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Issler et al.

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[54] **IGNITION ARRANGEMENTS FOR INTERNAL COMBUSTION ENGINES**

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[58] **Field of Search**....................123/148 E; 315/209

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[57] **ABSTRACT**

The ignition capacitor is connected to a DC to AC converter to be charged, and then discharged in synchronism with the desired firing of the spark plugs. The ignition capacitor is discharged by rendering conductive a thyristor, which has a de-ionization period. During discharge and immediately thereafter, a timer, consisting of a multivibrator, and an auxiliary switch prevent the DC to AC converter from charging for a period at least equal to the discharge period of the thyristor The auxiliary switch can be a transistor that open circuits the conductive path to the control winding of the converter or a thyristor connected in series or in shunt with the secondary winding of the converter.

27 Claims, 3 Drawing Figures

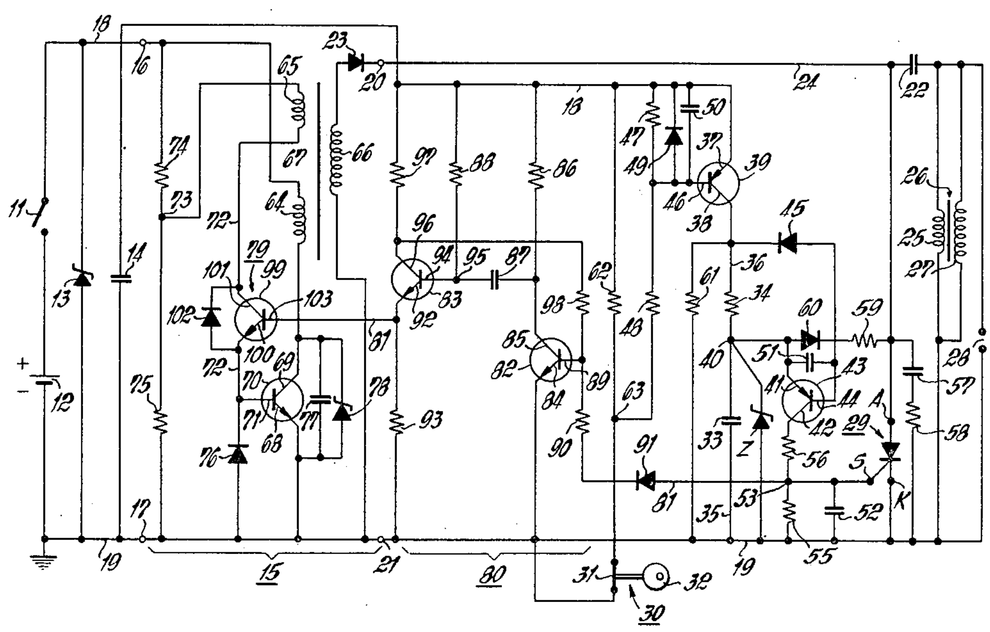

