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(54) ELECTRIC TIMEPIECE

(71) We, KABUSHIKI KAISHA SUWA SEIKOSHA, a Japanese company, of 3—4, 4-chome, Ginza, Chuo-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention concerns an electric timepiece.

According to the present invention, there is provided an electric timepiece provided with hand setting means for setting a hand of the timepiece to at least one datum position, the hand setting means having an operating member which is disposed externally of the timepiece, a first abutment member movement of which effects corresponding movement of said hand, and a second abutment member which is normally out of engagement with said first abutment member, said operating member being movable to cause the second abutment member to engage the first abutment member and move the latter to a predetermined position such that the hand is returned to the or a said datum position, and adjusting means for adjusting the said predetermined position of the first abutment member.

Preferably the hand is a seconds hand. The hand setting means may, if desired, be adapted to set the hand to the nearest one of a plurality of angularly spaced apart datum positions.

The operating member is preferably axially movable, axial movement of said operating member effecting setting of the said hand to the or a datum position.

The second abutment member may be a pivotally mounted hammer having arms which are respectively engageable with the operating member and first abutment member. Thus the hammer may be resiliently urged towards a position in which one of said arms always engages the said operating member.

The first abutment member may be a cam. Thus the cam may be so shaped that, when fully engaged by the second abutment member, it is always moved thereby into

one single predetermined position only. Alternatively, the cam may be provided with a plurality of equi-angularly spaced apart recesses into each of which the second abutment member may extend.

The first abutment member may be mounted, by way of the said adjusting means, on a wheel which is drivingly connected to said hand.

The timepiece may be provided with an electric motor having a rotor which drives the said hand, the electric motor being connected in an electrical circuit which includes a resetting switch, operation of said operating member causing actuation of said resetting switch such that the rotor returns to a rest position.

The motor may be an electrical stepping motor having a stator the polarities of portions of which are periodically inverted by alternating pulses from an oscillator, the rotor comprising at least one permanent magnet disposed adjacent to said stator.

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

Figure 1 is a broken-away diagrammatic plan view of part of an electric timepiece according to the present invention;

Figure 2 is a plan view, on a larger scale, of a portion of the structure shown in Figure 1;

Figure 3 is a broken-away section taken on the line III—III of Figure 2;

Figure 4 is an electrical diagram illustrating an alternating pulse signal;

Figure 5 shows the polarities of portions of a stator which forms part of the structure of Figure 1, such polarities being those prevailing after the seconds hand of the timepiece has been returned to indicate zero seconds and a re-setting switch, which forms part of the said structure, has been released;

Figure 6 is a view similar to Figure 5, but showing the polarities of the said portions of the stator after a lapse of one second; and

Figures 7 and 8 are views similar to Figure 1, but illustrating modified embodiments.

(12)

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.

5 In Figure 1 there is shown an electric timepiece, e.g. a wrist watch, having a quartz oscillator 10 which drives an electrical stepping motor 11 by way of a frequency divider circuit 12. Thus the frequency of the signals from the quartz oscillator 10 is divided to produce pulses which enable the stepping motor 11 to move the seconds hand (not shown) of the timepiece step-wise at one second intervals.

15 The electrical stepping motor 11 comprises a rotor 13 which is mounted on a shaft 14, the rotor 13 being rotatably mounted within a substantially cylindrical recess 15 in a stator 16.

20 As indicated in Figure 1, the rotor 13 is constituted by a permanent magnet having diametrically oppositely disposed North and South poles 20, 21 respectively.

25 The stator 16 has a pair of pole portions 22 and a pair of pole portions 23, each pole portion 22 being spaced by a gap from an adjacent pole portion 23. The stator 16 is provided with a coil 24 which receives alternating pulses from the frequency divider circuit 12. The arrangement is such that the pole portions 22 always have the opposite polarity to the pole portions 23, but these polarities are inverted once a second, whereby the seconds hand is moved once every second by the magnetic attraction and repulsion which occurs between the rotor 13 and the stator 16, as a result of which the rotor is rotated 180° per second.

