July 5, 1927. 1,634,737

W. A. CHRYST ET AL

IGNITION APPARATUS

Original Filed Dec. 22, 1917 3 Sheets-Sheet 1

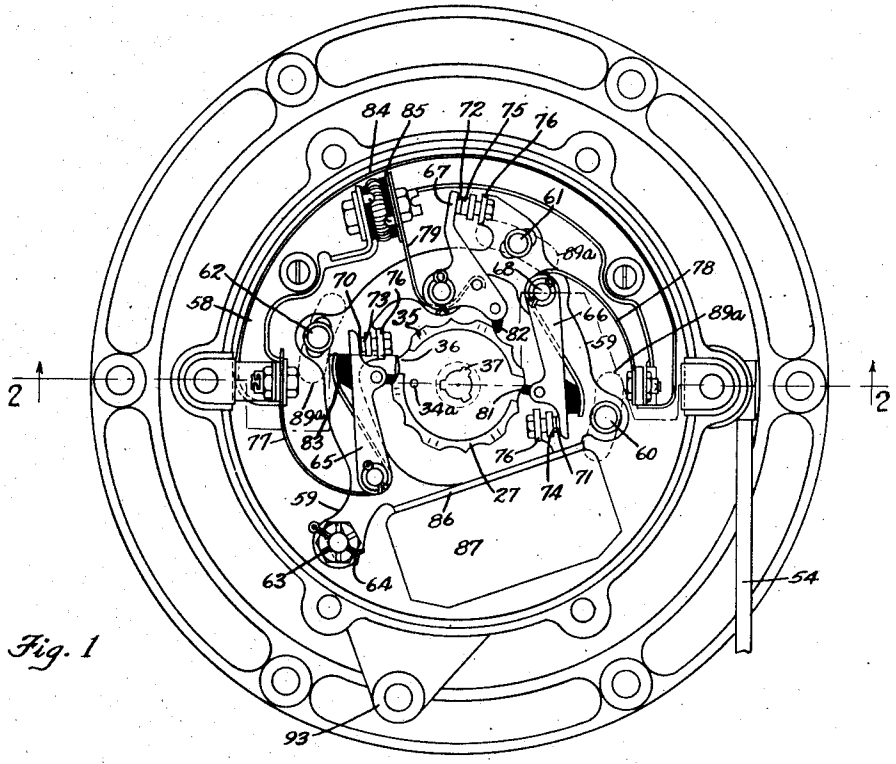


Fig. 1

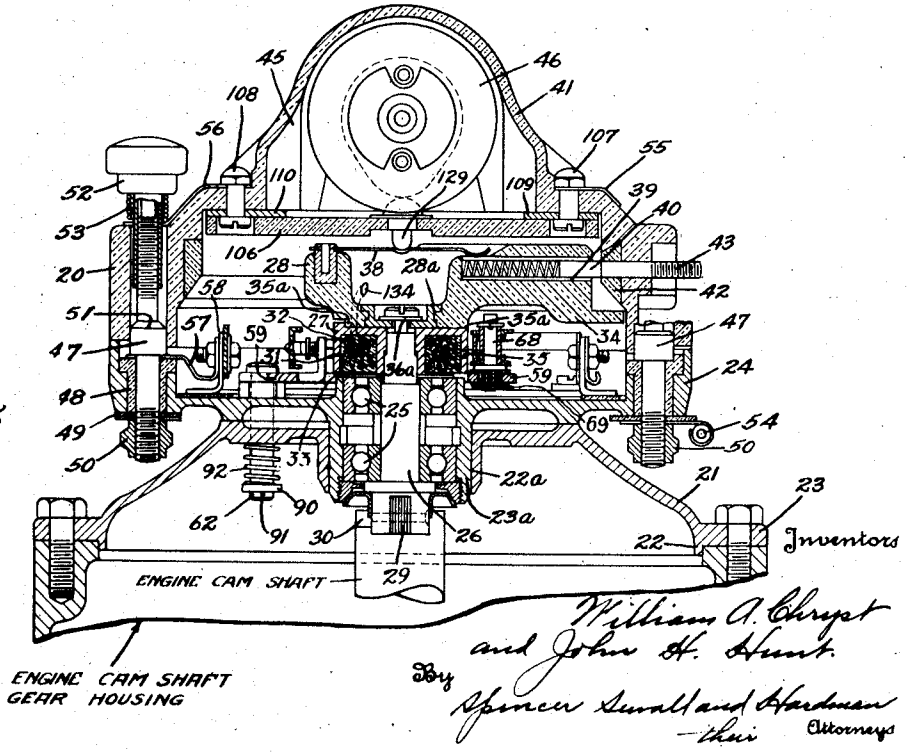


Fig. 2

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IGNITION APPARATUS

Original Filed Dec. 22, 1917 3 Sheets-Sheet 2

