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Miyazawa

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[54] **INDEXING DEVICE FOR A STEP MOTOR IN AN ELECTRONIC TIMEPIECE**

[75] Inventor: **Hideichi Miyazawa,** Owa Suwa, Japan

[73] Assignee: **Kabushiki Kaisha Suwa Seikosha,** Tokyo, Japan

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[30] **Foreign Application Priority Data**

Feb. 17, 1971 Japan 46/8428

[52] **U.S. Cl.** ..... **58/116 R,** 58/23 D

[51] **Int. Cl.** **G04c 17/00,** G04c 15/00

[58] **Field of Search** ..... 58/4 A, 7, 23 R, 58/23 A, 23 AC, 23 D, 23 V, 26, 85.5, 116 R, 27; 74/575

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Primary Examiner—Richard B. Wilkinson
Assistant Examiner—U. Weldon
Attorney—Eric H. Waters et al.

[57] **ABSTRACT**

An indexing device is provided for an electronic timepiece which includes a rotor and stator arrangement. The indexing device includes a pinion rotatable with the rotor and an index wheel engaged with and rotated by the pinion. An index spring having cantilever form is mounted adjacent the index wheel and a pallet jewel is mounted on the spring and is in engagement with the index wheel to prevent reverse rotation and vibration of the same.

