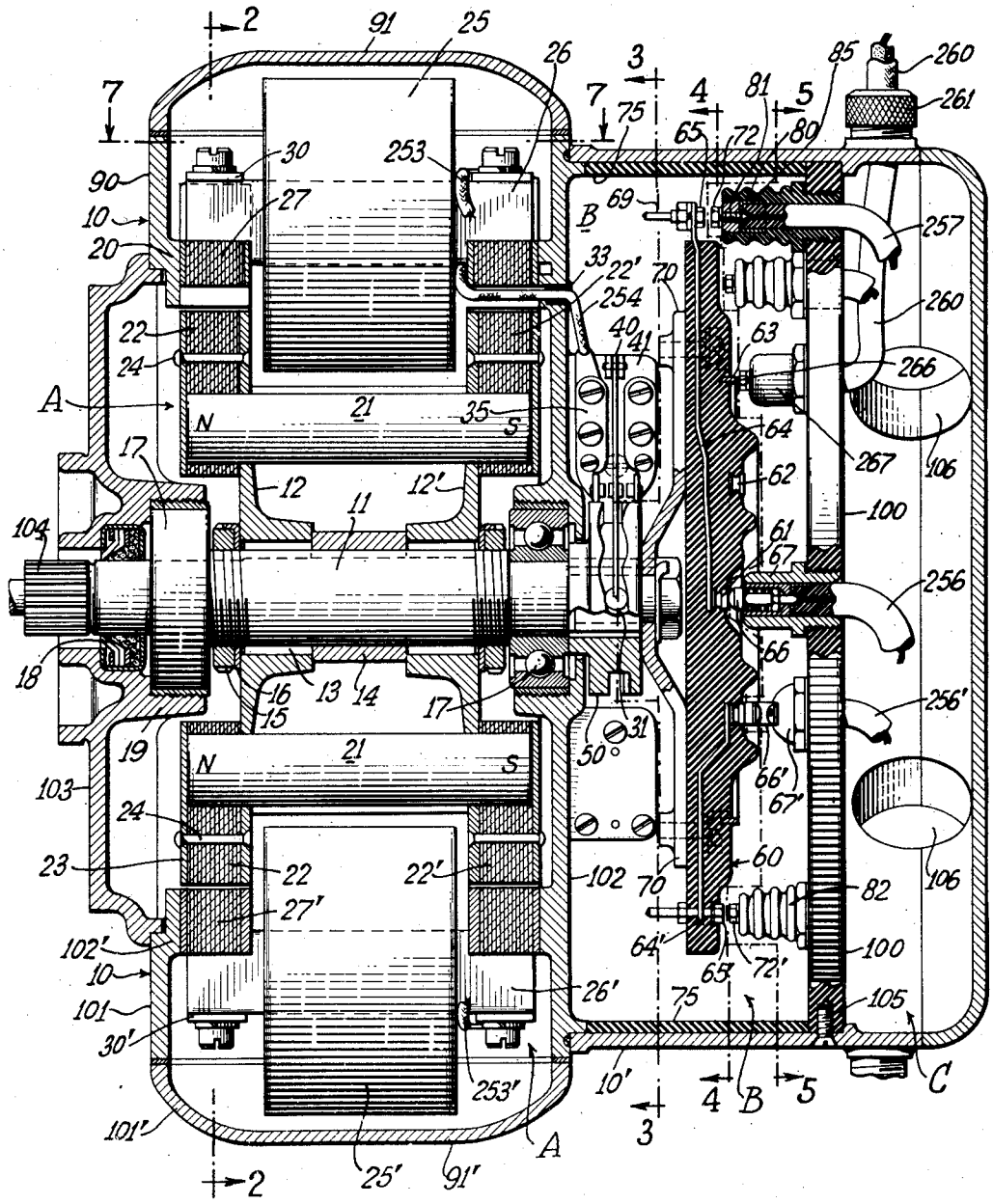
June 16, 1942. L. H. SCOTT 2,286,232

MAGNETO-ELECTRIC MACHINE

Filed Jan. 14, 1941 8 Sheets-Sheet 1

Fig. 1.



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BY Lloyd H. Scott

Watson, Bristol, Johnson & Leavenworth

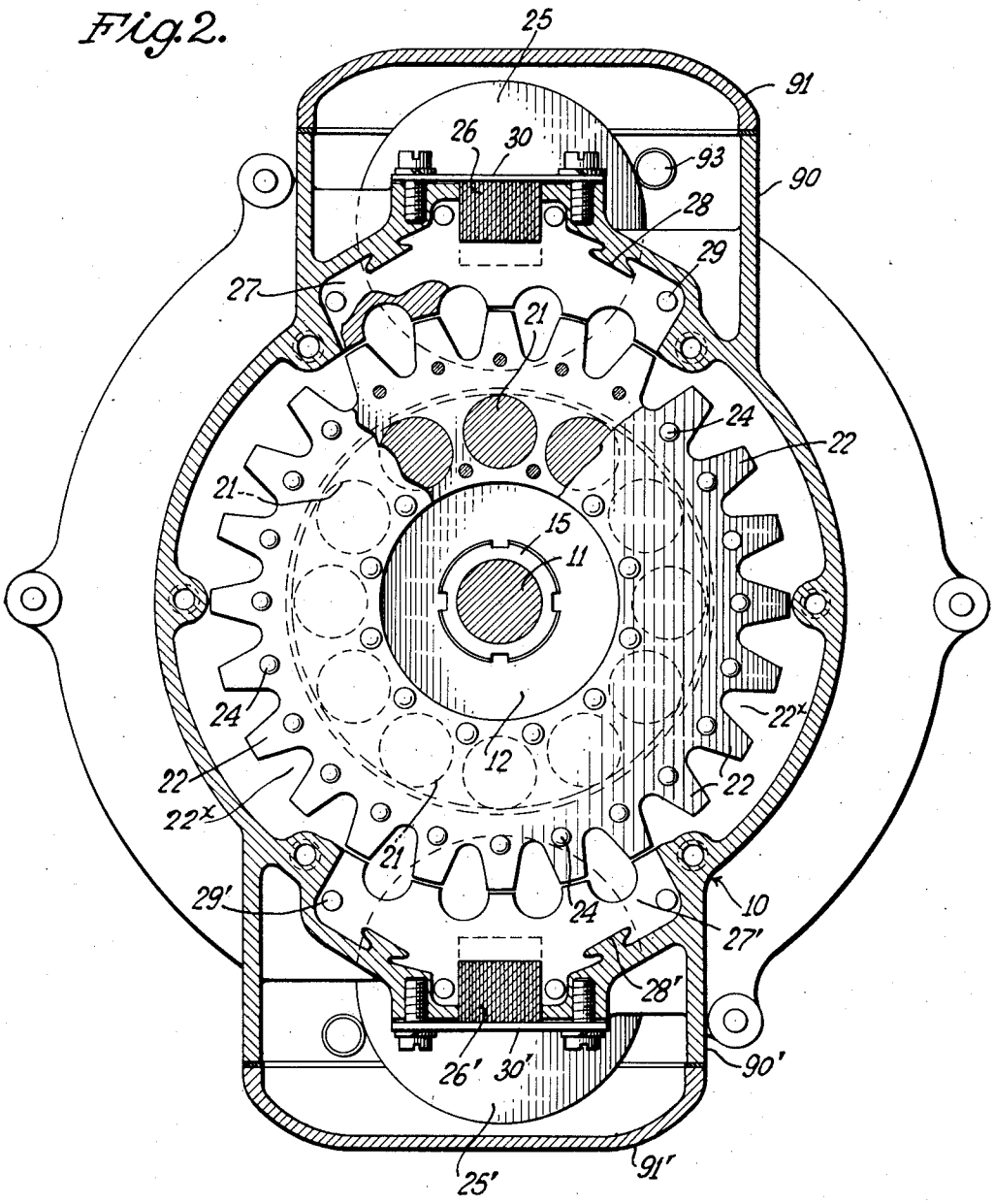
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June 16, 1942. L. H. SCOTT 2,286,232

MAGNETO-ELECTRIC MACHINE

Filed Jan. 14, 1941 8 Sheets-Sheet 2

Fig. 2.



