C. F. KETTERING.

IGNITION SYSTEM.

APPLICATION FILED JUNE 3, 1910.

1,040,349.

Patented Oct. 8, 1912.

3 SHEETS—SHEET 1.

Fig. 1.

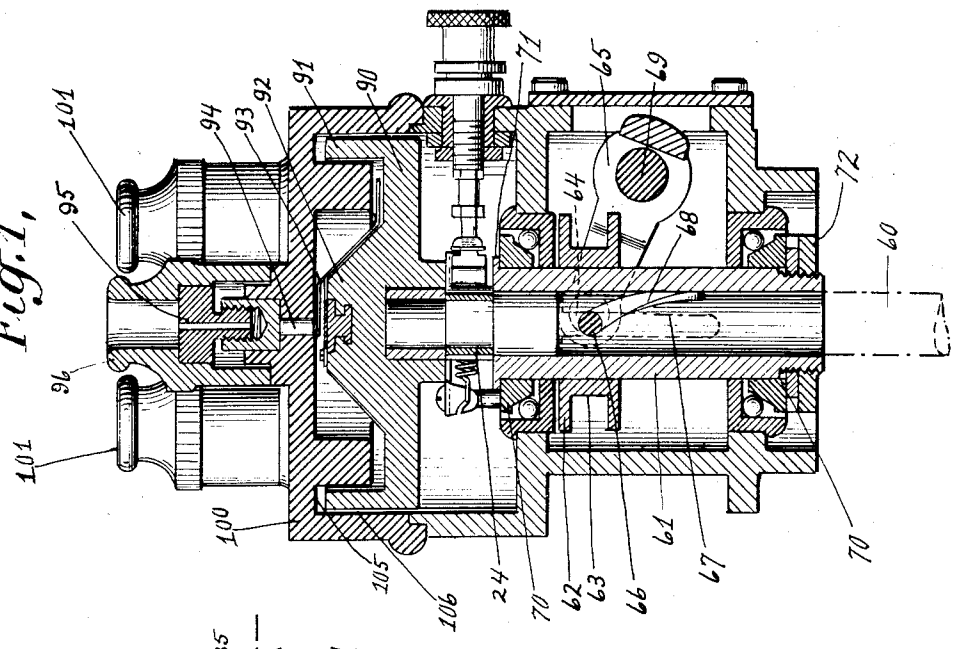


Fig. 2

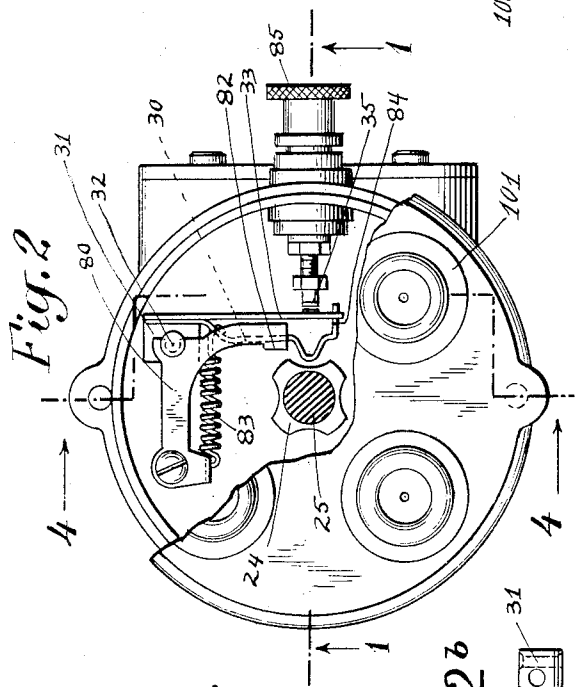


Fig. 3

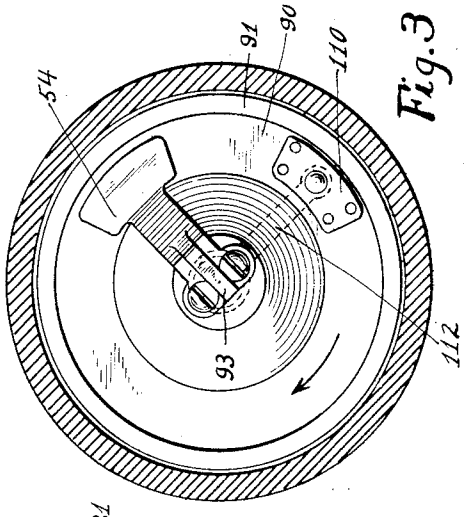


Fig. 2a

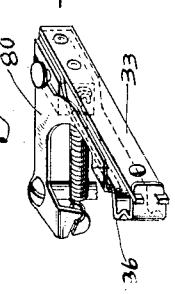


Fig. 2b

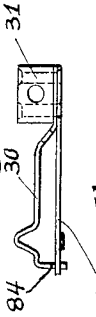
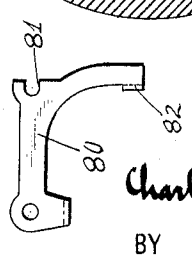


Fig. 2c



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3 SHEETS—SHEET 2.

