

Dec. 30, 1947.

S. K. SMART ET AL

2,433,715

IGNITION APPARATUS

Filed April 18, 1946

5 Sheets-Sheet 1

Fig. 3.

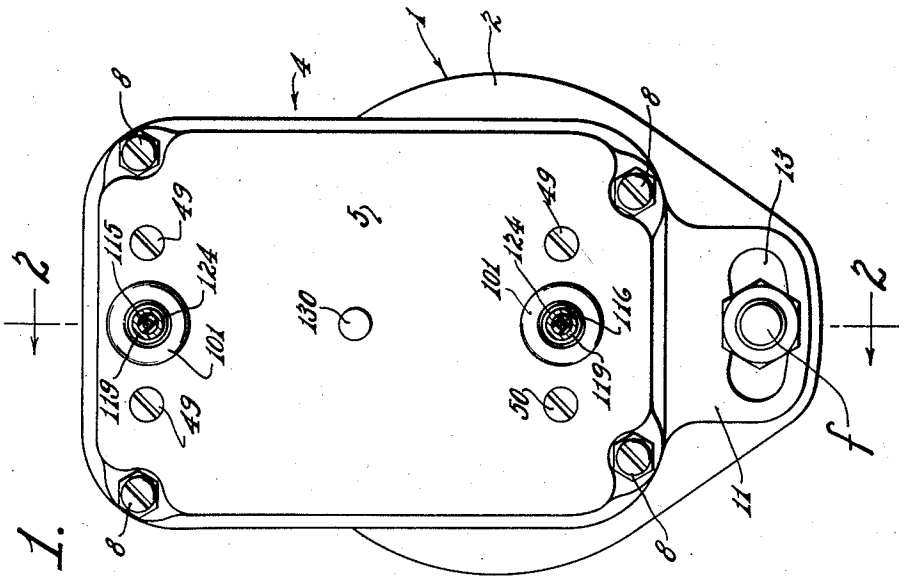
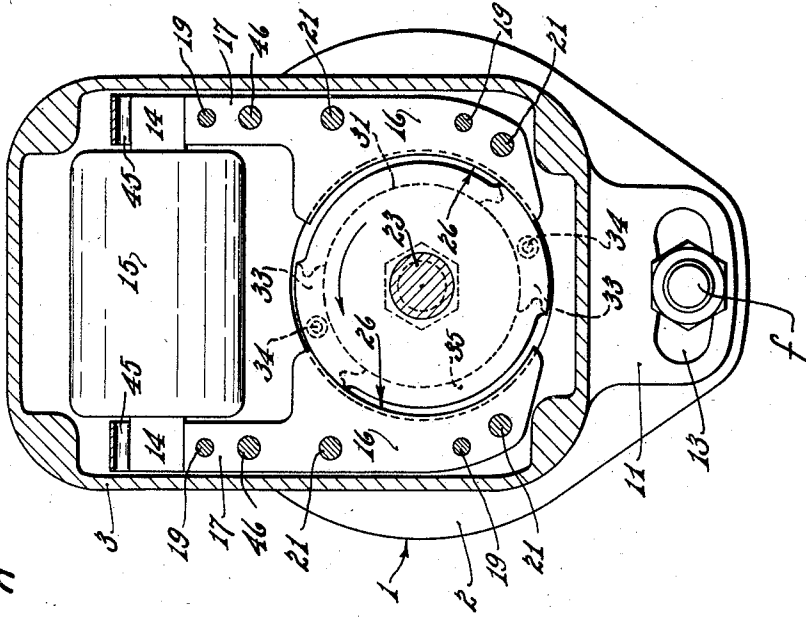


Fig. 1.

