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[21] Appl. No. 872,991
[22] Filed Nov. 31, 1969
[45] Patented Apr. 27, 1971
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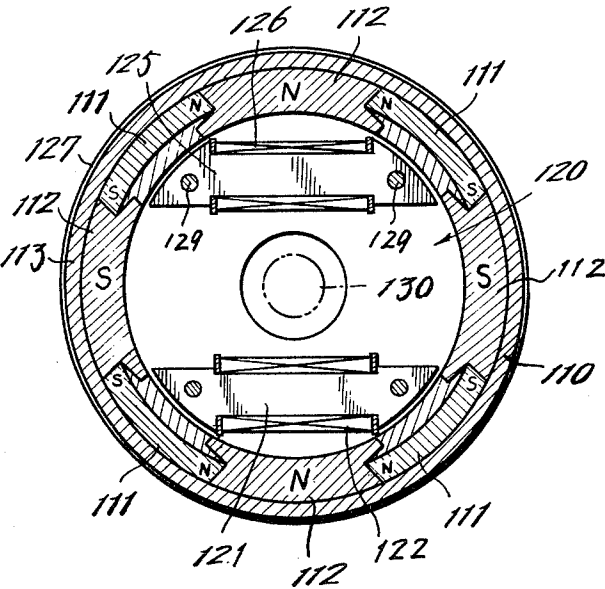
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[54] IGNITION SYSTEM FOR A TWO-CYCLE ENGINE
20 Claims, 22 Drawing Figs.
[52] U.S. Cl..... 123/148E,
315/209, 123/148AC
[51] Int. Cl..... F02p 1/00
[50] Field of Search..... 123/148
(E), 149, 148 (AC); 310/70

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ABSTRACT: An ignition system for a two-cycle engine comprising in combination a magnet-type generator having a magnetic field provided by a plurality of magnets and housing a capacitor charging coil and a signal coil therein for cooperation with said magnetic field, a capacitor charged with the output of said charging coil, an ignition coil having a primary coil and a secondary coil through which primary coil a discharge current flows as said capacitor is discharged, an ignition plug connected to said secondary coil and a solid-state-type switch means controlled by the output of said signal coil for determining discharge time points of the load on said signal coil.



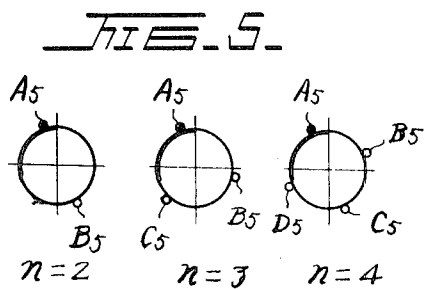
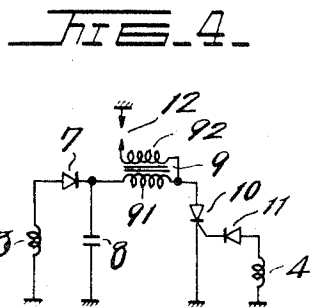
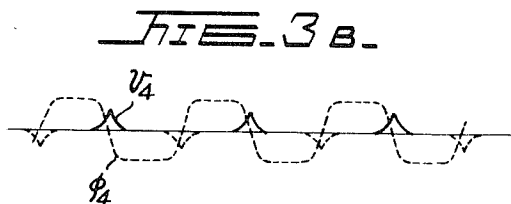
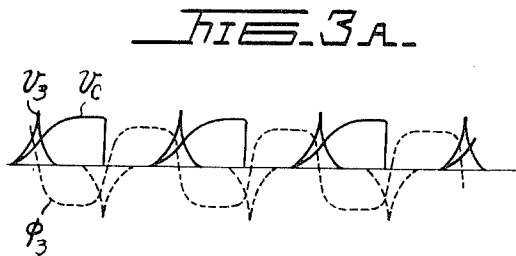
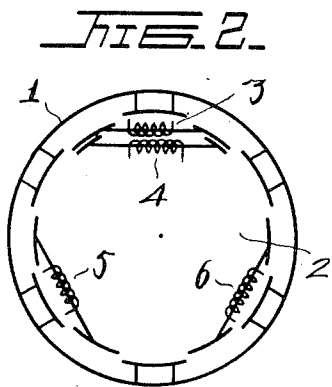
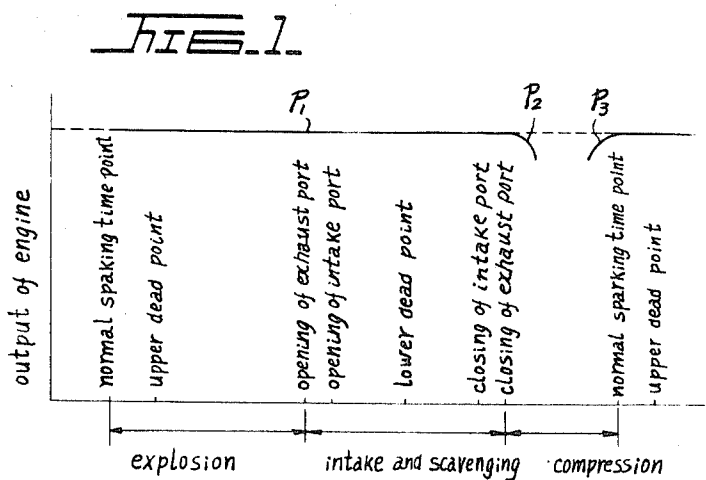