Fig. 3,

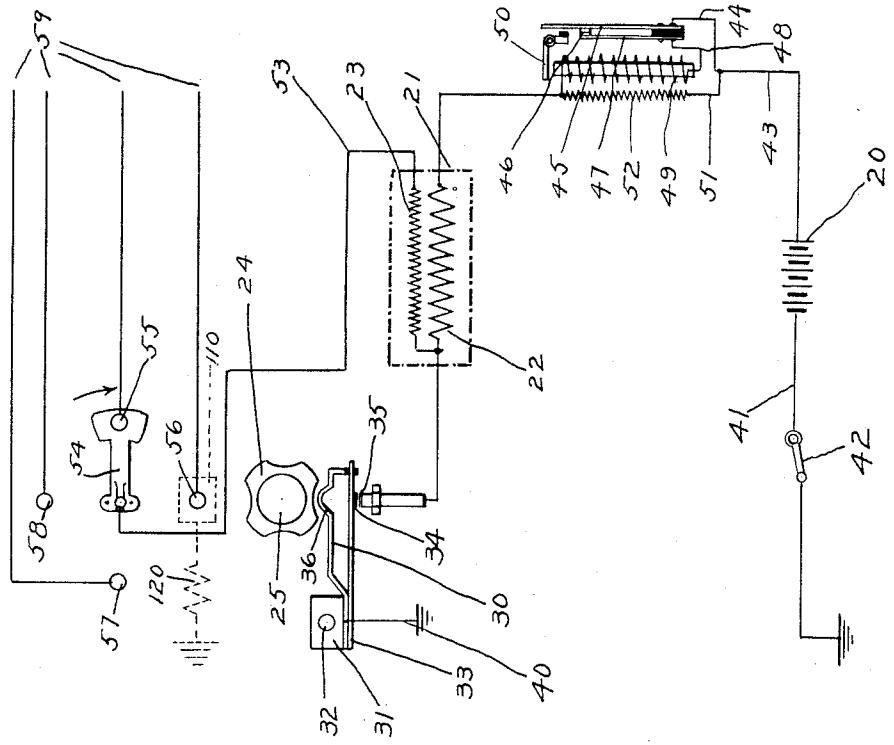
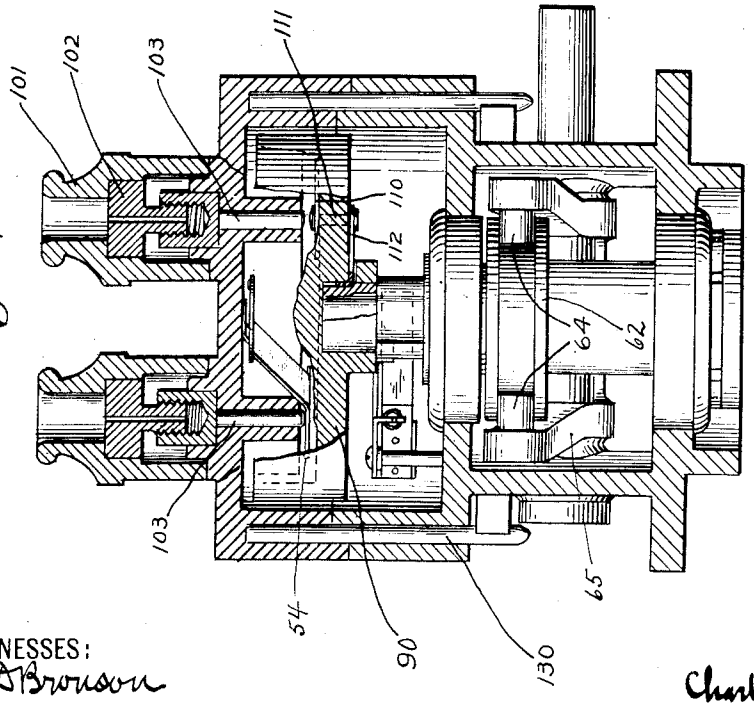


Fig. 4,



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3 SHEETS—SHEET 3.

