Nov. 3, 1936. H. B. HOLTHOUSE 2,059,237

IGNITION SYSTEM

Original Filed April 22, 1929 2 Sheets-Sheet 1

Fig. 1

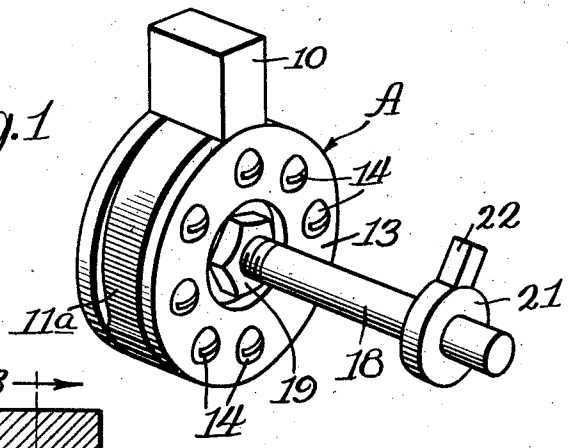


Fig. 2

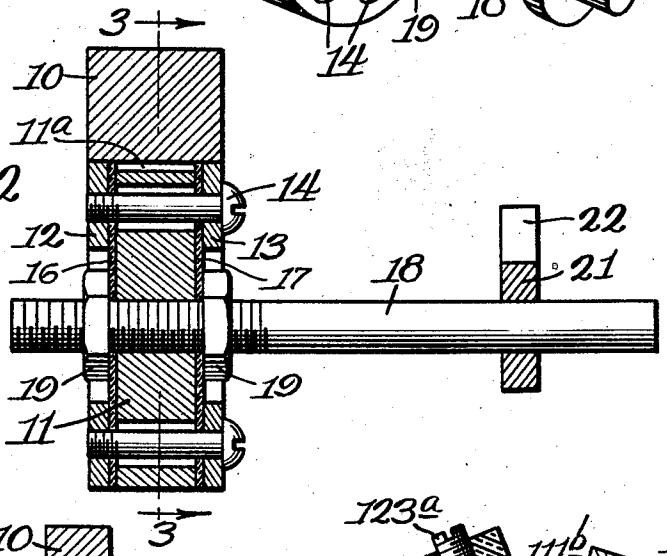


Fig. 3

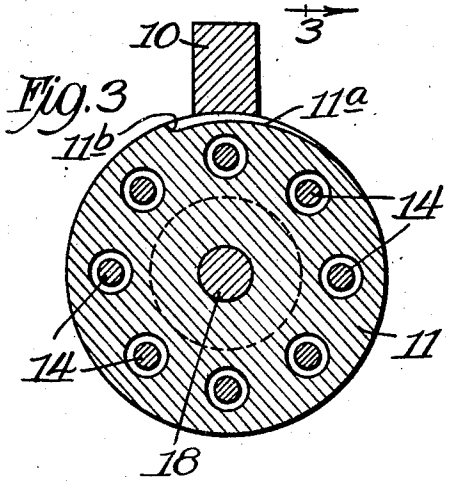
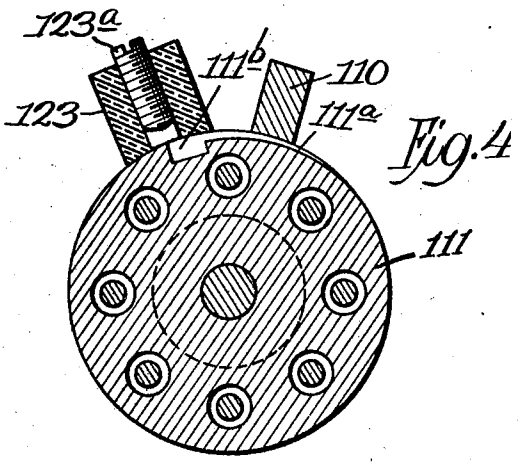


