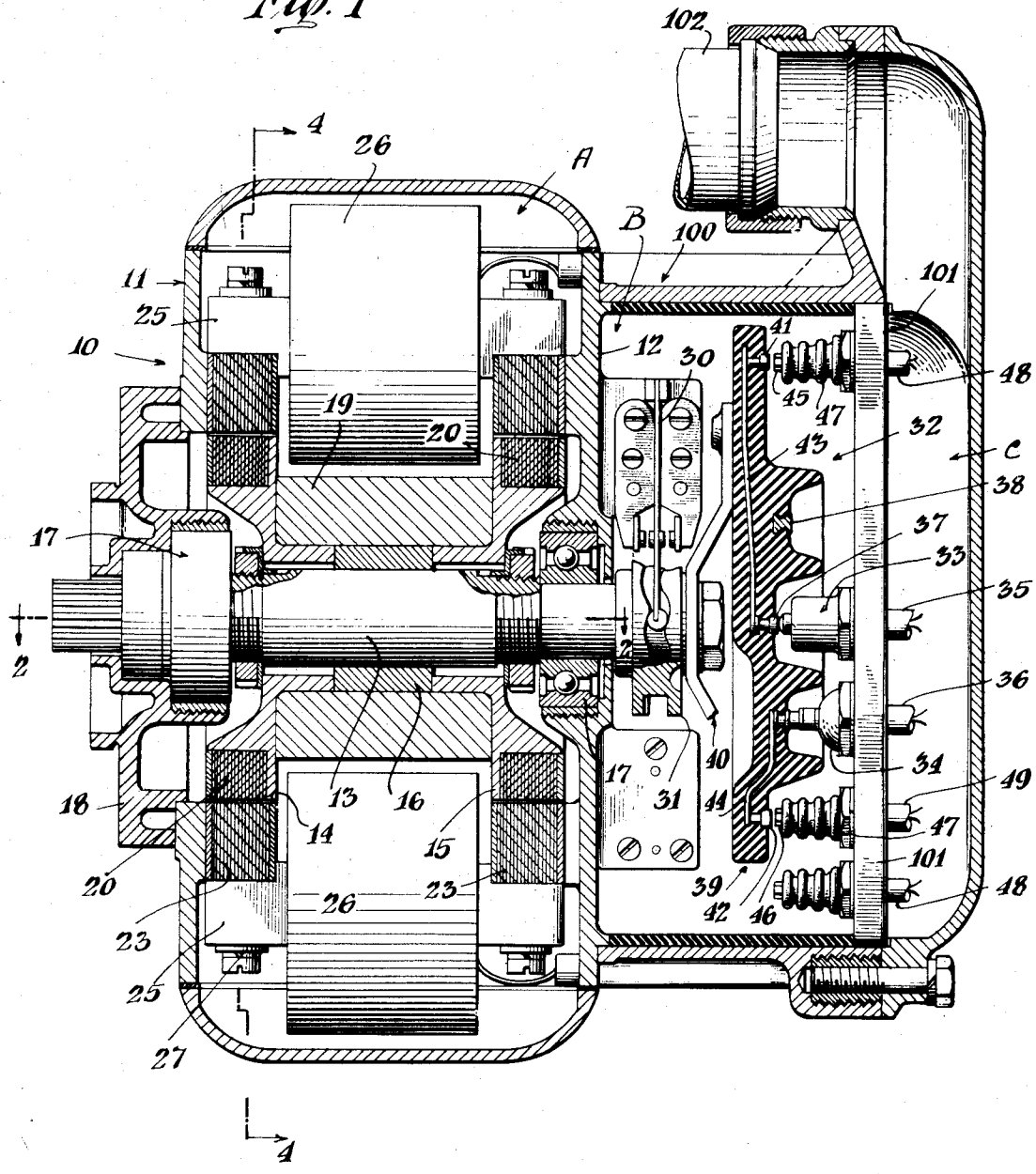
June 16, 1942. L. H. SCOTT 2,286,234

MAGNETO-ELECTRIC MACHINE

Filed June 21, 1941 3 Sheets-Sheet 1

Fig. 1



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MAGNETO-ELECTRIC MACHINE

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Fig. 2