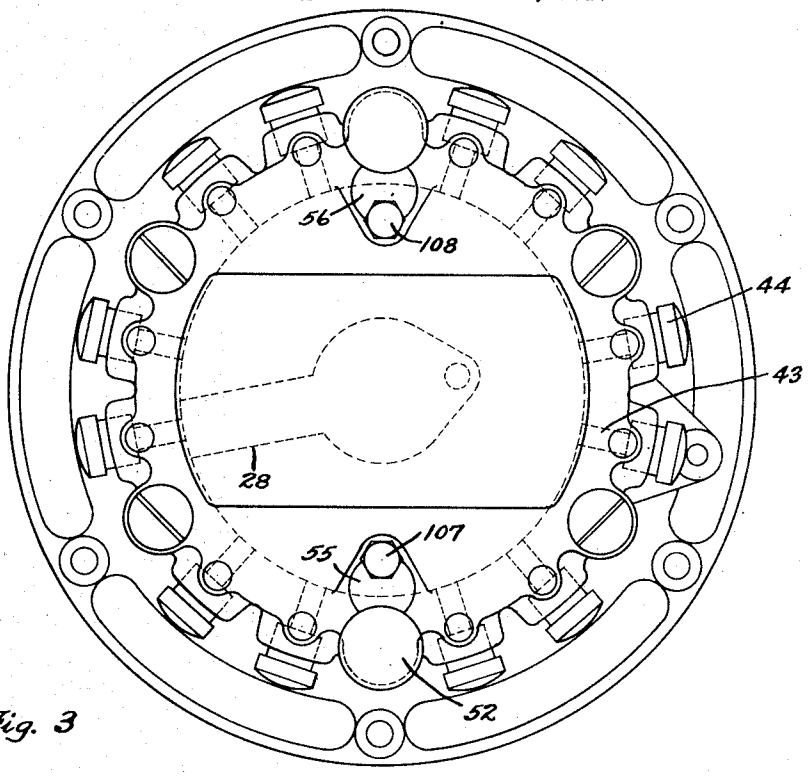


Fig. 3

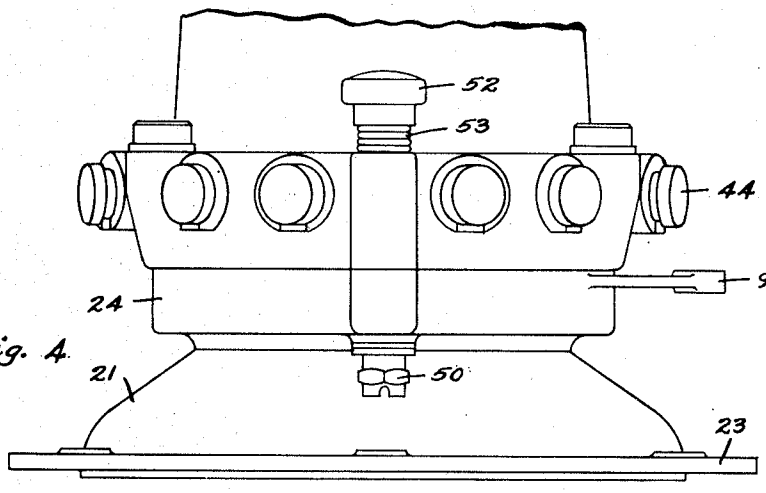


Fig. 4

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IGNITION APPARATUS

Original Filed Dec. 22, 1917 3 Sheets-Sheet 3

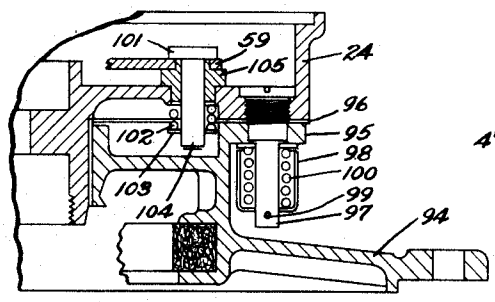


Fig. 5

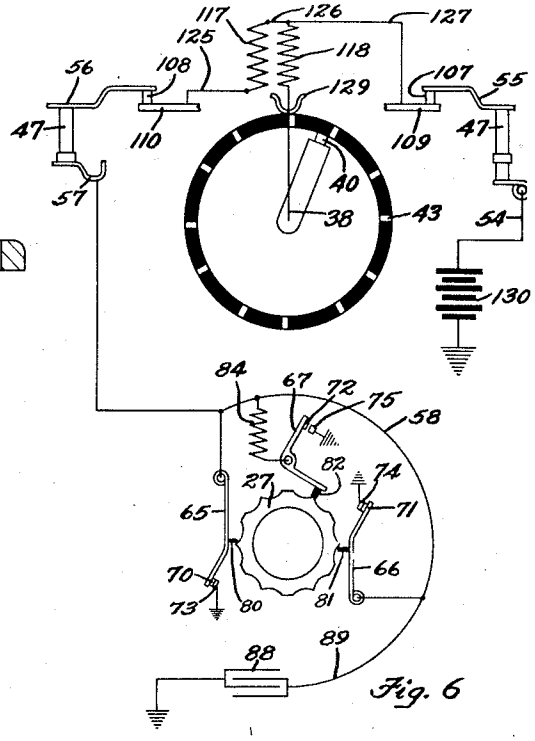


Fig. 6

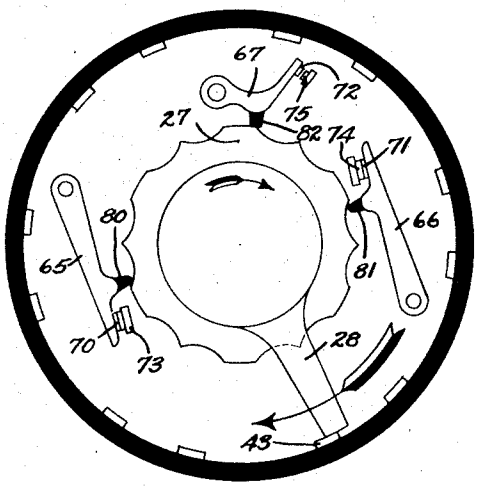


Fig. 7

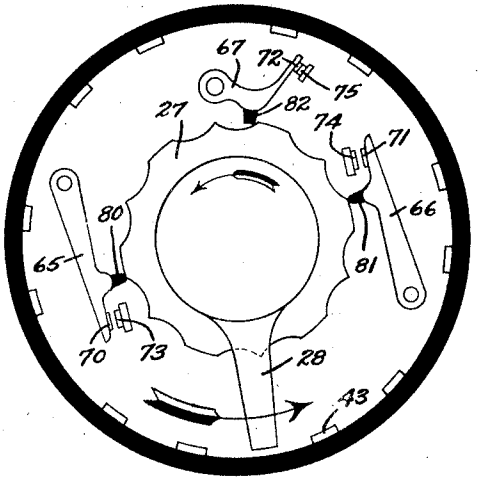


Fig. 8

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Patented July 5, 1927. 1,634,737

UNITED STATES PATENT OFFICE.

WILLIAM A. CHRYST AND JOHN H. HUNT, OF DAYTON, OHIO, ASSIGNORS, BY MESNE ASSIGNMENTS, TO DELCO-REMY CORPORATION, OF DAYTON, OHIO, A CORPORATION OF DELAWARE.

