

March 4, 1941.

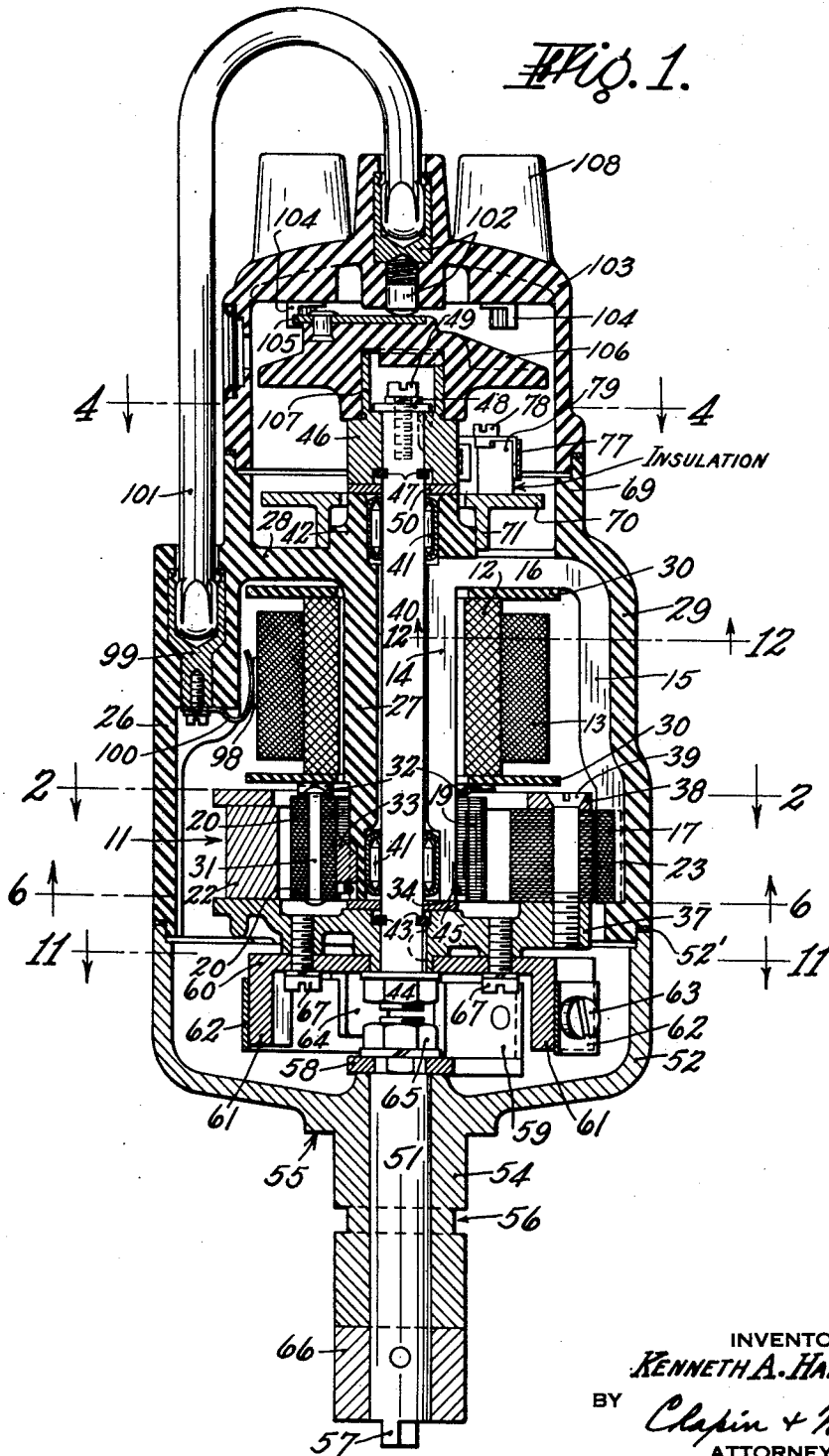
K. A. HARMON

2,233,946

MAGNETO

Filed Jan. 26, 1939

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March 4, 1941.

K. A. HARMON

2,233,946

MAGNETO

Filed Jan. 26, 1939

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Fig. 2.

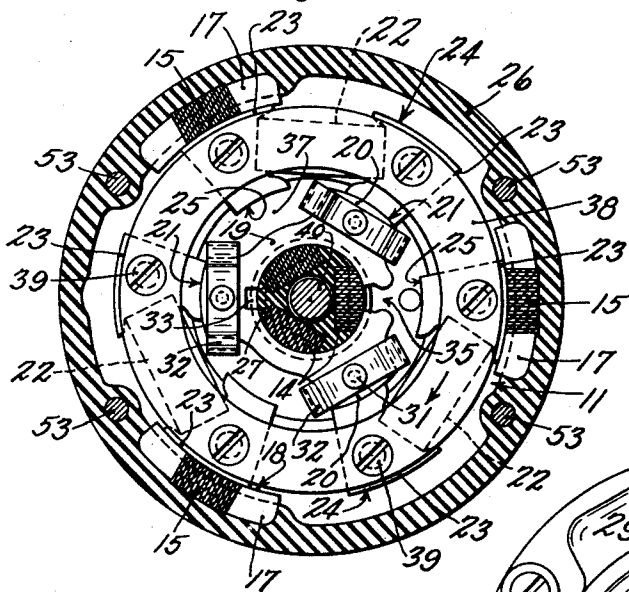


Fig. 3.