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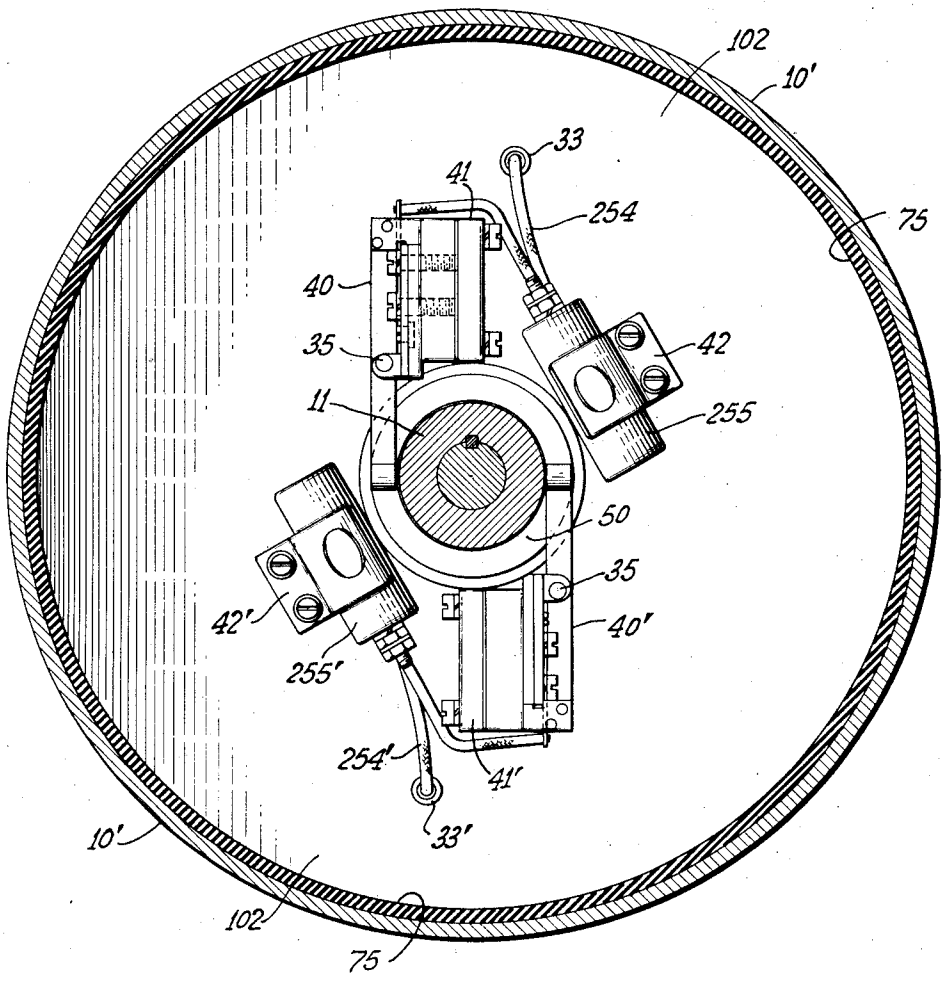
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MAGNETO-ELECTRIC MACHINE

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Fig. 3.



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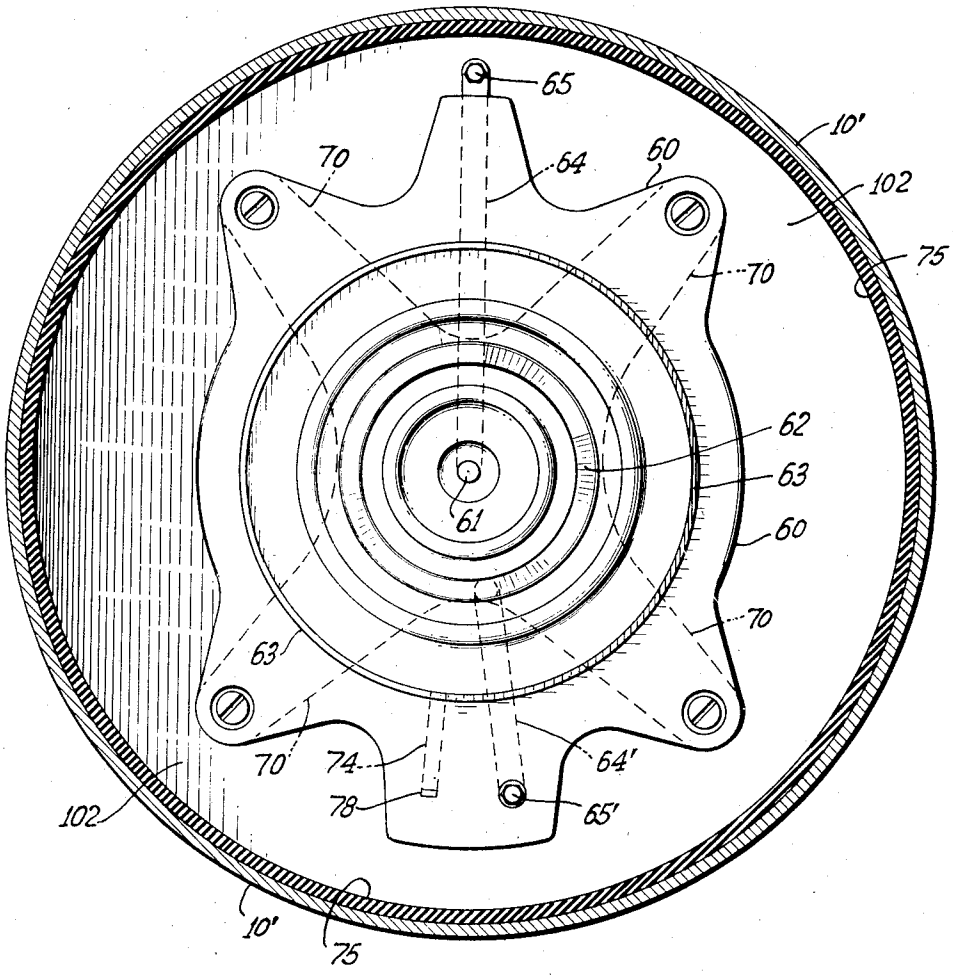
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June 16, 1942. L. H. SCOTT 2,286,232

MAGNETO-ELECTRIC MACHINE

Filed Jan. 14, 1941 8 Sheets-Sheet 4

Fig. 4.



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June 16, 1942. L. H. SCOTT 2,286,232

MAGNETO-ELECTRIC MACHINE

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Fig. 6.

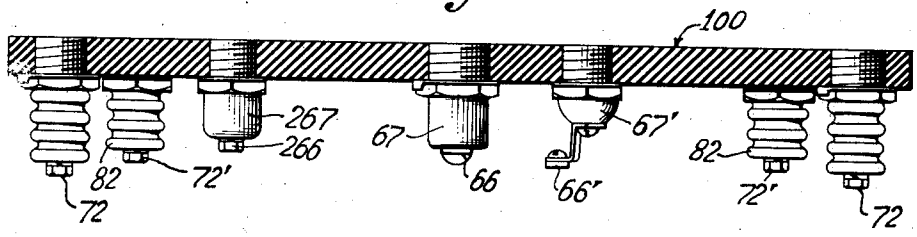
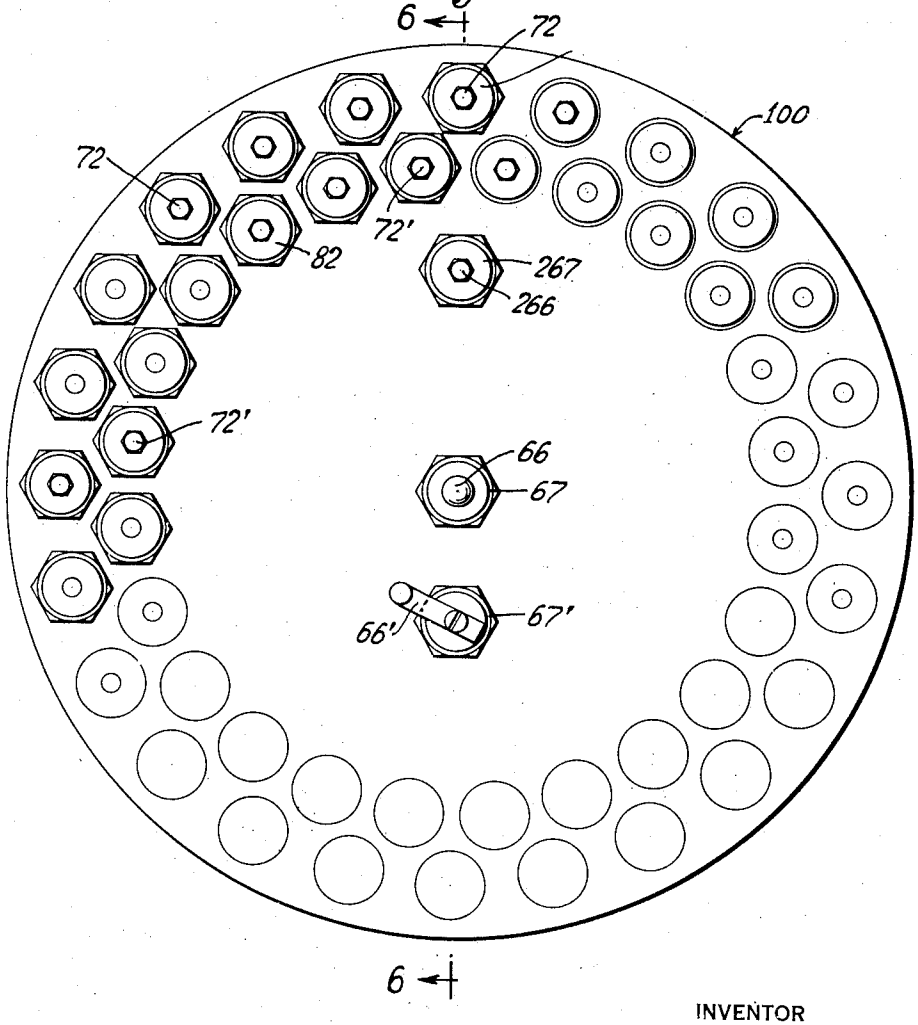


Fig. 5.



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June 16, 1942. L. H. SCOTT 2,286,232

MAGNETO-ELECTRIC MACHINE

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Fig. 7.