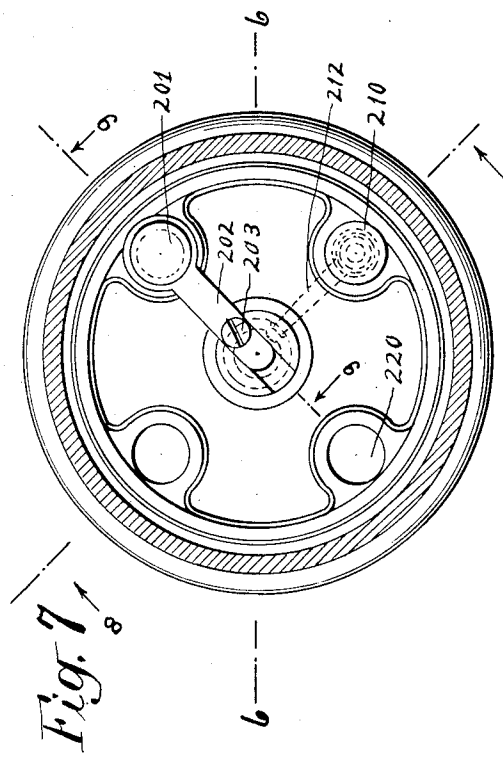

Fig. 7

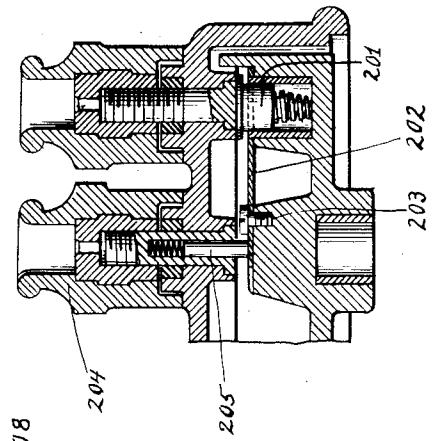

Fig. 9

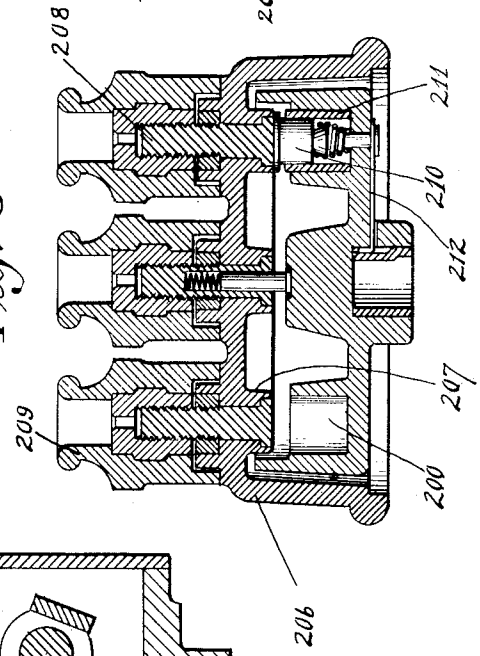

Fig. 8

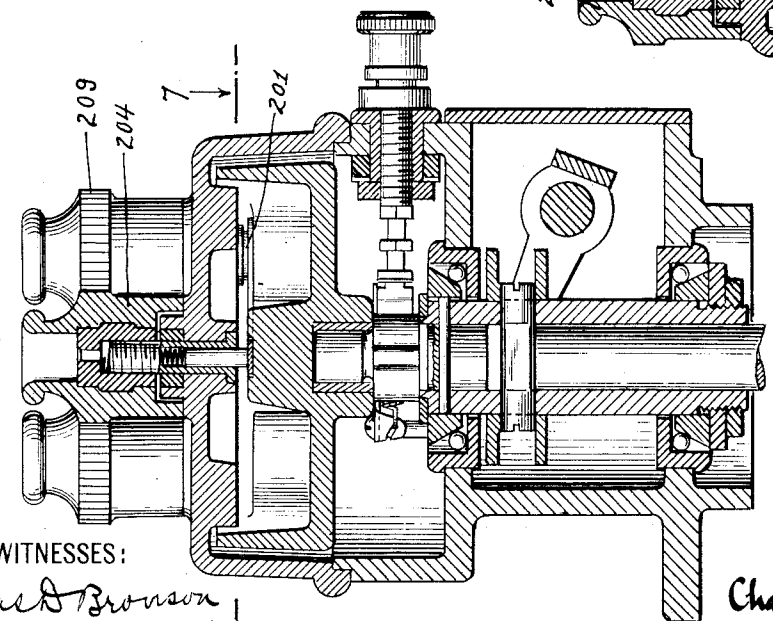

Fig. 6

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UNITED STATES PATENT OFFICE.