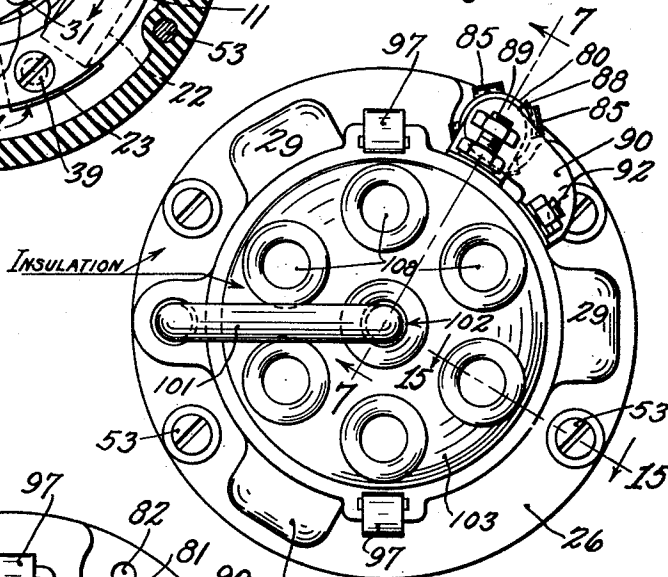
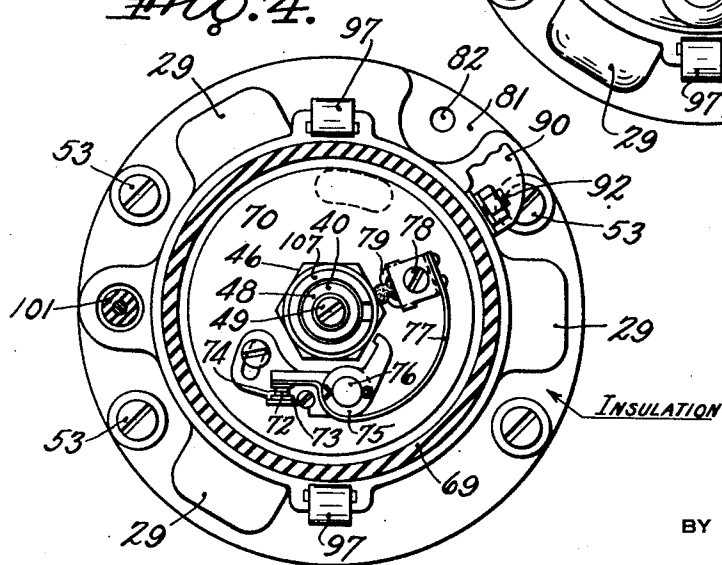


Fig. 4.



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Fig. 5.

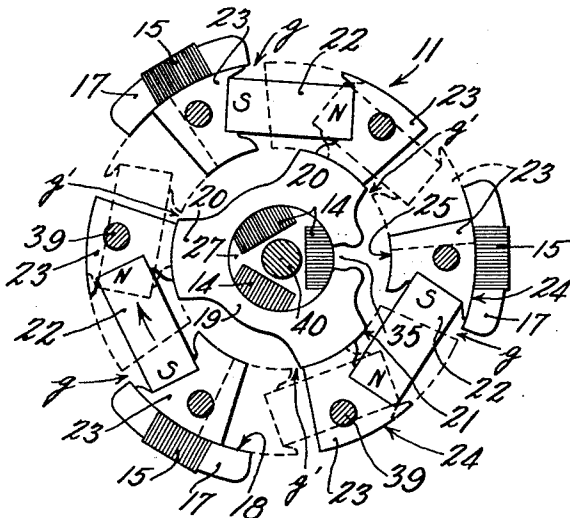


Fig. 6.

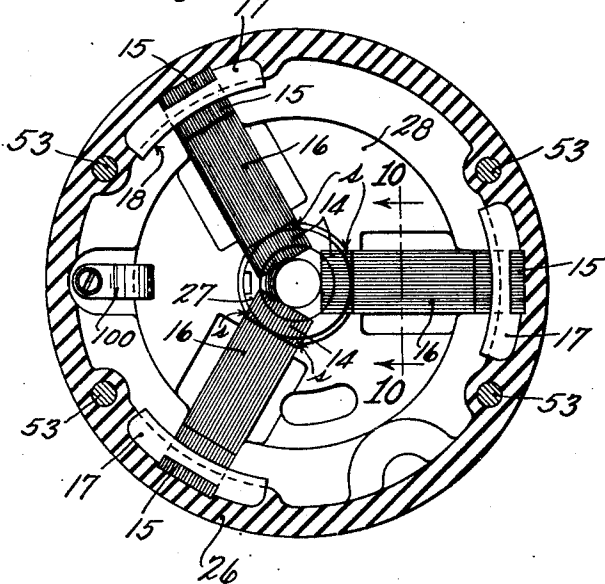


Fig. 10.

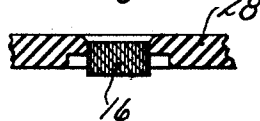


Fig. 7.

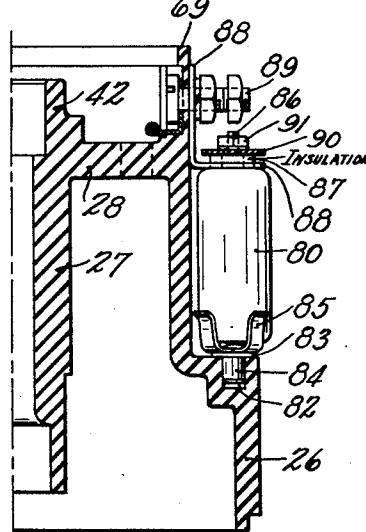


Fig. 8.

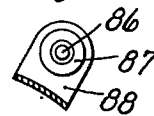
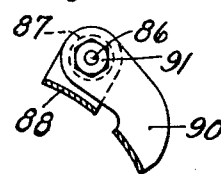


Fig. 9.



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Fig. 11.