FIG. 1

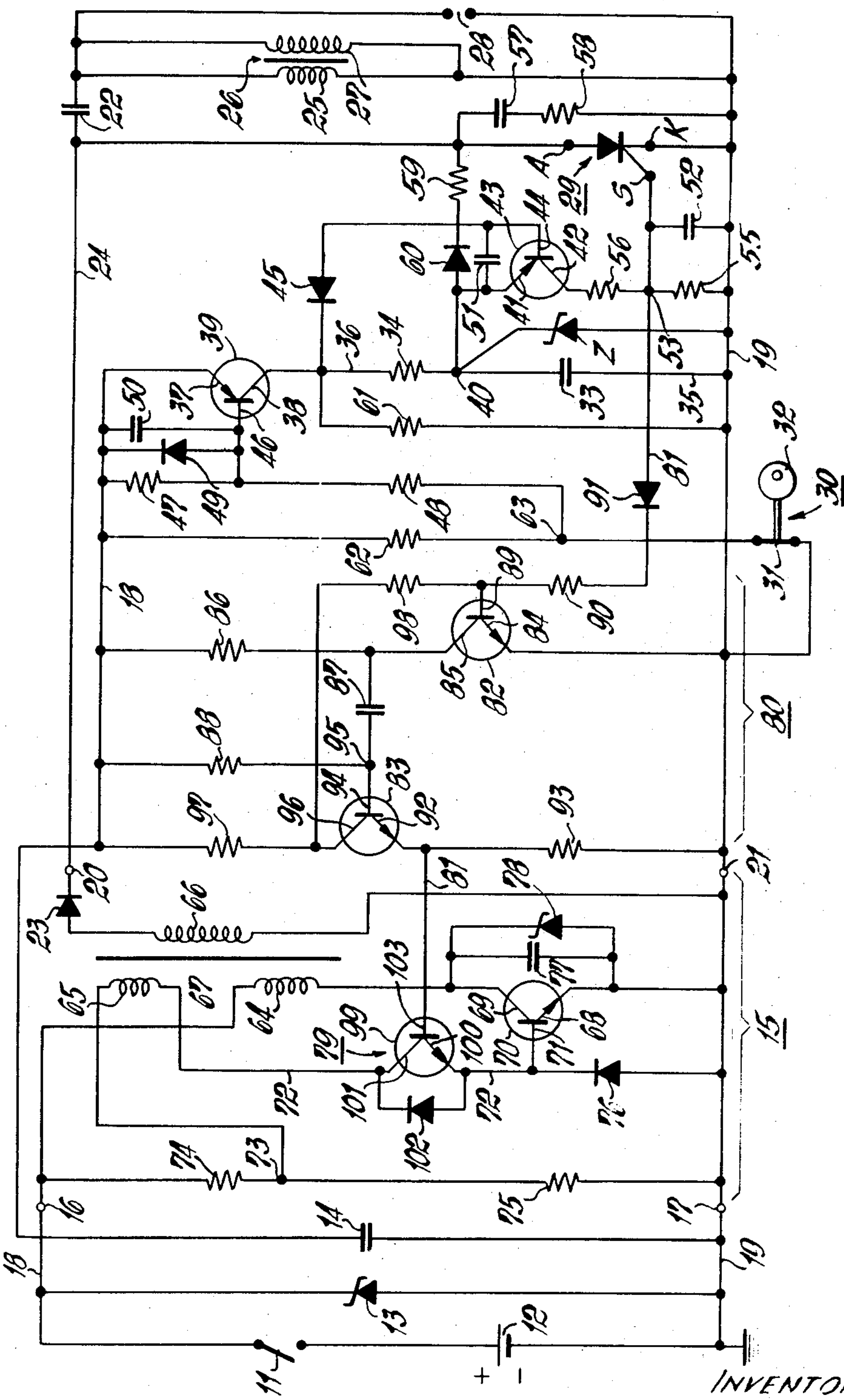

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FIG. 3

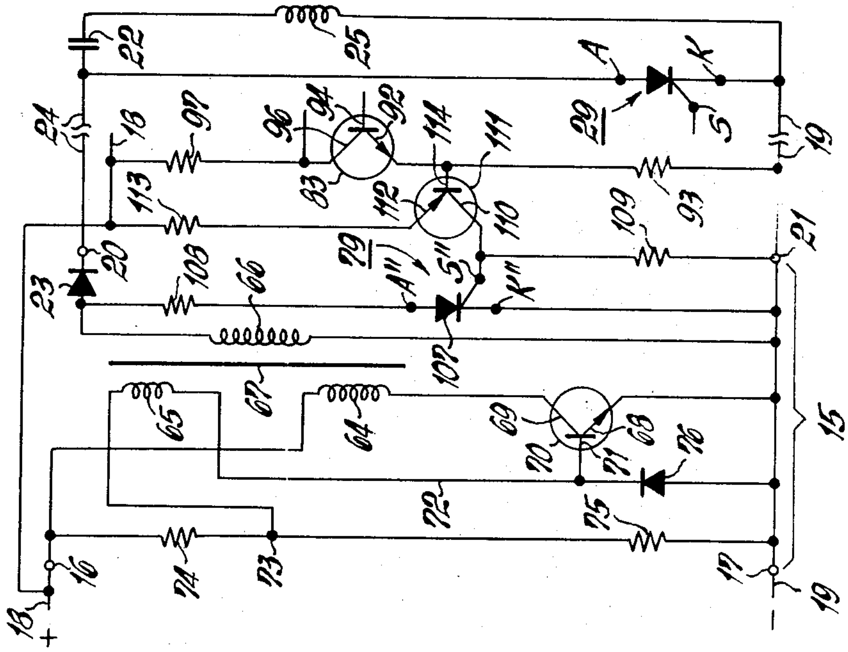
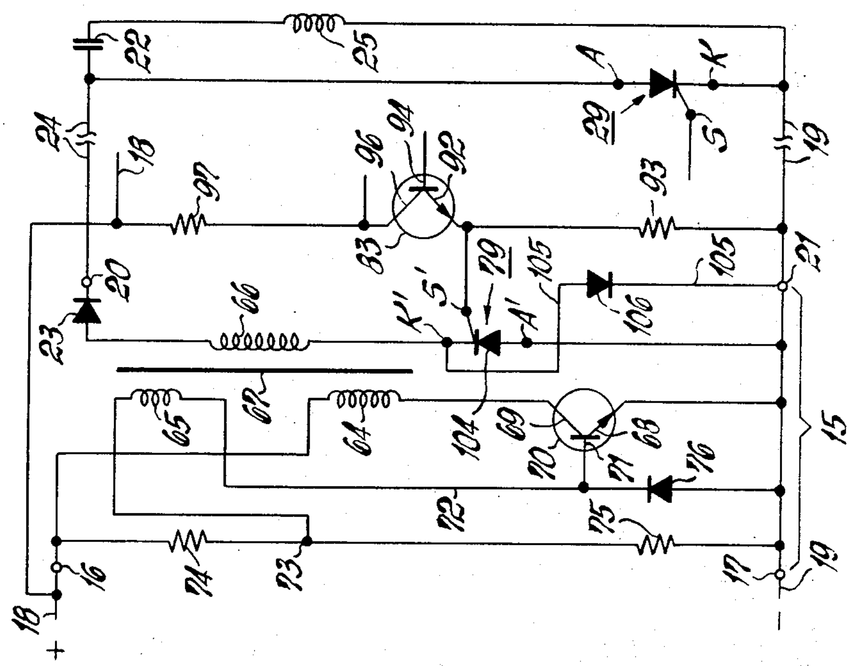


FIG. 2



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IGNITION ARRANGEMENTS FOR INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

The invention relates to ignition arrangements for internal combustion engines.

Among the known ignition arrangements for internal combustion engines are those having some means for charging the ignition capacitor, such as a DC to AC converter, the high voltage output of the converter being connected to the ignition capacitor. The ignition capacitor is connected to discharge through the secondary winding of the spark coil when a pulse operated, normally non-conductive, electronic switch, such as a thyristor, is made conductive in synchronism with the operation of the engine. The spark coil secondary is connected to one or more spark plugs to fire the latter, and a pulse generator, operating in dependence on the engine, controls the electronic switch.

