April 18, 1933. K. A. HARMON 1,904,308

MAGNETO

Original Filed Oct. 6, 1931 4 Sheets-Sheet 1

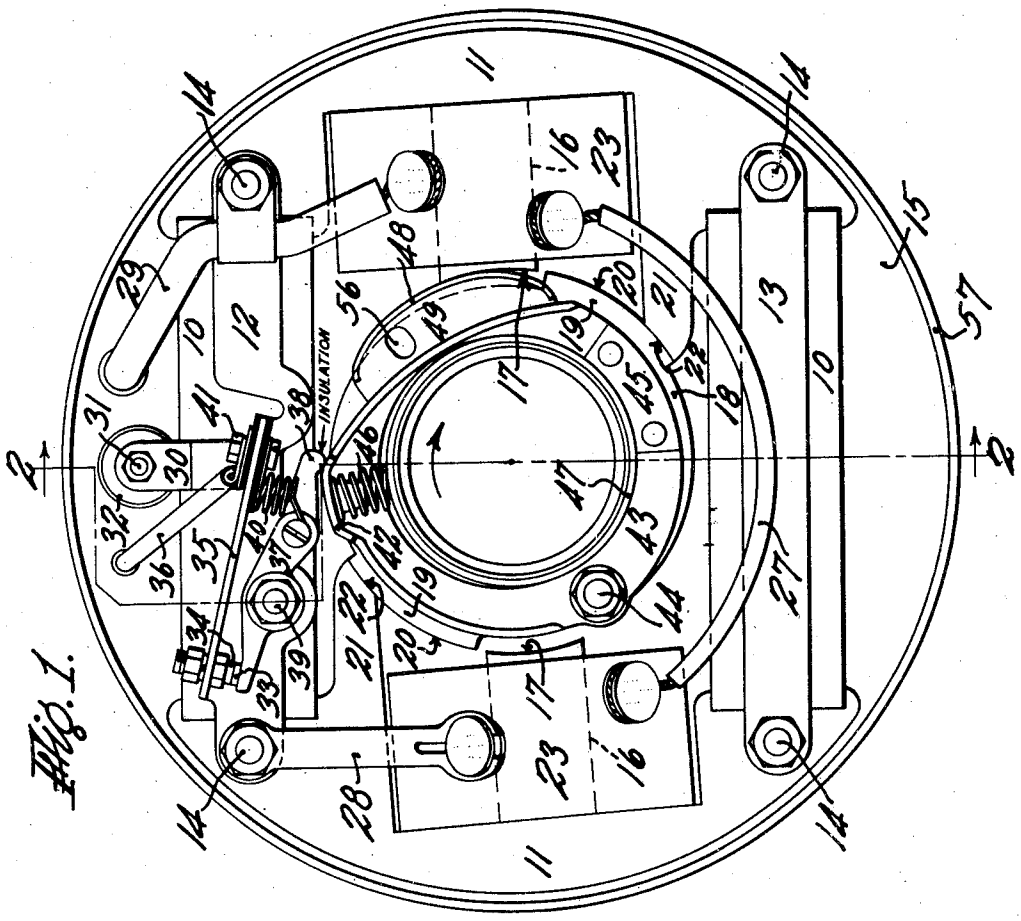


Fig. 1.

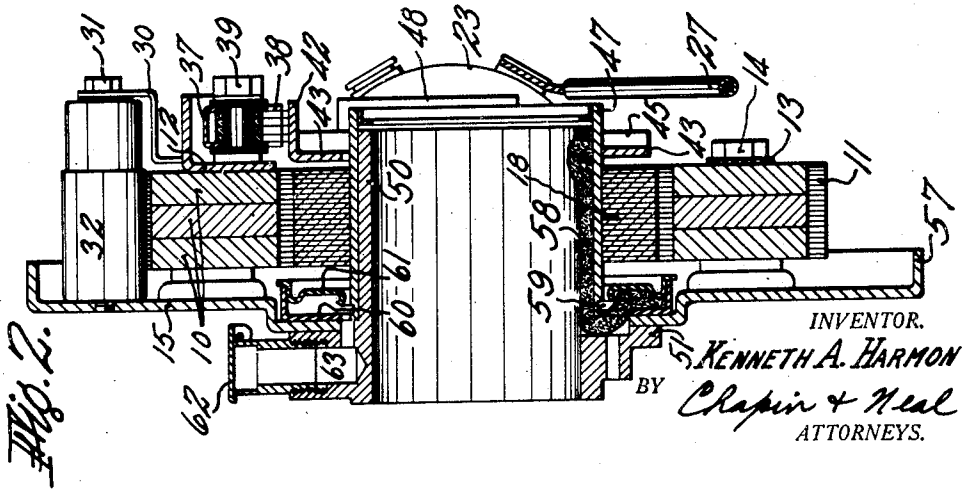


Fig. 2.

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April 18, 1933. K. A. HARMON 1,904,308

MAGNETO

Original Filed Oct. 6, 1931 4 Sheets-Sheet 2

Fig. 3.

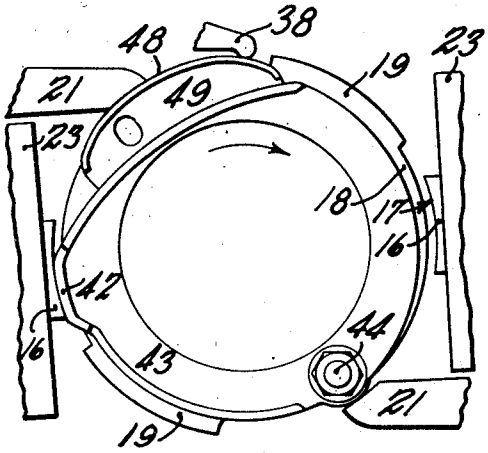


Fig. 4.

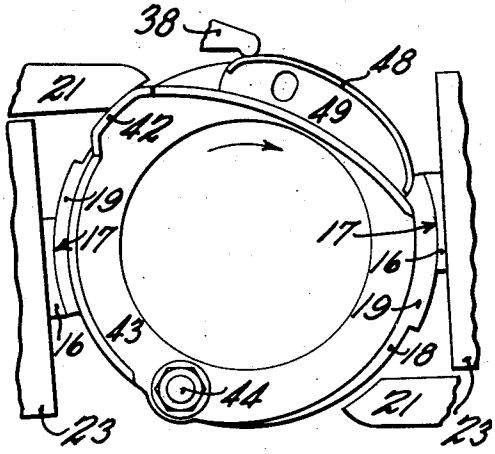


Fig. 5.

