June 5, 1934. B. E. LENEHAN 1,961,975

HYSTERESIS CLOCK MOTOR

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Fig. 1.

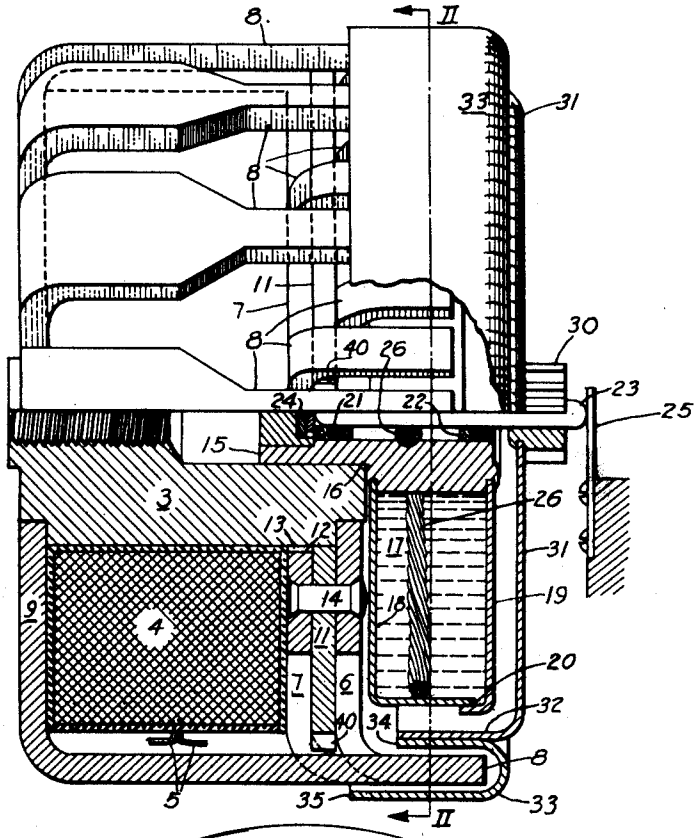
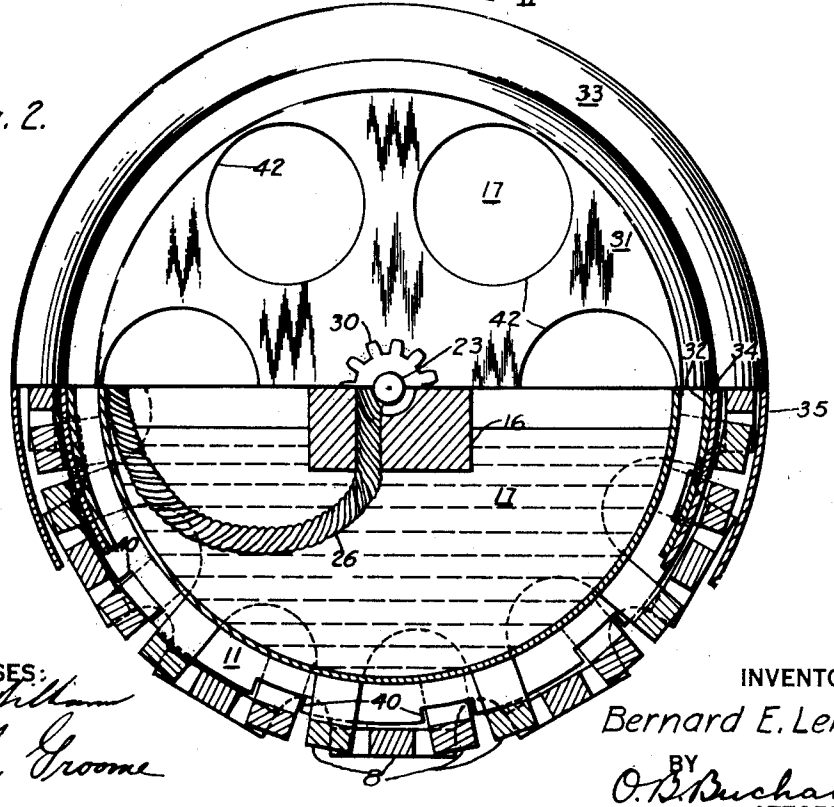


Fig. 2.



