C. F. KETTERING.

IGNITION SYSTEM.

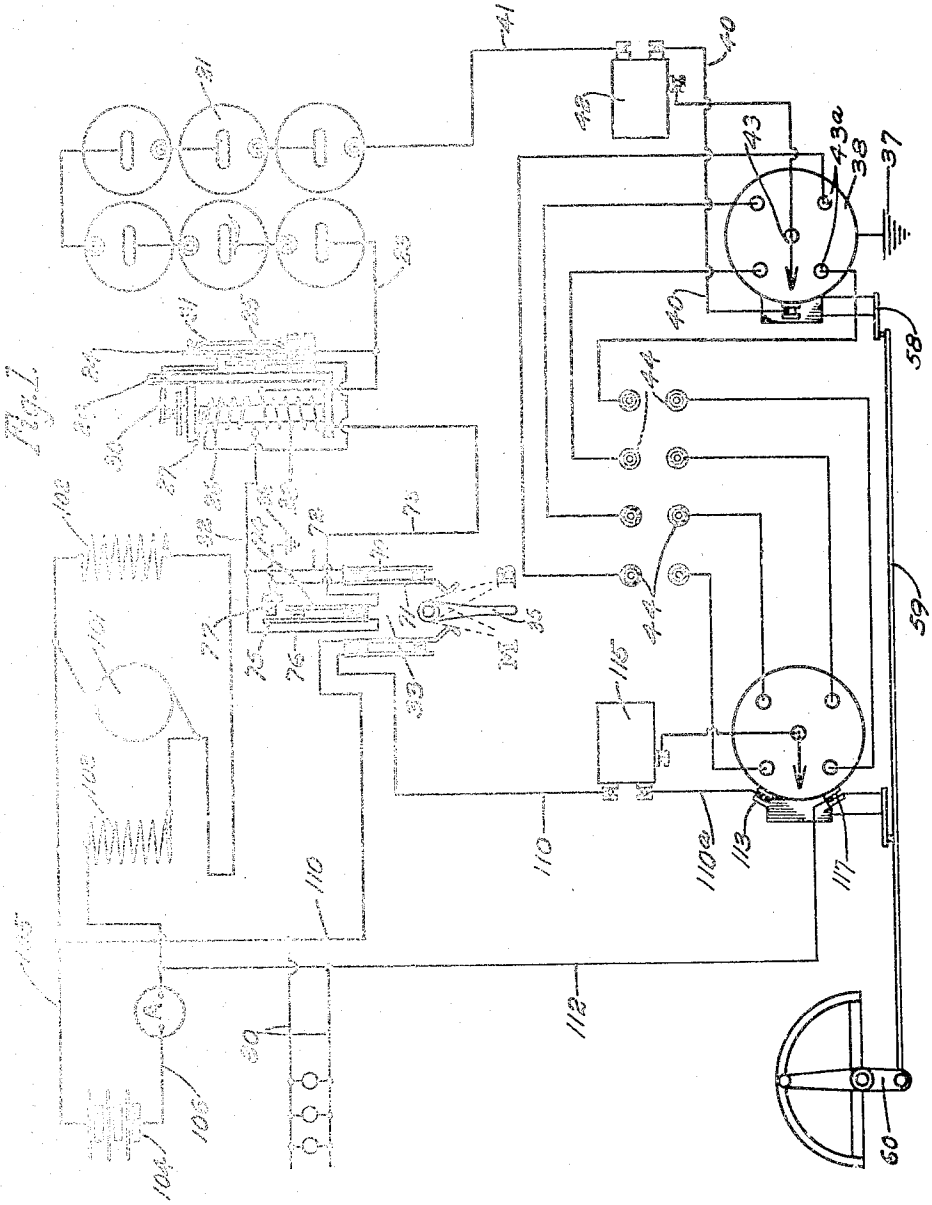
APPLICATION FILED MAR. 4, 1912.

1,190,175.

Patented July 4, 1916.

2 SHEETS—SHEET 1.

Fig. 1.



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2 SHEETS—SHEET 2.

Fig. 2.

