Aug. 29, 1933. L. HAMMOND 1,924,853

ALTERNATING CURRENT CLOCK

Filed Sept. 5, 1929 2 Sheets-Sheet 1

Fig. 2

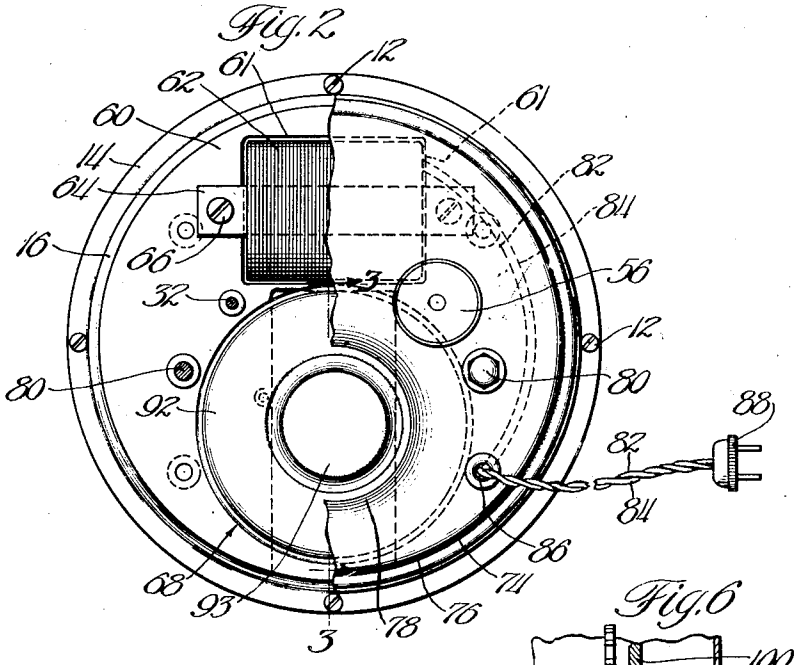


Fig. 1

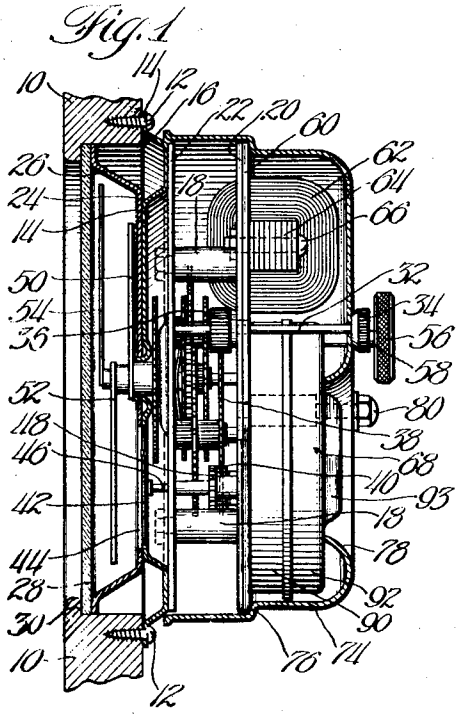


Fig. 6

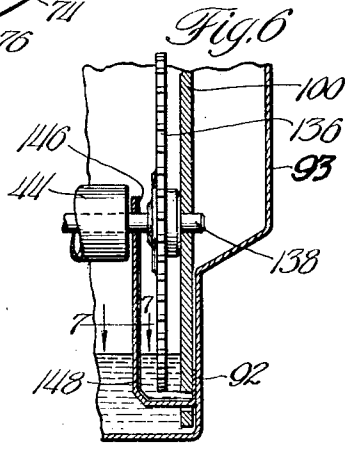
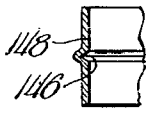