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HYSTERESIS CLOCK MOTOR

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18 Claims. (Cl. 172—275)

My invention relates to synchronous clock motors and it has special relation to the self-starting type of such motors.

One of the objects of my invention is to provide improved means for securing a rotating field for a single-phase clock motor.

Another object of my invention is to provide an improved rotor construction utilizing the principle of the hysteresis motor, whereby a speed-torque characteristic, covering the accelerating period of my motor, is obtained which is singularly free from cusps or depressions corresponding to points of deficient torque. My motor results in a construction in which the starting torque and the pull-in torque, and all intermediate torques are substantially equal to the pull-out synchronous torque so that there will be little or no tendency for the motor to run at any speed other than the full synchronous speed.

Another object of my invention is to provide a rotor construction which is supported from only one end of the rotor shaft and in which the center of gravity lies at some point within the bearing supporting the shaft.

A further object of my invention is to provide a construction in which ample oil-storage space is provided.

A still further object of my invention is to provide a multipolar three-phase field structure, having three pole pieces for producing a larger number of pairs of poles, and utilizing but a single field coil.

With the foregoing and other objects in view, my invention consists in the structure and combinations hereinafter described and claimed and illustrated in the accompanying drawing, wherein

Figure 1 is a longitudinal elevational view of a preferred form of embodiment of my invention, the bottom half being in section, and

Fig. 2 is a pinion-end elevation of the same, with the bottom half of the figure in section on the line II—II in Figure 1.

In the drawing, I have illustrated my invention in a 24-pole motor which runs synchronously at 300 R. P. M. on a 60-cycle supply circuit, or at 125 R. P. M. on a 25-cycle supply circuit. The field structure comprises a cylindrical core member 3 of cold-rolled steel, which extends through the center of a magnetizing coil 4, the terminals of which are indicated at 5, and are intended to be connected to a single-phase supply. The front end of the core 3 is provided with two radially-extending disks or pole pieces 6 and 7, each having twelve radially-extending teeth 8 which are bent forwardly so as to extend in cylindrical formation. The rear end of the core 3 has a radially-extending disk or single pole piece 9 having twelve radially-extending fingers 8 which are bent so as to provide pole pieces lying in the same cylinder as the bent fingers 8 of the pole pieces 6 and 7. Thus are provided thirty-six polar projections disposed in a cylinder, with the thirty-six polar projections about equally spaced from each other.

The front and back pole pieces 6 and 9 are connected directly to the core 3, with a tight frictional engagement. The flux which traverses the front pole piece 6 is caused to lag by means of a lag ring 11 which is placed directly behind the radial or disk portion of the said pole-piece. The inner front pole piece 7 is placed next to the lag ring 11, but its flux is not affected by said lag ring because it derives its flux from the portion of the core 3 which is not affected by the lag ring.

In order to make the flux in the inner front pole piece 7 substantially equal to the lagging flux in the front pole piece 6, the inner pole piece 7 is provided with a cylindrical bore 12 which is slightly larger than the core 2 so that an air gap 13 is provided which reduces the maximum flux density in the pole piece 7 about as much as the lag ring 11 reduces it in the pole piece 6. In this manner, the flux in the twelve terminal poles or teeth 8 of the front pole piece 6 lags about sixty degrees behind the flux in the twelve terminal poles or teeth 8 of the pole piece 7, and the maximum flux is about the same in each of these groups of teeth. The rear pole piece 9 carries the return flux which is equal and opposite to the vector sum of the fluxes in the teeth of the two front pole pieces 6 and 7.