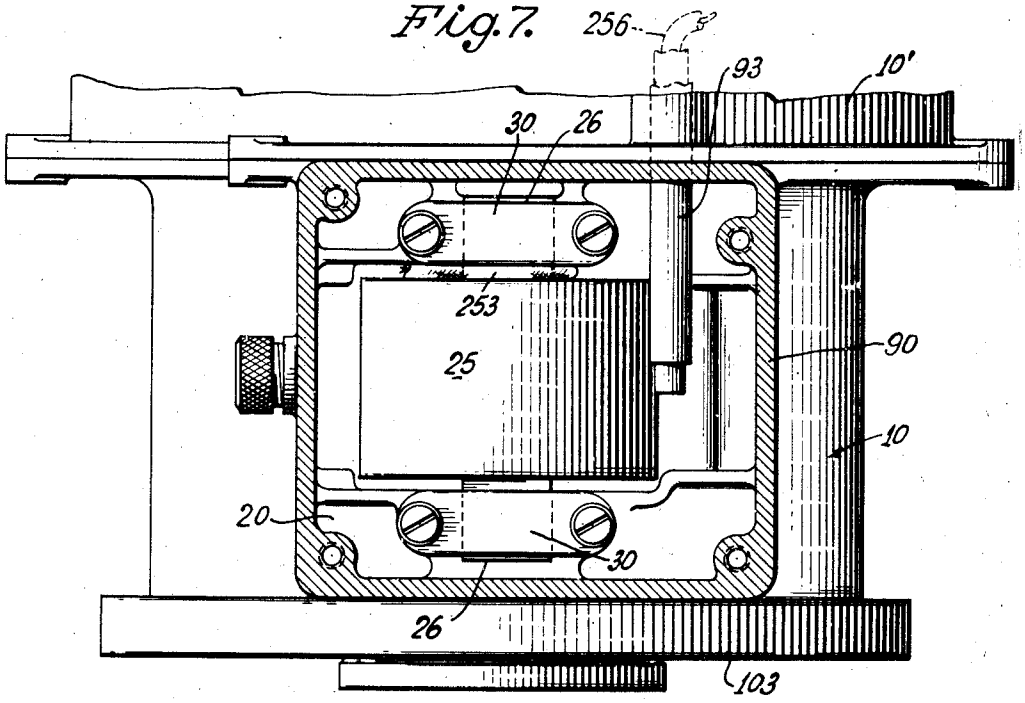
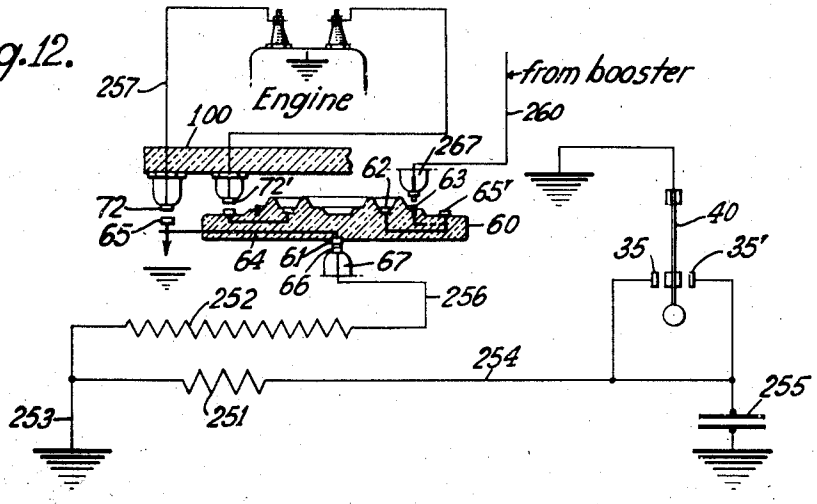


Fig. 12.



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June 16, 1942. L. H. SCOTT 2,286,232

MAGNETO-ELECTRIC MACHINE

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Fig. 8.

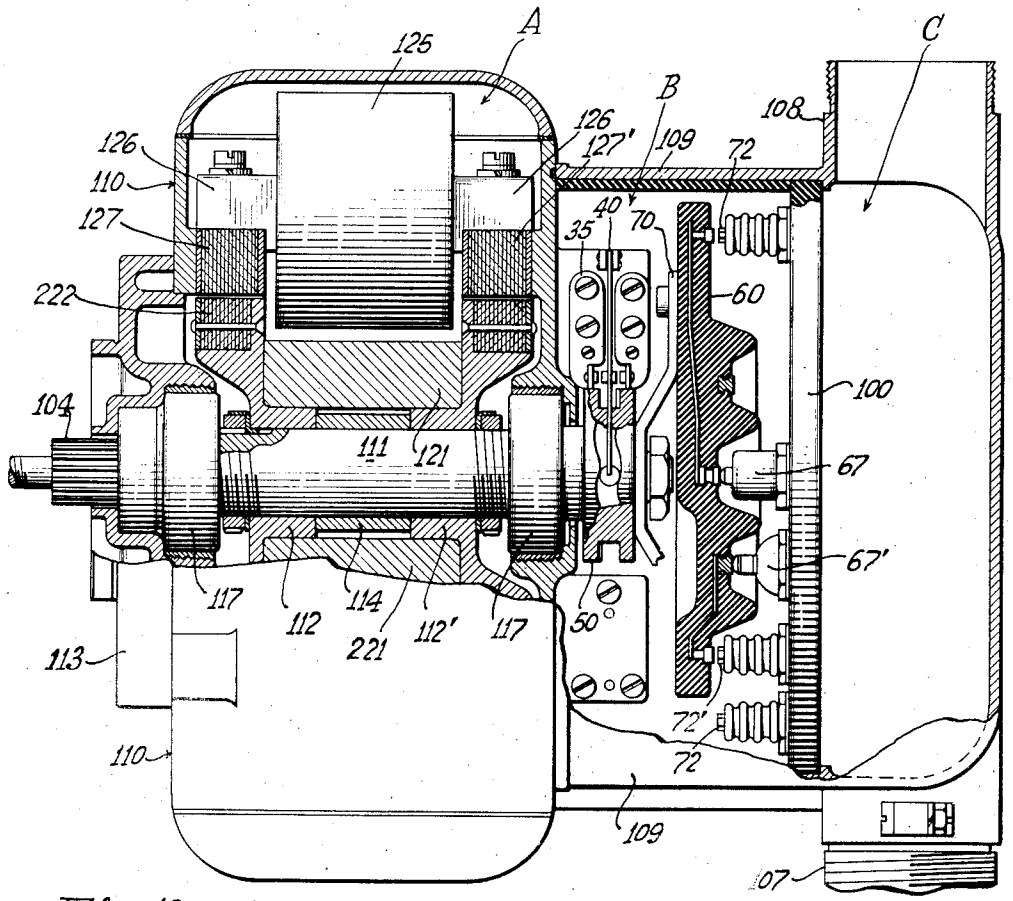
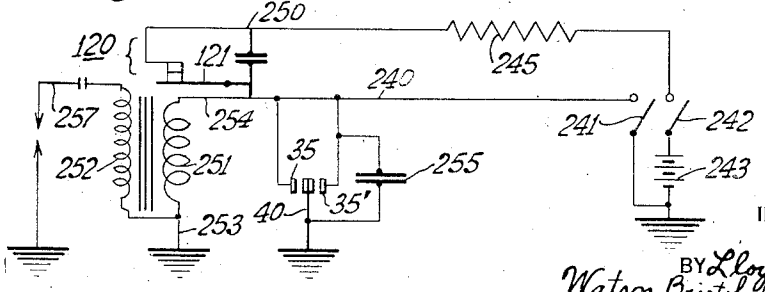


Fig. 13.



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MAGNETO-ELECTRIC MACHINE

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Fig. 9.

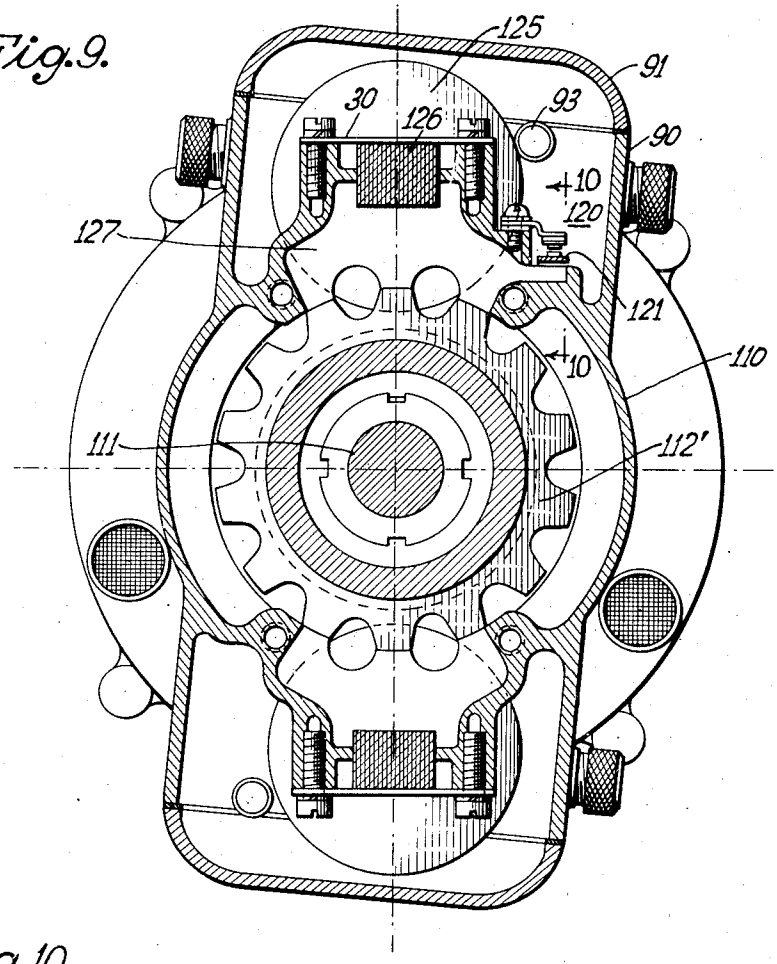


Fig. 10.