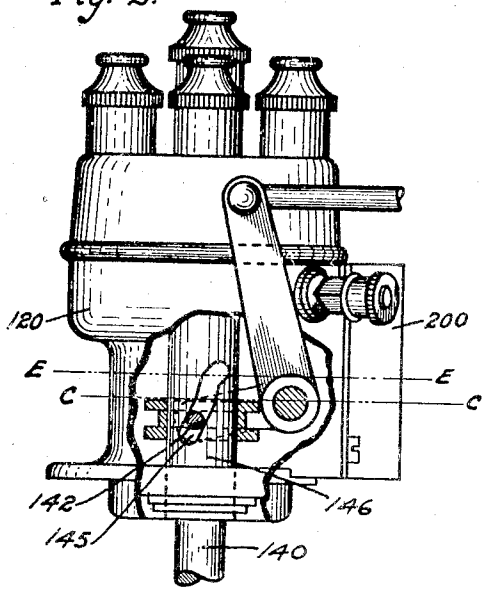


Fig. 3.

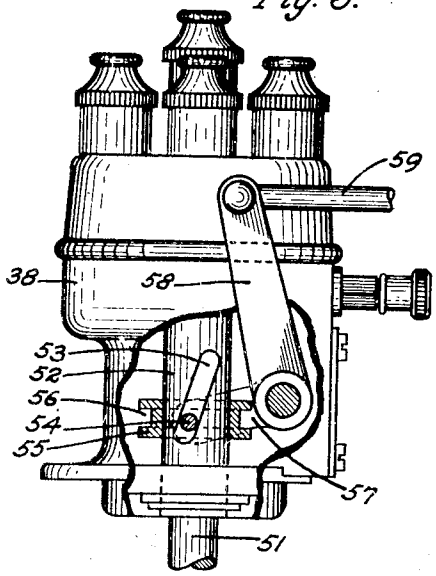
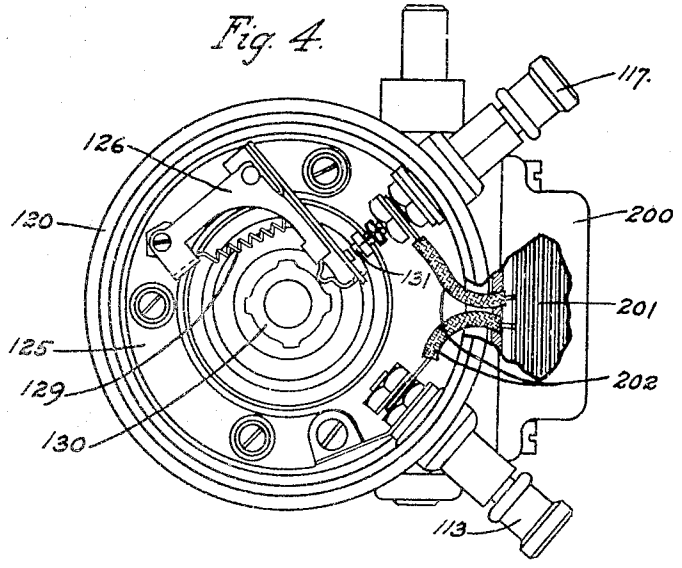


Fig. 4.



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UNITED STATES PATENT OFFICE.

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IGNITION SYSTEM.

1,190,175. Specification of Letters Patent. Patented July 4, 1916.

Application filed March 4, 1912. Serial No. 681,401.

To all whom it may concern:

Be it known that I, CHARLES F. KETTERING, a citizen of the United States, residing at Dayton, county of Montgomery, and State of Ohio, have invented certain new and useful Improvements in Ignition Systems, of which the following is a full, clear, and exact description.

This invention relates to improvements in ignition systems, and more particularly to that class of devices wherein mechanism is provided for advancing and retarding the spark of the ignition system.

Devices of the character referred to, usually have a timer which is capable of adjustment through a given range of advance and retard, and by this means the timing of the spark impulse is varied in a manner which is well known in the art.

It is among the objects of the present improvements to provide a controlling mechanism or lever for advancing and retarding the spark, but with coöperating provisions, whereby equal increments of movement of the controlling lever will adjust the timing device, or the spark advance, to variable distances; and moreover to provide an arrangement, whereby for a comparatively short movement of the spark control lever, a relatively great advance of the timer, or of the spark, will be produced, when the engine is running at high speed,—as compared with the advance produced at normal or lower speeds of the engine by the same short movement of the controlling lever.