40 As will be seen from Figure 1, the North pole 20 of the rotor 13 is, in the position shown, closer to an adjacent pole portion 22 than to an adjacent pole portion 23, while the South pole 21 is closer to an adjacent pole portion 23 than to the adjacent pole portion 22. Consequently the position shown in Figure 1 is a rest position of the rotor 13.

50 Although, for the sake of simplicity, the rotor 13 is shown in Figure 1 as having only two poles, it can in fact have, if desired, several pairs of North and South poles, and it is also possible to provide the rotor 13 with several different permanent magnets.

55 The rotor shaft 14 is provided with a pinion 17 which meshes with a fifth wheel 26, the latter being provided with a fifth wheel pinion 27. The fifth wheel pinion 27 meshes with a fourth wheel 30 which is provided with the seconds hand. The fourth wheel 30, moreover, drives a third wheel (not shown), the third wheel meshing with an hour wheel pinion (not shown) provided with a minute hand (not shown).

65 A heart-shaped cam 31 is mounted on and adjustably secured to the fourth wheel

30 by way of an adjusting pin 32. The adjusting pin 32 has an upper or main portion 33 (Figure 3) which is of cylindrical shape and which is mounted in a correspondingly shaped aperture 34 in the heart-shaped cam 31. The upper end of the said main portion 33 is provided with a screw-driver slot 35. The adjusting pin 32 is also provided with a lower or cylindrical portion 36 which is of smaller diameter than the upper portion 33 and is disposed eccentrically with respect to the latter. The lower portion 36 is slidably mounted in an oval hole 37 in the fourth wheel 30. The heart-shaped cam 31 also has an aperture 40 through which extends a reduced diameter portion of the rotor shaft 14.

As will be appreciated, on rotating the upper portion 33 of the adjusting pin 32, the angular position of the heart-shaped cam 31 with respect to the fourth wheel 30 will be adjusted.

The heart-shaped cam 31 is normally disposed in the dashed line position shown in Figure 1 in which it is spaced from an arm 41 of a hammer 42 which is mounted on a pivot 43. The hammer 42, is also provided with an arm 44 which engages the inner end of an axially movable operating stem 45, the stem 45 having at its outer end a head 46 which is disposed externally of the timepiece for manual operation by the user thereof. A spring 47 which acts on the arm 41, urges the arm 44 at all times into engagement with the inner end of the stem 45, and urges both the stem 45 and the hammer 42 into the dashed line position shown in Figure 1 in which the arm 41 is spaced from the heart-shaped cam 31.

When the stem 45 is in the dashed line position, the timepiece operates normally, the fourth wheel 30 being intermittently rotated so as to effect stepwise movement of the seconds hand.

When, however, it is desired to return the seconds hand to a zero seconds position, e.g. immediately the user hears a time signal on a telephone, the stem 45 is pushed inwardly into the full line position, with the result that the hammer 42 is rotated counterclockwise about the pivot 43, and against the action of the spring 47, into the full line position. The radially inner end 41a of the arm 41 thus strikes the heart-shaped cam 31 and moves the latter from the dashed line to the full line position. This movement of the heart-shaped cam into the full line position causes the fourth wheel 30 to adopt a predetermined angular position in which the seconds hand will be returned to show zero seconds (or some other datum position).

Such rotation of the heart-shaped cam 31 into the full line position will of course cause corresponding movement of the rotor 130

13 by way of the fourth wheel 30, the fifth wheel pinion 27, the fifth wheel 26, and the rotor pinion 17, but such movement of the rotor 13 does not matter, since the rotor 13 is not mechanically restrained in any way.

If, when the arm 41 is brought into full engagement with the heart-shaped cam 31, the seconds hand is not restored to the zero position, then appropriate rotation of the adjustment pin 32 will effect adjustment of the relative positions of the heart-shaped cam 31 and the fourth wheel 30 so that the seconds hand will be exactly at the zero position at this time.

If desired, however, instead of providing an adjustment pin 32, the pivot 43 could be formed as an eccentric pin so that the fulcrum of the hammer 42 could be appropriately adjusted.