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5 Sheets-Sheet 2

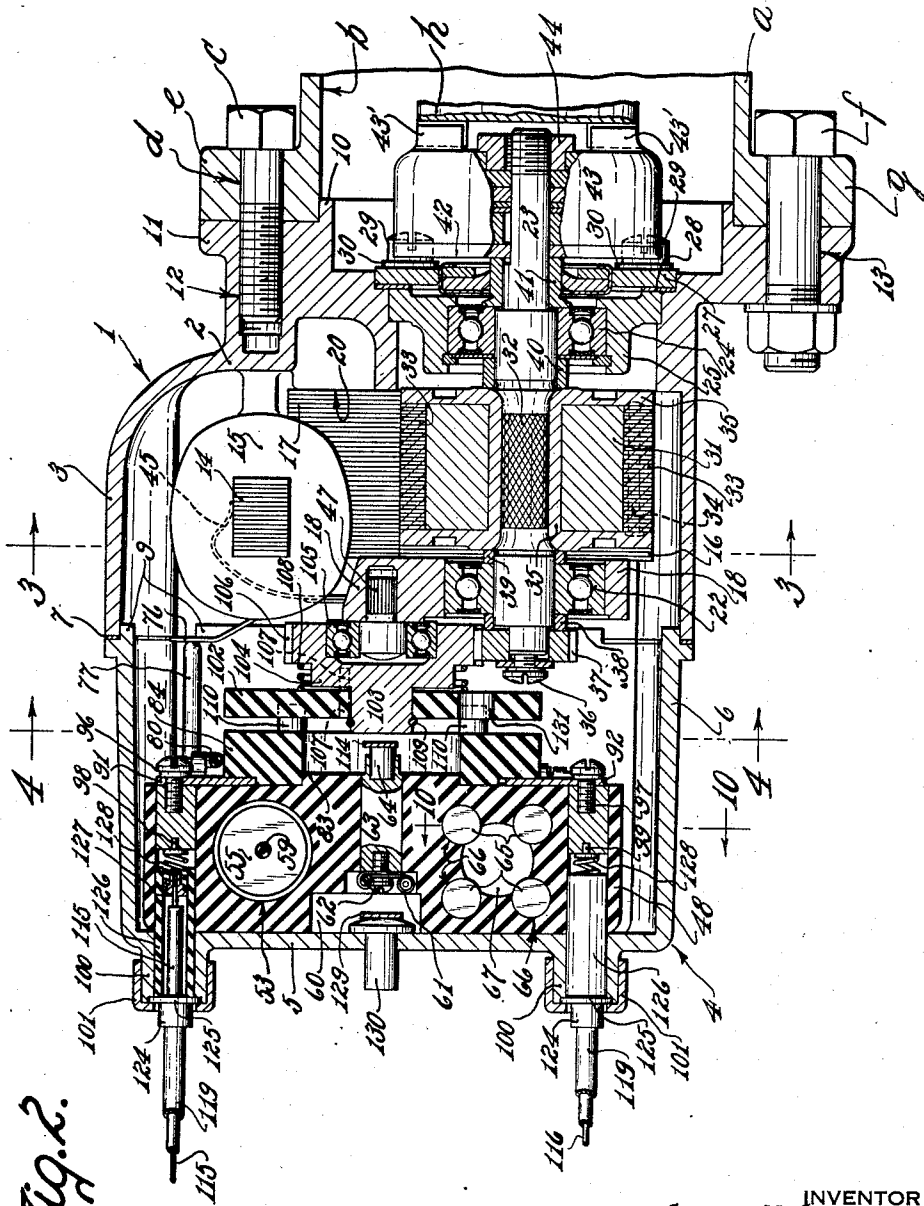


Fig. 2.

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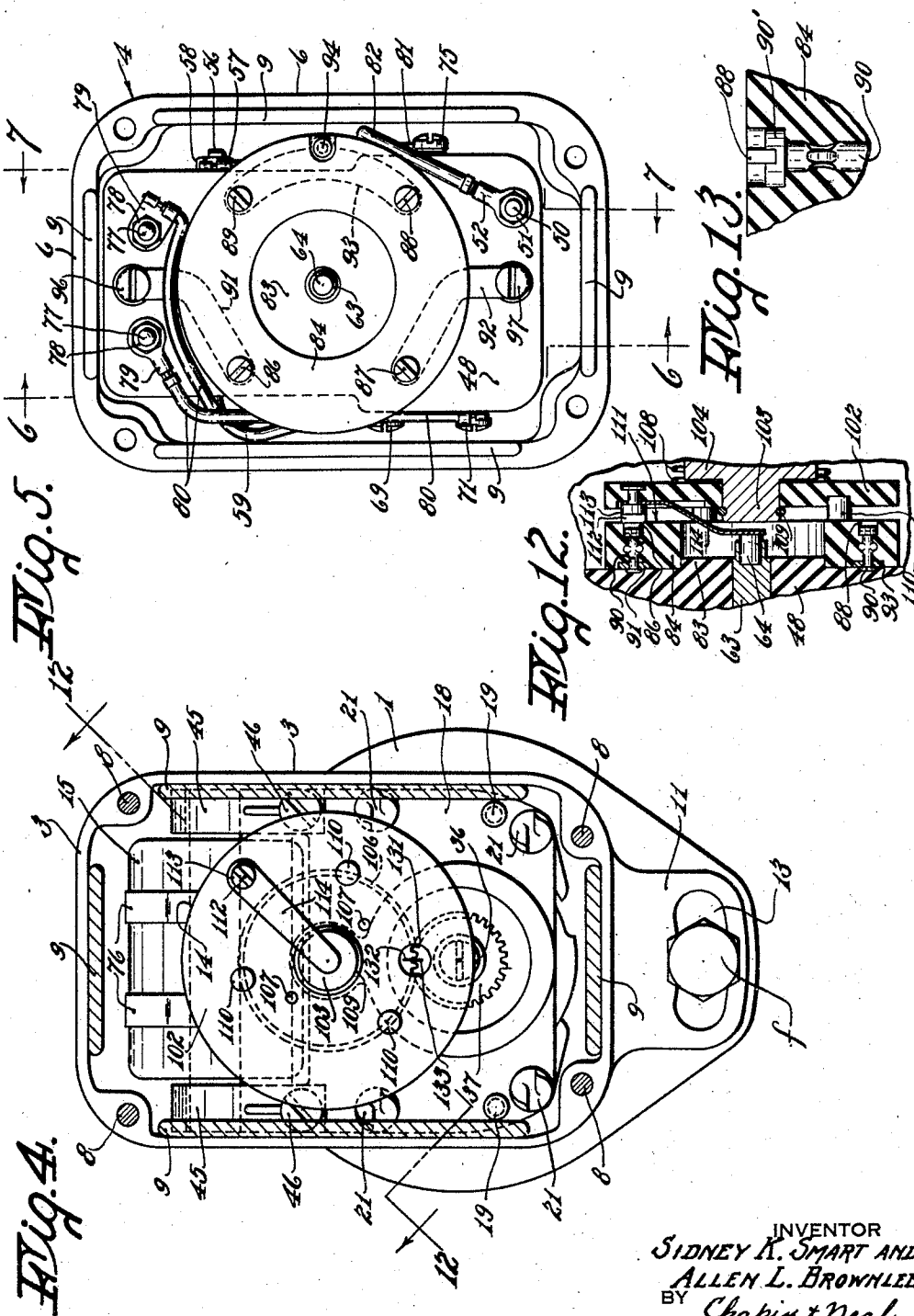
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Fig. 6.

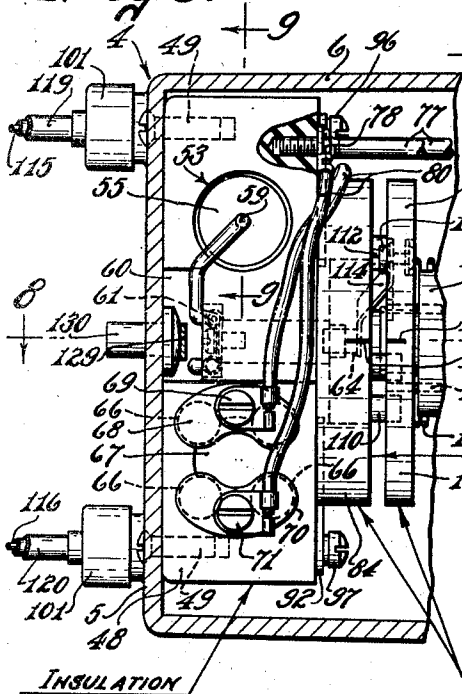


Fig. 7.