It is another of the objects of the present invention to combine in one apparatus, two separate ignition systems, such as are sometimes known as "double systems"; both of these systems being individually controlled by a common spark controlling lever or member, and these parts associated with provisions whereby the spark impulses produced by the two individual systems, will be synchronous, that is, will occur at the same instant, with reference to the engine. When double systems of ignition, of this character, are utilized, it may happen that the individual conditions inherent in each system, are such as to tend to make a variation in the time when the spark impulse would occur. And it is one of the purposes of the present improvements to arrange these devices, so as to insure the simultaneous occurrence of the spark impulses in the two systems, irrespective of the individual characteristics, which would otherwise vary the time of sparking or the effectiveness thereof.

It is among the general objects of the present invention to embody novel combinations of mechanical and electrical elements, whereby the above named results may be obtained, in the most advantageous manner.

Further and incidental objects and advantages of the present invention will appear as the description progresses, reference being had to the accompanying drawings, wherein a preferred form of one embodiment of the present invention is disclosed.

In the drawings, Figure 1 represents a diagrammatic view of the electrical connections and circuits of the present system, Figs. 2 and 3 are views in side elevation of the timer and distributer apparatus embodied in the generator, or magneto and battery systems, a section of the casing in each view being broken away in order to show some of the operating parts thereof. Fig. 4 is a top plan view of the spark timing apparatus employed in the generator or magneto ignition system.

It is well known that, in the use of internal combustion engines, and more especially where engines of the explosive or combustion type are employed as a means of propulsion for vehicles, there are provided, as a general rule, two separate and independent sets of means for providing ignition for the engine. One of these sets of means, generally comprises a magneto or other engine operated machine for generating current and supplying the sparking impulses directly to the cylinders of the engine, through suitable induction coils, and distributing means, so that a single spark is produced at the proper spark plug, for each successive impulse passing through the primary and secondary winding of the induction coil. The circuit connections in a system of this character, are opened and closed by suitable means, whereby the sparking impulses are induced into the secondary or sparking circuits. As a general rule, the second set of ignition is of that type, known as "battery ignition", wherein a series of battery cells are employed as a source of electrical energy. The reason for employing two sets of ignition in the above described manner, is that under certain conditions, as for instance when starting the engine, one of the

systems may be used to a greater advantage than the other, while after the engine has once become operative, it may be desirable to employ the other system.

One of the principal objections to the combining of ignition systems of the above named types, has been the failure to provide means whereby a corresponding or equal retard or advance of the time of occurrence of the spark in each of the said systems, can be secured by the movement of the controlling means, a given distance, inasmuch as certain electrical lag is created in the system, wherein indirect means are employed for creating the sparking impulses. The present invention is designed to overcome these objections, in the manner set forth hereinafter.

Referring to Fig. 1, there is disclosed a diagrammatic view, showing one arrangement of the electrical circuit and connections for a complete set of ignition, including a generator or magneto system, and a system of battery ignition, so combined that a corresponding and synchronous advance or retard of the time occurrence of the spark, in each of said systems, will be secured for a given movement of the common operating member, regardless of which system is in actual service.

Some of the elements included in the battery ignition system, have been clearly illustrated and described in my co-pending applications, Serial Numbers 548,921, 564,737, 592,290, and 592,291, filed March 12, 1910, June 3, 1910, Nov. 14, 1910, and Nov. 14, 1910, respectively. As will be obvious from an inspection of the co-pending applications above referred to, this battery system of ignition is of the type known as the single spark ignition, wherein the engine actuated timer opens and closes the circuit successively and a controlling electro-magnet tends to intermittently open said main circuit, during the interval that the said circuit is closed by the engine timer and to maintain said circuit in open position, until such time as the main circuit is broken by the operation of the engine timer, whereby a single sparking impulse is induced into the secondary winding of the induction coil, thereby causing a single spark to be generated in the cylinder selected by the distributing system.