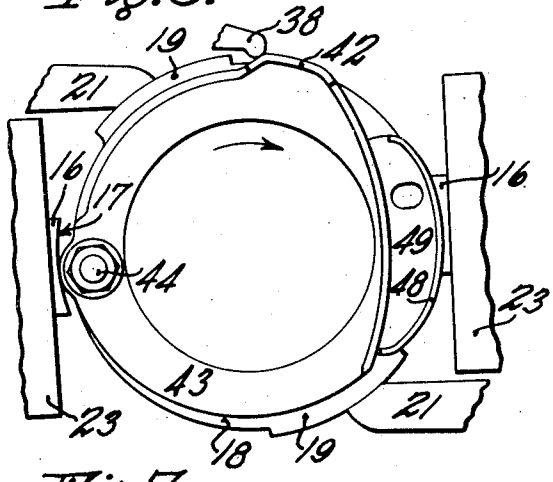


Fig. 6.

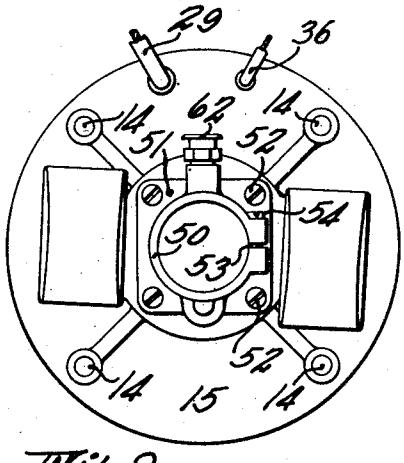


Fig. 7.

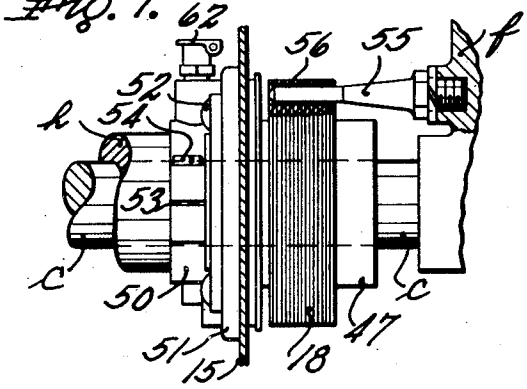
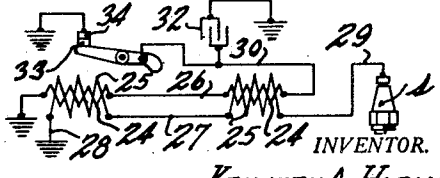


Fig. 8.



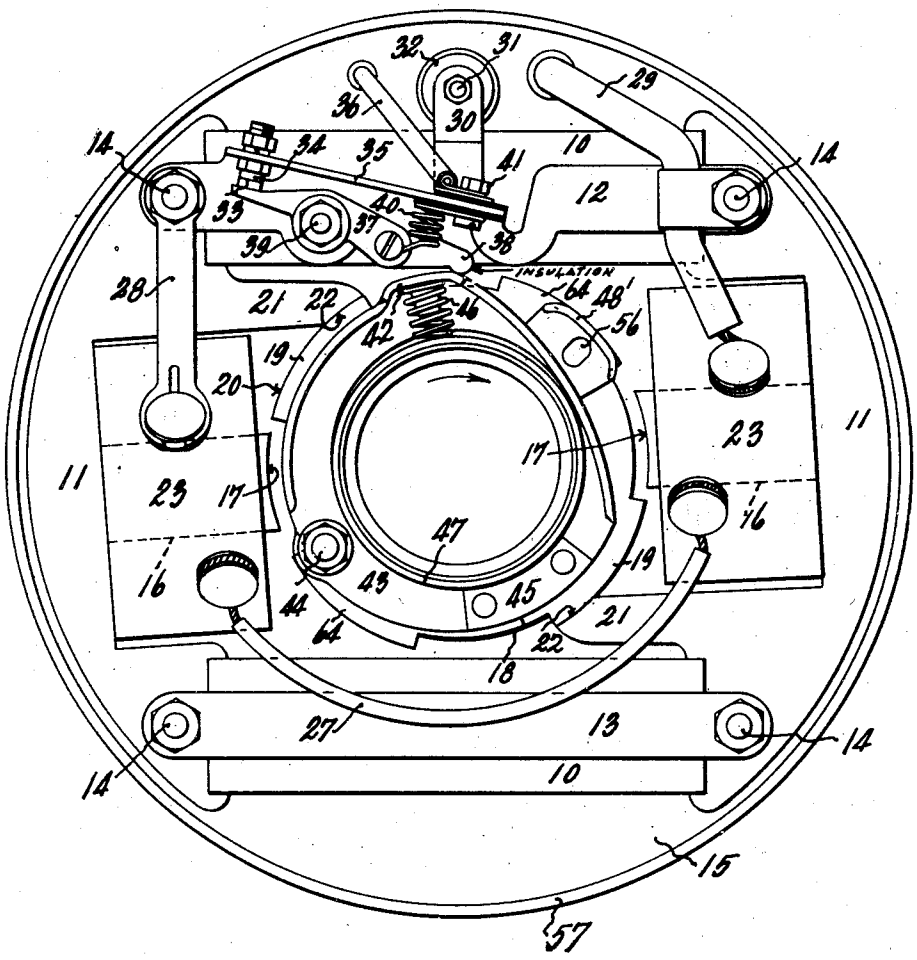
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MAGNETO

Original Filed Oct. 6, 1931 4 Sheets-Sheet 3

Fig. 9.



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April 18, 1933. K. A. HARMON 1,904,308

MAGNETO

Original Filed Oct. 6, 1931 4 Sheets-Sheet 4

Fig. 10.

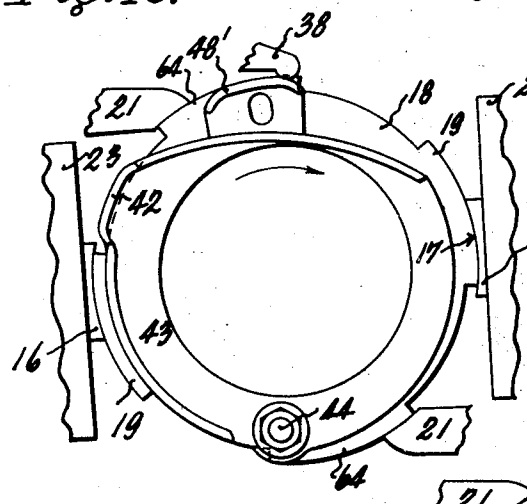


Fig. 13.

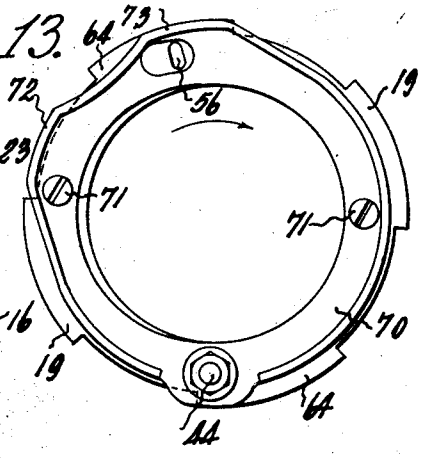


Fig. 11.