FIG. 6

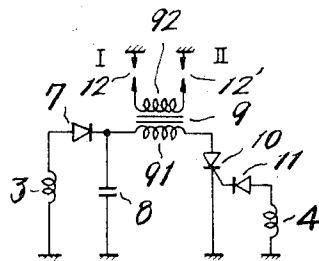


FIG. 7

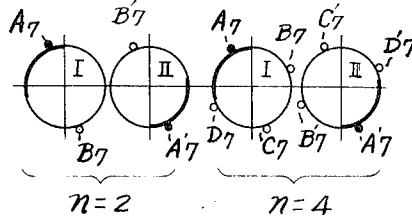


FIG. 8

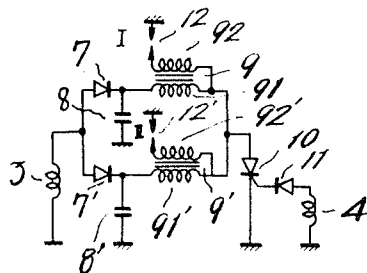


FIG. 9

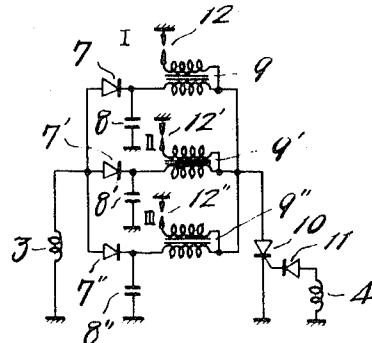


FIG. 10

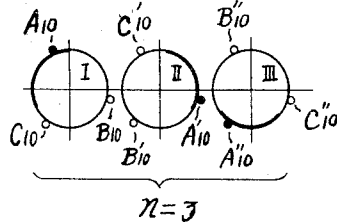


FIG. 11

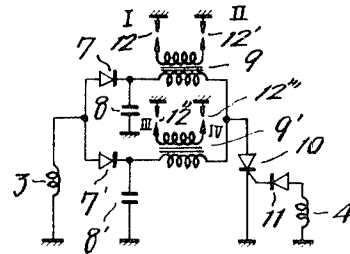


FIG. 13

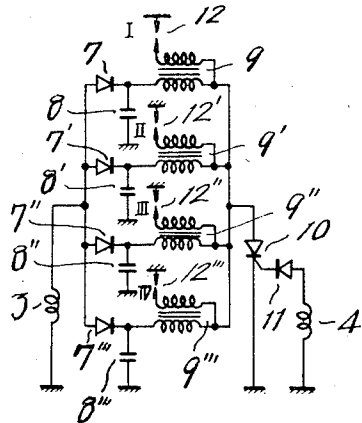


FIG. 12

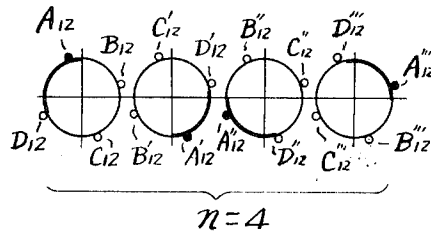


FIG. 14.

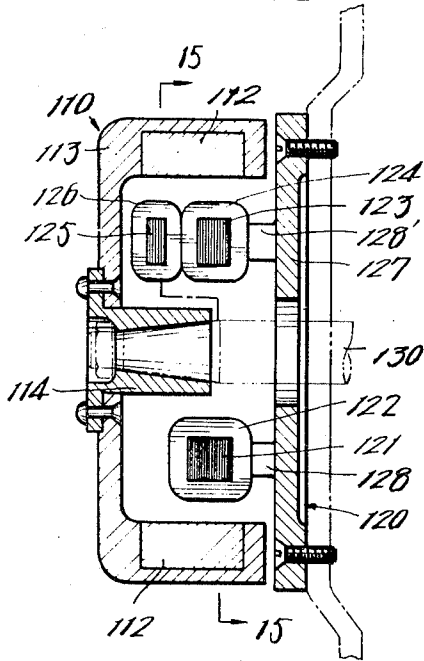


FIG. 16.

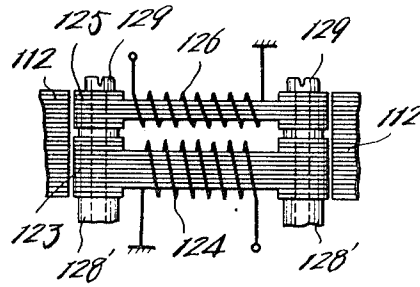


FIG. 15.

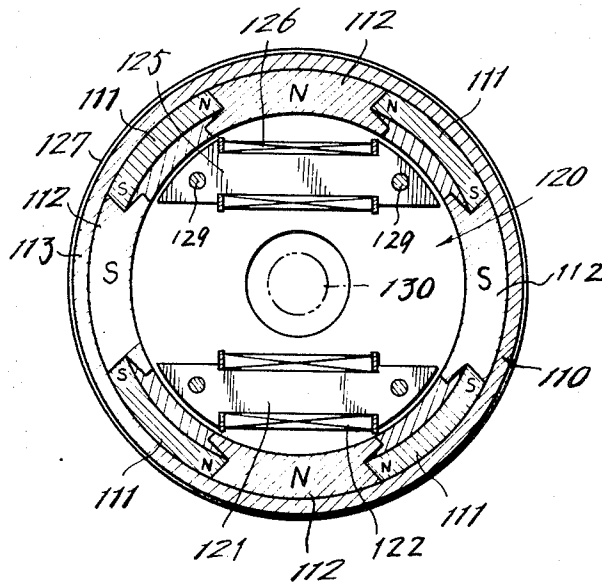


FIG. 17A.

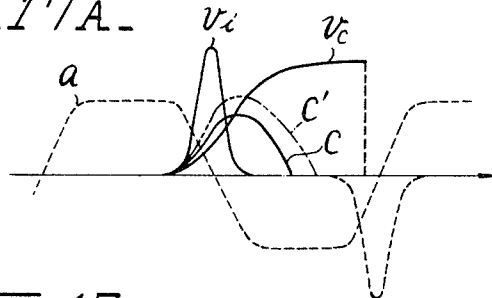


FIG. 17B.

