

DRIVE UNIT FOR A ROTARY DECORATION MEMBER

The present invention relates to a drive unit for a rotary decoration member which may be used in a table clock with a rotary decoration member, for example.

5 Highly decorative table clocks with a rotary decoration member are popular. The rotary decoration member in such a table clock is usually mounted on a rotatable vertical shaft extending from a case which houses a drive mechanism. The drive mechanism causes
10 the vertical shaft to rotate so as to cause a horizontal rotary swinging movement of the rotary decoration member.

Several types of drive unit for such a table clock have previously been proposed.

15 In Japanese Utility Model Publication No. 4864 of 1986 the drive unit comprises a hair-spring, a coil, and a drive magnet.

Although an elegant swinging movement of the rotary decoration member can be obtained using a drive
20 unit equipped with a hair spring, there are some disadvantages with this prior arrangement.

The spring constant of the hair-spring must be matched to the mass, rotational angle, and period of reciprocative swing movement of the rotary decoration.
25 In addition the design and manufacturing process of the hair spring is complicated, resulting in a high cost. Moreover, the balance wheel mechanism used as the drive source is arranged in such a manner that a plurality of permanent magnets and coils are arranged alternately on
30 top of one another. Therefore, the overall size of the drive unit may become so bulky that the outer design of a table clock is restricted thereby.

The present applicant has previously proposed a different type of motor-driven unit in Japanese Patent
35 Application No. 43718 of 1991 wherein a stepping motor capable of rotating in both the forward and reverse

directions is provided instead of a hair-spring, coil, and drive magnet.

Although this arrangement dispenses with the need for a hair-spring, there are also disadvantages with
5 this arrangement. In operation, the stepping motor is accelerated in response to operation pulses and is braked in the period without an operation pulse. Thus the stepping motor pulses in its rotation by the repetition of acceleration and braking. If this
10 intermittent rotation of the stepping motor is directly transmitted to the shaft onto which the rotary decoration is mounted, the rotational speed of the rotary decoration will be subject to irregularities.

The present invention seeks to provide a drive
15 unit for a rotary decoration member which has a simple, low cost structure yet is capable of providing a smooth swing movement despite the use of a stepping motor as its driving source.

According to a first aspect of the present
20 invention there is provided a drive unit for a rotary decoration member having a stepping motor which drives an output shaft through a drive train wherein the drive train includes a transmission gear comprising a first and a second sub-gear, the first sub-gear being coupled
25 to the stepping motor and the second sub-gear being coupled to the output shaft, and in which the transmission gear further comprises a resilient transmission element coupling the first and second sub-gears such that the transmission element allows a
30 limited amount of relative rotation between the first and second subgears and is able to store rotational force.

According to a second aspect of the present invention there is provided a drive unit for a rotary
35 decoration member comprising;

a stepping motor capable of rotating in both the

forward and reverse directions;

a drive gear for meshing with a transmission gear that transmits the rotational driving force of said stepping motor;

5 a rotary shaft inserted into said drive gear and rotatably supported to stand upright in a vertical direction;

a rotary decoration member mounted on one end of said rotary shaft;

10 said transmission gear being divided into upper and lower sections coupled together through the medium of a coil spring;

said drive gear being loosely received in a housing which is established in a fixed position;

15 said housing containing a viscous material.

For a better understanding of the present invention, and to show how it may be brought into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

20 Figure 1 is a partially cross-sectional view of one embodiment of the present invention.

Figure 2 is an enlarged cross-sectional view showing an enlarged part of the embodiment of Figure 1;

Figure 3 is a cross-sectional view taken along a
25 line A-A of Figure 2; and

Figure 4 is an enlarged cross-sectional view of the part shown in Figure 2 in an operational condition.

In Figure 1, there is shown an upper casing 1 and a lower plate 2 connected with each other to form a
30 box. A drive unit for a rotary decoration 6 is housed in this box.

A cup 3, having a bearing 3a secured therein, is provided on the upper casing 1 and a housing 4 is provided on the lower plate 2. A rotary shaft 5 is
35 supported by this bearing 3a and the housing 4, so as to be rotatable about its axis. The rotary shaft 5

protrudes out of the upper casing 1 and a rotary decoration 6 is mounted on the top end portion of the rotary shaft 5.

Furthermore, a toroidal permanent magnet 7 is secured in the cup 3 on the upper casing 1. Hereinafter, this magnet 7 is referred to as the "fixed magnet 7". This fixed magnet 7 faces a toroidal permanent magnet 8 which is secured to the rotary shaft 5 by means of a bush 8a.