The number 21 represents a series of battery cells, being connected in series in any approved manner. The wire 23 extends from what may be termed, the initial battery cell to the contact 24, which forms a part of the relay or current interrupter. This current interrupter has been made the subject matter of one of my co-pending applications, hereinbefore mentioned, and comprises a primary winding of heavy wire 26, surrounding the stem or core 27 of the electro-magnet, together with a holding coil or winding 28, of fine wire of much higher resistance than that of the heavy winding. The magnet coils and stem or core are mounted upon a substantially L shaped bar 29, which has a right angle armature 30, pivotally secured thereto. One of the angled arms of this armature 30, lies adjacent to one end of the magnet core 27, while the other arm thereof, is so positioned that upon movement, it will be brought into engagement with and tend to actuate the contact member 24, which is normally closed with the contact member 25, by means of the spring plate 31. One end of the primary winding 26, is connected with the contact plate 25, while the opposite end thereof, leads to the contact plate 70 of the switch 33, while the secondary or fine wire winding 28, is tapped onto the wire 23, the opposite end thereof, being connected to a suitable contact plate 74 of the switch 33. The switch 33 which is of the double throw type, that is, adapted to control the selection of the ignition system to be operated, is provided with the handle 35. The casing of the switch 33 has a ground connection 36. This ground connection and the ground connection 37 which is connected to the timer casing 38 (see Fig. 3) forms one line of the battery circuit.

The timer apparatus (not shown in detail in the present system) is connected with the primary winding of the induction coil, by means of the wire 40, while the wire 41 leads from said induction coil to what may be termed, the final cell of the battery. The secondary winding of the induction coil 42, is connected in the usual manner with the distributer vane 43, which rotates over the contacts 43^a, and is adapted to properly distribute the spark impulses to the spark plugs 44, located in the various cylinders of the engine.

When the switch handle 35 is moved into the position designated "B" in Fig. 1, the contact points 71 and 70 will be closed. This forms a complete circuit through the battery system for each contact of the engine actuated timer, connected with the battery system. The course of the current from the battery 21, will be through wire 23, into the contact plates 24 and 25, and thence through the low resistance coil 26, which is mounted about the magnet core 27. This low resistance winding 26 is connected with the controlling switch mechanism through the medium of the lead wire 32, and a short branch wire 72, which connects with the contact plate 70. Contact plate 70 coöperates with the plate 71, which is moved into coöperative relation with regards to the plate 70, by the movement of the switch handle 35, into dotted line position designated "B". The contact plate 71 is con-

nected with the ground 36, through the medium of a short connecting wire. This ground connection 36 leads to the ground connection 37, from where the current flows through the timer to the wire 40, into the induction coil 42, wire 41, back to the battery. As soon as the main circuit just described, is broken by the actuation of the armature 30, to separate the contact plates 24 and 25, sufficient current will be flowing through the fine wire winding 28, to sufficiently energize the core 27, of the magnet, so that the armature 30 will be held in its attracted position, thus maintaining the spark in the main circuit, until the engine timer breaks its contact. Throughout the period of time that the current is passing through the main circuit, a slight amount of current will also be passing through the fine wire winding 28, from which it passes through the wire 73, into the contact plates 74 and 75, thence through wire 76, branch wire 72, contact plates 70 and 71, into the ground connection 36, by the short lead wire. However, the resistance of the fine wire winding is such that there is not a sufficient amount of current flowing therethrough to cause any spark when the engine actuated timer breaks the main circuit.

In the system just described, what may be termed "the time constant of the relay", occurs for each time that the main circuit is closed by the engine operated timer, inasmuch as it is necessary to pass sufficient current through the windings 26 and 28, to attract the armature. This time constant constitutes the electrical lag referred to hereinbefore.

Under certain conditions, it may be advantageous to use the vibrating or shower spark system for starting the car. In order that this may be accomplished with a system of the character set forth herein, a push button 77 is mounted on the switch 33, and forms practically a second switch when taken in combination with the contact plates 74 and 75. Supposing that the lever 35 is in its neutral or "off" position, and it is desired to secure a vibrating or shower spark system, it is only necessary for the operator of the system to press inwardly upon the button 77. This will cause the normal contact between the plates 74 and 75 to be broken, but will establish a circuit connection between the plate 75 and the button 77, which in turn is electrically connected with the ground connection 36. When conditions are as above set forth, the current from the heavy winding 26 will pass through the wire 32, wire 76, contact plate 75, push button 77, into the ground connection 36, back to the battery in the usual manner.

