

Jan. 22, 1952

A. L. BROWNLEE

2,583,466

FLYWHEEL MAGNETO

Filed June 10, 1950

3 Sheets-Sheet 1

Fig. 1.

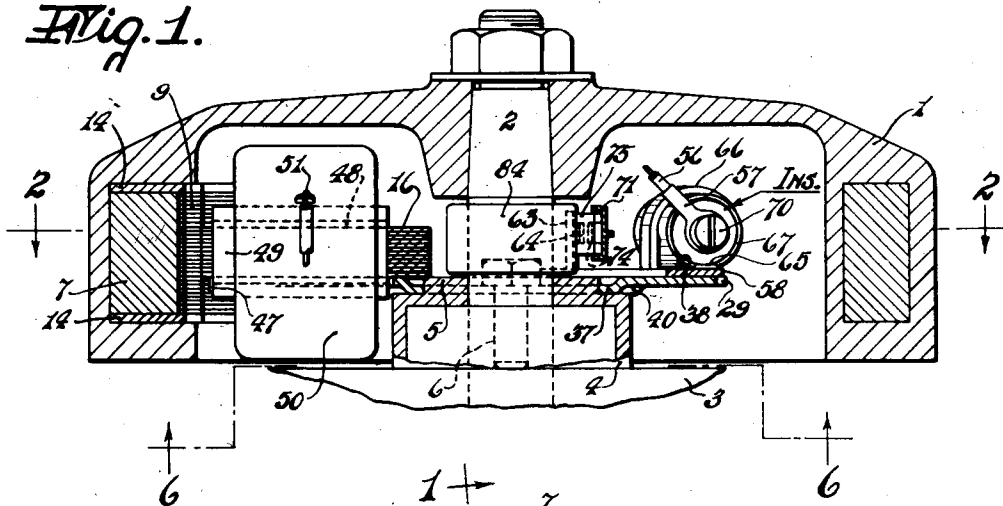
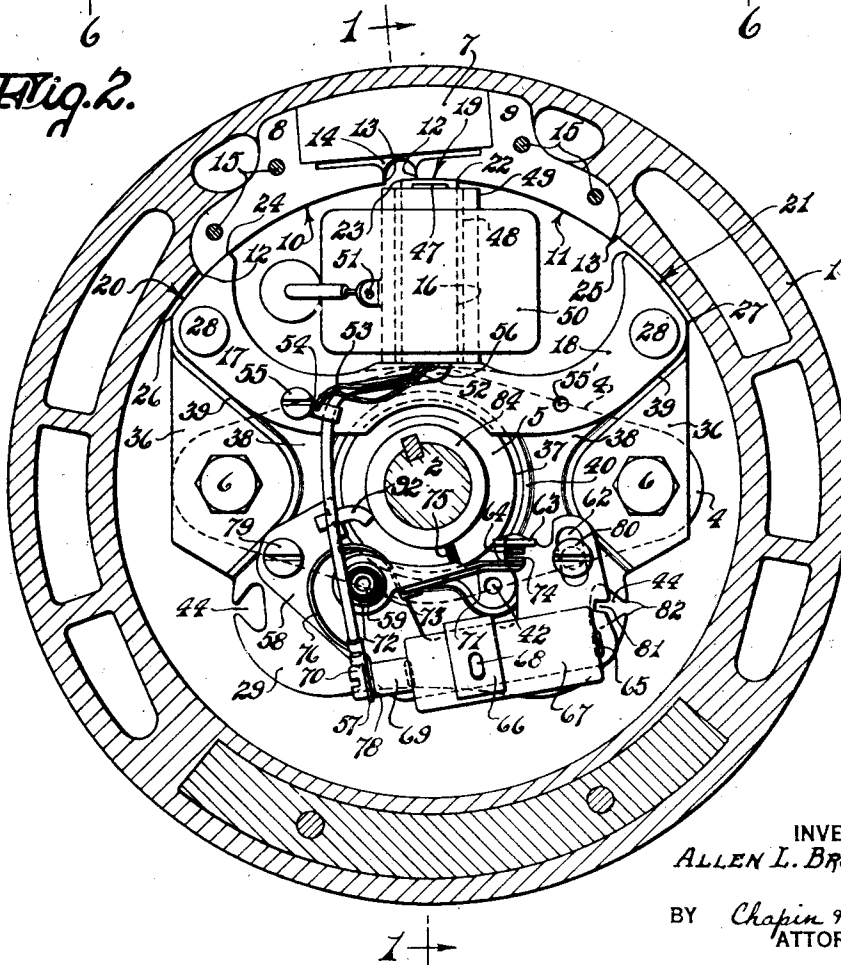


Fig. 2.