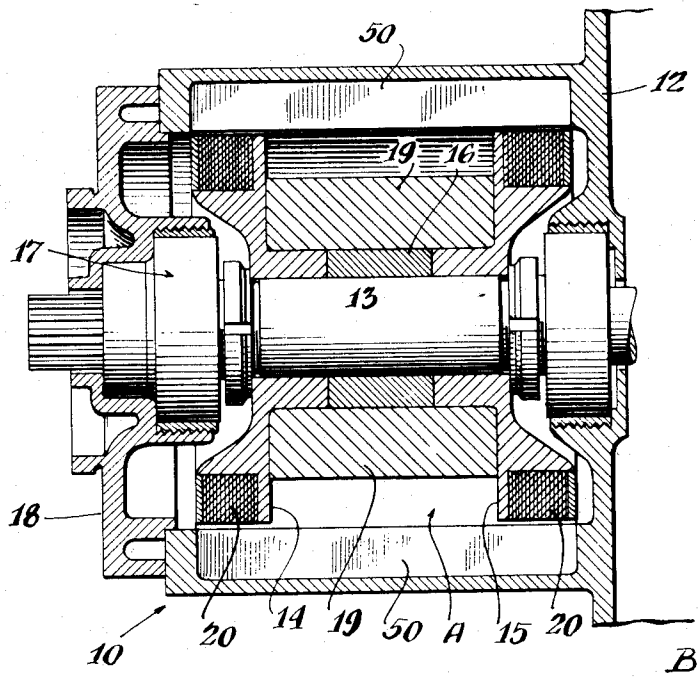
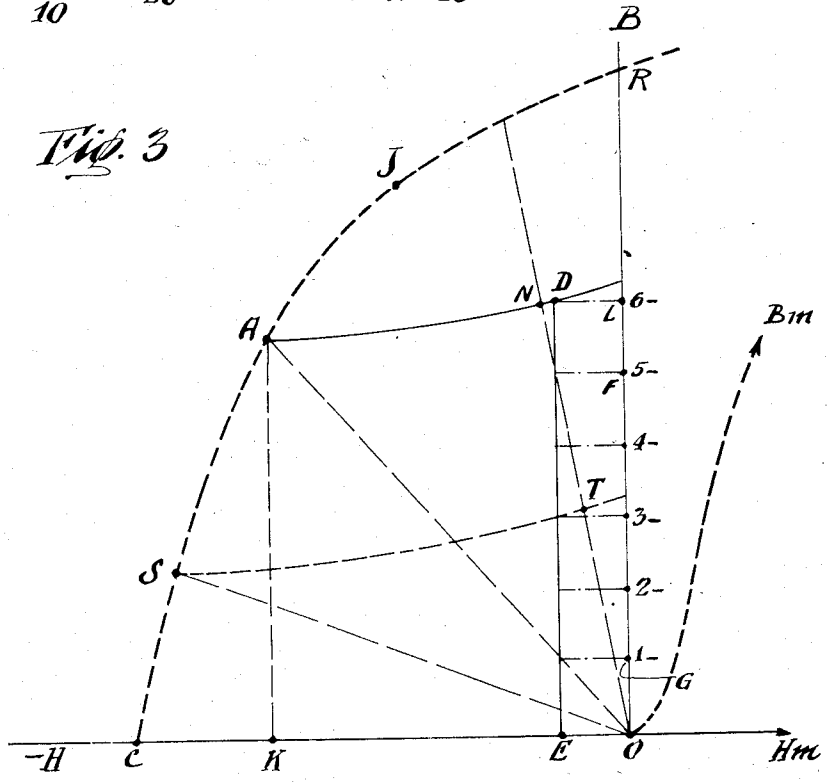


Fig. 3



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MAGNETO-ELECTRIC MACHINE

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Fig. 4

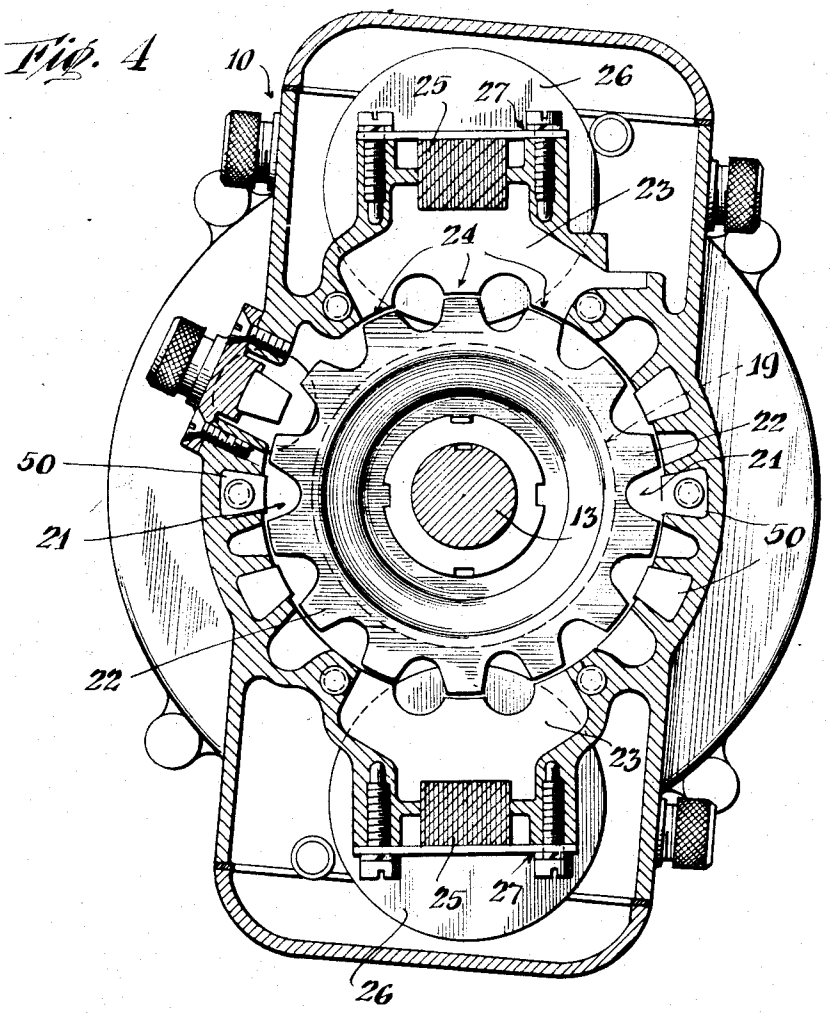
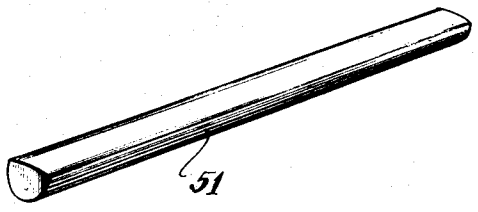