Fig. 7



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Fig. 4

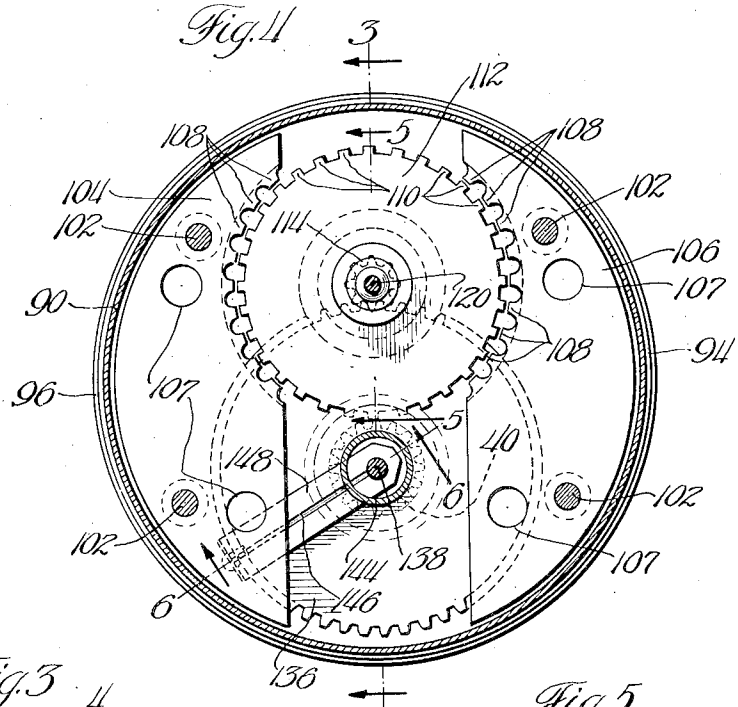


Fig. 3

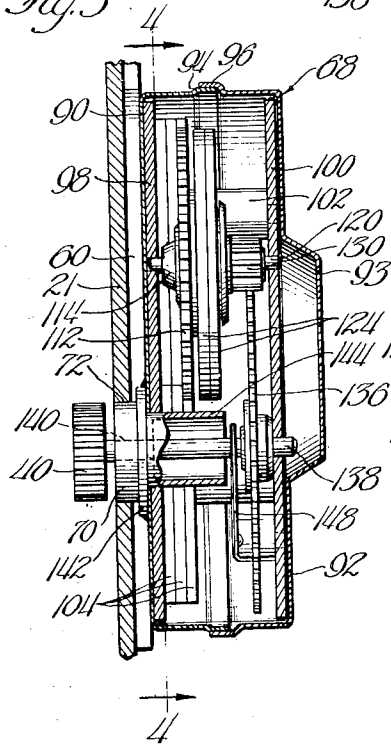
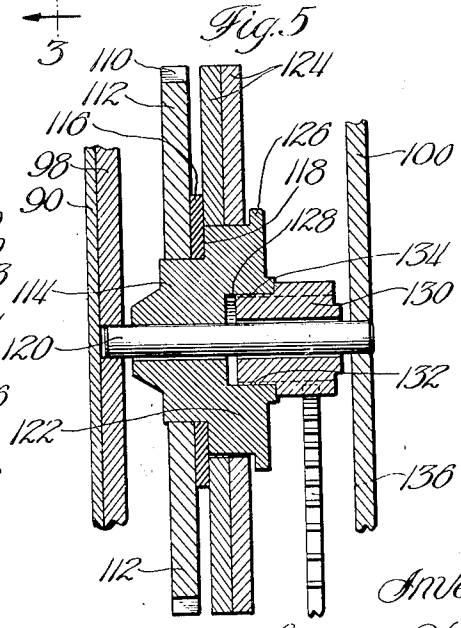


Fig. 5



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Patented Aug. 29, 1933

1,924,853

UNITED STATES PATENT OFFICE

1,924,853

ALTERNATING CURRENT CLOCK

Laurens Hammond, Evanston, Ill., assignor, by mesne assignments, to The Hammond Clock Company, Chicago, Ill., a corporation of Delaware

Application September 5, 1929. Serial No. 390,551

17 Claims. (Cl. 172—275)

My invention relates, generally, to clocks, and more particularly to clocks driven directly by a synchronous electric motor connected directly to an alternating current source, such as a commercial light and power system.