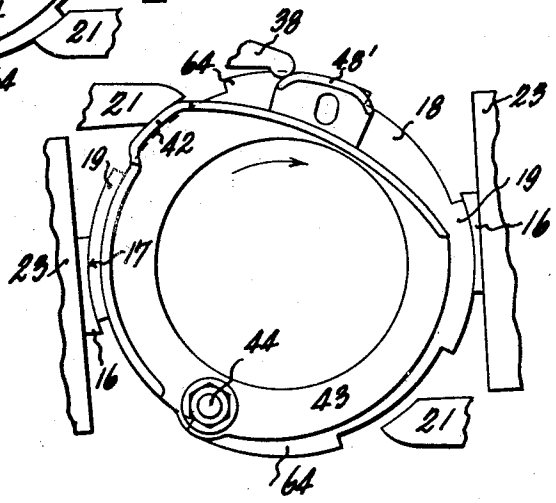
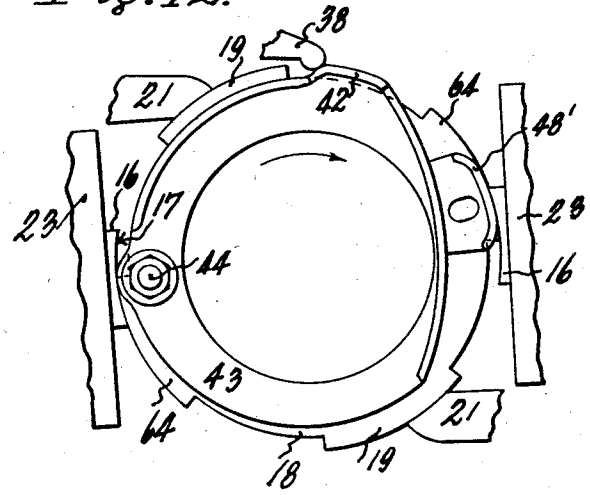


Fig. 12.



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UNITED STATES PATENT OFFICE

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MAGNETO

Application filed October 6, 1931, Serial No. 567,171. Renewed May 27, 1932.

This invention relates to improvements in magnetos of the rotary inductor type.

The inductor, of magnetic material and usually of the unwound type, is notched or has non-magnetic portions in its periphery and the remaining unnotched portions form magnetic projections which cooperate with two pole pieces, connected one to each polar extremity of a suitable magnetic source, such as a permanent magnet, for example. These projections are adapted during part of each revolution of the inductor to interconnect the two pole pieces and establish a magnetic circuit from said source through the pole pieces and inductor. When the notched portions of the inductor lie adjacent the pole pieces, this magnetic circuit is broken. Primary and secondary windings are applied to some part of such circuit, usually to at least one and preferably both of the pole pieces. The primary circuit, in accordance with usual practice, is in a normally closed electrical circuit, the opening and closing of which is controlled by a pair of relatively movable breaker points, the operation of which is controlled by suitable means, such as a cam, usually carried by or at least movable with the inductor.

The problem of this invention is to improve the efficiency of such a magneto. This has been effected primarily by the provision of an additional means, preferably independent of the usual means, for operating the breaker points. An additional opening and closing of the primary circuit is effected with the advantages set forth below.

If the magneto is operated with a normally closed primary circuit, flux builds up relatively slowly in the magnetic circuit. Considerable time is required for the purpose. The magnetic projections have to be relatively long in peripheral extent in order to maintain the pole pieces interconnected for a sufficient length of time to build up the necessary amount of flux against the restraining influence of a short circuit primary winding. By my invention, a magneto operating according to such plan, is improved by the extra opening and closing of the breaker points. They are made to open as the inductor moves into position to "make" the magnetic circuit and are held open for a substantial interval to allow flux to build up as rapidly and completely as possible in the magnetic circuit. They are closed before the inductor breaks this circuit in order to hold the flux against substantial diminution until the inductor has moved into an "optimum" position for the break, i. e., one in which a substantial double air gap exists between the magnetic projections and the pole pieces. Then the breaker points are again opened by the usual mechanism to release the flux and cause a sudden change in the magnetic circuit through the windings.

The action may be, and preferably is, aided and improved by the provision of extensions, one from each pole piece, with which the rotor projections cooperate to make a shunt circuit from the magnetic source in a low reluctance path lying wholly outside the windings. Thus shunt circuit is made just prior to the break of the magnetic circuit and to the spark-producing opening of the breaker points. Accordingly, the decrease in flux in the main magnetic circuit through the windings is accelerated by the provision of the shunt circuit, which affords a better path for the flux and thereby diverts it from the main circuit.

In the magneto above described, there are at least two positions of the inductor during each revolution thereof in which the magnetic circuit is made and broken. There may to advantage be more than two such positions, as will later appear. In many cases, only one of these positions is utilized for the production of a spark. The other position or positions, however, has or have spark producing possibilities, and if the breaker points are open while the inductor moves into and through any other position, a spark may be produced which is bothersome because it occurs at an undesired time. This extra spark is not so effective but it is often substantial enough to cause trouble. My invention enables the suppression of this undesired spark. It enables the primary circuit to be maintained closed, while the inductor travels

through all but a selected one of its two or more ranges, in which the magnetic circuit is made and subsequently broken, and thus the closed circuited primary winding is effective to restrain a substantial flux change in the circuit. Yet, when the inductor enters the selected one of its ranges, the restraining influence is removed by the additional opening of the breaker points, enabling flux to build up rapidly and effectively.

Other objects and advantages will appear as the detailed description proceeds and will be pointed out in the appended claims.

The invention will be disclosed for illustrative purposes with reference to the accompanying drawings, in which:

Fig. 1 is a front elevational view of a magneto embodying my invention;

Fig. 2 is a sectional view thereof taken on the line 2—2 of Fig. 1;

Figs. 3, 4 and 5 are diagrammatical views, illustrative of the operation of the magneto and particularly of the times of opening and closing of the breaker points with relation to the position of the rotor;

Fig. 6 is a small-scale rear elevational view of the magneto;

Fig. 7 is a fragmentary side elevational view showing the manner of mounting the magneto on and driving it from an engine;

Fig. 8 is a diagrammatical view illustrative of the electrical connections of the magneto;

Fig. 9 is a view taken similarly to Fig. 1 but showing a modification of the invention,—a rotor with four projections;

Figs. 10, 11 and 12 are views showing the rotor of Fig. 9 in three different positions which correspond to the positions shown in Figs. 3, 4 and 5 in connection with the rotor of Fig. 1; and

Fig. 13 is an elevational view of the rotor equipped with a modified form of cam for operating the breaker points.