It might be stated that the detail structure of the switch preferably used in a system of this kind, has been clearly set forth in one of the co-pending applications mentioned hereinbefore, and for this reason, only a diagrammatic showing has been made in the present case. From Fig. 1, however, it will be seen that the movement of the lever or handle 35 into either of its dotted line positions, designated respectively by "M" and "B", will tend to close the magneto or generator circuit or battery circuit respectively. The movement of the switch handle 35, into either of its extreme positions, however, does not normally prevent the actuation of the push button 77, and the resulting vibrating or shower spark effect. Thus, it will be seen that the vibrating system may be used concurrently with the magneto or generator system.

By referring to Fig. 3, it will be seen that there is illustrated in this view, a side elevation of the timer and distributer casing, partly broken away, so that the mechanism for securing the advance or retard of the time occurrence of the sparking impulses, may be more clearly understood. The means employed in this timing mechanism for securing the advance and retard of the spark, is substantially the same as that shown in the two last mentioned co-pending applications namely, Serial No. 564,737 and 592,291, filed June 3, 1910, and Nov. 14, 1910, respectively, and comprises the rod 51, which is as a general rule, actuated by suitable means connected with and driven by the engine. This rod actuates the hollow sleeve 52, which is provided with an angular or spiral slot 53, through which projects the pin 54. This pin is rigidly mounted on the collar 55, having an annular groove 56, wherein lugs, formed on the ends of the yoke member 57, are adapted to fit. The sleeve 52 may be termed, the distributer and timer shaft, inasmuch as the timer cam which causes the successive opening and closing of the main circuit, is connected with said sleeve, together with the means for operating the rotor of the distributer. The yoked arm 57 is connected with the short arm or lever 58, which projects from the distributer housing and is connected with the link member 59. This link member 59 (see Fig. 1) may be connected in any desired manner with the manually controlled lever 60 which is conveniently arranged to be actuated by the operator. By the adjustment of the lever 60, the time occurrence of the spark generating impulses on the battery side of the ignition system, may be either advanced or retarded in accordance with the movement of the lever 60, inasmuch as when the lever 60 is moved in a given direction, as for instance, for the advance of the time occurrence of the spark, the short arm lever 58 will be actuated to cause the movement of the pin 54, located in the

spiral slot 53 of the sleeve 52. As has heretofore been stated, the sleeve 52 being connected with the main operating member or cam which tends to operate contact plates to close the main circuit, will be moved forward, relative to its normal movement and thus effect the advance of the sleeve and cam and the consequent advancement in the closing of the main circuit.

The generator or magneto type of ignition system embodied in the present instance, preferably comprises certain of the elements embodied in my co-pending application, filed April 17, 1911, Serial No. 621,512.

While it should be understood that various types of current generators may be employed in systems of this character, the generator described in the above named co-pending application, is preferably made use of.

Referring again to Fig. 1, numeral 101 designates a generator of approved type, having a shunt and series field 102 and 103 respectively, and so constructed and arranged that they will tend to coöperate to regulate the out-put of the generator. An accumulator 104, of any approved type is connected with one brush of the generator, through the medium of the wire 105, while the circuit is completed through the said accumulator by means of the wire 106, which in turn passes through an ampere-hour-meter or other measuring device, similar to that set forth in my co-pending application, filed April 17, 1911, Serial No. 621,512, and which is adapted to measure the current flowing to and from the accumulator 104. The wire 105 has tapped therefrom, a branch wire 110, which connects with the contact point 111 of the switch 33. This wire 110 forms one side of the generator ignition circuit, the opposite line of said circuit comprising a wire 112 which connects directly with the terminal 117, connected with the timer casing (see Fig. 4).

It has been stated heretofore, that the wire 110 constitutes one line of the generator ignition circuit, but this wire, it should be understood, is broken in the switch 33, so that the circuit may be opened and closed by the manipulation of the switch handle 35, which tends to close the contact points 111 and 114. Contact point 114 is connected with one end of the primary winding of the induction coil 115, by means of the continuation of the wire 110, while the opposite end of the primary coil is connected with the terminal 113, of the timer mechanism by conductor 110^a.