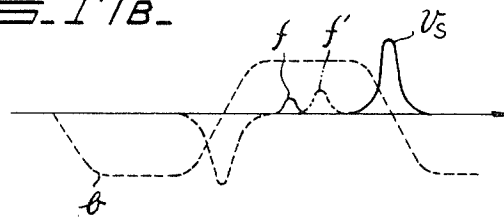


FIG. 18.

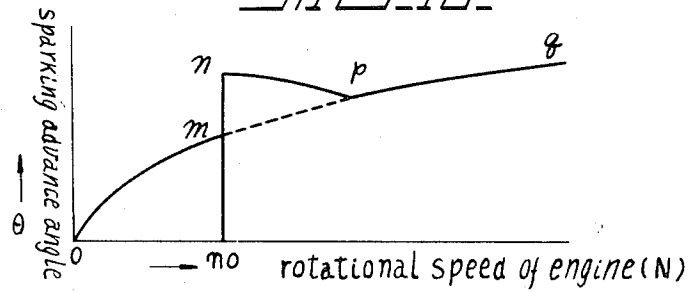


FIG. 19.

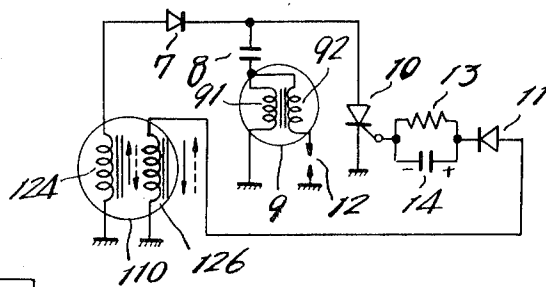
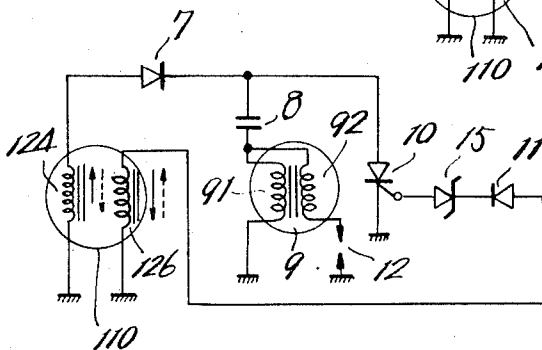


FIG. 20.



IGNITION SYSTEM FOR A TWO-CYCLE ENGINE

BACKGROUND OF THE INVENTION

When a two-cycle engine is employed in a vehicle, since such an engine comprises an AC generator for supplying power to a load such as a battery or lamp, it is advantageous that such a generator is employed as the power source for ignition. As well known in the art, in a capacitor-charge discharge-type ignition system in which the generator is employed as the power source for ignition, the output of the capacitor-charging coil in the magnet-type generator is fed to the input of a rectifier and the rectified DC current at the output of the rectifier is fed to the capacitor to charge the capacitor with the current. The load on the charged capacitor is then discharged through a semiconductor such as a thyristor to the primary coil of an ignition coil thereby to obtain a high voltage which will cause sparks to be struck from the ignition plug. In the above-mentioned ignition system, the continuity of the semiconductor switch element has been conventionally controlled by a signal generator which is adapted to generate one pulse per one complete revolution of the engine. However, in such an ignition system, when the magnet-type generator and signal generator are separately provided the number of apparatus to be incorporated in a vehicle will increase resulting in an undesirably bulky construction to the vehicle. In order to eliminate such a disadvantage, it is desirable to house the signal generator within the magnet-type generator so that the coil of the signal generator will be energized by the magnetic field provided in the magnet-type generator. And when the capacitor-charging output, signalling output, storage-battery-charging output and lighting output are to be induced from the same magnetic-type generator, it is necessary to provide the magnetic field with a number of poles accordingly and the magnetic field should be provided with at least four poles. However, in a two-cycle engine it has been generally considered that when sparks are struck from the ignition plug on strokes other than the compression stroke of the cylinders, the output of the engine would be decreased. Therefore, it has been considered that the signal coil cannot be housed within the magnet-type generator, since the signal coil should not be energized by the magnetic field in the magnetic-type generator.

SUMMARY OF THE INVENTION

The present invention relates to an ignition system adapted to be suitably employed in connection with a two-cycle engine and more particularly, to a breakerless-type ignition system in which a magnet-type AC generator is employed as the power source for igniting the system and a capacitor is repeatedly charged and discharged.

Through experiments conducted by us, we have confirmed that in a two-cycle engine when sparks are struck when the engine cylinders are at predetermined normal time points and also at different time points than the normal time points, if the spark-striking time points other than the normal time points are successively shifted, the output of the engine would vary as shown in FIG. 1 of the accompanying drawings. As seen from FIG. 1, when the normal sparking time point of each engine cylinder is preset at a time point just before the cylinder reaches its upper dead point and then sparks are successively struck from the cylinder on both its explosion stroke and gas intake stroke, no variation will occur in the output of the engine as shown with the solid line P_1 in this FIG., but when sparks are struck from the cylinder on its compression stroke, the output of the engine will vary as shown with the solid lines P_2 and P_3 therein. This means that in a two-cycle engine sparks may be equally allowed to be struck on cylinders strokes other than at the predetermined normal sparking time point on its compression stroke as well as on its compression stroke. This phenomenon is considered due to the fact that the pressure of a mixture gas within the cylinder is at a low value near that of the surrounding atmospheric pressure and sparking energy is small when the cylinder is on strokes other than its

compression stroke and thus, when the pressure of the mixture gas within the cylinder is low a higher sparking energy will be required accordingly. Therefore, even if sparks are struck from the ignition plug of each cylinder on the cylinder strokes other than its compression stroke, such sparks are insufficient to ignite the mixture fuel gas.