Referring to these drawings; the magneto includes a source of magnetic flux,—such as the permanent magnets 10,—and, as illustrated, the magnets of the source are arranged in two spaced parallel groups. Like ends of the magnets in these two groups are interconnected by members 11 (Fig. 1) made up of soft iron laminations. The ends of the magnets tightly fit in recesses in the members 11. These members are tied together by bars 12 and 13 of non-magnetic material and the assembly is secured by cap screws 14 to a circular supporting plate 15 of non-magnetic material. The cap screws 14, which pass through the laminated members 11, serve to bind the cross bars to the members 11 and the latter to plate 15 (Fig. 2). The laminated members 11 have extensions 16 (Fig. 1), forming cores which project from their respective members toward one another and terminate with curved polar faces 17. An unwound inductor 18, made up of soft iron laminations, rotates between these faces and has two substantially diametrically opposed projections 19, having faces 20 curved concentrically with the faces 17 and of a diameter only slightly less than the distance between the faces 17. Intermediate these projections, the periphery of the rotor is of less diameter to create, when positioned as shown, a double break in the magnetic circuit from said source through the cores 16. When the rotor moves into such position that the projections 19 interconnect the cores as shown in Fig. 4, the aforesaid magnetic circuit is established.

In addition to providing for the aforesaid break in the magnetic circuit to periodically cause decrease in flux through said cores, means are provided for shunting the magnets to cause a more rapid and more effectual decrease in flux through the cores by diverting it through a path of low reluctance. For this purpose, each member 11 has an extension 21 to cooperate with the projections 19 of the rotor. One of these extensions lies above one core 16 and the other below the other core 16 and the two have polar faces 22, which are arranged substantially in diametrically opposed relation and are curved concentrically with the faces 17 and 20. When the rotor is positioned as in Fig. 1, the two extensions 21 are interconnected by the rotor 18 and these elements afford a low reluctance shunting path for the flux from the magnets. Flow of flux through cores 11 is effectually diverted.

The magneto also includes primary and secondary windings on the cores 16. On each is a coil case 23, which contains a primary coil 24 and a secondary coil 25. These coils are shown diagrammatically in Fig. 8. As shown for illustrative purposes, the two primary coils and the two secondary coils are connected in series, as by wires 26 and 27, respectively. One terminal of the primary winding and one terminal of the secondary winding is grounded, as indicated. The secondary ground wire is shown at 28 in Fig. 1 as being connected to the cross bar 12 and clamped thereto by cap screw 14. The other terminal of the secondary winding is adapted to be connected by a wire 29 to the ignition system and directly or indirectly to a spark plug *s*. The other terminal of the primary winding is connected by a wire 30 to one terminal 31 of a condenser 32 and to an insulated and movable breaker point 33. The cooperating and fixed breaker point 34 is grounded by being connected directly to a flange 35 on cross bar 12 (Fig. 1). The other terminal of condenser 32 is also grounded, being connected as shown in Fig. 2 to plate 15. The wire 36, in Figs. 1 and 6, is adapted for connection, if desired, to a ground switch (not shown) by which the normally insulated terminal of the primary winding may be grounded.

The breaker point mechanism includes a lever, comprising a metallic portion 37 (Figs. 1 and 2), of inverted U-shape section, and a portion 38 of insulating material. This lever is pivotally mounted on and insulated from a stud 39, carried by cross bar 12. Breaker point 33 is fixed to the metallic portion 37 of this lever and such portion is electrically connected by means of a spring 40 and bolt 41 to the conductor 30,—the bolt passing through flange 35 but being insulated therefrom as are also the spring 40 and conductor 30. The spring 40 also serves to hold the breaker points in engagement. For the purpose of separating the breaker points, a cam 42 carried by the rotor is employed. As shown, this cam is a flange-like extension of a ring 43, which is pivotally connected to the rotor by a stud 44 and carries a weight 45. A spring 46 acts between a sleeve 47 (to which the rotor is fixed) and cam 42 tending to force it radially outward and swing ring 43 on its pivot 44. Such motion is limited by the engagement of the lower part of the inner periphery of ring 43 with sleeve 47. The arrangement constitutes a governor-operated cam. When the rotor reaches a predetermined speed, the weight 45 will move outwardly by centrifugal force, overcoming the force of spring 46 and drawing cam 42 inwardly out of the path of the end of the breaker point lever 38. If the "hit or miss" ignition is not desired, the ring 43 may be clamped to the rotor so as not to turn independently thereof.

In addition to the above cam, whether it be of the centrifugally-operated or fixed type, there is provided an auxiliary cam 48, which enables an additional opening and closing of the breaker points 33 and 34 and effects certain advantages, which will hereinafter be pointed out in connection with the operation of the magneto. This auxiliary cam constitutes one of the main features of my invention. It consists of a flange formed on a plate 49 fixed to an end face of the rotor. It is preferably independent of the other cam, so that in cases where "hit or miss" ignition is employed, it does not have to partake of the movement of, or be effected by, the centrifugally actuated cam.

The rotor 18 is, as described, fixed to a sleeve-like shaft 47 and the latter is journalled on a hollow stud 50 (Fig. 2) which has a flange 51 (Fig. 6) secured by cap screws 52 to plate 15. One end of stud 50 is split, as at 53, and the split parts may be drawn together by a cap screw 54. This stud is adapted to be clamped in various positions of angular adjustment to a suitable support, such as a cylindrical hub *h* (Fig. 7) which is partly telescoped in the stud and which may be assumed to be a hub on the crank case of an internal combustion engine. Through this hub, the engine crankshaft *c* passes for connection to the flywheel, indicated in part at *f*. The crankshaft passes freely through stud 50 with ample clearance. The driving connection with the rotor may be effected by a stud 55 fixed to the inner face of the flywheel, extending toward the rotor, and into a hole 56 therein. As shown in Fig. 7, there is radial freedom for the stud 55 to move in hole 56 and, should the flywheel not run true, its irregularities of movement will not be communicated to the rotor. The latter has its own bearing, on which it turns truly, and the driving of it from the crankshaft is effected in the described, or any other equivalent way, which will prevent the rotor from partaking of any irregularities in the running of the crankshaft.

The plate 15 has a circular flange 57 (Fig. 1) extending toward the flywheel and adapted, although not shown, to cooperate therewith to enclose the working parts of the magneto in the usual and well understood way.

Lubrication for the rotor is provided by a wick 58 (Fig. 2) extending from an oil reservoir 59 upwardly into stud 50 and axially along the same in a slot formed therein. Part of the wick rests directly against the rotor shaft 47. The reservoir 59 is formed between two pressed metal pieces 60 and 61, the former being suitably attached to plate 15 and the latter have a tight fit in piece 60. Oil may be supplied to the reservoir through an oil cup 62 by way of a passage 63.