In my preferred construction, the three pole pieces 6, 7 and 9 are made of cold-rolled steel. The two front pole pieces 6 and 7, with the intermediately disposed lag ring 11, are riveted together by means of two rivets 14, so as to support, and properly center, the lag ring 11 and the inner front pole piece 7.

The stator core 3 is provided with a bore so as to receive a bearing member 15 which extends into the front end thereof. Said bearing member comprises a bearing mount 16 of brass, the rear end of which is turned down so as to fit within the bore of the stator core member 3. The front portion of the bearing mount 16, which is in front of the core 3, carries an annular oil reservoir 17 which is composed of two copper disks 18 and 19, the outer peripheries of which are bent toward each other and soldered together at 20.

The bearing mount 16 carries two spaced journal bearings 21 and 22 which support a rotor shaft 23, the inner end of the rotor shaft abutting against an end stone or thrust-bearing 24, against which it may be lightly pressed as by means of a leaf-spring 25, or other means. Oil is supplied to the bearings by means of a wick 26, one end of which extends in the space immediately surrounding the shaft 23, between the two bearings 21 and 22, and the other end of which is disposed in the oil in the oil chamber 17. In this way, an ample supply of oil is provided, sufficient for an indefinitely long run.

The front end of the rotor shaft 23 carries a pinion 30 which drives the clock mechanism (not shown). This pinion carries a rotor spider 31 which is preferably made of aluminum in order to reduce the weight of the rotor and thus increase the life of the bearings. The outer end of the rotor spider 31 is bent inwardly, in cylindrical formation, as indicated at 32. Around this cylindrical portion 32 of the rotor spider is disposed an annular hysteresis member 33, of U-shaped cross-section, made of a thin sheet of tool steel, providing an inner cylindrical portion 34 which is disposed on the inside of the cylindrically disposed pole teeth 8, and an outer cylindrical member 35 which is disposed on the outside of the cylindrically disposed teeth 8, with any convenient air gap between the hysteresis member and the pole pieces or teeth 8. The air gap is not critical and is made as small as is convenient for mechanical reasons, without requiring too much refinement in the shop processes. The outer cylindrical portion 35 of the hysteresis member 33 may extend back for a greater distance than the inner cylindrical member 34, in order to take advantage of as much of the flux of the pole pieces 8 as possible.

The general theory of the hysteresis motor is well known, and need not be repeated here, being explained, for example, in Steinmetz' book on "Alternating-Current Phenomena", 1900 edition, pages 293 to 296, and in Robertson's article on "Rotor Hysteresis in Polyphase Induction Motors", published in The Electrician (London) October 13, 1911, pages 12 to 14. Suffice it to say that the rotating component of the flux set up in my unbalanced three-phase pole structure produces a dragging effect on the hardened steel rotor member 33 by reason of the large hysteresis loop or high remanence effect of the tool steel, this same effect causing the motor to lock into step at synchronous speed, and enabling the rotor member 33 to resist any shifting of its magnetization when operating at synchronous speed.

While I am not limited to any particular structural design or proportions, insofar as the broader aspects of my invention are concerned, it may be helpful to give some proportions which I have found advantageous for clock motors.

The outside stator diameter of the particular motor shown is 1.532 inches. The diameter of the core 3 is ⅝ inch. The three pole pieces 6, 7 and 9 are each of .063 inch thickness. The lag ring 11 is made from a zinc sheet .060 inch thick, for a 60-cycle motor, and from a copper sheet .064 inch thick for a 25-cycle motor. The inner hole of the inner front pole piece 7 is of .650 inch diameter. The lag ring is as large in outer diameter as may be made, being even provided with twelve notches 40 for receiving the teeth 8 of the inner front pole piece 7, as they are bent out from the radial disk portion of said pole piece. The circumferential thickness of each of the teeth 8 is .10 inch. The annular U-shaped hysteresis member 33 is made from a sheet of tool steel .012 inch thick, the internal distance between the two cylindrical members 34 and 35 thereof being .112 inch.