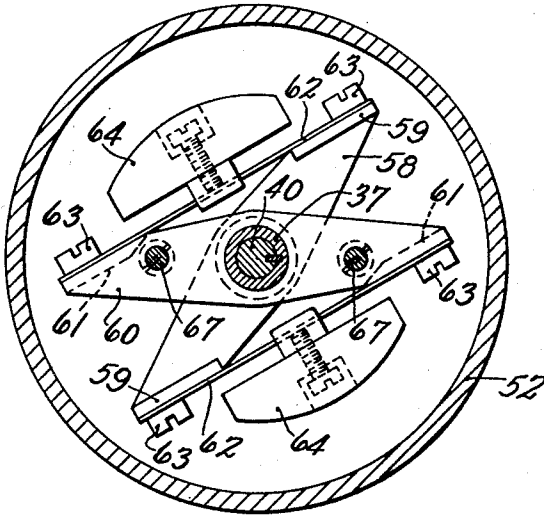


Fig. 15.

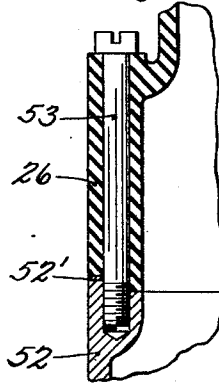


Fig. 12.

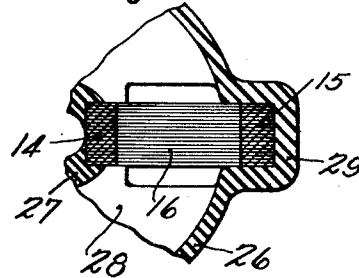


Fig. 14.

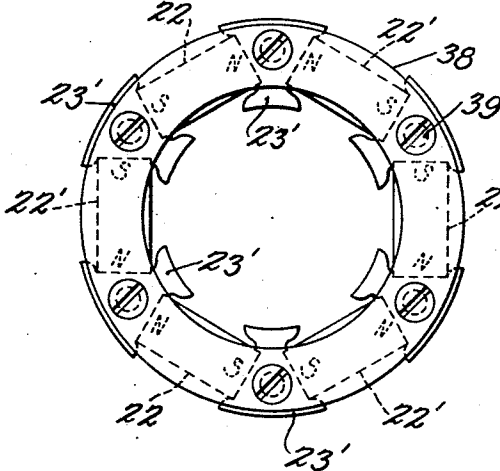
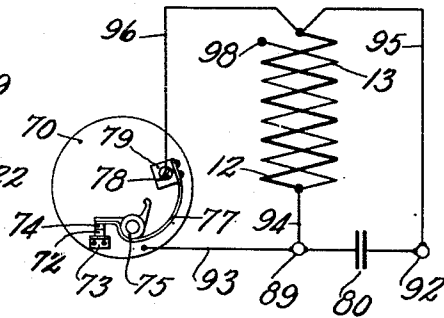


Fig. 13.



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2,233,946

MAGNETO

Kenneth A. Harmon, Longmeadow, Mass., assignor to Wico Electric Company, West Springfield, Mass., a corporation of Massachusetts

Application January 26, 1939, Serial No. 253,025

9 Claims. (Cl. 171-209)

This invention relates to improvements in magnetos.

One object of the invention is to provide a magneto of improved construction which is suitable, because of its exterior shape and small dimensions, for mounting in place of the usual timer-distributor unit of an automobile engine.

Another object of the invention is to provide an improved magneto having the coil unit encompassing the shaft of a magnetic rotor in coaxial relation therewith and having a circular series of U-shaped flux-conducting members arranged so that one leg of each passes between the coil unit and shaft and the other leg passes outside the coil unit, each leg having pole pieces for cooperation with the rotor, characterized by an improved construction of the U-shaped members affording high magnetic efficiency and by an improved mounting of such members affording a rugged structure and enabling important manufacturing economies.

A further object of the invention is to provide in a magneto of the type just set forth a non-metallic, die-cast casing in which said U-shaped members, each of one piece construction, are embedded during the process of casting the casing in such a way as to provide a rigid support for such members in a simple and commercially satisfactory way adapted to quantity production at low unit cost.

A further object of the invention is to provide in a magneto of the type described, an arrangement of pole pieces in an inner and an outer circular series with a magnetic rotor, the magnets of which are arranged in a circular series and travel in the space between the inner and outer sets of pole pieces with the axes of the magnets extending approximately lengthwise in said space and preferably being located in their entirety in said space.

A further object of the invention is to provide in a magneto of the general type set forth, a stator construction devoid of joints except for those between the pole pieces and laminations and having those joints made in a magnetically-efficient manner.

A further object of the invention is to provide in a magneto of the type described a stator and rotor affording a magnetic circuit through the laminated members, of which each is composed, with the parts arranged for flow of flux along the laminations throughout the entire circuit.

These and other objects will best be understood as the detailed description proceeds and they will be pointed out in the appended claims.

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

Fig. 1 is a sectional elevational view of a magneto embodying the invention;

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

Fig. 3 is a top plan view of the magneto;

Fig. 4 is a sectional plan view thereof taken on the line 4-4 of Fig. 1;

Fig. 5 is a diagrammatical view illustrative of the manner in which the rotor and stator cooperate in making and breaking the magnetic circuits;

Fig. 6 is a sectional plan view taken on the line 6-6 of Fig. 1 showing the molded casing with the stator elements embedded therein;

Fig. 7 is a fragmentary sectional view taken on the line 7-7 of Fig. 3;

Figs. 8 and 9 are fragmentary plan views illustrative of the terminals for the condenser shown in Fig. 7;

Fig. 10 is a cross sectional view taken on the line 10-10 of Fig. 6;

Fig. 11 is a sectional plan view taken on the line 11-11 of Fig. 1;

Fig. 12 is a fragmentary sectional plan view taken on the line 12-12 of Fig. 1;

Fig. 13 is a diagrammatical view illustrative of the electrical connections of the magneto;

Fig. 14 is a plan view of a modified form of magnetic rotor; and

Fig. 15 is a fragmentary sectional view taken on the line 15-15 of Fig. 3.