The operation of the magneto will next be described. It will be noted that there are two positions of the rotor in each revolution thereof when the cores 16 are interconnected. The rotor may be utilized, in either or both of these positions, to build up flux through cores 16, preparatory to the subsequent production of a spark by effecting a sudden decrease of flux through the cores. As shown, a spark is produced in only one of these positions and it is particularly desired and one of the problems of this invention to prevent the production of any substantial spark, when the rotor is in the other position. Fig. 1 shows the rotor in the position which it occupies just prior to the production of the spark. A slight additional clockwise movement of the rotor will cause cam 42 to separate the breaker points 33 and 34 and create a spark. If the breaker points 33 and 34 were allowed to remain open during the next time when the rotor projections interconnect the cores 16, a change of flux would occur in the cores and a spark would be created. This spark would not be so effective as the one produced on the preceding interconnection of the cores by the rotor but it would be substantial enough to cause trouble by its occurrence at an undesired time. To kill this undesired and so-called "maverick"

spark, the breaker points might be maintained closed except at the desired sparking time. Such a plan would restrain a change in flux through the cores at the undesired time due to the choking influence of the short circuited primary winding and would hold the flux change down to such limits that no substantial spark would be produced. But such plan also means that the flux change through the cores 16 at the desired time is also restrained. Flux has to be built up against the opposing influence of the short circuited primary winding and the change takes place slowly. While this can be done, if the cores are interconnected by the rotor for a sufficiently long time interval, it is far more desirable to permit flux to build up in cores 16 while the breaker points are open so that the change takes place as rapidly as possible without any restraining influence.

With the above considerations in mind, the plan adopted is a compromise between the two plans above outlined. It combines the advantages of both plans and eliminates the disadvantages. The cam 42 is the sort which would be used where the plan is to maintain the breaker points closed except at the one sparking time during each revolution of the rotor. Consequently, the advantage of killing the "maverick" spark will be obtained. But this cam is supplemented by the auxiliary cam 48, the purpose of which is to open the breaker points and thereby remove the restraining influence of the short circuited primary winding, as the rotor moves into position to interconnect the cores 16 just prior to the sparking time. Thus the flux is allowed to build up rapidly in cores 16 while the primary circuit is open. The action of the auxiliary cam can best be visualized from a consideration of Figs. 3 and 4. Fig. 3 shows the rotor projections 19 approaching the cores 16 to interconnect them and the auxiliary cam 48 as about to move the breaker point lever to open the breaker points. The cam 48, having opened the breaker points, maintains them open while the projections 19 swing into position to interconnect the cores and during an additional period, viz. up to the point shown in Fig. 4. During all of the period while the projections 19 fully cover the faces 17 of cores 16, the breaker points are held open to facilitate the establishment, as rapidly and completely as possible, of magnetic flux in the cores. The breaker points close at about the position of the rotor shown in Fig. 4. This enables the flux, built up in the cores as described, to be held by the closed circuited primary winding until the rotor has moved to the most effective position for the release of the flux. Such position is shown in Fig. 1. The rotor projections 19 are then separated from cores 16 by substantial air gaps and are engaged with projections 21 to shunt the flux from the magnets in a low reluctance path lying wholly outside the cores. Hence, when the breaker points separate, the restraining influence of the short circuited primary winding is removed and, in addition, a better path is afforded for the flux by way of the shunt extensions 21. As a consequence, an exceedingly rapid decrease in flux occurs, due to the combined effects of the optimum position of the rotor and the low reluctance shunt path. An exceedingly effective spark results when the breaker points separate.

Shortly following the projection of the spark, the rotor moves into the position in Fig. 5, in which the breaker points close and remain closed until again opened by cam 48. Particularly, they remain closed during the next succeeding interval when the rotor interconnects the cores for the purpose of killing the maverick spark, which would otherwise be created at a point in the movement of the rotor spaced about 180 degrees from the point at which the desired spark is created.

As above alluded to, the invention is not necessarily restricted in all its features to a rotor having only two projections. There may be more than two such projections and the invention is concerned with a magneto rotor which has at least two projections and may have more. For example, in Fig. 9 a rotor is shown having four projections and there is an advantage accruing from the use of the additional projections in that the magnets are never entirely open circuited. There is always available some low reluctance path for the magnetic flux. There are four ranges of travel of the rotor during each revolution thereof, in which the cores 16 are magnetically interconnected to afford a path for the magnetic flux. There are four other ranges of travel of the rotor during each revolution thereof, in which the shunt projections 21 are interconnected by the magnetic rotor to afford an alternative path for the flux; and the first-named and second-named ranges overlap so that there is never a time when the magnets are open circuited and without a path of low reluctance. The flux from the magnets alternately passes through the cores 16 and through the projections 21, first through one and then through the other. And the path through cores 16 is not broken until the path through projections 21 is established and the last named path is not broken until the path through the cores is again established. This results in markedly improved efficiency and is the preferred arrangement.

The arrangement of Fig. 9 differs from Fig. 1 only by the addition of the rotor projections 64, of the same size and shape as the projections 19 but disposed at right angles thereto. The auxiliary cam 48 has been

changed slightly and is designated 48'. All other parts are marked with the same reference numerals as used in Figs. 1 to 8.