CHARLES F. KETTERING, OF DAYTON, OHIO, ASSIGNOR TO THE DAYTON ENGINEERING LABORATORIES CO., A CORPORATION OF OHIO.

IGNITION SYSTEM.

1,040,349. Specification of Letters Patent. Patented Oct. 8, 1912.

Application filed June 3, 1910. Serial No. 564,737.

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 has among its objects to provide an improved form of device more particularly as a distributer for systems where the secondary impulses are distributed in turn through the successive secondary circuits; although certain features of the invention are applicable to other forms of ignition systems.

It is particularly one of the objects of the present invention to provide means for dissipating the inductive currents which may arise in the secondary circuits adjacent to the circuit of the cylinder ready to fire, thereby preventing premature firing or sparking in the cylinders.

Another purpose is to provide an improved form of make-and-break device for the primary circuit; also an improved form of distributer head.

With these and incidental objects in view, the invention consists in certain novel combinations and constructions, the preferred forms of embodiment of which are shown in the accompanying drawings and are described in the specification which follows:

In said drawings, Figure 1 is a vertical section through the distributer, taken on the line 1—1 of Fig. 2 and looking in the direction of the arrows. Fig. 2 is a top plan view of the distributer, partly broken away to show the make and break device. Figs. 2^a, 2^b and 2^c are detail views of parts of the make and break device. Fig. 3 is a detail sectionalized view showing the distributer conductor vane and the advance guard vane. Fig. 4 is a partly sectionalized view along the line 4—4 of Fig. 2, and broken away to reveal certain of the interior mechanisms of the distributer. Fig. 5 is a diagrammatic view of the circuits. Fig. 6 is a sectionalized view (along the line 6—6 of Fig. 7) of a modified form of distributer, said modifications residing principally in the distributer head and distributer cap. Fig. 7 is a horizontal section on the line 7—7 of Fig. 6. Figs. 8 and 9 are detail sectional views along the lines 8—8 and 9—9 of Fig. 7.

In the diagrammatic view of Fig. 5 the battery 20 supplies the current for the induction coil 21 comprising the primary 22 and secondary 23. The make-and-break of the current through this primary 22 is under the control of a timer cam 24 attached to the shaft 25, and this make-and-break device includes means for securing a single impulse in the primary coil for each operative contact of the timer cam 24 whereby to produce a single spark in the secondary circuit instead of a series of sparks. Adjacent to the cam 24 is a resilient arm 30 made fast to a hub 31 pivoted at 32. This hub also carries a contact arm 33 on the outer end of which is a contact point 34 adapted to make contact with a stationary point contact 35. These parts will be described more in detail later, it being sufficient for the present to state that the cam 24 in rotating strikes the projection 36 on the arm 30 and closes the contact at the points 34 and 35. The hub 31 is grounded by the wire 40.

The battery 20 is grounded by wire 41 through an ordinary switch key 42. The other side of the battery is connected by a wire 43 to what may be called the locking relay, the construction of which is shown in my co-pending application. Wire 43 is connected by wire 44 to a movable contact arm 45 which normally closes contact at the contact points 46 with another contact arm 47. The latter arm is connected by a wire 48 with a coil 49 forming a solenoid which acts upon the bell crank armature 50 to pull the same downward. The wire 43 is also connected by wire 51 to a locking coil 52 which is wound around the same core as the coil 49 and is of higher resistance compared with the coil 49. Thus when the timer cam 24 closes the contact at the points 34 and 35, this thereby completes the battery circuit through the primary coil 22 and through the coil 49. The latter by thus becoming energized, attracts the armature 50, the other arm of which strikes the extension of the contact arm 45 and thereby breaks the contact at the points 46. The armature 50 is held in this position by the locking coil 52 so long as the contact is closed at the make-and-break points 34 and 35 by the cam pro-