Fig. 5



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2,286,234

MAGNETOELECTRIC MACHINE

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Application June 21, 1941, Serial No. 399,078

6 Claims. (Cl. 171—209)

This invention relates to magneto-electric machines and method of making same, and more particularly to inductor types of magneto-electric machines in which the intensity but not the direction of the magnetic flux changes.

The invention has for its object generally the provision of an improved construction and arrangement of parts for magneto-electric machines of the character indicated, whereby a greater efficiency is had and the mass of the parts may be reduced; and an efficient method of making the same.

More specifically, an object of the invention is to provide means for increasing the magnetic flux differential, or value between maxima and minima, in the unidirectional flux which links with the magneto windings in machines of the character indicated; and means for practical use in attaining higher percentage of retentivity of magnetizing force by the magnetizing means making possible a reduction in the mass of parts in addition to that made possible by increase of the magnetic flux differential.

Another object is to provide a shunt path for a portion of the magnetic flux which otherwise links with the windings at the instant of a flux minimum in machines of the character indicated whereby the minimum is materially decreased in value.

Another object is to introduce into the construction of an inductor type of magneto-electric machines magnetic flux conducting means at convenient points for reducing cyclic irregularities in the rotor torque, thereby minimizing strain on driving mechanism.

Still another object is to provide magneto-electric machines of the character indicated with means for reducing tendency of demagnetization of the magnetizing means for such machines, such as that due to counter M. M. F. produced by primary current.

A further object of the invention is the provision of an efficient method of assembling the rotor structure of the device of the present invention with the stator structure thereof so that the rotor magnet is at no time, either during transfer from the magnetizing machine to the stator structure or in the field during substitution of coils and associated cores, open-circuited; thereby making possible efficient operation on a high recovery curve making for desired reduction in weight of parts.

A more specific object is the provision of such method characterized by the use of temporary keeper members of paramagnetic material bridged across the rotor magnet poles to keep the iron circuit thereof closed during transfer of the rotor magnet from the magnetizing field to the stator structure.

A still further object of the invention is the provision of such a construction characterized by substantially stable magnetic circuits in substantially all space locations, and magnetic circuits having substantially constant characteristics making possible as a practical matter accuracy of prediction of magneto performance heretofore uniformly unattainable.

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

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combinations of elements and arrangement of parts, all as exemplified in the following detailed disclosure, 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 of the inductor type constructed in accordance with the invention.

Fig. 2 is a sectional view taken on line 2—2 in Fig. 1;

Fig. 3 is an explanatory diagram;

Fig. 4 is a transverse sectional view taken on broken line 4—4 in Fig. 1; and

Fig. 5 is a perspective view of a keeper member designed for use in the practice of the present invention.

A construction for an inductor type of magneto-eelctric machine adapted to furnish electrical energy for a dual ignition system of an internal combustion engine of the multi-cylinder type is disclosed in U. S. patent to Spohn, No. 2,015,091, issued September 24, 1935, in which a plurality of unidirectional localized fields are provided, the magnetic circuits of which correspond in number to the number of cylinders in the engine to be fired. In the Spohn magneto, the rotor carries the magnetizing means for the several magnetic circuits, such magnetizing means comprising a plurality of bar magnets. The windings in which current is induced are stationary, an independent set of windings being provided for each set of sparks for the dual ignition system. The effective flux change

which induces the current in the magneto windings is the flux differential between the values of the flux at maxima and minima, respectively, provided by the localized fields of induction.