The operation of the magneto shown in Fig. 9 is essentially no different from that shown in Fig. 1 except for the addition of the four additional paths for the magnetic flux which are afforded by the addition of the two projections 64. A spark is produced at only one of the four positions in which the cores 16 are interconnected although, as above noted, more than one spark per revolution may be produced. The production of a spark at the other positions is prevented. Tracing the operation in detail, Fig. 9 shows the rotor in the position which it occupies just prior to the production of the spark. A slight additional clockwise movement of the rotor will cause cam 42 to separate the breaker points 33 and 34 and produce a spark. The rotor projections 19 have moved far enough away from cores 16 to create an effective air gap and to make an alternative shunt circuit through projections 21. While this has been happening, the flux built up in cores 16, while projections 19 were interconnecting the same, has been held by the closed circuited primary winding. On an opening of the breaker points, this flux will be released and rapidly and practically instantaneously die out of cores 16 because of the other and better path available through projections 21. The rotor projections 64 are not functioning at this time. Shortly after the production of the spark, the rotor assumes the position shown in Fig. 12, in which the breaker points close and remain closed for a substantial interval. The projections 19 are then interconnecting the shunt projections 21 and the projections 64 have moved part way into the position in which they interconnect cores 16. There will be but a comparatively small flux change in the cores because the shunt circuit through projections 21 has not yet been broken. On continued rotation, the projections 19 leave the shunt projections and the shunt magnetic circuit is broken but the projections 64 have already established an alternative circuit through cores 16, thus avoiding open circuiting of the magnets. During all of the time while the projections 64 are travelling adjacent cores 16, the primary circuit is closed and no spark is therefore produced. The projections 64 next move into range to interconnect the shunt projections 21 but before they leave cores 16, the projections 21 will have been interconnected by projections 19. The primary circuit is still closed and maintained so during all the range of travel of projections 19 in interconnecting relation with cores 16. Continued movement of the rotor will carry the projections 19 away from the cores 16 but not until they have come into interconnecting relation with shunt projections 21. Then, when the projections 19 swing away from projections 21, the projections 64 will again have moved into interconnecting relation with cores 16. Then the projections 64 move out of connecting relation with cores 16 but not until they have moved into such relation with shunt projections 21. During all this time the breaker points remain closed and no spark is produced by the shiftings of the magnetic circuit described. The rotor now occupies the position shown in Fig. 10. The projections 19 are moving into connecting relation with the cores 16 and the projections 64 are moving out of such relation with projections 21. The breaker points will be opened by the auxiliary cam 48' and some flux will build up in cores 16 but there still exists the shunt path through projections 21 and the flux will not build up completely until projections 64 leave projections 21, which occurs before the breaker points again close. Immediately the shunt path is broken, the flux builds up almost instantaneously in cores 16 due to the open primary circuit. The breaker points close as the rotor moves into the position shown in Fig. 11 and at a time when projections 64 are separated from projections 21 by a substantial air gap while cores 16 are still substantially covered by projections 19. The closed primary circuit has the effect of resisting flux change in cores 16 while the rotor is moving from the position shown in Fig. 11 to that shown in Fig. 9. Meanwhile, the rotor projections 19 move away from cores 16 and into covering relation with shunt projections 21, preparatory to the spark producing opening of the breaker points above described in connection with Fig. 9.

It will thus be seen that the invention enables the suppression of the spark as the result of magnetic changes effected by the rotor at all but certain selected positions where a spark is desired. Also that the form of invention shown in Fig. 9 is substantially similar so far as the described suppression of spark is concerned, differing only in that the spark is suppressed at two other positions of the rotor and in that better results are obtained due to providing at all times a closed circuit from the magnetic source.

It is not necessarily essential for all purposes that the main and auxiliary breaker point cams be structurally independent as heretofore disclosed and in Fig. 13 both are shown as integral parts of a one piece annular member 70. This member, as shown, is fixed to the rotor by the bolts 71 but, if governor action is desired, it may be had by removing these bolts, the member 70 then being free to turn on the stud 44 as a pivot. It will also be necessary in such case to add a weight and return spring, such as are shown at 45 and 46, respectively, in Fig. 1.

The member 70 has two cam lobes 72 and 73 which may be used interchangeably as the main and auxiliary cams. For clockwise rotation of the rotor, the lobe 72 will act as the main cam and lobe 73 as the auxiliary cam. For anti-clockwise rotation, the same member 70 will serve without change,—the lobe 73 then serving as the main cam and the lobe 72 as the auxiliary cam. If this same member 70 is converted to secure the governor action, the auxiliary cam 73 although integrally united to the main cam 72 will function satisfactorily because it is of short length (as compared to cam 49) and is located substantially diametrically opposite the pivot point 44. Radial movement of cam 72 can then be effected without effecting any substantial degree of radial movement of cam 73.

The invention has utility in a rotary magneto irrespective of whether or not there is a "maverick" spark to be killed. It enables the extra opening and closing of the breaker points for the purpose of allowing flux to build up in the main magnetic circuit (through cores 16) under the best conditions, viz. that of an open circuited primary winding. The flux, thus built up, is held against substantial diminution while the inductor moves into an optimum position for the break of the main magnetic circuit, at which time the breaker points open by the usual means,—cam 42.

The features stressed in the description of the operation of the invention are the essential ones. The invention may be embodied in many forms differing specifically from that herein shown. The use of two banks of magnets, while desirable, is not necessarily essential for all purposes. The same effects, but differing in degree, would also be obtained if one coil unit were omitted from one core 16. Also, these two coils need not necessarily be connected in series as shown. They might even function as independent units. Various other changes may readily be made and the details hereinabove described are not to be considered essential to my invention except insofar as they are included in the appended claims.

What I claim is:

1. In a rotary magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotor having projections thereon movable in close proximity to said pole pieces and adapted during each revolution of the rotor to make and subsequently break a magnetic circuit from said source through said pole pieces and rotor, primary and secondary windings associated with said magnetic circuit, normally-engaged but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by the separation and engagement respectively of said breaker points, and means movable with the rotor for opening the breaker points when the rotor moves into position relatively to said pole pieces to make said magnetic circuit and for closing them prior to the breaking of said magnetic circuit and again opening said points when the rotor moves into position to break said magnetic circuit and again closing them after said last named break.

2. In a rotary magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotor having projections thereon movable in close proximity to said pole pieces and adapted in a plurality of positions during each revolution of the rotor to make and subsequently break a magnetic circuit from said source through said pole pieces and rotor, primary and secondary windings associated with said magnetic circuit, normally-engaged but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by the separation and engagement respectively of said breaker points, and means movable with the rotor for opening the breaker points when the rotor moves into one but not the other of said positions and for closing them prior to the movement of the rotor out of such position and for again opening the breaker points when the rotor has moved out of such position far enough to cause an effective break in the magnetic circuit and for shortly after closing the breaker points and maintaining them closed while the rotor passes through the other of said positions.

3. In a rotary magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotor having projections thereon movable in close proximity to said pole pieces and adapted during each revolution of the rotor to make and subsequently break a main magnetic circuit from said source through said pole pieces and rotor, extensions one from each pole piece extending into the path of said rotor projections for cooperation therewith to make a shunt magnetic circuit from said source shortly before the main magnetic circuit is broken and to subsequently break the shunt circuit, primary and secondary windings included in the main magnetic circuit but lying outside said shunt magnetic circuit, normally-engaged but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by the separation and engagement respectively of said breaker points, and means movable with the rotor for opening the breaker points when the rotor moves into position relatively to said pole pieces to make said main magnetic circuit and for closing them

prior to the breaking of said main magnetic circuit and prior to the establishment of said shunt circuit and for again opening said points when the rotor moves into position to break said main magnetic circuit and while said shunt circuit is established and again closing them after said last named break.

