

"DEVICE FOR DRIVING TWIST PENDULUMS"

The present invention relates to a device for driving twist pendulums.

A twist pendulum has been used for a table clock or the like. Generally, the pendulum has been attached to a lower portion of a pendulum shaft which projects downwardly from a mechanism casing, and which is rotated by magnetic action between a magnet and a driving coil housed in the casing, while the rotational angle through which the pendulum moves has been restricted by spring force of a hair spring, so that the pendulum continues the rotation repeatedly.

Recently it is said that the market is changing from a mass consumption to an individual market. In order to cope with such a change, it is necessary to increase the value of a commodity, and a great demand for the commodity cannot be expected unless the commodity has individuality or unexpectedness. From this point of view, the conventional twist pendulum cannot satisfy the variety of requirements of the various customers because there is only one pendulum on a pendulum shaft, so that the movement of the pendulum is very simple and monotonous, while it has few decorative parts, and so lacks interests as a commodity.

According to the present invention, there is provided a device for driving twist pendulums comprising a first pendulum shaft which acts as a driving shaft; a second pendulum shaft which is a tubular shaft mounted concentrically

about the first pendulum shaft; electro-magnetic means arranged to drive the first pendulum shaft in a predetermined angular direction; spring means for driving the first pendulum shaft in the opposite angular direction; drive transmission means for transmitting drive from the first pendulum shaft to the second pendulum shaft; and first and second connector means which are respectively secured to the first and second pendulum shafts and which are respectively adapted to be connected to first and second twist pendulums.

Preferably, the drive transmission means cause the first and second pendulum shafts to rotate simultaneously in opposite directions.

The electro-magnetic means may comprise at least one magnet and driving coil. Preferably, the or each magnet is secured to a respective yoke, the or each yoke being carried by a driving wheel which is secured to the first pendulum shaft.

The spring means preferably comprises a hair spring.

The drive transmission means may comprise first and second transmission gears fixed on the first and second pendulum shafts respectively, at least one intermediate gear being provided to transmit drive between the said first and second transmission gears.

There may be magnetic means provided respectively on the first transmission gear and adjacent fixed structure for urging the first transmission gear away from the adjacent fixed structure so as to maintain the first transmission gear in a floating condition.

First and second twist pendulums may be respectively secured to the first and second connector means.

In the preferred form of the present invention, being driven by the driving wheel, one of the pendulum shafts is rotated so as to rotate one of the twist pendulums in the said predetermined direction, and then the rotation of the said one twist pendulum is reversed by the spring force of the hair spring, the reversible rotation being repeated in the same manner through a predetermined rotational angle. The other pendulum shaft is rotated by the rotational force of the driving wheel transmitted from the first transmission gear to the second transmission gear through the intermediate gear or gears, so that the other twist pendulum is rotated and then reversed. Thus, the other twist pendulum is reversely rotated through a predetermined angle in a direction opposite to that of the said one twist pendulum, and then reversed.

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

Figure 1 is a longitudinal cross-section of a device according to the present invention,

Figure 2 is a plan view of a main portion of the said device; and

5 Figure 3 is a diagrammatic view showing a portion of the device of the present invention with the twist pendulums attached thereto.

 An embodiment according to the present invention will be described hereunder. In Figures 1 and 2, there is shown
10 a pendulum shaft 1 which acts as a driving shaft and a tubular pendulum shaft 2 which is drivingly connected to the pendulum shaft 1 to be rotated thereby, the shafts 1, 2 being concentric and extending vertically in a mechanism casing 3.

15 The pendulum shaft 1 is rotatably supported at its upper end by a bearing 4 provided on an inner surface of an upper casing 3a of the mechanism casing 3. The pendulum shaft 1 is also rotatably supported at an intermediate portion thereof by a bearing 4a. The latter
20 is fixed on a first inner plate 5 which extends horizontally in a lower casing 3b. A flat T-shaped driving wheel 6 is fixed on the upper end portion of the pendulum shaft 1. A plate-like balancer 7 is attached to the driving wheel 6 at the lower surface of the latter
25 and on one side of the latter. Two yokes 8, 8 extend

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horizontally on the other side of the driving wheel 6 and are secured thereto, the yokes 8, 8 being separated from each other by a predetermined interval. Disk-like magnets 9, 9 are attached respectively on the surfaces of the respective yokes 8,8 facing each other. A ring-like driving coil 10 fixed on a holder (not shown) projecting from a side wall of the mechanism casing 3 is disposed between the magnets 9, 9 so that the driving wheel 6 can be driven to rotate in a predetermined direction by the magnetic action of the driving coil 10 and the magnets 9. 9. Such rotation of the driving wheel 10 causes rotation of the pendulum shaft 1 in the same direction as that of the driving wheel 6. A hair spring 11 (Figure 2) is arranged between the upper end portion of the pendulum shaft 1 and the inner surface of the upper casing 3a, so that the angle through which the driving wheel 6 and the pendulum shaft 1 can be rotated is restricted by the spring force of the hair spring 11, the latter causing the driving wheel 6 and the pendulum shaft 1 to be reversely rotated through a predetermined angle.