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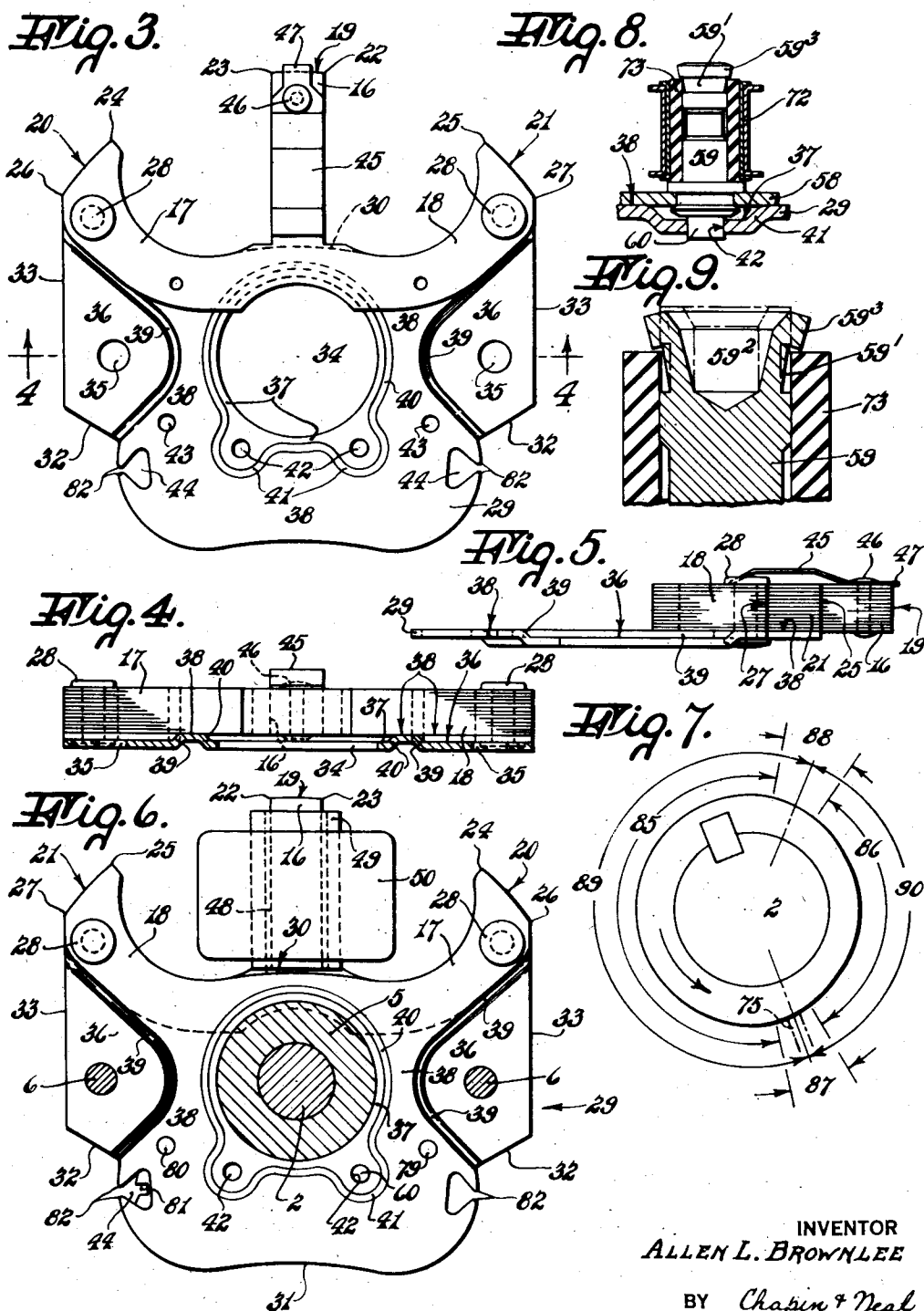
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Fig. 10.

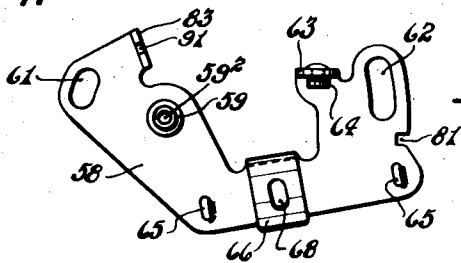


Fig. 12.

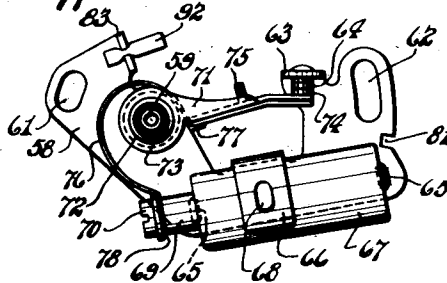


Fig. 11.

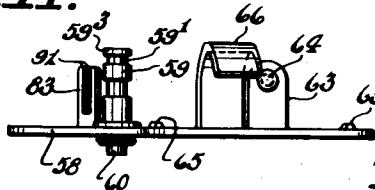


Fig. 13.

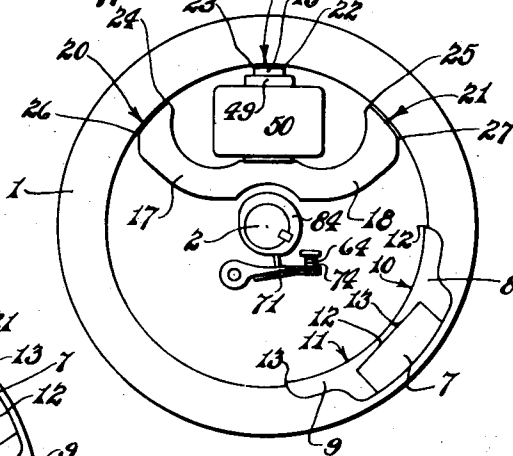
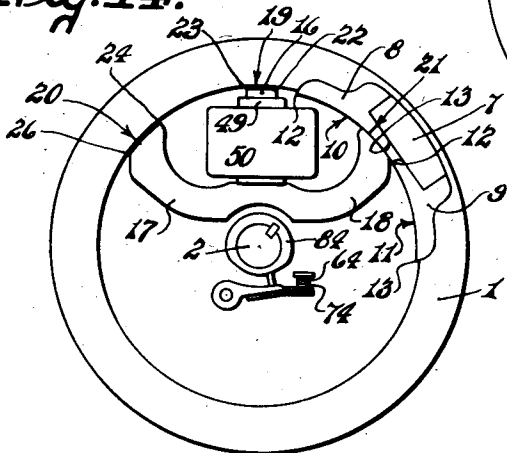


Fig. 14.



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UNITED STATES PATENT OFFICE

2,583,466

FLYWHEEL MAGNETO

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Application June 10, 1950, Serial No. 167,309

15 Claims. (Cl. 171-209)

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This invention relates to improvements in flywheel magnetos, adapted for the ignition of internal combustion engines and, more particularly, engines, such as outboard motors, and those used on lawn mowers, motorized bicycles, scooters, chain saws and the like, which operate at very high speeds.

