat. No. 3,703,889 issued November 28, 1972.

SUMMARY OF THE INVENTION

The invention provides a capacitor discharge ignition system which prevents ignition operation during engine rotation above a predetermined speed. Such prevention of ignition operation is provided incident to increasing speed by reason of the decrease in time interval which occurs between successive events caused by engine rotation. More specifically, prior to charging of the capacitor with an ignition charge and subsequent triggering of the ignition circuit, the capacitor is charged with a speed control charge which is subsequently discharged through an electronic speed control switch, preferably a normally nonconductive SCR, connected in series with a resistor which controls the time interval of full discharge. Such time interval is essentially independent of engine speed. Because of the use of an SCR, the switch remains "on" until full discharge. When the time interval (related to engine speed) between the beginning of discharge of the speed control charge and subsequent charging of the capacitor with an ignition charge becomes less than the time interval (independent of engine speed) for full discharge of the speed control charge through the resistor, subsequent charging of the capacitor with an ignition charge occurs when the speed control switch is on. Accordingly, when the engine is rotating above the predetermined speed, the ignition charge will be immediately disipated through the resistor as the speed control switch is still conducting. However, in the event the engine is rotating below the predetermined speed, the speed control switch opens prior to the next charging of the capacitor with an ignition charge and, accordingly, the ignition charge is available for discharge in the normal manner to produce a spark.

More specifically, the invention provides a capacitor discharge ignition circuit with engine over-speed control comprising an engine ignition sub-circuit electrically connected to a charge capacitor and including a primary ignition coil winding and a normally nonconductive electronic ignition switch connected in series with the primary winding and including a trigger element operative to close the ignition switch and thereby to discharge the capacitor through the ignition sub-circuit to effect spark production, a speed control sub-circuit connected to the capacitor in parallel with the ignition sub-circuit and including resistor means and a normally nonconductive electronic speed control switch connected in series with the resistor means and

including a control element operative to close the speed control switch and thereby to discharge the capacitor through the speed control sub-circuit during a time interval determined by the resistor means and independent of engine rotation, and coil and magnet means rotatable relative to each other in accordance with engine speed and electrically connected to the capacitor, to the control element, and to the trigger element for sequentially charging the capacitor with a speed control charge, generating a speed control pulse and applying the speed control pulse to the control element, charging the capacitor with an ignition charge, and generating a trigger pulse and applying the trigger pulse to the trigger element.

Accordingly, when the engine rotates above a predetermined speed, the time interval between generation of the speed control pulse and charging of the capacitor with the ignition charge is less than the time interval of discharge of the speed control charge from the capacitor through the speed control sub-circuit, whereby the speed control switch is conductive at the time of charging of the capacitor with the ignition charge, and whereby the ignition charge is immediately discharged through the speed control sub-circuit to prevent subsequent discharge of the ignition charge through the ignition sub-circuit in response to generation of the ignition trigger pulse.

One of the principal features of the invention is the provision of a capacitor discharge ignition circuit in which engine ignition is prevented in response to rotation above a predetermined speed because a switch which would otherwise be closed at slower speeds remains open at the faster speed to discharge the ignition charge on the capacitor prior to ignition triggering of the capacitor.

Other features of the invention will become known by reference to the following drawings, general description, and claims.

DRAWINGS

FIG. 1 is a schematic wiring diagram of an ignition circuit in accordance with the invention.

FIG. 2 is a schematic illustration of a magnet and coil arrangement provided in an ignition system including the circuit shown in FIG. 1.

Before explaining the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts set forth in the following general description or illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

GENERAL DESCRIPTION

Shown in FIG. 1 of the drawings is a capacitor discharge ignition circuit **11** which is adapted to operate a single cylinder engine (not shown) and which includes means for preventing engine ignition operation above a predetermined engine speed.

The ignition circuit **11** includes a spark plug **13** which is connected to the secondary winding **15** of an ignition assembly or coil **17** including a primary winding **19**. Also included in the ignition circuit **11** is a charge capacitor **21** which includes opposed plates **23** and **25**,

with the plate 23 grounded at 27 and with the plate 25 connected through a resistor 29 to an ignition "kill" switch 31 which is grounded at 27 and which, when closed, connects the plate 25 to ground 27 so as to prevent engine ignition operation.

In accordance with the invention, there is provided coil and magnet means rotatable relative to each other in accordance with engine speed, electrically connected to the capacitor, to the control element of a still to be described normally nonconductive electronic speed control switch connected in series with a resistor, and to a trigger element of a still to be described normally nonconductive electronic ignition producing switch, and operable to sequentially charge the capacitor with a speed control charge, generate a speed control pulse and apply the speed control pulse to the control element, charge the capacitor with an ignition charge, and generate a trigger pulse and apply the trigger pulse to the trigger element.

