

"DRIVE APPARATUS"

This invention relates to drive apparatus and, although it is not so restricted, it relates more particularly to drive apparatus for use in a timepiece, e.g. for driving an angularly movable member provided with a decoration or ornament such as a doll.

Clocks are known having movable decorations or ornaments. For example, a cuckoo clock is known in which at each hour a door opens and a cuckoo appears to indicate the hour. Another known clock has a doll on a terrace which rotates during the playing of a melody by a music box after a door opens and a cuckoo sings at the hour. In such clocks, rotary gears and stationary gears are used to cause the rotational motion. On the other hand, large clocks of this kind use drive apparatus comprising air cylinders, air pressure control units, limit switches, etc. In either case, such a drive apparatus is arranged externally of the part being rotated thereby.

In such clocks in the prior art, the whole drive apparatus is large compared with the part which is rotated thereby so that the clocks take up considerable space. Moreover, a cover needs to be provided for covering a drive apparatus disposed externally of the moving part. Since considerable storage space is required for a cuckoo or the like, it is difficult to dispose a plurality of moving decorations or ornaments close to one another inside the same clock. Furthermore, a clock employing an air unit or the like is complicated and expensive.

Therefore, it is an object of the present invention to provide at a low cost, a drive apparatus whose total dimensions are not significantly greater

than the part being rotated thereby so that a plurality thereof can be employed in the same clock.

According to the present invention, there is provided drive apparatus comprising an angularly movable member; a drive motor which is carried by the angularly
5 movable member and which drives a drive gear; a stationary gear which is mounted externally of the angularly movable member and concentrically of the axis of rotation of the latter; and a rotary gear which is
10 carried by the said angularly movable member and which meshes with the drive gear, the rotary gear having a part which meshes with the stationary gear so that operation of the drive motor causes the rotary gear to move around at least part of the periphery of the
15 stationary gear so as to effect angular movement of the angularly movable member.

Preferably, the angularly movable member is provided with a decoration or ornament, angular movement of which is effected by moving the angularly movable
20 member angularly.

The said part of the rotary gear is preferably constituted by a pinion thereof.

There are preferably regulation means for restricting the angle of rotation of the angularly
25 movable member.

The regulation means may comprise two engagement portions on the angularly movable member at positions corresponding to the ends of the desired angle of rotation of the latter; a fixed stopper; and a damper
30 which is carried by the stopper and is frictionally movable thereover, the damper being engageable with each of the engagement portions when the latter is in a said position.

Means are preferably provided for releasing

engagement between the rotary gear and the stationary gear. Thus the rotary gear may be mounted on a resiliently displaceable shaft, the pinion being disposed at the distal end of said shaft.

5 The invention also comprises a timepiece provided with at least one such drive apparatus.

10 In its preferred form, the drive apparatus prevents the angularly movable member from rebounding when the latter stops rotating. In its preferred form, moreover, the teeth of the rotary and stationary gears are prevented from being subjected to damage or breakage even if some external force is applied such that the angularly movable member is forced to rotate beyond the extent of a given angle and thus an excessive force is
15 imposed on the rotary gear.

20 In the preferred form of the present invention, when the drive motor on the angularly movable member starts, the rotary gear rotates in response to the rotation of the drive gear, the pinion rolls around the stationary gear, and thus the angularly movable member moves angularly with the decoration or ornament and the drive motor.

25 Even after the angularly movable member has rotated through a given angle of rotation and a driving signal to the drive motor has terminated, the angularly movable member may rotate further due to inertia. At the same time, however, one engagement portion of the angularly movable member resiliently contacts the damper to push it. The damper shifts against its friction with
30 the stopper, and finally the damper compresses, whereby the turning force is absorbed completely.

