E. P. COWLES.

ELECTRIC IGNITING DEVICE FOR EXPLOSIVE ENGINES.

APPLICATION FILED MAY 12, 1902.

1,050,002.

Patented Jan. 7, 1913.

3 SHEETS—SHEET 1.

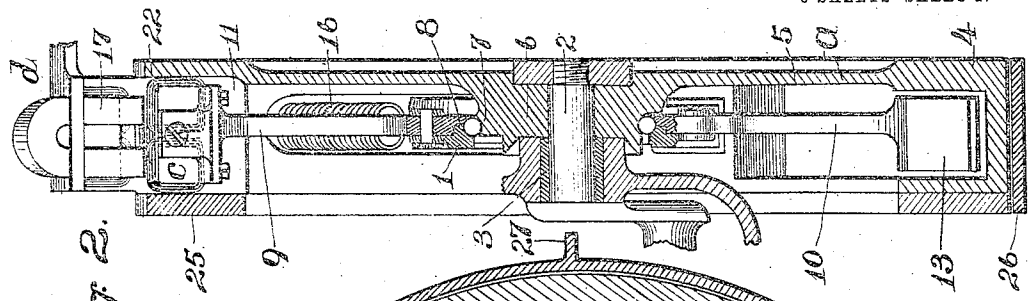

Fig. 2.

