May 11, 1937. L. HAMMOND 2,080,371

MOTOR

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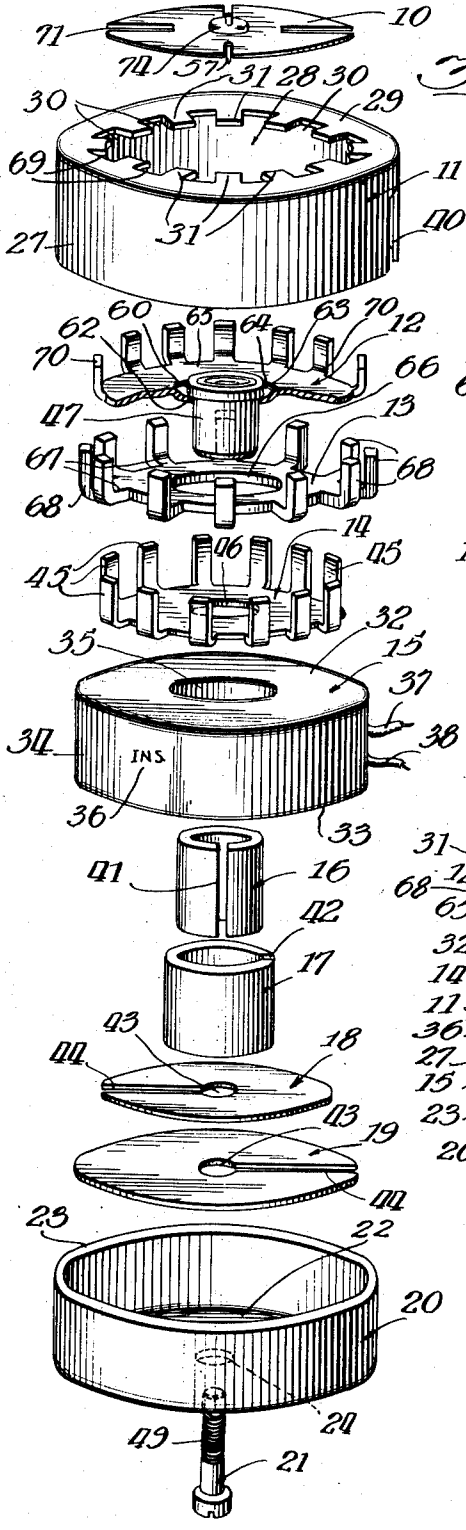


Fig. 3.

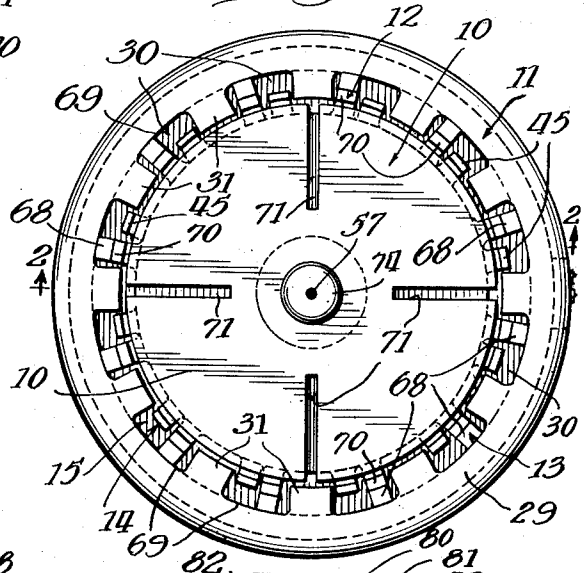


Fig. 1.

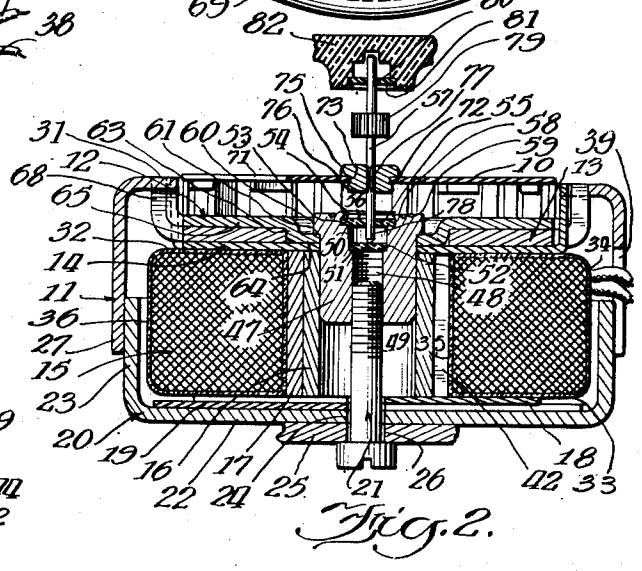


Fig. 2.