Thus, according to the above discovery, it will be understood that a magnet-type generator having a multiple pole-type magnetic field provided with four or more poles can house therein a signal coil which is adapted to cooperate with the magnetic field.

When the signal coil is housed in the above-mentioned magnet-type generator there are two necessary conditions which must be observed. One of such conditions is that the signal coil has to be so positioned that the coil will energize an ignition circuit only when the engine cylinder is in its predetermined appropriate position and the other is that the signal coil has to be so positioned that the signal coil will not be magnetically affected by other coils within the magnet-type generator, especially, the lighting and capacitor-charging coils.

One major object of the present invention is to provide an ignition system of the above type which can employ a magnet-type generator in the interior of which capacitor-charging and signal coils which cooperate with one common magnetic field are provided.

Another object of the present invention is to provide an ignition system of the above type in which in order to increase the output of a lighting coil even when the magnetic field of said magnet-type generator is provided with more poles than those in any conventional magnet-type generator the engine can be protected from adverse effects which would be otherwise inevitable in conventional ignition systems by the energization of an ignition circuit with the output of the signal coil.

A further object of the present invention is to provide an ignition system of the above type in which even if the signal coil is disposed adjacent to the capacitor-charging coil within the magnet-type generator the ignition circuit can be effectively prevented from erroneously functioning due to an irregular voltage to be generated in the signal coil which is caused by a current flowing through the capacitor-charging coil.

A further object of the present invention is to provide an ignition system of the above type in which a multicylinder engine employs an ignition circuit to cause the various cylinders of the engine to spark successively without the use of any distributor.

A still further object of the present invention is to provide a power source for the ignition system of the above type in which even when the magnet-type generator houses the signal coil therein, the generator can provide a large output when the generator is rotated at a low rate thereby to provide a sufficient power to the load and to improve the performance of sparks to be struck when the generator is rotated at the low rate.

The above and other objects and attendant advantages of the present invention will be more apparent to those skilled in the art from a reading of the following detailed description referring to the accompanying drawings which show the embodiments of the invention for illustration purpose only, but not for limiting the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a characteristic diagram showing variation in the output of a two-cycle engine in which the present invention is incorporated when the cylinders of said engine are sparked at a predetermined normal time point and also at time points other than the normal time point;

FIG. 2 is a schematic end elevational view of a magnet-type AC generator of the invention which houses a capacitor-charging coil, a lighting coil and a signal coil therein;

FIG. 3A is a diagram showing a magnetic flux which interlinks said capacitor-charging coil and a voltage which is to be induced in the charging coil as the magnet-type generator of FIG. 2 is rotated one complete revolution;

FIG. 3B is a diagram showing a magnetic flux which interlinks said signal coil and a voltage which is to be induced in the signal coil as the magnet-type generator of FIG. 2 is rotated one complete revolution;

FIG. 4 is a first embodiment of ignition circuit diagram of the invention which is adapted to cooperate with said generator of FIG. 2 and which includes one ignition plug;

FIG. 5 is a diagram showing time points at which cylinders of said two-cycle engine are sparked or dead-sparked by the ignition circuit of FIG. 4 when the generator employs various different numbers of poles of magnetic field;

FIG. 6 is substantially similar to FIG. 4, but shows an embodiment in which said ignition circuit includes two ignition plugs;

FIG. 7 is substantially similar to FIG. 5, but shows time points at which cylinders of said two-cycle engine are sparked or dead-sparked by the ignition circuit of FIG. 6;

FIG. 8 is substantially similar to FIG. 6, but shows a different arrangement of the two ignition plugs in the ignition circuit of FIG. 6 from that of the ignition plugs shown in FIG. 6;

FIG. 9 is substantially similar to FIG. 8, but shows an embodiment in which the ignition circuit of FIG. 4 includes three ignition plugs;

FIG. 10 is a diagram showing time points at which cylinders of a three-cylinder two-cycle engine are sparked or dead-sparked by the ignition circuit of FIG. 9;

FIG. 11 is substantially similar to FIG. 6, but shows an embodiment in which said ignition circuit of FIG. 4 includes four ignition plugs;

FIG. 12 is a diagram showing time points at which cylinders of a four-cylinder two-cycle engine are sparked or dead-sparked by the ignition circuit of FIG. 11;

FIG. 13 is substantially similar to FIG. 11, but shows a different arrangement of the ignition plugs of the ignition circuit of FIG. 11 from that of the ignition plugs shown in FIG. 11;

FIG. 14 is a vertically sectional view of a four-pole magnet-type generator according to the present invention;

FIG. 15 is a cross-sectional view of said generator of FIG. 14 taken substantially along the line 15-15 of FIG. 14;

FIG. 16 is a view showing an arrangement of an iron core on which the capacitor-charging coil is wound and that on which the signal coil is wound in the generator shown in FIGS. 14 and 15;

FIG. 17A is a characteristic diagram showing a magnetic flux which interlinks said capacitor-charging coil, a voltage which is to be induced in the capacitor-charging coil and a capacitor voltage as the generator of FIGS. 14 and 15 is rotated one complete revolution;

FIG. 17B is a characteristic diagram showing a magnetic flux which interlinks said signal coil and a voltage which is to be induced in the signal coil in said generator of FIGS. 14 and 15 as the generator is rotated one complete revolution;

FIG. 18 is a diagram showing variation in the ignition-advancing angle against variation in the rotational rate of an engine;

FIG. 19 is a diagram of an ignition circuit in which the generator shown in FIGS. 14 and 15 is employed as the power source; and

FIG. 20 is a diagram of another ignition circuit in which the generator shown in FIGS. 14 and 15 is employed as the power source.