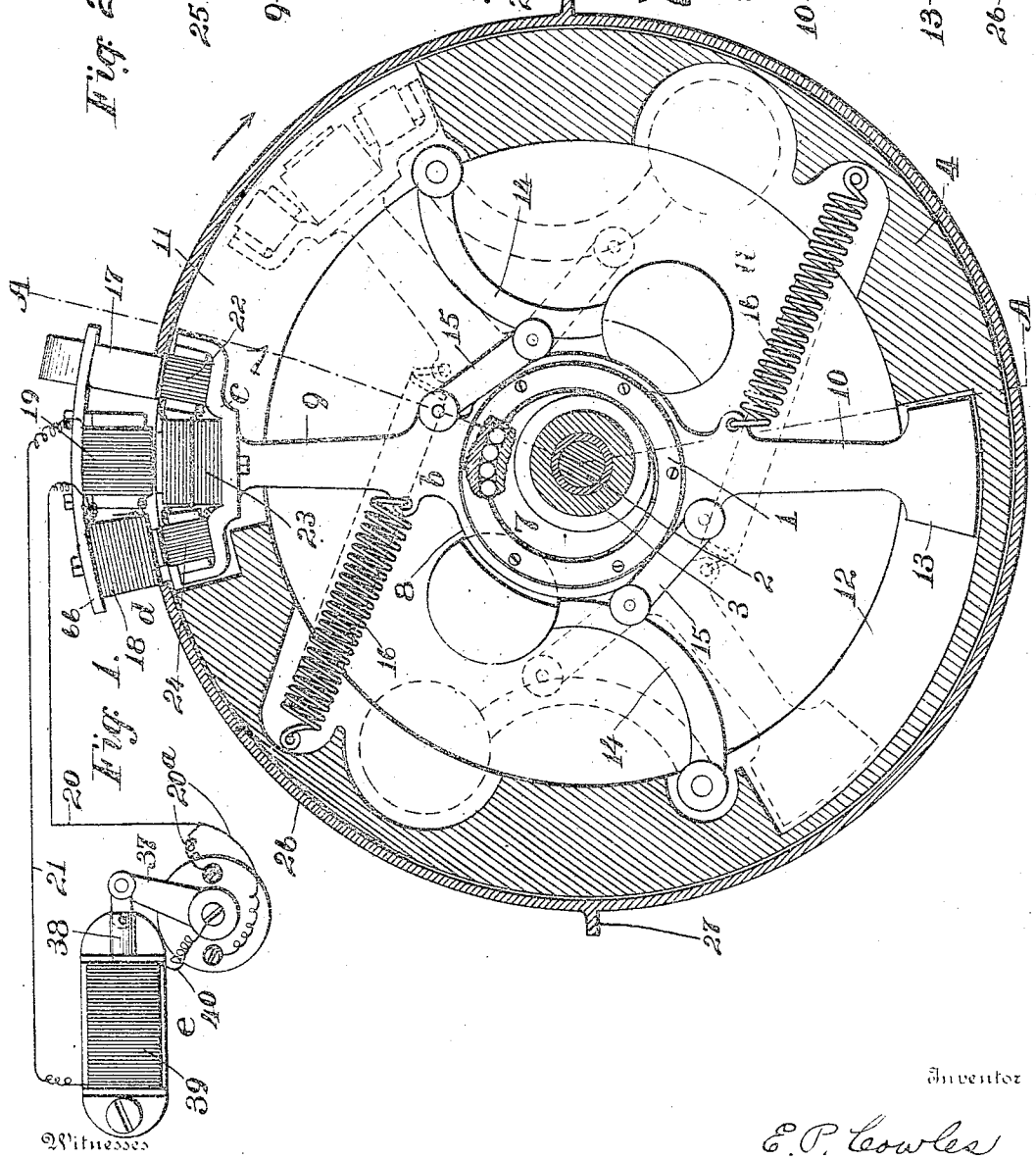

Fig. 1.

Witnesses

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Fig. 3.

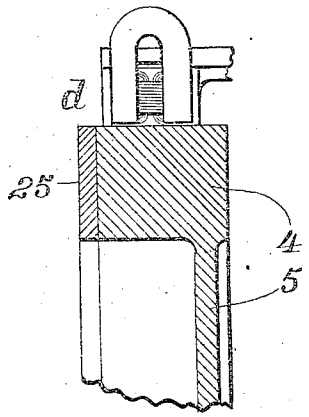
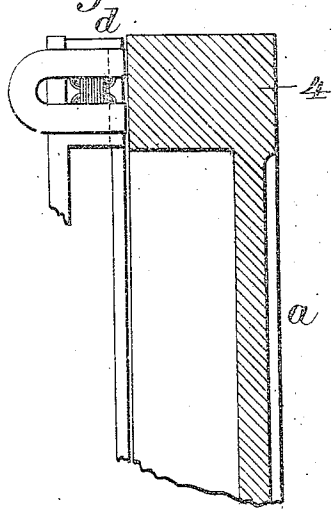


Fig. 5.



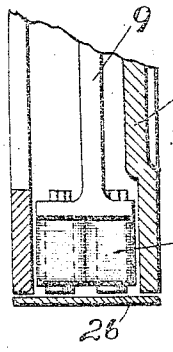


Fig. 4.

Fig. 8.

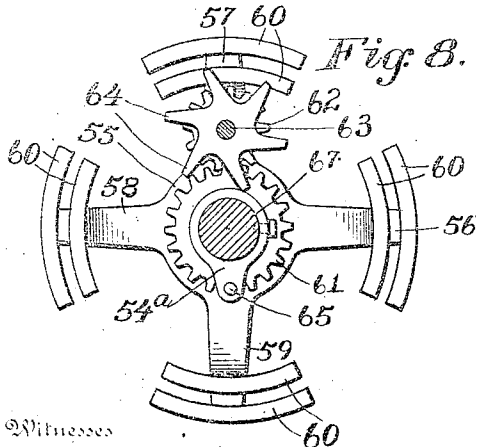
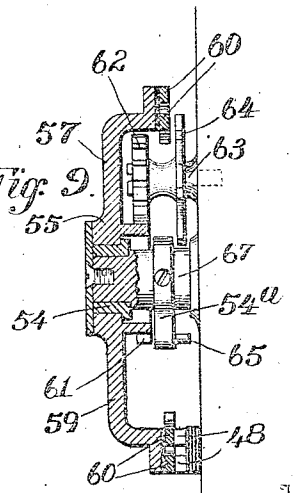


Fig. 9.



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3 SHEETS—SHEET 3.

Fig. 6.