Referring to these drawings; the magneto includes a magnetic rotor 11, mounted to rotate about a vertical axis, and a stator which includes primary and secondary coils 12 and 13, respectively, telescoped one within the other and disposed in coaxial relation with but axially spaced from the rotor 11. The stator also includes a plurality of laminated, flux-conducting members each of approximately the form of an inverted U and having inner and outer legs 14 and 15, respectively, and a connecting cross bar portion 16. All the inner legs 14 extend through the central axial opening of the primary coil 12 from the top to and beyond the bottom thereof, being disposed parallel to the axis of the rotor. The outer legs 15 extend outside the secondary coil 13, from the upper end to and beyond the lower end thereof in a direction parallel to the axis of the rotor. The cross bar portions lie just above the upper end of the coils. These U-shaped members are disposed in a circular series (Fig. 6), circumferentially spaced one from another by equal angular

intervals about the axis of the rotor. The number of these members may be varied as desired. In this case, there are three such members, that being a convenient number for a magneto intended to serve a six cylinder engine.

Each outer leg 15 has fixed to its lower end a laminated pole piece 17 (Fig. 2), presenting a concave surface 18 of part-cylindrical form disposed coaxially with respect to the rotor. The inner legs 14, at their lower ends, are interconnected by a single laminated member 19 having three radial projections 20 terminating with convex surfaces 21 of partly-cylindrical form disposed coaxially with respect to the rotor. The projections 20 are circumferentially spaced about the axis of the rotor at equal angular intervals but in staggered relation with the pole pieces 17 so that each projection 20 lies between two pieces 17 and is equally spaced from each.

The rotor includes a plurality of permanent magnets 22, each of short bar form and arranged in a circular series. These magnets travel in the annular space between the surfaces 21 and the surfaces 18. Each magnet has pole shoes 23 engaged one with each polar extremity thereof. Each shoe 23 has outer and inner convex and concave surfaces 24 and 25 respectively, each of partly-cylindrical form and disposed coaxially with respect to the surfaces 17 and 21 and designed to cooperate respectively therewith. There are as many magnets 22 as there are U-shaped stator members. The arrangement is such that when three "north" pole shoes 23 connect one with each of the three projections 20 as shown in Fig. 5, the "south" pole shoes will connect one with each of the pole pieces 17 and vice versa. Thus, flux from the north poles of the three magnets will first pass up through the three inner legs 14, through the coils, across the parts 16 and down the outer legs 15 outside the coils to the south poles of the magnets. Then, after a sixty degree movement of the rotor, the course of the flux will be reversed, travelling up the outer legs 15 and down the inner legs 14 through the coils. A magnetic circuit through the coils will thus be made and broken six times during each revolution of the rotor.

The magneto parts, above described, are mounted in a casing 26 (Fig. 1) which may be of any suitable non-magnetic material but which is preferably of non-metallic material, such for example as molded Bakelite, or similar material. Eddy currents around the pole pieces and ends of the flux-conducting members are avoided by the use of non-metallic material. This casing is approximately of inverted cup shape, having a closed top, an approximately cylindrical exterior (increasing in diameter near its lower end) and an open lower end. The casing 26 also has a central elongated hollow hub 27 extending from the closed top 28 downwardly toward the bottom but terminating a little above the latter. The U-shaped laminated members and the pole pieces 17 are embedded in the casing during the process of molding the same, the inner legs 14 lying in the hollow hub 27 (Fig. 6), the cross bar portions 16 lying partly in the top wall (see also Fig. 10) and the outer legs 15 with their pole pieces 17 lying in the outer wall. In the upper portion of casing 26 which portion is of smaller diameter, vertical ribs 29 (Fig. 12) protrude from the cylindrical surface to receive the legs 15. The coils with insulating heads 30, one at each end thereof, are slipped axially over the hollow hub 27.

The lower ends of the inner legs 14, over a distance equal to the axial thickness of member 19, are turned down (Fig. 6) to receive and closely fit the hole in the laminated member 19, thus forming shoulders against which the upper face of the latter abuts. The laminations of the latter are held together by three rivets 31. These rivets also serve to bind to the upper face of member 19 three springs 32 (see also Fig. 2) which press upon the lower head 30 of the coils as shown in Fig. 1. The member 19 and hub 27 are suitably interengaged, as by the key 33, to properly locate the member angularly with respect to pole pieces 17 and to prevent it from turning out of this position. The lower end of member 19 is counterbored (Fig. 1) and hub 27 is circumferentially grooved to receive a split ring 34 which serves to hold member 19 in place against said shoulders and against axial displacement. The springs 32 press the coil 12 upwardly until its end plate 30 abuts the lower faces of the three parts 16. Thus, the one ring 34 serves to retain the coils as well as the member 19 in axial position in the casing.

The member 19 is preferably split to form a gap 35 (Fig. 2) to avoid the eddy currents that would otherwise be produced in the member if it were in the form of a continuous ring. It will be noted that the bridging of gap 35 by one of the legs 14 is not a good connection such as would destroy the effect of the gap because current cannot flow effectively through the laminations from one to another.

The magnets 22 and pole shoes 23 are mounted on a circular base plate 37. The magnets and shoes rest upon the top face of this plate and an annular ring 38 rests on top of the magnets and shoes. Screws 39 serve to bind the parts together, each screw passing through the ring 38, a pole shoe 23 and threading into the base plate. Each magnet is clamped between the plate and ring and also between its two shoes 23, the latter being recessed in their confronting faces to receive the polar ends of the magnet. The ring and plate may be made of any suitable non-magnetic material.

The rotor shaft is shown at 40. It passes centrally through the hollow hub 27 (Fig. 1) and is mounted in suitable bearings, such as the needle bearings 41, disposed one near the lower end of the hub 27 and one in a hollow hub 42 which is formed as an integral part of and upstands from the top wall 28 of the casing. The rotor plate 37 is keyed to the lower end of shaft 40 and is also clamped in axial position thereon between a member 43, fixed to the shaft, and a nut 44 threaded on the lower end of the shaft. A washer 45 of non-magnetic material surrounds shaft 40 and is positioned between the upper face of plate 37 and the lower face of pole-piece member 19. The shaft 40 also extends above the hub 42 to receive the cam 46 of the breaker-point mechanism. This cam is keyed to shaft 40 and is clamped in axial position thereon between a member 47, fixed to the shaft, and a washer 48 clamped to the upper end of the shaft by a cap screw 49, threaded into the shaft. A special thrust washer 50 is interposed between the lower face of cam 46 and the upper end face of hub 42.