 If some external force causes an excessive force to act on the angularly movable member, the resiliently displaceable shaft is displaced so as to release the

engagement of the pinion with the stationary gear.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

5 Figures 1 and 2 are front views of a clock on a reduced scale, the clock being provided with drive apparatus according to the present invention, and the clock being shown in Figures 1 and 2 in different states of operation;

10 Figure 3 is a front view of an angularly movable block with a decoration or ornament mounted in front;

 Figure 4 is a right side view of the angularly movable block with the decoration or ornament mounted in front;

15 Figure 5 is a sectional view taken along line A-A of Figure 3;

 Figure 6 is an enlarged sectional view showing an important portion of a device for effecting angular movement of the angularly movable member;

20 Figure 7 is an enlarged plan view of a stationary gear forming part of said device;

 Figure 8 is an enlarged plan view explanatory of the engagement and disengagement of the stationary gear with a pinion of said device;

25 Figure 9 is an enlarged explanatory front view showing a portion of the device for effecting actuation of switches thereof;

 Figure 10 is a sectional view of the angularly movable block with an hour indicating surface thereof presented in front;

30 Figure 11 is a bottom view of a regulation means for regulating the extent of angular rotation of the said block;

 Figure 12 is an enlarged sectional view of the regulation means;

Figure 13 is an enlarged back view of a portion of a power supply unit for a drive motor of the device; and

Figure 14 is a right side view of the power supply unit.

5 Terms such as "upper" and "lower", as used in the description below, are to be understood to refer to directions as seen in the accompanying drawings.

10 Figures 1 and 2 are front views of a clock for domestic use to which the present invention is applied, Figures 1 and 2 showing the clock in different states of operation. Numerals indicative of the hours between 1 and 12 are shown respectively on twelve angularly movable blocks 1 described hereinafter. Each angularly movable block 1 is mounted on a case 2 at an angular position such that the numeral expressed on an hour indicating surface 71 of each angularly movable block 1 accords with the hour indicating numeral of the clock which is implied by its said angular position. An hour hand 4 and a minute hand 5 are positioned in front of a dial 3 and are rotated by a timepiece movement (not shown) secured to the back of the dial 3.

20 As shown in Figures 3 to 5, each angularly movable block 1 comprises an angularly movable member 7 which is rotatably mounted in a frame member 6 and which has a substantially U-shaped section. The frame member 6 is secured to the case 2 by means of bracket members 6a which form part of the frame member 6. As shown in Figure 5, the angularly movable member 7 is substantially triangular in the plan view. One surface of the angularly movable member 7 is planar and constitutes the hour indicating surface 71 on which the hour indicating numeral is shown. Another surface of the rotary member 7 is constituted by a circular arc surface 72 on which is mounted a decoration or ornament

8 in the form of a doll such as a clown. The remaining surface 76 of the angularly movable member 7 has an opening 73 therein. The angularly movable member 7 is rotatably supported on the frame member 6 by a centre shaft 9 which passes vertically, as shown in the drawings, through a central portion of the angularly movable member 7.

As shown in Figures 5 and 6, means for effecting angular movement of the angularly movable member 7 are arranged inwardly of the periphery of the angularly movable member 7 itself. A drive motor 10 for driving the angularly movable member 7 is attached via a supporting plate 11 on the angularly movable member 7. A shaft 10a of the drive motor 10 has a drive gear 12 secured thereon, the lower end of the drive gear 12 being loosely mounted in an opening 7a formed in the bottom of the angularly movable member 7. The supporting plate 11 has a resiliently displaceable shaft 11a which extends vertically, and a rotary gear 13 is rotatably mounted on the shaft 11a. The rotary gear 13 meshes with the drive gear 12 and has a pinion 13a formed integrally therewith. The pinion 13a is rotatably mounted on a distal end of the shaft 11a. The bottom of the angularly movable member 7 has an opening 7b through which the pinion 13a can pass and into which it projects. Adequate space is provided between the surface of the opening 7b and a shaft portion of the rotary gear 13.