IGNITION APPARATUS.

Original application filed December 22, 1917, Serial No. 208,369. Divided and this application filed September 26, 1924. Serial No. 740,102.

This invention relates to ignition equipment for multi-cylinder engines, and, more particularly, for engines used in aviation work where maximum efficiency, lightness of weight and compactness of arrangement are required. Among the objects of invention, the following are enumerated.

This application is a division of copending application Serial No. 208,369, filed December 22, 1917.

To provide an improved ignition unit which is exceedingly simple and compact in design, light in weight, and reliable in operation; and one wherein the various parts are readily accessible for repairs or adjustments.

To provide an engine controlled ignition unit adapted for ready connection with the engine, the base of the unit serving as a cover for a casing inclosing a part of the engine gearing, so that practically no weight is added to the motor by the mounting of the unit thereon.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein preferred embodiments of the present invention are clearly shown.

In the drawings:

Fig. 1 is a plan view of the ignition unit, the distributor head and rotor being removed;

Fig. 2 is a view showing a vertical cross section of the distributor, taken along the line 2—2 of Fig. 1;

Fig. 3 is a plan view of the unit;

Fig. 4 is a fragmentary side view of the unit;

Fig. 5 is a fragmentary section of the distributor, as shown in Fig. 2, but with slight modifications;

Fig. 6 is a wiring diagram of one of the ignition units with a single source of current; and

Figs. 7 and 8 are diagrammatic plan views of the timer and distributor rotor of one of the units, showing relative positions during normal and reverse rotations respectively of the engine.

One of the ignition units will first be described: Referring to the drawings, 20 designates the unit having a circular base 21, provided with an annular boss 22 and a flange 23, adapted to secure the unit in place upon the cam shaft gear housing of an engine. The usual end cover for the cam shaft gear housing is replaced by the base 21, which is centrally apertured to provide a bearing 22^a for a rotatable sleeve 23^a which forms an extension of the timer cup 24 or timer supporting element. The sleeve 23^a is provided with bearings 25 for a central shaft 26 carrying at its upper end the timer cam 27 and the distributor rotor 28. The end of the shaft 26 nearest the engine is provided with a leaf-spring connection 29 and a locating pin 30 for connecting the shaft with the engine cam shaft.

The cam 27 is provided with an annular channel 31 for the reception of felt or other oil absorbing material 32 and held in place by means of an annular retaining ring 33. The upper wall of the cam is apertured at 34^a and the cylindrical walls are apertured at 35. Oil is introduced at 34^a and is absorbed by the felt. Upon rotation of the cam, oil will be withdrawn from the felt by centrifugal force and pass out through holes 35 to the outer surface of the cam for purpose of lubrication. Thus a further object of this invention has been accomplished, namely, the provision of a self-lubricating cam in which may be stored a quantity of oil to be conducted as needed to the outer surface of the cam, to prevent undue wear and reduce friction between the camming surface and the cam followers. The weight of the cam is reduced to a minimum consistent with strength and rigidity by virtue of the hollow construction.

The rotor comprises an arm 34 of insulating material mounted upon the cam 27, and held in proper relation therewith by means of lugs 35^a projecting into non-diametrically opposed recesses 36, formed in the upper surface of the cam. Since lugs 35^a and recesses 36 are not diametrically opposite, whenever the rotor is placed upon the cam with said lugs seated in said recesses, it is certain that the rotor will be correctly located with respect to the cam. Both the rotor and cam are held in place upon the shaft 26 by means of a screw 36^a, the cam being broached as at 37 for the securing thereof upon the shaft 26 in fixed relation.

The rotor carries a spring 38 which engages a metallic sleeve 39, in which slides a spring pressed plunger 40 made of conducting material. The weight of the rotor has been reduced by recessing the hub. A metal disc 28a, about which the insulating material composing the rotor is cast, serves as an element which can be machined to close limits; and, seated upon the accurately machined upper surface of the cam and serving as a seat for the screw 36a, disc 28a will maintain the rotor in correct alinement with the distributor track to be described. The rotor is provided with a passage 134 leading to hole 34 in the cam, whereby oil may be introduced into the cam without first removing the rotor.