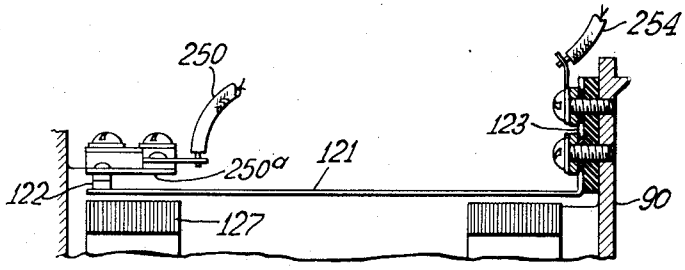
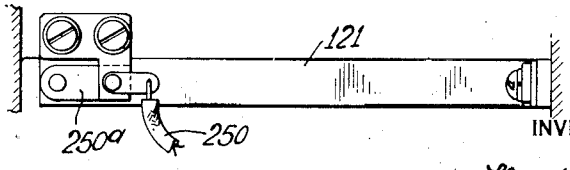


Fig. 11.



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ATTORNEYS

Patented June 16, 1942

2,286,232

UNITED STATES PATENT OFFICE

2,286,232

MAGNETOELECTRIC MACHINE

Lloyd H. Scott, Garden City, N. Y., assignor to The Seymour Corporation of Delaware, Seymour, Conn., a corporation of Delaware

Application January 14, 1941, Serial No. 374,324

18 Claims. (Cl. 171—209)

This invention relates to magneto-electric machines, and particularly to the general construction and assembly of magneto-electric machines.

The invention has for its object generally the provision of an improved construction and arrangement of parts in magneto-electric machines by which it is made light in weight and rugged in structure; all moving parts being rigidly assembled as a single rotating unit, whereby proper synchronization of the moving parts is assured in the assembly.

More specifically, the object of the invention is to provide a magneto-electric machine of the character indicated which is safe and reliable in operation at substantially any engine speed and is adapted to provide sparks in proper phase for any number of cylinders in an internal combustion engine.

Another object is to provide a magneto adapted to supply dual ignition in a multi-cylinder engine in a positive manner and in which the sparks are regenerated, thereby avoiding degradation.

Another object is to provide a magneto of the character indicated adapted for use with multi-cylinder engines, for example, with an airplane engine, and is constructed and arranged to be applied as a unit to the engine and adapted to be run at a relatively low speed such as one-half the engine speed.

Another object is to provide a construction which is adapted to incorporate in a single unit of relatively small size two or more magneto machines, for example, two magnetos which supply the sets of sparks for a dual ignition system.

Another object is to provide a magneto for multi-cylinder internal combustion engines with a distributor and spark gap arranged in a manner so as to be relatively unaffected by atmospheric conditions, such as humidity and pressure.

Another object is to provide a magneto with a casing or housing that has separate chambers which segregate the variously functioning elements; for example, a chamber for the windings, a second for the breaker and/or distributor, and a third for the distributing cable.

Another object is to provide a magneto with a casing or housing having segregating chambers for various operating parts, the chambers, or at least one of them, being made substantially gastight.

Another object is to provide a magneto with improved safety means for the high tension windings which employs a rotating spark gap, whereby, when arc-over occurs, no arc can be maintained.

Another object is to provide a magneto with improved means for attaching and detaching distributing cables, which is not only protected from dampness, corrosion, and the like, but also is convenient of access, whereby the cables may be quickly attached and/or detached.

Another object is to provide a magneto with a distributor having an improved arrangement for the electrodes or terminals of cables of a dual ignition system, whereby the same occupies relatively little space while maintaining a desired factor of safety.

Another object is to provide a magneto of the inductor type with an improved arrangement of magnetizing means whereby a single magnet may be substituted for a plurality of independent permanent magnets.

Still another object is to provide a magneto with an arrangement of windings which also incorporates a booster for starting purposes.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts, which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a vertical sectional view showing a magneto-electric machine constructed and adapted to supply high tension ignition current for a multi-cylinder internal combustion engine in accordance with the invention;

Fig. 2 is a transverse sectional view taken in the plane of the line **2—2** of Fig. 1, and looking in the direction of the arrows;

Fig. 3 is another sectional view, taken in the plane of broken line **3—3** on Fig. 1, and looking in the direction of the arrows;

Fig. 4 is a similar view, taken in the plane of broken line **4—4** of Fig. 1, and looking in the direction of the arrows;

Fig. 5 is a similar view, taken in the plane of broken line **5—5** of Fig. 1, and looking in the direction of the arrows;

Fig. 6 is a sectional view taken in the plane of the line **6—6** of Fig. 5;

Fig. 7 is a sectional view taken in the plane of

the line 7—7 of Fig. 1, and looking in the direction of the arrows;

Fig. 8 is a view, partly in section and partly in elevation, showing a modified form of magneto-electric machine constructed in accordance with the invention;

Fig. 9 is a transverse section of the modification shown in Fig. 8, and discloses additionally the vibrator of a booster which may be incorporated in the magneto-electric machine in accordance with the invention;

Fig. 10 is a fragmentary sectional view, taken on the line 10—10 of Fig. 9;

Fig. 11 is a plan view of the vibrating element shown in Figs. 9 and 10;

Fig. 12 is a circuit diagram for the electrical system used with the modification shown in Fig. 1; and

Fig. 13 is a similar diagram for the electrical system used with the modification shown in Fig. 8.

A construction for a magneto adapted to furnish electrical energy for the ignition system of internal combustion engines of the multi-cylinder type is disclosed in the U. S. patent to Spohn, No. 2,015,091, issued September 24, 1935, in which a plurality of localized fields of induction are provided, each in a magnetic circuit, the number of which corresponds to the number of cylinders in the engine to be fired. In the Spohn magneto, the rotor carries the magnetizing means for the magnetic circuits, the windings in which current is induced being stationary and an independent set of windings being provided for each of the sets of sparks to be produced in a cylinder of an internal combustion motor or engine to be fired.

An improved construction for magnetos of the Spohn type is provided by the present invention, the arrangement comprising a casing having completely separate chambers for the windings with inducing elements, for the breaker and distributor mechanisms, and for the distributing cables, here employed. Such chambers may be, and for certain purposes are, made substantially gas-tight.

By the present invention, dual ignition may be conveniently provided for a multi-cylinder engine of substantially any number of cylinders, for example, a 24-cylinder unit. The arrangement permits of positively inducing the spark in each cylinder at the proper instant, even at relatively high speeds, for example, 72,000 sparks per minute may be had for a 24-cylinder engine, with a crank shaft speed of 3000 R. P. M. For such an engine, it is seen that the rotor need have but twenty-four localized fields of induction or poles to supply the desired ignition for a 24-cylinder engine. In such arrangement, the magneto rotor is driven at half engine speed, for example, 1500 R. P. M. for an engine crank shaft speed of 3000 R. P. M.

The segregation of the distributor in a separate chamber of the magneto permits the use of simply made parts which provide the desired insulating strength with the use of fabricated parts. A fabricated distributor head made of a single disk of insulating material permits the use of separately made insulating bushings for the terminals of the distributing cables. Where dual ignition is employed for a 24-cylinder engine, it is seen that forty-eight insulating bushings are required to be mounted on the distributor head for the single magneto to be employed in accordance with the invention. To have these terminal bushings arranged in a relatively small space, these may be arranged in two concentric circles in which the proper spacing is obtained as well as the desired sequence in the firing of the engine cylinders.

Referring now to the drawings, and particularly to Figs. 1 and 2, 10 denotes generally a main casing which is arranged to house the magneto structure, the casing having an auxiliary portion 10' mounted thereon. Walls 101 and 102, together with an insulating member or disk 100 disposed in portion 10' (for purposes hereinafter more fully described), divide the casing into three chambers, namely, those denoted A, B, and C, respectively. The chamber A, between walls 101 and 102, serves to house the rotor and windings of the magneto, while chamber B, between wall 102 and partition or disk 100, serves to house breaker and distributor mechanisms, hereinafter described. Chamber B may be open to the atmosphere, but, if in a magneto for an engine intended for high altitude aviation, is substantially gas-tight. The disk 100, which separates chambers B and C, is fitted tightly into casing portion 10' and held in place by means of screw 105; such disk being readily formed or cut from sheet insulating material. Chamber C houses distributing cables and hence has a plurality of openings, as shown at 106.

Rotatably mounted in the walls of chamber A is a shaft 11 which is preferably of non-magnetic material and arranged to support the rotor structure of the present magneto-electric machine, together with other moving parts. The rotor is shown as comprising a pair of oppositely disposed supporting plates 12 and 12' which are preferably of magnetic material and spaced apart and rigidly secured on shaft 11 in any suitable manner, for example, by keys 13. The proper spacing is advantageously insured by means of an interposed collar 14 of non-magnetic material that is slipped over the shaft 11 before the supporting plates are put in place. The shaft 11 is preferably reduced at its ends and the shoulders threaded for the reception of securing means, such as a nut and washer, denoted respectively 15 and 16, and shown in engagement with the shoulder. The reduced ends of the shaft 11 are slipped into suitable bearing means, for example, antifriction bearings, as shown at 17, each bearing being supported in suitable recesses in the casing walls 101 and 102, the former advantageously having removable portion or closure 103 that carries the bearing. The wall 102, i. e., the one which separates the chambers A and B, has an integral portion recessed for the reception of one bearing. Closure 103 advantageously has a hub portion 19 recessed to receive not only the bearing but also an oil-seal 18 that operates to exclude oil or lubricant which otherwise might pass inwardly from the engine casing.

