H. J. PODLEŠÁK.

IGNITION SYSTEM.

APPLICATION FILED NOV. 12, 1910.

1,006,678. **Patented Oct. 24, 1911.**

FIG. 1.

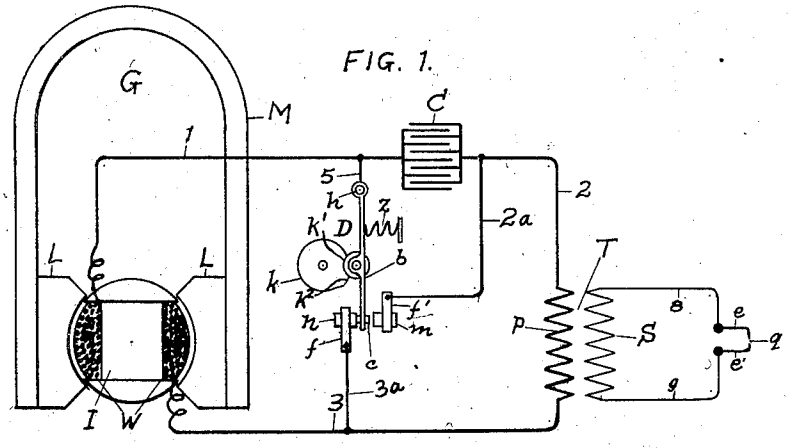


FIG. 2.

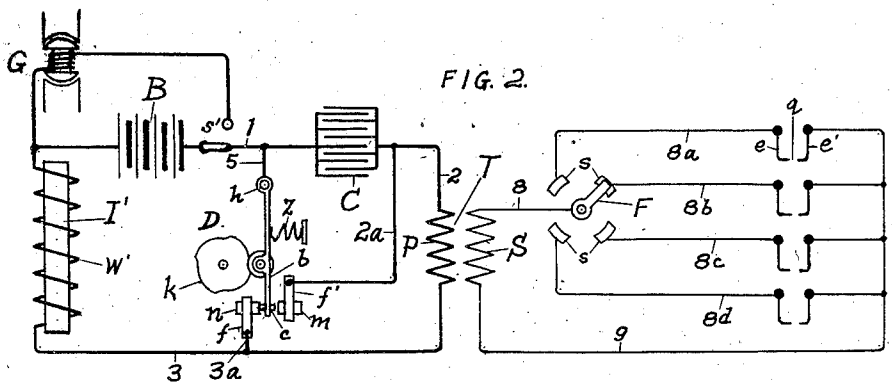
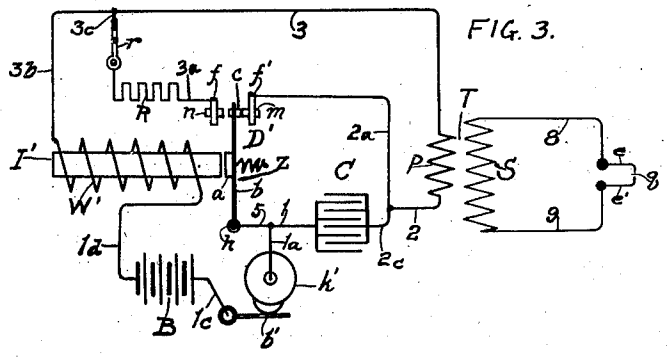


FIG. 3.



WITNESSES

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IGNITION SYSTEM.

1,006,678. Specification of Letters Patent. Patented Oct. 24, 1911.

Application filed November 12, 1910. Serial No. 591,995.

To all whom it may concern.

Be it known that I, HENRY J. PODLEŠÁK, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Ignition Systems, of which the following is a specification.

This invention relates to high tension ignition systems for internal combustion engines and the like.

The invention has for one of its objects to improve the design and operation of systems of this character so as to be reliable and efficient in use, and capable of producing efficient ignition of the explosive charges in the engine, the system being especially effective in producing hot sparks at the comparatively low rotation speed of the magneto armature when starting the engine.

Another object of the invention is the provision of a novel combination of condenser, inductance device and make and break device in the supply or primary circuit, whereby the make and break device is capable of closing the circuit in shunt relation to the condenser which is in series with the source of current and the primary winding of the transformer, then opening the circuit to permit the condenser to receive a charge due to the inductance in the circuit, then completing the circuit with the condenser and primary winding in series to cause the condenser to discharge through the primary, and finally opening the circuit so that the flow of current through the primary, incident to the charging and discharging of the condenser, will induce a high electrical pressure in the secondary circuit of the system for producing sparks between the electrodes of the spark plug or plugs, the operation of the make and break device being properly timed with respect to the cycle of the engine to effect the ignition of the compressed charge by the arcs at the spark plug.