The invention is an improvement on that disclosed in the Harmon patent No. 2,101,392, dated December 7, 1937. The magneto disclosed in this patent is satisfactory for engines, which operate at about 300 revolutions per minute or less. It is not satisfactory for engines operating at much higher speeds because it produces each revolution, in addition to the ignition spark, an unwanted or so-called "maverick" spark, which is of sufficient intensity and occurs at such time as to adversely affect the operation of the engine by causing pre-ignition and loss of power. In this type of magneto, one complete reversal of magnetic flux through the coil-carrying core is effected once during each revolution and this flux reversal is utilized to produce the ignition spark. The breaker points which control the circuit of the primary coil, are closed at the start of such reversal and opened at the end of such reversal to produce the E. M. F., relied on for the ignition spark. This flux reversal, however, is preceded by an increase or building up of flux in the coil-carrying core and is followed by a decrease of flux through the core, both increase and decrease occurring while the breaker points are open. An E. M. F. is produced by the flux increase and also by the flux decrease. The amount of E. M. F. produced increases with the speed, other factors being equal. The E. M. F. produced following the flux reversal occurs at such a time in the engine cycle as to cause no trouble. The E. M. F. produced by the flux increase, however, occurs at such a time, as to cause pre-ignition, if the voltage is sufficiently high. The maverick E. M. F. produced at low engine speeds, say 3000 R. P. M. or less, was not high enough to cause trouble but, if the magneto is operated at high speeds, presently being used such as 5000 to 7000 R. P. M. the maverick E. M. F. becomes very high, say 3000 volts, and will cause pre-ignition and resulting power loss. As engine speeds increased from those originally used with the magneto of the Harmon patent, unsymmetrical pole shoes and/or unsymmetrical faces on the outer ends of the legs of the laminated armature were used in order to weaken the maverick E. M. F. and prevent a maverick spark of sufficient intensity to cause pre-ignition.

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This is as shown, for example, in the Alstrom and Brownlee Patent No. 2,447,727, granted August 24, 1948. As engine speeds became still higher, the use of such unsymmetrical shoes and faces was no longer effective to keep the voltage, occurring from the building up of flux, within sufficiently low limits to prevent pre-ignition and the resultant interference with engine operation.

This invention has for an object the provision of improvements in flywheel magnetos of the general type shown in the Harmon patent for preventing the occurrence of a maverick spark even though the magneto is operated at the very high speeds at present contemplated.

The invention also has for an object the provision of an improved stator plate construction for a flywheel magneto, adapted for mass production at low unit cost, being made as a stamping from thin sheet metal with offset portions shaped to give adequate rigidity at the necessary locations.

The invention has for another object the provision of a stator plate of magnetic material functioning as part of the armature which it supports.

The invention has for another object an improved stator plate with provisions for a right and left hand mounting thereon of the breaker point mechanism to adapt the latter for use with an actuating cam rotating in either direction.

The invention has for a further object the provision in a flywheel magneto of breaker point mechanism and a condenser mounted as a separate unit on a supporting plate, adapted for attachment to the stator plate of the magneto.

Another object of the invention is to anchor the spring of the breaker lever to the insulated terminal of the condenser and utilize it as an electrical conductor, both lever and condenser and the stationary point being mounted on a single plate which is adjustably secured to the stator plate, the adjustment of the breaker plate on the stator plate being for the purpose of varying the extent of opening of the breaker points and such adjustment being capable of being made without changing the force of the spring, which tends to hold the breaker points engaged.

These and other objects will best be understood from the following description of the invention in connection with the one illustrative example of it shown in the accompanying drawings, in which

Fig. 1 is a full size sectional elevational view, taken on the line 1-1 of Fig. 2, of a flywheel magneto embodying the invention;

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Fig. 2 is a full size sectional plan view taken on the line 2—2 of Fig. 1, showing the parts in the positions which they occupy at the time of production of the ignition spark;

Fig. 3 is a top plan view of the stator plate and armature;

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 3;

Fig. 5 is an end elevational view of the stator plate and armature;

Fig. 6 is a fragmentary sectional view taken on the line 6—6 of Fig. 1;

Fig. 7 is an enlarged view of the cam for actuating the breaker lever;

Fig. 8 is an enlarged fragmentary sectional view of the pivotal mounting of the breaker lever;

Fig. 9 is a much enlarged view of the upper portion of Fig. 8, illustrating how the hub of the breaker lever is held to its pivot;

Figs. 10 and 11 are plan and side elevational views of the breaker plate;

Fig. 12 is a plan view of the complete breaker unit;

Fig. 13 is a digrammatical view showing the relative positions of pole shoes and cooperating armature faces for the early limit time of closure of breaker points; and

Fig. 14 is a view similar to Fig. 13 but showing the relative positions of pole shoes and cooperating armature faces for the late limit time of closure of the breaker points.

Referring to these drawings, the magneto includes a flywheel 1 (Figs. 1 and 2) adapted to be fixed as indicated to the outer end of the crankshaft 2 of an internal combustion engine, a portion of the crankcase of which is designated 3. Such portion has a boss 4, having a cylindrical pilot hub 5 (see also Figs. 2 and 6) coaxial with the crankshaft and having tapped holes (Fig. 2), one on each side of the hub, to receive screws, such as 6, by means of which the stator element of the magneto is fixed to the crankcase.

The flywheel has a rim of non-magnetic material (Fig. 2) in which a permanent magnet 7 and two pole shoes 8 and 9 are embedded or otherwise fixed thereto. These shoes 8 and 9, which are fixed one to each polar end of magnet 7, have concave curved faces 10 and 11, respectively, which are of equal radius and coaxial with the flywheel. The adjacent edges of these shoes are separated by a small acute angle, as shown about 9°, and they are of equal angular extent and symmetrically located with reference to a radial center line passing through the magnet at a location centrally between its polar ends. The leading and trailing edges 12 and 13, respectively, of each shoe are separated by an acute angle several times larger, about four as shown, than the angle which separates their adjacent edges. The angular spacing between the trailing edge 13 of the pole shoe face 11 and the leading edge of the pole shoe face 10 is a little less than 90°, say 85°. The shoes are made up of laminations (Fig. 1) clamped between two non-magnetic plates 14 by rivets indicated in Fig. 2 at 15. This fastening means holds the two shoes and the magnet together to facilitate the embedding of these parts in the rim of the flywheel during the casting of the same.