PREFERRED EMBODIMENTS OF THE INVENTION

The present invention is based on the discovery that even when cylinders in a two-cycle engine are sparked on strokes other than their compression stroke, that is, on the explosion

stroke and gas-intake and scavenging stroke, the output of the engine will not be reduced (see FIG. 1).

Based on the above discovery, according to the present invention there is provided an ignition system for a two-cycle engine which comprises a magnet-type generator having a magnetic field provided with $2n$ poles (n is an integer of two or more), said generator including a capacitor-charging coil and a signal coil provided in the interior thereof for cooperating with said magnetic field; a capacitor or capacitors adapted to be charged with the output of said capacitor-charging coil; an ignition coil or coils having a primary coil or coils through which a discharge current flows when the load on said capacitor or capacitors is discharged at predetermined time points; an ignition plug or plugs connected to the secondary coil or coils of said ignition coil or coils; and a thyristor or solid-state semiconductor-type switch controlled by said signal coil for setting said predetermined discharge time points for the capacitor or capacitors; said n is a number selected for causing each of said cylinders to spark by its respectively associated one of said ignition plugs in a predetermined normal igniting position when each cylinder is in said normal igniting position and in any positions on its strokes other than its compression stroke when each cylinder is not in said predetermined normal igniting position.

FIG. 2 illustrates one type of magnet-type generator suitably employed in the ignition system of the present invention. The generator generally comprises a flywheel-type magnet rotor 1 and a stator 2. The magnet-type rotor 1 includes $2n$ poles (n is an integer of two or more) and in the embodiment shown in FIG. 2, the rotor is shown as having six poles. While $2n$ poles may consist of $2n$ magnets as shown in FIG. 2, these poles may consist of n magnets and n iron pieces, which magnets and iron pieces are alternately arranged along the inner periphery of the rotor 1. The stator 2 includes a coil 3 for charging a capacitor with a load in an ignition circuit of which description will be made hereinafter, a signal coil 4, a lighting coil 5 and a coil 6 for charging a storage battery with a load. The coils 3, 5 and 6 are arranged in a 120° angular spaced relation in the inner periphery of the rotor 1 and the coil 4 is disposed in the same angular position as the coil 3 with respect to the coils 5 and 6 in the periphery of the rotor 1. The coils 3 and 4 are wound on separate iron cores which are spaced superimposed one upon another to be simultaneously excited by the same poles of the rotor. In such an arrangement of the iron cores, the coils 3 and 4 are wound on their respective iron cores so as to induce voltages in the opposite directions to each other with respect to ground. Since the magnet rotor 1 is connected to the crankshaft of the two-cycle engine, the various coils of the generator induce three cycles of AC voltage as the engine is rotated one complete revolution.

The outputs of the coils 3 and 4 as the magnet-type generator is rotated one complete revolution are shown in FIGS. 3A and 3B, respectively. In these FIGS., Φ_3 and Φ_4 are magnetic fluxes which interlink the coils 3 and 4, v_3 and v_4 are the output voltages of the coils 3 and 4. The broken line sections of v_3 and v_4 (one half-cycle in negative) are blocked off by a diode with respect to the ignition circuit and v_c is a voltage on the capacitor in the ignition circuit.

FIG. 4 illustrates an ignition circuit suitably employed in a one-cylinder two-cycle engine. The ignition circuit employs as its power source the above-mentioned generator with the capacitor-charging coil 3 and signal coil 4 positioned within the generator as shown in FIG. 2, but the number of poles of the generator may be selected such as $4(n=2)$, $6(n=3)$ or $8(n=4)$. FIGS. 14 and 15 illustrate the generator as having four magnet poles.

When the generator having four magnet poles is employed in the ignition circuit of FIG. 4, two cycles of voltage is induced in each of the coils as the generator is rotated one complete revolution. When one-half cycle of positive current is initially induced in the capacitor-charging coil 3, a charging voltage will flow from the coil 3 through a diode 7 to a capacitor 8. The capacitor voltage increases as time goes by

until the voltage reaches a constant value. A voltage which is induced in the coil 4 in correspondence to the one-half cycle of positive voltage induced in the coil 3 is negative and accordingly, the negative voltage is blocked by a diode 11. When a positive signal voltage is induced in the signal coil 4 in the ensuing one-half cycle, a current will flow from the coil 4 through the diode 11 and the gate and cathode of the thyristor 10. When this current reaches the turn-on gate of the thyristor 10, the resistance between the cathode and anode of the thyristor will reduce and the load on the capacitor 8 is discharged through the primary coil 91 of an ignition coil 9. Since this discharge current flows momentarily, a high voltage is induced in the secondary coil 92 of the ignition coil 9 sufficient to strike sparks from an ignition plug 12. The above-mentioned sequence of operations is performed when the magnet-type generator is rotated for the first one-half of one complete revolution of the generator and the same operation sequence is also repeated during the rotation of the generator for the remaining one-half of the complete revolution. Therefore, if the cylinder associated with the ignition plug 12 is so set that the cylinder is precisely positioned in its normal ignition position when sparks are struck from the ignition plug during the initial one-half portion of one complete revolution of the generator, the cylinder will be on strokes other than its compression stroke when sparks are struck from the ignition plug 12 during the remaining one-half portion of the one complete revolution of the generator. In FIG. 5, the thick line arcuate section in each of the circles denotes the time space during which the cylinder remains on its compression stroke. As seen from this FIG., when the number of magnet poles n is 2, the position A_5 is the normal ignition position and B_5 is an ignition position other than the normal ignition position. It will be apparent that the ignition position B_5 is located on a stroke other than the compression stroke of the cylinder. Even when sparks are struck from the ignition plug 12 when the cylinder is in the position B_5 , fuel gas will not be ignited and accordingly, the output of the engine will not be reduced.