The distributor head 41 is constructed of insulating material, such as bakelite, which has been moulded around a vulcanized rubber ring 42 which serves as the distributor track. Metallic stationary contact elements 43 extend through the side walls of the head and terminate flush with the surface of the track. Members 43 are threaded to receive binding nuts 44 for the purpose of attaching the leads which conduct current from the stationary contacts to the various spark plugs of the motor. The upper portion of the head is provided with an interior chamber 45 for the reception of an induction coil 46 which will be described later. The head is held in place upon the timer cup by means of bolts 47, insulated from the cup by means of bushings 48 and washers 49, and provided at their lower extremities with nuts 50. The tightening up of nuts 50 will draw the enlarged portions 51 of the bolts down upon bushings 48. The upper portions of the bolts extend through the head and are threaded to receive thumb nuts 52 of insulating material. Springs 53 are interposed between a shoulder formed on nuts 52 and the upper surface of the head, and serve to transmit a yielding pressure from the nuts to maintain the head in place on the timer cup.

These bolts 47 serve as electrical conductors, one of them being connected by means of a conductor 54 with a source of current which it transmits to a metallic strip 55. The other bolt 47 is electrically connected at its upper end with strip 56, and at the enlarged portion 51 with a strip 57, which in turn is connected with a connecting plate 58 mounted upon the bottom of the timer cup, but insulated therefrom.

Upon the bottom of the timer cup is mounted a breaker arm bracket 59, by means of pins 60, 61 and 62, extending through the bracket, timer cup, and base; and by means of a stud 63 mounted in the timer cup and having its upper end threaded to receive a nut 64. The pin 60 extends through a round hole in the bracket and serves as a pivot about which the bracket may be swung for adjustment, which will be described later, slotted apertures being formed in the bracket for the reception of the pins 61 and 62, and for the stud 63.

It will be seen that by loosening the nut 64, that the bracket 59 may be swung about the pin 60 to a desired position and may be secured by tightening the nut 64. The breaker arm bracket 59 carries breaker arms 65, 66 and 67, mounted upon posts 68 secured to the bracket, but insulated therefrom by means of non-conducting bushings 69. The arms 65, 66 and 67 are provided with contacts 70, 71, 72, respectively, which engage with stationary contacts 73, 74 and 75, respectively, which are adjustably mounted upon up-turned ears 76, formed integral with the bracket 59. Springs 77, 78 and 79 are electrically connected at one end with the member 58, and at other portions thereof with the arms 65, 66 and 67, respectively. The springs serve to keep the stationary and movable contacts in touching relation, except at such times when the cam cooperating with the fiber followers 80, 81 and 82 will cause the pairs of contacts to separate. Rubber cushions 83 are interposed between the ends of springs 77 and 78, and their respective arms, and serve to transmit the spring pressure to maintain the contacts in engagement. The rubber cushions 83 serve to absorb the shock, due to the sudden impact of the contacts when the cam permits the arm to swing back, and thus prevent rebound or chattering when revolving at high speeds. This rubber cushion feature, however, forms no part of the present invention, but is fully described and claimed in the patent to John H. Hunt, No. 1,462,860, issued July 24, 1923. A resistance coil 84, supported upon a spool 85 of non-conducting material, is interposed between the spring 79 and connecting plate 58, the purpose of which will be described later. The breaker arm bracket 59 is provided with an upturned projection 86, upon which is mounted a condenser casing 87 containing a condenser of well known construction shown diagrammatically in Fig. 6 at 88. One terminal of the condenser is connected with the connecting plate 58 by a wire 89, and the other terminal is grounded upon the bracket 59 (see Fig. 6).