It is an object of my invention to provide an improved synchronous motor driven clock in which the moving parts of the motor are thoroughly enclosed in a casing and in which the motor and casing may readily be removed as a unit from the clock mechanism.

A further object is to provide an improved means for the lubrication of the bearings of a synchronous motor of the type used to drive timing devices and clocks.

Another object is to provide an improved pole construction for synchronous motors of this type.

A further object is to provide an improved rotor construction.

A further object is to provide an improved casing for housing the moving parts of the motor and a portion of the speed reducing gear train in which the possibility of leakage of oil is eliminated.

A further object is to provide an improved means for securing a motor assembly to the mechanism of a clock or timing device.

Other objects will appear from the following description, reference being had to the accompanying drawings, in which

Figure 1 is a side elevation of my improved clock, the casing thereof being shown in central vertical cross section;

Figure 2 is a rear elevation of the clock, a portion of the rear casing being broken away better to show the underlying parts;

Figure 3 is an enlarged central vertical section of the detachable motor, taken on the line 3—3 of Figure 2;

Figure 4 is a sectional view thereof taken on the line 4—4 of Figure 3;

Figure 5 is a greatly enlarged section taken on the line 5—5 of Figure 4;

Figure 6 is a fragmentary sectional view taken on the line 6—6 of Figure 4; and

Figure 7 is a sectional view of the capillary oil duct taken on the line 7—7 of Figure 6.

As best shown in Figure 1, the clock of my invention is adapted to be mounted in a casing 10, made of wood or other suitable material, by means of screws 12 passing through a front sheet 14 which has a rearwardly extending annular trough-shaped depression 16. Shoulder bolts 18 having their rear ends secured in the rear frame 20 and their forward ends of reduced diameter projecting through the front frame 22 and through the sheet 14 at the base of the trough-shaped depression 16, are provided.

A dial 24 has a Z-shaped peripheral flange 26, the extremity of which engages a sheet of glass 28, the latter being held against an annular shoulder 30 formed in the casing. I have illustrated merely a fragment of the casing which may be of any desired construction.

The time gear train of the clock is mounted between the two frames 20 and 22 and may comprise any customary gear train such, for example, as that shown in my Patent No. 1,719,805, granted July 2, 1929, with the addition of the shaft 32 having a thumb nut 34 secured at its outer extremity and a pinion 36 secured at a point between the frames 20 and 22. The pinion 36 meshes with a high speed gear 38, which gear is in mesh with the motor drive pinion 40. A flasher 42 which is a circular disc, one half of the face of which is enameled with one color and the other half of which is enameled with a contrasting color so that the rotation of the disc will be readily observed through an aperture 44 formed in the face of the dial 24, is fastened to a shaft 46 which carries a pinion 48 meshing with the motor pinion 40.

The gear train drives the hour hand 50, the minute hand 52 and the second hand 54 in the usual manner, as more fully described in my aforementioned patent. The hour and minute hands may be set by rotation of a thumb nut 56 secured to a shaft 58 which, at its inner end, is geared to the arbors to which the minute and hour hands are secured, respectively, the usual frictional drive being provided between the time gear train and the arbors to permit resetting of the hands without rotation of the time gear train.

Rigidly secured to the rear frame 20 and lying closely adjacent thereto is a plate 60 of magnetic material. A coil 62 is wound about a core formed of a plurality of rectangular laminations 64 which are collectively secured to the plate 60 and frame 20 by bolts 66 or other suitable fastening means. The plates 60 and 20 have rectangular openings 61 formed therein to receive the coil.