As previously noted, the center of gravity of the rotor member, because of the overhanging construction of the steel hysteresis element 33, is well within the bearing 21—22. The aluminum spider 31 of the rotor may be lightened by means of a plurality of holes 42, in a well known manner.

In operation, my novel field-magnet structure provides twelve pairs of electric poles, using three polar projections per pair of poles, the fluxes in these polar projections being in an unbalanced three-phase relation to each other, so that a distorted three-phase, or rotating, field is produced, from a single-phase source. The method of operation of the hysteresis element has already been described.

While, at present, for clock service, I prefer a pure hysteresis characteristic, without any special induction-motor effect or reaction-motor effect, it will be obvious that I am not limited thereto.

While I have shown the several elements of my invention in a preferred form of construction and in a preferred combination with each other, it will be obvious that many of these elements are of utility when used separately or in other combinations, and that many changes in form and construction may be made within the spirit of my invention. The embodiment of my invention which is shown in the drawing is given merely for illustrative purposes, and the appended claims are to be limited only as may be required by the language thereof, when read in the light of the prior art.

I claim as my invention:

1. A single-phase electric motor characterized by a three-phase pole structure utilizing three circumferentially displaced salient polar projections per pair of electric poles, said pole structure comprising three disk-shaped pole pieces, one core and a single-phase winding surrounding said core, two of said disk-shaped pole pieces being at one end of said winding, with a lag ring therebetween, the third pole piece being at the other end of said winding, to carry the return flux, each of said three pole pieces having a plurality of polar projections extending laterally into a common circular formation, with the respective polar projections circumferentially displaced from each other.

2. A single-phase electric motor characterized by a three-phase multipolar field magnet stator structure utilizing three circumferentially displaced salient polar projections per pair of electric poles, said field magnet structure comprising a core, a single-phase field winding therearound, and disk-shaped pole means at each end of said winding, said disk-shaped pole means terminating in a multipolar pole-face arrangement comprising a plurality of salient polar projections extending laterally into a substantially cylindrical formation, the polar projections deriving their flux from one end of the winding being twice as many as the polar projections deriving their flux from the other end of the winding and being sandwiched, in pairs, between the last-mentioned polar projections, respective polar projections being circumferentially displaced from each other, and damping means for causing the flux in one of each pair of polar projections to lag behind the flux in the other polar projection of said pair, the reluctance of the magnetic circuit of the undamped polar projection of each of said pairs being larger than the reluctance of the magnetic

circuit of said damped polar projection of each of said pairs, so that the maximum effective fluxes in said damped and undamped polar projections shall be approximately equal.

3. A single-phase electric motor characterized by a three-phase pole structure utilizing three circumferentially displaced salient polar projections per pair of electric poles, said pole structure comprising three disk-shaped pole pieces, one core and a single-phase winding surrounding said core, two of said disk-shaped pole pieces being at one end of said winding, with a lag ring therebetween, the third pole piece being at the other end of said winding, to carry the return flux, each of said three pole pieces having a plurality of polar projections extending laterally outwardly into a common cylindrical formation, with the respective polar projections circumferentially displaced from each other, the disk-shaped pole piece which is disposed between said lag ring and said winding being magnetically separated from said core, the other two disk-shaped pole pieces being in contact with said core.

4. An electric motor comprising a stator member having its torque-producing portion extending cylindrically from a supporting structure at only one end, a rotor member mounted on a shaft and having its torque-producing portion extending cylindrically from a supporting spider at the other end, bearing-means for said shaft in said stator member, the center of gravity of said rotor member falling within said bearing-means, and a lubricant-storing chamber carried by said stator member in the space within the overlapping torque-producing cylinders of said rotor and stator members.