4. In a rotary magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotor having projections thereon movable in close proximity to said pole pieces and adapted in at least two positions during each revolution of the rotor to make and subsequently break a main magnetic circuit from said source through said pole pieces and rotor, extensions one from each pole piece extending into the path of said rotor projections for cooperation therewith to make a shunt magnetic circuit from said source shortly before the first named magnetic circuit is broken and to subsequently break the shunt circuit, primary and secondary windings included in the main magnetic circuit but lying outside said shunt magnetic circuit, normally-engaged but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by the separation and engagement respectively of said breaker points, and means movable with the rotor for opening the breaker points when the rotor moves into one but not the other of said positions and for closing them prior to the movement of the rotor out of said one of said positions and prior to its movement into position to make said shunt circuit and for again opening the breaker points when the rotor has moved far enough out of said one of said positions to create an effective break in the main magnetic circuit and to make said shunt circuit and for shortly after closing the breaker points and maintaining them closed while the rotor passes into and through the other of said positions.

5. In a magneto, a source of magnetic flux, a pair of pole pieces connected one to each polar extremity of said source and terminating with substantially opposed polar faces, a rotary inductor mounted between said faces and having substantially diametrically opposed projections to cooperate therewith and make and break a magnetic circuit from said source, primary and secondary windings on at least one of said pole pieces, normally-closed but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points, said electrical circuit being opened and closed by the opening and closing of the breaker points, and means movable with the inductor for controlling the breaker points and causing them to open as the inductor moves into position to make said magnetic circuit and causing them to close prior to the breaking thereof and to again open them when the inductor moves into position to break said magnetic circuit and to again close them after said last named break.

6. In a magneto, a source of magnetic flux, a pair of pole pieces connected one to each polar extremity of said source and terminating with substantially opposed polar faces, a rotary inductor mounted between said faces and having substantially diametrically opposed projections to cooperate therewith and make and break a magnetic circuit from said source at least twice during each revolution of the inductor, primary and secondary windings on at least one of said pole pieces, normally-closed but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points, said electrical circuit being opened and closed by the opening and closing of the breaker points, and means movable with the inductor for controlling the breaker points and causing them to open as the inductor moves into one but not the other of its positions in which a magnetic circuit is made and causing them to close prior to the breaking of such magnetic circuit and causing them to again open when the inductor moves into position to break such magnetic circuit and causing them to again close and remain closed while the inductor moves into the other positions in which a magnetic circuit is made.

7. In a magneto, a source of magnetic flux, a pair of pole pieces connected one to each polar extremity of said source and terminating with substantially opposed polar faces, a rotary inductor mounted between said faces and having substantially diametrically opposed projections to cooperate therewith and make and break a main magnetic circuit from said source, extensions one from each pole piece terminating with substantially diametrically opposed faces for cooperation with said inductor projections to make a shunt magnetic circuit from said source just prior to the breaking of the main circuit, primary and secondary windings on at least one of said pole pieces, normally-closed but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points, said electrical circuit being opened and closed by the opening and closing of the breaker points, and means movable with the inductor for controlling the breaker points and causing them to open as the inductor moves into position to make the main magnetic circuit and causing them to close prior to the breaking thereof and prior to the making of said shunt magnetic circuit and to again open them when the inductor moves into position to break the main magnetic circuit and after the shunt circuit has been established and to again close them after said last named break.

8. In a magneto, a source of magnetic flux,

a pair of pole pieces connected one to each polar extremity of said source and terminating with substantially opposed polar faces, a rotary inductor mounted between said faces and having substantially diametrically opposed projections to cooperate therewith and make and break a main magnetic circuit from said source at least twice during each revolution of the inductor, extensions one from each pole piece terminating with substantially diametrically opposed faces for cooperation with the projections of the inductor to make a shunt magnetic circuit from said source just prior to the breaking of the main circuit, primary and secondary windings on at least one of said pole pieces, normally-closed but relatively movable breaker points, an electrical circuit including said primary winding and breaker points, said electrical circuit being opened and closed by the opening and closing of the breaker points, and means movable with the inductor for controlling the breaker points and causing them to open as the inductor moves into one but not the other of the positions in which the main magnetic circuit is made and causing them to close prior to the breaking of the main magnetic circuit thus formed and prior to making of the shunt circuit and causing them to again open after the shunt circuit has been made and after the inductor has moved far enough to create an effective break in the first named magnetic circuit and causing them to again close and remain closed while the inductor moves into and through the other positions in which a magnetic circuit is made.

9. A magneto, including a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotary inductor cooperating with said pole pieces to make and break a magnetic circuit from said source, primary and secondary windings associated with said circuit, normally-closed but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by said breaker points, means movable with said inductor and movable relatively thereto in response to variations in the speed thereof for opening said breaker points after said magnetic circuit has been broken and for subsequently closing said breaker points, and a second means independent of the first named means and movable with said rotor for opening said breaker points as the inductor approaches the position in which to make said magnetic circuit and for closing them after said magnetic circuit has been made and prior to the breaking thereof.

10. A magneto, including a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotary inductor cooperating with said pole pieces in at least two positions during each revolution to make and break a magnetic circuit from said source, primary and secondary windings associated with said circuit, normally-closed but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by said breaker points, means movable with said inductor and movable relatively thereto in response to variations in the speed thereof for opening said breaker points after the inductor moves out of one but not the other of said positions, and a second means independent of the first named means and movable with said inductor for opening said breaker points just prior to the time when the inductor moves into said one of said positions and for closing the breaker points before the inductor moves out of said one of said positions, whereby when the inductor moves into and through the other of said positions the breaker points are maintained closed.

11. In a magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotary inductor having substantially diametrically opposed projections, said pole pieces extending into cooperative relation with said inductor and terminating closely adjacent the path of said projections in substantially diametrically opposed relation, said inductor by its rotation making and breaking a main magnetic circuit from said source, primary and secondary windings on at least one of said pole pieces, extensions one from each pole piece terminating with substantially diametrically opposed faces for cooperation with said projections to make and break a shunt magnetic circuit from said source in a low reluctance path outside said windings, a normally closed electrical circuit in which said primary winding is included, relatively movable breaker points to control said electrical circuit, and means for operating said breaker points including a governor operated cam movable with the inductor for opening the breaker points after said main circuit has been broken and said shunt circuit made and for shortly after closing said points, and an independent cam movable with the inductor for opening said points when the inductor moves into position to make said main circuit and for closing them before the main circuit is broken and the shunt circuit established.

12. In a magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotary inductor having substantially diametrically opposed projections, said pole pieces extending into cooperative relation with said inductor and terminating closely adjacent the path of said projections in substantially diametrically opposed relation, said inductor by its rotation making and breaking a main magnetic circuit from said source in at least two ranges of travel during each revolution, primary

and secondary windings on at least one of said pole pieces, extensions one from each pole piece terminating with substantially diametrically opposed faces for cooperating with said projections to make and break a shunt magnetic circuit from said source in a low reluctance path outside said windings, a normally closed electrical circuit in which said primary winding is included, relatively movable breaker points to control said electrical circuit, and means for operating said breaker points including a governor operated cam movable with the inductor for opening the breaker points after the inductor moves out of one but not the other of said ranges and causes a break in the magnetic circuit through said windings and for subsequently closing said points and maintaining them closed while the inductor moves through the other of said ranges, and an independent cam movable with the inductor for opening said points while the inductor moves in said one of said ranges and for closing them before the inductor leaves such range to break the main magnetic circuit and before the inductor moves into position to establish said shunt circuit.