The stator of the magneto includes a three-legged armature structure made up of iron laminations and stationarily supported inside the flywheel as indicated in Fig. 2. This armature is shown separately in Figs. 3, 4 and 5. It in-

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cludes a central leg 16, which is disposed radially of the flywheel and forms a core, and two outer legs 17 and 18, which are located one on each side of leg 16 and the inner ends of which are united to the inner end of the central leg. The legs 17 and 18 extend outwardly in diverging relation with the central leg. The legs 16, 17 and 18 have on their outer ends curved faces 19, 20 and 21, respectively, which have the same radius and one just slightly less than the radius of the faces 10 and 11 of the pole shoes and are intended to be positioned coaxially of the flywheel as will later appear. The central leg or core 16 (Fig. 4) is of approximately square cross section. The angular spacing (Fig. 2) between the front and rear edges 22 and 23, respectively, of face 19 is just slightly greater than the spacing between the adjacent edges 13 and 12 of the faces 10 and 11 of pole shoes 8 and 9, respectively. The angular spacing between the front edge 24 of the face 20 and the rear edge 23 of face 19 is just slightly less than the angular spacing between the leading and trailing ends 12 and 13 of either pole shoe. The angular spacing between the front edge 22 of face 19 and the rear edge 25 of face 21 is equal to that between the leading and trailing ends 12 and 13 of pole shoe 9 and preferably and as shown to that between the edges 24 and 23. The angular spacing between the rear edge 26 of face 20 and its front edge 24 equals the angular spacing between the rear edge 25 of face 21 and its front edge 27 and exceeds the angular spacing between the front and rear edges 22 and 23 of face 19. The armature structure, as shown, is symmetrical with reference to the radial center line of core 16.

The armature described is secured by rivets 28 to a supporting plate 29, as best shown in Figs. 3, 4, 5 and 6. This plate is made as a stamping of thin sheet steel. One end edge 30 (Figs. 3 and 6), of this plate substantially coincides with the outer face of the legs 17 and 18 and the curved faces 20 and 21 on their outer ends. The magnetic quality of this plate is utilized as part of the armature in that it adds to the cross section of the legs the equivalent of two laminations (Fig. 5). The other end edge 31 of plate 29 is complementary to the first-named edge 30, except for the angular edges 32. The side edges 33 are straight and parallel. The contour of the plate is not critical. However, it is important that all edges of the plate, except those which coincide with the faces 20 and 21 on the outer ends of legs 17 and 18, be spaced from the axis of the flywheel by radial distances substantially less than the radius of the faces 10 and 11 of the pole shoes in order to maintain a large air gap between the magnet shoes 8 and 9 and the magnetic plate 29. This plate has a circular opening 34 to closely fit the outer periphery of the pilot hub 5 and is mounted thereon. On each side of opening 34 are holes 35 for the screws 6, which clamp plate 29 against the face of boss 4. This plate is made of thin steel and as shown has a thickness of about $\frac{1}{16}$ inch. Certain portions of the plate are offset from other portions thereof by a distance about equal to the thickness of the plate. Thus, the side areas 36 and a central area 37 are in a plane lower than the parallel plane in which the intervening area 38 is located. This offsetting provides the necessary rigidity for the thin plate. It results in half ribs, such as 39, which connect the portions 36 and 38 and a half rib 40, which connects the portions 37 and 38 and

is substantially annular except for two offsets 41, extending one around each of two holes 42, which are pilot holes for locating with precision the pivot of the breaker mechanism, as will later appear. The plate also has two tapped holes 43 for use in attaching the breaker mechanism and two notches 44 for a purpose to be later described. The stator plate 29 and all the parts described, (except holes 35) are symmetrical about an extended diameter of opening 34, which diameter passes centrally through the core 16. The holes 35 are unsymmetrically spaced from the opening 34 to prevent mounting the plate on the crankcase in any other than the illustrated position.

The plate described is fixed, as shown in Fig. 2, by two screws 6 which pass through holes 35 and thread into the tapped holes in boss 4, the opening 34 closely fitting the outer periphery of pilot hub 5 and accurately locating the curved faces 19, 20 and 21 of the armature in coaxial relation with the crankshaft 1 and flywheel 2 and the pole shoes 8 and 9 of the magnet. The bottom face of the portion 37 of plate 29 abuts the shoulder at the bottom of the pilot hub 5 (Fig. 1). This leaves sufficient clearance between the end face of hub 5 and the lower face of the laminated armature, which partially overlaps the opening 34. The half-rib 40, which encompasses the part 37, gives strength and rigidity to the plate at a location, which is very important because of its function of locating the curved faces of 19, 20 and 21 coaxially of the flywheel and crankshaft. It is also important to have rigidity between the core structure and the areas of plate 29, which are clamped to the engine crankcase by screws 6, and the half ribs 39 (Fig. 2), provide this rigidity. Each such half rib partially encompasses a fastening screw 6 and then follows along an outer portion of the lower face of the outer legs of the armature structure.

Referring again to the armature, the central leg or core 16 (Figs. 3, 4 and 5) has fixed to one face thereof a spring 45. As shown, this spring is secured near one end by a rivet 46 and has an extension 47 beyond the rivet. A coil unit (Figs. 2 and 6), comprising a central tubular core 48 of hollow square cross section; a primary coil 49 mounted upon the core; and a secondary coil 50 mounted upon the primary coil 49, is placed on core 16. As the core 48 is slide on core 16, the spring 45 will be compressed to some extent and its acts to take up any play between core 16 and the tubular core 48, which encompasses it. The coil unit is held in place by bending the extension 47 (Figs. 1 and 2) over and upon the upper end face of the core 48. Secondary coil 49 has a terminal 51 for connection to the spark plug of the engine. The coils 49 and 50 (Fig. 2) have ground wires 52 and 53, respectively, which are connected together and soldered to a clip 54. This clip is fastened to the armature structure by a self tapping screw 55 threaded into one of two holes 55', provided in such structure. The other terminal of the primary coil 49 is connected to a wire 56, having a lug 57 on its outer end. The clip 54 is bent over and upon this wire 56 to hold it in place.

The breaker point mechanism and the condenser therefor are provided as a separate unit, which may be readily removed from and replaced on the stator plate 29. One such unit is shown separately in Fig. 12. Another similar unit (not shown) is made reversely to the Fig. 12 unit and can be mounted on plate 29 for use when the flywheel and the cam for actuating the breaker

point mechanism rotates clockwise instead of counterclockwise, as shown. The breaker point mechanism includes a flat plate 58 (Figs. 10 and 11), having riveted thereto a stud 59, which projects from the top face thereof and a coaxial pilot 60, which projects from the bottom face thereof. The plate 58 (Fig. 10) also has two slots 61 and 62 thereof, each curved coaxially with the stud 59 and pilot 60. From one edge of plate 58, near slot 62, a lug 63 is bent up at right angles and, secured to this lug, is the stationary breaker point 64. The plate 58 has two spaced parallel abutments 65 struck up therefrom. Between these abutments is a curved clasp 66 bent up from one edge of plate 58. This clasp has a curved portion, of somewhat more than 90° extent, bent to the radius of the casing of a condenser 67. This casing is placed on the left hand abutment 65 with one end beneath clasp 66 and is then pressed to the right until its leading end engages the right hand abutment 65. The left hand end of the casing will then lie just to the right of the left hand abutment and the condenser will be pressed tightly to the plate with its ends engaging the abutments to prevent lengthwise displacement. A hole 68 is provided in clasp 66 to permit the metallic casing 67 to be soldered to clasp 66 if desired. The casing 67 is the ground terminal of the condenser contained in it. The other terminal of the condenser is a small post 69 having a screw 70 threaded therein.