The sudden discharging of the ignition capacitor causes a voltage pulse with a steep wave front, so that even badly fouled spark plugs produce a hot spark.

With these known ignition arrangements, the means for charging the ignition capacitor, such as the DC to AC converter, continually charges the ignition capacitor, even when the latter is discharging. It has been observed that the de-ionization of the electronic switch for discharging the ignition capacitor is prevented, the electronic switch, which is commonly a thyristor, remaining continuously conductive and thereby preventing the generation of ignition pulses for the spark plugs.

SUMMARY OF THE INVENTION

An object of the invention is an arrangement for insuring de-ionization of the electronic switch for discharging the ignition capacitor.

The invention consists essentially of ignition capacitor means adapted to be charged and then discharged so as to produce an ignition causing spark, means for charging the ignition capacitor means, pulse operated, normally non-conductive, electronic switch means in circuit with the ignition capacitor means to permit discharge of the latter when conductive, said electronic switch means having a de-ionization period, pulse generator means for generating pulses in dependence on engine operation to render the electronic switch means conductive, and auxiliary switch means controlled by the pulses for preventing charging of the ignition capacitor means for at least the duration of the de-ionization period of the electronic switch means, whereby the latter can become non-conductive in the interval between the pulses.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a circuit diagram showing one embodiment of the invention; and

FIGS. 2 and 3 are circuit diagrams showing two further embodiments of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIG. 1, an operating switch 11 connects the ignition arrangement to a direct current source 12, which can be, for example, the battery of a motor vehicle driven by an internal combustion engine, not shown. When the switch 11 is closed, the current source 12 is shunted by a Zener diode 13, which is connected to be normally non-conductive. A capacitor 14, which bypasses interference pulses conducted to the ignition arrangement, also shunts the current source 12.

The ignition arrangement comprises a DC to AC converter 15, which has a low voltage input with terminals 16 and 17, the converter being connected to the current source 12 when the switch 11 is closed. A positive line 18 connects the input terminal 16 to the positive pole of the source 12, and a negative, or ground, line 19 connects the input terminal 17 to the negative pole of the source. The high voltage output of the converter has terminals 20 and 21, the terminal 20 being connected by a lead 24 to one plate of an ignition capacitor 22. The other plate of the ignition capacitor is connected by the primary winding 25 of the spark coil 26 and by the ground line 19 to the other output terminal 21. The cathode of a charging diode 23 is connected to the output terminal 20. The secondary winding 27 of the spark coil is connected to at least one spark plug 28. In accordance with the invention, there can be provided, in a known manner, an ignition distributor for connecting the secondary 27 to successive spark plugs of a series.

Connected between the lead 24 and the ground line 19 is the switching path A–K of a controllable electronic discharge switch 29, which preferably is a thyristor, the anode A being connected to the lead 24 and the cathode K to the ground line 19. A pulse generator 30 is operatively connected to the control electrode lead of the discharging switch 29. The pulse generator operates in dependence on the operation of the internal combustion engine, and produces a triggering pulse whenever a spark plug 28 is to be sparked, which triggering pulse renders the switching path A–K of the switch 29 conductive.

By way of example, the pulse generator 30 can operate photoelectrically or electromagnetically. In the present embodiment, however, the pulse generator 30 comprises a conventional circuit interruptor 31, which is operated by a cam 32 driven by the internal combustion engine. With a suitable control circuit, this form of the pulse generator is particularly suited to the ignition arrangement of the invention. This control circuit has a control capacitor 33 and a control resistor 34 connected in series, the capacitor end 35 being connected to the ground line 19 and the resistor end 36 being connected by way of an emitter collector path 37, 38 of a PNP input transistor 39 to the positive line 18. The common junction 40 between the control capacitor and control resistor is connected by the emitter collector path 41–42 of a PNP control transistor 43 to the control electrode S of the discharging switch 29. The base 44 of the control transistor is connected by at least one diode 45 to the resistor end

36 of the series connected control capacitor and control resistor. The polarity of the diode 45 permits current to flow only in a conductive direction for the control transistor 43. A resistor 47 connects the base 46 of the input transistor 39 to the positive line 18, and a resistor 48 connects the base 46 to the ground line 19 by way of the circuit interruptor 31. The resistor 47 is shunted by a non-conductively connected diode for protecting the base emitter path 46–37 of the input transistor 39 from excessive voltage. The capacitor 50 also shunting the resistor 47 prevents interference pulses from reaching the base emitter path 46–37. A capacitor 51 shunts the base emitter path 44–41 of the control transistor 43 to prevent interference pulses from reaching this control path. Interference pulses are prevented from reaching the control path S–K of the discharging switch 29 by capacitor 52 shunted across this path. The control electrode S of the discharging switch 29 is connected to the common junction between two series connected resistors 55 and 56 that are connected between the ground line 19 and the collector 42 of the control transistor 43. The anode A of the discharge switch 29 is connected to the ground line 19 by a series connected capacitor 57 and resistor 58. The anode A is also connected by a resistor 59 to the cathode of a diode 60 the anode of which is connected to the junction 40. A resistor 61, which simplifies the setting of the voltage, is shunted across the series connected control capacitor 33 and control resistor 34. A resistor 62 is connected between the positive line 18 and the junction 63 to which the resistor 48 is connected. The Zener diode Z shunted across the control capacitor 33 limits the voltage to which the latter can be charged.