With these objects in view and others, as will appear as the description proceeds, the invention comprises the various novel features of construction and arrangement of parts which will be more fully described hereinafter and set forth with particularity in the claims appended hereto.

In the accompanying drawings, which illustrate certain embodiments of the invention, Figure 1 is a diagrammatic view of an ignition system adapted for a single cylinder engine and in which the source of current is a magneto generator. Fig. 2 is a diagrammatic view of the ignition system designed for a multi-cylinder engine and in which a battery or generator may be used interchangeably. Fig. 3 is a diagrammatic view in which the make and break device is electro-mechanically operated, and in which a timing device is employed for energizing the circuits at the proper period with relation to the cycle of the engine.

Similar reference characters are employed to designate corresponding parts throughout the views.

Referring to the drawing, G designates a generator of the magneto type, the same including permanent magnets M, pole pieces L, and an armature I, there being a winding or energizing coil W on the armature which supplies the primary current and is so designed that a comparatively high inductance will be developed. The transformer T includes primary and secondary windings P and S, the first having one terminal connected by the wires 1, 2, with one terminal of the armature winding W, and the other terminal connected by the wire 3 with the remaining terminal of the armature winding.

In Fig. 1, the secondary winding of the transformer is connected by wires 8 and 9 with electrodes *e* and *e'* of an ordinary spark plug, so that when a current is induced to the secondary, a spark will jump across the gap *q*.

Connected in series with the wires 1 and 2 is a condenser C which plays an important part in the present invention, as it is during the charging and discharging of the condenser that the flow of current through the primary winding induces the current in the secondary circuit for producing the ignition. A wire 2^a leads from one side of the condenser to a fixed contact *f'* of a circuit make and break device D or switch, and from the other side of the condenser leads a wire 5 that is connected with the swinging member or movable contact *b* of the make and break

device. The metal piece f' is provided with a platinum tip or contact point m with which engages a corresponding tip on the member b, and when these tips or points are engaged, a shunt is formed around the condenser so that current can flow through the primary winding of the transformer. On the side of the swinging member b of the make and break device opposite from the fixed contact f' is another contact f which is connected by a wire 3^a with the opposite side or wire 3 of the supply circuit, and on this contact f is a platinum tip or contact point n that is adapted to be engaged by a tip c on the member b. The vibration of the movable contact element b is effected by the co-action of a rotary cam k and a spring s which presses on the element or member b to hold the roller on the latter against the periphery of the cam. This cam is operatively connected with the armature of the magneto so as to rotate synchronously therewith, and the cam has a depression k' and an elevation k^2 contiguous therewith, the said depression and elevation being of such radii that when the roller is entered in the depression, the movable element of the circuit make and break device is engaged with the contact point n, whereas it will be engaged with the contact m when the roller bears on the high portion k^2 of the cam. At all other points, the cam is of uniform radius and serves to hold the movable element b of the make and break device in mid-position so that its tips c will be out of contact with the contact points m and n. Obviously, the cam will be so positioned on the rotating part of the engine that the vibration of the member b will take place at the proper period in the cycle of operation of the engine.

When the armature turns, at the time the engine is started, current will flow through the primary circuit when the element b is engaged with the contact point m by the high portion of the cam engaging the roller on the element b. The circuit is immediately broken by the element b moving away from the contact point m, and as the result, current will flow, due to the inductance of the primary winding P of the transformer T and the winding W of the magneto, and consequently the condenser becomes charged. Immediately following the breaking of the circuit at the contact point m, the circuit is completed by the element b engaging the contact point n, so that the condenser will be connected in series with the primary winding of the transformer, and as the result, the condenser will discharge through the said primary winding. The sudden flow of current through the primary, incident to the charging and discharging of the condenser, produces a high electrical pressure in the secondary winding of the transformer, so that currents will be induced in the secondary circuit to cause sparking at the electrodes of the spark plug. In other words, two sparks will follow each other in succession, due to the opening of the primary circuit in that portion where a shunt is formed around the condenser and then closing the circuit in which the condenser and primary winding are connected in series.

