H. H. GORDON.

ELECTRICAL SYSTEM.

APPLICATION FILED DEC. 4, 1916.

1,224,739.

Patented May 1, 1917.

3 SHEETS—SHEET 1.

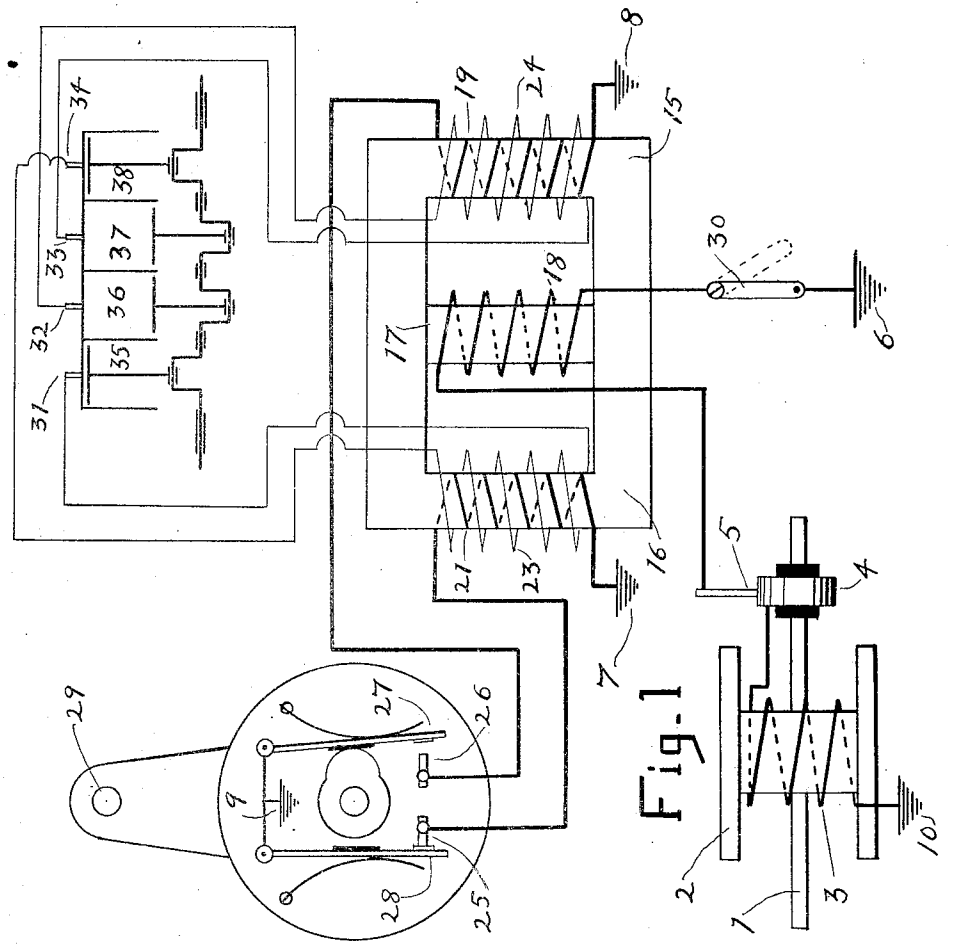


Fig. 1

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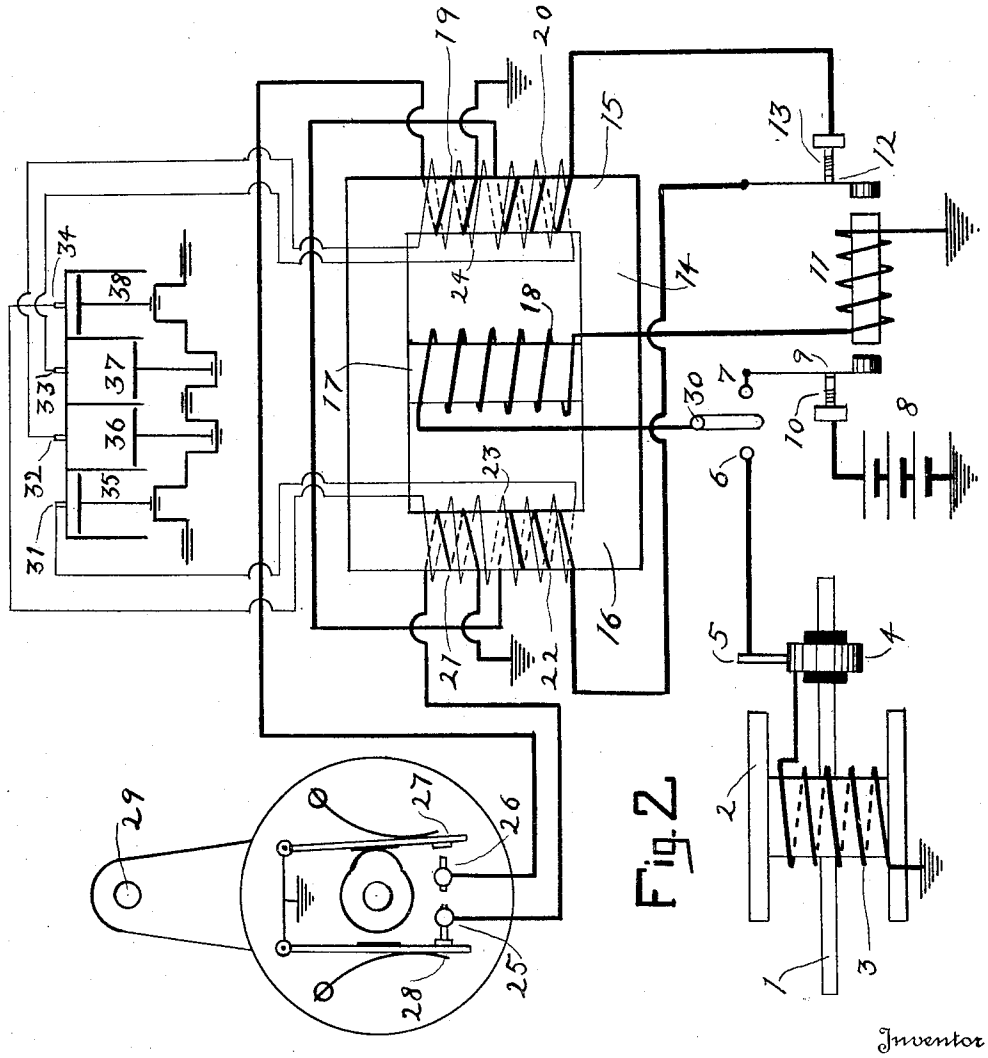