It is usual to provide for automatic advance of the spark by speed-responsive mechanism, interposed between the rotor shaft of the magneto and the driving shaft therefor. When such mechanism is desired, it may be located as shown in Fig. 1 just below the rotor and interposed be-

tween the lower end of shaft 40 and the upper end of a drive shaft 51. A cup-shaped casing 52, houses this speed-responsive mechanism and closes the lower end of casing 26. Screws 53 serve to clamp the casings 26 and 52 together, the mating ends of the two casings interfitting as shown and with an interposed gasket 52' providing a tight closure. The casing 52 has an elongated hub 54 in which shaft 51 is mounted. This hub or quill is adapted to fit in a socket of an internal combustion engine in the same manner as the usual timer-distributor unit used in battery ignition systems. The quill has a seat 55 adapted to rest upon and be supported by the top end face of said socket and a circumferential groove 56 to receive the usual retaining means for holding the quill in axial position in the socket. The lower end of shaft 51 carries a suitable element 57 for coupling engagement with a shaft of an engine.

The speed-responsive mechanism may be of any suitable type. The type herein shown consists of a driving plate 58 fixed to shaft 51 and having at diametrically opposite points thereon two upstanding lugs 59, and a driven plate 60 fixed to shaft 40 and having at diametrically opposite points thereon two downwardly extending lugs 61. The plates 58 and 60 cross each other like a letter X (Fig. 11) so that one lug 59 lines up with one lug 61 and the other lug 59 lines up with the other lug 61. Each set of aligned lugs 59 and 61 is interconnected by a flat spring 62, fixed at its ends one to each of the lugs by screws 63. Each spring, at a point between its ends, carries a weight 64 suitably fixed thereto. These weights are moved outwardly by centrifugal force, causing each spring 62 to bend intermediate its ends, thereby drawing the lugs 59 and 61 toward one another and thus swinging the plates 58 and 60, the one relatively to the other, and moving shaft 40 ahead of its drive shaft 51.

The driving plate 58 is keyed to shaft 51 and rests on top of hub 54. A nut 65 on shaft 51 holds plate 58 against upward movement. A collar 66, fixed on shaft 51 engages the lower face of hub 54. The shaft 51 is thus held against endwise displacement in hub 54 by the plate 58 and collar 66. The driven plate 60 is clamped to plate 37 by the rotor nut 44 and is additionally held thereto by two cap screws 67, threaded into the plate.

The casing 26 has an upper tubular extension 69, within which is housed the breaker point mechanism. This mechanism is mounted on a circular plate 70 having a depending hollow hub 71, telescoped over the hub 42 and capable of being turned thereon in any suitable way to effect variations in timing if desired. One breaker point 72 is carried by a metallic bracket 73 adjustably fixed to plate 70. The other breaker point 74 is fixed to one end of an arm 75 of insulating material. Arm 75 is pivoted at a point intermediate its ends on a stud 76 fixed to plate 70. The other end of arm 75 engages cam 46. A flat spring 77 is secured at one end to arm 75 in electrical contact with breaker point 74 and at the other end by a screw 78 to a block 79 of insulation, suitably fixed to plate 70. This spring serves to move the breaker points into contact and it also serves as an electrical conductor for connecting terminal screw 79 to the movable breaker point.

A condenser 80, of the cartridge type, is mounted outside the housing, the latter being

recessed as shown in Figs. 4 and 7 to receive the lower end of the condenser and provide a flat seat 81 with a hole 82. A disc 83 has a depending pin 84 engaged in hole 82 and four upstanding spring clips 85. The condenser is mounted with its axis disposed vertically and its lower end is engaged by and between the spring clips 85. The outer shell of this condenser is metallic and forms one terminal thereof, the other terminal comprising a central screw-threaded stud 86 which rises through an insulating washer 87 in the upper end of the casing. A metallic clip 88 has a horizontal arm which bears against the upper end of the condenser and holds it in place in its seat. Said arm has a hole to receive washer 87. The other arm of clip 88 is clamped against the casing part 69 by a bolt 89, forming a binding post. On top of washer 87 is a metallic connector 90 fastened to stud 86 by a nut 91. This connector is likewise held to part 69 by a bolt 92 which forms a second binding post. The two binding posts are in electrical connection with the terminals of the condenser.

The post 89 is respectively connected by wires 93 and 94 (Fig. 13) to the plate 70 and to one terminal of coil 12. The other terminal of coil 12 is connected by a wire 95 to the second binding post 92 and a wire 96 connects the latter to terminal 79. Here, there are no grounded connections, as is usual,—the ground connection being made outside the magneto if necessary or desired. The terminals 89 and 92 are exposed to render them accessible for connection in a special kind of ignition system but, if the magneto is not to be used in such a system, it would naturally not be necessary to have these parts exposed.

The secondary coil 13 has one terminal connected by the wire 94 to binding post 89. The other terminal is a metallic button 98 (Fig. 1). Molded in the casing 26 is a metallic member 99 to the inner end of which is secured a spring clip 100, which engages button 98. A wire 101 seated in a socket in member 99 extends to a terminal 102 mounted in a distributor cap 103, which is mounted on top of and closes the casing part 69. Cap 103 is held in place in the usual manner by spring clips indicated at 97. The distributor includes a circular series of contacts 104 fixed to and exposed inside cap 103, in position to cooperate with the rotary brush 105 which connects at its inner end with terminal 102. The brush is mounted on a body 106 of insulation which has a detachable driving engagement with a hollow tubular extension 107 of cam 46 in the usual way indicated in Fig. 1. Sockets 108, one for each contact 104 and electrically connected therewith, are provided on cap 103 to receive the spark plug wires (not shown).