The armature or rotor of the motor, together with the first stage of speed reduction gearing, is mounted within an oil containing casing 68 which has a boss 70 secured thereto, the boss 70 registering with a suitable guiding and positioning aperture 72 formed in the frame 20. A cover 74, shouldered at 76 to rest against the plate 60, has an inwardly bent flange 78 adapted

to engage the casing 68, the cover 74 being secured to the frame of the clock by suitable bolts 80. The ends of the coil 62 are connected by conductors 82 and 84 which pass through an aperture 86 formed in the cover 74 and at their ends are secured to a connecting plug 88 by which connection may be made to a suitable source of alternating current.

The casing 68 is formed in two halves 90 and 92, the casing 90 having an outwardly bent rim 94 fitting in a similar rim 96 formed on the casing half 92, and the rims 94 and 96 being welded or soldered together to form a substantially air and oil tight container for a part of the motor and a part of the gear train. The casing half 92 has a frusto-conical projection 93 which is adapted to register with the opening formed inside the flange 78 and thus aid in holding the casing against movement relative to the clock frame and cover.

The motor frame is composed of two substantially circular plates 98 and 100 which fit snugly within the casing and are joined in suitable spaced relation by a plurality of shouldered rivets 102. These rivets also pass through pole plates 104 and 106 and accurately position the pole plates relative to the frame. The frame plates 98, 100 and the pole plates 104, 106 have accurately positioned holes 107 formed therein. In the process of assembling these plates, they are placed on a jig which has pins adapted to project through these holes, so that when the heads of the shouldered rivets are hammered down, all of the pole plates will be correctly positioned on the frame and the frame plates will be rigidly secured directly opposite one another, thereby insuring that the rotor is properly centered between the arcuate rows of poles.

The innermost of these plates 104 and 106 have a plurality of projecting poles 108 which are suitably spaced in an arcuate row so as to be adapted to register with salient projections or "teeth" 110 formed on a rotor 112. The rotor 112 is staked to a rotor hub 114, a thin washer 116 spacing the rotor from a shoulder 118 formed on the hub. The hub is mounted for free rotation upon a shaft 120 mounted in the frame plates 98 and 100. Rotatably mounted upon an enlarged portion 122 of the hub 114 are a pair of non-magnetic washers or friction inertia members 124, the hub having an annular flange 126 to hold said washers on the hub.

The hub is formed with an enlarged central bore 128 which is slightly greater in diameter than the root diameter of a pinion 130, a portion of the teeth of which are turned away at 132 so that the pinion may be secured in the bore 128 by a press fit.

It will be noted that since the diameter of the turned away portion of the pinion 130 is slightly greater than the root diameter of the pinion small capillary oil ducts 134 are formed to permit flow of oil from the teeth of the pinion to the space at the end of the bore 128.

The pinion 130 is axially bored to a diameter slightly larger than that of the shaft 120 so as not to bear thereon, and meshes with a gear 136 which is rigidly secured to a shaft 138 and is mounted for free rotation in suitable bearings formed in the plate 100 and in a bushing 140 which is formed integrally with the boss 70 and has a flange 142 which is welded to the casing half 90. The bushing has an inwardly projecting skirt portion 144 which extends over half the distance between the side walls of the casing. This skirt portions serves as a simple means to prevent the escape of lubricant from the bearing in the bushing 140, since no matter which way the clock upon which the motor is mounted is tilted or moved (as long as the movement is not too violent), none of the oil which partially fills the casing will be in position to leak out through the bearing by gravitational flow. I have also provided means to conduct therefrom any oil which may have found its way into the tubular portion 144. This means comprises a capillary duct 146 formed in an L-shaped strip 148 which is suitably secured to the plate 100 by spot welding or other suitable means. The upper end of the strip 148 fits around shaft 138 and lies closely adjacent the end of the skirt portion 144. Any excess oil within the portion 144 will thus be drawn therefrom by capillary attraction and drain to the bottom of the casing.