Fig. 2

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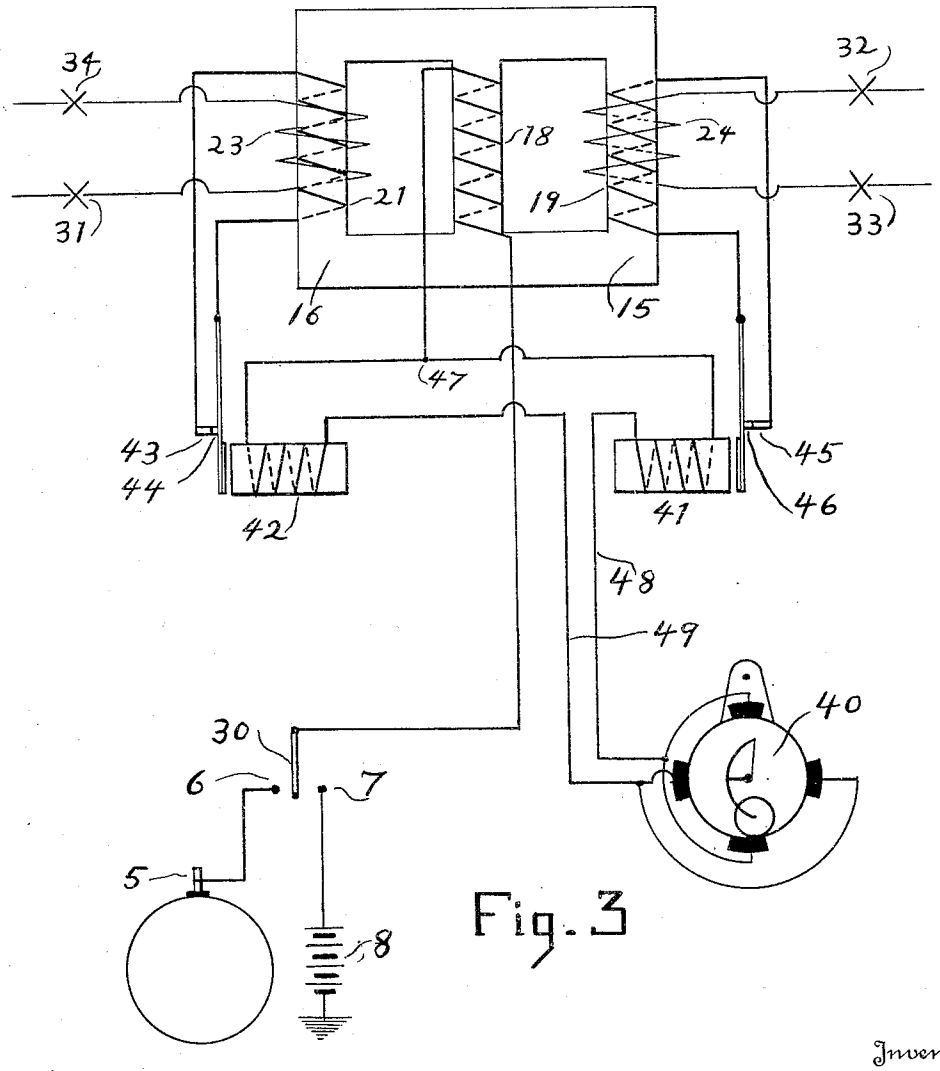


Fig. 3

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UNITED STATES PATENT OFFICE.

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ELECTRICAL SYSTEM.

1,224,739. Specification of Letters Patent. Patented May 1, 1917.

Application filed December 4, 1916. Serial No. 134,917.

To all whom it may concern:

Be it known that I, HAYNER H. GORDON, a citizen of the United States of America, residing at Washington, in the District of Columbia, have invented new and useful Improvements in Electrical Systems, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form part of this specification.

This invention relates to electrical systems. It may find embodiment in many systems in which it is desired to control an intermittent flow of current in a plurality of circuits energized from a common source. In the particular instance I have selected as an embodiment of my invention, an ignition system for a multiple cylinder internal combustion engine, in which the flow of the high tension current to the spark plugs of the engine is controlled.

The usual ignition system for an internal combustion engine of the multiple cylinder type must comprise either a plurality of induction coils or transformers, there being as many coils required as there are spark plugs in the engine, or else one coil or transformer is used, and a high tension current thus generated is led to a distributer which mechanism is employed to selectively distribute the high tension current to the spark plugs in the necessary firing sequence. In the first case there is never absolute synchronism present in the spark timing owing to the fact that it is almost impossible to construct a plurality of coils which will have the same electrical lag. This is due to the fact that the quality or quantity of iron in the core will vary as well as the electrical constants of the various coils. In the second case the objection due to unequal electrical lags is overcome, but this is only accomplished by the addition of a distributer, a device whose delicate and expensive construction is well known and the use of which adds greatly to the complication of the ignition system.

The general object of my invention is to provide an electrical system in which a plurality of high tension circuits are successively energized from a common source of variable magnetic flux, the high tension circuits being controlled by means of low tension or choke circuits.

A further object is to provide an ignition system for a multiple cylinder internal combustion engine in which but one transformer or coil is used and which does not necessitate the use of a high tension distributer.