More specifically, the ignition circuit 11 also includes an ignition sub-circuit 35 connected to the plates 23 and 25 of the capacitor 21 and including an electronic ignition switch 37 which is connected in series with the primary winding 19 and which includes a trigger element 39. In the illustrated construction, the ignition switch 37 comprises a normally nonconductive SCR having an anode 41 connected to the primary winding 19 which, in turn, is connected to the capacitor plate 23, together with a cathode 43 which is connected to the other capacitor plate 25. The ignition SCR 37 also includes a gate which constitutes the trigger element 39 and which is operative, upon application of a triggering pulse, to turn on the ignition switch, i.e., to render the trigger switch conductive.

The ignition circuit 11 also includes means for generating a trigger pulse and applying the trigger pluse to the trigger element 39 to trigger or turn on the ignition SCR. In the illustrated construction, such means comprises a trigger coil 51 connected to the trigger element 39 and wound about a core 53 (shown schematically) situated adjacent to a pulse magnet 55 rotating in accordance with engine speed so as to produce a trigger pulse in the trigger coil 51 once for every rotation of the magnet 55.

In addition, there is provided a diode 61 having an anode 63 connected to the cathode 43 of the ignition SCR 37 and a cathode 65 connected to the trigger element 39 of the ignition SCR.

The circuit 11 also includes a capacitor charging subcircuit 71 including means for charging the capacitor 21 with an ignition charge at a time prior to generation of the trigger pulse. Accordingly, subsequent triggering of the ignition switch 37 by the trigger pulse will discharge the capacitor 21 through the ignition subcircuit 35 to generate a spark at the plug 13. In the illustrated construction, such means comprises a charge coil 73 which is located adjacent the path of a charge magnet 75 rotating in accordance with engine speed. At its ends, the charge coil 73 is connected to the capacitor plates 23 and 25. Also provided in the charging subcircuit 71 is a diode 77 having an anode 79 connected to the end 80 of the charge coil and a cathode 81 connected to the other end 82 of the charge coil and to the capacitor plate 23. In addition, there is provided a second diode 83 which includes an anode 85 connected to the other capacitor plate 25 and a cathode 87 connected to the anode 79 of the diode 77 and to the end 80 of the charge coil 73.

In normal operation below the predetermined speed, travel of the charge magnet 75 past the charge coil 73 effects charging of the capacitor 21 and, when a trigger pulse is thereafter generated, such pulse turns on the ignition SCR 37 to discharge the capacitor 21 through the ignition coil 17 and thereby to generate a spark at the plug 13.

In accordance with the invention, means are provided for preventing engine ignition operation as just described in the event of engine rotation above the predetermined speed. In further accordance with the invention, such overspeed control means comprises an engine overspeed control sub-circuit 91 connected to the capacitor 21 and including resistor means in the form of a resistor 93 chosen to control the time interval of discharge of the speed control charge independently of engine speed, and a normally open electronic speed control switch 95 connected in series with the resistor 93. In the illustrated construction, the speed control switch 95 compries an SCR having an anode 97 connected to the resistor 93 which, in turn, is connected to the capacitor plate 23, and a cathode 99 which is connected to the other capacitor plate 25. In addition, the speed control SCR 95 also includes a gate 101 which constitutes a control element and which is operative, upon application of a speed control pulse, to turn on the speed control switch 95, i.e., to render the speed control switch 95 conductive.

The means for preventing engine ignition operation in the event of engine rotation above a predetermined speed also includes means for charging the capacitor 21 with a speed control charge during the interval between trigger pulse generation and subsequent charging of the capacitor 21 with an ignition charge in response to travel of the magnet 75 past the charge coil 21. In the illustrated construction, such means comprises the previously described capacitor charging subcircuit and, in addition, a second charge magnet 105 which rotates, in accordance with engine speed, past the charge coil 73 so as to charge the capacitor 21 with a speed control charge during the interval between capacitor discharge through the ignition sub-circuit and subsequent charging of the capacitor 21 with an ignition charge in response to rotation of the magnet 75 past the charge coil 73.