The gear 136, as it rotates, dips into the oil (Fig. 6), and carries it upwardly to the pinion 130 from which a portion flows through the capillary ducts 134 to the space between the end of the pinion and the end of the bore 128 and thus assures an adequate supply of lubricant for the bearing of the hub 114 on the shaft 120. Another portion of the lubricant supplied to the pinion 130 flows along the side wall of the hub 114 so as to lubricate the bearings of the washers 124 on the hub.

The projections 108 on the pole plates 106 are so spaced relative to a horizontal plane through the axis of the shaft 120 that when the motor is in operation the resultant of the magnetic forces acting on the rotor will approximately overcome the force of gravity acting on the rotor and thus minimize wear between the hub and the shaft 120.

The plates 104 and the plates 106 are of exactly the same shape so that a single die suffices to stamp all of these plates. A portion of the magnetic flux produced by the coil 62 is "short circuited" by the portions of plate 60 surrounding the aperture 61, which results in a reduction in the reluctance of the magnetic circuit of the coil, and thus increases the impedance of the coil with a consequent reduction of current and power required. The major limitation on the size of the coil is in the number of turns required to prevent the coil from overheating and not the amount of power required to operate the motor. The positioning of the coil in the apertured plate thus makes possible the use of a shorter length of wire of greater diameter with a consequent reduction in the overall dimensions of the coil and in power consumption.

I am aware that various types of electric motors have been proposed in which the rotating armature is enclosed or partially enclosed in a casing so as to separate it from the stationary poles. In these motors, however, it is essential that the casing be accurately positioned with reference to the stationary poles, and the casing wall occupies part of the air gap between the stationary poles and the rotating poles thereby decreasing the efficiency of the motor. In the motor of my invention the rotor may be readily and accurately positioned between the stationary and the rotating poles and the casing need not be accurately positioned relative to the plate (60) against which it is secured. The elimination of the necessity for accurately positioning the rotor oil containing casing in the clock makes it feasible to have the motor replaced by any unskilled person, greatly reduces the cost of manufacture

and assembly, and insures satisfactory operation of the device.

In operation the plug 88 is connected in any suitable socket supplied with current from a regulated alternating current source, thus causing a flux circuit through the core laminations 64, plate 60, through the casing half 90 to the pole plates 104, across the gap between the projections 108 on the plate 104 and the salient projections 110 formed on the rotor 112, through the rotor to the pole plate 106, through the casing wall 90 into the plate 60 back to the core laminations 64. It has been found that the flux loss caused by the gap between the plate 60 and the pole plates 104 and 106 is insufficient materially to interfere with the operation of the motor.

The variations in the flux density resulting from the alternating current passing through the coil 62 cause the rotor to rotate at synchronous speed after it has been set in motion at synchronous speed by an external source of power. In the present instance the motor is started by manually twirling the thumb piece 34 which, through its shaft 32, pinion 36, gear 38, motor pinion 40, shaft 138 and gear 136, will rotate the rotor. This gearing between the pinion 36 and the rotor is of such a ratio that a single slow twirl of the thumb piece 34 will suffice to rotate the rotor 112 at super-synchronous speed. Thereafter, as the rotor slows down, due to the load imposed upon it and the friction in the motor itself, the washers 124 will cause the rotor invariably to drop into synchronous speed and prevent the rotor from falling out of step. The operation and relationship of the friction inertia members 124 to the rotor are fully disclosed in my aforesaid patent.

In the present instance the oil which is present between the inertia members 124 and the hub and which forms a film between the spacing washers 116, the annular rim 126 and the inertia members, functions as the frictional drive connection between the rotor and the inertia members. For this reason the diameter of the portion 122 of the hub is comparatively large with the result that the frictional torque capable of being transmitted from the inertia members to the rotor is correspondingly great.

The rotor having been started in operation at synchronous speed, it will maintain this speed as long as the supply of alternating current continues. Any slight surges or brief interruptions in the supply of the current will not cause the motor to stop, since the inertia members 124 are capable of imparting sufficient energy to the rotor to carry it over such brief interruptions in the current supply.