The magnets of the circular series may be arranged in other ways. For example, additional magnets 22' may be interposed between the magnets 22 as shown in Fig. 14. The pole shoes 23' are appropriately modified in shape, as shown, to receive these additional magnets. Like poles of a magnet 22 and a magnet 22' will engage the same pole shoe 23'. The arrangement shown provides a continuous series of magnets and, in effect, forms the equivalent of an annular magnet having six poles at equally spaced intervals. With this magnetic rotor, as with the preceding form, the axis which connects the polar ends of each magnet extends lengthwise of the annular space between the inner and outer series of pole pieces and, in fact, the entire body of each magnet lies in said space. The arrangement shown

in Fig. 14 provides additional magnetic power without requiring any increase in size of the rotor. The same arrangement may likewise be employed to yield the same power and enable some saving in space by the use of magnets of smaller cross sectional area.

The operation of the magneto will next be described. Assuming that the rotor occupies the position shown in full lines in Fig. 5 and is rotating in the direction of the arrow, the outer surface 24 of each pole shoe 23 of south polarity connects one with each of the surfaces 18 of the pole pieces 17 of the outer series. Thus, magnetic flux passes simultaneously up all of the legs 14, through the coils 12 and 13, across the bars 16, and down the legs 15 and back to the rotor. Continued movement of the rotor will cause this magnetic circuit to be broken (at about the position shown by dotted lines). There will then be an air gap g between the trailing end of each pole shoe of south polarity and the adjacent pole piece 17 and a second gap g' between the trailing end of each pole shoe of north polarity and the adjacent pole piece 20. At the same time, all the pole shoes 23 of south polarity will have moved into a position such that their inner surfaces 25 now connect one with each of the surfaces 21 of the pole pieces 20 of the inner series while all the pole shoes of north polarity will have moved into a position such that their outer surfaces 24 connect one with each of the surfaces 18 of the pole pieces 17 of the outer series. Thus, magnetic flux from the pole pieces 23 of north polarity will simultaneously pass up all the legs 15, across bars 16, down through the inner legs 14, through the coils 12 and 13, and pole pieces 20 to the pole shoes 23 of south polarity. The magnetic flux through the coils is thus reversed. On movement of the rotor sixty degrees from the dotted line position, the magnetic circuit, last established, will be broken and the magnetic circuit, first described, will be again created. Six times during each revolution of the rotor, there will be a break in the magnetic circuit through the coils accompanied by a reversal of flux therethrough. At each such break, the cam 46 will cause the breaker points 72 and 74 to separate, thereby producing a high tension electromotive force which is distributed by the brush 105 to the proper spark plug wire.

The operation of the modified form of the invention shown in Fig. 14 is exactly like that just described, the additional magnets simply supplying additional magnetic flux without in any way affecting the operation.

The invention provides a construction such that the parts may be easily and quickly assembled. The coils are simply pushed over the hub 27 into the casing. The pole piece member 19 is then pushed in place on the lower end of the hollow hub 27 and fastened by the snap ring 34. The springs 32 press against the lower head 30 of the coils to hold them in place. The parts of the magnetic rotor are assembled on plate 37 and fastened to shaft 40. So also, the governor parts are separately assembled, fastened to shaft 51 and then to the rotor plate 37. Then shaft 40 is inserted into the hollow hub 27 and the cam 46 is applied to the upper end of shaft 40 to hold the parts in place. The lower casing 52 is next slipped over shaft 51 and the collar 56 fixed on the shaft. The screws 53 are then applied to clamp the casing sections 26 and 52 with the gasket 52' therebetween to secure a tight

joint. The interrupter mechanism, previously assembled on plate 70, is dropped in place in the upper casing 59 over the hub 42. The distributor brush 106 is slipped in place on the end 107 of cam 46 and the cap 103 applied to casing 59 to close the same, the cap being retained in the usual way by the spring clips 87.

The invention also provides a magneto construction which is well adapted to manufacture in quantities at low unit cost. No unusual, special, or expensive operations in the finishing or assembly of the parts are required. The casing 26 with the U-shaped laminated members embedded therein, simply requires finishing of the seats for the bearings 41; of the outer surfaces of the legs 14 near the lower ends thereof and of the surfaces 18 of the outer pole pieces 17. The rotor parts are clamped in place on plate 37 and the surfaces 24 and 25 of the pole shoes are then finished. The pole piece member 19 also requires finishing to fit the hub 27 and to provide coaxial surfaces 21 for the inner set of pole pieces. These finishing operations are of an ordinary kind.

At the same time, a construction is provided which is strong and rugged and in which the parts have been compacted into small compass by an efficient utilization of space and materials. Special steel, having exceedingly high coercive force, is used for the magnets so that their dimensions may be small. The needle bearings 41 provide the necessary supports for shaft 40 without necessitating any enlargement of hub 27. The inner legs 14 lie as closely as possible to shaft 40. The coil 12 closely fits hub 27. The coil 13 closely fits coil 12. The outer legs 15 lie close to the coils and partly in the outer wall of the casing 26. Below the coils 12 and 13 are the pole pieces and the magnets move in the space therebetween. The governor lies immediately below the rotor. Thus, the various parts are packed as closely as possible into a casing structure which is of reasonably small diameter and small height, considering that a high-powered magneto is housed in it. The outside dimensions of the casing are sufficiently small to make it commercially feasible to mount the magneto in place of the usual timer-distributor unit of an automobile engine. A rugged structure is provided by the use of the U-shaped flux-conducting members, each constructed of a stack of one-piece laminations. There are no joints in the structure of these members. The laminations for each member are stacked up, riveted or otherwise suitably held together and then positioned in a mold to become embedded in the casing 26 when it is cast. The laminated members reinforce the casing structure. The inner legs 14, being integral with their cross-bar portions 16 and outer legs 15, are rigidly held in place. A stiff backbone for the hub 27 which supports within it the rotor shaft 40, is thus provided and one that is securely anchored in the top and in the side wall of the casing. The invention offers a simple but effective and a commercially satisfactory solution, from a mechanical point of view, of the problem of providing and mounting flux conductors in a circular series with each conductor looping through the coils, around one end of the same and back outside the coils. Aside from the mechanical aspects, the parts of the stator are associated and connected together to provide an efficient magnetic arrangement. Joints in the stator element are confined to those between the pole pieces and the legs of the flux