The means for preventing engine ignition operation in the event of engine rotation above a predetermined speed also includes means for generating a speed control pulse and for applying the speed control pulse to the control element 101 of the speed control switch 95 to close the speed control switch 95 and thereby prevent engine rotation above the predetermined speed during the interval between charging of the capacitor 21 with a speed control charge by the magnet 105 and charging of the capacitor 21 with an ignition charge by the magnet 75. Such means can comprise a trigger coil connected to the control element 101 and wound about a core situated adjacent to pulse magnet rotating in accordance with engine speed so as to produce a pulse in the trigger coil once for every rotation of the magnet.

In addition, there is provided a diode 105 having an anode 107 connected to the cathode 99 of the speed control SCR 95 and a cathode 109 connected to the control element or gate 101 of the speed control SCR 95.

While the immediately preceding description refers to two trigger coils, the preferred and illustrated construction employs a single trigger coil i.e., the coil **51**, in connection with the magnet **55** which, in response to rotation past the core **53** of the single trigger coil **51**, produces both the trigger pulse and the speed control pulse with respect to the coil **51**. In addition, the trigger element **39** and control element **101** are connected to the opposite ends of the coil **51** and it is preferred that the trigger element **39** of the ignition SCR **37** be operative in response to a pulse of one polarity relative to the coil **51** and that the control element **101** of the speed control SCR **95** be operative in response to a pulse of the other polarity relative to the coil **51**. Further, in the specifically disclosed construction, the pulse magnet **55** comprises two magnet members **111** and **113** each having an arcuate extent of slightly less than 180°, with one of the magnet members constituting a north pole and with the other magnet member constituting a south pole.

The resistor **93** included in the speed control sub-circuit **91** is chosen so as to obtain capacitor discharge through the resistor **93** and speed control switch **95** during a time interval greater than the time interval which occurs between the beginning of such discharge i.e., the time of speed control pulse generation, and subsequent charging of the capacitor with an ignition charge by the magnet **75**. As a result, when the engine is rotating above the predetermined speed in the clockwise direction as seen by the arrow **115** in FIG. **2**, the speed control switch **95** is still conducting at the time of attemped capacitor charging by the magnet **75**. Accordingly, such attempted charging results in immediate dissipation of the charge through the resistor **93** so that an effective charge on the capacitor **21** is not available at the time of next trigger pulse generation. Thus, engine ignition is discontinued.

Upon decrease in the rate of engine rotation below the predetermined speed, the time interval between generation of the speed control pulse and charging of the capacitor **21** with an ignition charge by the magnet **75** increases due to the slower rotational speed and becomes greater than the time interval of full discharge through the speed control sub-circuit **91** of the speed control charge applied to the capacitor by the magnet **105**. Thus, during engine operation are speeds below predetermined speed, the speed control switch **95** opens after full discharge through the speed control sub-circuit **91** of the speed control charge and prior to subsequent charging of the capacitor with an ignition charge by the magnet **75**. Such subsequent charging of the capacitor **21** with an ignition charge provides an effective charge upon the capacitor **21** at the time of generation of the trigger pulse.

In the illustrated construction, the magnets **75** and **105** which charge the capacitor **21** can each be single magnets or can each constitute two or more adjacent magnets **75A** and **75B** or **105A** and **105B** extending in an arcuate array.

Various of the features of the invention are set forth in the following claims.

What is claimed is:

1. In an internal combustion engine, a capacitor discharge ignition circuit with engine overspeed control comprising

a charge capacitor,

a spark plug,

an ignition coil including a secondary winding electrically connected to said spark plug and a primary winding,

an engine ignition sub-circuit electrically connected to said capacitor and including said primary winding and a normally nonconductive electronic ignition switch connected in series with said primary winding and including a trigger element operative to close said ignition switch and thereby to discharge said capacitor through said ignition sub-circuit to effect spark production,

means connected to said capacitor and including a first charge magnet for charging said capacitor with an ignition charge prior to spark-producing operation of said ignition sub-circuit,

means connected to said trigger element for generating a trigger pulse after charging of said capacitor with said ignition charge, and for applying said trigger pulse to said trigger element to effect closure of said ignition switch, whereby to effect spark production in response to discharge of said ignition charge from said capacitor through said ignition sub-circuit,

and means for preventing spark-producing operation of said ignition sub-circuit in the event of engine rotation above a predetermined speed comprising a speed control sub-circuit connected to said capacitor in parallel with said ignition sub-circuit and including resistor means and a normally nonconductive electronic speed control switch connected in series with said resistor means and including a control element operative to close said speed control switch and thereby to discharge said capacitor through said speed control sub-circuit,

means connected to said capacitor and including a second charge magnet for charging said capacitor with a speed control charge during the interval between generation of speed trigger pulse and charging of said capacitor with said ignition charge,