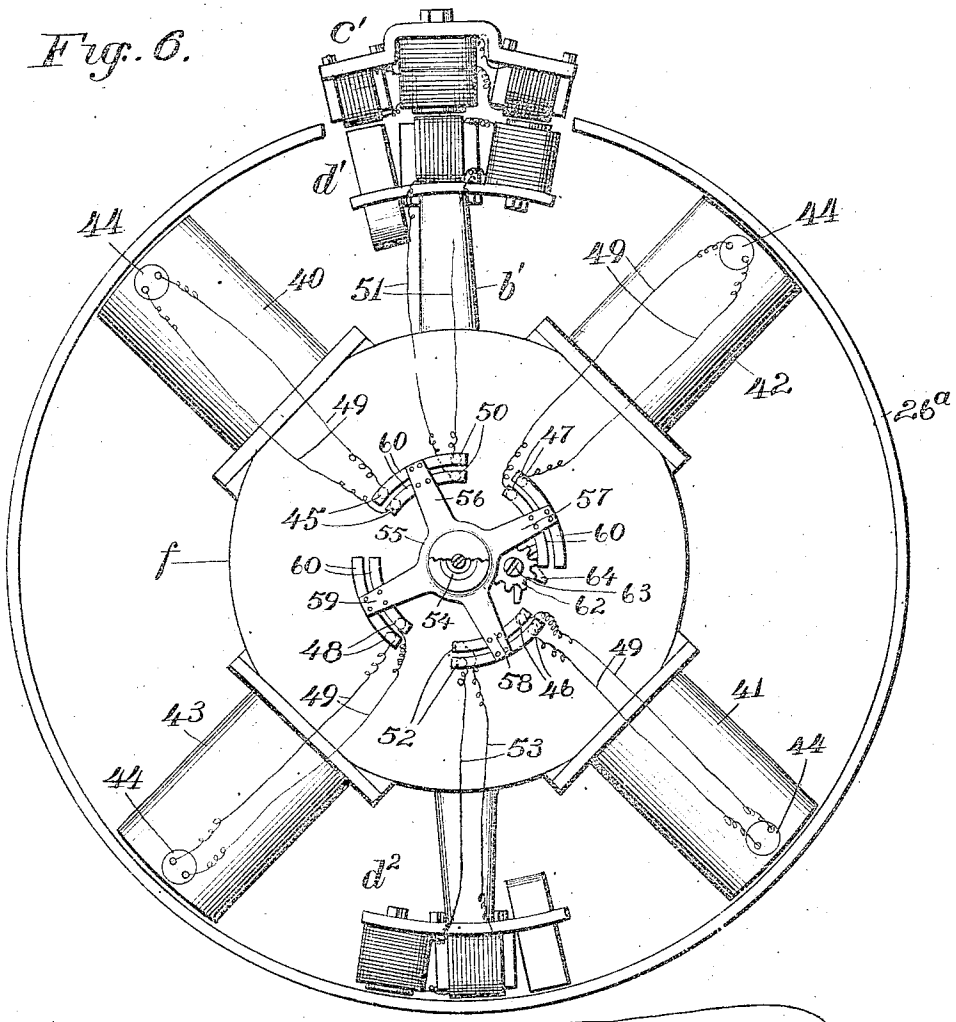
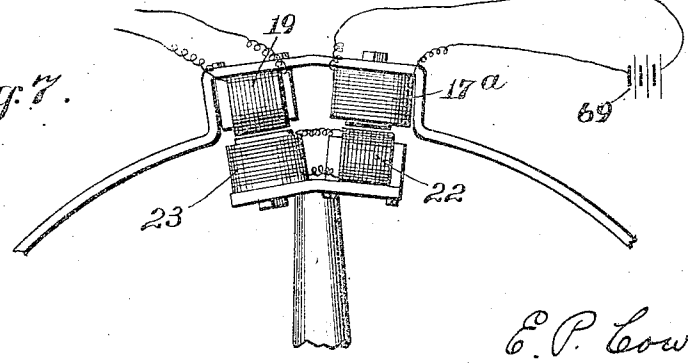


Fig. 7.



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ELECTRIC IGNITING DEVICE FOR EXPLOSIVE-ENGINES.

1,050,002. Specification of Letters Patent. Patented Jan. 7, 1913.