Fig. 4



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Fig.5

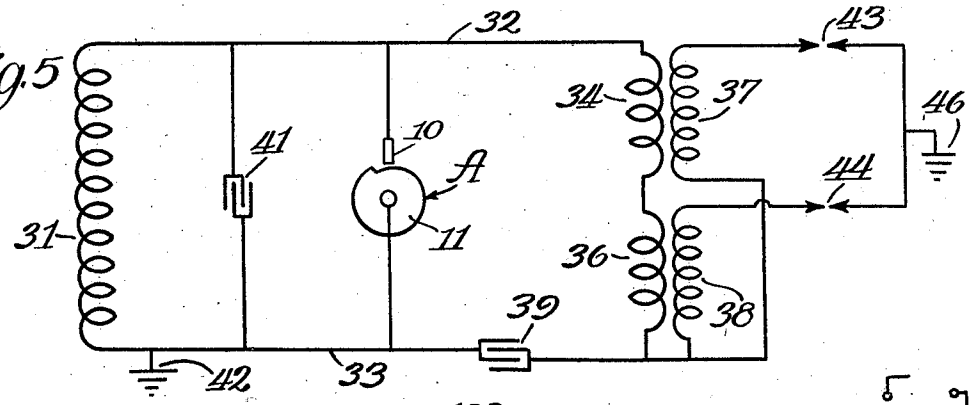


Fig.6

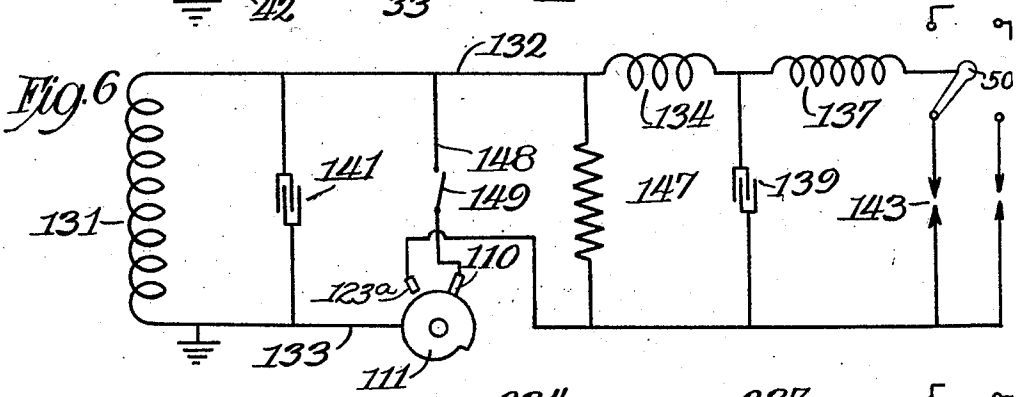


Fig.7

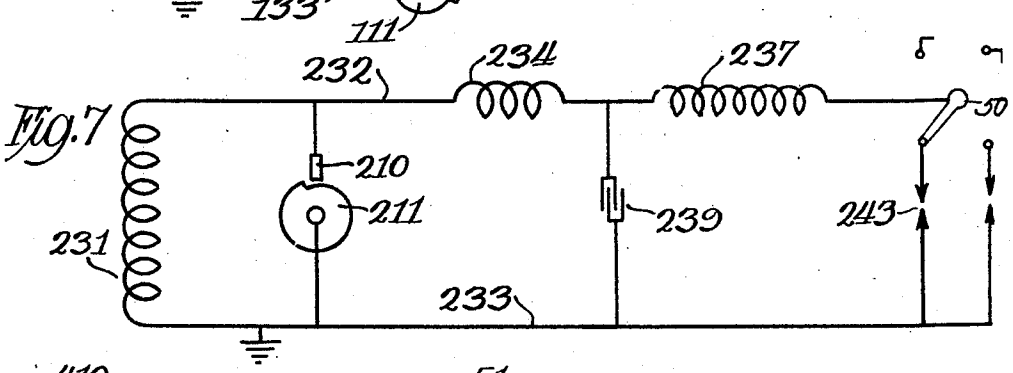


Fig.9

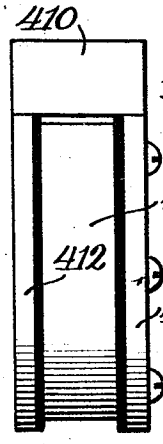
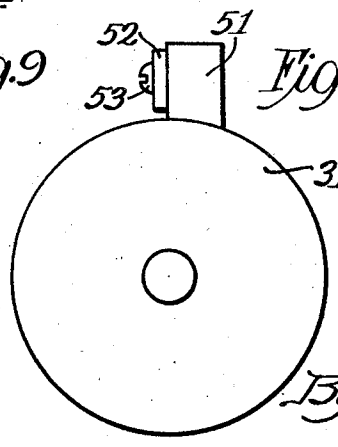


Fig.8



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UNITED STATES PATENT OFFICE

2,059,237

IGNITION SYSTEM

Harry Barnard Holthouse, Chicago, Ill.

Application April 22, 1929, Serial No. 356,963
Renewed January 3, 1933

39 Claims. (Cl. 123—148)

My invention relates to ignition systems, and particularly to an ignition system employing the principles set out in my prior Patent No. 1,710,541, issued April 23, 1929, on an application which was co-pending with this one.

The object of the invention is the provision of a system which will develop a spark of such characteristics as to ignite a combustible mixture under pressure more readily and efficiently than possible in ignition systems heretofore known.

Another object is the provision of an ignition system which will facilitate quick starting.

Another object is the provision of an ignition system which will make possible the development of greater power.

Another object is to apply the principles of the high frequency oscillating circuit, set forth in my said patent, to an improved ignition system. The use of a high frequency oscillating circuit is very advantageous in an ignition system. Apparently there are two reasons for this, one being that because the current oscillates back and forth until it dies down, the spark lasts longer; the other reason being that ozone is formed just before or during the high frequency sparking. Ozone apparently has a very desirable effect in facilitating ignition.

A further and important object of my invention is the provision of an improved timer mechanism for use with a system of this character.