By the present invention suitable magnetic flux conducting members are incorporated in the construction of inductor type magneto-electric machines in which the magnetic flux through the rotor carrying the magnetizing means and other associated parts constituting the paths for magnetic flux is unidirectional, such magnetic flux conductors comprising a plurality of magnetic shunts incorporated in the frame and arranged to be substantially coincident with rotor poles when the latter are substantially midway between poles of stationary windings, i. e. spaced about 180 electrical degrees from the instant of flux maxima linking through the windings, whereby the value of the flux obtaining at the flux minima linking through the set of windings is materially reduced and the resulting flux differential which induces voltage in the spark plug circuits is materially increased.

While the invention is applicable generally to magneto-electric machines of the inductor type, such as illustrated in the Spohn patent above referred to, the machine illustrated in the drawings is one form of that disclosed in my copending application Serial No. 374,324, filed January 14, 1941, the arrangement illustrated employing but one magnetizing means in the form of a cylindrical magnet which is common to all the localized fields of induction.

Referring now to the drawings, and particularly to Figs. 1, 2 and 4, 10 denotes generally a main casing which is arranged to house the magneto structure, the casing having an auxiliary portion 100 mounted thereon. Walls at 11 and 12 respectively, together with an insulating partition or disk 101 (disposed in portion 100), divide the casing into three chambers, namely, those denoted at A, B and C. Chamber A is between walls 11 and 12 and serves to house the rotor and windings of the magneto; chamber B between wall 12 and partition 101 serving to house the breaker and distributor mechanisms, while chamber C, which is beyond chamber B, houses the distributing cables leading to the spark plugs, preferably through tubular conduit 102.

Rotatably mounted in the walls of chamber A is a shaft 13 of non-magnetic material which supports the rotor structure of the present machine together with other moving parts. The rotor comprises a pair of oppositely disposed spaced apart pole pieces 14 and 15 which are keyed or otherwise secured on the shaft 13, the proper spacing of the pole pieces being obtained by means of the interposed collar 16 of non-magnetic material. The shaft 13 is supported at its ends by suitable bearing means which are preferably of the anti-friction variety, such as ball bearing units 17 disposed in the casing walls 11 and 12; the casing preferably having a removable closure portion 18.

Between pole pieces 14 and 15 is located a cylindrical magnet 19 of annular cross-section, the ends of which abut against the pole pieces supporting magnetic flux directing means, such as laminated magnetic shoes 20, 20 that are disposed peripherally about the pole pieces on each end of the rotor. While a laminated structure is shown, a solid flux directing means may be employed. The outer circumference of each magnetic pole piece and associated magnetic flux directing means or shoe is cut back or notched, as shown at 21—21 (see Fig. 4), whereby a series of pole formations 22—22 are provided about each end of the rotor structure, whereby a series of U-shaped portions of magnetic circuits are formed in the rotor which have the permanent magnet 19 as the common magnetizing means.

The stator structure is rigidly mounted in the casing 10 and comprises one or more complementary U-shaped magnetic circuit portions, such portions here consisting of stator pole pieces 23—23 that have serrations or pole formations 24—24 preferably though not necessarily laminated as shown, spanning a desired number of pole formations 22—22 on the rotor. These stator pole pieces 23—23 are advantageously secured in the casting 10 when it is cast, the pole pieces on the two sides of the casing being bridged by a core member 25 that may also be laminated and arranged to support a set of magneto windings, as indicated at 26. Two such sets of magneto windings which may be diametrically arranged on opposite sides of the rotor as shown, may be utilized to provide sparks for a dual ignition system. The cores 25, 25 are advantageously made removable together with their windings. To this end, each core 25 is indicated as held in place at its ends by removable clamping means 27, 27.

In order that desired voltages in proper phases may be induced in the respective sets of windings 26, a breaker mechanism, shown at 30 in chamber B, is provided and positively driven in both directions by a cam 31 on the end of shaft 13 which protrudes into chamber B. While, of course, any suitable breaker mechanism may be employed, that preferred and shown is the one disclosed in my copending application, Serial No. 350,533, filed August 3, 1940.

The high tension currents thus generated in sets of windings 26, 26 are conducted to a distributor mechanism 32, also in chamber B, from terminals or electrodes in bushings 33 and 34 on the partition or disk 101, which are respectively charged electrically by cables 35 and 36 each leading from one of the sets of windings 26, 26. This conduction is accomplished by exposed conductors, such as a button shown at 37 and a ring at 38, on one face of an insulating plate 39 that is rotatively carried by means of a spider 40 which is fixed on the end of the shaft 13 extending into chamber B.

To distribute the high tension current thus conducted electrodes 41 and 42, that are conductively connected respectively to conductors 37 and 38, such as by strap members 43 and 44 preferably embedded in plate 39, are disposed at suitable points in the face of plate 39 which carries conductors 37 and 38 but preferably at greater radial distances from the center than the latter; the electrodes 41 and 42 which rotate with plate 39 being arranged to cooperate with sets of stationary electrodes 45 and 46 respectively, mounted in bushings 47—47 which are disposed in concentric circles about the periphery of disk 101. From the rear of the latter lead the distributing cables 48 and 49, which are anchored in the bushings 47—47, by way of conduit 102, to the two sets of spark plugs in the cylinders of the engine for which the machine is to provide ignition.