The frame member 6 has a stationary gear 14 on the bottom thereof, the stationary gear 14 being disposed concentrically of the centre shaft 9 and hence externally of the angularly movable member 7 and concentrically of the axis of rotation of the latter. As shown in Figure 7, the stationary gear 14 has a hole

14f at the centre thereof through which the centre shaft 9 passes. The stationary gear 14 includes a thin portion 14b and a thick portion 14a having a toothed portion 14c. The toothed portion 14c is in mesh with the pinion 13a. Since the pinion 13a is supported by the resiliently displaceable shaft 11a as described above, when an excessive force is applied to the pinion 13a, the shaft 11a is moved within the space of the opening 7b as shown in Figure 8 so that the engagement of the teeth of the pinion 13a with those of the stationary gear 14 can be released. To facilitate such release, the teeth of the toothed portion 14c and/or of the pinion 13a are made circular at the end thereof.

As shown in Figures 9 and 10, the supporting plate 11 has microswitches 15 and 16 for control of the drive motor 10, the microswitches 15 and 16 being mounted on a support plate 17 which is secured to the drive motor 10. A flexible cable 18 is secured to the upper surface of the support plate 17. The flexible cable 18 is connected to both the switches 15 and 16. The cable 18 has integral elongated portions 18a and 18b which connect the drive motor 10 to a circuit board 19 described hereinafter. The portion 18b of the cable 8 connects the switches 15 and 16 to the circuit board 19.

Actuation of the switches 15 and 16 will now be described.

As shown in Figure 9, the switches 15, 16 have respective operating members 15a and 16a which retractably project from their respective bottom surfaces. The operating members 15a, 16a are in operation retracted in response to angular movement of operating springs 15b and 16b which pivotally engage the bottom surfaces of the switches, so as to actuate the switches. The operating springs 15b and 16b have on

their respective distal ends rollers 15c and 16c projecting downwards through an opening (not shown) in the bottom surface of the angularly movable member 7. The rollers 15c, 16c are adapted to roll over the thin portion 14b of the stationary gear 14 within a given angle of rotation. The travel loci of the two rollers are defined as circumferences whose radii from the centre of the stationary gear 14 differ from each other. That is, the roller 15c has a large-diameter circumference as its travel locus and the roller 16c has a small-diameter circumference as its travel locus. The thin portion 14b has an inclined surface at one end (the left hand end in Figure 9) on the large-diameter travel locus which defines a cam surface 14d, and another inclined surface at the other end (the right hand end in Figure 9) on the small-diameter travel locus which defines another cam surface 14e whose direction of inclination is opposite to that of the cam surface 14d. Therefore, when the angularly movable member 7 rotates through a given angle of rotation, one of the rollers 15c, 16c rolls upwards over a cam surface 14a, 14e, so that one of the operating springs 15b, 16b swings to cause retraction of the respective operating member 15a, 16a, thereby turning off the respective switch 15, 16.

A regulation means 20 for restricting the angle of rotation of the angularly movable member 7 will now be described.

As shown in Figures 11 and 12, the angularly movable member 7 is provided on its bottom with two engagement portions 74 and 75 which correspond to the angle of rotation (120 degrees) of the angularly movable member 7. The frame member 6 has a stationary stopper 21 projecting therefrom. The stopper 21 has a ring-like damper 22 fitted on a neck portion 21a of the stopper

21. The damper 22 is prevented from coming off by a screw 23. The damper 22 is dimensioned so that its inner diameter is larger than the diameter of the neck portion 21a but smaller than the diameter of the stopper 21. The thickness of the damper 22 is larger than the width of the neck portion 21a. The damper 22 is made of a resilient material such as rubber. Thus, the damper 22 can shift frictionally in relation to the stopper 21. The engagement portions 74 and 75 of the angularly movable member 7 can resiliently contact the damper 22 in opposite directions. To secure the stopper 21 to the frame member 6, the stopper 21 has a threaded portion 21b formed in a lower portion thereof, and a nut 24 is screwed to the threaded portion 21b on the underside of the frame member 6.

A unit for supplying power to the driving motor 10 will now be described.