Another object is the development of a new piece of apparatus applicable for use with high frequency oscillating ignition systems, which piece of apparatus is of utility as a spark gap, timer, commutator, or the like, or timer and spark gap, as required in the use of the circuit. This piece of apparatus comprises a rotary contact or electrode, and a stationary contact or electrode riding either directly on and in contact with the rotary contact or slightly spaced therefrom, depending on its use. When the device is used as a timer, the rotary contact has a depression in its surface which passes under the stationary contact to interrupt the flow of current between them, the stationary contact being held removed from the rotary contact at this time by insulated guards at the sides of the rotary contact.

This construction has an advantage over previous rotary types of timers in that the use of a depression instead of an insulating segment prevents the formation of a thin conductive film beyond the contact, along which film the other contact would wipe. Such a conductive film extending between the contacts when they should be separated has heretofore made the interruption of the current less sharp and sudden than the interruption secured by the present invention. Of course, the ordinary spring contact type of timer cannot compare with this in the sharpness of current interruption.

When the device is used as a spark gap, the same stationary contact may form a sparking electrode when it is spaced from the rotating contact by the depression mentioned, or a separate electrode constantly separated from the rotating contact or electrode may be provided. In either case this invention has the advantage of forming a spark gap, the length of which is absolutely accurate, while the efficiency of the spark gap is assured by constant renewal of the air therein. Furthermore, the depression, when shaped as illustrated, will accurately reduce the length of the gap during each sparking period. A reduced gap will permit a spark to be initiated or continued with a lower voltage.

When the same contact is used, both for timing and sparking, it has an additional distinct advantage over spring contacts in that with this device the gap may be extremely small without interfering with the timer action, while spring contacts can hardly be separated quickly without forming a fairly long gap.

Other objects and features of the invention will be apparent from a consideration of the detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a perspective view showing one embodiment of a novel piece of apparatus constructed in accordance with the present invention.

Fig. 2 is a longitudinal sectional view through the apparatus of Fig. 1.

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 2.

Fig. 4 shows another arrangement which can be employed with the timer sparking apparatus.

Fig. 5 is a circuit designed for a particular use and embodying the features of the present invention.

Fig. 6 is a modified circuit arrangement in which the timer apparatus is slightly differently arranged.

Fig. 7 is still another and simplified circuit arrangement, also embodying the principles of the present invention.

Figs. 8 and 9 show modified arrangements for use with the roller, these modifications being par-

ticularly suitable when automatic timing is employed.

As previously stated, the application of high frequency oscillating circuits to ignition systems is one of the important features of this invention. To get the best results from such high frequency ignition, certain timing and sparking apparatus has been developed, and therefore before describing the circuit arrangements shown in Figs. 5 to 7, I will describe the apparatus of Figs. 1 to 4, which is of great importance in the practical working out of the systems of Figs. 5 to 7.

The structure of Figs. 1 to 3 may first be considered simply as a make-and-break device or timer as if it had merely the function of a make-and-break timer of the conventional ignition systems now used in automobiles. As is well known, such timers first close the circuit so that a current will flow therein and then open the circuit to interrupt the current. The purpose of such timers is to build up, at the proper time and by means of the other parts of the system, a high induced voltage either in the circuit in which the contacts of the timer are connected or in a secondary circuit. A very sudden break in the current is desirable since the more sudden the break is, the higher the voltage will be.

In the structure of Figs. 1 to 3, the timer contacts which make and break the current are the contact 10 and the rotary contact 11 which rotates with its circumferential surface in sliding engagement with contact 10, except when separated therefrom by the depression 11*a* in the surface of the rotary contact 11. Except for the depression 11*a* the rotary contact 11 is circular, as shown best in Fig. 3. On the two sides of the rotary contact 11 are secured ring-shaped side plates 12 and 13, which may be insulated by mica sheets 16 and 17.

The rotary contact 11, together with the side plates 12 and 13, comprises a roller A which is mounted on a shaft 18 in any suitable way, as by nuts 19. When the roller is employed in an ignition or similar circuit, it becomes necessary to connect the rotary contact 11 electrically in the circuit. This may be done in any way known in the art, and for illustration I show a small slip ring 21 carried by the shaft 18 with a suitable type of brush 22 whereby the rotary contact 11 may be connected into the circuit through the shaft, slip ring and brush.

The roller A is driven by the shaft 18 in synchronism with the motor, and the depression 11*a* is so positioned as to break the circuit when a spark in the engine is desired. As the shoulder 11*b* passes out from under the contact 10 toward the position illustrated in Fig. 3, the contacts 10 and 11 will thus be separated breaking the circuit through them. The depression 11*a* insures a sharp break, since, as shoulder 11*b* passes under the contact 10, there is no adjacent surface onto which the contact 10 could wipe a conductive film from the contact 11.

In some high frequency ignition systems, such as those illustrated in Figs. 5 and 7, it is essential that a spark gap be provided, either between the timer contacts or in parallel with them. In the structure shown in Figs. 1 to 3, the depression 11*a* forms the spark gap between contact 10 and the rotary contact 11. Thus, after the shoulder 11*b* passes from under the contact 10, breaking the circuit, a spark may jump between the contact 10 and the bottom of the depression 11*a*. Since the contact 10 rests on the side plates 12 and 13 which are rigidly secured to the rotary contact 11, and since the depth and shape of this depression are fixed, it follows that the size of the spark gap formed by the depression 11*a* is very exactly predetermined.