To provide the magneto-electric machine above described with means for increasing the magnetic flux differential, i. e., to provide means for dropping the value of the flux minima link-

ing sets of windings, and for incorporating the other desired features of the present invention, a plurality of magnetic flux conductors or shunt bars 50—50 (see Figs. 2 and 4) are secured, preferably on the interior of casing 10, at points which are directly over the centers of cut-away portions or notches 21—21 of the rotor when the latter has its pole formations 22—22 in coincidence with pole formations 24—24 of the stator pole pieces 23—23. In such positions each of the bars 50—50 is seen to be 180° electrically displaced from coincidence with pole formations 22—22 of the rotor.

Bars 50—50 may be of solid or laminated construction and preferably have relatively high magnetic characteristics; the casing 10 which supports them being preferably of nonmagnetic material and made by casting of a light metal, such as aluminum or an aluminum alloy. Bars 50—50 are preferably of a length such as axially to span completely the rotor structure, bridging across magnetic shoes 20—20 of the spaced apart rotor pole pieces 14 and 15, and have cross-sectional areas such as to accommodate readily a relatively large portion of the flux emanating from the rotor pole formations 22—22. The cross-sectional area of the flux path for flux drawn from the pole formations 22—22 when coincident with the bars 50—50 may be provided by the use of one bar, or by a plurality of bars, a plurality of symmetrically placed bars being preferred.

The shunt path for the magnetic flux provided by the bars 50—50 is seen to operate to reduce the flux traversing the cores 25, 25, when the rotor has its pole formations 22—22 coincident with the bars (i. e., when 180° electrically out of phase with maximum flux through the cores 25, 25), since each bar 50 is then directly aligned with a pair of axially spaced rotor pole formations 22, 22 for coincident cooperation, this providing paths of low reluctance in parallel with the paths through cores 25, 25, which at that instant have relatively high reluctance. Hence the flux is largely drawn from these latter paths of high reluctance. For example, if it be assumed that in a machine without the shunt bars the flux normally traversing a core 25, when pairs of axially spaced rotor and stator pole formations 22—22 and 24—24 are in coincidence (i. e., in a position for coincident cooperation to form a magnetic circuit of low reluctance), has a maximum value of 50,000 lines and that such flux is normally decreased to a minimum value of 40,000 lines when the rotor pole formations 22—22 are in mid-positions between the pole formations 24—24 on stator pole pieces 23, 23 (i. e., when 180 degrees electrically out of phase from the position of maximum flux linkage of the set of windings), then the flux differential operative to generate voltage is 10,000 lines. When shun bars 50—50 are provided these operate when in coincidence with rotor pole formations 22—22 to shunt flux from the rotor magnet 19 away from the core 25 constituting the path for flux linking with the set of windings 26, so that the minimum of lines linking with the set of windings is decreased to say 10,000 lines. Hence the differential of flux through core 25 operative to induce voltage has been increased to say 40,000 lines.

The capacity of the magneto-electric machine for delivering high tension current, when equipped with magnetic shunts as here disclosed, is seen to be substantially increased. For a given service, it is then seen that the mass of the several parts of a magneto necessary to produce a given electrical effect at the spark plugs may be reduced by the present invention. This becomes of importance in fields where reduction in weight is desirable, for example, in the field of aviation.

The change of the flux path through the cores 25, 25 to those through shunt bars 50—50 at instants of flux minima in the cores 25, 25 also has the effect of accelerating the rate at which flux collapses in the cores 25, 25 whereby the magnitude of the voltage induced is further increased. This characteristic makes possible further decrease in mass of parts for a given service.

Also it will be seen that with the shunt bars 50—50 provided, the paths for the flux set up by the magnet 19 are at all times of comparatively low reluctance and vary only slightly in their total reluctance as contrasted with the alternately low and high reluctance paths when no shunt bars are provided. With large variation of reluctance of flux path from a minimum value when rotor poles are coincident with stator poles to a maximum value when those poles are 180° electrically displaced from coincidence, as would be the case with the omission of the shunt bars, large value of cyclic irregularities in required rotor torque with consequent high stresses in driving mechanism would be characteristic. This is true since increasing the reluctance of a magnetic circuit requires considerable energy to be supplied, i. e., the rotor requires a large driving torque; and decreasing the reluctance generates energy with consequent tendency to rotate the rotor. The shunt bars of the present invention avoid such difficulties. Obviously when the rotor is rotated, as the reluctance of one set of flux paths (either through the coil cores or the shunt bars) is increasing the reluctance of the other set of paths is decreasing, so that the total reluctance across the rotor is practically constant in all rotor positions and cyclic irregularities in the rotor torque substantially minimized.