By the present invention, the supporting plates 12 and 12' are adapted to support localized fields of induction and are designed to provide the number of magnetic circuit elements needed to induce the desired number of sparks for firing the multi-cylinder engine for which the magneto is provided. Accordingly, plates 12 and 12' are arranged to carry the magnetizing means which, in the modification of the invention shown in Figs. 1 to 7, comprises a plurality of bar magnets 21 arranged to be slipped through suitable openings in plates 12 and 12', such openings being preferably in register with or in lines parallel to the

axis of shaft 11. The bar magnets in such arrangement are all disposed with their like poles at one end, for example, the bar magnets 21 are shown in Fig. 1 with all north poles at the left, and all south poles are at the right. The bar magnets advantageously have a length such that the poles extend through or project beyond the sides of plates 12 and 12' a desired distance. While the bar magnets 21 may have substantially any desired cross-section, a circular cross-section makes for ease of manufacture and assembly; circular cross-sections are accordingly shown.

The projecting ends of the bar magnets are each associated with or enclosed in magnetic flux directing shoes 22 and 22'; such shoes being preferably composed of laminations, as illustrated, and secured to plates 12 and 12' respectively. While substantially any suitable means may be employed for securing the shoes to the supporting plate, a convenient means comprises an outer facing plate 23 that fits down over the ends of the bar magnets to prevent displacement, the whole being advantageously secured by means of rivets as shown at 24. By such an arrangement, it is seen that the shoes, together with the bar magnets, provide a series of U-shaped portions of a magnetic circuit in which the base portions of the U's are parallel and arranged to be displaced laterally; the shoes directing the flux outwardly in a radial direction about the rotor. In such an arrangement, the bar magnets 21 are advantageously made of a suitable alloy which has a relatively high retentivity, for example, of the alloy known under the trade-name "Alnico," which is capable of receiving and retaining magnetization in a relatively high degree. The laminations of the shoes 22 and 22' are of magnetic material, such as transformer iron, that has a relatively high permeability and saturation value. The laminations when assembled in a stack are insulated from one another by suitable insulating material, for example, by surface oxides, varnishes, and the like, whereby eddy currents and iron losses in the magnetic circuit may be reduced. The facing plates 23 may or may not be of magnetic material, as desired.

The shoes at their outer circumferences are notched or cut back to provide a plurality of alternate poles and gaps, for example, as shown at 22 and 22× about the serrated periphery in Fig. 2. By thus notching or cutting back the shoes at their peripheries, the desired number of localized fields of induction are provided. The number of localized fields of induction here shown as provided is that corresponding with the number of cylinders in the engine which are to be fired, for example, twenty-four.

To provide a dual ignition system in accordance with the invention, two windings, or two sets of windings, as the case may be, are disposed in inductive relation to the magnetic circuits in chamber A, for example, the sets or coils 25 and 25'. Such coils are preferably disposed stationarily with respect to the portions of the magnetic circuits which are displaced by rotation of the rotor and are disposed at suitable points about the inside cylindrical wall of chamber A, for example, at substantially diametrically opposite points. This is especially advantageous when the number of cylinders in the engine to be fired is an even number. In Figs. 1 and 2, the inductively arranged coils 25 and 25' are shown each on a core member at 26 and 26' respectively; such cores being preferably laminated.

To support coils 25 and 25' in a stationary manner in the chamber A, casing 10, which is also preferably of non-magnetic material, is shown formed interiorly with anchoring means 20 for the core ends which preferably extend beyond the end faces of coils 25 and 25'. The anchoring means provided may, of course, have any convenient form, for example, that of shoulders, as shown, formed by die casting about complementary shoe members 27 and 27' that are notched, as at 28, in order to be locked in place in the casing, and have rivets 29 for retaining the laminations of each shoe in stacked relation. Clamps, as shown at 30 and 30', may also be employed for removably retaining the cores 26 and 26' with their coils 25 and 25'.

Shoe members 27 and 27', together with core members 26 and 26', are seen by this arrangement to provide U-shaped portions of magnetic circuits which are adapted to cooperate with those on the rotor which admit of maximum flux through the coils 25 and 25' whenever a tooth on the rotor is under a tooth on the members 27 and 27'; the sets of teeth thereon being preferably arranged with equal angular spaces therebetween.

The coils 25 and 25' may, of course, employ any suitable arrangement of windings. An arrangement using a primary wound closely around the core and an outer secondary, however, is preferred. An electrical system of a character suitable to cooperate with such windings is diagrammatically shown in Fig. 12 which depicts a circuit suitable for the magneto-electric machine of the present invention. Here the primary is denoted 251 and the secondary 252, the windings being indicated as having a common ground at one end through a conductor 253. Such conductor is depicted in Fig. 1 as grounded on the cores, the conductors being denoted 253 and 253', respectively. From the other end of primary 251 a conductor 254 leads to a suitable breaker mechanism disposed in chamber B; for example, that shown therein comprising a vibratorily mounted arm or blade 40, cooperating with contacts 35 (see Figs. 1 and 3), having an actuating follower 31 and driving cam 50 that is made fast to an end of shaft 11 in chamber B. While, of course, any suitable breaker may be used, the arrangement here shown by way of example is that disclosed in copending application, Serial No. 350,533, filed August 3, 1940, in the name of L. H. Scott. The breaker mechanism is shown in Figs. 1 and 3 where the end of blade 40 remote from the follower is mounted on an abutment or base 41 projecting outwardly from casing wall 102. Blade 40 is grounded and engages with contacts 35. Electrically connected in parallel with the contacts 35 is a condenser 255, one side of which is grounded (see Fig. 12). There is a breaker for each of the circuits which include coils 25 and 25', respectively. Accordingly two breakers are shown mounted on wall 102. The arms or blades of the two breakers are denoted 40 and 40', the mounting abutments 41 and 41', the pair of contacts on each being denoted 35, while the conductors which lead thereto are denoted 254 and 254', and their associated condensers, by 255 and 255'. These latter are secured in place on wall 102 by clips 42 and 42', respectively. Conductors 254 and 254' are passed through the wall 102 from the windings by bushings 33 and 33' which preferably have relatively tight fit on the conductors passed.

From the other terminal of each secondary winding, as shown at 252 in Fig. 12, there leads another conductor 256 to a distributing mechanism which is preferably disposed in the same chamber as the breakers and has one or more electrodes rotatively arranged for transferring the high tension current selectively to stationary electrodes in bushings which anchor cables connected respectively to the spark plugs in the engine cylinders which are to be fired. Conductor 256 is shown as led through the wall 102 by means of an elongated insulating bushing or tube 93. In order to support the rotating electrode or electrodes in proper synchronism with the engine and with the rotor of the magneto, such electrode or electrodes are advantageously mounted in a suitable insulating carrier that is secured to shaft 11.

A preferred form of distributing mechanism has an insulating carrier or plate denoted 60, in Figs. 1 and 4. Such plate is preferably secured to the end of shaft 11 in chamber B at a point outwardly beyond cam 50 by means of a spider 70. Plate 60 has one rotating electrode at 65 which is charged from the windings of coil 25, and another at 65' charged from the windings of coil 25'. Plate 60 carries in addition a plurality of charge collecting means or devices, with working surfaces exposed and opposing the disk 100. Here, there are three such devices, namely, those denoted 61, 62, and 63, only two being needed for distributing the current for dual ignition, the third being arranged to provide a booster spark, as hereinafter explained.

The device at 61 consists of a centrally located contact which engages with a resiliently pressed terminal 66 in an insulating bushing 67 that is mounted in and held stationary by disk 100. The bushing 67 provides anchorage for the conductor 256 which is secured in conducting relation with the terminal 66.

Electrical connection is established in plate 60 between contact device 61 and electrode 65 by means of a conductor 64 that is bar-like and preferably embedded in the plate 60, such conductor being here extended beyond the edge of plate 60 and arranged to serve as a support for the electrode 65. Such electrode here preferably has an oppositely extending needle-point electrode 69 arranged to terminate a desired distance from wall 102, which is a conductor, and thereby provides a safety gap across which arcs, caused by excessive potential, may strike and pass to ground. Electrode 65, which may be flat topped, revolves with plate 60, and cooperates with a series of similarly shaped stationary electrodes 72 disposed about the periphery of plate 100. The number of stationary electrodes 72 correspond to the number of cylinders to be fired and are arranged in the outermost circle in plate 100, and have the cables for ignition lead from the rear of the plate in order that they may be convenient and free from interference with magneto parts. Each electrode 72 is supported in a suitable insulating bushing 80 that has a receptacle providing anchorage for a distributing cable, for example, that shown at 257 in Fig. 12, leading to a spark plug in an engine cylinder to be fired.

The contact device 62 provides a similar distributing mechanism that furnishes the other spark for ignition in each engine cylinder. Device 62 is in the form of a conducting ring embedded in insulating plate 60 but arranged to be concentric with the device 61. Ring device 62 is arranged for current collecting purposes and engages with or wiped by a flexible brush or terminal 68' that is in bushing 67'; this latter being also stationarily mounted in disk 100 and providing anchorage for a conductor 256'. This latter is similar to that at 256 and leads from the other magneto winding.

Another bar-like conductor 64' is embedded in plate 60 but has no protruding end. Instead, it terminates in the plate 60 and has an electrode 65' that is similar to that at 65 but which is at a radial distance different from that at 65 (in the illustration the distance is less), and hence is adapted to cooperate with another set of fixed electrodes 72' on disk 100 with gap intervening and arranged peripherally and staggered to be at a less distance from the center than those at 72. Electrodes 72' also correspond in number to the number of cylinders to be fired; their connection being in the order in which the cylinders are fired, as is the case for electrodes 72.