13. In a rotary magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotor having a plurality of pairs of projections thereon, each such pair arranged to interconnect said pole pieces during a certain range of travel of the rotor, other projections from said magnetic source cooperating successively with said pairs of rotor projections to make and break a shunt magnetic circuit from said source, said rotor projections being so spaced and located with respect to said pole pieces and second named projections as to provide at all positions a closed magnetic circuit from said source either through said pole pieces or through said shunt path, primary and secondary windings on at least one of said pole pieces, normally-engaged but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by the separation and engagement respectively of said breaker points, and means movable with the rotor for opening the breaker points when the pole pieces are interconnected by one pair of rotor projections and for closing them before said pair of projections move out of such interconnecting relation and for again opening them after the said pair of projections have moved out of such relation and into interconnecting relation with the shunt forming projections and for shortly thereafter closing said breaker points and maintaining them closed while the rotor moves into and through another range of travel in which said pole pieces are interconnected by a pair of rotor projections.

14. In a magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, shunt forming projections connected one to each polar extremity of said source, a rotor having a plurality of pairs of projections to cooperate successively with said pole pieces and shunt forming projections to maintain at all times a closed magnetic circuit from said source either through said pole pieces or through said shunt forming projections, primary and secondary windings on at least one of said pole pieces, a normally closed electrical circuit including said primary winding, and means controlled by movement of the rotor for opening, closing and again opening said electrical circuit while the rotor moves through a selected one of its several ranges in which a magnetic circuit is made and subsequently broken through said pole pieces and for thereafter closing said circuit and holding it closed while the rotor moves through another one of said ranges.

15. In a rotary magneto the combination of means comprising a magnetic source, cooperating pole pieces, an inductor means to cooperate with the pole pieces to establish magnetic circuits from said source through the pole pieces and inductor, the inductor and pole pieces being relatively rotatable so as to make and break successive magnetic circuits during each revolution, an electrical circuit arranged for inductive relation to all the magnetic circuits, a make and break device in said electrical circuit and operable by the rotation of the magneto for the spark producing operation, once in each revolution of said magneto, additional means mounted for operative movement by the rotating part of the magneto to open and close the electrical circuit before the part of the magneto's revolution occurs, when the flux in a particular one of the magnetic circuits is utilized in the aforementioned spark producing operation.

16. In a magneto of the rotary inductor type operable to successively establish maximum and minimum magnetic flux in different magnetic circuits, the combination of means for a magnetic field, an inductor, an electrical circuit, a usual make and break device for the latter operable to open and close upon continuous relative rotation of said means and inductor for a single spark producing effect per revolution of said inductor, and additional means positioned so as to open and close said electrical circuit and fully establish said magnetic flux before said first mentioned make and break device opens said electrical circuit.

17. In a magneto of the rotary inductor type, the combination of an inductor, means to successively make and break a plurality of magnetic circuits through the inductor upon each relative and complete rotation of

the inductor and said means, a normally closed electrical circuit in inductive relation to said magnetic circuits, a usual make and break device operable by the magneto's rotation to open and close the electrical circuit once in each revolution after one of said magnetic circuits is broken and before the succeeding magnetic circuit is made, additional means operable by the magneto's rotation to open and close said electrical circuit before the time of said first-named opening to aid the establishment of magnetic flux in preparation for said first-named opening.

18. In a magneto of the rotary inductor type in which a plurality of maximum and minimum flux changes occur on each revolution, only one of which is desired for use in effecting a single spark producing result, the combination of means for a magnetic field, an inductor, an electrical circuit, a usual make and break device for the latter operable upon continuous relative rotation of said means and inductor for a spark producing effect once for each revolution of said magneto, a governor on the rotating part of the magneto operable to render said make and break device ineffective upon excessive speed of rotation, and an additional make and break device mounted on the rotating part of the magneto operable in each revolution of the magneto to open and close the electrical circuit, said additional make and break device being operable independently of the governor's action for controlling the electrical circuit to open it at a time in the magneto's rotation when if closed the electrical circuit would choke off a desired establishment of the flux.

19. In a rotary magneto the combination of means comprising a magnetic source, cooperating pole pieces, an inductor means to cooperate with the pole pieces to establish magnetic circuits from said source through the pole pieces and inductor, the inductor and pole pieces being relatively rotatable so as to make and break successive magnetic circuits during each revolution, an electrical circuit arranged for inductive relation to all the magnetic circuits, a make and break device in said electrical circuit and operable by the rotation of the magneto for the spark producing operation, once in each revolution of said magneto, additional means mounted for operative movement by the rotating part of the magneto to open and close the electrical circuit before the part of the magneto's revolution occurs, when the flux in a particular one of the magnetic circuits is utilized in the aforementioned spark producing operation, and a governor device on the rotatable part of the magneto operable on excessive speed of the magneto's rotation to put the first-mentioned make and break device out of operation, said additional means to open and close said electrical circuit being operable at any speed independently of the governor.

20. In a magneto of the rotary inductor type operable to successively establish maximum and minimum magnetic flux in different magnetic circuits, the combination of means for a magnetic field, an inductor, an electrical circuit, a usual make and break device for the latter operable to open and close upon continuous relative rotation of said means and inductor for a single spark producing effect per revolution of said inductor, and additional means positioned so as to open and close said electrical circuit and fully establish said magnetic flux before said first-mentioned make and break device opens said electrical circuit, and a governor rotatable with the magneto to put only the first-mentioned make and break device out of operation on excessive speed of the magneto.

21. In a magneto of the rotary inductor type, the combination of an inductor, means to successively make and break a plurality of magnetic circuits through the inductor upon each relative and complete rotation of the inductor and said means, a normally closed electrical circuit in inductive relation to said magnetic circuits, a usual make and break device operable by the magneto's rotation to open and close the electrical circuit once in each revolution after one of said magnetic circuits is broken and before the succeeding magnetic circuit is made, additional means operable by the magneto's rotation to open and close said electrical circuit before the time of said first-named opening to aid the establishment of magnetic flux in preparation for said first-named opening, and a speed governor operable to put the first-mentioned make and break device out of operation when the magneto speed exceeds a predetermined value, said additional means to open and close said electrical circuit being operable in each revolution of the magneto not only when the first-mentioned make and break device is in operation but also when it is not in operation.

In testimony whereof I have affixed my signature.

KENNETH A. HARMON.