In Fig. 4 I have shown a construction very similar to that in Figs. 1 to 3, except that the contact 110 is utilized merely for interrupting the circuit, a separate sparking electrode 123*a* being provided. This electrode 123*a* is secured in a brush or spacer block 123 of insulating material which rides on the peripheral face of the roller A. The electrode 123*a* is preferably threaded into the spacer block 123 so that the distance of its separation from the rotary contact 111 may be easily adjusted. The rotary contact 111 thus forms a rotary electrode which, together with electrode 123*a*, forms a spark gap, the length of which is accurately determined by the position of electrode 123*a* in its spacer block 123. In the illustrated form the depression 111*a* is formed deeper at its forward end 111*b* than the depression 11*a*, so that the spark will not jump so easily between contacts 110 and 111 when the portion 111*b* passes under contact 110.

As is clearly seen from Fig. 4, a circuit may be closed by engagement of the contact 110 with the rotary contact 111 during a part of the revolution of roller 111. When the depression 111*b* passes entirely under the contact 110, the flow of current between the contact 110 and the rotary contact 111 is interrupted. At this time a spark will jump from the electrode 123*a* to the rotary contact or electrode 111, the depression 111*b* not yet having reached the position of the electrode 123*a*.

I might mention briefly here further details of mechanical construction of the roller. The conducting portion 11 of the roller is, of course, made of a current-carrying material, and I prefer the use of such a grade of steel as will have the proper mechanical characteristics to withstand the friction, etc., to which it is subjected. The plates 12 and 13 carry no current, having solely the function of supporting the brushes away from the roller during the sparking interval. I would prefer to make them of non-conducting material, but at the time of the present writing I have found no non-conducting material with the proper mechanical characteristics to stand up under constant use. I have tried many materials and, so far, my best results have been obtained with a high grade of steel, which makes it necessary to insulate these circular plates from the conducting portions of the roller. To this purpose, the mica sheets 16 and 17 are employed and, as Fig. 2 shows, the portion 11 is cut away to avoid all possible contact with the assembling screws 14. I may employ an insulating material to surround the screws 14, but I have found that when using a high frequency current, I obtain the best results by leaving the open space shown.

In describing the circuits shown in Figs. 5, 6 and 7, it is probably best to start with Fig. 7, since this is the simplest of the three circuits. The coil 231 is the coil of a magneto and as such is both a source of power and an induction coil. Because this coil is assumed to be a magneto coil, no other source of current is shown, since the voltage would be generated in the coil 231 by the magneto. It should be understood, however, that any other sources of current can be used, such as those illustrated in my prior patent previously mentioned, the application for which was co-pending with this application.

The combined source of current and inductance coil represented by coil 231 is connected across conductors 232 and 233 to which is also connected a time-sparker comprising the contact 210 and the contact 211, this timer-sparker being perhaps the same as that illustrated in Figs. 1 to 3. When the contacts 210 and 211 are in contact, the coil 231 is short-circuited so that a heavy current flows through said coil and through the said contacts during the period of excitation of the coil. As the rotary contact 211 rotates so that its depression passes under the contact 210, separating the contacts, the current flow through these contacts is interrupted, with the result that a high induced voltage is built up in the coil 231, and this voltage charges the condenser 239. The condenser 239 is connected in series with a primary coil 234 of a high frequency transformer, and the two are connected across the conductors 232 and 233, thus being connected in a series circuit with the coil 231. It is the momentary flow of current in this circuit which charges the condenser. It will be observed, however, that the coil 234 and the condenser 239 are also in a series circuit with the contacts 210 and 211. The condenser discharges through this primary circuit with a high frequency oscillating current which, in flowing through the primary coil 234, induces a corresponding potential in the secondary coil 237 of the high frequency transformer. The coil 237 is also in a high frequency oscillating circuit which includes the condenser 239 and a spark gap 243, this gap being that formed by the contacts of a spark plug in the internal combustion motor with which this ignition system is used. The spark plug may be one of several which are successively connected through a distributor 50 diagrammatically illustrated. It is evident from the circuit that as long as there is present in the wires 232 and 233 a voltage or current adequate to charge the condenser 239 and cause an adequate sparking voltage, a spark will therefore continue to jump across the gap 243. A ground symbol is applied to conductor 233 to indicate that ground instead of a wire may be used for this conductor.

Fig. 5 illustrates a similar ignition system in which sparks are produced simultaneously at the two spark plugs 43 and 44 which may be in an engine having two opposed cylinders firing simultaneously. In this system the primary oscillating circuit includes, besides condenser 39 and contacts 10 and 11, two primary windings 34 and 36, each of which is associated with one of the secondary windings 37 and 38. Winding 37 is in a high frequency oscillating circuit including spark plug 43 and condenser 39 connected through ground, and winding 36 is in a high frequency oscillating circuit which is the same except that it includes spark plug 44 instead of spark plug 43. The timer including contacts 10 and 11 is connected across conductors 32 and 33 across which are also connected the condenser 41 and a coil 31 similar to coil 231. Except for the addition of condenser 41, this circuit is similar in operation to that of Fig. 7 just described, though producing two simultaneous sparks instead of one. Condenser 41 takes any of the charge developed by coil 31 when its circuit is interrupted at 10 which the condenser 39 may not be able to absorb at once, and hence the condenser 41 may act as a reservoir for condenser 39.