The breaker lever 71 (Fig. 12) is of metal and has at one end a hub 72 encompassing a tube 73 of insulating material, which closely fits the stud 59. The ends of tube 73 (Fig. 8) project beyond the ends of this hub and thus the hub and lever are insulated from the stud 59 and plate 58. The upper end of stud 59 is expanded to hold the breaker arm against removal from the stud. It is important to spread the upper end of the stud to overlie the upper end face of tube 73 without causing any portion of the stud that lies within the tube from being expanded against the inner peripheral surface of the tube. To secure this result, a circumferential groove 59' is formed in the outer periphery of the stud near its upper end. Most of this groove will lie within the tube but the upper wall of the groove is located slightly above the end face of tube 73. Then a punch is forced in the hole 59² in the upper end of stud 59, which expands the upper part of the stud throwing the end 59³ outwardly and a little downwardly until it overlies the upper end face of tube 73 and is spaced therefrom by the desired clearance. The peripheral wall of groove 59' is necessarily expanded to some extent but since it was originally of less diameter than the tube, it can and does expand as much as necessary without touching the internal periphery of the tube and causing binding. The outer end of lever 71 has fixed thereto a breaker point 74 to cooperate with point 64. Fixed to the lever 71 at a location intermediate its ends is a cam follower 75 of insulating material. A spring 76 has right angular bent ends 77 and 78. A portion of the spring passes through a slot in the breaker lever and one end 77 abuts the outer face of the lever. This spring curves around hub 72 and then extends to the post 69 where its end 78 is secured together with the lug 57 on wire 56 (see Fig. 2) by screw 70. The spring serves as an electrical conductor between the insulated breaker lever and the insulated terminal of the condenser. The spring exerts a radially outward

thrust (to the right as viewed in the drawings) on the breaker lever and thus takes up any clearance between stud 59 and tube 73 and prevents sliding of breaker point 74 on breaker point 64.

The breaker mechanism unit is mounted on the stator plate 29 by laying the breaker plate 58 on plate 29 and inserting the pilot 60 in the left hand pilot hole 42. Screws 79 and 80 are inserted through slots 61 and 62, respectively, to clamp the plates together. Adjustment of the breaker plate around the pivotal axis of the breaker lever may be made to vary the extent of opening of the breaker points and since spring 76 is anchored to condenser 67 on plate 58, the force of the spring, acting to hold the points engaged is not changed by the adjustment. This adjustment may be made while screws 79 and 80 are loosened, by inserting a screw driver in a notch 44 in plate 29 and into a notch 81 in the breaker plate and swinging the screw driver as a lever, using either the upper or lower of the knife edges 82 as a fulcrum, accordingly as the plate 58 is to be turned clockwise or counterclockwise, respectively. The screws 79 and 80 are then tightened to clamp plate 58 in adjusted position. If the flywheel turns clockwise, a reversed form of breaker mechanism is used and its pilot is inserted in the right hand pilot hole 42. Otherwise the plate of the reversed form of breaker mechanism is mounted, adjusted and secured in a manner similar to that described. The second notch 44 is provided to serve as a fulcrum for a screw driver, when used to adjust the plate of the reversed form of breaker mechanism. It is to be noted that the same shaped piece of metal is used for the plate of the reversed form of breaker mechanism but the lug 64, clasp 66 and seat 65 and a lug 83 are bent in the opposite direction from the top face of plate 58.

The follower 75 rides on the periphery of a cam 84 fixed on crankshaft 2. The counterclockwise rotation of this cam creates a thrust on follower 75 to the right but the spring 76 has taken up any clearance between the stud 59 and tube 73 so that the cam will not cause relative sliding of the breaker points. Reverse rotation of the cam would create a thrust to the left on the breaker lever and tend to slide the breaker point 74 on point 64 against the force of spring 76. That is why it is better to provide the reversely formed breaker mechanism and use it where the rotation of the cam is clockwise.

The cam 84 is constructed as best shown in Fig. 7. It has a high dwell surface 85, a low dwell surface 86, a rise surface 87 and a drop surface 88. When the follower 75 is engaged by the rise surface 87, the breaker points will be opened. This occurs at the position shown in Fig. 2. The high dwell surface 85 holds the points open for a substantial interval and then the drop surface 88 allows the points to close and the low dwell surface 86 maintains them closed for an interval of about 137° as shown. When the breaker points are closed, the cam follower 75 does not engage the surface 86, allowing the breaker spring 76 to press the points tightly together. The breaker points open when the cam is positioned as shown in Fig. 2 and then remain open while the cam travels through the angle 89, then closing and remaining closed while the cam is travelling through the angle 90. Fig. 13 shows diagrammatically the position of shoes relatively to the armature structure, when the breaker points close, and Fig. 2 shows the position when

they open. The Fig. 13 position provides for a large factor of safety because the primary coil circuit does not need to be closed until a position such as shown in Fig. 14 is reached, where the leading edge 12 of the leading pole shoe 8 is no closer than 5° to the front edge 22 of the curved surface 19 of core 16. As actually shown, the angle 90 between closed and open position is 137°. This angle 90 could be reduced to about 74°, which represents the latest limit for the closing of the primary coil circuit and is shown in Fig. 14. The reason for using an earlier closing of the breaker points is to insure that they will be actually engaged when the pole shoes reach the Fig. 14 position. When the cam allows the breaker points to be engaged by the spring, they will engage but they may not immediately remain in engagement, particularly when the engine is being operated at the very high speeds, such as are prevalent today. The movable breaker point may impinge on the fixed breaker point and rebound, separating the points, after which, the points may reengage and again rebound and separate and then close and remain closed. The mass of breaker lever is made as small as possible in order to reduce as much as possible the rebounding of the movable breaker point following its initial engagement with the fixed breaker point. However, for full insurance that the points will be closed from at least the Fig. 14 position to the Fig. 2 position of the pole shoes, it is better to close the breaker points at some earlier time, as for example when the pole shoes are in the Fig. 13 position.