The DC to AC converter 15 can be of known design, having either a single ended or push-pull output. In the preferred embodiment, shown in FIG. 1, the converter has a single ended output. The input of the converter 15 has a primary winding 64 and a control winding 65, and the output has a secondary winding 66, all of these windings being wound on a common iron core 67. The primary winding 64 together with the emitter collector path 68–69 of the NPN switching transistor 70 forms a series circuit, one end of which is connected to the input terminal 16 and the other end of which is connected to the input terminal 17. A lead 72 connects the base 71 of the switching transistor 70 to one end of the control winding 65, the other end of which latter is connected to the common junction 73 of two series connected resistors 74 and 75, which form a voltage divider between the positive line 18 and the ground line 19. A non-conductively connected diode 76 connects the base 71 to the ground line 19. A parallel connected capacitor 77 and a Zener diode 78 are shunted across the emitter collector path 68–69 to protect the latter against excessive voltage. One end of the secondary winding 66 of the converter 15 is connected to the anode of the diode 23, and the other end is connected to the terminal 21 in the ground line 19.

The ignition arrangement thus far described operates in the following manner. When the operating switch 11 is closed, the DC to AC converter 15 begins to oscillate. Assuming, first of all, that the lead 72 connects the base 71 of the switching transistor 70 directly to the control winding 65, the converter 15 oscillates continuously as long as the operating switch 11 is closed. It being presumed that the operation of the converter 15 is known, it will simply be remarked that the frequency of the high voltage induced in the secondary winding 66 is appreciably higher than the frequency at which the spark plugs 28 are sparked. The charging diode 23 insures that only the positive half waves of the AC high voltage are used, so that the plate of the ignition capacitor 22 connected to the lead 24 receives a positive potential and the plates connected to the ground line 19 are at negative potential.

At the moment that a spark plug 28 is supposed to spark, the cam 32 opens the circuit interrupter 31, causing a positive potential to appear at the base 46 of the input transistor 39, thereby rendering non-conductive the emitter collector path 37–38 of this transistor. The control capacitor 33, which has been previously charged while the emitter collector path 37–38 was conductive, can now discharge, whereby a current flows from the upper plate of the capacitor 33 through resistors 34 and 61 to the ground line 19. The resulting voltage drop across the resistor 34 causes at the base 44 of the control transistor 43 a negative voltage that turns on the emitter collector path 41–42, so that the control capacitor 33 can now also discharge through this emitter collector path and the two resistors 55 and 56 connected in series. The resulting voltage at the junction 53 of these two resistors constitutes for the control electrode S of the discharge switch 29 a triggering pulse that turns on the anode cathode path A–K. The ignition capacitor 22 is now free to discharge through this anode cathode path and the primary winding 25 of the spark coil 26, thereby inducing in the secondary winding 27 a high voltage pulse that causes the plug 28 to produce an ignition spark.

Once the anode cathode path A–K of the discharge switch 29 is conductive, there is provided for the control capacitor 33 a further discharge path that runs through the diode 60 and the resistor 59. This additional discharge path accelerates the discharge of the control capacitor 33. The junction 40 is then held at such a potential during the sparking procedure that there are no disturbing effects should the circuit interruptor 31 momentarily close while it is opening.

The series connected capacitor 57 and resistor 58 conduct the negative halfwaves, which appear while the ignition capacitor 22 is discharging, to the anode A of the discharge switch 29, thereby encouraging deionization of the anode cathode path A–K.

After the sparking procedure is over, the circuit interrupter 31 is again closed, and energy is again stored in the control capacitor 33 for starting the next sparking procedure. Contact chatter of the circuit interruptor 31, causing the latter momentarily to reopen while closing, cannot cause the plug 28 to spark, because the control capacitor 33 has stored too little energy to produce a trigger pulse of sufficient peak amplitude to turn on the thyristor 29.

Even though a conventional circuit interrupter 31 is used, the described circuit insures that an effective trigger pulse is produced only when a spark is desired.

With the described ignition arrangement, the ignition capacitor 22 is also charged during the sparking procedure. Consequently, it may occur at very high firing frequencies that the anode cathode path A–K of the discharge switch 29 does not de-ionize and thus remains continuously conductive. Therefore, no ignition sparks are produced. To avoid this, the trigger pulse used to turn on the switching path A–K of the discharge switch 29 is also used to operate an electrically controlled auxiliary switch 79, which prevents the DC to AC converter 15 from charging the ignition capacitor 22 at least for the de-ionization period of the thyristor 29.

The period of time that the trigger pulse switches the switching path of the auxiliary switch 79 is precisely determined by an electric timer 80, which is connected in the control connection 81 leading from the control electrode S of the discharge switch 29 to the auxiliary switch 79. The electric timer can be, for example, an RC circuit or a time dependent differentiator. It can also be a Schmitt trigger, which as long as the trigger pulse at the control electrode S of the discharge switch 29 exceeds a predetermined level, switches the auxiliary switch 79. Particularly suitable is a monostable multivibrator, shown in FIG. 1. The monostable multivibrator comprises an npn input transistor 82 and an NPN output transistor 83. The emitter 84 of the input transistor 82 is connected to the ground line 19; the collector 85 is connected by a resistor 86 and also by a series connected feedback capacitor 87 and a resistor 88 to the positive line 18; and the base 89 is connected by a control connection 81 —composed of a resistor 90 and a diode 91, which conducts only positive control pulses — to the junction between the two resistors 55 and 56 and thus to the control electrode S of the discharge switch 29. The emitter 92 of the output transistor 83 is connected by an emitter resistor 93 to the ground line 19; the base 94 is connected to the junction 95 between the feedback capacitor 87 and the resistor 88; and the collector 96 is connected by a resistor 97 to the positive line 18 and by a feedback resistor 98 to the base 89 of the input transistor 82.