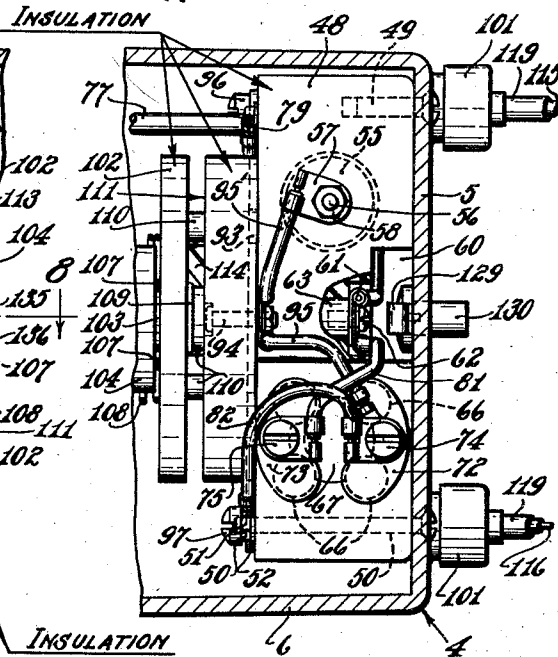


Fig. 8.

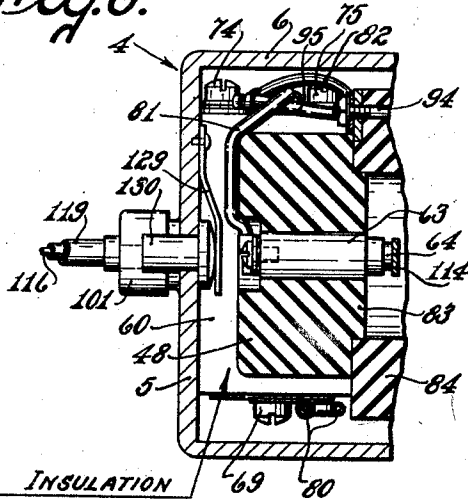
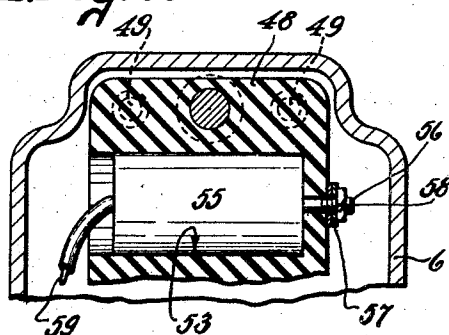


Fig. 9.



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Fig. 10.

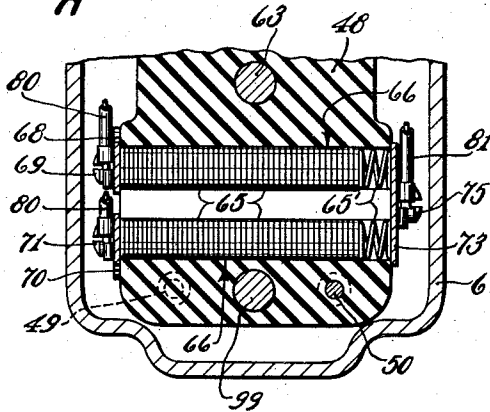


Fig. 11.

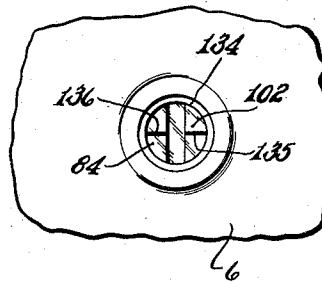
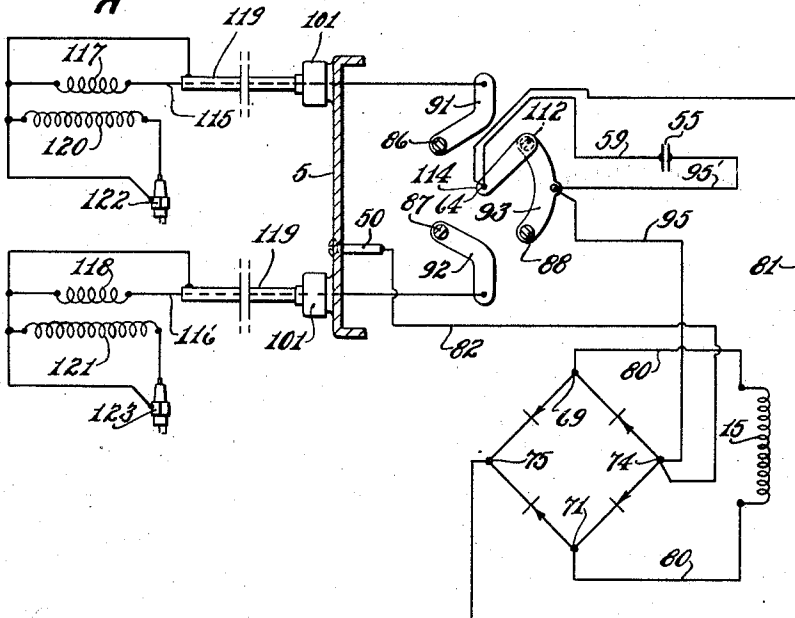


Fig. 14.