The lug 83 on breaker plate 58 is provided with a vertical slot 91 (Figs. 10 and 11) for the purpose of retaining one end of a piece 92 (Fig. 12) of flexible, absorbent material, such as felt, the other end of which engages the periphery of cam 84 (Fig. 2), and acts as a wiper.

The operation will next be described. Assuming that the flywheel 1 and cam 84 are rotating in a counterclockwise direction, the cam allows the breaker points 64 and 74 to engage when the pole shoes 8 and 9 of the magnet 7 reach the position shown in Fig. 13. As above set forth, this early engagement of the points is to provide for a margin of safety to insure that the movable breaker point 74 finally comes to rest in engagement with the stationary breaker point 64 by the time that the pole shoes reach the Fig. 14 position because it is desired to have the circuit of the primary coil 49 closed when the leading edge 12 of the leading pole shoe 8 approaches closely to the front edge 22 of the face 19 on the core 16 in order to prevent the sudden change of flux, which would otherwise occur at this time if the circuit to the primary coil was open, and the production of a spark of sufficient intensity to ignite the mixture in the cylinder of the engine during the building up of flux in one direction in core 16. The primary circuit should be closed not later than when the rotor reaches the Fig. 14 position and a gap of five degrees exists between the leading edge 12 of shoe 8 and the front edge 22 of the face 19 on core 16 or somewhat greater than the air gap subsequently created between the trailing edges 13 of the shoes 8 and 9 and the rear edges 23 and 25, respectively, of the faces 19 and 21 of the armature at the time of production of the ignition spark (the condition shown in Fig. 2). As shoes 8 and 9, continuing their counterclockwise movement, traverse the curved faces 19 and 21 of core 16 and leg 17, respectively, flux is built up in one direction

through core 16, say for example, from shoe 8 through core 16 and legs 17 to shoe 9. This building up of flux is retarded because the circuit of the primary coil is closed and no substantial E. M. F. is produced. As the shoes 8 and 9 continue their counterclockwise movement, the leading edge 12 of shoe 8 will engage the face 20 of leg 17 and the leading edge of shoe 9 will engage the curved face 19 of core 16. This occurs shortly before the trailing edges 13 of the shoes 8 and 9 respectively leave the edges 23 and 25 of the faces 19 and 21, respectively. As the shoes leave the last-named edges, the former magnetic circuit through core 16 is broken and one established in the opposite direction. That is, flux now passes from shoe 8, through leg 17 and then through core 16 to shoe 9. The closed primary coil retards this flux change but when the trailing edges of the shoes 8 and 9 are spaced from edges 23 and 25 of faces 19 and 21, respectively, by a sufficient air gap, for example, as shown in Fig. 2, the cam 84 separates the breaker points 74 and 64 and a reversal of flux occurs through core 16 and the high voltage for the ignition spark is produced. The flux reversal consists of a decrease from a maximum in one direction to zero followed by an increase from zero to a maximum in the opposite direction. On continued rotation, the shoes 8 and 9 will leave the faces 20 and 19 respectively, causing a decrease in flux through core 16 to zero. An E. M. F. will be produced by this decrease in flux but it occurs at such a time in the engine cycle as to do no harm.

The closing of the breaker points during the building up of flux in the first-named direction to suppress the maverick spark, which would cause pre-ignition, limits the maximum to which the flux can build up in such direction and causes a loss. To help offset this loss, several compensating factors have been employed. A magnet, having much higher coercive force than any available at the time the magneto of the Harmon patent was made is used. The number of turns in the primary coil has been reduced to lessen the choking effect of the call, when in closed circuit. And the design of the armature is of great importance. The particular armature shown has a short core, short pole shoes and leakage is low. With this magnetic circuit as a basis, I have been able by the use of compensating factors to secure enough build-up of magnetic flux to provide adequate ignition under all usual conditions of engine operation. The spark at the higher speeds is not as large as it is at lower speeds but it is adequate for ignition at that time. The more difficult ignition condition is when the engine is operated at lower speeds by retarding the time of ignition and that condition is met by the better spark then produced. The use of a lesser spark at the higher engine speeds at which the engine is operated most of the time is an advantage in that it affords longer life of the breaker points. Thus, the invention provides for the suppression of a maverick spark shortly prior to the ignition spark by closing the circuit of the primary coil during the building up of flux in the coil-carrying core that occurs just prior to the reversal of flux through such coil that is utilized to produce the ignition spark. While this tends to decrease the maximum to which flux can build up in one direction in the core and thus to lessen the total amount of the flux change during the reversal, nevertheless, by proper design of the electrical and magnetic components of a mag-

neto, having the particular type of magnetic circuit herein shown, it is possible to secure sufficient flux change to provide adequate ignition for the purpose under all usual conditions of engine operation.

What is claimed is:

1. A flywheel magneto, comprising, a flywheel, a single pair of pole shoes fixed to the flywheel and angularly spaced about the axis of revolution thereof, said shoes having curved polar faces of equal radius coaxial with the flywheel, the adjacent edges of the faces of the two shoes being separated by a small acute angle, the leading and trailing edges of the face of each shoe being separated by an acute angle several times larger than the first-named angle, a source of magnetic flux magnetically interconnecting said shoes, an armature of magnetic material stationarily mounted inside the flywheel and having three legs which are magnetically connected together at their inner ends and diverge outwardly, said legs having on their outer ends curved faces of a radius slightly less than the radius of said pole shoe faces and coaxial therewith, the faces on said legs being angularly spaced about said axis to cooperate with the shoes during rotation of the flywheel, the angular spacing of the front and rear edges of the curved face on the central leg of the armature being substantially commensurate with the angular spacing between the adjacent edges of the two pole shoes, the curved faces on said legs being separated by an angle substantially commensurate with that between the leading and trailing edges of a pole shoe, primary and secondary coils on the central leg of the armature, said shoes being operable on rotation of the flywheel to bridge the polar ends of the source of flux through the central coil-carrying leg first through a first one of the outer legs and then through a second one of the outer legs, whereby a magnetic circuit is created through the coils first in one and then in the other direction, an electrical circuit including said primary coil, and means actuated with the rotation of the flywheel for closing said circuit once during each revolution of the flywheel and before the leading edge of the leading pole shoe approaches closer than five degrees to the front edge of the curved face on said central leg and maintaining such circuit closed until the leading edge of the leading pole shoe connects with the front part of the curved face on the second outer leg and its trailing edge is spaced from the rear edge of the central leg by about three degrees, and the leading edge of the trailing pole shoe connects with the front part of the curved face on the central leg and the trailing edge of the trailing shoe is spaced from the rear edge of the curved face on the first outer leg by about three degrees, and then opening said circuit.