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MOTOR

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9 Claims. (Cl. 172—278)

The present invention relates to alternating current electric motors, and is particularly concerned with small electric motor units adapted to be used for driving the mechanism of clocks, timing devices, or similar apparatus which does not require a very high torque.

One of the objects of the invention is the provision of an improved electric motor unit of the class described which is adapted to be manufactured very economically so that the device may be placed within the means of a vast number of purchasers and employed for numerous purposes in cases where the cost of the more expensive devices of the prior art would be prohibitive.

Another object of the invention is the provision of an improved motor of the class described which is more quiet than the devices of the prior art, which is more efficient than the devices of the prior art by virtue of the arrangement and construction of its parts, and which is adapted to give service for long periods of time without developing noisy defects due to use or wear.

Another object is the provision of a device of the class described having a minimum number of parts, and the parts of which lend themselves readily to manufacture by stamping operations so that expensive machining operations may be eliminated in so far as possible.

Another object of the invention is the provision of a motor of the class described which is self-starting and which has a greater torque than devices of the same size of the prior art at synchronous speed.

Other objects and advantages of the invention will be apparent from the following description and from the drawing, in which similar characters of reference indicate similar parts throughout the several views.

Referring to the single sheet of drawing:

Fig. 1 is a top plan view of the motor, with the pinion removed;

Fig. 2 is a transverse sectional view taken on the plane of the line 2—2 of Fig. 1; and

Fig. 3 is an exploded view in perspective, showing the parts one above the other in position to be assembled, with certain of the parts in section to show the details of construction.

The present illustration of the invention is made with the spindle in vertical position and the rotor on top, but it should be understood that the motor may be mounted in any position, and in fact is most frequently mounted with the spindle in a horizontal position. The magnetic thrust on the rotor is preferably sufficient to support the rotor in proper position, even when the rotor is inverted.

For convenience in explanation of the invention, the terms "upper" and "lower" have been used in connection with the drawing, but it should be understood that these terms are merely used in their relative sense, referring to one part relative to the location of another, and the terms are not intended to be applied in any limiting sense.

Referring to Fig. 3, the complete motor preferably includes the parts which are indicated as follows, rotor disc 10, upper shell 11, upper pole piece disc 12, shading disc 13, lower pole piece disc 14, coil 15, core sleeve 16, core sleeve 17, core washer 18, core washer 19, lower shell 20, securing screw bolt 21.

It should be understood that all of the details and specific features of these elements are not necessarily required in every embodiment of the invention, and simpler embodiments of the invention, not having all of the advantages of the preferred construction, need not include all of the foregoing elements.

The present invention includes not only the preferred construction, but all of the simpler embodiments of the invention which may be constructed to utilize any of the advantages of the present construction without embodying all of the features described herein.

The motor preferably comprises a casing which is formed of the upper shell 11 and lower shell 20, and which is also adapted to form a part of the magnetic circuit of the motor when assembled as shown in Fig. 2. Both of these members may be stamped or drawn out of sheet metal, such as sheet steel, having special magnetic qualities, and preferably including a predetermined percentage of silicon.

The lower shell 20 preferably comprises a substantially cylindrical sheet metal member having a flat bottom 22 and a substantially cylindrical pheripheral wall 23. The bottom 22 is provided with an aperture 24 for receiving the screw bolt 21 which is adapted to secure the parts of the motor together and also to secure the motor to a supporting frame member 25 having an aperture 26.

The upper shell 11 comprises a substantially cylindrical cup shaped member having a cylindrical peripheral wall 27, the inner surface of which is complementary to the outer surface of the peripheral wall 23 of the lower shell. The upper and lower shells are so proportioned that they may be secured together by close frictional

engagement of the parts of these walls which engage each other in Fig. 2, and the casing may be assembled and secured together by merely pressing the upper and outer shell 11 upon the lower and inner shell 20 with the other parts confined in the shells.

The upper shell 11 has a substantially circular aperture 28 in its bottom 29, the periphery of the aperture 28 being provided with radially extending slots 30 forming a multiplicity of pole pieces 31 located at regularly spaced points about the periphery of the aperture 28 and projecting radially inward.