5. An electric motor comprising a stator member having its torque-producing portion extending cylindrically from a supporting structure at only one end, a rotor member mounted on a shaft and having its torque-producing portion extending cylindrically from a supporting spider at the other end, bearing-means for said shaft in said stator member, the center of gravity of said rotor member falling within said bearing-means, and a lubricant-storing chamber carried by said stator member in the space within the overlapping torque-producing cylinders of said rotor and stator members, the torque-producing portion of said rotor member comprising two metallic cylindrical members, one inside and the other outside of the torque-producing portion of said stator member.

6. An electric motor comprising a stator member having its torque-producing portion extending cylindrically from a supporting structure at only one end, a rotor member mounted on a shaft and having its torque-producing portion extending cylindrically from a supporting spider at the other end, and the center of gravity of said rotor member falling within said bearing-means, the torque-producing portion of said rotor member comprising two metallic cylindrical members, one inside and the other outside of the torque-producing portion of said stator member.

7. An electric motor comprising a stator member having its torque-producing portion extending cylindrically from a supporting structure at only one end, a rotor member mounted on a shaft and having its torque-producing portion extending cylindrically from a supporting spider at the other end, and the center of gravity of said rotor member falling within said bearing-means, the torque-producing portion of said rotor member comprising two metallic cylindrical members, one inside and the other outside of the torque-producing portion of said stator member, said stator member comprising means for producing a rotating magnetic field in its torque-producing portion.

8. The invention as specified in claim 6, characterized by the fact that said two metallic cylindrical members are of hard steel.

9. The invention as specified in claim 7, characterized by the fact that said two metallic cylindrical members are of hard steel.

10. The invention as specified in claim 7, characterized by the fact that said two metallic cylindrical members are portions of an annular U-sectioned rim of thin sheet-steel mounted on said rotor spider member.

11. A single-phase electric motor characterized by a three-phase multipolar field magnet stator structure utilizing three circumferentially displaced salient polar projections per pair of electric poles, said field magnet structure comprising a core, a single-phase field winding therearound, and disk-shaped pole means at each end of said winding, said disk-shaped pole means terminating in a multipolar pole-face arrangement comprising a plurality of salient polar projections extending laterally into a substantially cylindrical formation, the polar projections deriving their flux from one end of the winding being twice as many as the polar projections deriving their flux from the other end of the winding and being sandwiched, in pairs, between the last-mentioned polar projections, the respective polar projections being circumferentially displaced from each other, and damping means for causing the flux in one of each pair of polar projections to lag behind the flux in the other polar projection of said pair, said motor being further characterized by a rotor member mounted on a shaft and having a driving pinion on one end of the shaft and a spider member carried by said driving pinion, said rim constituting a hysteresis-motor element in operative relation to the polar projections of the field structure, the center of gravity of said rotor member falling within said bearing-means.

12. A single-phase electric motor characterized by a three-phase multipolar field magnet stator structure utilizing three circumferentially displaced salient polar projections per pair of electric poles, said field magnet structure comprising a core, a single-phase field winding therearound, and disk-shaped pole means at each end of said winding, said disk-shaped pole means terminating in a multipolar pole-face arrangement comprising a plurality of salient polar projections extending laterally into a substantially cylindrical formation, the polar projections deriving their flux from one end of the winding being twice as many as the polar projections deriving their flux from the other end of the winding and being sandwiched, in pairs, between the last-mentioned polar projections, the respective polar projections being circumferentially displaced from each other, and damping means for causing the flux in one of each pair of polar projections to lag behind the flux in the other polar projection of said pair, said motor being further characterized by a rotor member mounted on a shaft and having a driving pinion on one end of the shaft and a spider member carried by said driving pinion, bearing-means for the other end of

said shaft in said stator structure, the spider member terminating in an in-turned cylindrical rim overhanging said bearing-means, and a hysteresis-motor element mounted on said rim in operative relation to the polar projections of the field structure, said hysteresis-motor element comprising an annular U-sectioned rim of thin sheet-steel mounted on said rotor spider member.