The pins 60, 61 and 62, extend through curved slots 89a in the upper wall of the base. These pins are provided at their lower ends with washers 90 and held in place with cotter pins 91. Springs 92 are interposed between the upper surfaces of the washers and the inside of the top wall of the base. The purpose of these springs and slots 89a is to permit an adjustment of the timer cup on the base to regulate the time of the spark and to hold the timer cup 24 in adjusted po-

sition. The timer cup is provided with an outwardly extending arm 93 (see Figs. 1 and 4), to which may be attached any suitable device within easy reach of the operator which will transmit motion to the timer cup for the purpose of revolving the contact arms carrying the movable contacts, and the stationary primary contacts about the timer cam; and revolving the distributor stationary contacts carried by the head about the distributor rotor, for the purpose of obtaining an advance or retard in the timing of the spark in a manner well known in the art.

In Fig. 5 is shown a slight modification of the construction just described. The base 94 in this construction is provided with an outwardly extending annular flange 95. The bottom surface of the timer cup 24 rests upon a copper gasket 96 interposed between the cup 24 and flange 95, for the purpose of securing a more perfect electrical connection. Pins 97 are fixed at their upper ends in the cup 24 and extend through slots formed in the flange 95, similar to the slots 89 already described. The lower ends of pins 97 are provided with spring retaining cups 98, held in place by cotter pins 99; and springs 100 are interposed between the flange and bottom of the retaining cup, and serve the same purpose as springs 92 described. Separate pins 101 cooperating with springs 102 interposed between the bottom of the timer cup and washers 103, held in place by means of cotter pins 104, serve to hold the breaker arm bracket 59 in place upon shouldered washers 105 carried by the timer cup.

The ignition coil 46 is supported by brackets 109 and 110 attached to a nonconducting base 106 which is seated in a circular recess formed in the distributor head above the track 42. Brackets 109 and 110 are secured to the head 41 by bolts 107 and 108 respectively, which pass through and make electrical connections with the coil brackets 109 and 110, and with the strips 55 and 56, respectively.

One end of the coil primary winding is connected to bracket 110. The other end of the coil primary winding and one end of the coil secondary winding are connected to the bracket 109. The other end of the coil secondary winding is connected to a metallic button 129 mounted upon the center of the base 106. Button 129 is axially aligned with shaft 26 and bears at all times upon the spring 38 carried by the distributor rotor 28.

The circuits through the ignition unit are shown diagrammatically in Fig. 6, with a single source of current supply. The current from the battery 130, grounded on the motor base, passes through connections 47, 55, 107, 109, 127 and 126, through the primary winding 117, and other connections 125, 110, 108, 56, 47 and 57, to the connecting plate 58, from which are taken four parallel circuits. One circuit is formed through the breaker arm 65, contacts 70 and 73, to the distributor base which forms a ground connection on the engine; a second circuit is through resistance 84, breaker arm 67, contacts 72 and 75, to ground; a third circuit is through breaker arm 66, contacts 71 and 74, to ground; and the fourth circuit is through wire 89, condenser 88, to ground.

One end of the secondary circuit 118 is grounded through the battery or through the timer, and a path for the secondary current is formed through button 129, spring 38, rotor contact 40, one of the stationary contacts 43 leading to one of the engine spark plugs (not shown), the other terminal of which is grounded.

From the foregoing description, it is apparent that there has been provided an ignition unit in which the weight of the parts has been reduced to a minimum consistent with strength and stability. The cam shaft gear housing of the engine being replaced by the base of the ignition unit, very little weight is added by the attachment of the unit. The arrangement of the parts contained in the unit is very compact, yet conducive to convenience in assembling. Some of the mechanical connections between the parts serve as conductors, and in the assembling together of the main parts of the unit, namely, the base, timer cup, and distributor head, there are no wires or "pigtails" to be connected. Since the unit and the source of current are grounded on the engine, as will be fully shown later, there is only one external low tension wire attached to each unit. The only other external conductors are the leads from the distributor to the spark plug terminals, which are necessarily present in any ignition system.