As has been stated heretofore, it is very desirable to obviate any ground connections in the generator ignition circuit, inasmuch as the lighting circuit is tapped therefrom and it will be understood that any slight disorder, such as short circuits, etc., in the ignition circuit, would render the lighting circuit ineffective. For this and other reasons, the generator ignition circuit is a completely insulated electrical circuit, that is, there are no ground connections whatever. This condition is secured by connecting the terminal 113 with the plate 125. The plate 125 is so formed that it may be positioned within and detachably secured to the timer casing 120. It will of course be understood that this plate is constructed from any suitable electrical conductive material, inasmuch as this plate forms a part of the completely insulated circuit. This plate 125 forms a support for the movable contact member 126, which is actuated against the effect of the spring 129, to close the main circuit, through the operation of the cam 130. The movable contact member 126 is of substantially the same structure in detail as that disclosed in my co-pending application, filed Nov. 14, 1910, Serial No. 592,291, and is adapted to engage when under the influence of the dwells of the cam, with a fixed contact point 131 which in turn is connected with the terminal 117.

The structure of the elements and combinations thereof which control the retard and advance of the time occurrence of the spark in the magneto or generator ignition system, are different from those heretofore described for securing the advancement or retard of the time occurrence of the spark in the battery ignition system.

The shaft 140 which corresponds to the shaft 51 in Fig. 3, is arranged to carry the timer cam 130, see Fig. 4, and the distributer of the generator ignition system, in substantially the same manner heretofore described, relative to the shaft 52. The means for securing the advancement or retard of the spark is also substantially the same, with the exception that provision is made for compensating, in a novel manner, for the electrical lag or time constant of the relay, which is present in the battery ignition system.

For certain range of engine speeds, as controlled by the time occurrence of the spark, the electrical lag or time constant of the relay in the battery ignition system, does not seriously interfere with the synchronous adjustment of the generator ignition system. This range extends over what is known as the retarded condition of the spark, that is, the occurrence of the spark at any point wherein the spark is generated and delivered to the engine cylinders after the piston has passed over top center and is starting on its downward stroke. However, for all speeds wherein it is necessary to advance the time occurrence of the spark beyond top center, some means must be provided to compensate for the time constant of the relay in the battery system, or else the time occur-

rence of the spark generating elements in each of said systems, will not correspond. One manner of compensating for the time constant of the relay, is to change the angularity of the slot 145, formed in the timer and distributer sleeve.

As has heretofore been described, the timer and distributer sleeve, and consequently the timer cam and rotor of the distributer, are adapted to be advanced or retarded relative to their normal actuation, by the same spark advance lever that controls the advance and retard of the elements of the battery ignition system. This spark advance lever is preferably associated with the steering mechanism, in the usual manner. The angular slot 145, up to the point designated by the line C—C (see Fig. 2), is of substantially the same angularity relative to the vertical axis of the timer shaft, as the constant spiral slot 53, as formed in the shaft 52. From this point upward to the point marked E—E, the angularity of the slot is reduced, so that an extremely slight movement of the cross pin 142, will tend to move the sleeve or shaft 146 relative to the shaft 140 and thus advance the timer cam and distributer, sufficiently to give any range of engine speed, in so far as the time occurrence and deliverance of the sparks are concerned, up to engine speed of from 35 to 40 miles per hour. It will, of course, be understood that the reason that the angularity of the slot 145 is reduced relative to the vertical axis of the shaft 140, from the point designated by the line C—C, to the point designated by the line E—E, is because of the absence of any electrical lag or time constant of any of the elements which control the time occurrence of the spark. The extent of this reduced angularity of the slot, relative to the vertical axis of the shaft 140, may be predetermined in any suitable manner and is adapted to permit a wide range of engine speeds, to be secured for a relatively short movement of the spark control lever.

From the above, the operation of the device will be as follows:—Supposing that the double throw switch is in such position that the battery ignition system is placed in active service. Now, if it is desired to advance the time of occurrence of the spark, as when an increased speed of the engine is desired, the lever 50 is operated, which in turn operates to move the transverse pin 54, in the slot 53. Inasmuch as this slot 53, formed in what may be termed, the timer cam shaft or distributer shaft, the sleeve 52 will be rotated, relative to its normal rotation by the shaft 51, and thus advance the timer cam, relative to the contact points in the timer, and cause the advanced closing of the ignition circuit. Simultaneously with the actuation of the spark advance mechanism of the battery ignition system, the pin 142, which is located within the angular slot 145, formed in sleeve 146, of the generator ignition system, will effect the movement of said sleeve 146 in a direction similar to the movement of sleeve 52, effected by the pin 54. However, because of the decrease of the angularity of the slot 145, between the points C—C and E—E, the sleeve 146 will not be moved a distance equal to the movement of the sleeve 52. However, if the switch 33 is now thrown so as to render the battery ignition system inoperative and bring into use, the magneto or generator system, the sparking impulses generated in the magneto or generator system, will occur at intermittent intervals, corresponding with the time of occurrence of the spark, when the battery system was in use. The reason for this is that it is necessary to advance the timer cam in the battery ignition system, a greater distance than it is necessary to move the timer cam in the generator system, because of the electrical lag which creates what has heretofore been termed, the time constant of the relay in the battery ignition system.