13. A single-phase electric motor characterized by a three-phase pole structure utilizing three circumferentially displaced salient polar projections per pair of electric poles, said pole structure comprising three disk-shaped pole pieces, one core and a single-phase winding surrounding said core, two of said disk-shaped pole pieces being at one end of said winding, the third pole piece being at the other end of said winding, to carry the return flux, each of said three pole pieces having a plurality of polar projections extending laterally outwardly into a common cylindrical formation, with the respective polar projections circumferentially displaced from each other, damping means for causing a lag in the flux in the polar projections of one of said two disk-shaped pole pieces at one end of said winding, the other one of said two disk-shaped pole pieces being magnetically separated from said core, the other two disk-shaped pole pieces being in contact with said core.

14. A single-phase electric motor characterized by a pole structure comprising a plurality of disk-shaped pole pieces, one core and a single-phase winding surrounding said core, two of said disk-shaped pole pieces being at one end of said winding, with a lag ring therebetween, each of said disk-shaped pole pieces having a plurality of polar projections extending laterally into a common cylindrical formation, with the respective polar projections circumferentially displaced from each other, the disk-shaped pole piece which is disposed between said lag ring and said winding being magnetically separated from said core, and the disk-shaped pole piece which is disposed on the other side of said lag ring being in contact with said core.

15. A single-phase electric motor characterized by a pole structure comprising a plurality of disk-shaped pole pieces, one core and a single-phase winding surrounding said core, two of said disk-shaped pole pieces being at one end of said winding, each of said disk-shaped pole pieces having a plurality of polar projections extending laterally into a common cylindrical formation, with the respective polar projections circumferentially displaced from each other, damping means for causing a lag in the flux in the polar projections of one of said two disk-shaped pole pieces at one end of said winding, said disk-shaped pole piece being in contact with said core, the other one of said two disk-shaped pole pieces being magnetically separated from said core.

16. A single-phase electric motor characterized by a three-phase multipolar field magnet stator structure utilizing three circumferentially displaced salient polar projections per pair of electric poles, said field magnet structure comprising a core, a single-phase field winding thereabout, and disk-shaped pole means at each end of said winding, said disk-shaped pole means terminating in a multipolar pole-face arrangement comprising a plurality of salient polar projections extending laterally into a substantially cylindrical formation, the polar projections deriving their flux from one end of the winding being twice as many as the polar projections deriving their flux from the other end of the winding and being sandwiched, in pairs, between the last-mentioned polar projections, the respective polar projections being circumferentially displaced from each other, and damping means for causing the flux in one of each pair of polar projections to lag behind the flux in the other polar projection of said pair.

17. A single-phase electric motor characterized by a three-phase pole structure utilizing three circumferentially displaced salient polar projections per pair of electric poles, said pole structure comprising three disk-shaped pole pieces, one core and a single-phase winding surrounding said core, two of said disk-shaped pole pieces being at one end of said winding, with a lag ring therebetween, the third pole piece being at the other end of said winding, to carry the return flux, each of said three pole pieces having a plurality of polar projections extending laterally outwardly into a common circular formation, with the respective polar projections circumferentially displaced from each other, the polar projections of all three pole pieces extending all in the same direction beyond said core and winding at one end thereof.

18. A single-phase electric motor characterized by a three-phase multipolar field magnet stator structure utilizing three circumferentially displaced salient polar projections per pair of electric poles, said field magnet structure comprising a core, a single-phase field winding thereabout, and disk-shaped pole means at each end of said winding, said disk-shaped pole means terminating in a multipolar pole-face arrangement comprising a plurality of salient polar projections extending laterally into a substantially cylindrical formation, the polar projections of all three pole means extending all in the same direction beyond said core and winding at one end thereof, the polar projections deriving their flux from one end of the winding being twice as many as the polar projections deriving their flux from the other end of the winding and being sandwiched, in pairs, between the last-mentioned polar projections, the respective polar projections being circumferentially displaced from each other, and damping means for causing the flux in one of each pair of polar projections to lag behind the flux in the other polar projection of said pair.

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