When the circuit is completed through the right contact point m, current flows through the path consisting of the winding W, wires 1 and 5, contact element b, contact point m, wires 2^a and 2, primary winding P, wire 3, and winding W. As soon as the circuit is opened by the element b moving out of engagement with the contact point m, the condenser becomes electrically related with the windings P and W, so that the energy stored therein will cause a current to flow into the condenser and charge the same, the current entering the right terminal of the condenser. As soon as the element b of the make and break device engages the contact point n, current flows by the condenser discharging through the wire 2, primary P, wires 3 and 3^a, contact point n, element b, wires 5 and 1, and condenser C. It will thus be seen that although the armature of the magneto does not rotate at a relatively high speed at the time of cranking the engine, nevertheless sufficient current will flow to electrify the primary circuit and cause the charging and discharging of the condenser to be accompanied by a heavy flow of current, which induces sparking currents in the secondary of sufficient magnitude to effectively ignite the explosive charge.

In the diagram shown in Fig. 2, a battery B is employed as the source of current, although this may be used interchangeably with the magneto G, which can be cut into and out of circuit by a two-point switch s'. When a battery is employed, an induction I' is used in series with the battery and primary winding P of the transformer T. The make and break device D is the same as in the first diagram, except that the cam has four sets of elevations and depressions, since it is intended to open and close the circuit four times in succession with each revolution of the cam, as there are four spark plugs to be supplied with current. The secondary circuit includes a distributer F that comprises a rotating arm or contact which is preferably mounted on the same shaft or rotates at the same speed with the cam k, and this revolving contact is adapted to successively engage spaced fixed contacts s that are connected, respectively, by wires 8^a, 8^b, 8^c and 8^d, with spark plugs in the respective cylinders of the engine, the electrodes of the spark plugs opposite to those connected with the distributer F being connected with a common return wire 9 which leads to the secondary winding S, the latter being con-

nected with the rotating arm of the distributer. The operation of the make and break device and the accompanying changes in the circuit connections are the same as those explained in connection with Fig. 1, there being two electrical effects produced in the charging and discharging of the condenser. However, there will be a third electrical effect produced in the transformer as soon as the contact *b* of the make and break device leaves the contact point *n*, due to the inductive charge from the inductance I′ in the circuit. By the succession of these three electrical effects, there are three chances for igniting the explosive charge in the engine so that there is little likelihood of the charge failing to ignite.

In the system shown in Fig. 3, the make and break device D′ is so designed that the vibratory element *b* thereof is actuated by the coöperation of the spring *z* and the electro-magnet I′ that constitutes an inductance device. The core of this electro-magnet has one end disposed adjacent the armature *a* of the element *b* so as to move the element from the contact point *m* to the contact point *n*, when current flows through the winding W′ of the magnet. The battery B has one terminal connected by a wire 1^d to the winding of the electro-magnet, while the other terminal is connected by a wire 1^c to a brush *b′* of a timing device in the form of a cam *k′* connected with some rotating part of the engine. This cam or disk *k′* is connected with a wire 1^a that has branches 1 and 5 leading, respectively, to the condenser C and make and break device D. One fixed contact *f* of the make and break device connects with a non-inductive resistance R, through the wire 3^a, the said resistance in turn connecting through a switch *r* with the wires 3 and 3^b, at 3^c. The wire 3 leads to the primary winding P of the transformer T, and this winding is connected by wires 2 and 2^c with the condenser, the shunt around the condenser being completed by the wire 2^a. The secondary circuit is similar to that circuit in Fig. 1. In this system, the shunt around the condenser is normally closed and is opened as soon as the electro-magnet I′ becomes energized by the contact disk of the timing device coming into engagement with the brush *b′*. As soon as this engagement is effected, current will flow through the primary winding of the transformer and also through the electro-magnet, and as the magnetism of the latter increases in strength, it will attract the armature *a* and cause the primary or supply circuit to open at *m*. The inductance in this circuit will when the latter is broken cause a discharge into the condenser and charge the same; the secondary being energized, a spark being produced at the same time. As soon as the engagement is effected between the element *b* and contact point *n*, by the action of the energized core I′ on the armature *a* another circuit will be completed so as to keep the electro-magnet energized, the circuit consisting of the battery B, timing device, make and break device D′, resistance R, switch *r*, and winding of the electro-magnet. At the time this contact is made between the movable contact *b* and the contact point *n*, the condenser will discharge so as to produce another electrical effect sufficient to cause a spark at the spark plug *q* in the secondary circuit. As soon as the contact disk of the timing device passes out of engagement with the brush *b′*, the electro-magnet will become deënergized so that the element *b* will return to normal position in engagement with the contact *m*. As the decline of the magnetism in the electro-magnet takes place gradually, a third electrical effect will not be produced as in the case with the arrangement shown in Fig. 2, when the make and break device opens the circuit in which the electro-magnet or inductance is included. The resistance R is so proportioned that just sufficient current will flow while the timing device closes the circuit to maintain the electro-magnet energized. By opening the switch *r*, the make and break of the circuit can take place in rapid succession, similar to an ordinary vibrator so that two alternative methods of operation can be used in connection with the system shown in Fig. 3.