2. A flywheel magneto, comprising, a flywheel, a single pair of pole shoes fixed to the flywheel and angularly spaced about the axis of revolution thereof, said shoes having curved polar faces which are of equal radius and equal angular extent and which are coaxial with the flywheel, the adjacent edges of said faces being separated by a small acute angle, and the leading edge of one shoe being separated from the trailing edge of the other shoe by an angle of about ninety degrees, a source of magnetic flux magnetically interconnecting said shoes, an armature of magnetic material stationarily mounted inside the flywheel and having three legs which are magnetically connected together at their inner ends

and diverge outwardly, said legs having on their outer ends curved faces of a radius slightly less than the radius of said pole shoe faces and coaxial therewith, the faces on said legs being angularly spaced about said axis to cooperate with the shoes during rotation of the flywheel, the angular spacing of the front and rear edges of the curved face on the central leg of the armature being substantially commensurate with the angular spacing between the adjacent edges of the two poles shoes, the curved faces on said legs being separated by an angle slightly less than that between the leading trailing edges of the curved face of a pole shoe, the curved faces on said outer legs being symmetrically spaced with reference to a radial line passing centrally through the central leg, primary and secondary coils on the central leg of the armature, said shoes being operable on rotation of the flywheel to bridge the polar ends of said source of flux through the central coil-carrying leg first through a first one of the outer legs and then through a second one of the outer legs, whereby a magnetic circuit is created through the coils first in one and then in the other direction, an electrical circuit including said primary coil, and means actuated with the rotation of the flywheel for closing said circuit once during each revolution of the flywheel and before the leading edge of the leading pole shoe approaches closer than five degrees to the front edge of the curved face on said central leg and maintaining such circuit closed until the leading edge of the leading pole shoe connects with the front part of the curved face on the second outer leg and its trailing edge is spaced from the rear edge of the central leg by about three degrees, and the leading edge of the trailing pole shoe connects with the front part of the curved face on the central leg and the trailing edge of the trailing shoe is spaced from the rear edge of the curved face on the first outer leg by about three degrees, and then opening said circuit.

3. A stator for a flywheel magneto, comprising a stator plate of thin sheet steel adapted to be secured to the crankcase of an engine and having a cylindrical opening therethrough adapted to receive the pilot hub on such crankcase, a laminated-iron armature fixed to said plate and having three legs which are magnetically interconnected at their inner ends and which diverge outwardly and terminate with curved outer end faces of equal radius located coaxially of said opening and in angularly spaced relation with respect to said axis, primary and secondary coils on the central leg of said armature, said plate having portions contiguous with one side face of the outer legs of the armature and substantially coextensive with such faces, whereby such steel portions function as magnetic parts of said outer legs, the outer peripheral margins of the plate except at the curved faces of the outer legs being spaced from the axis of said opening by dimensions substantially less than the radius of said curved faces.

4. A stator for a flywheel magneto, comprising, a stator plate, an armature of magnetic material fixed thereto, primary and secondary coils mounted on said armature and having one terminal of each grounded thereto, and control means for the primary coil mounted as a separate unit on said stator plate and including a second plate secured to the stator plate for convenient removal and replacement, a breaker point fixed to the second plate, a breaker arm of electrical conducting material pivoted at one end

to and insulated from the second plate and having near its other end a breaker point yieldingly urged toward the fixed breaker point, a condenser fixed to the second plate and having one terminal grounded thereto, and electrical connections from the other terminal of the condenser and the other terminal of the primary coil to said breaker arm.

5. A stator for a flywheel magneto, comprising, a stator plate, an armature of magnetic material fixed thereto, primary and secondary coils mounted on said armature and having one terminal of each grounded thereto, a breaker arm of electrical conducting material pivotally supported at one end and insulated from said plate and having near its other end a breaker point, a relatively stationary breaker point supported by said plate for cooperation with the first breaker point, a condenser supported by said plate and having one terminal grounded thereto, a spring for moving the breaker arm to engage the breaker points, said spring having one end fixed to the breaker arm and its other end fixed and electrically connected to the other terminal of the condenser, and a wire connecting the other terminal of the primary coil to the last-named terminal of the condenser.

6. A stator for a flywheel magneto, comprising, a stator plate, an armature of magnetic material fixed thereto, primary and secondary coils mounted on the armature and each having one terminal grounded to the armature, and control means for the primary coil mounted as a separate unit on the stator plate and including a second plate mounted on the stator plate, a breaker point fixed to said second plate, a breaker arm of electrical conducting material pivotally connected at one end to and insulated from the second plate and having fixed thereto near its other end a breaker point for cooperation with the first-named breaker point, a condenser, a metallic casing enclosing the condenser and forming one terminal thereof, said casing being mounted in fixed position on the second plate and thereby grounded thereto, a post fixed to and insulated from said casing and forming the other terminal of the condenser, a spring for moving the breaker arm in one direction to engage the breaker points and yieldingly holding them engaged, said spring being fixed at one end to the breaker arm and at the other end to said post, a wire connecting the other end of the primary coil to said post, and means for securing the second plate to the stator plate for angular adjustment about the pivotal axis of the breaker arm for the purpose of adjusting the extent of opening of the breaker points; the second plate, carrying the condenser casing to which said spring is anchored, being adjustable on the stator plate without varying the force of the spring acting to hold the breaker points engaged.

7. In a stator for a flywheel magneto, a stator plate of thin sheet metal having a cylindrical opening therethrough adapted to receive the pilot hub of an engine crankcase and having holes therethrough one on each side of said opening adapted to receive screws for fastening the plate to such crankcase, said plate having certain face portions in one plane and certain other face portions in another closely-spaced parallel plane, and integral connecting parts between the face portions in different planes, said parts forming half-ribs for stiffening the plate, an armature crossing said plate above said opening and above

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said holes and secured at its ends to a portion of said plate that lies in one said plane, said holes located one in each of two other portions located in the other of said planes, the half-rib connecting parts between each latter portion and the portion to which the armature is secured each extending around the inner side of the hole therein and thence diverging outwardly along the inner face of the armature.