In the magnet-type generator employing the ignition circuit shown in FIG. 4, when n is 3, sparks are also struck from the ignition plug 12 in both the positions B_3 and C_3 which are located on strokes other than the compression stroke as well as the normal ignition position, that is, the position shown with A_3 . And when n is 4, sparks will be further struck from the plug 12 in the positions B_4 , C_4 and D_4 which are located on strokes other than the compression stroke as well as the normal position or compression stroke shown with A_4 . In these positions B_4 , C_4 and D_4 , sparks struck from the ignition plug 12 will not affect the output of the engine. However, when n is 5, at least one spark is struck from the ignition plug 12 on the compression stroke and accordingly, the engine output will be reduced and this makes such a generator practically useless.

FIG. 6 illustrates an ignition circuit in which the secondary coil 92 of the ignition coil 9 of the ignition circuit of FIG. 4 is also connected to another ignition plug 12' as well as the previously mentioned ignition plug 12. The ignition circuit of FIG. 6 is suitably employed in connection with a two-cylinder two-cycle engine. In this ignition circuit, as shown in FIG. 7, by the use of a magnet-type generator in which $n=2$ or $n=4$ or four poles or eight poles are employed, sparks are struck from the ignition plugs 12 and 12' on strokes other than their compression stroke, that is, in the positions B_7 or B_7 , C_7 and D_7 or B_7 or B_7 , C_7 and D_7 , respectively. In FIG. 7, I denotes a cylinder having the ignition plug 12 and II denotes a cylinder having the ignition plug 12'. A generator in which n is 4 or more can not be employed.

FIG. 8 shows an ignition circuit to be suitably employed in connection with a two-cylinder two-cycle engine and the ignition circuit comprises a first circuit section which includes a diode 7, a capacitor 8, an ignition coil 9 and an ignition plug 12; and a second circuit section which includes a diode 7', a capacitor 8', an ignition coil 9' and an ignition plug 12'. These circuit sections are in parallel connected, and these paralleled circuit sections are in series connected to the

capacitor-charging coil 3 of the generator and thyristor 10. This ignition circuit can employ magnet poles in the number of four or eight, that is, $n=2$ or $n=4$ in the same way as mentioned in connection with the ignition circuit of FIG. 6 (see FIG. 7).

FIG. 9 shows an ignition circuit suitably employed in connection with a three-cylinder two-cycle engine. In this ignition circuit, the ignition circuit shown in FIG. 8 is added thereto a circuit section including a diode 7'', a capacitor 8'', an ignition coil 9'' and an ignition plug 12''. In this ignition circuit of FIG. 9, only when the number of n is 3, dead sparks are struck from the ignition plugs on strokes of the cylinders other than the compression stroke thereof. In FIG. 10, A_{10} , A'_{10} and A''_{10} denote the normal sparking time points of the respective cylinders I, II and III, respectively and B_{10} , B'_{10} and B''_{10} and C_{10} , C'_{10} and C''_{10} denote the dead sparking time points of the respective cylinders which have nothing to do with the output of the engine. When $n>3$, this ignition circuit can not be used because sparks are struck from the ignition plugs on the compression stroke of the cylinders.

FIG. 11 shows an ignition circuit suitably employed in connection with a four-cylinder two-cycle engine. In this ignition circuit, ignition plugs 12, 12' and 12'', 12''' are respectively connected to the coils 92 and 92' of the ignition coils 9 and 9' in the ignition circuit shown in FIG. 8. In the ignition circuit shown in FIG. 11, only when n is 4, dead sparks are struck from the ignition plugs on their strokes of the cylinders other than the compression stroke. In FIG. 12, A_{12} , A'_{12} , A''_{12} and A'''_{12} denote the normal sparking positions of the respective cylinders I, II, III and IV and B_{12} , C_{12} , C'_{12} and C''_{12} and D_{12} , D'_{12} , D''_{12} and D'''_{12} denote dead sparking positions of the respective cylinders which have nothing to do with the output of the engine. If n is 8 in the generator, this ignition circuit can not be employed for such a generator because sparks are struck from the ignition plugs on the compression strokes of the cylinders.

FIG. 13 shows an ignition circuit suitably employed in connection with a four-cylinder two-cycle engine and the circuit comprises the ignition circuit shown in FIG. 11 having a circuit section including a diode 7''', a capacitor 8''' and an ignition coil 9''' added thereto. This ignition circuit of FIG. 13 can be employed in connection with a four-cylinder two-cycle engine in the same manner as the ignition circuit (see FIG. 12).

FIGS. 14 and 15 show a preferred embodiment of magnet-type generator having a signal coil according to the present invention. In these FIGS., the generator is shown as having four magnet poles, but it will be understood that the generator may be equally embodied as having six or eight magnet poles. The generator generally comprises a rotor which is generally indicated by numeral 110 and a stator which is generally indicated by numeral 120 in FIGS. 14 and 15, respectively. The rotor 110 includes four magnets 111 and four pole pieces 112. These magnets 111 and pole pieces 112 are fixedly secured to the inner periphery of a cup-shaped flywheel 113 in the manner as mentioned hereinafter. In the embodiment shown in FIGS. 14 and 15, the flywheel 113 is formed of light metal such as Al alloy, Mg alloy or Zn alloy and the magnets and pole pieces are incorporated into the flywheel while the same is being formed. The flywheel 113 has a center opening formed in the end disc portion and a boss member 114 which extends inwardly is received in the center opening and has a flange fixedly secured to the end disc portion by means of rivets. The boss member 114 is also fixedly secured to the crankshaft 130 of the engine (indicated by the phantom line in FIG. 14). As shown, the magnets 111 have the opposite ends having the opposite polarities and are disposed in such manner that the opposite ends of the adjacent magnets have the same polarity. Accordingly, the pole pieces will have alternately opposite polarities.