Attention is now directed to Figs. 7 and 8. The arrows in Fig. 7 indicate the direction of rotation of the cam and distributor rotor when the engine crank shaft is rotating in the normal direction. The arrows in Fig. 8 indicate the direction of rotation of these elements upon a reversal of the engine. Fig. 7 shows the relative position of the cam and cam followers just before the cam touches followers 80 and 81, and after engaging follower 82. It will be noted that upon rotation of the cam in the normal direction, contacts 72 and 75 will separate before contacts 70, 73, and contacts 74 and 71. Contacts 70, 73 and 74 and 71, are so located with respect to the cam that separation is effected simultaneously. Adjustment to bring about this simultaneous separation is effected by means of the adjustable breaker arm bracket previously described. It will be seen that by rotating the bracket 59 about pin 60, that the edges of cam followers 80 and 81 may be brought diametri-

cally opposite to one another, so that both followers will be engaged by the cam lobes at the same time. This adjustment of followers 80 and 81 will not materially affect the relation of follower 82 to the cam, for the reason that follower 82 moves through a short arc substantially radially of the cam 27, the adjustment being so small as not to affect appreciably the relative positions of the cam followers 80 and 81, and 82 to the cam. Hereafter breaker arms 65 and 66 with their parts cooperating therewith, will be known as main circuit breakers. The breaker arm 67 with its cooperating parts will be known as the resistance circuit breaker since resistance 84 is included between the breaker arm and the connecting plate 58. Two main circuit breakers are used so that in case of faulty adjustment of the breaker contacts, two chances are available of obtaining perfect contact during the period of closing of the primary circuit.

Upon reference to Fig. 8, it will be noted that upon a reversal of rotation of the cam, the main circuit breakers open before the resistance circuit breaker opens. Referring again to Fig. 7, it will be noted that just as the main circuit breakers open, the distributor rotor will be in contact with one of the stationary contacts 43, while, referring to Fig. 8, it will be seen that upon a reversal of the engine, the resistance circuit breaker will be closed at the time in which the main circuit breakers are open, with the result that all of the primary current must now pass through the resistance 84. When these conditions are present, the current in the primary will not only be greatly reduced, but the change in intensity of the magnetic field surrounding the induction windings will be partially reduced and at a rate slow enough to prevent sparking at the plugs. As an extra precaution against sparking upon a reversal of the engine, the distributor rotor is so arranged with relation to the cam that at the time when the much enfeebled sparking impulse is induced in the secondary, the rotor will not be in contact with any one of the stationary contacts 43, but there will be a gap between these elements as shown in Fig. 8.

When the circuit is finally broken, upon the separation of the contacts of the resistance circuit breaker, the current in the primary has reached so low a value that there is not sufficient energy to produce appreciable sparking at the engine plug, the presence of the resistance 84 in the condenser circuit helping to inhibit sparking. Apparatus embodying this invention has been successfully operated to entirely eliminate sparking at the plugs upon reversal of the engine. Thus a double protection against back firing of the engine upon a reversal of rotation is afforded. The timer is rendered ineffective to break the primary circuit in such a manner as to induce a current in the secondary of sufficient strength to cause ignition of a combustible mixture in the engine cylinders; and the distributor is rendered ineffective to distribute even the much weakened sparking impulse which may be created upon reversal of the engine. Therefore the possibility of serious accidents and of damage to the engine attendant upon back firing, often occurring when the engine is started by rocking the propeller against compression, has been eliminated in a thoroughly reliable manner.

The foregoing description, relating to the non-sparking upon reversal of operation of the timer cam, has been fully described, claimed and illustrated in the copending application of John H. Hunt, Serial No. 209,844, filed January 2, 1918.

What we claim is as follows:

1. In an ignition timer mechanism, the combination of a timer cam, a plurality of breaker arms having cam followers cooperating with the cam; a support for the arms; means for moving the support relatively to the cam for changing the relative angular location to the cam of certain of the cam followers, without changing the relative angular location of other of the cam followers.

2. An ignition device comprising, in combination, a timer cam; a plurality of circuit interrupters including stationary contacts and cooperating contact arms having cam followers cooperating with the cam; a supporting plate for said interrupters; and means for moving the supporting plate relative to the cam for changing the relative angular location to the cam of the circuit interrupters.