The third contact device 63 is arranged to provide the booster ignition system which is used when starting airplane and similar motors. The booster ignition system, however, may be dispensed with where other systems of starting are provided. The contact device 63 is in the form of another annular conductor embedded in plate 60 and arranged to be concentric with the device at 61. This third device collects high tension current from a source (not shown in the drawings in the interests of clearness). To this end, a conductor 260 is shown as leading from such source (indicated symbolically in Fig. 12) into the chamber C through a bushing 261 which is passed through the chamber wall to the rear of disk 100 (or that part remote from the magneto proper) and leads to and is anchored in a bushing 267 (which may or may not be similar to that at 67) that is preferably mounted in disk 100 on the same side and in the same manner as bushings 67 and 67'. Bushing 267 has an electrode 266 that is similar to that at 72 and terminates at a little distance from the plane of and in line with the edge of the conducting ring 63. By this means, the ring 63 is charged with a high tension current that is at a voltage materially higher than that generated in the windings at 25 and 25' when low cranking speeds prevail. Another bar-like conductor 74, embedded in the plate 60 and displaced angularly from conductor 64' (or from 64) to achieve a desired retardation of the firing at starting, leads radially outwardly and terminates in a prong-like electrode 78 that extends transversely through the face of plate 60 to an exterior point that is adapted to cooperate with one set of the stationary distributing electrodes, in this instance, the electrodes 72'; it being obvious that the stationary distributing electrodes 72 could equally well have been chosen. By this means, when the engine is starting and the sparks from the magneto are weak, the ignition system may be switched to the booster system to obtain strong sparks.

Casing portion 10' is preferably made removable from the magneto proper. Access is hence readily had to the breaker and distributor mechanisms when desired. Since corrosive gases, such as ozone and nitric oxide, are formed by the action of electric sparks, the provision of the separate chamber is seen to serve as means for substantially excluding such corrosive substances from the chamber A which houses the coils 25 and 25' and the elements of the magnetic circuits.

To insulate properly the current carrying conductors, especially those carrying high tension current, the interior cylindrical wall of chamber B is covered with suitable insulating material, which is also preferably acid resisting. A covering of this character for the cylindrical wall of chamber B is shown at **75**. Through openings **106** which are in chamber C and at the rear of disk **100**, are led the cables or conductors, such as **256** and **257**, which distribute ignition energy to the engine. In order that these latter conductors may be anchored in disk **100** and connected with their proper stationary electrodes **72** and **72'**, suitable bushings therefor are provided in disk **100** which incorporate suitable anchoring means. A suitable bushing formed for both supporting electrodes and for providing cable anchorage is that shown by way of example in copending application, Serial No. 386,421, filed April 2, 1941, in the name of L. H. Scott, one form of which is depicted in Fig. 1. Such bushing is shown at **80** made of suitable insulating material, and may have its outer surface corrugated or petticoated and provided with a bore closed at one end by a perforated conducting block or plug **81** which is preferably threaded and adapted to engage with a corresponding thread on the shank of an electrode **72**.

The cable to be anchored in a bushing at **80** is cut off "square," i. e., in a plane at right angles to the cable, and provided with a conducting cap which, when the cable is anchored, is in conducting relation with the cable and is preferably threaded or otherwise formed to engage positively with the threaded tip of the shank of an electrode **72**.

When the threaded shank of an electrode **72** is passed down through block **81**, it is then screwed into the cap **82**, and draws the cable firmly into place; lock nuts and/or washers being preferably disposed over the shank and interposed between an electrode **72** and the top of a bushing **80** for locking the parts in place when the desired adjustment has been attained. By this means a quick and secure anchorage for all of the engine cables, and/or other conductors, leading to disk **100** may be had.

The magneto casing may, of course, be constructed of any suitable material. A light metal, such as aluminum, is preferred, as it shields the magneto windings to prevent radio interference and contributes to a light-weight magneto which is desired in the field of aviation. The casing **10** preferably follows the contour of the parts housed. The portions of the casing which envelop the rotor are hence cylindrical but those which house the coils **25** and **25'** are enlarged and elongated, as shown at **90** and **90'**, in order to clear properly the high tension windings. Each of these portions is substantially rectangular in cross-section and has closures, as at **91** and **91'** respectively, secured thereto.

In practice, the shaft **11** is coupled through its projecting end **104** which may be fluted or toothed to engage with a coupling device by which driving force is transmitted from the engine to the magneto. Any suitable coupling may be applied at the end **104** and may include means for close adjustment of the angular relation between the driving shaft and the shaft **11**. In the form of the invention shown the magneto is intended to be driven at one-half the engine crankshaft speed for a four-cycle engine.

When the desired phase adjustment has been achieved, the starting of the engine transmits driving force to the shaft **11** which simultaneously rotates the magneto rotor carrying the magnetizing means comprising the bar magnets **21**, together with the breaker drum **50** and the distributor plate **60**.

The magnetic flux engendered by the magnetizing means is seen to be passed by the shoes **22** and **27** through the cores of the coils **25** so that the magneto windings **251** and **252**, shown in Fig. 12, are cut by flux. As the rotor rotates, it is seen that a series of poles of localized induction pass under each shoe by which air gaps of varying width are periodically moved into and out of the magnetic circuit, causing a periodic fluctuation in the number of lines of magnetic flux passing through the cores of the surrounding coils. This periodic variation induces in the well-known manner a periodic current of corresponding frequency in the primary winding **251** of each coil. A secondary current in each winding **252** is generated by the quick change of the flux when the primary current is interrupted, such secondary current being of a relatively high potential and adapted to discharge across the spark gap in an engine cylinder. The distribution of the current from an electrode **65** when adjacent an electrode **72** is accompanied by a spark that jumps across the gap between an electrode **65** and an electrode **72**. As electrode **65** is on the distributor plate **60**, it rotates with the shaft **11**, and thus passes successively over the outermost stationary electrodes that are disposed about the circumference of disk **100**. In this way, the several cylinders comprising the engine are fired in the proper sequence. It is seen that the coil **25'** similarly provides current to the electrode **65'** which cooperates with the series of electrodes **72'**, to provide the other of the dual sparks.

By the present invention, it is seen that relatively large bearings may be provided for the shaft **11** with the result that bearing trouble is substantially eliminated in the arrangement of the present invention. The fact that the breaker is positively driven in the double-acting cam **50** also results in a positive make and break which maintains its uniformity in character no matter what the engine speed may be. The rotating safety electrode at **69** on plate **60** substantially avoids the maintenance of such arcs as may strike to ground in the chamber B, since this requires constant ionization of new paths, which is unlikely. Incident corrosive products are also substantially excluded from chambers A and C by the segregation thus provided by the present invention.

It will be seen further that, by the placing of the north poles of the magnetizing means all at one end of the rotor, the direction in which the current is passing when the transient condition occurs is always the same, with the result that as the engine increases speed, with the sparks crowded into smaller and smaller periods of time, any overlapping in the periods which may take place at high speeds does not operate to nullify the spark impulses. Hence degradation of the spark is seen to be substantially avoided.

While a plurality of permanent magnets, such as shown at **21** in Fig. 1, may be employed as the magnetizing means of magnetos provided in accordance with the present invention, such permanent magnets being carried by supporting plates **12** and **12'** of magnetic material, it is by no means necessary that the magnetizing means be a plurality of permanent magnets, since a single permanent magnet may be employed and arranged as a common magnetizing means to supply flux to

the pole shoes which guide the flux and provide the plurality of localized fields of induction. A hollow cylindrical magnet, made of a suitable magnetic alloy, may be employed. An arrangement of this character is shown in Figs. 8 and 9. Here, a casing 110, which may be similar to that shown at 10, and made of aluminum, has a non-magnetic rotating shaft 111 mounted therein in bearings 117, the shaft carrying supporting members 112 and 112'. The latter are shown as spaced apart by a bushing 114. Casing 110 is also shown with a removable cover portion 113. This latter may be removed in order to afford access to the interior.

To provide a single magnetizing means for the several localized fields of induction as here proposed, a single cylindrical permanent magnet 221 is disposed about the shaft 111 and secured at the ends between the supporting plates 112 and 112'. The latter are preferably of magnetic material. Each of the supporting plates 112 and 112' may be shouldered for the reception of magnetic shoe members; such shoe members are composed of laminations 222, although laminations may be dispensed with. The shoe members shown are arranged to cooperate with similar magnetic shoe members 127 and 127' which are disposed in the stator or frame of the casing 110. The shoe members 127 and 127' cooperate to support core elements 126 which pass respectively through the center of the sets of coils, as shown at 125. Each core and coil is here mounted in substantially the same manner as shown in the modification of Fig. 1.

A separable casing portion 109 here provides the chambers, heretofore denoted B and C, and houses the breaker and distributor mechanisms and cables respectively. The breaker mechanism is here shown in identically the same form as in Fig. 1, and is operated by a double-acting cam drum 50 secured on the end of shaft 111. This shaft also supports a spider 70 which has a distributor plate 60 provided with distributing conductors and electrodes as shown in the first form of the invention.

In this second form of the invention, the casing also has a stationary terminal carrying insulating member or disk 100 which divides a casing portion 109 into forward and rear chambers, the latter housing the cables, which enter by way of tubular extensions 107 and 108.

In this form of the invention, the magneto is also adapted to be directly mounted on the internal combustion engine for which ignition is to be supplied. In such magneto, it may be desirable to incorporate the booster. To this end, one of the stator coils, such as the upper coil 125 on a core 126, is arranged to be in commission at starting also and has a magnetically actuated vibrator 120 for making and breaking the circuit of the primary of the coil at 125 during the starting period.