It will be understood from the present disclosure that this condition is attained when the total magnetic cross-section of all of the shunts bars which together form a shunt magnetic circuit for a certain coil core, or that is their cooperative flux carrying ability, is substantially at least equal to the magnetic cross-section or flux carrying ability of that coil core with reluctance of that magnetic circuit inclusive of air gaps therein at least substantially no greater than the reluctance of the magnetic circuit through that coil core inclusive of air gaps therein. This is shown by way of example in the drawings wherein the air gaps at opposite ends of the rotor are substantially equal for both magnetic circuits and the total cross-sectional area of the three shunt bars 50—50 for cooperative operation with one coil core 25 is a little larger than the cross-sectional area of the latter. This feature is further explained hereinafter in connection with Fig. 3, more particularly with reference to line N—O shown therein.

Referring to Fig. 3 there is therein shown a curve R—J—A—S—C which will be readily recognized as the demagnetization portion of the hysteresis loop with R—O representing the residual magnetism of the magnetic substance after the magnetizing field has been removed. This will represent the demagnetization curve of the rotor magnet. If now the rotor assembly be re-

moved from the iron circuit of the magnetizing machine the rotor magnet is open-circuited so that the reluctance of the flux path is high which demands a large value of magneto-motive force for a small value of flux density. As a result the point of operation of the magnet will drop along the demagnetization curve from R to some point such as S. When the rotor is assembled in the stator with the coil cores in place and the rotor and stator poles in coincidence the reluctance of the flux path is again comparatively low so the point of operation of the magnet travels along the recovery curve such as S—T to some equilibrium point T where the M. M. F. is of a value sufficient to drive the flux through the coil core at the highest possible value for this set of conditions.

It is obvious that this maximum value of the flux is only a small portion of the residual magnetism R—O due to the demagnetization which occurs when the rotor magnet is open-circuited to be transferred from the magnetizing machine to the stator. Magnetic keepers to maintain the rotor magnet in closed circuit for this transfer do not alone solve the problem since service demands that the coils be replaceable in the field. If the coils are removed with their cores when the rotor is assembled in the stator the iron circuit of the rotor magnet is opened and demagnetization as above will occur.

However in accordance with the present invention wherein shunt bars are provided in the stator, 180° electrically out of phase with the position of maximum flux linkage with stator poles and wherein the total cross-sectional area thereof is at least substantially equal to that of the coil cores such demagnetization is avoided. Keeper members of paramagnetic material, such as shown at 51 in Fig. 5, shaped to be received in notches 21—21 between pole formations 22—22 will avoid open-circuiting the rotor magnet during this transfer from the magnetizing machine to the stator structure. After the rotor structure has been assembled in operative relation to the stator structure the keepers are then removed and in service if it is necessary to replace the coils their removal with their cores does not result in open-circuiting of the rotor magnet by virtue of the presence of the shunt bars which maintain the desired closed magnetic circuit condition. Obviously it is desirable that the total of the cross-sectional areas of the keeper bars used should be at least as great as that of the coil cores or the shunt bars.

As a result the operating point of the magnet falls along the curve R—J—A—S—C to some point such as J. Assuming that the magnetization curve for the iron circuit is linear, line N—O represents the reluctance of the set of flux paths through the coil cores when the rotor and stator poles are in coincidence. This line also represents the reluctance of the set of flux paths through the shunt bars when the rotor poles are in coincidence therewith. Line A—O represents the reluctance of either of the sets of flux paths through the coil cores and the shunt bars when the rotor poles are out of coincidence therewith. Thus when the rotor is assembled in the stator structure and the keepers are removed the reluctance of the flux path cannot be greater than line A—O even if the coil cores are removed and the rotor poles are not in coincidence with the shunt bars resulting in the operating point falling from J to A.

When the coil cores are mounted in place and the rotor poles brought into coincidence with the stator poles the operating point of the rotor magnet will move along the recovery A—N—D to some equilibrium point D. In this position there are two sets of flux paths in parallel across the rotor magnet, one provided by the coil cores and the associated stator poles in coincidence with the rotor poles thus having a reluctance represented by line N—O and a flux value of F, the other being provided by the set of shunt bars which are not in coincidence with the rotor poles and thus have a reluctance represented by the line A—O and a flux value of G. The sum of these flux values F and G will be equal to the total flux delivered by the magnet as represented by the value L. When the rotor is turned 180 electrical degrees so that the shunt bars are brought into coincidence with the rotor poles flux of a value F will flow through the shunt bars and flux of a value G will flow through the coil cores. Accordingly the flux value F—G is the flux change available for generation of voltage. It will be noted that this characteristic of the operation of the device of the present invention is a large portion of the maximum core flux value F which in turn is a large portion of the residual magnetism represented by the value R—O. The keepers operate to keep the recovery curve A—N—D high by preventing such initial demagnetization in assembly of the rotor in the stator structure.