Application filed May 12, 1902. Serial No. 106,947.

To all whom it may concern:

Be it known that I, EDWARD P. COWLES, a citizen of the United States, residing at Sparta, in the county of Kent and State of Michigan, have invented certain new and useful Improvements in Electric Igniting Devices for Explosive-Engines, of which the following is a specification.

This invention relates to electric igniting devices for gas engines and it comprises an electric generator, one part of which is stationary, the other part of said generator being mounted upon the balance-wheel or other moving part of the engine and arranged to be carried thereby into inductive relation to the stationary part of the generator at the proper time to generate the required current for producing the igniting spark. The part of the generator in which the spark-producing current is induced is stationary, or nearly so, with respect to the electrodes in the combustion chamber, and sliding contacts are therefore unnecessary, except in certain types of multi-cylinder engines, wherein it is desired to switch the current to different cylinders, in which case, of course, a periodically movable switch is required as herein explained.

The invention also comprises means for automatically regulating the time of ignition to properly correspond with the speed of the engine and for automatically regulating the inductive relation between the parts of the generator to compensate for changes in speed in order to provide a current of substantially uniform intensity at different speeds.

The invention further comprises means for maintaining the strength of the permanent magnets and for preserving the residual magnetism in the electro-magnets employed, and means for operating the electrodes in the combustion chamber with precision.

In the accompanying drawing which illustrates the invention, Figure 1 is a view showing my improvements applied to and operated by the balance-wheel of a gas engine, the rim of the wheel being shown in central section; Fig. 2 is a section on the line A—A of Fig. 1; Figs. 3 and 4 are views illustrating the manner in which the permanent and residual magnetism are maintained in the magnets; Fig. 5 is a view showing the fixed part of the generator arranged at the side of the balance-wheel instead of opposite its face or periphery; Fig. 6 is a view showing the igniting device applied to a multi-cylinder engine in which the shaft is stationary and the cylinder and casing revolve; Fig. 7 is a view illustrating a generator with an electro-magnet substituted for the permanent magnet; Fig. 8 is a rear view of the switch illustrated in Fig. 6 and the operating mechanism therefor; and Fig. 9 is a central section through the same.

Referring to Figs. 1 and 2 of the drawing, *a* indicates the fly-wheel of a gas engine which is secured to a crank-shaft 2, and 3 indicates one of the bearings for said shaft. The rim 4 of the fly wheel is preferably connected to the hub by a web 5 which forms a partial housing for parts of the igniting mechanism. The hub 6 of the fly-wheel has an eccentric portion 7 surrounding which is a collar or strap 8, the latter being part of a governing lever *b* having arms 9 and 10 projecting radially in opposite directions. The strap is preferably mounted upon a ball bearing, the balls being held in place by a retainer 1 attached to the strap. The arm 9 projects into a slot 11 in the rim of the balance-wheel which slot extends in the plane of the wheel through an angle of about 60 degrees, and one part *c* of a magneto-generator is carried upon the end of said arm and movable therewith within the slot. A groove or recess 12 is formed in the rim diametrically opposite the slot 11 and a weight 13 upon the arm 10, which counterbalances the part *c* of the generator, is movable within this groove.

The position of the governing lever is automatically controlled while the machine is in operation by weighted arms 14 which are pivoted to the wheel and connected by links 15 to the governing lever, these weighted arms acting in opposition to springs 16 which tend to hold the lever in the position shown in full lines in Fig. 1. The positions of the parts at full speed are indicated in dotted lines. The movement of the governing lever is controlled by the springs and weighted levers in the same manner as such devices are employed to shift the eccentric in automatic steam engines, and the purpose of this shifting will be hereinafter more fully explained.