The vibrator 120 is conveniently disposed in the casing 110 on the stator structure in a manner completing a magnetic circuit through the core 126 when the primary of coil 125 is energized, the general arrangement being one in which shoes 127 and 127' are bridged by the vibrator, as shown in Figs. 10 and 11. Such vibrator comprises a resilient magnetizable element 121 arranged to span the stator structure for completing the local magnetic circuit indicated. The free end of element 121 has a contact 122 that may also serve as mechanical loading and contributes to the desired timing of the period of vibration. The other end is made fast to the shoe structure as shown at 123. A conducting element 250a secured to the stator is provided with a cooperating contact which is engageable by contact 122; the element 121 being a conductor as well as a magnetizable element is conductively connected to conductor 254.

The windings of the selected coil 125 are preferably connected for service during such period by means of a suitably arranged electric circuit or system, for example, that shown in Fig. 13. Here, the primary and secondary windings are denoted 251 and 252 respectively, as in Fig. 12, the windings having a common ground at 253. Conductor 254 leads from the other terminal of the primary to the breaker at 40 and has condenser 255 in parallel with the breaker contacts; there being a grounding conductor 240 which has conductor 254 and a grounding switch 241 in series.

In this arrangement, a conductor 250 is led from conducting element 250a to a second switch 242 that has a D. C. source of E. M. F., such as battery 243, in series with it. The conductor 250 is also preferably provided with a current limiting resistance, as shown at 245. The second switch is adapted to energize the vibrator 120 when starting.

In operation, when the engine and the magneto connected thereto are not running, switch 241 is normally closed but opened when starting or running. Switch 242 is open except when starting. When it is desired to start the engine, switch 241 is first opened, then switch 242 is closed. A circuit is then seen to be established including winding 251 and ground through which current from the battery passes, provided the breaker at 40 is open. Current passing in winding 251 energizes it so that the vibrator 121 operates to make and break the circuit and produce a high tension voltage which passes through conductor 257 to fire an engine cylinder. This booster spark causes the engine to fire, turning over at first slowly but soon fast enough to generate a proper voltage in the magneto windings which is of sufficient magnitude to fire the engine without the aid of a booster. The switch 242 is then opened and normal operation ensues.

In the event breaker 40 is not open when switch 242 is closed at starting, current from battery 243 is short circuited to ground. To prevent a surge of current at such time, conductor 250 preferably has in series with it a current limiting means, such as the resistance 245. By this means excessive current values are avoided and the battery 243 protected. The instant the breaker 40 opens, winding 251 is in operation and a booster spark provided. This is seen to insure proper timing with the engine so that danger of prematurely firing the engine is avoided by incorporating the booster in the magneto in accordance with the invention.

Since certain changes may be made in the above construction and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a magneto-electric machine, the combination comprising a casing formed with segregating chambers, a structure stationarily mounted in one of said chambers, a shaft journaled in said chamber, an inner structure mounted on

said shaft and rotatively arranged with respect to said stationary structure, magnetizing means mounted on said inner structure together with magnetizable elements whereby a plurality of portions of magnetic circuits are provided, a cooperating magnetic circuit portion including a core disposed in said stationary structure, magneto windings on said core, breaker and distributor mechanisms in a second chamber including rotatable elements rigidly secured in a desired phase relation on said shaft, an insulating disk stationarily mounted and arranged to close said second chamber; and electrode supporting bushings, adapted to provide anchorage for distributing cables, demountably disposed on said disk in said second chamber and arranged to receive cables from without said second chamber.

2. In a magneto-electric machine, the combination comprising a casing formed with three segregated chambers, a structure stationarily mounted in one of said chambers, a shaft journaled in said chamber, an inner structure mounted on said shaft and rotatively arranged with respect to said stationary structure, magnetizing means mounted on said inner structure together with magnetizable elements whereby a plurality of laterally displaceable portions of magnetic circuits are provided, a cooperating magnetic circuit portion including a core disposed in said stationary structure, primary and secondary magneto windings on said core, a breaker mechanism connected in the circuit of said primary magneto windings and disposed in a second chamber, a distributor mechanism having a terminal connected in the circuit of said secondary magneto windings and disposed in said second chamber, elements of said breaker mechanism and said distributor mechanism being mounted to rotate with said shaft and secured in a desired phase relation thereto, an insulating disk stationarily mounted in said casing and serving as a gas-tight closure for said second chamber and as a wall for the third chamber, and a plurality of electrode supporting bushings having cable anchoring receptacles, said bushings being disposed on said disk in said second chamber and arranged to have said receptacles accessible from said third chamber.

3. In a magneto-electric machine, the combination comprising a casing formed with three chambers, a structure stationarily mounted in one of said chambers, a shaft journaled in said chamber, an inner structure mounted on said shaft and rotatively arranged with respect to said stationary structure, magnetizing means mounted on said inner structure together with magnetizable elements whereby a plurality of laterally displaceable portions of magnetic circuits are provided, a cooperating magnetic circuit portion including a core disposed in said stationary structure, primary and secondary magneto windings on said core, a breaker mechanism having a breaker arm connected in the circuit of said primary magneto winding and disposed in a second chamber, a distributor plate having a terminal connected in the circuit of said secondary magneto winding and disposed in said second chamber, a cam on said shaft arranged to drive positively said breaker arm in two opposite directions, said distributor plate being also secured to said shaft and in a desired phase relation, an insulating disk stationarily mounted in said casing and serving as a gas-tight closure for said second chamber and as a wall for the third chamber, and a plurality of electrode supporting bushings having cable anchoring receptacles, said bushings being disposed on said disk in said second chamber and arranged to have said receptacles accessible from said third chamber.

4. In a magneto-electric machine, the combination comprising a casing formed with three chambers, a structure stationarily mounted in one of said chambers, a shaft journaled in said chamber, an inner structure mounted on said shaft and rotatively arranged with respect to said stationary structure, magnetizing means mounted on said inner structure together with magnetizable elements whereby a plurality of laterally displaceable portions of magnetic circuits are provided, a cooperating magnetic circuit portion including a core disposed in said stationary structure, magneto windings on said core, a breaker mechanism for said magneto windings disposed in a second chamber having a breaker arm mounted on a dividing wall, a cam on said shaft for actuating said breaker arm in two opposite directions, a distributor plate on said shaft in said second chamber and provided with a terminal, an insulating disk stationarily mounted in said casing and serving as a gas-tight closure for said second chamber and as a wall for the third chamber, and a plurality of electrode supporting bushings having cable anchoring receptacles, said bushings being disposed on said disk in said second chamber and arranged to have said receptacles accessible from said third chamber.

5. In a magneto-electric machine, the combination comprising a casing formed with three chambers, a structure stationarily mounted in one of said chambers, a shaft journaled in said chamber, an inner structure mounted on said shaft and rotatively arranged with respect to said stationary structure, magnetizing means mounted on said inner structure together with magnetizable elements whereby a plurality of laterally displaceable substantially U-shaped portions of magnetic circuits are provided, a cooperating substantially U-shaped magnetic circuit portion including a core disposed in said stationary structure, magneto windings on said core, a breaker mechanism for said magneto windings disposed in a second chamber having a breaker arm mounted on a dividing wall, a cam on said shaft for actuating said breaker arm in two opposite directions, an insulating disk stationarily mounted in said casing and serving as a gas-tight closure for said second chamber and as a wall for the third chamber, and a plurality of electrode supporting bushings having cable anchoring receptacles, said bushings being disposed on said disk in said second chamber and arranged to have said receptacles accessible from said third chamber, said second chamber having an insulating lining disposed therein and spaced from said bushings.

6. In a magneto-electric machine, the combination comprising a casing formed with three chambers, a structure stationarily mounted in one of said chambers, a shaft journaled in said chamber, an inner structure mounted on said shaft and rotatively arranged with respect to said stationary structure, magnetizing means mounted on said inner structure together with magnetizable elements whereby a plurality of magnetic circuit portions are provided, a cooperating magnetic circuit portion including a core disposed in said stationary structure, magneto windings on said core in the first-named chamber, a breaker mechanism for said magneto

windings in a second chamber, a cam on said shaft in said second chamber for actuating said breaker mechanism, distributor mechanism in said second chamber on said shaft, a conducting needle-point associated with said distributor mechanism and rotating therewith and arranged to discharge to a wall of said second chamber, an insulating disk stationarily mounted in said casing and serving as a gas-tight closure for said second chamber and as a wall for the third chamber, and a plurality of electrode supporting bushings having cable anchoring receptacles, said bushings being disposed on said disk in said second chamber and arranged to have said receptacles accessible from said third chamber.

7. In a magneto-electric machine, the combination comprising a casing formed with three chambers, a structure stationarily mounted in one of said chambers, a shaft journaled in said chamber, an inner structure mounted on said shaft and rotatively arranged with respect to said stationary structure, magnetizing means mounted on said inner structure together with magnetizable elements whereby a plurality of substantially U-shaped portions of magnetic circuits are provided, a cooperating substantially U-shaped magnetic circuit portion including a core disposed in said stationary structure, magneto windings on said core in the first-named chamber, a breaker mechanism for said magneto windings on a wall dividing the first chamber from a second chamber, a cam on said shaft in said second chamber for actuating said breaker mechanism, distributor mechanism in said second chamber rigidly secured to said shaft, a conducting needle-point associated with said distributor mechanism and rotating therewith and arranged to discharge to a wall of said second chamber and provide a safety spark gap, an insulating disk stationarily mounted in said casing and serving as a gas-tight closure for said second chamber and as a wall for the third chamber, and a plurality of electrode supporting bushings having cable anchoring receptacles, said bushings being disposed on said disk in said second chamber and arranged to have said receptacles accessible from said third chamber, said second chamber having an insulating lining disposed therein in spaced relation from said bushings and said spark gap.