In Fig. 6 the rotary contact 111 is connected to conductor 133 and contact 110 is merely a timing contact connected to conductor 132 through a wire 148 and a manually controlled switch 149. A sparking contact 123a is also provided, primary coil 134 and condenser 139 being connected across conductors 132 and 133 through this contact 123a and contact 111. A second condenser 141 is connected across the conductors 132 and 133 to which the magneto coil 131 is connected. Also a resistance 147 has been shown shunted across the primary transformer coil 134 and the condenser 139 to give improved performance under certain conditions, though satisfactory results may be obtained without it. The secondary oscillating circuit, including secondary coil 137, condenser 139 and spark plug 143, is similar to that of Fig. 7.

In the operation of this circuit when the switch 149 is closed, as during starting, the coil 131 is first short-circuited by the contacts 110 and 111 to cause a heavy current to flow therethrough. When these contacts separate and interrupt the current, a high voltage charge is impressed on the condensers 141 and 139, which impress a high voltage across the spark gap formed by electrodes 123a and 111. When this voltage is sufficiently high, the spark occurs and a high frequency current flows through the primary circuit including the primary coil 134 of the high frequency transformer. This of course induces a high frequency current in the secondary circuit including the secondary coil 137 of the transformer, the condenser 139 and the spark plug 143 of the motor.

One of the principal utilities of my invention is the readiness with which it can be adapted for automatic timing, and in actual practice this is the way in which I have employed it, especially the circuit of Fig. 6, with the best results. It is well known that in a magneto the voltage rises and falls approximately in accordance with a sine wave. It is also well known that the maximum voltage at the peaks of the waves and therefore the voltage between zero and the peak of the wave, increases as the speed of the magneto increases, and since the speed of the magneto when it is used in the ignition system of a motor is of course proportional to the speed of the engine, it follows that the voltage of the magneto increases as the motor speed increases. Nevertheless, the crest of the sine wave is always synchronized with a predetermined position of the engine.

The use of this speed-increased voltage of synchronized sine wave form in automatic timing was described in my prior patent previously mentioned. I am able to arrange the spark gap so that at a given speed the voltage at the crest of the sine wave will be sufficient to cause a spark to jump across the gap and so generate the high frequency oscillating current in the primary circuit which inductively generates an oscillating current in the secondary circuit, causing a spark to occur at the points of the spark plug. As the engine speeds up, the voltage necessary to jump the gap is reached at an earlier part of the sine wave, and therefore the timing of the spark is advanced. In other words, once the proper adjustment of the gap is obtained, the spark is automatically advanced or retarded in accordance with the motor speed, full automatic timing being obtained even with motor speeds as low as 50 R. P. M.

When the motor has been started and the manual switch 149 of Fig. 6 has been opened, the system of Fig. 6 is automatically timed in accordance with the above description. Because of the fact that the switch 149 is open, the automatic contact 110 is ineffective and may be

ignored. Therefore instead of the spark occurring when the depression in the rotary contact 111 passes under the contact 110, the spark will occur when the voltage of the magneto coil 131, increasing according to its sine wave characteristic, reaches a sufficient value to jump the gap between the rotary contact or electrode 111 and the stationary electrode 123a. As the engine speeds up so that this voltage is reached earlier in the sine wave, the spark is advanced, and conversely, as the engine slows down, the spark is retarded.

It is in connection with such systems using automatic timing that the type of apparatus shown in Figs. 8 and 9 is of particular utility. Referring to Fig. 8 first, the roller 311 is formed with no depression whatsoever, and a spacing block or brush 51 of insulating material, such as fiber, rides constantly on the periphery of the roller. An electrode 52 is secured by a screw 53 to the side of the brush in such a way as to clear the roller and leave a narrow gap of such clearance as to permit sparking between this electrode and the roller. This electrode can be adjusted to have the proper clearance and is used in automatic timing. In actual fact, I employ this installation where the roller 311 is the fly-wheel of a motor and the spacing block 51 rides on the periphery of the fly-wheel, and the spark is between the fly-wheel and the electrode 52 carried by the spacing block. With a grounded system, the circuit is readily arranged to permit use of this character.

Now, in Fig. 9, the roller 411 is of lesser diameter throughout than the guides 412 and 413, so that the current-carrying brush 410 is never in contact with the current-carrying roller 411. The spark clearance is such, however, that when the predetermined sine wave voltage is impressed across the gap, the gap will be jumped and a spark created, with the results previously described.

It will be understood that the circuits, which I have shown, are illustrative, as they may be modified to include any of the usual requirements of a circuit.