As shown in Figures 13 and 14, a mounting plate 25 is secured to the back surface of the circuit board 19 which is connected to the portion 18b of the flexible cable 18. The circuit board 19 is secured via the mounting plate 25 to the back surface of the frame member 6. The mounting plate 25 has a recess portion 25a in which a connector 26 for the connection of the circuit board 19 to a control circuit (not shown) can be accommodated. The bottom of the recess portion 25a has protrusions 25b for supporting a side surface of the connector 26. The mounting plate 25 has a plurality of backwardly projecting resilient pawls 25c which are adapted to secure the mounting plate 25 to the frame member 6. The frame member 6 has engagement holes 6b in which the resilient pawls 25c are engageable through their resilient deformation.

As described above, the drive motor 10 is carried

on the angularly movable member 7, so as to move together with the angularly movable member 7. Therefore, the portion 18b of the flexible cable 18 for connection of the driving motor 10 to the circuit board 19 is liable to touch the peripheral surface of the drive motor 10, the corners of the angularly movable member 7 and of the frame member 6 lying on the path of the portion 18b of the flexible cable 18, and so on. To reduce sliding friction between the said components and the portion 18b of the flexible cable 18, as shown in Figures 4, 5, 9 and 10, a protective non-conductive wall 11b (e.g. of plastics) is formed integrally with the supporting plate 11 around the drive motor 10. Therefore, the portion 18b of the flexible cable 18 never slides directly on the peripheral wall of the motor 10, so that there is no sliding friction with metal. Thus the service life of the flexible cable 18 can be prolonged effectively.

Because of the foregoing structure, while the clock shown in Figures 1 and 2 is indicating time with the angularly movable member 7 of each angularly movable block 1 presenting its hour indicating surface 71 in front, when a predetermined hour (e.g. three o'clock) is reached, the individual angularly movable members 7 are moved angularly at random in harmony with a melody, so that the decorations or ornaments 8 are presented in front as shown in Figure 2. Then, an electronic time signal corresponding to the count of the current hour (three o'clock) is sounded, the angularly movable members 7 are successively moved angularly starting with the one next to that corresponding to the current hour, and finally, each initial hour indicating surface 21 is presented in front.

The above operation of the angularly movable

member 7 will now be described in more detail.

When the angularly movable member 7 remains stationary with its hour indicating surface 71 presented in front, the engagement portion 74 is in resilient contact with the damper 22 as illustrated by the chain line in Figure 11, the roller 16c having ridden on the cam surface 14e so as to lie on the thick portion 14a and the other roller 15c being disposed on the thin portion 14b.

When a driving signal is supplied through the flexible cable 18 to the drive motor 10, the drive motor 10 starts to rotate the drive gear 12, so that the gear 13 and the pinion 13a are rotated. Since the pinion 13a is in mesh with the toothed portion 14c of the stationary gear 14, it moves around the toothed portion 14c while rotating. As a result, the angularly movable member 7 is angularly moved clockwise from the position where the hour indicating surface 71 is presented in front as shown in Figure 10. During this angular movement of the angularly movable member 7, both the rollers 15c and 16c roll over the thin portion 14b. When the angularly movable member 7 is angularly moved further so that the roller 15c rides on the cam surface 14d, the supplying of the driving signal is terminated so as to stop the drive motor 10. Although the drive motor 10 and the angularly movable member 7 try to continue rotation due to their inertia, as illustrated by the solid line in Figure 11, the engagement portion 75 comes into resilient contact with the damper 22 in the opposite direction to push the damper, so that the damper shifts frictionally in relation to the stopper 21 while absorbing a turning force resulting from the inertia. Finally, the damper 22 completely absorbs the turning force through its resilient deformation, whereby

the angularly movable member 7 can be stopped smoothly without bounding. At this stage, the decoration 8 is presented in front.

5 During the foregoing angular movement of the angularly movable member 7, the drive motor 10 also moves from the position shown in Figure 10 to the position shown in Figure 5. The portion 18b of the flexible cable 18 maintains its gentle curved shape and makes contact only with the peripheral surface of the protective wall 11b even in the position shown in Figure 10; thus, it never makes contact with the peripheral surface of the drive motor 10.