10 Magnets 7 and 8 are arranged such that their opposing faces are of the same polarity. As a result the magnets are mutually repelled and the rotary decoration 6 is at least partly supported by the magnetic repulsion. The lower end of the rotary shaft
15 5 is secured by a nut 9 which prevents the shaft 5 from escaping upwardly out of the housing 4.

 In the box comprised of the upper casing 1 and lower plate 2, there is mounted a stepping motor M which is capable of rotating in both the forward and
20 reverse directions. The stepping motor M includes a stator 10 and a rotor 11. The stepping motor M serves as the driving source for the rotary decoration 6.

 A rotor pinion 11a, an integral part of the rotor 11, meshes with a middle gear 12 which in turn meshes
25 with a transmission gear 13. Further, the transmission gear 13 meshes with a drive gear 14 into which the rotary shaft 5 is inserted. Thus, a gear train is constituted so that the forward and reverse rotation of the stepping motor M can cause a reciprocative swing
30 motion of the rotary decoration 6.

 The transmission gear 13 is divided into an upper gear 13a and a lower gear 13b with a coil spring 15 interposed therebetween. An upper end and a lower end of the coil spring 15 are fixed to the upper gear 13a
35 and the lower gear 13b respectively. When the upper gear 13a rotates, the resilient coupling, formed by the

coil spring 15 is wound up storing its spring force. With this charged spring force of the coil spring 15, the lower gear 13b is rotated to transmit the rotational force to the drive gear 14.

5 The drive gear 14 into which the rotary shaft 5 is inserted is loosely engaged to the housing 4 provided on the lower plate 2. A viscous material 16, such as grease, is daubed between the inside surface of this housing 4 and the outside surface of the drive gear 14.

10 The function of this viscous material 16 will now be described.

During the transmission of the rotational driving force from the stepping motor M to the drive gear 14, the upper gear 13a receives a rotational force
15 intermittently in response to the operation of the stepping motor M.

Then, the upper gear 13a rotates by the transmitted rotational force, and the coil spring 15 is wound up to store its spring force. With this charged
20 spring force of the coil spring 15, the lower gear 13b is rotated and transmits the rotational force to the drive gear 14.

Through the insertion of the coil spring 15 in the transmission gear train, the rotation of the lower gear
25 13b is smoothed to a certain degree even though the upper gear 13a is rotated in stepwise manner. When the rotation of the lower gear 13b is transmitted to the drive gear 14, the viscous material 16 contained in the housing 4 acts as a resistance against rotation of the
30 drive gear 14 and so the above described intermittent rotational movement of the stepping motor M can be further smoothed. Accordingly, the rotary decoration 6 can smoothly rotate with reduced rotational irregularities.

35 When the rotary decoration 6 has passed the middle point of one revolution cycle, the rotational speed of

the stepping motor M is gradually decreased. When its speed has sufficiently decreased, the stepping motor M initiates the reversal of its rotational direction from the forward direction to the reverse direction causing
5 the upper gear 13a also to rotate in the reverse direction. The deceleration, stopping and reversing of the stepping motor M are thus transmitted to the transmission gear 13a.

As a result, the coil spring 15 having been wound
10 during rotation in the forward direction is loosened and is again oppositely wound to charge its spring force, which charged spring force initiates rotation of the lower gear 13b in the reverse direction. In this manner, when the upper gear 13a is decelerated, braked,
15 or reversed, the lower gear 13b rotates by being driven by the spring force of the coil spring 15 stored in it. Therefore, a phase deviation or dislocation in the rotation of the upper gear and lower gear occurs.

The drive gear 14 is uneven in its rotation due to
20 this phase deviation or dislocation when its rotational direction reverses. However, the viscous material 16 contained in the housing 4 acts as a resistance against the drive gear 14 and so the drive gear 14 is braked.

As a result, the above described deceleration,
25 braking, and reversal rotation force of the stepping motor M can be moderated. Accordingly, the rotation decoration 6 can smoothly rotate without causing intermittent deceleration, braking, or reversal, or without unevenness in its rotation. The identical
30 operation is repeated in the subsequent revolution cycles.

The rotary shaft 5 is engaged with the drive gear 14, so as to be capable of sliding along the axis of the drive gear 14, but it is not rotatable with respect
35 to the drive gear 14. Hereinafter, the details of the construction of the rotary shaft will be described.