My invention as herein set forth for the sake of illustration comprises broadly a source of current, a single transformer energized therefrom, a plurality of high tension leads or conductors connecting the transformer to the spark plugs of the internal combustion engine, and a plurality of low tension circuits associated with the transformer for controlling the successive energization of the high tension conductors as will be hereinafter, fully set forth.

Figure 1 is a diagrammatic view of circuits and apparatus, said diagram showing a particular electrical system, such as may be used in connection with an internal combustion engine and to be hereinafter more fully referred to.

Figs. 2 and 3 illustrate modifications of my invention showing the utilization of electromagnetic forms of circuit control in which like numerals are used to designate corresponding parts.

Referring to Fig. 1, 2 represents a two pole armature carrying a winding 3 connected to a slip ring 4 and brush 5. This armature is mounted upon a shaft 1 driven in synchronism with the crank shaft of the internal combustion engine. Although I am not limited to the use of a generator in which any given number of pulsations or alternations of the current takes plate at each revolution of the armature, for ignition systems, I may employ a type of machine of such construction as shown and so arranged that two alternations of the generator current take place during each revolution of the armature 2. The primary winding 18 on the leg 17 of the transformer will therefore be energized by the current produced by the generator when the switch 30 is closed. It will be noted that the transformer possesses two other legs or parts 15 and 16, each one of these having respectively a low tension winding 19 and 21 consisting of a few turns of heavy wire and also a high tension wind-

ing 24 and 23 consisting of many turns of fine wire. One end of the heavy winding on each of these legs is grounded at points 7 and 8 respectively, the other ends of these windings leading to the contacts of the circuit breaker consisting of fixed contacts 25 and 26 which coöperate with two movable contacts 27 and 28 respectively which contacts control the grounding of the windings or choke coils at the point 9. It will also be noted that the circuit breaker is shown with the usual spark controlling arm 29.

The four cylinders of the internal combustion engine are represented diagrammatically by the reference numerals 35, 36, 37, and 38, the four spark plugs being at 31, 32, 33 and 34 respectively.

It will be noted that the secondary winding 24 has the ends thereof led respectively to the spark plugs 32 and 33 while the secondary winding 23 has the two leads connected respectively to the spark plugs 31 and 34. It will be noted that the leads from any one of the secondary coils go to the plugs of those cylinders in which the cranks are in the same position. The reason for this will appear later.

As the armature 2 rotates setting up a current of approximately sine wave form, the coil 18 in circuit with the armature will be correspondingly symmetrically energized setting up a magnetic flux in the transformer core 17. Normally the circuits of the coils 19 and 21 are closed at the interrupter contacts 26 and 25 so that these coils effectually act as choke circuits upon the magnetic lines of force set up in the transformer cores, causing a repression thereof from the transformer legs 15 and 16, and causing the magnetic lines of force to assume a leakage path across the air gap or space between the sides of the transformer. Rotation of the interrupter cam, however, will cause a sudden successive opening of the choke windings at suitable points in the current wave. This point of opening of the circuits may take place, by reason of synchronous relationship of the interrupter cam and generator 1, at or near the maximum point of the current wave. Opening of the coil 19 as stated, will cause a disruptive discharge of high voltage current to take place in the secondary coil 24 which is in circuit with the spark plugs 32 and 33. In like manner opening of the winding 21 at the interrupter contacts 25—28, will cause a disruptive discharge of high voltage current in the secondary coil 23 which is connected to spark plugs 31 and 34. Repression of the flux by the choke windings, as previously stated, cause the magnetic lines of force to assume an abnormal path across the air gap between the sides of the transformer. Now when either of the choke windings is opened the diverted flux immediately assumes the normal less resistant path through the core of the open circuited coil, causing a magnetic surge of great intensity. Because of this, voltage is at once built up in the turns of secondary which surround the open circuit choke winding, sufficiently to break down the two air gaps at the two spark plugs connected therewith. The spark thus formed, however, is not a mere instantaneous flash such as is obtained from the ordinary induction coil, but it continues to burn in the form of a flaming arc for as the arc or spark is established, current flows in the secondary circuit associated with the spark plugs under discussion, the current flowing in the secondary coil tending to again choke the flux and preventing the instantaneous discharge of energy in the system.