10 When returning the angularly movable member 7 to the state wherein the initial hour indicating surface 71 is presented in front, a driving signal for reverse angular movement is supplied to the drive motor 10, whereby a series of operations identical with those described above is performed.

15 If some external force is applied to the angularly movable member 7 to cause its angular movement forcibly, the toothed portion 14a and the pinion 13a would normally collide because the gear 14 which is engaged by the pinion 13a is fixed, so that the toothed portion 14a may be damaged. In the illustrated embodiment, however, the shaft 11a is resiliently displaced to the chain line position in response to a force acting thereon as shown in Figure 8, so that the engagement of the pinion 13a with the toothed portion 14c is released, thereby preventing such damage.

20 It should be noted that the angularly movable member 7 may have a cylindrical or hexagonal shape as well as a triangular one.

25 In the embodiment described above, most of the components of the device, such as the drive motor 10 and

the gears, are carried on the angularly movable member 7 having the decoration 8, and the stationary gear 14 is the only component disposed outside the angularly movable member 7. Therefore, the whole device can be reduced in size, a plurality of the angularly movable blocks 1 can be arranged in the same clock, and the clock can be produced at a low cost.

The regulation means for regulating the angle of rotation of the angularly movable member 7 comprises a damper 22 frictionally shiftable in relation to the stopper 21. Thus, any shock resulting from the restriction of the angle of rotation can be efficiently absorbed, thereby preventing the angularly movable member from rebounding when stopping.

Further, even if some external force is applied to the angularly movable member 7 to rotate the latter beyond the extent of a given angle so that an excessive force is imposed on the gear 13, the flexure of the shaft 11a can allow the meshing parts 13a, 14c to be released from engagement, thereby preventing them from being damaged or broken.

CLAIMS

1. Drive apparatus comprising an angularly movable member; a drive motor which is carried by the angularly movable member and which drives a drive gear; a stationary gear which is mounted externally of the angularly movable member and concentrically of the axis of rotation of the latter; and a rotary gear which is carried by the said angularly movable member and which meshes with the drive gear, the rotary gear having a part which meshes with the stationary gear so that operation of the drive motor causes the rotary gear to move around at least part of the periphery of the stationary gear so as to effect angular movement of the angularly movable member.
2. Drive apparatus as claimed in claim 1 in which the angularly movable member is provided with a decoration or ornament angular movement of which is effected by moving the angularly movable member angularly.
3. Drive apparatus as claimed in claim 1 or 2 in which the said part of the rotary gear is constituted by a pinion thereof.
4. Drive apparatus as claimed in any preceding claim comprising regulation means for restricting the angle of rotation of the angularly movable member.
5. Drive apparatus as claimed in claim 4 in which the regulation means comprises two engagement portions on the angularly movable member at positions corresponding to the ends of the desired angle of rotation of the latter; a fixed stopper; and a damper which is carried by the stopper and is frictionally movable thereover, the damper being engageable with each of the engagement portions when the latter is in a said



position.

6. Drive apparatus as claimed in any preceding claim comprising means for releasing engagement between the rotary gear and the stationary gear.

5 7. Drive apparatus as claimed in claim 6 when dependent upon claim 3 in which the rotary gear is mounted on a resiliently displaceable shaft, the pinion being disposed at the distal end of said shaft.

8. Drive apparatus substantially as
10 hereinbefore described with reference to and as shown in the accompanying drawings.

9. A timepiece provided with at least one drive apparatus as claimed in any preceding claim.

10. A device for turning a decoration for a
15 timepiece, comprising:

a rotary member provided with a decoration,
a stationary gear disposed concentrically to a
centre shaft of said rotary member,

a driving motor carried on said rotary member
20 for rotating the latter, and

a gear carried on said rotary member so as to mesh with a drive gear of said driving motor and having a pinion engaged with said stationary gear.