The generator consists of the part *c* rotatable with the fly-wheel and a fixed part *d* arranged adjacent to the fly-wheel so that

the part *c* will be brought into inductive relation therewith by the rotation of the fly-wheel at the proper instant to produce a spark in the combustion chamber of the engine. As shown in Figs. 1 and 2 of the drawing the part *d* of the generator consists of a permanent magnet 17, a secondary electro-magnet 18 and an intermediate secondary generating coil 19, the terminals of which are connected by wires 20 and 21 to the sparking device *e*. The electro-magnet 18 is connected in shunt or otherwise to the coil 19 and in operation is energized by current from said coil. The part *c* of the generator consists of primary generating coils 22 arranged transversely in the line of motion of the wheel and adapted to cut the lines of force of the permanent magnet 17. This primary generating coil 22 is connected to coils upon a primary electro-magnet 23 which is brought into inductive relation with the secondary generating coil 19 when the coil 22 is opposite the permanent magnet 17. A tertiary generating coil 24 is also arranged upon the arm 9 and adapted to cut the lines of force set up by the secondary electro-magnet 18 when the magnets 17 and 23 are opposite the coils 22 and 19.

In operation when the fly-wheel is moving in the direction indicated by the arrow, Fig. 1, and the parts of the generator are opposite as shown in said figure a current is induced in the primary coil 22 while passing under the permanent magnet 17 which current flows around the coils of the primary electro-magnet 23, energizing the latter which induces a current in the secondary generating coil 19, which current is transmitted to the sparking device. A portion of this secondary current passing around the secondary electro-magnet 18 energizes the latter, and the generating coil 24 which is at that moment cutting the lines of force in the secondary electro-magnet has a tertiary current generated therein which is transmitted to coils upon the primary electro-magnet 23, thus augmenting the power of said magnet and the induced current in the secondary coil 19.

The two parts of the generator are arranged so that the pole pieces will just clear the coils when the governing lever is in the position relatively to the wheel shown in Fig. 1. This is the position of the lever when the gas engine is stopped or moving slowly and the air gap between the pole pieces and coils is at a minimum. As the inductive effect, and consequently the intensity of the current would increase proportionately with the speed if the two parts of the generator always maintained the same relation, it is desirable to vary the relation between the moving and stationary parts to compensate the changes in speed in order to obtain a current of substantially the same intensity at all speeds. This is accomplished by mounting the governing lever eccentrically in the manner heretofore described so that with an increase in speed of the fly-wheel the arm 9 carrying the part *c* of the generator will move radially inward as indicated in dotted lines, Fig. 1, thus increasing the width of the air gap between the parts of the generator and decreasing the strengths of the magnetic fields as the speed increases. The number of lines of force cut by the coils per second will therefore be substantially the same at different speeds.

In starting the engine it is desirable to create the spark within the explosion chamber after the crank has passed the center at the commencement of the forward stroke, and as the speed of the engine increases it is desirable to advance the time of ignition so that the explosion will take place earlier.

As the governing lever carrying the movable part of the generator, swings forward when the speed of the engine increases as indicated in dotted lines Fig. 1, it will be seen that the two parts of the generator will co-act at an earlier portion of the stroke when operated at high speed than when operating at low speeds and the time of explosion will thus be automatically regulated by the movement of the governing lever.

When the stationary part of the generator is arranged opposite the face of the wheel as shown in Figs. 1 and 2, the movable part may be inclosed laterally by a ring 25. Instead of arranging the stationary part opposite the face of the wheel it may be arranged at the side of the rim as indicated in Fig. 7.

The stationary part in Fig. 1 is carried by a fixed support 66, suitably connected to the motor frame. A steel band 26, extends around the periphery of the wheel and very close thereto. This band may be supported in any suitable way as by means of the lugs 27 attached to suitable supports. Said band serves as a keeper for the electro-magnet 23, the polar face of which lies flush or nearly flush with the periphery of the wheel. The ring therefore tends to preserve the residual magnetism in the electro-magnet core. Fig. 4 illustrates the relation between the magnet core and the ring after the two parts of the generator have separated. The periphery of the wheel at every point, except opposite the slot 11, also serves as a keeper for the permanent magnet 17 and the secondary electro-magnet 18, as will be readily seen from an inspection of Fig. 3. In order to further preserve the permanent and residual magnetism of the magnets the similar poles of the fixed magnets 17 and 18 are arranged at the same sides of the wheel and the poles of the magnet 23 are reversed with relation to the fixed poles in order that the mutual

attraction between dissimilar poles may strengthen the magnetism of all of the magnets.