The stator 120 includes a lighting coil 122 wound on an iron core 121, a capacitor-charging coil 124 wound on an iron core 123, and a signal coil 126 wound on an iron core 125. A

stationary mounting plate 127 is provided and the mounting plate is formed with bosses 128 and 128' on one side or the inner side extending inwardly into the flywheel 113. The iron core 121 of the lighting coil 122 is secured to one of the bosses or the boss 128 while the iron core 123 of the charging coil 124 and the iron core 125 of the signal coil 126 are secured to the other boss 128' by means of setscrews 129 in a spaced one-upon-another relation (see FIG. 16). The stationary mounting plate 127 is secured to a part of the crankcase of the engine and has a center opening through which the crankshaft 130 of the engine extends. As shown in FIG. 14, the stator 113 is so disposed that when the stator is assembled with the rotor the respectively opposite ends of the iron cores 121, 123 and 124 are slightly spaced from the respectively adjacent pole pieces during the rotational movement of the rotor 110. The lighting coil 122 and capacitor-charging coil 124 are disposed in a 180° angular spaced relation in the inner periphery of the flywheel 113 and the signal coil 126 is disposed in the same angular position as the capacitor-charging coil 124 with respect to the lighting coil 122. The charging coil 124 and signal coil 126 are wound so as to induce voltages in the opposite directions with respect to ground.

FIG. 17A graphically shows one cycle of voltage v_i to be induced in the charging coil 124 and in this FIG., a denotes the waveform of a magnetic flux interlinking the coil 124, c denotes a charging current flowing through the capacitor in the ignition circuit (FIGS. 19 and 20) and v_c denotes a voltage in the capacitor.

FIG. 17B graphically shows one cycle of voltage v_s to be induced in the signal coil 126. In this FIG., b denotes the waveform of a magnetic flux interlinking the coil 126. The negative half wave of the voltage v_i is blocked by the diode in the ignition circuit and the negative half wave of the voltage v_s is blocked by the diode provided at the gate of the thyristor in the ignition circuit. These negative half waves are shown by the broken lines in FIG. 17, respectively.

In the magnet-type generator shown in FIGS. 14 through 16, since the signal coil 126 is disposed closely adjacent to the capacitor-charging coil 124, when the charging current flows through the charging coil 124 as shown by c in FIG. 17A, the current magnetically affects the signal coil 126 to the extent that an abnormal voltage will be induced in the signal coil which sometimes cause an abnormal phenomenon to occur in the ignition-advancing angle characteristics of the ignition device. To put more particularly, when the charging current c (FIG. 17) flows through the charging coil 124, the current provides a magnetic flux which will interlink the signal coil 126 thereby to induce an abnormal voltage in the signal coil 126 which is shown with f in FIG. 17B. Although the abnormal voltage f is of a small value, when the voltage f increases to a value sufficient to provide a current which will turn on the thyristor of the ignition circuit, the thyristor will be made conductive just before the normal signal voltage v_s is induced and the load on the capacitor is discharged to the primary coil of the ignition coil while a high voltage is induced in the secondary coil of the ignition coil thereby to cause sparks to be struck from the ignition plugs. As seen from the aspect of the ignition-advancing angle characteristic of the ignition circuit under consideration, this phenomenon manifests an abnormal ignition-advancing angle. In other words, as the rotational rate of the engine increases, the voltage v_s increases accordingly. A normal ignition advancing angle curve obtainable as the building-up of the increased voltage v_s advances the phase is shown with the curve $o-m-p-q$ in FIG. 18. However, when the abnormal voltage f is generated, the ignition-advancing angle characteristic of the voltage leaps rapidly from the m point to the n point when the engine rotational rate reaches the point no as shown in FIG. 18. The current from the coil 124 changes from the point c to the point c' as the rotational rate of the engine increases and accordingly, the abnormal voltage induced in the signal coil 126 will provide a phase delay from the point f to the point f' as shown in FIG. 18. When the abnormal voltage f' is at last

delayed to the position where the normal signal voltage v_s is generated, the advancing angle curve again returns the normal line $p-q$. The transit of the advancing angle curve through the section including the points $m-n-p$ shown in FIG. 18 will displace the normal sparking positions in the ignition circuits shown in FIGS. 4, 6, 8, 9, 11 and 13 to the extent that such positions may be located on the compression strokes of the engine cylinders. It will be evident that such displacement of the normal sparking positions will lead to reduction of the engine output.

FIGS. 19 and 20 show ignition circuits which are provided with means for preventing such abnormal advancing angle phenomenon. Although these ignition circuits are shown as being employed in connection with a one-cylinder two-cycle engine, the circuit can be equally employed in connection with two-cycle engines having two, three or four cylinders. The ignition circuits shown in FIGS. 19 and 20 are substantially identical with that shown in FIG. 4 except for the provision of abnormal advancing angle prevention means and the provision of the primary coil of the ignition coil in the capacitor-charging circuit section.

In the ignition circuit of FIG. 19, a network having a resistor 13 and a capacitor 14 in parallel connected to each other is disposed between the cathode of a diode 11 and the gate of a thyristor 10. The resistor 13 and capacitor 14 are selected from those having relatively large values. In the ignition circuit of FIG. 19, when a current is caused to flow through the gate of the thyristor 10 due to the normal voltage v_s induced in the signal coil 126, the capacitor 14 is charged. However, when the engine is rotated at a relatively low rate, the load on the capacitor 14 is discharged through the resistor 13. As the rotational rate of the engine increases the time interval of one sparking cycle is shortened and accordingly, a portion of the load on the capacitor 14 will remain without being discharged. As shown in FIG. 19, the polarity of the voltage charged on the capacitor 14 is opposite to that of the signal voltage. And since the gate of the thyristor 10 is biased in the reverse direction, there will be no possibility that the thyristor is biased in the forward direction due to abnormal voltages f and f' and accordingly, in such a case, the thyristor will not be turned on.