In some cases, it is desirable to employ the generator system for furnishing ignition when the engine is to be driven at still greater speeds and it is also desirable to be able to advance the time of occurrence of the spark, with celerity and abruptness. In the present instance, this is made possible by changing the angularity of the extreme upper portion of the slot 145, so that for a comparatively short movement of the spark control lever 60, and the consequent short movement of the pin 142, the sleeve 146, together with the timer cam and distributer rotor will be advanced to a much greater degree than a corresponding movement of the spark control lever, while the pin 142, was traveling in that portion of the slot 145, between the points C—C and E—E.

In order to prevent sparking at the contact points on the timer of the magneto ignition system, I have provided a novelly arranged condenser which is provided with a casing 200, adapted to contain the condenser elements 201 (shown in Fig. 4). This condenser casing is so mounted on the distributer housing that it provides a cover for the lubricating chamber formed within the said distributer, or timer housing. The wires leading to the condenser, designated by the numerals 202, are connected with the terminal members 117 and 113 respectively. This construction and arrangement of the condenser, directly across the contact points of the timer, tends to eliminate the sparking at the timer contact points, and thereby prevents the same from pitting or burning out.

From the above, it will be seen that if the operator desires to employ the battery

system of ignition, during the starting period of the engine, it is preferable to use a series of sparks, such as is obtained in the ordinary vibrating coil system of ignition, and this is done by cutting out the fine wire winding 28, of the relay, in the battery ignition system, by the closing and opening of certain contacts in the switch 33, in the manner described in my co-pending application, Serial No. 548,921, filed March 12, 1910. As soon as the engine has become self-actuating, the switch handle may be thrown so that either the single spark battery ignition may be used or the magneto or generator system. The operation of the system then proceeds in the usual manner, that is, the advancement and retard of the spark is effected by the operation of the lever 60. However, if it is desirable to switch from, say, battery system of ignition to the magneto or generator system, the switch lever 35 is thrown into the proper position, and it will be found, providing that the time occurrence of the spark is advanced in the system previously in service, that the time occurrence of the spark of the system formerly inoperative but now being used, will occur at substantially the same intervals. This action will be the same in case the operation of the switch handle is reversed, so that the magneto system is rendered inoperative and the battery system is brought into service.

While the form of mechanism herein shown and described constitutes a preferred form of embodiment of the invention, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What I claim is as follows:—

1. In an ignition system for combustion and explosion engines, the combination with a plurality of sparking circuits, one of said circuits having a greater electrical lag therein than the other; means for advancing and retarding the time at which the sparking impulses take place; and means coöperating with said last named means for compensating for the electrical lag in either of said circuits, whereby sparking impulses will take place at a given time, in the circuit that is in use, upon a given movement of said last named means.

2. In an ignition system for combustion and explosion engines, the combination with a direct and indirect sparking circuit, one of said circuits having a greater electrical lag than the other, a common operating member, of means operable by said common operating member for compensating for the increased lag in one of said circuits; whereby the adjustment of said operating member, a given distance, will equalize the advance of the means for controlling the sparking impulse in the circuit that is in use.

3. In an ignition system for combustion and explosion engines, the combination with a direct ignition circuit, having connection with an engine operated generator; a timer for opening and closing said circuit, to generate a sparking impulse for ignition purposes; of a second ignition circuit having connection with a constant supply of electrical energy; a timer for closing said circuit; and means having a time constant for breaking said circuit during the interval it is closed by the timer, to generate a sparking impulse.

4. In an ignition system, the combination with a direct and an indirect sparking circuit, having varying degrees of electrical lag; of means operable by a common operating member for compensating for the differential electrical lag, whereby the adjustment of said operating member a given distance, will operate to equalize the advance or retard of the time occurrence of the spark in either of said circuits.