My construction combines the advantages of such systems as operate to induce a spark by the interruption of the primary current and of the systems in which a spark is produced by the closing of the primary circuit. In addition my system operates to break down the resistance of the spark gap with a current of high voltage and to follow the initial formation of the spark with a current of sustained heating value.

The instantaneous establishment of the spark and its maintained utilization of energy causes the active secondary circuit containing the spark plugs in action to so absorb the energy and control the flux action, as to prevent self-inductive effects in the choke coil circuit. This together with the fact that the choke coils consist of relatively few turns of coarse wire causes little or no sparking at the interrupter contacts 25 and 26. Ordinary material such a copper or steel may therefore be employed for these points and the use of a condenser is not necessary across the interrupter contacts.

It is of course evident that I am not limited to the use of the primary winding 18, for the production of a variable magnetic flux, any suitable form of magnetic flux changer could be used.

Fig. 2 discloses a modification of my device, which modification may be used where it may be inconvenient to obtain exact synchronism between the interrupter cam and the armature of the electric generator. This modification is also applicable to a source of direct current such as a storage battery.

In this figure, 2 indicates an armature mounted upon a shaft 1 carrying a winding 3 connected to slip ring and brush 4 and 5 the latter being connected to the switch contact 6. When the switch lever is thrown to the left the current will pass from the armature winding 3 through the exciting winding 18, thence through the winding of the electro-magnet 11 and back to ground.

This will cause the contacts 12 and 13 of the spring interrupter to open and close in synchronism with the current wave peaks produced by the alternating current generator.

The interrupter contacts are in series with the choke windings 20 and 22 positioned on the legs of the transformer 15 and 16 respectively. These choke windings which are of a few turns of coarse wire are in series with each other as well as with the interrupter contacts 12 and 13. These choke windings will be hereinafter referred to as the flux controlling coils. The legs 15 and 16 of the transformer each are inclosed in a second choke winding 19 and 21 respectively, these being also comprised of a few turns of coarse wire. While these coils are shown beside the flux controlling coils 20 and 22 it is of course to be understood that such showing is merely diagrammatic, the coils in practice being superimposed upon each other. These choke windings 19 and 21 each of which is normally short circuited through the interrupted contacts 26 and 25 and connected to ground are hereinafter designated as selective choke coils. Reference numeral 8 designates a battery connected through the spring interrupter contacts 9 and 10 thence to switch contact 7, and if the switch lever be thrown to the right, the battery circuit will be through 30, coil 18 and through the winding of electromagnet 11. This will cause the interrupter contacts 9 and 10 to periodically open and close producing a current of pulsating character in the winding 18. As before stated in connection with the alternating generator circuit, the contacts 12 and 13 will open and close in synchronism with the current pulsations opening and closing the flux controlling choke coils 20 and 22. It will now be noted that whenever the switch arm is on either contact 6 or 7 connecting either source of current to the transformer exciting winding that a periodically changing magnetic flux will be set up in the transformer core. As long as choke windings 19 and 21 remain closed, this flux cannot pass through either legs 15 or 16 of the transformer, but must take a leakage path as already described in connection with Fig. 1. The fact that the flux controlling choke windings are being periodically opened in synchronism with the exciting current wave peaks will not have any effect on the path of the magnetic flux as long as choke windings 19 and 21 remain closed. As soon as the interrupter cam opens either selective choke winding however, it will be seen that as the first exciting current wave occurring thereafter reaches a maximum value, the circuit of the flux controlling choke windings will be opened at the contacts 12 and 13 and the magnetic flux will at once assume its normal path through the leg of the transformer upon which is wound the now open circuited selective choke winding. This will at once give rise to the spark or flaming arc at the spark plugs connected with the secondary winding on this leg in the same manner as fully set forth in connection with Fig. 1.