conducting members. Each joint is of simple character, readily made tight to avoid loss of flux. Of prime importance is the arrangement of all parts of the magnetic circuit for flux flow along the laminations. Flux flows along the laminations from one end to the other of the flux conducting members, then radially along the laminations of the pole pieces and into the pole shoes of the rotor. Close clearances between the pole shoes and pole pieces is employed to reduce air gap loss. Each lamination of each flux-conducting member has edge to edge contact with and distributes flux to each lamination of each of its pole pieces for a full and effective transfer of flux between the member and pole pieces with a minimum of loss. The magnetically efficient arrangement of parts enables reduction of dimensions of the parts over other arrangements wherein substantial losses have not been so carefully avoided.

The invention thus provides an exceedingly effective and efficient magneto with a compact arrangement of parts, enabling the timer-distributor type of mounting, and a design of parts adapted to manufacture in quantities at low unit cost.

It will be understood that the magneto may readily be adapted to serve various engines regardless of the number of cylinders which they have. The number of pole shoes and pole pieces in the magneto and the number of sparks produced per revolution of the rotor may be varied to suit the requirements of the particular engine which the magneto is to serve.

What I claim is:

1. In a magneto, a drive shaft, a plurality of substantially U-shaped flux conducting members each made up of a plurality of one-piece U-shaped laminations of rectangular cross section and having inner and outer legs of substantially equal length and a cross bar portion interconnecting these legs at one end, said members mounted in angularly spaced relation in a circular series about the axis of said shaft with the inner legs paralleling the shaft and located closely adjacent thereto, primary and secondary coils mounted coaxially of said shaft and located between the several inner and the several outer legs with all the inner legs passing through the coils and all the outer legs passing outside the coils, an outer circular series of angularly-spaced laminated pole pieces connected to the other ends of the outer legs, an inner circular series of angularly-spaced laminated pole pieces connected to the other ends of the inner legs, the pole pieces of the inner series being staggered with respect to the pole pieces of the outer series, all the pole pieces located between two parallel planes disposed at right angles to the axis of said shaft and marking off substantially the limits in the direction of said axis of said pole pieces, and a magnetic rotor fixed to said shaft and comprising a plurality of bar magnets mounted one after the other about the axis of said shaft in a circular series coaxial with the shaft, each said magnet in its entirety being located between said planes and having laminated shoes with polar surfaces for cooperation with said pole pieces as the rotor is revolved.

2. In a magneto, a drive shaft, a plurality of substantially U-shaped flux conducting members each made up of a plurality of one-piece U-shaped laminations of rectangular cross section and having inner and outer legs of substantially equal length and a cross bar portion intercon-

necting these legs at one end, said members mounted in angularly spaced relation in a circular series about the axis of said shaft with the inner legs paralleling the shaft and located closely adjacent thereto, primary and secondary coils mounted coaxially of said shaft and located between the several inner and the several outer legs with all the inner legs passing through the coils and all the outer legs passing outside the coils, an outer circular series of angularly-spaced laminated pole pieces connected to the other ends of the outer legs, an inner circular series of angularly-spaced laminated pole pieces connected to the other ends of the inner legs, the pole pieces of the inner series being staggered with respect to the pole pieces of the outer series, all the pole pieces located between two parallel planes disposed at right angles to the axis of said shaft and marking off substantially the limits in the direction of said axis of said pole pieces, and a magnetic rotor fixed to said shaft and comprising a plurality of bar magnets mounted one after the other about the axis of said shaft in a circular series coaxial with the shaft, each said magnet in its entirety being located between said planes and having laminated shoes with polar surfaces for cooperation with said pole pieces as the rotor is revolved, the laminations of all said pole pieces and shoes paralleling said planes.

3. In a magneto, a drive shaft, a plurality of substantially U-shaped flux conducting members each made up of a plurality of one-piece U-shaped laminations of rectangular cross section and having inner and outer legs of substantially equal length and a cross bar portion interconnecting these legs at one end, said members mounted in angularly spaced relation in a circular series about the axis of said shaft with the inner legs paralleling the shaft and located closely adjacent thereto, primary and secondary coils mounted coaxially of said shaft and located between the several inner and the several outer legs with all the inner legs passing through the coils and all the outer legs passing outside the coils, an outer circular series of angularly-spaced laminated pole pieces connected to the other ends of the outer legs, an inner circular series of angularly-spaced laminated pole pieces connected to the other ends of the inner legs, the pole pieces of the inner series being staggered with respect to the pole pieces of the outer series, all the pole pieces located between two parallel planes disposed at right angles to the axis of said shaft and marking off substantially the limits in the direction of said axis of said pole pieces, and a magnetic rotor fixed to said shaft and comprising a plurality of bar magnets mounted one after the other about the axis of said shaft in a circular series coaxial with the shaft, each said magnet in its entirety being located between said planes and having laminated shoes with polar surfaces for cooperation with said pole pieces as the rotor is revolved, the laminations of each U-shaped member paralleling a plane extending radially of the shaft and centrally through both legs of the member.