jection 24. This results in a single breaking impulse through the primary coil 22 and therefore a single spark impulse through the secondary coil 23. This secondary coil 23 is connected at one end to the primary coil whereby to ground the secondary at this point, and the other end of the secondary coil is connected by wire 53 to a distributer vane 54 which rotates in the direction of the arrow in Fig. 5 and thus distributes the secondary impulse in turn to the terminals 55, 56, 57 and 58. From these terminals lead wires 59 extend, connecting the same with the spark plugs of the four cylinders of the gasolene or explosive engine. This distributer mechanism will be described more in detail later. It will be seen from this arrangement of the circuits, that each time the cam 24 operates the contact arm 30 to close the contact at the make-and-break points 34 and 35, a single breaking impulse is sent through the primary coil and this induces the necessary sparking impulse in the secondary coil, said coil then forming part of a secondary circuit for some one of the four cylinders according to the position of the distributer vane 54, which is suitably connected to the timer cam 24 as presently described.

Referring now to Figs. 1 and 2, the mechanical construction of these parts including the timer cam and the distributer mechanism embodied compactly in one piece of apparatus, will now be described.

The driving shaft 60, shown in dotted lines of Fig. 1 is suitably connected to the engine shaft and geared to the proper ratio of movement to operate the timer and distributer in proper cycle. This driving shaft 60 drives a surrounding sleeve 61 which sleeve for convenience may be called the distributer shaft since it carries at its upper end the timer cam 24 and also the distributing mechanism as presently explained. A collar 62 loosely surrounds the sleeve 61 and is formed with an annular groove 63 into which groove project rollers 64 (see Fig. 4) carried by yoke arms 65. This yoke may be called the advance yoke since it is operated to advance or retard the spark as is customary in mechanisms of this sort. The said collar 62 has extending centrally through it a pin 66 (see Fig. 1) over which fits the slotted end 67 of the driving shaft 60. Said cross-pin 66 also extends through a spiral slot 68 formed in said sleeve 61. By this means, the rotation of the driving shaft 60 acts through the cross-pin 66 to rotate the collar 62 and the sleeve 61, that is, thus rotating the distributer shaft carrying the timer cam 24. The change of timing is effected merely by changing the relative positions of the driving shaft 60 and the distributer sleeve 61, this being accomplished by rotating the advance yoke 65 about its pivotal shaft 69 (by means of suitable hand lever and connections). The result of thus rocking the advance yoke 65 is to move the collar 62 up or down, thus moving the cross-pin 66 up or down and thereby bearing upon the walls of the spiral slot 68 to rotate the sleeve 61 into different positions relatively to the drive shaft 60. This at the same time of course changes the relative position of the timer cam 24 and advances or retards the time of the make-and-break. The sleeve 61 carries suitable roller bearing 70 at top and bottom, and is formed with a supporting flange 71 at the top and is locked in position by a suitable locking nut 72 at the bottom.

The make-and-break device controlled by the timer cam 24 will now be described, with more particular reference to Figs. 2, 2^a, 2^b, and 2^c. These parts have been described in general with reference to Fig. 5. There is also associated with the resilient arm 30, a stop-arm 80, the exact shape of which is shown in Fig. 2^c. One end of this arm is screwed to the casing of the instrument, and the middle portion is slotted as at 81 to surround the pivotal stud 32 of the hub or block 31, thus holding the stop-arm in rigid position. At the other end of this arm a lateral projection 82 extends in under the resilient arm 30 so as to form a stop for the inner movement of said arm toward the cam 24. A spring 83 attached at one end to the stop-arm 80 and at the other end to the arm 30, holds the hub 31 rotated to the position shown in Fig. 2 with the resilient arm 30 resting against the stop projection 82. The contact arm 33, carrying the contact points 34, as already described, is carried rigidly on the pivotal hub 31. The outer end of the arm 30 is bent at right angles and is slotted at 84 on both sides (see Figs. 2 and 2^b), thus forming a T-shaped end which engages the forked extremity of the contact arm 33 (see Fig. 2^a). There is a slight amount of play between the arm 33 and this slotted portion 84 of the resilient arm 30, for the purpose presently explained, (see also Fig. 1.) In the operation of this make-and-break device, the rotating cam 24 strikes the nose 36 of the resilient arm 30, and this arm is of sufficient rigidity to turn the hub 31 on its pivot 32 thereby bringing the contact arm 30 into contact-making position. The resilient arm 30 however yields further to the camming movement of the cam 24, the slot 84 permitting this additional movement of the resilient arm 30, such additional movement causing additional pressure on the contact arm 33. When the contact projection 24 rides by the nose 36 and brings a recess in the cam opposite said nose, the spring 83 rotates the hub 31 back to normal position with the arm 30 against its stop projection 82, thus breaking the contact.