The auxiliary switch 79 can be, for example, an electromagnetic relay or a semiconductor component. The auxiliary switch can be connected either in the low voltage input or in the high voltage output of the DC to AC converter 15. In the preferred embodiment, shown in FIG. 1, the auxiliary switch 79 is an NPN transistor 99, of which the emitter collector path 100–101 forms the switching path. This switching path lies in the connection 72 between the base 71 of the switching transistor 70 and the control winding 65, the emitter 100 of the transistor 99 being connected to the base 71 of the switching transistor 70 and the collector 101 being connected to the control winding 65. The emitter collector path 100–101 is protected in a known manner by a diode 102. The base 103 of the transistor 99 is connected to the emitter 92 of the output transistor 83 of the multivibrator.

If, when an ignition spark is to be produced, a trigger pulse appears at the control electrode S of the discharge switch 29, this pulse is conducted through the diode 91 and the resistor 90 to the base 89 of the multivibrator input transistor 82, thereby triggering the multivibrator to its unstable state. In this state the emitter collector path 84–85 of the input transistor 82 is conductive, whereas the emitter collector path 92–96 of the output transistor 83 is non-conductive. While the multivibrator is in its unstable state the base 103 of transistor 99 therefore is not biassed, so that the emitter collector path 100–101 is non-conductive; and the control winding 65 of the converter 15 is not energized. Therefore, the converter 15 cannot charge the ignition capacitor 22 while the multivibrator is in its unstable state. The charging time constant of the feedback capacitor 87 is chosen to be equal or somewhat longer than the de-ionization time of the particular kind of electronic discharge switch 29 used.

If the DC to AC converter has push-pull output, there being, as is well known, two control windings, two primary windings, and two switching transistors, the described action is obtained if the transistor that composes the auxiliarly switch is so connected to one of the two control windings and to one of the two switching transistors as shown in FIG. 1.

With reference to FIG. 2, the ignition arrangement shown differs from that shown in FIG. 1 in that the auxiliary switch 79 is composed by a thyristor 104 connected in the high voltage output of the converter 15. The anode cathode path A'–A' of the thyristor 104 is connected in series with the secondary winding 66, the anode A' being connected to the ground line 19 and the cathode K' to the secondary 66. The cathode K' is also connected to the ground line 19 by a lead 105 having at least one diode 106 of which the cathode is connected to the line 19. The control electrode S of the thyristor 104 is connected to the emitter 92 of the output transistor 83 of the monostable multivibrator. In this embodiment, the lead 72 is connected directly between the base 71 of the switching transistor 70 and the control winding 75. Aside from he foregoing, the embodiment shown in FIG. 2 is exactly the same as that shown in FIG. 1. Therefore, the circuit of FIG. 2 is shown and described only insofar as it differs in design and operation from that of FIG. 1. All components having the same function are denoted by the same reference numerals.

The circuit shown in FIG. 2 operates in the following manner. The emitter collector path 92–96 of the multivibrator output transistor 83 is normally conductive during operation. The resulting voltage drop across the emitter resistor 93 insures that the control electrode S' of the thyristor 104 is biassed positive with respect to the cathode K'. Each of the positive charging pulses produced by the converter 15 is conducted by the auxiliary switch 79 to the ignition capacitor 22. As soon as a trigger pulse appears at the control electrode S of the discharge switch 29 and the monostable multivibrator is triggered to its unstable state, the emitter collector path 92–96 of the output transistor 83 is rendered non-conductive, and the positive bias across the emitter resistor 93 is no longer present, so that the auxiliary switch 79, formed by the thyristor 104, is non-conductive while the multivibrator is in its unstable state. Consequently, as long as the multivibrator is in its unstable state the ignition capacitor 22 is not charged, therefore preventing any hindrance of de-ionization of the discharge switch 29. The diode 106 insures that no charging pulses can be conductive through the lead 105 extending from the cathode A' to the ground line 19.

The ignition arrangement shown in FIG. 3 also differs from that shown in FIG. 1 in that the auxiliary switch 79 is composed of a thyristor 107, which is connected in the high voltage output of the converter 15.

In this embodiment, the anode cathode path A''–K'', which is the switching path, is shunted across the secondary winding **66** of the converter **15**, the anode cathode path A''–K'' preferably being connected in series with a resistor **108**. The cathode K'' of the thyristor **107** is connected to the ground line **19**, the anode A'' is connected by a resistor **108** with the anode of the charging diode **23**, and the control electrode S'' is connected to the collector **110** of a PNP transistor **111** and by a resistor **109** to the ground line **19**. The emitter **112** of the transistor **111** is connected by a resistor **113** to the positive line **18**, and the base **114** to the emitter **92** of the multivibrator output transistor **83**. The lead **72** connects the base **71** of the switching transistor **70** directly to the control winding **65**.

Aside from the foregoing, the circuit is the same as that shown in FIG. **1**. For this reason, the circuit is shown and described only insofar as it differs in design and operation from the circuit shown in FIG. **1**. Components having the same function are denoted by the same reference numerals.