5. In ignition systems for combustion engines, the combination with a sparking circuit; engine actuated means for intermittently opening and closing said circuit, comprising a rotatable sleeve having a slot therein, of varying angularity; and means associated with said slot and adjustable to advance said sleeve variable degrees for equal increments of adjustment of said means.

6. In an ignition system, the combination with direct and indirect sparking circuits having varying degrees of electrical lag; a cam for opening and closing said circuits; mechanism for operating said cam; means operable by said cam operating mechanism for compensating for the varying electrical lag in the several circuits, whereby the adjustment of said operating member a given distance will operates to equalize the advance or retard of the time of occurrence of the sparking impulses in either of said circuits.

7. In an ignition system, comprising a source of electrical energy; a timer; a completely insulated metallic primary ignition circuit connecting said source of electrical energy and said timer, and adapted to be opened and closed by the actuation of said timer; and an electric lighting circuit tapped from said completely insulated circuit.

8. In an ignition system for combustion and explosion engines, the combination with an ignition circuit having connection with a constant supply of electrical energy; a timer for closing said circuit; means having a time constant for breaking said circuit during the interval it is closed by the timer to generate the sparking impulses; of a direct ignition circuit having connection with the engine operated machine; a timer for opening and closing said circuit to generate

the sparking impulses for ignition purposes; means for advancing and retarding the time of occurrence of the sparking impulses in each of said circuits; and means associated with the direct ignition system and operable by said last named means for compensating for the time constant of the means in the first named ignition circuit, whereby the movement of the advance and retard mechanism will cause the time of occurrence of the sparking impulses in each of said systems to be synchronous.

9. In a system for supplying ignition to combustion or explosion engines, the combination with a plurality of ignition systems, one of said systems having greater lag therein than the others; and means for compensating for said lag, whereby synchronous sparking impulses will be generated in each circuit.

10. In ignition systems, the combination with a plurality of ignition systems including sparking devices capable of independent operation, having separate timers, one of said systems having greater lag therein than the others; of a common controlling mechanism; and means associated with the timers, for compensating for said lag to secure synchronous time of occurrence of the spark in each of the sparking devices for given positions of the controlling mechanism.

11. In an ignition system for combustion and explosion engines, the combination with a plurality of ignition systems including sparking devices, one of said systems having greater lag than the others, comprising a timer for each sparking device, and means for securing a differential adjustment between said timers to compensate for the said lag and thereby secure synchronous time of occurrence of the spark in said sparking devices.

12. In an ignition system for combustion and explosion engines, comprising a plurality of ignition systems including sparking devices, one of said systems having characteristics which tend to prevent the synchronous occurrence of sparking impulses therein with the occurrence of sparking impulses in the other systems; timers for each of said sparking devices, having provisions permitting a differential adjustment between said timers for compensating for said characteristics so as to secure synchronous time occurrence of the spark in said sparking devices.

13. In an ignition system for combustion or explosion engines, the combination with a sparking device including a timer capable of adjustment throughout a given range of advance and retard; and means for adjusting said timing device variable distances for equal increments of movement of said adjusting means.

14. In ignition systems for combustion engines, the combination with a sparking circuit; means for opening and closing said circuit comprising a movable element provided with a slot of varying angularity; and means associated with said slot for advancing the closing and opening of the said circuit different degrees throughout a given range upon equal movements of said means.

15. In a system for supplying ignition to combustion or explosion engines, the combination with a plurality of ignition systems, one of said systems including an element having a determined amount of reluctance; and means for compensating for said reluctance, whereby synchronous sparking impulses may be generated in each circuit.

16. In a device of the character described, the combination with two ignition systems having spark timing devices therefor, of a common spark controlling member for simultaneously controlling the spark advance and retard of both timing devices; and mechanism intervening between said spark controlling member and said timing devices whereby equal increments of movement of the controlling member will shift the timing device of one system through varying angular distances, and will shift the other timing device through angular distances different therefrom.

17. In an ignition system, the combination with a spark control lever, of a spark timing device, and mechanism connected therewith and constructed to produce a relatively great advance of the timing device for comparatively short movement of said lever, whereby for high engine speeds a greater spark advance will ensue than is produced by the same short movement of the lever for low engine speeds.

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

CHARLES F. KETTERING.

Witnesses:
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J. W. MCDONALD.