The coil 15, which is located in the shell 20, preferably consists of a preformed coil of insulated wire of a predetermined number of turns, the coil being provided with flat ends 32, 33, a substantially cylindrical periphery 34, and a cylindrical aperture 35 passing through the coil. The coil is covered with an insulating layer 36 of paper, tape, thin fiber, or other suitable insulation.

The coil 15 is provided with a pair of leads 37, 38 which project from the casing 11, 20 through an aperture 39 which is formed by a slot 40 in the upper shell.

The coil 15 may be supported in central position in the shell 20 by means of a plurality of sleeves 16 and 17. Each of the sleeves 16, 17 consists of a circular tube or a strip of metal formed into the shape shown, and preferably provided with a slot 41, 42 extending from one end of the sleeve to the other to eliminate excessive eddy current losses.

The sleeve 16 is adapted to fit within the sleeve 17, and the sleeve 17 fits within the aperture 35 in the coil 15, the slots 41, 42 being preferably staggered.

Any number of sleeves may be employed to increase the number of laminations in the sleeve core. In the embodiment illustrated, two sleeves are employed for the reason that satisfactory results are secured with a minimum number of sleeves, and such a structure may also be manufactured most economically.

When the coil is energized, the flux path is through the sleeves, 16, 17, and the shells 11, 20. At the lower end of the sleeves 16, 17 the flux extends outward radially in the bottom of the shell 20, and it will be evident that the cross section of the flux path at any point in the bottom 22 would be equal to the thickness of the metal at that point multiplied by the width of the path at that point. The width of the path at any point would be determined by the circumference of a circle drawn at that point with the axis of the screw 21 as a center. The cross section of that part of the core which is formed by the bottom 22 would increase in a radial direction, and the point of minimum cross section of the core would be immediately below the lower ends of sleeves 16, 17, were it not for the core washers 18, 19, which are included for the purpose of providing a flux path of substantially constant cross sectional area. Thus the washer 19 comprises a circular disc of magnetic sheet steel, having a centrally located aperture 43 for passing the screw bolt 21 and a radially extending slot 44 for reducing eddy current losses.

The washer 18 comprises a member of exactly similar structure, but of lesser diameter, and the washers are preferably assembled with the slots staggered. Any number of washers or laminations may be employed, but a flux path of sufficiently constant cross sectional area is provided by the use of two washers, as shown. The washers 18 and 19 when assembled with the bottom 22 of shell 20 increase the cross sectional area of the flux path in the bottom by increasing the thickness of the bottom assembly toward the center and decreasing the thickness of the core toward the outer edge of the bottom. The core washers 18 and 19 are clamped between the bottom 22 and coil 15 and secured in place by the same screw 21 which secures the other parts of the assembly together.

The lower pole piece disc 14 comprises a disc-like metal member constructed of magnetic sheet metal having a plurality of upwardly extending pole pieces 45 located at regularly spaced points about the periphery of the disc 14. The disc is provided with a centrally located circular aperture 46 adapted to receive a cylindrical core plug 47 which is provided with an axially located threaded bore 48 having threads complementary to the threads 49 on the end of screw bolt 21. The plug 47 is also provided with a counterbore 50 forming an annular shoulder 51 against which is seated a disc 52 of insulating material, such as an insulating fiber, constructed of layers of fabric impregnated with a phenolic condensation compound. The size of the disc 52 is such that it may be fixedly retained in the counterbore 50 against the shoulder 51 by the frictional engagement of its periphery with the wall of the counterbore 50.

The plug 47 is also provided with a second counterbore 53, thereby forming a second annular seat 54, against which is seated a similar fiber disc 55, having a cylindrical aperture 56, which forms a bearing for a spindle 57. The disc 55 may be permanently secured in the counterbore 53 by staking over the adjacent metal of the plug, thereby forming an overhanging shoulder 58 of metal for retaining the disc 55 in place. The groove 59 is formed by the roller of the tool which effects the staking operation.

The plug 47 is provided with a radially extending portion 60, having a lower annular shoulder 61 for securing the parts 12 to 21 together in the shells 11, 20. If desired, the upper pole piece disc 12 may have its aperture 62 of such a size that the plug 47 has a close frictional fit in the aperture 62. The upper pole piece disc 12 is preferably formed with a circumferentially extending offset 63 spaced slightly from the border of the aperture 62, thereby locating the central part 64 of the disc 12 in a plane slightly below the outer part 65 of the disc 12 and forming a space between the outer portion of disc 12 and disc 14 for receiving the shading disc 13. The shading disc 13 comprises a substantially circular sheet metal member which is preferably constructed of non-magnetic metal having electrical conducting properties, such as, for example, copper. The shading disc 13 is provided with an enlarged centrally located aperture 66 adapted to receive the offset portion 63 of the upper pole piece disc 12.