The embodiment shown in FIG. **3** operates in the following manner. As in the previous embodiment, the emitter collector path **92–96** of the multivibrator output transistor **83** is conductive during operation. The emitter collector path **92–96** insures that the base **114** of transistor **111** is held at the same potential as the emitter **112**. Consequently, the emitter collector path **112–110** of transistor **111** is nonconductive. Therefore, the control electrode S'' of the thyristor **107** is not positively biassed, and the anode cathode path A''–K'' is non-conductive. The positive charging pulses from the converter **15** are free to charge the ignition capacitor **22**. As soon as the trigger pulse appears at the control electrode S of the discharge switch **29** and the monostable multivibrator is triggered to its unstable state, the emitter collector path **92–96** of the output transistor **83** becoming non-conductive, the base **114** of transistor **111** is negatively biassed, so that the emitter collector path **112–110** is rendered conductive, and a positive voltage appears at the control electrode S'' of the thyristor **107**. Consequently, the anode cathode path A''–K'' becomes conductive, whereby for the duration of the unstable state of the multivibrator all voltages appearing across the secondary winding **66** are at least partly short circuited by the resistor **108** and the conductive switching A''–K'', thereby preventing effective charging of the ignition capacitor **22**.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of circuits differing from the types described above.

While the invention has been illustrated and described as embodied in ignition arrangements for internal combustion engines, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

We claim:

1. In an ignition system for an internal combustion engine, in combination, spark plug means; ignition capacitor means adapted to be charged and then discharged so as to produce a single spark at said spark plug means for igniting a combustible mixture with said single spark; oscillator means connected to said capacitor means for applying charging pulses to said capacitor means; pulse-operated, normally non-conductive electronic switch means in circuit with said ignition capacitor means and operative to permit discharge of the latter when said electronic switch means is in conductive state, said electronic switch means having a deionization period; pulse generator means coupled to said engine and connected with said electronic switch means for generating control pulses and applying such pulses individually to said electronic switch means and each for the duration of a first time interval for thereby rendering said electronic switch means conductive, the frequency of generation of said control pulses being dependent on the operation of said engine; and auxiliary switch means connected with said oscillator means and with said pulse generator means and including electric timer means controlled by the respective control pulse for preventing charging of said ignition capacitor means for the duration of a second time interval subsequent to said first time interval independent of the timing of the discharge of said capacitor and at least equalling the de-ionization period of said electronic switch means, the frequency of generation of said control pulses corresponding to the frequency of sparks produced at said spark plug means, and the frequency of said charging pulses being substantially higher than the frequency of said control pulses and of said sparks.

2. An arrangement as defined in claim **1**, wherein said timer means is a monostable multivibrator.

3. An arrangement as defined in claim **1**, wherein said electronic switch means has a control electrode, said control electrode being connected to operate said auxiliary switch means.

4. An arrangement as defined in claim **3**, wherein said electronic switch means is a thyristor and said pulse generator means is an engine operated circuit interrupter.

5. An arrangement as defined in claim **4**, further including a direct current source; series connected control resistor and control capacitor, wherein said control capacitor and the cathode of said thyristor are connected to the negative pole of said direct current source; an input transistor of which the emitter collector path is connected between said control resistor and the positive pole of said DC source; a control transistor of which the emitter collector path is connected between the junction between said control resistor and capacitor and the control electrode of said thyristor; at least one diode connected non-conductively between the base of said control transistor and the junction between said control resistor and said emitter collector path of said input transistor; at least one first resistor connecting the base of said input transistor to the positive pole of said direct current source; and at least one second resistor connected in series with said circuit interrupter, said second resistor and said circuit interrupter being connected between the base of said input transistor and the negative pole of said direct current source.

6. An arrangement as defined in claim 5, including a voltage setting resistor shunted across said series connected control resistor and capacitor.

7. An arrangement as defined in claim 5, including two series connected resistors connected between the collector of said control transistor and the cathode of said thyristor, and the common junction between said two series connected resistors being connected to said thyristor control electrode.

8. An arrangement as defined in claim 5, including at least one first diode connected between the anode of said thyristor and the common junction between said series connected control resistor and capacitor, the cathode of said first diode being connected to said thyristor anode.

9. An arrangement as defined in claim 8, including a resistor connected in series with said first diode.

10. An arrangement as defined in claim 8, including series connected capacitor and resistor shunted across the anode cathode path of said thyristor.

11. An arrangement as defined in claim 1, wherein said means for charging is a DC to AC converter having an input and an output, said input comprising at least one primary winding and at least one control winding and said output having a secondary winding; a common core for said windings; a switching transistor of which the emitter collector path is connected in series with said primary winding across said direct current; means connecting the base of said switching transistor to said control winding; and a charging diode connecting said secondary winding to said ignition capacitor means to form for the latter a charging current path composed of said secondary winding, charging diode, and ignition capacitor means.

12. An arrangement as defined in claim 11, including a diode non-conductively connecting the base of said switching transistor to one pole of said direct current source; two series connected resistors connected across said direct current source, said control winding being connected to the common junction between said two series connected resistors, whereby the base of said switching transistor is connected through said control winding to said common junction.

13. An arrangement as defined in claim 11, wherein said input and output are respectively low and high voltage, and said auxiliary switching means comprises a switching path, said switching path being connected in said input.

14. An arrangement as defined in claim 11, wherein said auxiliary switching means comprises a switching path, and said switching path and said secondary winding are connected in series.

15. An arrangement as defined in claim 11, wherein said auxiliary switching means comprises a switching path, and said switching path is connected in shunt with said secondary winding.

16. An arrangement as defined in claim 15, including a resistor connected in series with said switching path, said series connected resistor and switching path being shunted across said secondary winding.