The rotational force of the pendulum shaft 1 is transmitted to the pendulum shaft 2 through a transmission mechanism. That is, a transmission gear 12 is fixed to the pendulum shaft 1 at its intermediate portion. The transmission gear 12 is provided at its lower side with a toothed portion

12a. The lower end surface of the transmission gear 12 is disposed adjacent to the upper surface of the bearing 4a of the first inner plate 5. A first intermediate gear 13 is engaged with the toothed portion 12a of the transmission gear 12. The lower and upper ends of a shaft 13a of the first intermediate gear 13 are respectively rotatably supported by the respective bearing portions of the first inner plate 5 and of a second inner plate 14.

An upper toothed portion 15a of a second intermediate gear 15 is engaged with the first intermediate gear 13, the number of teeth of the toothed portion 15a being selected to be the same as that of the toothed portion 12a of the transmission gear 12. A shaft 15c of the second intermediate gear 15 is rotatably supported by the respective bearing portions of the second inner plate 14 and the lower casing 3b. A lower toothed portion 15b of the second intermediate gear 15 is engaged with a toothed portion 16a of a drive transmission gear 16 having the same number of teeth as that of the toothed portion 15b.

The drive transmission gear 16 is made in the form of a sleeve and is forcibly inserted onto the pendulum shaft 2 at an upper portion of the latter. The drive transmission gear 16 is provided at its upper central portion with a bearing portion which engages a bearing portion 5a which extends vertically down from the first inner

plate 5. The lower end surface of the drive transmission gear 16 is disposed adjacent to an inside portion $3b_2$ of an intermediate reduced portion of a cylindrical portion $3b_1$ projecting down from the outer surface of the lower casing $3b$.

The pendulum shaft 2 is fitted on the lower half of the pendulum shaft 1. The lower portion of the pendulum shaft 2 is supported by a sleeve-like bearing 17 which is forcibly inserted into a lower end opening portion of the cylindrical portion $3b_1$. The lower end portion of the pendulum shaft 2 projects down from the lower end of the cylindrical portion $3b_1$ together with the pendulum shaft 1, and the pendulum shaft 1 further extends down from the lower end of the pendulum shaft 2 so as to be exposed thereat.

Hooks 20, 21 for respectively hooking twist pendulums 18, 19 are forcibly inserted into the respective lower ends of the pendulum shafts 1, 2. Convex hooking surfaces $20a$, $21a$ are formed on the whole outer circumferences of the hooks 20, 21 respectively. Protrusions $18b$, $19b$, which are formed on upper portions of four arm portions $18a$, $19a$ provided respectively on the twist pendulums 18, 19 are coaxially arranged as shown in Figures 1 and 3, and are hooked respectively onto the hooking surfaces $20a$, $21a$. Accordingly, as the pendulum shafts 1, 2 rotate, the twist pendulums 18, 19 can rotate integrally with the shafts 1 and 2. In order

to make the integral rotation more effective, four engageable recess portions 20b, 21b are equidistantly provided in the hooking surfaces 20a, 21a so that the respective protrusions 18b, 19b of the four arms are made engageable with the recess portions respectively. As shown in Figure 3, the twist pendulum 18 projects down at its lower portion beyond the lower end of the twist pendulum 19. Pendulum decorations 18c, 19c are horizontally secured to the lower ends of the respective pendulums.

The pendulum shafts 1, 2 are urged downwardly by the respective weights of the twist pendulums 18, 19. Accordingly, as to the pendulum shaft 1, the lower surface of the transmission gear 12 comes into contact with the bearing 4a, while in the pendulum shaft 2, the drive transmission gear 16 comes into contact with the inside portion 3b₂ of the cylindrical portion 3b₁, so that there is a risk that the twist pendulums 18, 19 and pendulum shafts 1, 2 may be prevented from rotating smoothly by the frictional resistance. Therefore, friction-free means are shown in Figure 1. That is, a pair of magnet rings 24, 24a provided on the upper outer circumferential portion of the transmission gear 12 and on the second inner plate 14 respectively are arranged vertically opposite to each other. The respective magnetic poles of the magnets

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repel each other to keep the transmission gear 12
always in a floating state. The lower end surface of the
transmission gear 12 is thus separated up from the bearing
4a. Similarly to this, a pair of magnet rings 24b, 24c
5 are secured to the drive transmission gear 16 and to the
inner portion of the cylindrical portion 3b₂ respectively
so as to make the drive transmission gear 16 float by the
repellent force between the magnet rings.