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UNITED STATES PATENT OFFICE

2,433,715

IGNITION APPARATUS

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Application April 18, 1946, Serial No. 663,098

3 Claims. (Cl. 320—1)

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This invention relates to improvements in ignition apparatus for use in ignition systems for internal combustion engines and, more particularly, ignition systems of the low-tension, high-frequency type, in which the ignition spark is produced by a discharge from a capacitor.

One example of an ignition system of the type referred to, is disclosed in the copending application for U. S. Letters Patent of Kenneth A. Harmon and Allen L. Brownlee, filed December 7, 1944, under Serial No. 567,092, and assigned to the assignee of the present application. In the system of the prior application, an engine-driven alternating-current generator is utilized to charge a capacitor through a full-wave rectifier and the discharges from the capacitor are controlled and timed by a distributor driven by, and in timed relation with, the generator. At proper intervals, the distributor completes a discharge circuit from the capacitor and the charge, which was built up by the generator and maintained at its peak by the rectifier, is discharged at low tension through the primary of a spark plug transformer. A high voltage is induced in the secondary of the transformer and a discharge occurs across the gap of the plug at a frequency in the neighborhood of one megacycle.

This invention has for one of its objects to provide an improved apparatus for use in an ignition system of the type disclosed in said prior application.

The invention has for a further object the provision within a single housing, and as one unit, all the apparatus required for an ignition system of the kind described, except for those parts which are necessarily located at the engine such as the spark plugs and spark plug transformers and the necessary distribution wires.

The invention has for another object the provision of ignition apparatus, such as described, in a single unit, which is made up of two groups, one comprising all the parts of the electrical generator and the other comprising all those parts needed to adapt the generator for use in an ignition system of the class described, such for example as the capacitor, rectifier and timing-distributing means.

The invention has for a further object the provision of a simple and a compact arrangement of parts within a single casing, which is adapted for attachment to the housing of a generator of suitable characteristics, whereby an ignition system of the kind disclosed in the prior application, can be produced by attaching the casing to the

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generator and by applying distribution wires to connect terminals on the casing to the several spark plug transformers, located at the engine cylinders.

The invention has for other objects improvements in the arrangement and mounting of parts, such as the rectifier, capacitor and timing-distributing means.

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

Fig. 1 is an exterior end elevational view of an ignition apparatus embodying the invention;

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

Figs. 3 and 4 are cross-sectional views taken on the lines 3—3 and 4—4, respectively, of Fig. 2;

Fig. 5 is an end elevational view, showing the inside of the cover of the housing of the apparatus and the parts mounted thereon;

Figs. 6 and 7 are sectional elevational views taken on the lines 6—6 and 7—7, respectively, of Fig. 5;

Fig. 8 is a fragmentary sectional plan view taken on the line 8—8 of Fig. 6;

Fig. 9 is a fragmentary cross sectional view taken on the line 9—9 of Fig. 6;

Fig. 10 is a fragmentary cross sectional view taken on the line 10—10 of Fig. 2;

Fig. 11 is a fragmentary exterior side-elevational view of the cover;

Fig. 12 is a fragmentary sectional view taken on the line 12—12 of Fig. 4;

Fig. 13 is a view showing one of the distributor contacts; and

Fig. 14 is a diagrammatical view showing the electrical connections of the apparatus.

Referring to these drawings and first to Fig. 2 thereof, the housing for the apparatus includes a hollow, die-cast member 1 of non-magnetic metal, which has an end wall 2 with an opening therethrough large enough to permit passage of the rotor, and a peripheral wall 3. The housing also includes a die-cast cover 4 of similar material, which has an end wall 5 and a peripheral wall 6. The peripheral walls 3 and 6 are held together, with a gasket 7 clamped therebetween, by a plurality of screws 8 (Figs. 1 and 4), which pass through the cover and are threaded into wall 3. The wall 6 preferably has a plurality of spaced flanges 9 (Fig. 5) which engage inside the wall 3 (Figs. 2 and 4) to maintain the peripheral walls 3 and 6 in alignment.

The housing may be mounted either horizontally or vertically, as desired, and will have mounting flanges, which are appropriate for the

style of mounting desired. The particular housing shown is adapted to be mounted horizontally and to be secured to the crankcase *a* (Fig. 2) of an internal combustion engine. For this purpose, the end wall 2 has an annular pilot flange 10 to closely fit a cylindrical opening *b* in such crankcase and a mounting flange 11 adapted to be suitably secured to a wall of the crankcase, as for example, by a cap screw *c*, passing through a slot *d* in an ear *e* on the crankcase *a* and threaded into the hole 12 in flange 11, and by a bolt *f* passing through a hole in another ear *g* on the crankcase *a* and through a slot 13 (Fig. 2) in the flange.

The stator of the magneto (Figs. 2 and 3) includes a laminated core 14 of magnetic material, on which is mounted a coil 15, and suitable pole pieces 16, each of laminated magnetic material and each having parallel extensions 17 (Fig. 3), the outer ends of which are engaged one with each of the ends of the core 14. The number, shape, size and location of these pole pieces will vary according to the particular use for which the magneto is designed. These pole pieces are permanently fixed to a non-magnetic frame member 18 by rivets 19 (see also Fig. 4). This unit, comprising the frame 18 and pole pieces 16, is clamped against a seat 20 (Fig. 2) on the end wall 2 of the housing by means of a plurality (four as shown in Fig. 4) of irremovable screws 21. The heads of these screws are so formed that they may be turned inwardly but not outwardly. Thus, this unit is permanently fastened in the housing.