17. An arrangement as defined in claim 2, wherein said electronic switch means has a control electrode, said control electrode being connected to operate said auxiliary switch means; and further including a direct current source; an input and an output transistor comprised by said multivibrator, the emitter of said input transistor being connected to one pole of said direct current source; a resistor connecting the collector of said input transistor to the other pole of said direct current source; a feedback capacitor connecting the collector of said input transistor to the base of said output transistor; a resistor connecting the base of said output transistor to said other pole of said direct current source; a feedback resistor connecting the base of said input transistor to the collector of said output transistor; an emitter resistor connecting the emitter of said output transistor to said one pole of said direct current source, the collector of said output transistor being connected to said other pole of said direct current source.

18. An arrangement as defined in claim 17, including a resistor connected between the collector of said output transistor and said other pole.

19. An arrangement as defined in claim 17, wherein said input and output transistors are both NPN type, the collector and emitter of both said transistors being respectively connected to the positive and negative poles of said direct current source.

20. An arrangement as defined in claim 13, wherein said auxiliary switch means is a transistor of which the emitter collector path forms a switching path.

21. An arrangement as defined in claim 13, wherein said auxiliary switch means comprises a switching path, said switching path being connected between the base of said switching transistor and said control winding.

22. An arrangement as defined in claim 14, wherein said auxiliary switch means is a thyristor and the cathode anode path thereof comprises said switching path.

23. In an ignition system for an internal combustion engine, in combination, ignition capacitor means adapted to be charged and then to be discharged so as to produce an ignition causing spark; means for charging said ignition capacitor means; pulse operated, normally non-conductive, electronic switch means in circuit with said ignition capacitor means to permit discharge of the latter when conductive, said electronic switch means having a de-ionization period; pulse generator means for control pulses in dependence on engine operation to render said electronic switch means conductive; auxiliary switch means controlled by said control pulses for preventing charging of said ignition capacitor means for at least the duration of said de-ionization period of said electronic switch means, whereby the latter can become non-conductive in the intervals between said control pulses; electrical timing means for determining the duration during which said auxiliary switch means prevents charging of said ignition capacitor means, said timing means being a monostable multivibrator, said electronic switch means having a control electrode, said control electrode being connected to operate said auxiliary switch means; a direct current source; an input and an output transistor comprised by said multivibrator, the emitter of said input transistor being connected to one pole of said direct current source; a resistor connecting the

collector of said input transistor to the other pole of said direct current source; a feedback capacitor connecting the collector of said input transistor to the base of said output transistor; a resistor connecting the base of said output transistor to said other pole of said direct current source; a feedback resistor connecting the base of said input transistor to the collector of said output transistor; an emitter resistor connecting the emitter of said output transistor to said one pole of said direct current source, the collector of said output transistor being connected to said other pole of said direct current source, said electronic switch means being a thyristor and said pulse generator means being an engine operated circuit interrupter; series connected control resistor and control capacitor, wherein said control capacitor and the cathode of said thyristor are connected to the negative pole of said direct current source; a further input transistor of which the emitter collector path is connected between said control resistor and the positive pole of said direct current source; a control transistor of which the emitter collector path is connected between the junction between said control resistor and capacitor and the control electrode of said thyristor; at least one diode connected non-conductively between the base of the control transistor and the junction between said control resistor and said emitter collector path of said further input transistor; at least one first resistor connecting the base of said input transistor to the positive pole of said direct current source; at least one second resistor connected in series with said circuit interrupter, said second resistor and said circuit interrupter being connected between the base of said further input transistor and the negative pole of said direct current source; a diode connecting said thyristor control electrode to the base of said multivibrator input transistor to conduct only positive pulses to said base.

24. In an ignition system for an internal combustion engine, in combination, ignition capacitor means adapted to be charged and then to be discharged so as to produce an ignition causing spark; means for charging said ignition capacitor means; pulse operated, normally non-conductive, electronic switch means in circuit with said ignition capacitor means to permit discharge of the latter when conductive, said electronic switch means having a deionization period; pulse generator means for generating pulses in dependence on engine operation to render said electronic switch means conductive; auxiliary switch means controlled by said single control pulse for preventing charging of said ignition capacitor means for at least the duration of said de-ionization period of said electronic switch means, whereby the latter can become non-conductive in the intervals between said control pulses; electrical timing means for determining the duration during which said auxiliary switch means prevents charging of said ignition capacitor means, said timing means being a mono-stable multivibrator, said electronic switch means having a control electrode, said control electrode being connected to operate said auxiliary switch means; a direct current source; an input and an output transistor comprised by said multivibrator, the emitter of said input transistor being connected to one pole of said direct current source; a resistor connecting the collector of said input transistor to the other pole of said direct current source; a feedback capacitor connecting the collector of said input transistor to the base of said output transistor; a resistor connecting the base of said output transistor to said other pole of said direct current source; a feedback resistor connecting the base of said input transistor to the collector of said output transistor; an emitter resistor connecting the emitter of said output transistor to said one pole of said direct current source, the collector of said output transistor being connected to said other pole of said direct current source, said input and output transistors being both npn type, the collector and the emitter of both said transistors being respectively connected to the positive and negative poles of said direct current source, said means for charging being a DC to AC converter having a low voltage input and a high voltage output, said input comprising at least one primary winding and at least one control winding and said output having a secondary winding, and wherein said auxiliary switch means comprises a switching path, said switching path being connected in said input; and further including a common core for said winding; a switching transistor of which the emitter collector path is connected in series with said primary winding across said direct current source; means connecting the base of said switching transistor to said control winding; a charging diode connecting said secondary winding to said ignition capacitor means to form for the latter a charging current path composed of said secondary winding, charging diode, and ignition capacitor means; a diode non-conductively connecting the base of said switching transistor to one pole of said direct current source; two series connected resistors connected across said direct current source, said control winding means connected to the common junction between said two series connected resistors, whereby the base of said switching transistor is connected through said control winding to said common junction, and wherein said auxiliary switch means is an NPN transistor of which the collector is connected to said control winding, the emitter to the base of said switching transistor, and the base to the output transistor of said multivibrator.