3 Claims, 5 Drawing Figures

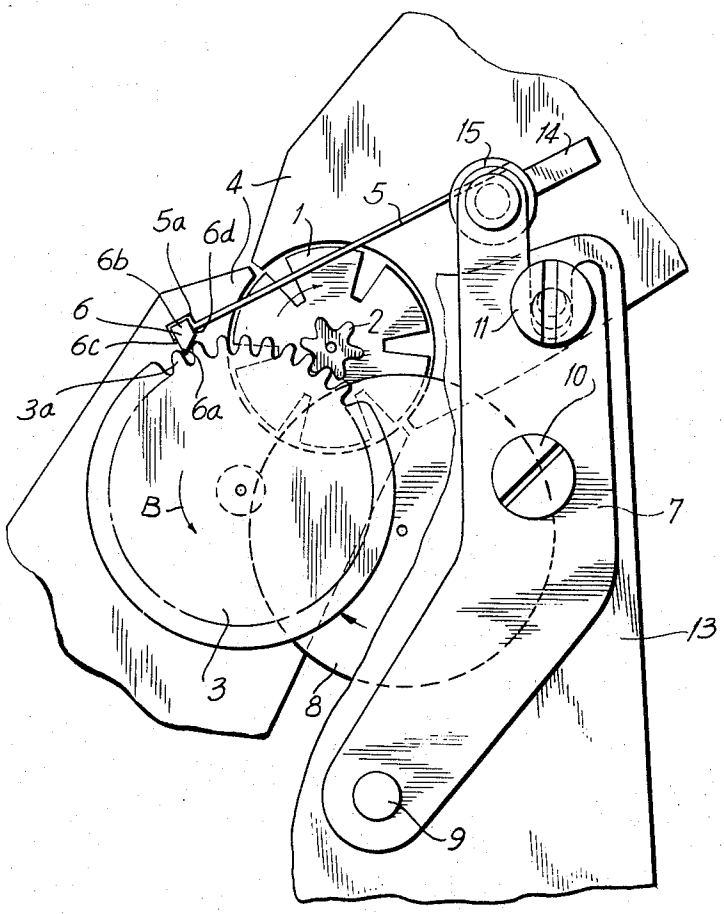


FIG. 1

PRIOR ART

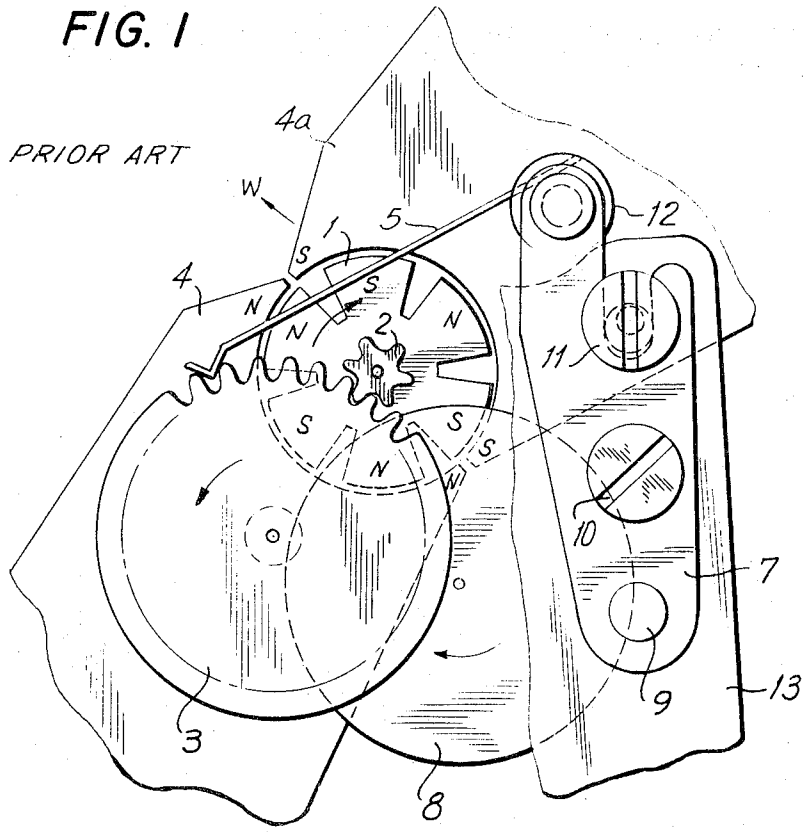


FIG. 2

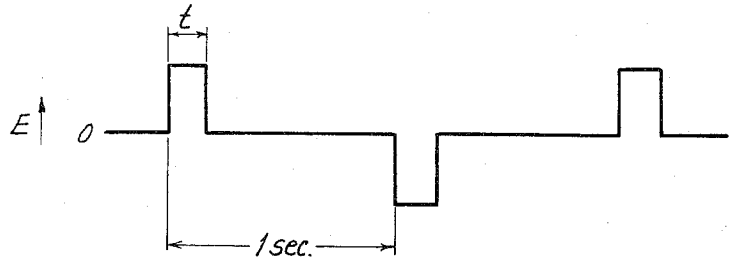


FIG. 3

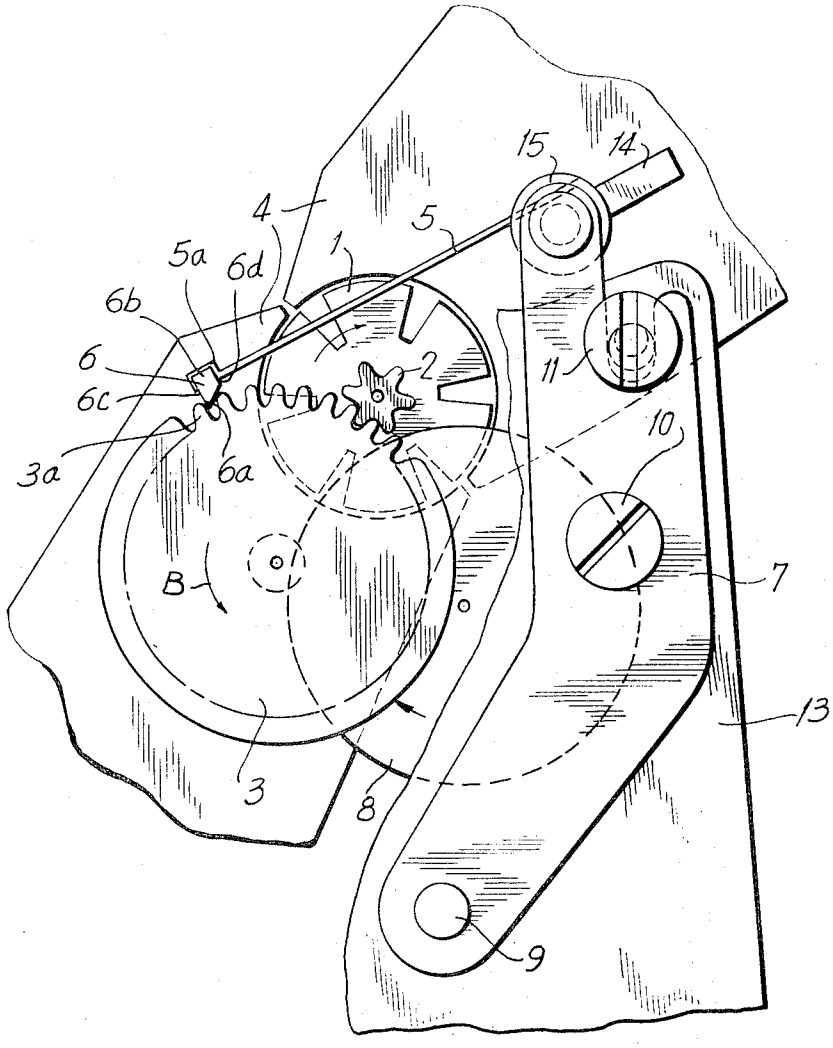


FIG. 4

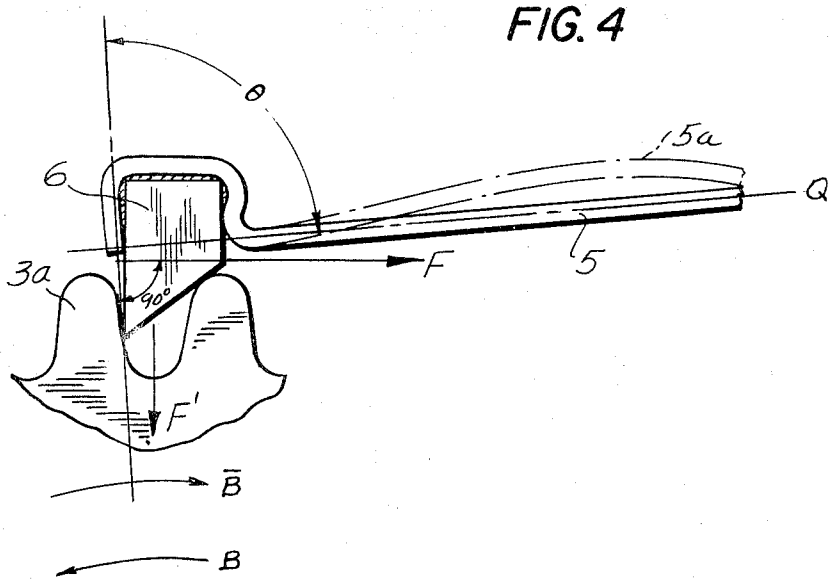
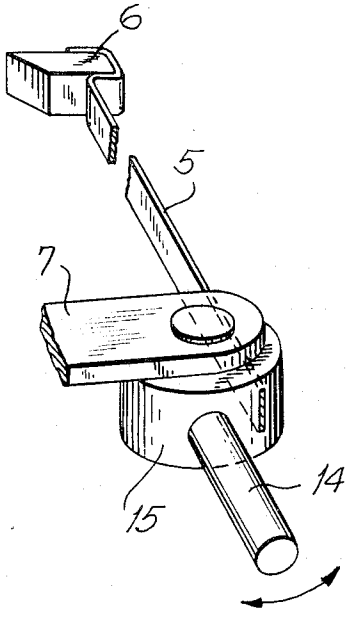


FIG. 5



INDEXING DEVICE FOR A STEP MOTOR IN AN ELECTRONIC TIMEPIECE

FIELD OF THE INVENTION

The present invention relates to improvements in indexing mechanisms for step motors in timepieces of the type wherein a crystal oscillator or tuning fork is used as a time standard to produce an electric signal which is divided and synchronized.

BACKGROUND OF THE INVENTION

Indexing mechanisms which are known in the art are known to have various defects.

First of all, these indexing mechanisms are generally attached to a calendar mechanism with a load torque being applied in reverse to the rotating direction of an associated gear train. As a result, when this torque is added to the vibration force of the rotor of the timepiece and in the reverse rotational direction with respect to the normal rotation thereof, the index wheel is capable of pushing past the index spring which is utilized to thereby rotate in reverse direction.

In addition, the adjustment of the engagement between the index wheel and the index spring in known constructions, in the tangential direction with respect to the index wheel, can be easily effected. However, adjustment in the radial direction requires a bending of the associated index spring at its base portion, as a result of which positioning of the index wheel in the radial direction is more difficult.

Specifically, it is to be noted that the engaging pressure of the index spring with the index wheel in known constructions can be either decreased or made larger. If decreased, this makes the indexing of the indexing wheel uncertain, while if the engaging pressure is increased, this induces a larger frictional loss.

SUMMARY OF THE INVENTION

An object of the present invention is to provide for preventing the malfunctioning of a step motor timepiece.

Another object of the invention is to provide an improved timepiece in which the adjustment of an indexing mechanism can be easily and precisely effected.

A further object of the invention is to provide an improved indexing mechanism which includes an index spring and which is less sensitive than those constructions heretofore known, with respect to the increasing or decreasing of the force of engagement of the index spring with the associated index wheel.

To achieve the above and other objects of the invention there is provided,in accordance with a preferred embodiment thereof, an indexing device for an electronic timepiece which comprises a rotor, means to rotate said rotor incrementally, a pinion rotatable with said rotor, an index wheel engaged with and rotated by said pinion, an index spring adjacent said index wheel, and a pallet jewel on said spring and in engagement with said index wheel to prevent reverse rotation and vibration of the same.