From the foregoing description, taken in connection with the accompanying drawings, the advantages of the construction and of the method of operation will be readily apparent to those skilled in the art to which the invention appertains, and while I have described the principle of operation of the invention, together with the apparatus which I now consider to be the best embodiment thereof, I desire to have it understood that the apparatus shown is merely illustrative, and that such changes may be made when desired as are within the scope of the claims appended hereto.

Having thus described the invention, what I claim as new, is:—

1. In an ignition system, the combination of primary and secondary circuits, a transformer inductively relating the circuits, a source of current and inductance in the primary circuit, a condenser in the primary circuit, means electrically-connected directly with the trminals of the condenser for completing the primary circuit around the condenser, and means for successively opening and closing the circuit to charge and discharge the condenser and connecting the condenser and transformer in series relation to produce successive transformation of

energy from the primary to the secondary elements of the transformer during the charging and discharging of the condenser.

2. In an ignition system, the combination of primary and secondary circuits, a transformer connecting the circuits inductively together, a source of current and inductance in the primary circuit, a condenser in series relation to the said source and primary winding of the transformer, a shunt around only the condenser, and a device for closing and opening the circuit by the shunt to energize the primary circuit and cause the latter to charge by the inductance the condenser and for subsequently connecting the charged condenser and primary winding together whereby the condenser will discharge through said winding.

3. In an ignition system, the combination of a transformer, a circuit including a source of current and inductance and in which the primary winding of the transformer is included, a make and break device for opening and closing the circuit, a condenser connected in shunt relation to the said device to receive an inductive charge from the inductance of the said circuit upon the opening of the latter by the said device, and means for including the charged condenser and primary winding in a closed circuit for permitting the condenser to discharge through the said winding.

4. In an ignition system, the combination of a transformer, a circuit including a source of current and inductance, a condenser having its terminals connected with a terminal of the source and of the primary winding of the transformer, means electrically connected directly to the terminals of the condenser for opening and closing the circuit around the condenser whereby the condenser will receive a charge from the inductance through the primary winding when the circuit is opened, and means for connecting the opposite sides of the circuit together between the condenser and source and between the transformer and source of current whereby the condenser will discharge through the primary winding of the transformer.

5. In an ignition system, the combination of a transformer, a circuit including a source of electric current and inductance, a condenser, and means for intermittently closing and opening said circuit alternately through the primary winding of the transformer alone and through the primary winding and condenser together, whereby a transformation of energy occurs during the flow in both directions through the primary winding incident to the charging and discharging of the condenser.

6. In an ignition system, the combination of a transformer, a circuit including a source of electric current and inductance, a condenser, means for intermittently closing and opening said circuit alternately through the primary winding of the transformer alone and through the primary winding and condenser together, whereby a transformation of energy occurs during the flow through the primary winding incident to the charging and discharging of the condenser, and a sparking device connected with the secondary winding of the transformer.

7. In an ignition system, the combination of a condenser, means including inductance for producing a single high potential current impulse to charge the condenser, a transformer primary winding through which the impulse passes during the charging of the condenser, means for connecting the charged condenser and primary winding in closed circuit to cause a reverse current impulse to traverse the winding by the discharging of the condenser, a secondary winding, and a sparking device for producing a spark by the energy transformed during both the charging and discharging of the condenser.

8. The combination of a transformer, a condenser, means for producing a current impulse through the primary winding of the transformer in charging the condenser, means for discharging the condenser through the primary winding of the transformer, and a sparking device connected with the secondary winding of the transformer to be energized by induced currents during the charging and discharging of the condenser.

9. The combination of a transformer, a condenser, means including an inductance for producing an electrical impulse through the primary winding of the transformer in charging the condenser, means for discharging the condenser through the primary winding of the transformer independently of the inductance, and a sparking device connected with the secondary winding of the transformer.