Any suitable form of sparking plug may be employed in connection with the above described apparatus.

In Fig. 6 I have shown my igniting generator applied to an engine having a number of cylinders which revolve with the casing about a stationary shaft and constitute in effect a fly wheel. In this case, the arrangement of the generator parts c' and d' is just the reverse of that shown in the previously described figures, the part d' being movable and the part c' being stationary. In this instance also, which shows a four-cylinder engine, requiring two ignitions in each revolution, a generator part d^2 takes the place of the weight 13 in Fig. 1, and the two parts d' and d^2 co-act successively with the part c', causing a current impulse at each half revolution. An iron or steel band 26^a, which may be a part of the motor casing, extends around the cylinders, serving as a keeper for the movable magnets.

The arm b' upon which the generator parts d' and d^2 are carried is rotatable with the cylinders and is eccentrically mounted upon the hub of the casing and automatically adjustable by means of a centrifugal governor, in the same manner as the arm b in Fig. 1 and a detailed illustration of the mounting of said lever b' is therefore unnecessary.

The cylinders 40, 41, 42 and 43, as shown, are radially arranged upon the central casing f and each cylinder is provided with a suitable sparking plug 44. Arranged upon the casing in circles concentric with the shaft, and 90 degrees apart, are four pairs of contact points or blocks 45, 46, 47 and 48, said pairs being connected by suitable wires 49 to the electrodes of the sparking plugs in the cylinders 40, 41, 42 and 43, respectively. As shown, these contact points are arranged centrally opposite the cylinders. Midway between the contacts 45 and 47 is arranged a pair of contact points 50 to which the terminals of the generator part d' are connected by wires 51 and diametrically opposite the contacts 50 is arranged a pair of contacts 52 which are connected to the terminals of the generating part d^2 by wires 53. The contacts 50 and 52 are arranged at the same radial distance from the center of the shaft as the contacts 45 to 48 inclusive. Rotatably mounted upon a fixed bearing 54 upon the stationary shaft is a spider 55, having four arms 56, 57, 58 and 59 at equal distances apart. Each arm carries a pair of contact strips 60, properly insulated from the spider and from one another. These contacts are arcuate in form and about 45 degrees in length so that they will bridge the distance between the contacts 50 and 52 and the adjacent contacts connected to the sparking plugs. The switch is shifted periodically in order to switch the current to the cylinders to cause explosion therein in the proper order. For this purpose a gear 61 is secured to the spider which gear meshes with a pinion 62 mounted upon a stud 63 said pinion being rotatable with a star-wheel 64 also mounted upon said stud. The stud is secured to the casing and the star-wheel and pinion are thus carried about the fixed shaft. Secured by an arm 54^a to the fixed shaft is a pin 65 which engages with an arm upon the star-wheel at each revolution and turns the latter thereby moving the switch. In the present instance the gears are arranged so that for eight revolutions of the engine the switch will make one complete rotation.

The operation is as follows: When the parts are in the position shown in Fig. 6 a current generated in the part d' of the generator will pass through the contacts 50 and 45 to the sparking plug in the cylinder 40 causing an explosion therein. The switch will remain stationary during the next half revolution and as the contact points 52 and 46 are bridged by the strips on the arm 58, when the generator part d^2 comes opposite the part c' a current impulse will be directed into the sparking plug of the cylinder 41. During the succeeding half revolution an arm of the star-wheel will engage the pin 65 and the spider will be given a one-eighth revolution in the direction indicated by the arrow, thus breaking the connections between points 50 and 45 and 52 and 46 and establishing connection between the points 50 and 47 and 52 and 48. The next time the generator parts d' comes into action therefore current will be transmitted to the sparking plug in the cylinder 42 and at the completion of the succeeding half revolution a current will be transmitted from the generator part d^2 to the plug in the cylinder 43; the switch will then be shifted another one-eighth revolution and will again bridge the contacts 50 and 45 and the contacts 52 and 46 as shown in the figure. This cycle of operations will continue as long as the engine is in operation.