8. In a magneto-electric machine, the combination comprising a casing formed with segregated chambers, a structure stationarily mounted in a selected one of said chambers, a shaft journaled in said selected chamber, an inner structure mounted on said shaft and rotatively arranged with respect to said stationary structure, magnetizing means mounted on said inner structure together with magnetizable elements whereby a plurality of magnetic circuits are provided, a pair of cooperating magnetic circuit portions rigidly mounted in said stationary structure and disposed at relatively opposite points and each including a core, said casing being arranged to have said first-named chamber provided with a wall in common with a second chamber and having elongated housings extending in opposite directions and enclosing said cooperating magnetic circuit portions, magneto windings on each of said cores, a breaker mechanism for each of said magneto windings disposed in said second chamber and mounted on said common wall, a common cam on said shaft in said second chamber for actuating said breaker mechanisms, a distributor plate mounted on said shaft in said second chamber and provided with a pair of terminals each connected respectively to the windings on said cores, a vibrator disposed to be actuated by a selected one of said cooperating magnetic circuit portions, and means associated with said vibrator for making and breaking an electric circuit in parallel with said breaker mechanism.

9. In a magneto-electric machine, the combination comprising a casing formed with segregated chambers, a structure stationarily mounted in a selected one of said chambers, a shaft journaled in said selected chamber, an inner structure mounted on said shaft and rotatively arranged with respect to said stationary structure, magnetizing means mounted on said inner structure together with magnetizable elements whereby a plurality of magnetic circuits are provided, a pair of cooperating magnetic circuit portions rigidly mounted in said stationary structure and disposed at relatively opposite points and each including a core, said casing being arranged to have said first-named chamber provided with a wall in common with a second chamber and having elongated housings extending in opposite directions and enclosing said cooperating magnetic circuit portions, magneto windings on each of said cores, a breaker mechanism for each of said magneto windings disposed in said second chamber and mounted on said common wall, a common cam on said shaft in said second chamber for actuating said breaker mechanisms, a distributor plate mounted on said shaft in said second chamber and provided with a pair of terminals each connected respectively to the windings on said cores, a vibrator disposed to be actuated by a selected one of said cooperating magnetic circuit portions, means associated with said vibrator for making and breaking an electric circuit in parallel with said breaker mechanism, an insulating disk mounted in said chamber and serving as a wall providing a third chamber, and a plurality of electrode supporting bushings having cable anchoring receptacles, said bushings being disposed on said disk in said second chamber and accessible from said third chamber.

10. In a magneto-electric machine, the combination comprising a casing formed with segregated chambers, a structure stationarily mounted in a selected one of said chambers, a shaft journaled in said selected chamber, an inner structure mounted on said shaft and rotatively arranged with respect to said stationary structure, magnetizing means mounted on said inner structure together with magnetizable elements whereby a plurality of magnetic circuits are provided, a pair of cooperating magnetic circuit portions rigidly mounted in said stationary structure and disposed at relatively opposite points and each including a core, said casing being arranged to have said first-named chamber provided with a wall in common with a second chamber and having elongated housings extending in opposite directions and enclosing said cooperating magnetic circuit portions, magneto windings on each of said cores, a breaker mechanism for each of said magneto windings disposed in said second chamber and mounted on said common wall, a common cam on said shaft in said second chamber for actuating said breaker mechanisms, a distributor plate mounted on said shaft in said second chamber and provided with a pair of terminals each connected respectively to the windings on said cores, a vibrator disposed to be actuated by a

selected one of said cooperating magnetic circuit portions, means associated with said vibrator for making and breaking an electric circuit in parallel with said breaker mechanism, an insulating disk stationarily mounted in said casing and serving as a gas-tight closure for said second chamber and as a wall for the third chamber, and a plurality of electrode supporting bushings having cable anchoring receptacles, said bushings being disposed on said disk in said second chamber and arranged to have said receptacles accessible from said third chamber, said second chamber having an insulating lining disposed therein and spaced from said bushings.

11. In a magneto-electric machine, the combination with a casing having a shaft journaled therein, of inner and outer structures in said casing, the inner of which is mounted to rotate with said shaft, the outer being disposed stationarily in said casing, said outer structure being cooperatively arranged and having at least two complemental portions including a core for completing local magnetic circuits through said inner structure, magneto windings on said core, means for connecting at will said windings in an electric circuit having an external source of E. M. F., a vibratorily mounted magnetizable element arranged to complete an independent magnetic circuit through said core, and contact means associated with said element and arranged to complete an electric circuit including said windings and said source of E. M. F. when in one position and to interrupt said circuit in another position.

12. In a magneto-electric machine, the combination with a casing having a shaft journaled therein, of inner and outer structures in said casing, the inner of which is mounted to rotate with said shaft, the outer being disposed stationarily in said casing, said outer structure being cooperatively arranged and having at least two complemental portions including a core for completing local magnetic circuits through said inner structure, magneto windings on said core, an electric circuit including a switch and a ground connected to said magneto windings, other switch means for connecting a source of E. M. F. in said electric circuit in series with said ground, a vibratorily mounted magnetizable element arranged to complete an independent magnetic circuit through said core, and contact means associated with said element and arranged when in contact to complete a circuit including said windings and source of E. M. F. but when open to break said circuit whereby voltages may be induced in said windings.

13. In a magneto-electric machine, the combination with a casing having a shaft journaled therein, of inner and outer structures in said casing, the inner of which is mounted to rotate with said shaft, the outer being disposed stationarily in said casing, said outer structure being cooperatively arranged and having at least two complemental portions including a core for completing local magnetic circuits through said inner structure, magneto windings on said core, means for connecting at will said windings in an electric circuit having an external source of E. M. F., a resilient magnetizable element disposed parallel to said core and spanning the associated complemental portions of said outer structure, said magnetizable element being secured at one end to a complemental portion while the other is free to vibrate under the attraction of a local magnetic field through said core and said magnetizable element, a make-and-break device in series with said windings and said source of E. M. F. arranged to be operated by the free end of said magnetizable element, and main breaker mechanism for said magneto windings having contacts in parallel with said vibratorily actuated make-and-break device.

14. In a magneto-electric machine, the combination with a metal casing having gas-tight segregating chambers and a shaft journaled in a selected one of the same, of inner and outer structures in said selected chamber having serrated pole formations providing localized magnetic fields, said outer structure comprising a stator for said machine and having a core provided with magneto windings, magnetizing means for said rotor, mechanisms for collecting and distributing high tension current disposed in a second one of said chambers, and cables leading from said distributing mechanism in a third one of said chambers including cables adapted to lead to spark plugs of an internal combustion engine; the electrical system including collecting and distributing mechanisms and cables being housed in a continuous metallic structure whereby they are shielded against external electrical interference.

15. In a magneto-electric machine, the combination with a casing having a shaft journaled therein; of inner and outer structures in said casing; the inner of which is mounted to rotate with said shaft; the outer being disposed stationarily in said casing, said outer structure being cooperatively arranged and having at least two complemental portions including a core for completing local magnetic circuits through said inner structure; a magnetizable element vibratorily mounted and arranged to complete an independent magnetic circuit through said core and associated complemental portions of said stator; and an electrical system comprising grounded windings on said core having rotor actuated breaker mechanism including contacts connected thereto and completing the circuit through ground, a condenser connected in parallel to said contacts, a grounding switch connected to said windings in parallel with said breaker mechanism, a make-and-break device including contacts in series with said windings and arranged to be actuated by said magnetizable element, and a second grounding switch including an external source of E. M. F. and a current limiting resistance connected in series with said last-named contacts and ground.

16. In a magneto-electric machine, the combination comprising a magnetizing means, a rotor including poles forming a part of unidirectional magnetic circuits including said magnetizing means, a stator including a magneto winding and a core extending through said winding terminating in poles adapted for coincident cooperation with said rotor poles to form such magnetic circuit of low reluctance through said winding for maximum unidirectional flux linkage thereof, means for connecting at will said winding in an electric circuit having an external source of E. M. F., a vibratorily mounted magnetizable element arranged to complete an independent magnetic circuit through said core, and contact means associated with said element and arranged to complete an electric circuit including said winding and said source of E. M. F. when in one position and to interrupt said circuit in another position.

17. In a magneto-electric machine, the com-

bination comprising a rotor including a magnetizing means having poles forming a part of unidirectional magnetic circuits, a stator including a magneto winding and a core extending through said winding terminating in poles adapted for coincident cooperation with said rotor poles to form such magnetic circuit of low reluctance through said winding for maximum unidirectional flux linkage thereof, means for connecting at will said winding in an electric circuit having an external source of E. M. F., a resilient magnetizable element disposed parallel to said core and spanning complemental portions associated with said stator poles, said magnetizable element being mounted at one end adjacent to a complemental portion while the other is free to vibrate under the attraction of a local magnetic field through said core and said magnetizable element, a make-and-break device in series with said winding and said source of E. M. F. arranged to be actuated by the free end of said magnetizable element, and main breaker mechanism for said magneto winding having contacts in parallel with said circuit including said vibratorily actuated make-and-break device.

18. In a high tension magneto-electric machine, the combination comprising a casing member adapted to be divided into a chamber for housing supply and distributing cables and a second chamber for housing a rotary distributing member, and a partition in said casing member adapted to prevent access of gases from the second chamber to the first, said partition including terminal mountings whereby the ends of cables housed in the first chamber may be brought into conducting relation with said rotary distributing member in the second chamber.

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