8. In a stator for a flywheel magneto, a stator plate of thin sheet metal having a cylindrical opening therethrough adapted to receive the pilot hub of an engine crankcase and having holes therethrough one on each side of said opening adapted to receive screws for fastening the plate to such crankcase, said plate having certain face portions in one plane and certain other face portions in another closely-spaced parallel plane, and integral connecting parts between the face portions in different planes, said parts forming half-ribs for stiffening the plate, an armature crossing said plate above said opening and above said holes and secured at its ends to a portion of said plate that lies in one said plane, said holes located one in each of two other portions located in the other of said planes, the half-rib connecting parts between each latter portion and the portion to which the armature is secured each extending around the inner side of the hole therein and thence diverging outwardly along the inner face of the armature, said opening being formed in an annular portion in the second-named plane and the half-rib part which connects such annular portion to portions in the other plane being substantially annular and coaxial with said opening.

9. A breaker mechanism, comprising, a plate, a stud fixed thereto and projecting from one face thereof, curved slots in said plate one on each side of said stud and concentric therewith, said slots adapted to receive screws for fastening the plate to a support, a breaker arm of electrical conducting material pivotally mounted at one end on and insulated from said stud, a breaker point fixed to the other end of said arm, a lug upturned from said plate at right angles, a breaker point fixed to said lug, a condenser secured to said plate with one terminal grounded thereto, and a spring for the breaker arm tending to move the latter to engage the breaker points.

10. A breaker mechanism, comprising, a plate, a stud fixed thereto and projecting from one face thereof, curved slots in said plate one on each side of said stud and concentric therewith, said slots adapted to receive screws for fastening the plate to a support, a breaker arm of electrical conducting material pivotally mounted at one end on and insulated from said stud and having a breaker point on its other end, a lug upturned from said first-named plate at right angles, a breaker point fixed to said lug, a condenser secured to said plate with one terminal grounded thereto, and a spring for the breaker arm tending to move the latter to engage the breaker points, said spring fixed at one end to said arm and at the other end to the other terminal of said condenser.

11. A breaker mechanism, comprising, a plate, a stud fixed to and projecting from one face of the plate and having a coaxial pilot projecting from the other face of the plate and adapted for closely fitting engagement in a pilot hole in a support to locate said stud with precision on the support, curved slots in said plate one on each side of said stud and concentric with the latter,

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said slots adapted to receive screws for fastening the plate to such support, a breaker arm of electrical conducting material pivotally mounted at one end on and insulated from said stud, a breaker point on the other end of said arm, a lug upturned from said plate at right angles, a breaker point fixed thereto, a condenser secured to said plate with one terminal grounded thereto, and a spring for the breaker arm tending to move the latter to engage the breaker points.

12. A breaker mechanism, comprising, a plate, a stud fixed to and projecting from one face of the plate, curved slots in said plate one on each side of said stud and concentric therewith, said slots adapted to receive screws for fastening the plate to a support, a breaker arm of electrical conducting material pivotally mounted at one end on and insulated from said stud, a breaker point fixed to the other end of said arm, a lug upturned from said plate at right angles, a breaker point fixed to said lug, a condenser on said plate, the latter having bent upwardly from one edge a clasp with a curved part to partially encircle the condenser, and abutments one for each end of the condenser struck up from said face of the plate one on each side of said clasp; said clasp pressing the condenser against the plate and frictionally holding it on the plate and between the abutments, and a spring for the breaker arm tending to move the latter and engage the breaker points.

13. A reversible mounting for the breaker mechanism of a magneto, comprising, a supporting plate for the armature of the magneto having a pilot hole for locating the armature relatively to the driving shaft of the magneto, said plate having right and left pilot holes of equal diameter located equidistant from the center of the first-named pilot hole and spaced one from another by a predetermined angle, said plate having a second pair of holes of equal size located equidistant from the center of the first-named pilot hole and in angularly spaced relation, the holes of the second pair being located on opposite sides of a radial line extending from the center of the first-named pilot hole and bisecting said angle between the second-named pilot holes and having an equal angular spacing with reference to said line, a second plate for supporting the breaker mechanism, a pivot stud fixed to and projecting from one face of the second plate, a pilot stud fixed to and projecting from the opposite face of the second plate coaxially of the pivot stud and having a diameter such as to closely fit in either of said pilot holes, said second plate having therethrough two slots both curved coaxially of the pivot and pilot studs, the radial center line of one slot being equal to the center to center distance between either of the second-named pilot holes and the nearest of the second pair of holes and the radial center line of the other slot being equal to the center to center distance between the same pilot hole and the more remote of the second pair of holes, the second plate being mounted on the first plate with its pilot stud engaged in a selected one of the second named pilot holes, fasteners extending one through each of the curved slots and one into each of the second pair of holes for holding the plates together in various positions of angular adjustment, a breaker lever pivotally mounted on said pivot stud, cooperating breaker points one on said lever and one on the second plate, and a spring for yieldingly holding the breaker points engaged.

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14. The combination of claim 13, in which the first plate has two notches one in each of two opposite edges, two walls of each notch intersecting the adjacent one of said edges to form two opposed and closely-spaced knife edges, the two notches and the pairs of knife edges being symmetrically disposed with reference to said radial line, said second plate having in one edge a notch adapted to lie over one or the other of the first-named notches according to whether the pilot stud is engaged in the right or the left pilot hole, whereby a screw driver can be engaged in the notch of the second plate and fulcrummed on one or the other of the adjacent knife edges to move the second plate about the axis of the pivot and pilot studs.

15. A pivotal mounting, comprising, a stud having near one end a flange, and a member having a hub mounted to turn on said stud and having one end face engaging said flange, said stud having its other end spread to overlie the other end face of said hub and retain the latter in axial position on the stud, such end being connected to

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the underlying bearing portion of the stud by a stem of less diameter than the bearing portion and located for the most part within said hub, whereby spreading of the stem can occur when the outer end is spread without causing engagement of the stem with the interior periphery of the hub.

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