It will readily be seen that the entire motor unit may be removed from the clock mechanism merely by unscrewing the nuts of the bolts 80 and removing the cover 74. It is thus a very simple matter to replace the motor should it break or wear out, or if a power company should change the frequency of the current supplied, the user could substitute a motor unit having gears and pinions of the proper ratio to operate the clock at the new frequency.

While the method and mechanism herein shown and described is admirably adapted to fill the objects primarily stated, it is to be understood that it is not intended to confine the invention to the one form of embodiment herein described, for it is susceptible of embodiment in various forms all coming within the scope of the claims which follow.

I claim:

1. In a device of the class described, the combination of a casing, a pair of pole plates secured therein, said plates having a plurality of pole projections, a notched plate rotor cooperable with said pole projections, a pinion located outside of said casing, means for operatively connecting said rotor with said pinion, and means outside of said casing for causing an alternating magnetic flux to pass through said pole plates thereby to rotate said rotor.

2. In a synchronous motor for driving an alternating current clock, the combination of frame plates, a shaft carried between said plates, pole pieces positioned adjacent said shaft, a rotor rotatably mounted on said shaft and co-operating with said pole pieces, said rotor having a hub, inertia elements rotatably mounted on said hub, and a driving pinion secured to said hub.

3. In a synchronous motor for driving a clock, the combination of a frame, a shaft mounted in said frame, pole pieces adjacent said shaft, means for producing a magnetic flux of varying density across said pole pieces, a hub member rotatable on said shaft, said member having a counterbore at one end thereof, a rotor of magnetic material secured to said member, a pinion having a sidewardly extending hub portion, said portion having a longitudinal capillary groove therein and projecting into the counterbore in said member, and a gear positioned below and meshing with said pinion, means forming a fluid lubricant reservoir a portion of said gear being normally immersed in the lubricant and serving to raise the lubricant to said pinion, whereby said lubricant will be supplied to said hub member through the groove in the hub of said pinion.

4. In a synchronous motor for driving a clock, the combination of a frame, a shaft mounted in said frame, pole pieces adjacent said shaft, means for producing a magnetic flux of varying density across said pole pieces, a hub member rotatable on said shaft, a rotor of magnetic material secured to said member, an inertia element rotatably mounted on said member, and means to supply lubricant to the bearing surfaces between said element and said member.

5. In a synchronous motor for driving a clock, the combination of a frame, a shaft mounted in said frame, pole pieces adjacent said shaft, means for producing a magnetic flux of varying density across said pole pieces, a hub member rotatable on said shaft, said member having a counterbore at one end thereof, a rotor of magnetic material secured to said member, a pinion having a sidewardly extending hub portion, said portion having a longitudinal capillary groove therein and projecting into the counterbore in said member, an inertia element rotatably mounted on said hub, and means to supply lubricant to the bearing surfaces between said element and said member, and between said member and said shaft.

6. In an alternating current electric synchronous motor driven clock, the combination of a coil, a non-magnetic container, magnetic means to lead the flux from said coil to separated portions of the external wall of said container, stationary pole plates secured within said container and adapted to receive the flux from said means, and a rotor mounted between said pole plates, there being a small air gap between said rotor and pole plates, whereby the magnetic flux from said coil will be conducted through said means, a portion of the wall of said non-magnetic con-

tainer, one of said pole plates across the air gap between said pole plate and rotor, through said rotor, across said air gap to the other pole plate, and from said last named pole plate through another portion of the wall of said container to said means.

7. A removable power unit for driving electric timing devices comprising, magnetizing means, a non-magnetic casing, a magnetic rotor mounted for rotation therein, and stationary magnetic pole pieces located adjacent said rotor, inside said casing and adapted to be magnetized by said magnetizing means located outside of said casing.