The member 18 also has therein a ball bearing 22 (Fig. 2) for supporting one end of the shaft 23 of the magnetic rotor. The other end of such shaft is supported by a ball bearing 24 mounted in a cage or support 25, seated in a counterbore in the cylindrical opening in the end wall 2 of housing member 1. After the above described unit has been clamped to its seat 20 in the housing member 1, the bore for the bearing 22, the arcuate surfaces 26 of the several pole pieces, the counterbore for cage 25 and its shoulder, and another and larger counterbore for a bearing-retaining disk 27 and its gasket 28, are finished at one time. Thus, it is insured that all the surfaces described are in true coaxial relation. After these machining operations have been performed, the magnetic rotor is inserted in place with its shaft 23 engaged in bearing 22. The bearing 24 in its cage 25 is then placed on the shaft 23 and then the support or cage 25, the periphery of which has previously been machined to closely fit the counterbore in housing member 1 and to lie in true coaxial relation with the bearing 24, is placed in such counterbore. Then gasket 28 and disk 27 are put in place and held there by a plurality of screws 29 and washers 30, the latter partially overlapping disk 27. The disk 27 thus serves to retain the bearing support 25 seated against the shoulder in its counterbore.

The magnetic rotor comprises a cylindrical permanent magnet 31 (Figs. 2 and 3) having a central, axially-disposed hexagonal opening therethrough to receive a knurled portion 32 (Fig. 2) of shaft 23. Pole shoes 33 (Fig. 3) of laminated magnetic material have inner surfaces curved to fit the periphery of the magnet 31. These shoes are riveted together, as at 34, and spot welded to the magnet. Then, the magnet 31, shoes 33 and shaft 23 are placed in a suitable

die and non-magnetic metal 35 is cast therein to fill the space between the knurled part 32 of the shaft and the hexagonal bore in the magnet (Figs. 2 and 3) and to encompass the end faces of the magnet and shoes and part of the outer periphery of the magnet. This metal also interlocks with the notched sides of each pole shoe 33. In this particular case, there are two diametrically opposed pole shoes 33.

The shaft 23 (Fig. 2) is extended to the left beyond the bearing 22 and has fixed thereto by a screw 36 a pinion 37 for driving the combined timing and distributing means, as will later appear. There is a spacer ring 38 between pinion 37 and the inner race of bearing 22; a spacer ring 39 between such race and the adjacent end of the rotor; a spacer sleeve 40 between the other end of the rotor and the inner race of bearing 24; and a spacer sleeve 41 between the last-named inner race and the driven plate 42 of an impulse coupling, the driving member of which is shown at 43. Plate 42 is keyed to shaft 23. A nut 44, threaded on the outer end of shaft 23, holds the member 43 in axial position but permits it to turn and it also forces the member 42, the sleeve 41, inner race of bearing 44 and sleeve 40 together and the latter against the rotor. The outer end of member 43 has lugs 43' adapted to fit into grooves in a suitable engine-driven member, indicated at *h* and located within the crankcase *a*. The impulse coupling, being well understood by those skilled in the art, has not been illustrated in detail. The coupling at starting, or at very low engine speeds, functions intermittently to impart to the rotor spring impulses. At such times, the part 43 turns intermittently relatively to member 42 to wind up the impulse spring. During normal operation, the coupling parts 42 and 43 are locked together.

The coil-carrying core 14, previously described, is held in place by two spring clips 45 (Figs. 2 and 4) one at each end of the core. Each clip is held to the frame 18 by a screw 46 (Fig. 4).

The frame 18 has fixed thereto a stud 47 (Fig. 2) for rotatably supporting the timing and distributing means to be described.

The generator, as above described, has its stator and rotor constructed and mounted in the same general manner as disclosed in the United States patent application of Ellingham and Brownlee, filed February 21, 1946, under Serial No. 649,338, now Patent 2,431,547, dated November 25, 1947, and owned by the assignee of the present application. The present generator, however, has but a single coil and omits the breaker mechanism of the last-named application, the member 18 supporting, in place of such mechanism, the timing and distributing mechanism.

The generator described is used to supply charging current to a capacitor through a full-wave rectifier which is utilized primarily as a means for holding the charge in the capacitor and maintaining peak voltage thereon until the discharge-timing means operates to permit the discharge of the capacitor for the purpose of producing a spark. The capacitor, rectifier and discharge-timing means are all located within the cover 4.

The capacitor and rectifier are mounted in a block 48 (Figs. 2, 5, 6 and 7) of suitable insulating material and this block is held in place by three screws 49 (Fig. 1), which pass through wall 5 of the cover and thread into the block but do not

pass-through it (Figs. 6 and 7) and by a bolt 50 which passes through the cover and block (Fig. 7) and carries on its inner end a nut 51, which serves to clamp a terminal piece 52 (Fig. 5) against the block. This block has a cylindrical opening 53 (Fig. 9) therein extending transversely from one side face toward but not quite to the opposite side face and in this opening is mounted a capacitor 55. This capacitor has a ground terminal post 56 which extends through the end wall of opening 53 and carries a terminal piece 57 (see also Fig. 7), clamped to the block by a nut 58, which also holds the capacitor in axial position in opening 53. The terminal pieces 52 and 57 are electrically connected as indicated and as will later be described in detail. The other terminal of the capacitor is connected to a wire 59 which, as shown in Fig. 6, extends part way down one side of block 48 and into and part way through a transverse groove 60 in the back of the block. This wire 59 (Figs. 2 and 6) is connected to a terminal piece 61 fixed by a screw 62 to one end of a metallic post 63 which is suitably fixed in and extends centrally through block 48 (Fig. 2), projecting beyond its front face and bearing a silver graphite brush 64.