Next, the operations of the twist pendulums 18, 19
10 will be described.

The driving wheel 6 is rotated by the magnetic action
between the magnets 9 and the driving coil 10 and then
reversely rotated by the spring force of the hair spring 11.
At the same time, the pendulum shaft 1 is rotated and reversed
15 in the same direction as that of the driving wheel
6, so that the twist pendulum 18 rotates, for example,
clockwise through 180 degrees and then reversely rotates
through the same rotational angle. On the other hand,
the driving force of the pendulum shaft 1 is transmitted
20 to the drive transmission gear 16 through the transmission
gear 12 and the first and second intermediate wheels 13
and 15 to rotate and reversely rotate the pendulum
shaft 2. Because the transmission gear 12 rotates clockwise,
the drive transmission gear 16 also rotates clockwise owing
25 to the existence of the intermediate wheels 13 and 15, so that
the twist pendulum 19 is rotated counter-clockwise through

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a rotational turning angle of 180 degrees and then reversely rotated. Accordingly, the twist pendulums 18 and 19 always rotate in the opposite direction to each other. The rotational angle and the cycle of the twist pendulum 18 are the same as those of the twist pendulum 19 because the number of teeth of the toothed portion 12a of the transmission gear 12 is the same as that of the toothed portion 15a of the second intermediate gear 15.

Although Figure 1 shows the use of a plurality of intermediate gears 13, 15, a single intermediate gear may be used if desired. In this case, for example, the transmission gears 12, 16 can be reversed in rotational direction by using a crown gear.

The twist pendulums 18, 19 are thus arranged to operate independently of each other and are rotated in opposite directions, so that the combination of operations of the pendulums can produce changes in their movement, can improve their decorative function, and can provide a unique construction of considerable commercial value.

CLAIMS

1. A device for driving twist pendulums comprising a first pendulum shaft which acts as a driving shaft; a second pendulum shaft which is a tubular shaft mounted concentrically about the first pendulum shaft; electro-
5 magnetic means arranged to drive the first pendulum shaft in a predetermined angular direction; spring means for driving the first pendulum shaft in the opposite angular direction; drive transmission means for transmitting drive from a first pendulum shaft to the second pendulum shaft; and
10 first and second connector means which are respectively secured to the first and second pendulum shafts and which are respectively adapted to be connected to first and second twist pendulums.
2. A device as claimed in claim 1 in which the drive
15 transmission means cause the first and second pendulum shafts to rotate simultaneously in opposite directions.
3. A device as claimed in claim 1 or 2 in which the electro-magnetic means comprises at least one magnet and driving coil.
- 20 4. A device as claimed in claim 3 in which the or each magnet is secured to a respective yoke, the or each yoke being carried by a driving wheel which is secured to the first pendulum shaft.



5. A device as claimed in any preceding claim in which the spring means comprises a hair spring.

6. A device as claimed in any preceding claim in which the drive transmission means comprises first and second transmission gears fixed on the first and second pendulum shafts respectively, at least one intermediate gear being provided to transmit drive between the said first and second transmission gears.

7. A device as claimed in claim 6 comprising magnetic means provided respectively on the first transmission gear and adjacent fixed structure for urging the first transmission gear away from the adjacent fixed structure so as to maintain the first transmission gear in a floating condition.

8. A device as claimed in any preceding claim in which first and second twist pendulums are respectively secured to the first and second connector means.

9. A device for driving twist pendulums substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

10. A timepiece provided with a device as claimed in any preceding claim.

~~11. Any novel integer or step, or combination of integers or steps, hereinbefore described and/or as shown in the accompanying drawings, irrespective of whether the present² claim is within the scope of, or relates to the same or a different invention from that of, the preceding claims.~~



12. A device for driving twist pendulums comprising:

a pendulum shaft operating as a driving shaft;

a pipe-like pendulum shaft arranged concentrically
with said pendulum shaft;

5 a driving wheel provided on said first-mentioned pendulum
shaft, arranged to be driven to rotate by magnetic force
between a magnet and a driving coil and to be reversed by
spring force of a hair spring;

a transmission gear provided on said first-mentioned
10 pendulum shaft;

an intermediate wheel for receiving the rotating
force of said transmission gear;

a drive transmission gear provided on said pipe-like
pendulum shaft, and arranged to receive rotating force
15 of said intermediate wheel, said drive transmission gear
being rotated in the direction opposite to said transmission
gear; and

said pendulum shafts being arranged such that twist
pendulums can be attached to said pendulum shafts respectively.