The breaker of the magneto-electric machine closes at some point near the flux maximum through the coil cores as the rotor is rotated and the flux attempts to decrease thus generating primary current. This generated current opposes this change of flux holding it relatively high until the breaker opens which occurs when the rotor poles are in coincidence with the shunt bars. Since the flux through the coil cores is always in the same direction as that through the rotor magnet there is no tendency to demagnetize the magnet. In fact it is found that due to the shunt bars being in coincidence at the time the breaker opens the primary current actually has a tendency to magnetize the rotor magnet.

It will accordingly be seen that the objects set forth above are efficiently attained, the structure providing for effective use of magnetic keepers during assembly operations so that a high recovery curve can be used which makes possible the use of a rotor magnet of relatively small size. A large portion of the maximum core flux is available for use in the generation of voltage making possible the employment of an iron circuit of relatively small cross-section and thus low weight and small size. The rotor magnet does not demagnetize in operation and may even increase in strength. Cyclic irregularities in rotor torque are substantially eliminated thereby reducing the strain on driving mechanism. A further result is the provision of substantially stable magnetic circuits in relatively all space locations which are of sufficiently constant characteristics as to make possible unusually accurate predictions of performance prior to construction of a device of the invention.

Since certain changes in carrying out the above method and certain modifications may be made in the above constructions and different embodiments of the invention may be made without departing from the scope thereof, it is intended that all matter contained in the description or shown in the accompanying drawings

shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

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 with a casing, of a cylindrical structure rotatably mounted therein provided with magnetizing means and a pair of axially spaced peripherally disposed flux directing pole pieces one at each end of said structure with each notched at a plurality of points about its outer circumference to provide a plurality of spaced apart local magnetic pole formations each having a flux directing face, a pair of axially spaced flux directing pole pieces having similar spaced apart pole formations stationarily disposed in said casing in radial spaced relation to said rotatably mounted pole formations and extending predetermined arcuate distances about said cylindrical structure for coincident cooperation with said rotatably mounted pole pieces, magnetic core connecting said stationary flux directing pole pieces, magneto windings carried by said core and arranged to be linked by magnetic flux emanating from said magnetizing means whereby voltage is induced therein by the cyclic recurrence of flux maxima and minima, the total area of the flux directing faces of rotatable pole formations which simultaneously are in coincidence with said stationary pole formations being sufficiently large as conveniently to accommodate maximum flux emanating from said magnetizing means for linkage of said windings, and a plurality of similarly spaced apart magnetic shunt bars axially disposed in said casing, each having a length such as to span said rotatable pole pieces in similar radial spaced relation thereto whereby flux is drawn from linkage with said magneto windings when said rotatable pole formations are 180 degrees electrically out of phase with the position of maximum flux linkage of said magneto windings, said magnetic shunt bars having a total magnetic cross-section at least about equal to that of said core.

2. In a magneto-electric machine, the combination with a casing, of a cylindrical structure rotatably mounted therein provided with magnetizing means and a pair of axially spaced peripherally disposed flux directing pole pieces one at each end of said structure with each notched at a plurality of points about its outer circumference to provide a plurality of spaced apart local magnetic pole formations each having a flux directing face, a pair of axially spaced flux directing pole pieces having similar spaced apart pole formations stationarily disposed in said casing in radial spaced relation to said rotatably mounted pole formations and extending predetermined arcuate distances about said cylindrical structure for coincident cooperation with said rotatably mounted pole pieces, an axially extending magnetic core connecting said stationary flux directing pole pieces, magneto windings carried by said core and arranged to be linked by magnetic flux emanating from said magnetizing means whereby voltage is induced therein by the cyclic recurrence of flux maxima and minima, the total area of the flux directing faces of rotatable pole formations which simultaneously are in coincidence with said stationary pole formations being sufficiently large as conveniently to accommodate maximum flux emanating from said magnetizing means for linkage of said windings, and a plurality of similarly spaced apart magnetic shunt bars disposed in said casing parallel to said core each having a length such as to span said rotatable pole pieces in similar radial spaced relation thereto whereby flux is drawn from linkage with said magneto windings when said rotatable pole formations are 180 degrees electrically out of phase with the position of maximum flux linkage of said magneto windings, said magnetic shunt bars having a total cross-sectional area at least about equal to that of said core.