3. An ignition device comprising, in combination, a timer cam; a plurality of circuit interrupters including stationary contacts and cooperating contact arms having cam followers cooperating with the cam; a supporting plate for said interrupters; and means for adjusting the supporting plate relative to the cam for changing concurrently, the relative angular location of one of the interrupters to the cam to a greater degree than the relative angular location of the other interrupter to the cam.

4. An ignition device comprising in combination, a timer housing; a timer cam; a pair of primary interrupters supported in the timer housing each including a stationary contact and a movable contact carrying arm; a rubbing block on each arm, adapted to be engaged by said cam for operating the respective arm; and means for making angular adjustments relative to the cam of one rubbing block relative to the other.

5. In an ignition timer mechanism, the combination with a timer cup, a cam and a

plurality of breaker arms; of a bracket supporting the breaker arms at various positions with respect to the cam, said bracket being mounted for adjustment upon the timer cup; and springs each fixed upon the cup at a portion thereof and cooperating with the breaker arms, the arrangement of the springs being such as to permit the adjustment of the bracket with respect to the timer cup.

6. In an ignition timer mechanism, the combination with a timer cup, a cam and a plurality of breaker arms; of a bracket supporting the breaker arms at various positions with respect to the cam, said bracket being mounted for adjustment upon the timer cup; a conductor plate mounted upon the timer cup; and springs each fixed upon the conductor plate at a portion thereof and cooperating with the breaker arms, the springs constituting parallel electric circuit conductors from the conductor plate to the arms, the arrangement of the springs being such as to permit the adjustment of the bracket with respect to the timer cup.

7. An ignition device comprising, in combination, a housing; a timer cam in said housing; a plurality of circuit interrupters including stationary contacts and cooperating contact arms having cam followers engaging with the cam at diametrically opposite points so as to be operated simultaneously by said cam; a supporting plate for said interrupters; and means for moving the supporting plate relatively to the cam for adjusting the cam followers of the interrupters relative to the cam, to maintain the diametrically opposite alignment of the contact points of cam followers and cam.

8. An ignition device comprising, in combination, a housing; a timer cam in said housing; a plurality of circuit interrupters including stationary contacts and cooperating contact arms having cam followers engaging with the cam at diametrically opposite points so as to be operated simultaneously by said cam; a supporting plate for said interrupters; and means for moving the supporting plate to change the relative angular location of the interrupter cam followers to the cam to obtain circuit interruptions either simultaneously or in close succession.

9. An ignition device comprising, in combination, a housing; a timer cam in said housing, a plurality of circuit interrupters including stationary contacts and cooperating contact arms having cam followers engaging with the cam at diametrically opposite points so as to be operated simultaneously by said cam; a supporting plate pivotally secured to the housing in close proximity to the plane passing through both cam followers and adjacent one of said cam followers, said plate supporting the circuit interrupters; and means for moving the supporting plate relatively to the cam for changing the relative angular location of the circuit interrupters and the cam.

10. An ignition device comprising in combination, a timer housing; a timer cam; a pair of primary interrupters each including a stationary contact and a movable contact carrying arm; a cam follower on each of said arms; leaf spring conductors interposed between each movable arm and the housing one end of each spring being secured to the housing and the other end being connected to the respective arm; and means for making angular adjustments relative to the cam of one cam follower relative to the other, without interfering with the operation and effect of the leaf spring conductors on their respective movable contact arms.

11. An ignition device comprising in combination, a timer housing; a timer cam; a pair of primary circuit interrupters each including a stationary contact and a movable contact carrying arm; a cam follower on each of said arms; a bridging conductor insulatingly supported in the timer housing; leaf spring conductors interposed between the bridging conductor and the respective movable contact carrying arms of the interrupters each of said leaf spring conductors having one end electrically anchored to the bridging conductor while the other end is electrically secured to the respective movable contact arm; and means for making angular adjustments relative to the cam of one cam follower relative to the other, without interfering with the operation and effect of the leaf spring conductors on their respective movable contact arms.

In testimony whereof we hereto affix our signatures.

WILLIAM A. CHRYST.
JOHN H. HUNT.