And if there should be any tendency of the contact points to stick, the T-shaped end of the arm 30 will, in returning, strike and pull the contact arm 33 back into non-contact position, this also serving to give a quick and positive break. This form of construction has various advantages among which may be instanced the minimizing of the chattering of the contact upon rapid operation. Any momentum of the arm 30 caused by the impact of the cam 24 is taken up resiliently with the lost motion provided by the slot 84 and serves merely to give increase in pressure on the contact arm 33, while the return of the arm 30 serves quickly to bring back the contact arm 33. The contact terminal 35 is connected to a terminal stud or knob 85 to which the wire may be attached for connecting said contact to the rest of circuit as shown in Fig. 5.

The distributer mechanism will now be explained.

Just above the timer cam 24 and made fast to the extension of the distributer sleeve or shaft 61 is a circular distributer disk 90 (see Figs. 1, 3 and 4), made of insulating material such for example as hard rubber. This disk is formed with a peripheral flange 91. The center portion of the disk is raised slightly in conical form as at 92, and on this conical center portion is mounted the aforesaid distributer vane 54 already described with reference to Fig. 5. The inner end of this vane is struck up to form a leaf spring 93 which normally bears against pin 94 connected with a metal screw 95 seated within the terminal cap 96. The lead wire 53 (see Fig. 5) which is connected at one end with the secondary coil 23, is connected at its other end with this terminal cap 96 and pin 94 and thus continuously connected to the distributer vane 54 during the rotary movement of the latter. This terminal cap 96 occupies the center portion of a distributer cap 100, likewise made preferably of insulating material such as hard rubber. This distributer head carries four other terminal caps 101 for the lead wires 59 (see Fig. 5) of the four secondary circuits for the four cylinders. As shown in Fig. 4, each of these terminal caps 101 contains a screw 102 adapted to receive the connecting wire and connected at their lower ends to the pins 103 which project through the lower side of the distributer head sufficiently to come into the path of the rotating distributer vane 54. The ends of these pins 103 therefore constitute the four secondary terminals 55, 56, 57 and 58 shown in Fig. 5, and the distributer vane 54 wipes over these four contact points in turn and thus distributes the secondary impulse to the cylinder which contains the explosive mixture ready for firing. At the same time that the distributer vane is making contact with one of the secondary terminals, the timer cam 24 is of course closing the make-and-break device to cause the locking relay to send a single impulse through the primary of the induction coil and thus cause a single spark in the secondary circuit of this cylinder which is ready for firing. It will be noticed from Figs. 1 and 4 that the said distributer head 100 is formed with a peripheral groove 105 which receives the aforesaid flange 91 of the distributer disk 90. And the disk 90 and head 100 are thus separated by an intervening air space 106, along the outer, upper, and inner walls of flange 91, thus forming an elongated and tortuous air path to minimize leakage from the secondary circuit.

The means for dissipating inductive currents in the adjacent secondaries will now be described.

An advance vane 110 (see Figs. 3 and 4) is carried upon the distributer disk 90 in a position about 90 degrees in advance of the distributer vane 54, at least, in such position that when the vane 54 is making contact with one of the secondary contact terminals, the guard-vane 110 will at the same time be making contact with the secondary terminal next in advance. The position of this guard-vane 110 is shown in dotted lines in Fig. 5, the distributer vane being in contact with the secondary terminal 55, and the guard-vane 110 being in contact with the secondary terminal 56 next in advance in the direction of rotation. This guard-vane 110 is grounded in the following manner: A pin 111 extends through the disk 90 and is connected to a grounding strip 112 which extends across the lower surface of the disk and is electrically connected to the upper end of the distributer shaft which thereby constitutes the grounding of this guard-vane, this grounding being shown diagrammatically in Fig. 5. It results from this construction that when the parts are in the position shown in Fig. 5, the secondary sparking impulse is sent through the terminal 55 to its corresponding cylinder. It will be understood that in such position of the distributing vane 54, the connected timer cam 24 would occupy a position about 45 degrees displaced from the position shown in Fig. 5 namely, wherein the cam projection would be engaging the nose 36 and thus making contact between the points 34 and 35. The sending of the secondary impulse through the secondary terminal 55 causes the spark in the cylinder of that circuit, which thus ignites the explosive mixture which has just been compressed ready for firing. In such case there is an adjacent cylinder which has had an explosive mixture taken into it and is the cylinder next to be fired.