25. In an ignition system for an internal combustion engine, in combination, ignition capacitor means adapted to be charged and then to be discharged so as to produce an ignition causing spark; means for charging said ignition capacitor means; pulse operated, normally non-conductive, electronic switch means in circuit with said ignition capacitor means to permit discharge of the latter when conductive, said electronic switch means having a de-ionization period; pulse generator means for generating pulses in dependence on engine operation to render said electronic switch means conductive; auxiliary switch means controlled by said pulses for preventing charging of said ignition capacitor means for at least the duration of said de-ionization period of said electronic switch means, whereby the latter can become non-conductive in the intervals between said pulses, said means for charging being a DC to AC converter having an input and an output, said input comprising at least one primary winding and at least one control winding and said output having a secondary winding; a common core for said winding; a switching transistor of which the emitter collector path is connected in series with said primary

winding across said direct current source; means connecting the base of said switching transistor to said control winding; a charging diode connecting said secondary winding to said ignition capacitor means to form for the latter a charging current path composed of said secondary winding, charging diodes and ignition capacitor means, said auxiliary switching means comprising a switching path, and said switching path and said secondary winding being connected in series, said auxiliary switching means being a thyristor and the cathode-anode path thereof comprising said switching path; monostable multivibrator timing means for determining the duration during which said auxiliary switch means prevents charging of said ignition capacitor means, and wherein said electrical switch means has a control electrode, said control electrode being connected to operate said auxiliary switch means; and further including a direct current source; an NPN input and an NPN output transistor comprised by said multivibrator, the emitter of said input transistor being connected to the negative pole of said direct current source; a resistor connecting the collector of said input transistor to the positive pole of said direct current source; a feedback capacitor connecting the collector of said input transistor to the base of said output transistor; a resistor connecting the base of said output transistor to said positive pole of said direct current source; a feedback resistor connecting the base of said input transistor to the collector of said output transistor; an emitter resistor connecting the emitter of said output transistor to the negative pole of said direct current source, the collector of said output transistor being connected to the positive pole of said direct current source; and wherein the control electrode and the cathode of said thyristor are respectively connected to the emitter of said multivibrator output transistor and to said charging diode; a diode of which the anode is connected to the cathode of said thyristor and the cathode is connected to the terminal of said emitter resistor remote from the emitter of said multivibrator output transistor.

26. In an ignition system for an internal combustion engine, in combination, ignition capacitor means adapted to be charged and then to be discharged so as to produce an ignition causing spark; means for charging said ignition capacitor means; pulse operated, normally non-conductive, electronic switch means in circuit with said ignition capacitor means to permit discharge of the latter when conductive, said electronic switch means having a de-ionization period; pulse generator means for generating pulses in dependence on engine operation to render said electric switch means conductive; auxiliary switch means controlled by said pulses for preventing charging of said ignition capacitor means for at least the duration of said de-ionization period of said electronic switch means, whereby the latter can become non-conductive in the intervals between said pulses, said means for charging being a DC to AC converter having an input and an output, said output comprising at least one primary winding and at least one control winding and said output having a secondary winding; a common core for said windings; a switching transistor of which the emitter-collector path is connected in series with said primary winding across said direct current source; means connecting the base of said switching transistor to said control winding; a charging diode connecting said secondary winding to said ignition capacitor means to form for the latter a charging current path composed of said secondary winding, charging diode, and ignition capacitor means, said auxiliary switching means comprising a switching path, and said switching path being connected in shunt with said secondary winding; monostable multivibrator timing means for determining the duration during which said auxiliary switching means prevents charging of said ignition capacitor means, and wherein said electrical switch means has a control electrode, said control electrode being connected to operate said auxiliary switch means; and further including a direct current source; an NPN input and an NPN output transistor comprised by said multivibrator, the emitter of said input transistor being connected to the negative pole of said direct current source; a resistor connecting the collector of said input transistor to the positive pole of said direct current source; a feedback capacitor connecting the collector of said input transistor to the base of said output transistor; a resistor connecting the base of said output transistor to said positive pole of said direct current source; a feedback resistor connecting the base of said input resistor to the collector of said output transistor; an emitter resistor connecting the emitter of said output transistor to the negative pole of said direct current source; the collector of said output transistor being connected to the positive pole of said direct current source, and wherein said auxiliary switch means is a thyristor and the cathode anode path thereof comprises said switching path, one end of said secondary winding being connected to the anode of said charging diode, the anode of said thyristor being connected to said one end of said secondary winding, and the cathode of said thyristor being connected to the other end of said secondary winding; and further including a resistor connecting said thyristor control electrode to said thyristor cathode; a transistor of which the collector is connected to said thyristor control electrode, the base is connected to the emitter of said multivibrator output transistor, and the emitter is connected to the positive pole of said direct current source.

27. An arrangement as defined in claim **26**, including a resistor connecting the emitter of said transistor to the positive pole of said direct current source.

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