The particular rectifier illustrated is of the selenium-cell, dry-disk type. It consists of four stacks of disks 65 mounted one stack in each of four parallel holes 66 (Fig. 2) which as shown in Fig. 10 extend transversely through block 48. These four holes are spaced ninety degrees apart around a central hole 67 and intersect the latter, whereby the disks are partially exposed to allow for dissipation of heat by way of hole 67 to the metal walls of cover 4. A spring 65' in each hole 66 serves to hold the disks 65 in contact one with another. The ends of the holes 66 are closed by metal plates which are fixed to the sides of block 48 and serve also as connecting conductors. Thus, a horizontal kidney shaped plate 68 (Fig. 6), which is secured to a side face of block 48 by a single centrally-located screw 69, extends across and electrically connects one end disk of one upper stack to the adjacent end disk of the other upper stack. Similarly, a plate 70 which lies below plate 68 and is held in place by a screw 71, electrically connects one end disk of one lower stack to the adjacent end disk of the other lower stack. On the opposite side of block 48 (Fig. 7) are two similar but vertical plates 72 and 73 held in place by screws 74 and 75, respectively. Plate 72 electrically connects one end disk of the right hand upper stack to the adjacent disk of the right hand lower stack. Plate 73 electrically connects one end plate of the left hand upper stack to the adjacent end disk of the right hand lower stack. By these means the four stacks of disks are connected to form a full-wave bridge rectifier, the input terminals of which are the screw 69 and 71 and the output terminals of which are the screws 74 and 75.

The input terminals of the rectifier are connected to coil 15. This is accomplished as set forth below. The coil has its two terminals connected one to each of two parallel upstanding metallic spring fingers 76, suitably fixed at their lower ends to the coil. The upper ends of these fingers are engaged one by the inner end of each of two parallel metallic pins 77. These pins are suitably fixed as by screw threading, in block 48 but do not extend therethrough. Each carries a nut 78, whereby to clamp against the block a terminal piece 79. These pieces 79 are connected by wires 80 one to each of the input ter-

minals 69 and 71 as will be clear from Figs. 5 and 6. The output terminal 75 (Fig. 7) is connected to a wire 81, which extends into groove 60 (Fig. 8) and is connected to the terminal 61 and thus to brush 64. The output terminal 74 is connected by a wire 82 to terminal piece 52, which, as above described, is grounded to a wall of the metallic housing. The electrical connections are schematically shown in Fig. 14.

The discharge-timing and distributing means will next be described. The block 48 (Figs. 2 and 5) has on its front face a cylindrical boss 83, located coaxially with respect to brush 64 and the described stud 47 on member 18. An annular ring 84 of suitable insulating material closely fits this boss and is thereby located in proper coaxial relation with the timing-distributing means. The rear face of ring 84 abuts the front face of block 48 and is suitably held thereto, as will later appear. The ring 84 carries four distributor contacts 86, 87, 88 and 89. Each consists of a short thin blade of tungsten inset into the head 90' of a rivet (Fig. 13). The heads 90' are inset into ring 84 (Fig. 12) so that the outer edges of contacts lie flush with the front face of the ring. The rivets are so set into the ring that they cannot turn and so that the contacts are radially disposed. Each rivet passes through the ring parallel with the axis of the latter and has its rear end headed over against and thereby electrically connected to a conducting strip. As shown, the contacts 86 and 87 are thus connected to conducting strips 91 and 92, respectively, while the contacts 88 and 89 are thus connected to opposite ends of a conducting strip 93. A central screw 94 (Fig. 7) passes through this strip 93 and threads into ring 84 and serves to clamp to the strip one end of each of two conductors 95 and 95'. The other end of conductor 95 is connected to screw 74 and thus to the ground. The other end of conductor 95' is connected to the ground terminal 57 of the capacitor. All the strips 91, 92 and 93 are set into recesses in the back of ring 84. The strips 91 and 92 are bent as shown in Fig. 5 and have ends which project radially outward from the disk at diametrically opposite points and these projecting ends are respectively secured by screws 96 and 97 to metal distributor terminals 98 and 99 (Fig. 2) which are fixed in block 48. Each of these terminals is set into the inner end of a hole which extends through the block 48, through the wall 5 of cover 4 and through a boss 100. These bosses are formed on and project outwardly from the wall 5 and have external threads to receive gland nuts 101.

The rotating element of the timing-distributing device includes a disk 102 (Figs. 2, 4 and 7) of suitable insulating material which is axially slidable on a central cylindrical part 103 which projects from one face of a member 104 toward ring 84. Set into the opposite face of member 104 (Fig. 2) is a ball bearing 105, the inner race of which telescopes over the stud 47 on member 18 and closely fits such stud. The rear portion of member 104 has an integral gear 106 which meshes with and is driven by pinion 37. Fixed in the member 104 are two pins 107 (Figs. 4 and 7), paralleling its axis and extending through disk 102 for the purpose of driving the same. A spring 108, encompassing member 104 and disposed between the adjacent faces of gear 106 and disk 102, presses the disk toward the contact-bearing ring 84. A snap ring 109, held in a groove in the outer part of stud 103, limits the movement of disk 102 by spring 108 and retains it on

the stud when the cover 4 is removed. The disk 102 has set into it three brushes 110 (Figs. 4 and 7) of carbon graphite arranged in angularly-spaced relation in a circular series. These brushes are pressed into engagement with a track 111 (Figs. 6, 7 and 12) formed on the inner face of ring 84. The disk 102 carries a contact 112 (Figs. 4 and 6), which, like the other contacts, is preferably a tungsten blade set into the head of a rivet 113, which passes through the disk and is headed over the back face of the disk. A spring 114, which at one end is clamped between the head of rivet 113 and the front face of disk 102 (Fig. 6), extends radially (Fig. 4) inward to the center of the disk so that the free end of this spring is engaged by the brush 64 above described. Thus, the capacitor 55 is connected to contact 112. The brushes 110 riding on track 111 maintain disk 102 so positioned that the outer edge of contact 112 lies in the same transverse plane which includes the outer edges of the contacts 86, 87, 88 and 89. Hence, the contact 112 will during its rotation successively engage the contacts 86, 87, 88 and 89 and, when this engagement occurs, the capacitor 55 will be discharged.