As shown in Figure 2 and Figure 3, the radial cross section of the rotary shaft 5 in the section where it meshes with the drive gear 14 is non-circular. Accordingly, the rotary shaft 5 can rotate together with the drive gear 14, and also can move along its axis.

In this manner, the axial length of the above described portion which has a non-circular cross section along its radius is designed to be longer than the axial thickness of the drive gear 14, by taking account of the amount of axial movement of the rotary shaft 5 itself. The width of the lower gear 13a of the transmission gear 13 that meshes with the drive gear 14 is set to "a".

Here, it is supposed the rotary shaft 5 is dislocated along its axial direction when the rotary decoration 6 is mounted on the rotary shaft 5, or when the rotary decoration 6 is mistakenly touched by someone's hand resulting in an external force being applied along the direction of the arrows, as shown in Figure 4, and the rotary shaft 5 being lowered by a length "b" against the magnetic repulsion force until permanent magnet 8 abuts the fixed magnet 7.

In this case, the rotary shaft 5 moves in the drive gear 14 by a length "b". However, the drive gear 14 does not move together with the rotary shaft 5. Therefore, the meshing between the drive gear 14 and the transmission gear 13 is not adversely affected.

In the case where the gear 14 is fixed to the rotary shaft 5, the drive gear 14 must move together with the rotary shaft 5 when the rotary shaft 5 is dislocated along its axis. In this case, the gear width "a" (see Figure 2) of the gear 13a of the transmission gear 13 which engages the drive gear 14 must be set to a sufficiently large value. However, in accordance with the configuration of the embodiment of

the present invention described herein this gear width "a" may be set to the smallest possible value.

In this embodiment, as shown in Figure 3, the radial cross section of the rotary shaft 5 in the section where it meshes with the drive gear 14 is non-circular. The coupling is not limited to this form, but can also be conceived in several other configurations such as using the section where the rotary shaft 5 meshes with the drive gear 14 as a biased column.

Thus, with a viscous material contained in the housing in which the drive gear is loosely engaged, the viscous material acts as a resistance against the drive gear. Accordingly, even if the stepping motor is intermittently rotated, the rotary decoration member rotates smoothly.



CLAIMS

1. A drive unit for a rotary decoration member having a stepping motor which drives an output shaft through a drive train wherein the drive train includes
5 a transmission gear comprising a first and a second sub-gear, the first sub-gear being coupled to the stepping motor and the second sub-gear being coupled to the output shaft, and in which the transmission gear further comprises a resilient transmission element
10 coupling the first and second sub-gears such that the transmission element allows a limited amount of relative rotation between the first and second subgears and is able to store rotational force.
2. A drive unit as claimed in claim 1 wherein
15 the transmission element is a spring.
3. A drive unit as claimed in any preceding claim, wherein the output shaft is supported within a part of a housing containing a viscous material so that the rotational movement of the output shaft is
20 smoothed.
4. A drive unit as claimed in claim 3 wherein the viscous material is grease.
5. A drive unit as claimed in any preceding claim wherein the drive train further comprises a drive
25 gear, which is coupled to the second sub-gear, and into which drive gear the output shaft is fitted.
6. A drive unit as claimed in claim 5 when dependent on claim 3 or 4 wherein the drive gear is housed within the housing and the viscous material is
30 arranged between the housing and the drive gear.
7. A drive unit as claimed in claim 5 or 6 wherein the output shaft is axially slidable relative to the drive gear.
8. A drive unit as claimed in any preceding
35 claim wherein the output shaft is further supported by a bearing comprising a first magnet attached to the



output shaft and a fixed magnet arranged so that the first and second magnets repel each other.

9. A drive unit for a rotary decoration member as claimed in any preceding claim wherein the stepping
5 motor is capable of rotating in forward and reverse directions.

10. A drive unit for a rotatable decoration member substantially as herein described with reference to the accompanying drawings.

10 11. A drive unit for a rotary decoration member comprising;

a stepping motor capable of rotating in both the forward and reverse directions;

a drive gear for meshing with a transmission gear
15 that transmits the rotational driving force of said stepping motor;

a rotary shaft inserted into said drive gear and rotatably supported to stand upright in a vertical direction;

20 a rotary decoration member mounted on one end of said rotary shaft;

said transmission gear being divided into upper and lower sections coupled together through the medium of a coil spring;

25 said drive gear being loosely received in a housing which is established in a fixed position;
said housing containing a viscous material.