In accordance with a more specific version of the invention, the aforesaid spring is a cantilever spring and there is provided a pivotal lever body supporting the spring and a pin supporting the said body, said index wheel having a center and further having a zone of engagement with said jewel, said pin being located proximate an imaginary line extending through said center and said zone.

According to a feature of the invention, the aforesaid jewel has a surface of engagement with said index wheel and a distal extremity relative to said surface, said spring engaging said distal extemity.

According to still another feature of the invention, there is provided an adjusting pin pivotal on the aforesaid body and supporting said spring and an adjustment lever coupled to said adjusting pin.

According to still another feature of the invention, the aforesaid jewel may include a flat top and front and rear sides extending perpendicularly to said top, said spring including a free extremity shaped to engage said top and sides.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be more readily understood from the following detailed description of a preferred embodiment of the invention as illustrated and compared in the accompanying drawing in which:

FIG. **1** is a fragmentary plan view of an indexing device provided for a step motor in an electronic timepiece as provided in accordance with the prior art;

FIG. **2** is a chart showing the driving voltage wave form employed in the construction illustrated in FIG. **1**;

FIG. **3** is a view corresponding to that of FIG. **1** but showing a preferred embodiment of the present invention;

FIG. **4** shows a detail of FIG. **3** on enlarged scale; and

FIG. **5** is a perspective view of a component of the detail of FIG. **4**.

DETAILED DESCRIPTION

FIG. **1** is a plan view of a known step motor which divides and synchronizes an electric signal and which uses a crystal oscillator (not shown) as its standard.

The structure in FIG. **1** includes a rotor **1**, a rotor pinion **2**, a second toothed wheel **3** engaged with the pinion **2**, a stator **4**—**4***a*, an index spring **5**, and a lever body **7** which is adapted to pivot on a pin **9** secured to a rotor supporter **13**. The pin **9** is preferably arranged in proximity of an imaginary straight line passing through the center of second wheel **3** and the zone of engagement between the second wheel (which serves as an index wheel) and the index spring **5**.

The apparatus furthermore includes a third wheel **8**, a screw **10** for fixing lever body **7** in position, and an eccentric pin **11** to rotate the lever body **7**. Element **12** is a fixing pin which is secured to lever body **7** and on which the index spring **5** is securely mounted. By positioning stator part **4a** eccentrically in the W direction, the relative position of rotor **1** and stator **4** will be magnetically retained as shown in the drawing. The direction of the rotation of rotor **1** is shown by the arrow A.

FIG. **2** shows a driving voltage wave form as applied to a driving coil (not shown) associated with the stator. In case the magnetic pole attitude of rotor **1** is as shown in FIG. **1**, the stator **4** being magnetized into such polarities as are shown in the drawing, the rotor **1** will advance by one pitch (one-sixth of a rotation) in the direction of arrow A when electric current flows into the driving coil. The positions of the magnetic poles of rotor **1** adjacent the gap in the stator after rotation will be reversed with respect to N and S polarity compared with the positions prior to rotation. However, the next

subsequent driving pulse will be of reverse polarity, so that the rotor 1 will continue to rotate in the same direction. The pulse width (t) of each driving voltage pulse depends upon the time length required for the rotor 1 to rotate by one pitch.

When the rotor 1 rotates by one pitch and is at its rest position, vibration of the rotor may occur due to the relationship between a turning effect determined by the inertia of the rotor and its angular velocity and the attracting force of the rotor magnet. To prevent the case where the rotor 1 might rotate in reverse or to prevent a two-pitch feeding which might occur due to this vibration, the index spring 5 is provided to eliminate the vibration of the rotor and to prevent its malfunctioning.

Indexing mechanisms known in the art are not perfect and have various defects. When attached to a calendar mechanism, a load torque is applied in reverse to the rotating direction of the associated gear train so that, when this torque is added to a vibration force in the reverse rotational direction of rotor 1, the second wheel 3 serving as the index wheel is capable of pushing past the index spring 5 to rotate in reverse. Further, while the adjustment of the engagement between the wheel 3 and the index spring 5 in tangential direction with respect to wheel 3 can be easily effected by rotation of eccentric pin 11 and of lever body 7 around the pin 9, positioning in radial direction of wheel 3 is adjusted by bending the index spring 5 generally at its base, as a result of which positioning in radial direction of second wheel 3 is more difficult. Specifically, it can be seen that if the engaging pressure of index spring 5 with the teeth of second wheel 3 is decreased, this makes the indexing of wheel 3 uncertain while, if the engaging pressure is made larger, this induces a larger frictional loss.