4. In a magneto, a drive shaft, a plurality of substantially U-shaped flux conducting members each made up of a plurality of one-piece U-shaped laminations of rectangular cross section and having inner and outer legs of substantially equal length and a cross bar portion interconnecting these legs at one end, said members mounted in angularly spaced relation in a circular series about the axis of said shaft with the

inner legs paralleling the shaft and located closely adjacent thereto, primary and secondary coils mounted coaxially of said shaft and located between the several inner and the several outer legs with all the inner legs passing through the coils and all the outer legs passing outside the coils, an outer circular series of angularly-spaced laminated pole pieces connected to the other ends of the outer legs, an inner circular series of angularly-spaced laminated pole pieces connected to the other ends of the inner legs, the pole pieces of the inner series being staggered with respect to the pole pieces of the outer series, all the pole pieces located between two parallel planes disposed at right angles to the axis of said shaft and marking off substantially the limits in the direction of said axis of said pole pieces, and a magnetic rotor fixed to said shaft and comprising a plurality of bar magnets mounted one after the other about the axis of said shaft in a circular series coaxial with the shaft, each said magnet in its entirety being located between said planes and having laminated shoes with polar surfaces for cooperation with said pole pieces as the rotor is revolved, the laminations of each U-shaped member paralleling a plane extending radially of the shaft and centrally through both legs of the member, and the laminations of all said pole pieces and all said shoes paralleling said planes, one edge of each lamination of each leg contacting with one edge of each lamination of the pole piece thereon.

5. In a magneto, a drive shaft, a plurality of substantially U-shaped flux conducting members each made up of a plurality of one-piece U-shaped laminations of rectangular cross section and having inner and outer legs of substantially equal length and a cross bar portion interconnecting these legs at one end, said members mounted in angularly spaced relation in a circular series about the axis of said shaft with the inner legs paralleling the shaft and located closely adjacent thereto, primary and secondary coils mounted coaxially of said shaft and located between the several inner and the several outer legs with all the inner legs passing through the coils and all the outer legs passing outside the coils, an outer circular series of angularly-spaced laminated pole pieces connected to the other ends of the outer legs, an inner circular series of angularly-spaced laminated pole pieces, said inner series being formed as outward projections from a single member in the form of a split ring to which the lower ends of all the inner legs are connected, and a magnetic rotor cooperating with said pole pieces to make and break magnetic circuits through said flux conductors.

6. In a magneto, a casing of molded, non-magnetic material constructed in cup-shaped form with a central hollow hub, a drive shaft extending through the hub in coaxial relation, U-shaped flux-conducting members each made up of a plurality of one-piece U-shaped laminations of rectangular cross section, said members being disposed in angularly spaced relation in a circular series about the axis of said shaft and fixed in said casing, the outer legs of said members located in the peripheral wall of said casing, the inner legs in said hollow hub and the cross-connecting portions in the end wall of the casing, a coil mounted coaxially of the shaft and between the hub and outer walls of the casing with the several inner legs cooperating to form a core therefor, a magnetic rotor fixed to said shaft adjacent the open end of the cup-shaped

casing and cooperating with the ends of the inner and outer legs to direct flux first up the inner legs and down the outer legs and then up the outer legs and down the inner legs.

7. In a magneto, a casing of cup-shaped form having a central hollow hub, a drive shaft mounted in the hub in coaxial relation, a plurality of U-shaped flux-conducting members mounted in said casing and each made up of a plurality of one-piece U-shaped laminations of rectangular cross section, said members being disposed in angularly-spaced relation in a circular series about the axis of said shaft with the inner legs paralleling and adjacent said shaft, the cross-bar portions paralleling the closed end of the casing and the outer legs paralleling said walls, a coil unit mounted coaxially of the hub and between said inner and outer legs, a pole piece member fixed to said inner legs, resilient means on said pole piece member for pressing said unit axially toward the closed end of the casing and holding it in position therein, and a magnetic rotor fixed to said shaft adjacent the open end of the cup-shaped casing and cooperating with said pole piece member and outer legs to direct flux first up the inner legs and down the outer legs and then up the outer legs and down the inner legs.

8. A stator structure for a dynamo electric machine, comprising, a coil, a plurality of substantially U-shaped flux-conducting members each made up of laminations and including inner and outer legs and a cross-connecting portion at one end of said legs all rigidly held together as one piece, said members disposed in angularly-spaced relation in a circular series around the axis of said coil with all the inner legs passing through the coil and all the outer legs located outside the coil, a housing for said coil and members constructed of non-magnetic material and having an end wall adjacent one end of said coil and a marginal wall encompassing the coil, all said outer legs being fixed in said marginal wall and all said cross connecting portions being fixed in said end wall, means for binding together all the inner legs into one rigid unit, rigidly supported and braced by the outer legs and cross-connecting portions which are anchored in said marginal and end walls, respectively, pole piece means carried by said outer legs, and pole piece means carried by said inner legs and held firmly in coaxial relation with the first-named pole piece means by said rigid unit.

9. In a magneto, a drive shaft, a plurality of substantially U-shaped flux conducting members each made up of a plurality of one-piece U-shaped laminations of rectangular cross section and having inner and outer legs of substantially equal length and a cross bar portion interconnecting these legs at one end, said members mounted in angularly spaced relation in a circular series about the axis of said shaft with the inner legs paralleling the shaft and located closely adjacent thereto, primary and secondary coils mounted coaxially of said shaft and located between the several inner and the several outer legs with all the inner legs passing through the coils and all the outer legs passing outside the coils, an outer circular series of angularly-spaced laminated pole pieces fixed one on the other end of each outer leg, an inner circular series of angularly-spaced laminated pole pieces one for each inner leg and connected to the other end thereof, the pole pieces of the inner series being staggered with respect to the pole pieces

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5 of the outer series, all the pole pieces located between two parallel planes disposed at right angles to the axis of said shaft and marking off substantially the limits in the direction of said axis of said pole pieces, and a magnetic rotor fixed to said shaft and comprising a series of bar

magnets each located in its entirety between said planes and mounted one after the other in an endless series extending around the shaft in coaxial relation.

KENNETH A. HARMON.

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