3. In a magneto-electric machine, the combination comprising a rotor including a magnetizing means having axially spaced radially outwardly extending serrated pole pieces providing a plurality of spaced apart pole formations each having a flux directing face, said magnetizing means and associated pole pieces forming a part of unidirectional magnetic circuits, a stator including a magneto winding and a core extending through said winding terminating in serrated pole pieces providing a plurality of spaced apart pole formations in radial spaced relation to said rotor pole formations and adapted for coincident cooperation with said rotor pole formations to form a magnetic circuit of low reluctance through said winding for maximum flux linkage thereof, the total area of the flux directing faces of rotor pole formations which simultaneously are in coincidence with said stator pole formations being sufficiently large as conveniently to accommodate maximum flux emanating from said magnetizing means for linkage of said winding, and a plurality of similarly spaced apart magnetic shunt bars associated with said stator free from flux conducting contact with said core in similar radial spaced relation to said rotor pole formations for coincident cooperation with said rotor pole formations when said rotor pole formations are 180 degrees electrically displaced from coincidence with said stator pole formations, said magnetic shunt bars having a total magnetic cross-section at least about equal to that of said core.

4. In a magneto-electric machine, the combination with a casing, of a rotor including a magnetizing means having axially spaced circular serrated pole pieces providing a plurality of equally spaced rotatable pole formations about the peripheries thereof each having a flux directing face, said magnetizing means and associated pole pieces forming a part of unidirectional magnetic circuits; a stator including a magneto winding, a core extending through said winding substantially parallel to the axis of said rotor and serrated pole pieces in flux conducting contact with the ends of said core extending predetermined arcuate distances about said circular pole pieces providing a plurality of equally spaced stationary pole formations in radial spaced relation to said rotor pole formations and adapted for coincident cooperation with said rotatable pole formations to form a magnetic circuit of low reluctance through said winding for maximum flux linkage thereof, the total area of the flux directing faces of rotor pole formations which simultaneously are in coincidence with said stator pole formations being sufficiently large as conveniently to accommodate maximum flux

emanating from said magnetizing means for linkage of said winding; and a plurality of magnetic shunt bars mounted in said casing substantially parallel to the axis of said rotor to span said rotor pole pieces, and in similar radial spaced relation to said rotor pole formations, said shunt bars being arranged arcurately about said rotor at points circumferentially spaced apart substantially equal to the circumferential spacing of said rotatable pole formations in coincident positions with respect to said rotatable pole formations when the latter are positioned out of coincidence with said stationary pole formations substantially at mid-points therebetween, said magnetic shunt bars having a total magnetic cross-section at least about equal to that of said core.

5. In a magneto-electric machine, the combination with a casing of non-magnetic material, of a rotor including a magnetizing means having axially spaced circular serrated pole pieces providing a plurality of equally spaced rotatable pole formations about the peripheries thereof each having a flux directing face, said magnetizing means and associated pole pieces forming a part of unidirectional magnetic circuits; a stator including a magneto winding, a core extending through said winding substantially parallel to the axis of said rotor and serrated pole pieces in flux conducting contact with the ends of said core extending predetermined arcuate distances about said circular pole pieces providing a plurality of equally spaced stationary pole formations in radial spaced relation to said rotor pole formations and adapted for coincident cooperation with said rotatable pole formations to form a magnetic circuit of low reluctance through said winding for maximum flux linkage thereof, the total area of the flux directing faces of rotor pole formations which simultaneously are in coincidence with said stator pole formations being sufficiently large as conveniently to accommodate maximum flux emanating from said magnetizing means for linkage of said winding; and a plurality of magnetic shunt bars carried by said casing out of contact with all parts of paramagnetic material substantially parallel to the axis of said rotor to span said rotor pole pieces and in similar radial spaced relation to said rotor pole formations, said shunt bars being arranged arcuately about said rotor at points circumferentially spaced apart substantially equal to the circumferential spacing of said rotatable pole formations in coincident positions with respect to said rotatable pole formations when the latter are positioned out of coincidence with said stationary pole formations substantially at mid-points therebetween, said magnetic shunt bars having a total magnetic cross-section at least about equal to that of said core.

6. In a magneto-electric machine, the combination comprising a rotor including a magnetizing means having axially spaced radially outwardly extending serrated pole pieces providing a plurality of spaced apart pole formations each having a flux directing face, said magnetizing means and associated pole pieces forming a part of unidirectional magnetic circuits, a stator including a magneto winding and a core extending through said winding terminating in serrated pole pieces providing a plurality of spaced apart pole formations in radial spaced relation to said rotor pole formations and adapted for coincident cooperation with said rotor pole formations to form a magnetic circuit of low reluctance through said winding for maximum flux linkage thereof, the total area of the flux directing faces of rotor pole formations which simultaneously are in coincidence with said stator pole formations being sufficiently large as to accommodate without saturation maximum flux emanating from said magnetizing means for linkage of said winding, and a plurality of similarly spaced apart magnetic shunt bars associated with said stator free from flux conducting contact with said core in similar radial spaced relation to said rotor pole formations for coincident cooperation with said rotor pole formations when said rotor pole formations are 180 degrees electrically displaced from coincidence with said stator pole formations, said magnetic shunt bars having a total magnetic cross-section sufficiently large as to accommodate without saturation maximum flux emanating from said magnetizing means when said rotor pole formations are in coincidence therewith.

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