It sometimes happens that as an accompaniment to the regular sparking in the di-

rectly energized spark circuit of the firing cylinder, there may be set up, or caused, in the adjacent secondary circuit, an inductive current, whether induced statically or under magnetic influence of some sort. If such inductive current arises in this adjacent circuit, it would cause premature firing of the cylinder next to be fired, thereby causing improper operation of the engine, and at times producing what has sometimes been termed "bucking" of the motor. With this guard-vane 110, however, it will be observed that the adjacent secondary circuit, for the cylinder next to be fired, is grounded. That is, the guard-vane is grounded through the pin 111 and conducting strip 112, and distributer shaft 61, to the engine frame. (It will of course be understood that the secondary lead wires 59 extend to one terminal of the respective spark plugs, the other terminals thereof being grounded to the engine frame.) The guard-vane 110 thus serves to ground or to short-circuit this adjacent secondary circuit and thus serves as a means for dissipating any inductive current in the adjacent secondary circuit. That is, the inductive current is caused to take a path other than through the spark plug of the cylinder next to the fire.

Although the above description has been applied to a four-cylinder engine, it will be apparent that this improvement is applicable to other systems having a different number of cylinders. For example, in a six-cylinder engine, this advance vane would be utilized to dissipate the inductive current in the secondary circuit of the cylinder next to fire, which would be the adjacent cylinder in point of cycle of operation although not adjacent as to mechanical location. This improvement, which has been referred to as a dissipating means, is also applicable to other forms of ignition systems where other devices are used for sending spark producing currents through the secondary circuits in the desired order,—not as a means of obstructing the passage of the inductive influence to the adjacent circuit, but as a means of dissipating it, should any such inductive current arise. It may happen that as an accompaniment to this very process of dissipation of the inductive current, an oscillatory effect or current may be set up in this adjacent secondary circuit in which it is desired to prevent the sparking. Therefore, to prevent such effect, there is introduced into this circuit of the grounded guard-vane 110 a resistance 120 shown in diagrammatic Fig. 5. This resistance may be in the shape of a small coil of wire mounted upon and carried with the rotating distributer disk 90, and intervening in the circuit at any convenient place between the guard-vane 110 and the grounded distributer shaft. This resistance 120 is so proportioned as to minimize any surging or oscillatory condition in this grounded circuit and thereby reduce the oscillatory effect to a negligible quantity and prevent disruptive discharges through this secondary circuit during this process of dissipation.

It will be seen this device for dissipating the inductive current in the adjacent secondary circuit has an additional advantage when acting in coöperation with the previously described locking relay which serves to produce a single sparking impulse in the secondary at each contact of the timer cam.

The distributer head 100 may be suitably held in place on the underlying base of the distributer frame, by means of upright rods 130 (see Fig. 4).

In Figs. 6, 7, 8 and 9, are shown modified forms of distributer disk and distributer head. In this case the distributer disk is formed near its periphery with four pockets 200. In one of these pockets (see Figs. 6 and 9) there fits a spring pressed plunger 201 which is connected by a metal strip 202 with the central portion of the distributer disk, being fastened to said central portion by a screw 203. This plunger 201 and plate 202 correspond with the previously described distributer vane 54. The central terminal cap 204 carries the spring pressed pin 205 to which is attached the common wire for the secondary circuits corresponding with the wire 53 of Fig. 5. The distributer cap 206 is formed with a downwardly projecting ring or flange 207, into which flange project four pins 208. These pins project upwardly into the four terminal caps 209 and are adapted to have attached to them the four lead wires 59 of the secondary circuit. Thus the plunger 201 is carried around by the revoluble distributer disk and is held by spring tension against the under surface of the ring 207, and makes contact in turn with the ends of the conducting pins 208, which ends of said pins lie embedded just even with the surface of the ring so as to form smooth but certain contact with the distributing plunger 201. The guard-vane in this case is in the shape of a plunger 210 seated in the pocket 211 next adjacent to the plunger 201 and in the direction of advance relatively to the direction of rotation. This guard plunger 210 is grounded to the distributer shaft and engine by a conducting plate 212, and operates similarly to the previously described guard-vane 110, traveling along the under surface of the ring 207 and making contact successively, in advance, with the pins 208 for the next adjacent secondary circuit. The distributer cap 206, including the ring 207 is of course made of insulating material.