The present invention is intended to eliminate the above-mentioned defects, and is particularly suited for preventing a rotor from rotating in reverse direction and for adapting index springs to be positioned easily and accurately.

In FIG. 3, which shows a preferred embodiment of the present invention, elements corresponding to parts in FIG. 1 are shown by like reference numerals. In this embodiment, a pallet jewel 6 (see also FIG. 4), which is engaged with a generally sinusaidally shaped tooth 3*a* of second wheel 3, is mounted on index spring 5. On the distal extremity of jewel 6 relative to the surface of pallet jewel 6 which engages the tooth 3*a* of wheel 3, there is a spring portion 5*a* which is part of index spring 5. When the rotor 1 tries to rotate in reverse and the second wheel 3 engaged with pinion 2 of the rotor tries to rotate in reverse, the index spring 5 is bent inwardly as a result of which the pallet jewel 6 is pushed onto the wheel 3. Therefore, the tooth 3*a* of wheel 3 never rotates in reverse due to the fact that it pushes the pallet jewel 6 up, this making it possible to positively prevent a reverse rotation of rotor 1.

The index spring 5 is secured to a rotatable adjusting pin 15 (see also FIG. 5) caulked to lever body 7. To the adjusting pin 15 is secured an adjusting lever 14. By rotating the adjusting pin 15 with adjusting lever 14, the degree of engagement of the pallet jewel 6 with the teeth of wheel 3 can be easily adjusted.

Relative to the pallet jewel 6, it is seen that the same tapers forwardly to a toe 6a in the direction which is the normal direction of rotation of the index wheel 3 as indicated by arrow B. It will also be noted that the jewel has a flat top 6b with a front side 6c and a rear side 6d extending perpendicularly from top 6b towards the center of index wheel 3.

The spring 5,which is a cantilever spring, has its free extremity 5a shaped in correspondence with the top and sides of the jewel 6 to engage and hold the same.

With B being the rotating direction of the index wheel, $\overline{B}$ is the direction of counter torque which acts opposite the direction of the index wheel. 5*a* indicates the bending condition of the flexible lever or spring 5 caused by the counter torque $\overline{B}$. θ is the angle between the direction Q of the flexible lever and the direction P of the tangent which touches the tooth surface of the index wheel at a point of contact with the head of the flexible lever portion. As θ is not more than 90°the lever 5 is not moved out of engagement with the index wheel, there being applied a force of direction F′ towards the inside of the index wheel.

From what has been stated hereinabove, it will be seen that the invention provides generally an indexing device for an electronic timepiece, which device comprises a rotor, means to rotate said rotor incrementally, a pinion rotatable with said rotor, an index wheel engaged with and rotated by said pinion, an index spring adjacent said index wheel, and a pallet jewel on said spring and in engagement with said index wheel to prevent reverse rotation and vibration of the index wheel.

Moreover, it has been shown that the spring is a cantilever type spring and that the device further comprises a pivotal lever body supporting the spring and a pin pivotally supporting this body, the index wheel having a center and further having a zone of engagement with the aforesaid jewel, said pin being located proximate an imaginary line extending through said center and zone.

There will now be obvious to those skilled in the art many modifications and variations of the construction set forth hereinabove. These modifications and variations will not depart from the scope of the invention if defined by the following claims.

What is claimed is:

1. An indexing device for an electronic timepiece, said device comprising a rotor, means to rotate said rotor incrementally, a pinion rotatable with said rotor, an index wheel engaged with and rotated by said pinion and including a plurality of sinusoidally shaped peripheral teeth, an index spring adjacent said index wheel, a pallet jewel on said spring and in engagement with said index wheel to prevent reverse rotation and vibration of the index wheel, said spring being a cantilever spring, a pivotal lever body supporting the said spring, a pin pivotally supporting said body, an adjusting pin pivotal on said body and supporting said spring, and an adjustment lever coupled to said adjusting pin.

2. An indexing device as claimed in claim 1 wherein said pallet jewel engages one tooth at a time, an angle θ being formed between a tangent touching said one tooth at the point of contact thereof with said pallet jewel, and said flexible lever, said angle θ being not more than 90° to prevent reverse rotation and vibration of said index wheel.

3. An indexing device as claimed in claim 1 wherein said index wheel has a center and further has a zone of engagement with said jewel, said pin being located proximate an imaginary line extending through said center and zone.

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