The arrangement of the timing rollers shown is illustrative, as the device, especially as shown in Figs. 1 to 3, shows one means for accomplishing certain objects of the invention, namely, the control of a spark gap to have the electrodes so moved with respect to each other that an accurate gap is obtained, the points cleaned automatically through the movement thereof, and, incidentally, the movement of the points serving the purpose of an unusually satisfactory timer if necessary. Instead of a single cam surface on a roller of this kind, a number of cam surfaces may be employed, and in adapting the system to various conditions, a single or plural number of rollers may be used, as the circuit might demand.

Although several embodiments of my invention have been herein shown and described, I do not wish to limit myself thereby, but am limited only by the scope of the appended claims.

What I claim as new and desire to protect by United States Letters Patent is:

1. In an ignition system, a circuit including a source of power and a primary transformer coil connected by two conductors, a grounded connection to one of said conductors, a current changing and sparking device of the character described bridged across said conductors, a condenser in the grounded conductor between the sparking device and the primary coil, the circuit so arranged to include a primary oscillating circuit, and a secondary oscillating circuit including a secondary transformer coil, a spark plug with one terminal connected to the secondary coil and the other connected to ground, and a connection from the other terminal of the secondary coil to the grounded terminal to includes said condenser in the resulting grounded secondary circuit.

2. An oscillatory circuit, a control device in said circuit including a current carrying roller, a pair of guards at the sides thereof electrically insulated from the roller, a current carrying brush engaging the roller and guides, the roller having a depressed portion, and means for driving the roller to periodically place the brush opposite the depressed portion of the roller, the guards supporting the brush away from the roller opposite the depressed portion thereof to form a spark gap therebetween.

3. The device set forth in claim 2 wherein the guides are formed of a hard resisting metal electrically insulated from the current carrying roller.

4. In an ignition circuit, a source of energy, a condenser connected across said source, a timing device in parallel with said condenser and consisting of a roller having an indented periphery and a contact element contacting with said roller during the rotation thereof and forming a gap with said indented portion, a high frequency output transformer, the primary of said transformer being short-circuited when said contact element engages the periphery of said roller, and a condenser common to the primary and secondary of said transformer.

5. In an ignition circuit, a course of low frequency energy, a high frequency transformer having its primary in series with said source, a condenser in series with said primary and source, said condenser being also in series with the secondary of said transformer, and a control device for intermittently providing a variable air gap in a series circuit with said primary and condenser.

6. In an ignition circuit, an oscillatory circuit including a source of low frequency energy, a high frequency output transformer, a condenser in series with said source, and the primary of said transformer, a control device for said circuit including a roller having a periphery which is circular in part and spiral in part, a pair of brushes adapted upon rotation of said roller to engage the circular periphery thereof and form a variable air gap with the spiral periphery thereof, one of said brushes being included in parallel in said circuit and the other being included in series in said circuit.

7. In an ignition circuit, an oscillatory circuit including a source of low frequency energy, a high frequency output transformer, a condenser in series with said source, and the primary of said transformer, a control device for said circuit including a roller having a periphery which is circular in part and spiral in part, a pair of brushes adapted upon rotation of said roller to engage the circular periphery thereof and form a variable air gap with the spiral periphery thereof, one of said brushes being included in parallel in said circuit and the other being included in series in said circuit, and means for rendering said parallel brush ineffective when the circuit is in operation.

8. In an ignition system, a circuit including a source of current, the primary windings of a transformer and a condenser, a primary oscillating circuit including a current changing means, the condenser and the primary winding above set

forth, a secondary oscillating circuit including a secondary coil, a spark plug, and the same condenser previously set forth, said current changing means comprising a current carrying roller and current carrying brush with means for separating them at proper intervals to produce a spark gap for the purpose described.

9. In an ignition system, a circuit including a source of power and a primary transformer coil, two conductors connected to said source of power, a grounded connection to one of said conductors, a current changing and sparking device of the character described bridged across said conductors, a condenser in one of said conductors between the sparking device and primary coil, the circuit so arranged as to include a primary oscillating circuit, and a secondary oscillating circuit including a secondary transformer coil, a spark plug with one terminal connected to the secondary coil and the other connected to ground, and a connection from the other terminal of the secondary coil to the grounded terminal to include said condenser in the resulting grounded secondary circuit.

10. In an ignition system, an exciting circuit including a source of power, a current changing and sparking device of the character described connected by a pair of conductors to the source of power and a condenser bridged across said conductors, a primary oscillating circuit including the primary of a transformer, a spark gap, a condenser, and said current changing and sparking device, and a secondary oscillating circuit including the secondary of said transformer, a spark plug, said spark gap and the same condenser included in said primary oscillating circuit.

11. A spark gap for use in an ignition circuit comprising a brush forming one sparking electrode, a moving member having a plane surface with a portion of the member forming a second electrode surface, and means for supporting the brush by the plane surface of the moving member in spaced relation to the moving electrode surface.

12. A spark gap for use in an ignition circuit comprising a rotatable member having a rotatable conducting portion, a second member riding on the rotatable member, said second member having a conducting portion, and means for supporting said second member to ride on the rotatable member but with the conducting portion of the second member out of contact with the conducting portion of the rotatable member, whereby said two members form a spark gap.