8. An alternating current electric motor, comprising a magnetic plate having two separated portions and a connecting portion, said connecting portion having an aperture therein, a coil positioned in said aperture, a core for said coil secured to said plate, and a rotor and stator unit having pole pieces removably positioned adjacent said separated portions of said plate.

9. An alternating current motor comprising a coil, means to supply an alternating current thereto, a core for said coil, means to short circuit a portion of the magnetic flux of said coil, separated magnetic means forming a path for another portion of the magnetic flux of said coil, and an electric motor unit removable from said magnetic means and including a rotor and stationary pole pieces, said motor unit being constructed and arranged to be operated by the flux passing through said separated magnetic means and said stationary pole pieces when the latter are placed adjacent to said magnetic means.

10. A motor driven device comprising in combination, a load mechanism, a frame for supporting the load mechanism, a coil and core connected to the frame, a flux transmitting member connected to the core of the coil, and a motor unit comprising a casing detachably mounted on the frame to rest against said member, a pair of plates rigidly secured within said casing and having large areas lying adjacent said member, pole projections on said plates, a magnetic rotor having salient projections cooperating with said pole projections, a shaft carried by the casing and projecting therefrom and driven by said rotor, and means carried by the shaft for driving said load mechanism from said shaft when said casing is in position adjacent said flux transmitting member.

11. A motor driven device comprising a synchronous motor operated by alternating current, a load mechanism, a casing for the motor with an external power take-off device from the motor drivingly engaging the load mechanism, a frame for supporting the load mechanism, a core and coil connected to the load mechanism, a plate of magnetic material carried on the frame and serving as a flux transmitting medium, and means for detachably mounting the casing on the frame to rest against said plate, the casing with its motor and said power take-off device constituting a separate removable unit, the motor comprising pole pieces secured within the casing adjacent the wall of said casing which lies against said plate, and a rotor mounted within the casing in cooperative relation with said pole pieces.

12. An alternating current electrical device comprising a synchronous motor, a load mechanism, a frame therefor, a magnetic member secured to said frame, a coil for producing an alternating flux in said member, an oil container detachably secured to said frame, stationary magnetic poles within said container for magnetization by said member, the magnetic flux passing through said container, a multi-pole magnetic rotor positioned between said stationary poles and adapted to be actuated thereby, and gearing connecting said rotor with said load mechanism, said gearing including a shaft projecting through the casing.

13. In an electric device for operation by alternating current, the combination of a load mechanism, a motor unit for driving said mechanism, said unit comprising an oil container, stationary magnetic poles within said container, a multi-pole rotor mounted for free rotation between said poles, said container, poles and rotor constituting a separate removable unit, means for removably mounting said unit on said device, and means associated with said load mechanism and outside the said container for magnetizing said poles.

14. A device of the class described comprising a fixed load mechanism, an electric coil mounted on the mechanism, and an enclosed removable driving unit comprising stationary magnetic pole pieces and a magnetic rotor mounted for rotation adjacent said pole pieces.

15. In a synchronous electric clock motor, the combination of means for producing an alternating magnetic flux field, a fixed shaft, a rotor of magnetic material mounted for rotation upon said shaft within said field, said rotor having a sidewardly projecting hub, and an inertia element movably mounted upon said hub.

16. In a synchronous electric motor, the combination of means for producing a varying magnetic flux field, a shaft, a rotor of magnetic material rotatable upon said shaft within said field, said rotor having a hub, and a disc-shaped inertia element of non-magnetic material mounted for movement on said hub relative to said rotor.

17. In a synchronous electric motor, the combination of means for producing an alternating magnetic field, a fixed small diameter shaft, a rotor rotatably mounted upon said shaft within said field and having a hub movable therewith, said hub having a bore therethrough of diameter only slightly greater than that of said shaft and having an external cylindrical bearing surface of diameter substantially greater than that of said shaft, and an inertia element movably mounted upon the said external cylindrical bearing surface of said hub.

LAURENS HAMMOND.