and means connected to said control element for generating a speed control pulse during the interval between charging of said capacitor with said speed control charge and charging of said capacitor with said ignition charge and for applying said speed control pulse to said control element to effect closure of said speed control switch whereby, when the engine rotates above the predetermined speed, the time interval between generation of said speed control pulse and charging of said capacitor with said ignition charge is less than the time interval of discharge of said speed control charge from said capacitor through said speed control sub-circuit, whereby said speed control switch is conductive at the time of charging of said capacitor with said ignition charge, and whereby said ignition charge is immediately discharged through said speed control sub-circuit to prevent subsequent discharge of said ignition charge through said ignition sub-circuit in response to the next generation of said ignition trigger pulse.

2. An ignition circuit in accordance with claim **1** wherein said speed control switch is an SCR.

3. An ignition circuit in accordance with claim **1** wherein said resistor means includes a resistance operable to control the time interval of discharge of said speed control charge through said speed control sub-circuit.

4. An ignition circuit in accordance with claim 1 wherein said means for generating said trigger pulse and said speed control pulse comprise a single trigger coil including one end connected to said trigger element and one end connected to said control element.

5. An ignition circuit in accordance with claim 4 wherein said means for generating said trigger pulse and said speed control pulse comprise a pulse magnet rotating in accordance with engine speed and including an arcuately extending north pole surface and an arcuately extending south pole surface spaced from said north pole surface, the sum of the arcuate extent of said north and south pole surfaces being slightly less than 360°.

6. An ignition circuit in accordance with claim 1 wherein said means for generating said trigger pulse and said speed control pulse comprise a pulse magnet which rotates in accordance with engine speed and includes an arcuately extending north pole surface and an arcuately extending south pole surface spaced from said north pole surface, a core located adjacent to the path of said surfaces, and a single trigger coil wound on said core and including one end connected to said trigger element and one end connected to said control element, whereby said trigger pulse is of one polarity and said speed control pulse is of the other polarity.

7. An ignition circuit in accordance with claim 1 wherein said means for charging said capacitor with said speed control charge and with said ignition charge include a charge coil connected to said capacitor and means for rectifying the voltage generated in said charge coil in response to passage of said charge magnets.

8. A capacitor discharge ignition circuit in accordance with claim 1 wherein said means for charging said capacitor with said speed control charge and with said ignition charge includes a charge coil connected to said capacitor and wherein said means for generating said trigger pulse and said speed control pulse comprise a pulse magnet including a north pole surface and a south pole surface spaced from said north pole surface, and a single trigger coil including one end connected to said trigger element and one end connected to said control element, and wherein said first and second charge magnets and said north and south pole surfaces rotate in accordance with engine speed, and wherein said first and second charge magnets, said charge coil, said north and south pole surfaces, and said trigger coil are located relative to each other so as to successively charge said capacitor with said speed control charge, generate said speed control pulse, charge said capacitor with said ignition charge, and generate said trigger pulse.

9. In an internal combustion engine, a capacitor discharge ignition circuit with engine overspeed control comprising a charge capacitor, a spark plug, an ignition assembly including a secondary winding electrically connected to said spark plug and a primary winding, an engine ignition sub-circuit electrically connected to said capacitor and including said primary winding and a normally nonconductive electronic ignition switch connected in series with said primary winding and including a trigger element operative to close said ignition switch and thereby to discharge said capacitor through said ignition sub-circuit to effect spark production, a speed control sub-circuit connected to said capacitor in parallel with said ignition sub-circuit and including resistor means and a normally nonconductive electronic speed control switch connected in series with said resistor means and including a control element operative to close said speed control switch and thereby to discharge said capacitor through said speed control sub-circuit during a time interval determined by said resistor means and independent of engine rotation, and coil and magnet means rotatable relative to each other in accordance with engine speed and electrically connected to said capacitor, to said control element, and to said trigger element for sequentially charging said capacitor with a speed control charge, generating a speed control pulse and applying said speed control pulse to said control element, charging said capacitor with an ignition charge, and generating a trigger pulse and applying said trigger pulse to said trigger element, whereby, when the engine rotates above a predetermined speed, the time interval between generation of said speed control pulse and charging of said capacitor with said ignition charge is less than the time interval of discharge of said speed control charge from said capacitor through said speed control sub-circuit, whereby said speed control switch is conductive at the time of charging of said capacitor with said ignition charge, and whereby said ignition charge is immediately discharged through said speed control sub-circuit to prevent subsequent discharge of said ignition charge through said ignition sub-circuit in response to generation of said ignition trigger pulse.

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