13. A spark gap for an ignition circuit comprising a moving electrode having an auxiliary moving surface all movable through a cycle of rotation, a stationary electrode, means for supporting the stationary electrode on the moving supporting surface of the moving electrode to maintain the electrodes in spaced relation, and means for varying the spacing between the electrodes during each cycle of rotation,

14. A rotatable spark gap comprising a rotatable member having a peripheral face serving as a moving electrode, and having a peripheral portion acting as a support, a stationary electrode having a portion riding upon said supporting portion of the rotatable member for supporting the stationary electrode in definite spaced relation to the moving peripheral face serving as a moving electrode.

15. In an ignition circuit, a source of low frequency energy, a high frequency transformer having its primary in series with said source, a condenser in series with said primary and source, said condenser being also in series with the secondary of said transformer, and a control device for intermittently providing an air gap in parallel with said primary and condenser and in a series circuit therewith.

16. In an ignition circuit, a source of low frequency energy, said source including high inductance, a high frequency transformer having its primary in series with said source, a condenser in series with said primary and source, said condenser being also in series with the secondary of said transformer, and a control device for intermittently and alternately providing a short circuit of said source and a variable air gap in parallel with said primary and condenser and in a series circuit therewith.

17. In an ignition circuit, a source of low frequency energy, said source including high inductance, a high frequency transformer having its primary in series with said source, a condenser in series with said primary and source, said condenser being also in series with the secondary of said transformer, and a control device for intermittently and alternately providing a short circuit of said source and an air gap in parallel with said primary and condenser and in a series circuit therewith.

18. A spark gap comprising a first electrode, a second electrode movable relative to said first electrode and slightly spaced therefrom, and insulating means bearing directly on each of said electrodes for accurately spacing said electrodes apart to form a spark gap between them.

19. A spark gap comprising a first electrode, a second electrode movable relative to said first electrode and slightly spaced therefrom, and an insulating member firmly secured to one of said electrodes and bearing on the other of said electrodes for accurately spacing said electrodes apart to form a spark gap between them.

20. A spark gap comprising a first electrode unit including an exposed electrode, a second electrode unit rotatable relative thereto and including an electrode exposed toward and slightly spaced from said electrode, one of said units bearing on the other of said units, and at least one of said units including insulating means for accurately spacing and alining said electrodes apart to form a spark gap.

21. A spark gap comprising a first electrode unit including an exposed electrode, a second electrode unit rotatable relative thereto and including an electrode exposed toward and slightly spaced from said electrode, one of said units bearing on the other of said units, and at least one of said units including insulating means for accurately spacing said electrodes apart to form a spark gap, said insulating means firmly engaging one of said electrodes and engaging the other of said electrode units at a point adjacent to said electrode.

22. In an ignition system, a high frequency oscillating circuit including in series a primary coil for high frequency induction, a condenser and a control device; and means for energizing said circuit by charging said condenser, said control device including an electrode and a rotary member having a cam-shaped surface effective before discharge of said condenser for providing an air gap in said high frequency oscillating circuit and effective for varying the size of an air gap in accordance with the shape of said cam-shaped surface.

23. In an ignition system, a circuit including a primary induction coil and a spark gap in series

therewith; means for impressing a potential on said circuit tending to cause a current to jump said spark gap; and means for reducing the length of said spark gap after the intended sparking time to insure the passage of current through said coil.

24. In an ignition system, a circuit including a primary induction coil and a spark gap in series therewith; means for impressing a potential on said circuit tending to cause a current to jump said spark gap; and means for reducing the length of said spark gap after the intended sparking time and thereafter closing said gap.

25. An ignition system including a source of power, a primary winding of a high frequency transformer, and a condenser, all connected by uninterrupted conductors in series in a closed circuit, a spark gap connected in series with said primary winding and condenser and in parallel with said source of power, and a secondary winding of said high frequency transformer, and an ignition spark gap connected in a series circuit with said condenser.

26. An ignition system including a source of power, and a condenser connected in series by uninterrupted conductors in a closed circuit, a primary high frequency oscillating circuit including said condenser, a spark gap and a primary winding of a high frequency transformer connected in series, and a secondary high frequency oscillating circuit including said condenser, the secondary winding of said transformer, and an ignition spark gap.

27. An ignition system including a source of power and a condenser connected by uninterrupted conductors in series in a closed circuit, a primary high frequency oscillating circuit including said condenser, a spark gap and a primary winding of a high frequency transformer connected in series, a high induction kick circuit for charging said condenser with sufficient potential to jump said gap, including said source of power and a pair of contacts connected in series, and a secondary high frequency oscillating circuit including said condenser, the secondary winding of said transformer, and an ignition spark gap.

28. An ignition system for use with internal combustion engines comprising a plurality of cylinders each having a spark plug, a distributor for said spark plugs, a circuit including a make and break device, an electric source of supply in series therewith, said circuit including an inductance coil series-connected therein, a low tension winding of a high frequency transformer and a condenser in series and both in parallel with said make and break device, and a spark gap forming a current path in parallel with the path of current interrupted by the make and break device.