The discharge circuits include wires 115 and 116, which respectively connect the terminals 98 and 99 to one terminal of the primary windings 117 and 118 of two spark plug transformers, indicated diagrammatically in Fig. 14. These wires each pass through a shielding tube 119. The other terminal of each of the primary windings 117 and 118 is connected to its metallic shielding. The secondary windings 120 and 121 of the spark plug transformers each have one terminal connected to a shielding 119. The other terminals of the secondaries 120 and 121 are respectively connected to the ungrounded terminals of spark plugs 122 and 123.

Each shielding 119 is connected to the metallic cover 4 as shown in Fig. 2. A sleeve 124, having a flange 125, is suitably fixed to the tube at one end. This sleeve fits in the hole in the end of the gland nut 101 and the latter, when screwed onto hub 100, firmly clamps flange 125 against the end face of the hub.

The wires 115 and 116 are connected to their respective terminals 98 and 99 as follows: each wire enters the open outer end of a tube 126, which is of suitable insulating material and slidably fits in the same hole that contains the terminal 98 or 99 as the case may be; the inner end of the wire is suitably fastened in the hub of a metallic disk 127, fixed in tube 126 near the inner end of the tube; and a coil spring 128, held in the inner end of tube 126, engages at one end the disk 127 and at the other the terminal 98 or 99, as the case may be.

The shielding 119 (Fig. 14) also serves as a conductor between the primary of each spark plug transformer and the metallic cover 4 to which one terminal of the capacitor 55 is connected. A complete metallic discharge circuit of good conductivity is thus provided between the primary of each transformer and capacitor 55. Each shield is furthermore made to fit, as closely as possible, its distribution wire 115 or 116, as the case may be, which it contains. The purpose here is to cancel the impedance of the distribution wires. The primary of each transformer may, for example, have but 10 turns and be of very low inductance. The impedance of the distribution wires would be substantial as compared to that of a primary winding unless cancelled out by the expedient shown of arranging the dis-

tribution conductor for each primary in closely-spaced relationship to its shield and so that the current flows through them in opposite directions.

A grounding switch (Figs. 2 and 8) may be conveniently provided by a spring 129, one end of which is riveted to wall 5 of cover 4 and the other end of which is adapted to be pressed into engagement with the screw 62 of the central terminal post 63 by means of a button 130, slidably mounted in said wall.

The distributor disk 102 is provided with an opening 131 (Fig. 4) therethrough. Through this opening, one may observe the intermeshing teeth of gear 106 and pinion 37. There are marks 132 and 133 provided on the gear 106 and pinion 37, respectively, which enable the proper assembly of the moving elements of the timer-distributor. When the marks 132 and 133 are in registration, the moving distributor contact 112 is in proper relation with respect to the rotor shaft 23 of the generator. The cover 4 (Fig. 11) has a window 134 in its peripheral wall 6 through which a portion of the outer peripheries of disk 102 and ring 84 may be observed. There are marks 135 and 136 on the outer peripheries of disk 102 and ring 84, respectively. When the engine is turned over so that the piston in one of its cylinders, say No. 1 cylinder, is in firing position and the marks 135 and 136 are in register, then the rotatable contact 112 will be engaged with stationary contact 86 to cause firing of that cylinder. This arrangement enables accurate timing of the ignition apparatus with the engine to be easily and conveniently effected. All that is required is to turn the shaft 23 until the marks 135 and 136 are approximately in register; turn over the engine until the piston in No. 1 cylinder is in firing position; mount the magneto on the engine by applying the screw c and bolt f but not completely tightening them, and engaging the lugs 63' in the groove of engine-driven part h; then turn the housing i relative to the crankcase a until the marks 135 and 136 exactly register; and then tighten up the screw c and bolt f to clamp the housing in place.

The particular apparatus shown herein by way of illustrative example, is designed for an odd-firing two-cylinder, four cycle internal combustion engine, wherein the firing occurs at 180 degrees and 540 degrees in the cycle. The generator is driven at crankshaft speed and has a two pole rotor, which produces two flux reversals per revolution, or four flux reversals in the two revolutions making up the complete cycle of 720 degrees. Since only two sparks are desired in each such cycle at intervals of 180 and 540 degrees, the sparks produced by the other flux reversals are dissipated by connecting the capacitor to ground at the intermediate positions. The timing and distributing disk 102 rotates at half the crankshaft speed and thus the firing intervals will be 90 and 270 degrees. With the parts positioned as shown, the moving contact 112 will, on 90 degrees movement of disk 102, engage contact 87 and the capacitor 55 will be discharged to produce a spark in one cylinder of the engine. When contact 112 moves another 90 degrees it will engage contact 88 and discharge the capacitor to ground. When this contact moves another 90 degrees, it will engage contact 89 and again discharge the capacitor to ground. A further 90 degree movement will carry contact 112 into engagement with contact 86 and discharge the capacitor to produce a spark in the

Another engine cylinder at the required 270° interval after the production of the first spark and thus complete the cycle.

By omitting the conducting strip 93 and providing other conductors, such as 91 and 92, between the contacts 88 and 89 and terminals, such as 98 and 99, for connection to other distribution wires, the apparatus will be suitable for a four-cylinder engine. Of course, the apparatus may be designed to serve engines with any desired number of cylinders. The generator may have any desired number of poles and the timing-distributing means any desired number of contacts. The one example, herein shown, will serve to illustrate how the invention may be practiced.