Fig. 3 shows still another modification of my invention, which modification is primarily adapted for use in connection with the Ford magneto which is of the non-synchronous type. This modification also shows the adaptation of my system to a battery system.

In this figure, 5 designates the magneto terminal on the top of the fly wheel housing of the Ford engine. This is connected by a lead to contact of switch 6 and a battery 8 is shown connected to contact 7 in a similar manner. It should be understood that the other terminal of the magneto is grounded as well as the other terminal of the battery. From switch lever 30 the primary circuit leads to the primary coil 18, thence to 47 where it divides one circuit going through relay winding 41, then through lead 48 to diametrically opposite contacts on the timer 40, while the other goes through relay winding 42 lead 49 to the two other contacts of the timer 40. The timer 40 is of the usual roller, segment construction in which a steel roller revolves making selective contact with four embedded metallic segments.

The legs 15 and 16 of the transformer carry the usual choke windings 19 and 21 and secondaries 24 and 23 connected to the four spark plugs 31, 32, 33 and 34 in the manner already disclosed. The choke windings are normally short circuited through the relay interrupter contacts 43—44 and 45—46.

If the switch lever 30 is thrown to make contact with either 6 or 7 and the timer roller is revolving, circuit closure is made through the primary winding and alternately through one of the relay coils 41 or 42. As the flow of current in the primary circuit attains a maximum value, the normally closed choke winding controlled by the particular relay now energized is suddenly opened at the relay contacts. This permits the magnetic flux produced by the exciting winding and which has been compelled to take the leakage path across the transformer, to assume its normal path and as current is therefore set up in the secondary winding associated with the particular leg of the transformer in which the magnetic lines of force now pass sparks are produced at the plugs connected with this secondary winding in the manner already described.

It will be noted that the timer 40 has four contact segments so that four circuit closures are made at each revolution of the roller. This type of timer is designed to be driven

at cam shaft speed in a four cylinder, four cycle internal combustion engine, while the circuit interrupters shown in Figs. 1 and 2 are shown as designed to be driven at engine speed. It will therefore be seen that in each complete cycle of operations of the motor to which my system is attached, that a spark will occur twice at each plug. The reason for connecting the plugs in those cylinders in which the cranks are together will now be apparent as one spark will take place near the end of the compression stroke, while the other spark produced by the same secondary will take place simultaneously in the cylinder which is just completing the exhaust stroke. It is by such an arrangement of secondary circuits used in connection with my multiple magnetic circuit transformer that I am enabled to dispense with a distributer.

What I claim is:

1. A source of energy, and a primary circuit therefor, a plurality of secondary coils, and means for successively placing said primary circuit in energizing relationship with said secondary coils.

2. A source of energy, and a primary circuit and coil therefor, a plurality of secondary coils, adapted to be energized from said primary circuit and coil and means for controlling the successive energization of the secondary coils.

3. A source of energy, and a primary circuit therefor, a plurality of secondary coils and means for successively placing said primary circuit in inductive energizing relationship with said secondary coils.

4. A source of energy, and a primary circuit and coil therefor, a plurality of secondary coils immovably fixed with respect to the primary coil and adapted to be energized therefrom, and means for controlling the successive energization of the secondary coils.

5. A source of energy, and a primary circuit and coil therefor, a plurality of secondary coils adapted to be energized from said primary coil, and means comprising choke windings for controlling the successive energization of the secondary coils.

6. A source of energy, and a primary circuit and coil therefor a plurality of secondary coils immovably fixed with respect to the primary coil and adapted to be energized therefrom, and means comprising choke windings for controlling the successive energization of the secondary coils.

7. A source of energy and a primary circuit and coil therefor, a plurality of secondary coils and spark plugs connected thereto, means comprising choke windings for controlling the successive energization of the secondary coils.