29. A spark gap comprising a first electrode, a second electrode movable relative to said first electrode and slightly spaced therefrom, and a tubular insulating member carrying one of said electrodes internally thereof and having its open end continually bearing on the other of said electrodes for accurately spacing said electrodes apart to form a spark gap between them.

30. A spark gap comprising a first electrode, a second electrode movable relative to said first electrode and slightly spaced therefrom, and a tubular insulating member carrying one of said electrodes internally thereof and having its open end continually bearing on the other of said electrodes for accurately spacing said electrodes apart to form a spark gap between them, and a recess in said other electrode in the path of movement of said open end thereon, to renew the air entrapped in said insulating member between said electrodes.

31. A combined interrupter and spark gap for use in ignition circuits comprising a sparking electrode and an interrupter contact electrically connected thereto, and a third member serving as both contact and electrode movable relative to said sparking electrode and contact, engaging the interrupter contact and slightly spaced from the sparking electrode by an insulating member firmly secured to one of said electrodes and bearing on the other of said electrodes for accurately spacing said electrodes apart to form a spark gap between them, said third electrode having a depressed portion therein; and means effective while said spark gap is thus formed for interrupting the engagement of said interrupter electrode by causing said depressed portion to pass under said interrupter electrode to separate it from said third electrode while maintaining said interrupter electrode against movement into the depression formed by said depressed portion.

32. A combined spark gap and interrupter comprising a current carrying roller having a depression in its peripheral surface on one side thereof, a pair of guards at the sides thereof electrically insulated from said roller, a current carrying interrupter brush engaging the roller, means for driving the roller to periodically place the brush opposite said depressed portion of the roller, said guards supporting the brush away from the roller opposite the depressed portion to interrupt the current as it passes from contact with the roller, and a sparking brush concurrently supported by the guards at a position accurately spaced from said roller to form a sparking gap therebetween.

33. In an ignition system, a rotary make and break device including a non-rotatable contact and a rotatable contact, one of which contacts is radially movable and urged toward the other, means for rotating said rotatable contact to slide across said fixed contact, support means for supporting said radially movable contact, said support means being associated with said other contact but insulated therefrom by suitable insulation and being positioned and shaped to form an air gap and an unobstructed sparking zone between said radially movable contact and said other contact to permit a good oscillating spark between said contacts; and an oscillating circuit including said contacts for causing a spark to oscillate therebetween.

34. An ignition system for use with internal combustion engines comprising a circuit including in series an inductance coil and a make and break device having separating contact areas which are in engagement last before the break, means for causing current to flow through said circuit, a condenser and a low tension winding of a high frequency transformer in series and both connected in a circuit across said contact points, and both connected in a circuit across electrode areas other than said separating contact areas and forming a spark gap across which the current may flow independently of said separating contact areas and independently of said inductance coil.

35. An ignition system for use with internal combustion engines comprising a plurality of cylinders each having a spark plug, a distributor for said spark plugs, an electric source of supply, an inductance and a make and break device both in series with said electric source of supply

to form a first circuit; a condenser, a low tension winding of a high frequency transformer and conductors connecting said elements together to form second and third circuits, the second including said inductance coil and condenser in series to charge said condenser when said make and break device breaks, and the third including said condenser and low tension winding in series and connected across a spark gap formed between electrode areas other than the areas through which the current last flows in said make and break device prior to its break, the length of the spark gap formed by said electrode areas being adjustable.

36. An oscillatory circuit including a transformer primary coil, a control device in said circuit in parallel with said primary coil including a current carrying roller, a current carrying brush normally contacting with the roller, means for turning the roller and means for moving the roller and brush out of contact with each other to impede the current and establish a sparking gap between them.

37. An oscillatory circuit including a transformer primary coil, a control device in said circuit in parallel with said primary coil including a current carrying roller, a current carrying brush normally contacting with the roller, means for turning the roller, the roller having an indented cam surface, and means for preventing the brush from following the contour of such surface whereby the roller and brush are separated and an arcing gap established between them.

38. An oscillatory circuit including a transformer primary coil, a control device in said circuit in parallel with said primary coil including a current carrying roller, a current carrying brush normally contacting with the roller, means for turning the roller, the cam surface of the roller being so arranged as to predetermine the exact point of circuit interruption so that the device may be utilized as a timer.

39. In an ignition system, a rotary make and break device including first and second contacts, one of which is rotatable to slide across the other in contact therewith, and the first of which is movable toward and away from the second and urged toward it, said second contact having a conducting surface at times engaging the first contact and terminated by an abrupt wall receding from the first contact, and supporting means secured to said second contact and having a supporting surface beyond the plane of said wall from said contacting surface but insulated therefrom; the rotation of said rotatable contact causing a relative motion between said conducting surface and said first contact whereby said first contact first contacts said surface and then is supported spaced from said second contact by said supporting surface, said supporting surface being so positioned with respect to said conducting surface as to form an air gap adjacent to it separating said contacts as one passes beyond the other to prevent the formation of a conductive film adjacent to said surface and to insure a clean break of the current as said make and break device breaks.

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