In the ignition circuit shown in FIG. 20, a Zener diode is disposed between the cathode of the diode 11 and the gate of the thyristor 10 which Zener diode will not break down with abnormal voltages f and f' induced in the signal coil 126. Also in the ignition circuit of FIG. 20, since no current flows through the gate of the thyristor 10 due to abnormal voltages f and f' the thyristor will not be turned on.

Thus, by the use of the ignition circuits of FIGS. 19 and 20, the ignition-advancing angle characteristic of the ignition system will provide the curve $o-m-p-q$ of FIG. 18 thereby to prevent the engine output from reducing.

In the foregoing, the invention has been described with reference to specific illustrative embodiments. It will be evident, however, that variations and modifications, as well as the substitution of equivalent parts or elements for those shown herein for illustration, may be made without departing from the broader scope and spirit of the invention as set forth in the appended claims. The specification and drawings are accordingly to be regarded in an illustrative rather than in a restrictive sense.

We claim:

1. An ignition system for a two-cycle engine comprising a magnet-type generator having a magnetic field provided with $2n$ poles (n is an integer of two or more) and housing a capacitor-charging coil and a signal coil therein, said capacitor-charging and signal coils being adapted to cooperate with said magnetic field; a capacitor or capacitors adapted to be charged with the output of said capacitor-charging coil; an ignition coil or coils having a primary coil or coils through which a discharge current will flow when load on said capacitor or capacitors is discharged at predetermined time points; and ignition plug or plugs connected to the

secondary coil or coils of said ignition coil or coils; and solid-state-type switch means adapted to be controlled by the output of said signal coil for determining said discharge time points for said capacitor or capacitors; said n being so selected that sparks may be struck from each ignition plug when its associated cylinder is in its predetermined normal ignition position and when the cylinder is in any position on any of its strokes other than the compression stroke.

2. An ignition system as set forth in claim 1, in which when said engine is a one-cylinder engine, said n is an integer selected from the group comprising 2, 3 and 4.

3. An ignition system as set forth in claim 1, in which when said engine is a two-cylinder engine, said n is an integer selected from the group comprising 2 and 4.

4. An ignition system as set forth in claim 1, in which when said engine is a three-cylinder engine, said n is 3.

5. An ignition system as set forth in claim 1, in which when said engine is a four-cylinder engine, said n is 4.

6. An ignition system as set forth in claim 1, in which said magnet-type generator houses said capacitor-charging coil and said signal coil in proximity to each other in the interior of said generator.

7. An ignition system as set forth in claim 1, in which said magnet-type generator comprises a rotor having $2n$ poles; and a stator having a lighting coil wound on an iron core, a capacitor-charging coil wound on a second iron core and a signal coil wound on a third iron core; said iron core for the capacitor-charging coil and that for said signal coil being disposed in a spaced one-upon-another relation extending axially of said generator.

8. An ignition system as set forth in claim 7, in which said $2n$ poles of the rotor comprise $2n$ magnets disposed in an equally spaced relation along the inner periphery of a cup-shaped flywheel.

9. An ignition system as set forth in claim 7, in which said $2n$ poles of the rotor comprise n magnets and n iron pieces which are alternately arranged in an equally spaced relation along the inner periphery of a cup-shaped flywheel.

10. An ignition system as set forth in claim 1, in which said switch means is a thyristor.

11. An ignition system as set forth in claim 1, in which the control terminal of said switch means is provided with a means which is adapted to eliminate any abnormal voltage which may be generated in said signal coil.

12. An ignition system as set forth in claim 11, in which said means for eliminating the abnormal voltage is a Zener diode

having an inverse voltage characteristic, said Zener diode being adapted not to break down at said abnormal voltage.

13. An ignition system as set forth in claim 11, in which said means for eliminating the abnormal voltage is a circuit comprising a capacitor and a resistor in parallel connected to each other.

14. An ignition system for a two-cycle engine comprising a magnet-type generator which includes a rotor having a magnetic field provided with $2n$ poles (n is an integer of two or more), a capacitor-charging coil and a signal coil, said capacitor-charging and signal coils being disposed axially of said generator in a spaced one-upon-another relation; a capacitor or capacitors adapted to be charged with the output of said capacitor-charging coil; an ignition coil or coils having a primary coil or coils through which a discharge current flows when the load on said capacitor or capacitors is discharged at predetermined time points; an ignition plug or plugs connected to the secondary plug or plugs of said ignition coil or coils; a thyristor adapted to be controlled by the output of said signal coil for determining said predetermined discharge time points for said capacitor or capacitors; and means disposed between the gate of said thyristor and said signal coil for eliminating any abnormal voltage to be induced in the signal coil; said n being so selected that sparks are to be struck from each ignition plug when its associated cylinder is in its predetermined normal sparking position and in any position on its strokes other than its compression stroke.

15. An ignition system as set forth in claim 14, in which said means for eliminating the abnormal voltage is a Zener diode having an inverse voltage characteristic wherein said Zener diode will not break down at said abnormal voltage.

16. An ignition system as set forth in claim 14, in which said means for eliminating said abnormal voltage is a circuit comprising a capacitor and a resistor in parallel connected to each other.

17. An ignition system as set forth in claim 14, in which when said engine is a one-cylinder engine, said n is an integer selected from the group comprising 2, 3 and 4.

18. An ignition system as set forth in claim 14, in which when said engine is a two-cylinder engine, said n is an integer selected from the group comprising 2 and 4.

19. An ignition system as set forth in claim 14, in which when said engine is a three-cylinder engine, said n is 3.

20. An ignition system as set forth in claim 14, in which when said engine is a four-cylinder engine, said n is 4.

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