It is obvious that a different number or arrangement of cylinders or a different number of cranks would require a different arrangement or modification from that shown, also that in a single cylinder engine one more current impulse would be generated than is necessary in which latter case the generator circuit might be short-circuited during one impulse. The switch devices may be variously arranged and operated.

The magnets and coils composing the generator may also be variously arranged and some of them may be omitted where a spark of less intensity is required. Instead of ar-

ranging the devices composing each generator part in succession in the plane of revolution of the fly-wheel, they may be arranged transversely thereof so that they will co-act simultaneously.

The electro-magnet 18 and generating coil 24 may be omitted from the generator shown in Figs. 1, 2 and 8, or the permanent magnet may be used in conjunction with a single generating coil, the latter being in substantially fixed relation to the sparking plug, so that sliding connections will be unnecessary.

In Fig. 7 I have illustrated a generator in which the magnet 18 and generating coil 23 above mentioned are omitted, and in which an electromagnet 17^a, connected to a battery 69 is substituted for the permanent magnet. In every instance, it will be noted, sliding contacts between the two parts of the generator, and between the generator and sparking plug are unnecessary.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent, is—

1. In an electric igniter for explosive engines, the combination with the engine fly-wheel and a generator comprising a stationary member and a member rotatable with the fly-wheel and adapted to be carried into and out of inductive relation with the stationary member, of means for automatically varying the time when said members are brought into inductive relation, relative to the time of commencement of the engine stroke, comprising a governing lever rotatable with the fly-wheel and upon which said movable member is mounted, and a centrifugally-operated governing device connected to said governing lever.

2. In an electric igniter for explosive engines, the combination of a generator, comprising a stationary member and a movable member connected with a rotatable part of the engine and adapted to be carried thereby into inductive relation to the stationary member once only during each revolution of said rotatable member, and means for automatically adjusting said movable member of the generator relative to said rotatable part of the engine to bring said rotary generator member into inductive relation with the stationary member at different points in its revolution in accordance with variations in the speed of the engine, substantially as described.

3. In an electric igniter for explosive engines, the combination with the engine fly-wheel and a generator comprising a stationary member and a member rotatable with the fly-wheel and adapted to be carried into and out of inductive relation with the stationary member, of means for automatically increasing the air-gap between said members as the speed increases, comprising an eccentrically mounted governing lever rotatable with the fly-wheel and upon which said rotatable member is carried, and a centrifugally-operated governing device connected to said governing lever.

4. In an electric igniter for gas engines, a magneto generator comprising two parts connected to relatively movable portions of a gas engine, one of said parts comprising a permanent magnet and a secondary generating coil and the other part comprising a primary generating coil arranged to co-act with the permanent magnet and a primary electro-magnet connected to the primary generating coil and arranged to co-act with the secondary generating coil.

5. In an electric igniter for gas engines, a generator comprising two parts connected to relatively movable portions of a gas engine, one of said parts comprising a permanent magnet, a secondary generating coil, and a secondary electro-magnet connected to said coil, and the other part comprising a primary generating coil arranged to co-act with the permanent magnet, a primary electro-magnet connected to the primary generating coil and arranged to co-act with the secondary generating coil, and a tertiary generating coil arranged to co-act with the secondary electro-magnet and connected to coils upon the primary electro-magnet.

6. The combination with a gas engine having a plurality of rotatable cylinders, each cylinder having a sparking device therein, of an electric generator consisting of a fixed part and a plurality of movable parts rotatable with the cylinders, each movable part having a generating coil and an automatic switching device arranged to switch the current from said coils to the sparking devices in the cylinder successively.

7. In a gas engine igniter the combination with a fly-wheel, of an electric generator one part of which comprises one or more magnets rotatable with the fly-wheel, the other part being fixed, and an iron or steel band adjacent to the fly wheel and serving as a keeper for the magnet or magnets of the movable part of the generator.

In testimony whereof I affix my signature in presence of two witnesses.

EDWARD P. COWLES.

Witnesses:
WILLIAM W. DRAY,
S. B. CRAIG.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."