The discs 12, 13 and 14 may be nested together upon the plug 47, and the annular shoulder 61, engaging the uppermost disc, may draw all of these parts together into engagement with the coil 15.

The shading disc is preferably provided with a plurality of outwardly extending lugs 67 which terminate in upwardly extending lugs 68. The lugs or fingers 68 are preferably so formed that

they fit within the slots 30 in the upper shell and that they engage the peripheral edges 69 of the slots 30 to effect an accurate centering of the disc assembly with respect to the shell 11 at the upper end of the motor. Lugs 68 may frictionally and resiliently engage the inner edges of the top 29 at the bases 69 of the slots 30, and by virtue of the interengagement between the discs 12, 13 and 14 the pole pieces carried by the discs 12 and 14 are also accurately centered with respect to the other parts at the top of the motor.

The upper pole piece disc 12 carries a multiplicity of regularly spaced outwardly and upwardly extending pole pieces 70 of predetermined width, which are located in the slots 30 in predetermined position with respect to the pole pieces 31 of the upper shell. The upwardly extending pole pieces 45 of the lower pole piece disc 14 are also located in the slots 30 in spaced relation to the pole pieces 31 and 70. The proportions of the cross sections of the pole pieces 45, 70, and 31 are preferably in the ratio of four to five to seven respectively. It will thus be observed that the shading disc 13 is interposed between the pole piece discs 12 and 14 at the upper end of the motor, thereby causing the flux to lag in predetermined poles.

The rotor disc 10 preferably comprises a magnetic sheet steel member of silicon steel which is preferably provided with four radially extending slots 71 located at equally spaced points about the periphery of the disc. The purpose of the slots 71 is to increase the torque at synchronous speed.

The disc 10 is provided with a centrally located aperture 72, which is received upon the cylindrical portion 73 of a hub 74. The disc may be secured between an annular shoulder 75 and the riveted-over portion 76 of the hub. The hub is provided with an axially extending cylindrical aperture 77 and is secured upon the spindle 57 by a close frictional fit between these parts. The spindle 57 may be suitably scored or grooved in an axial direction to prevent rotation between the hub and spindle.

The rotor disc 10 is preferably located above the poles 31, 45 and 70 in order to produce an axial thrust upon the spindle 57, which tends to maintain the conically pointed end 78 of the spindle in engagement with the fiber disc 52 and prevents a tendency toward rattling or other noisy defects. The spindle may be provided with a pinion 79 and with an auxiliary bearing at its upper end in the form of a circular aperture 80 in a similar fiber disc 81 carried by a frame member 82, which is fixedly supported with respect to the frame member 25. The fiber disc 52 constitutes a thrust bearing, while the fiber disc 81 constitutes a cylindrical bearing for the spindle 57.

The principle of operation of the present motor is fundamentally the same as other electric motors of the same type, and will be evident to one skilled in the art. The present structure, however, embodies a multiplicity of improved features, all of which have important advantages in the particular adaptation of the motor to the purpose for which it is intended. Thus the sleeves, laminations and shell form a flux path of substantially constant cross sectional area, thereby greatly increasing the efficiency of the assembly. The location of the rotor disc above the pole ends renders the operation of the rotor quiet at all times and permits the maintenance of quiet operation for a long period of time, in spite of the wear of parts.

The poles are located at right angles to each other so that there is less flux loss between the pole tips. The various parts lend themselves to formation by stamping or drawing operations so that the motors may be manufactured in large quantities at a minimum cost, and expensive machining operations are eliminated.

While I have illustrated a preferred embodiment of my invention, many modifications may be made without departing from the spirit of the invention, and I do not wish to be limited to the precise details of construction set forth, but desire to avail myself of all changes within the scope of the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an electric motor, the combination of a pair of cup shaped metallic shells of magnetic metal forming a casing, with an energizing coil located in said casing, a plurality of concentrically nesting sleeves located in said coil and forming a core, a disc of magnetic material having a plurality of axially extending pole pieces, one of said shells being formed with an aperture having radially inwardly extending pole pieces, and a rotor comprising a disc member rotatably mounted adjacent the ends of said pole pieces.

2. In an electric motor, the combination of a pair of cup shaped metallic shells of magnetic metal forming a casing, with an energizing coil located in said casing, a plurality of concentrically nesting sleeves located in said coil and forming a core, a disc of magnetic material having a plurality of axially extending pole pieces, one of said shells being formed with an aperture having radially inwardly extending pole pieces, a rotor comprising a disc member rotatably mounted adjacent the ends of said pole pieces, said rotor being located outside of said pole pieces, whereby said rotor is subjected to an axial thrust, and a thrust bearing for said rotor to effect a more quiet operation.