8. In an ignition system, an electrical transformer comprising a single exciting winding, and a plurality of closed magnetic circuits associated therewith, and means to control the passage of the magnetic flux set up by the exciting winding through any one of the magnetic circuits.

9. In an ignition system, an electrical transformer comprising a single exciting winding, and a plurality of closed magnetic circuits associated therewith, and means comprising choke windings for controlling the passage of the magnetic flux set up by the exciting winding, through any one of the magnetic circuits.

10. An electrical transformer comprising a single exciting primary winding, a plurality of closed magnetic circuits associated therewith, a secondary winding surrounding each closed magnetic circuit, a work circuit connected to each of said secondary windings and means for controlling the successive energization of the secondary windings and work circuits associated therewith.

11. An electrical transformer comprising a single exciting primary winding, a plurality of closed magnetic circuits associated therewith, a secondary winding surrounding each closed magnetic circuit, a work circuit connected to each of said secondary windings, and means comprising choke windings for controlling the successive energization of the secondary windings and work circuits associated therewith.

12. In an ignition system, an electrical transformer comprising a single exciting winding, a plurality of closed magnetic circuits associated therewith, a choke winding surrounding each closed magnetic circuit, a secondary winding surrounding each closed magnetic circuit, spark plugs connected to said secondary windings, and a timer connected to said choke windings so as to open the choke windings successively thereby permitting the successive energization of the secondary windings and spark plugs.

13. In an ignition system, an electrical transformer comprising a single exciting winding, a plurality of closed magnetic circuits associated therewith, a choke winding surrounding each closed magnetic circuit, a secondary winding surrounding each closed magnetic circuit, spark plugs connected to said secondary windings, and a timer connected to said choke windings so as to open the choke windings successively thereby permitting the successive energization of the secondary windings and spark plugs, said successive interruption of the choke windings occurrring at a time when the current flow in the exciting winding reaches a maximum value.

14. In a device for the generation of electricity, the combination of a plurality of separate magnetic paths, with means tending to simultaneously induce therein a magnetic flux change, and means for normally re-

straining said change in all the magnetic paths but one.

15. In a device for the generation of electricity, the combination with a plurality of separate magnetic paths, of means tending to simultaneously induce therein a magnetic flux change, and electrical means for normally restraining said change in certain of the magnetic paths.

16. In a device for the generation of electricity, the combination with a plurality of separate magnetic paths, of means tending to simultaneously induce a magnetic flux change in all of said paths and electrical means comprising choke windings for normally restraining said change in certain of the magnetic paths.

17. In a device for the generation of electricity, the combination with a plurality of separate magnetic paths, of means tending to simultaneously induce a magnetic flux change in all of said paths, a current producing winding mounted on each of said paths, and electrical means for normally restraining said magnetic flux change in certain of said magnetic paths.

18. An electrical transformer comprising two end pieces, a plurality of cores connecting said end pieces, a magnetic flux controlling and producing winding mounted on each of said cores, current generating windings also mounted on some of said cores, and means for opening and closing the magnetic flux controlling and producing windings selectively thereby causing a flux change to take place successively in each of the generating windings.

19. An electrical transformer comprising two end pieces, a plurality of cores connecting said end pieces, a magnetic flux producing winding mounted on one of said cores, a magnetic flux producing and controlling winding, and a current generating winding mounted on the remainder of said cores, and means for opening and closing said magnetic flux producing and controlling windings successively thereby causing a flux change to take place successively in each of the generating windings, and thereby producing successive current impulses in the generating windings.

20. In an ignition system, an electrical transformer comprising a single exciting winding, a plurality of closed magnetic circuits associated therewith, a choke winding surrounding each closed magnetic circuit said choke coils being connected to a timer adapted to open circuit the choke windings successively, a second choke winding surrounding each closed magnetic circuit each of these latter windings being connected in series with each other and with an electromagnetic device adapted to open said second choke winding circuit when the current flow in the exciting winding reaches a maximum value.

In testimony whereof I have hereunto set my hand.

HAYNER H. GORDON.

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