10. In an ignition system, the combination of a circuit including a source of current and inductance, a condenser in series in the circuit, a transformer primary winding in series in the circuit, a normally open low resistance shunt connected with the terminals of the condenser, means for closing the shunt to produce a heavy flow of current through the circuit to store up energy in the inductance and for thereafter opening the shunt to charge the condenser through the primary winding with a high potential current impulse whereby the winding is energized, means for connecting the charged condenser and primary winding in a closed circuit to energize the primary winding by a current impulse discharged from the

condenser, a secondary winding energized by the primary winding during the charging and discharging of the condenser, and a spark plug connected with the secondary winding.

11. The combination of a transformer, a primary circuit including a source of current and an inductance, a condenser, means for opening the circuit while one terminal of the condenser is connected with one terminal of the transformer primary winding to effect the charging of the condenser, and means for connecting the other terminals of the primary winding and condenser together after the opening of the said circuit to discharge the condenser through the said winding, and a secondary circuit energized during the charging and discharging of the condenser and including an ignition device.

12. The combination of a transformer, a condenser having one terminal permanently connected with one terminal of the transformer primary winding, a circuit including a source of current and an inductance connected with the transformer primary winding, means for opening the circuit to effect an inductive discharge into the condenser through the permanently connected terminals of the said winding and condenser, and a secondary ignition circuit energized by the current flow through the primary winding during the charging of the condenser.

13. The combination of a transformer, a condenser having one terminal permanently connected with one terminal of the transformer primary winding, a circuit including a source of current and an inductance connected with transformer primary winding, means for opening the circuit to effect an inductive discharge into the condenser through the permanently connected terminals of the said winding and condenser, means for connecting the other terminals of the winding and condenser together after the charging of the latter to effect a discharge of the condenser through the winding, and a secondary ignition circuit energized by the current flow through the primary winding during the charging and discharging of the condenser.

14. In an ignition system, the combination of a transformer, a primary circuit including a source of current and an electro-magnet forming an inductance, a condenser included in the circuit, a shunt around the condenser including a make and break device operated by the electro-magnet, and a timer for closing the circuit through the shunt to energize the electro-magnet for opening the shunt and causing the condenser to be charged through the primary winding of the transformer.

15. In an ignition system, the combination of a transformer, a primary circuit including a source of current and an electro-magnet forming an inductance, a condenser included in the circuit, a shunt around the condenser including a make and break device operated by the electro-magnet, a timer for closing the circuit through the shunt to energize the electro-magnet for opening the shunt and causing the condenser to be charged through the primary winding of the transformer, and means for connecting the charged condenser and primary winding of the transformer in series with each other to discharge the condenser through the winding.

16. In an ignition system, the combination of a transformer, a primary circuit including a source of current and an electro-magnet forming an inductance, a condenser included in the circuit, a shunt around the condenser including a make and break device operated by the electro-magnet, a timer for closing the circuit through the shunt to energize the electro-magnet for opening the shunt and causing the condenser to be charged through the primary winding of the transformer, and means including a non-inductive resistance for connecting opposite sides of the primary circuit together for forming a closed circuit for the source and electro-magnet whereby the latter is kept energized as long as the timer is closed and for forming another closed circuit for the charged condenser and primary winding whereby the condenser discharges through the latter.

17. In an ignition system, the combination of a transformer primary winding, a condenser having one terminal connected with one terminal of the winding, a timer connected with the other condenser terminal, a source of current connected with the timer, a shunt around the condenser including a normally closed make and break device, and an electro-magnet connected with the said source and the terminal of the winding opposite to that connected with the condenser for opening the shunt by the device when the timer closes the circuit and effecting a flow of current through the winding to the condenser.

18. In an ignition system, the combination of a transformer primary winding, a condenser having one terminal connected with one terminal of the winding, a timer connected with the other condenser terminal, a source of curent connected with the timer, a shunt around the condenser including a normally closed make and break device, an electro-magnet connected with the said source and the terminal of the winding opposite to that connected with the condenser for opening the shunt through the device when the timer closes the circuit and effect-

ing a flow of current through the winding to the condenser, and a non-inductive resistance connected between the electro-magnet and primary winding and adapted to be connected in circuit by the said make and break device after the shunt has been opened whereby the resistance effects a closed circuit through the source of current and electro-magnet for energizing the latter as long as the timer is closed and a closed circuit through the condenser and primary winding for energizing the latter by the discharge of the condenser.

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

HENRY J. PODLEŠÁK.

Witnesses:
H. W. Cook,
H. E. Rich.