3. In an electric motor, the combination of a cup shaped metal shell with a plurality of washer laminations of decreasing diameter located in said shell to provide a flux path of constant cross sectional area, a core, a coil in said shell, a second shell comprising a cup shaped sheet metal member having a multiplicity of inwardly extending pole pieces, a rotor rotatably carried by said core, and a second pole piece unit comprising a disc located above said coil and having pole ends located at right angles to the pole ends of said second shell.

4. In an electric motor, the combination of a cup shaped metal shell with a plurality of washer laminations of decreasing diameter located in said shell to provide a flux path of constant cross sectional area, a core, a coil in said shell, a second shell comprising a cup shaped sheet metal member having a multiplicity of inwardly extending pole pieces, a rotor rotatably carried by said core, a second pole piece unit having axially extending pole pieces located beside the pole pieces of the first pole piece unit in between the poles of said second shell, and an electrically conductive member disposed between said pole piece units.

5. In an electric motor, the combination of a pair of cup shaped shells of magnetic metal, said shells having a press fit with each other, and one of said shells having a multiplicity of radially in-

wardy extending pole pieces, with an inner pole piece assembly comprising an electrically conductive disc of non-magnetic metal, with a magnetic pole piece disc on each side of said electrically conductive disc, said pole piece discs having axially extending pole pieces located about their peripheries, a coil in said shells, and a rotor rotatably mounted upon said assembly with respect to said pole pieces.

6. In an electric motor, the combination of a pair of cup shaped shells of magnetic metal, said shells having a press fit with each other, and one of said shells having a multiplicity of radially inwardly extending pole pieces, with an inner pole piece assembly comprising an electrically conductive disc of non-magnetic metal, with a magnetic pole piece disc on each side of said electrically conductive disc, said pole piece discs having axially extending pole pieces located about their peripheries, a coil in said shells, and a rotor rotatably mounted upon said assembly with respect to said pole pieces, said electrically conductive disc having a plurality of outwardly and axially extending lugs engaging one of said shells between said radially inwardly extending pole pieces for centering said pole piece assembly with respect to said shells.

7. In an electric motor, the combination of a pair of cup shaped shells of magnetic metal, said shells having a press fit with each other, and one of said shells having a multiplicity of radially inwardly extending pole pieces, with an inner pole piece assembly comprising an electrically conductive disc of non-magnetic metal, with a magnetic pole piece disc on each side of said electrically conductive disc, said pole piece discs having axially extending pole pieces located about their peripheries, a coil in said shells, and a rotor rotatably mounted upon said assembly with respect to said pole pieces, said electrically conductive disc having a plurality of outwardly and axially extending lugs engaging one of said shells between said radially inwardly extending pole pieces for centering said pole piece assembly with respect to said shells, and a plurality of split sleeves located between said pole piece assembly and the lower one of said shells, forming a core in said coil.

8. In an electric motor, the combination of a pair of cup shaped shells of magnetic metal, said shells having a press fit with each other, and one of said shells having a multiplicity of radially inwardly extending pole pieces, with an inner pole piece assembly comprising an electrically conductive disc of non-magnetic metal, with a magnetic pole piece disc on each side of said electrically conductive disc, said pole piece discs having axialy extending pole pieces located about their peripheries, a coil in said shells, a rotor rotatably mounted upon said assembly with respect to said pole pieces, said electrically conductive disc having a plurality of outwardly and axially extending lugs engaging one of said shells between said radially inwardly extending pole pieces for centering said pole piece assembly with respect to said shells, a plurality of split sleeves located between said pole piece assembly and the bottom, one of said shells forming a core in said coil, a plug of magnetic material having an annular shoulder engaging outside said pole piece assembly, said plug engaging in the sleeves of said core, and threaded means extending through said bottom of said shell and engaging said plug to clamp said pole piece assembly, coil, shells and sleeves together.

9. A synchronous motor, comprising a shaft carrying a disc-shaped rotor formed of magnetic material, bearing means including an end thrust bearing for supporting said rotor shaft for rotation, a plurality of groups of poles positioned beyond the periphery of said disc in a plane spaced slightly from the plane of said disc thereby to exert an axially directed force upon said rotor in a direction to hold said shaft against said thrust bearing, a field winding arranged to be connected to a source of alternating current for energizing said poles and means for shading one of said groups of poles.

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