The generator, like that of the first-named prior application, has a square static flux wave pattern. That is, the flux changes occur quickly in short intervals and are relatively steep and between successive flux changes, are intervals of approximately constant flux. The shape of the pole pieces 16 and the shape of the pole shoes 33 and the large angular extent of the pole pieces 16 compared to the pole shoes 33 of the rotor, have much to do with the form of the static flux wave. The material, length and cross section of the magnet; the reluctance of the leakage paths in the stator and rotor; and the number of turns in coil 15 also contribute to the final result. Each flux change consists of a reversal of flux, —that is a decrease in flux from a maximum in one direction to zero and an increase in flux from zero to a maximum in the other direction. This occurs in the short interval necessary for each pole shoe 33 to leave one pole piece 16 and connect with the other pole piece. In Fig. 3, the rotor is shown in the position it occupies at the end of one such reversal. As a result of this form of flux wave, the open-circuit voltage wave has a sharply rising portion, an immediately-ensuing and sharply falling portion, followed by a portion where there is substantially no change in voltage. The flux curve and voltage curve for no-load operation are modified when the generator is under load. The design of the magnetic circuit is such that the amount of magnetomotive force acting through the coil core 14 is limited. When the speed increases, the generated counter magnetomotive force reaches this limit and there can be no further increase in current with increase in speed. When current flows, a counter magnetomotive force is produced which limits the rate of change of the flux. The completion of the flux reversal and the peak of the resulting voltage on the capacitor will occur later and later as the speed of the generator increases. But so far as speed is concerned, the flux rate is substantially constant over the normal speed range of the generator and so is the resulting voltage on the capacitor. The rectifier, by its valve-like action prevents back flow of current and maintains the voltage on the capacitor at peak value until the timing-distributing means acts to couple the capacitor to a discharge circuit. Then the capacitor, which was charged over a substantial period of movement of the rotor, is discharged instantaneously and a heavy flow of current at high frequency occurs for an instant in the primary of a spark plug transformer to cause the production of an ignition spark. The operation is essentially the same in all particulars as set forth in the first-named prior application.

It is to be noted that the assembly of all the

parts, which are housed within the cover 4, may be conveniently made. For example, before the member 48 is placed in the cover, all parts are assembled therein, —such as the capacitor, rectifier, center post 63, ring 84 with its contacts 86, 87, 88 and 89 and conductors 91 and 92, terminal posts 98 and 99, and pins 77. Then, all the wires are put in place. All this work may conveniently be done since access is had to all six faces of member 48. When this work is done, the member 48 is placed in cover 4 and the screws 49 applied to fasten it in place. The bolt 50 is then applied; the terminal 52 placed on the protruding end of the bolt; and the nut 51 screwed onto the bolt and turned up to clamp the terminal against the block 48.

The invention provides a compact arrangement of parts within a single casing section 4, which, when attached to an electrical generator having suitable characteristics, will complete an ignition apparatus of the low-tension, high-frequency type. No electrical connections need to be made, except the connection of the several distribution wires from the terminals on cover 4 to the spark-plug transformers. The supply current connections are automatically made during the act of applying the cover 4 to casing 1, when the pins 77 engage the springs 76 of coil 15. All that is necessary is to mount the distributor rotor on its stud 47 on the rotor-shaft-bearing supporting frame 18. The gear 106 is turned until it is so meshed with pinion 37 that the marks 132 and 133 coincide. Then, the cover is put in place and fastened by the screws 8. A magneto, such as disclosed in the second-named application, may be used as the generator for charging the capacitor by providing a slightly different frame, lacking the breaker mechanism and having the distributor support and driving pinion therefor and by substituting for the primary and secondary coils, a single coil such as 15. A breakerless magneto is thus provided and the timing of the sparks is effected solely by the rotating distributor contact 112.

The invention thus provides improved ignition apparatus for use in ignition systems of the low-tension, high-frequency type wherein the ignition sparks are produced by the discharge of a capacitor and are timed solely by the rotatable member of the distributor.

We claim:

1. Ignition apparatus, comprising, a casing having a wall embordered by an endless marginal flange and adapted for connection to the housing of an electrical generator, a member of insulating material having one side face abutting said wall and fixed thereto and encompassed by said flange, a distributor ring carrying contacts fixed to the opposite face of said member, a distributor brush mounted centrally of said ring, a capacitor and a rectifier mounted in said member, terminals fixed to said member and projecting therefrom for connection to said generator, electrical connections from said terminals to the input terminals of the rectifier and from the output terminals of the rectifier to the capacitor, an electrical connection from one terminal of the capacitor to said brush and from the other terminal thereof to said casing, terminals on said member adapted for connection outside the casing to distribution wires and connected inside the casing one to each contact on said ring, and a rotatable distributor element having a contact to successively engage the first-named contacts

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and a conductor connected to the last-named contact and engaged with said brush.

2. Ignition apparatus, comprising, a member of insulating material having front and back faces and connecting side and end faces, a distributor brush mounted in the member and projecting through its front face, a series of distributor contacts surrounding the brush, openings extending from one side face into said member above and below the brush, a capacitor in one opening, a rectifier in the other opening, supply terminals fixed to the front face of said member, electrical connections from the supply terminals to the input terminals of the rectifier and from the output terminals of the latter to the capacitor and from the capacitor one to said brush and one to be connected to the ground, discharge circuit terminals on said member and connected one to each said contact and having sockets opening to the back face of said member, a casing having a wall embordered by a marginal flange, said member with the parts mounted therein and with said electrical connections made adapted to be inserted in said casing with its back face against said wall and its side and end faces encompassed by said flange, and means securing said member to said wall, said wall having openings therethrough connecting one with each of said sockets.

3. Ignition apparatus, comprising, a member of insulating material having front and back faces and connecting side and end faces, a distributor brush mounted in the member and projecting through its front face, a series of distributor contacts surrounding the brush openings extending from one side face into said member above and below the brush, a capacitor in one opening, a rectifier in the other opening, supply

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terminals fixed to the front face of said member, electrical connections from the supply terminals to the input terminals of the rectifier and from the output terminals of the latter to the capacitor and from the capacitor one to said brush and one to be connected to the ground, discharge circuit terminals on said member and connected one to each said contact and having sockets opening to the back face of said member, a casing having a wall embordered by a marginal flange, said member with the parts mounted therein and with said electrical connections made adapted to be inserted in said casing with its back face against said wall and its side and end faces encompassed by said flange, means for fastening said member to said wall, and means for connecting said ground connection of the capacitor to said wall, said wall having openings therethrough connecting one with each of said sockets.

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