In case it should be desired to have the distributer disk run in a reverse direction (for example, where the direction of the

running of the engine or the connecting gearing necessitates using the distributer to run in a reverse direction,) this can very readily be accomplished by merely shifting the distributer plunger 201 over to its opposite pocket 220 (see Fig. 7), the screw 203 being loosened and the strip 202 being likewise turned in the opposite direction and the screw tightened up in its new position. It will be seen that the timer cam 24 and the make-and-break device are adaptable for this running of the parts forwardly or reversely, so that by this very simple means the distributer may be used for either direction of rotation in connection with this guard-vane or device for traveling in advance of the distributer conductor in order to dissipate the inducted currents as above described.

While the forms of mechanisms hereinbefore described are well adapted to accomplish the objects sought, it is to be understood that various other forms might be utilized, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In an ignition distributer system, the combination with the engine and cylinders; an ignition device including a spark coil, a secondary circuit for each of the several cylinders, and means for distributing the secondary current to the respective cylinders in the desired order; of means for dissipating the inductive current in the secondary circuit adjacent to the circuit of the cylinder fired by the distributing means.

2. In an ignition system, the combination with the engine and cylinders; an ignition device including sparking circuits for the various cylinders, and means for sending a spark producing current through said circuits in the desired order; of means for dissipating the inductive current in the secondary circuit adjacent to the directly energized spark circuit.

3. In an ignition distributer system, the combination with the engine and cylinders; an ignition device including a spark coil, a secondary circuit for each of the several cylinders, and means for distributing the secondary current to the respective cylinders in the desired order; of means connected with said distributing means for dissipating the inductive current in the secondary circuit adjacent to the circuit of the cylinder fired by the distributing means.

4. In an ignition distributer system, the combination with the engine and cylinders; an ignition device including a spark coil, a secondary circuit for each of the several cylinders, and a rotary distributer having a distributing conductor for closing the secondary circuits in the desired order; of means carried by said rotary distributer in advance of the distributing conductor for dissipating the inductive current in the adjacent secondary circuit.

5. In an ignition distributer system, the combination with the engine and cylinders; an ignition device including a spark coil, an open grounded secondary circuit for each of the several cylinders, and a rotary distributer having a distributing conductor plate to close the various secondary circuits in turn; and a grounded conductor mounted on said rotary distributer in advance of the conductor plate in position to close the next adjacent secondary circuit and ground the same to dissipate any inductive effect therein.

6. In an ignition distributer system, the combination with the engine and cylinders; an ignition device including a spark coil, a secondary circuit for each of the several cylinders, and means for distributing the secondary current to the respective cylinders in the desired order; of means for dissipating the inductive current in the secondary circuit adjacent to the circuit of the cylinder fired by the distributing means; and means associated with said dissipating means, for preventing disruptive discharges through this secondary circuit during such process of dissipation.

7. In an ignition system, the combination with the engine and cylinders; an ignition device including sparking circuits for the various cylinders, and means for sending a spark producing current through said circuits in the desired order; of a grounded circuit for successively dissipating the inductive current in the secondary circuit adjacent to the directly energized spark circuit; and proportioned resistance located in said grounded circuit for minimizing the oscillatory effect due to said dissipation.

8. In an ignition distributer device, the combination with a rotary driving shaft, primary and secondary circuits, and means connected with said shaft for making and breaking the primary circuit; of an insulating distributer disk mounted to revolve on said shaft and formed with an insulating peripheral flange; and an insulating cap surmounting said disk and carrying the secondary terminals, said cap being formed with a peripheral groove to receive said flange but separated therefrom by an air space whereby said flange and groove form an elongated and tortuous air path to minimize leakage from the secondary circuits.

9. In an ignition distributer system, the combination with the engine and cylinders, of an induction coil including a primary and a secondary coil; a circuit for said primary coil, including a make-and-break device and an operating member for the latter; means connected with the circuit of said primary coil for producing a single current-breaking impulse through the primary coil for each

operation of the make-and-break device by said operating member; a secondary circuit for each of the several cylinders, including said secondary coil; means for distributing the secondary current to the respective cylinders in the desired order; and means for dissipating the inductive current in the secondary circuit adjacent to the circuit of the cylinder fired by the distributing means.

10. In an ignition system, the combination with an engine and cylinders, sparking devices in the cylinders, and means for producing the sparking impulses; of means for dissipating the inductive current in the sparking circuit adjacent to the circuit of the cylinder fired by said sparking impulse means.

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

CHARLES F. KETTERING.

Witnesses:
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R. S. DE MAREE.