Accordingly, as will be appreciated, since the relative angular positions of the rotor 13 and the heart-shaped cam 31 can be adjusted either by means of the adjustment pin 32 or by means of an eccentric pivot pin 43, provided that the said relative position is appropriately adjusted when the parts are assembled, the rotor 13 will always return to its rest position whenever the heart-shaped cam 31 is forced into its predetermined position, i.e. its full line position on being hit by the arm 41 at the time of hand return. Thus the cam 31 is so shaped that, when fully engaged by the hammer 42, it is always moved thereby into a single predetermined position only.

Mounted on a plate 50 is a resetting switch 51 which is connected in an electrical circuit which includes the electric motor 11. The resetting switch 51 is urged by its inherent resilience towards the dashed line or inoperative position shown in Figure 1 in which it is, at that time, spaced from the arm 41 of the hammer 42. When, however, the stem 45 is pushed inwardly so as to move the hammer 42 from the dashed line to the full line position in which it strikes the heart-shaped cam 31, the arm 41 of the hammer 42 engages the resetting switch 51 and moves the latter into the full line or operative position shown. The arrangement is such that when the hammer 42 is engaged with the heart-shaped cam 31, the head 46 of the stem 45 is brought into contact with the plate 50 so as to limit travel of the stem 45 and thus ensure that the gear train constituted by the parts 17, 26, 27, 30 is not damaged. When, however, the seconds hand has been made to return to the zero seconds position, on releasing the head 46, the hammer 42 returns to its dashed line position under the action of the spring 47.

Figure 4 illustrates the alternating pulse signal which is generated by the frequency divider circuit 12. As shown in Figure 4, the said signal comprises positive pulses 52

and negative pulses 53. The start of each pulse is spaced from the start of the following pulse by an interval of one second.

The pulses 52, 53 constitute inversion pulses which periodically invert the polarities of the stator portions 22, 23. Thus during the negative pulses 53, the polarities of the stator portions are as shown in Figure 5 in which the stator portions 22 constitute South poles and the stator portions 23 constitute North poles. After the resetting switch 51 has been actuated the adjacent parts of the rotor 13 and the stator 16 attract each other, and the rotor 13 finally adopts the normal rest position shown in Figure 5. During the positive pulses 52, however, the polarities of the stator portions are shown in Figure 6 from which it will be seen that the stator portions 22 are of North polarity while the stator portions 23 are of South polarity. Thus in the Figure 6 condition, the adjacent parts of the rotor 13 and stator 16 repel each other, as a result of which the rotor 13 rotates through 180° and then comes to a standstill in the said normal rest position.

Accordingly, when the seconds hand is made to return to zero seconds as a result of inward movement of the stem 45, the hammer 42 engages the resetting switch 51 and this stops the operation of the inversion pulse signal. When, however, the stem 45 is no longer pressed inwardly, the hammer 42 returns to its dashed line position shown in Figure 1 under the action of the spring 47, and the resetting switch 51 is released thereby, as a result of which the inversion pulse signal shown in Figure 4 immediately re-starts. If, therefore, it is assumed that, at this time, a negative pulse 53 will be produced, the polarities of the stator 16 will be as shown in Figure 5, and the adjacent parts of the rotor 13 and stator 16 will attract each other. Even therefore if the rest position of the rotor 13 is affected by backlash in the various wheels, the magnetic forces will ensure that the rotor 13 will always return to its normal rest position and will stop in that state. After a lapse of one second from the state illustrated in Figure 5, the pulse is inverted so that the polarities are as shown in Figure 6, and there will then be mutual repulsion between the adjacent parts of the rotor 13 and stator 16, as a result of which the rotor 13 will rotate through 180° as described above. One second later the production of the next negative pulse 53 will cause the rotor 13 to rotate through a further 180°. Thus the rotor will rotate stepwise, at intervals of one second, by 180°.

The seconds hand is arranged to move from an even numbered second to an odd numbered second when a positive pulse 52 is generated, and is arranged to move from 130

an odd numbered second to an even numbered second when a negative pulse 53 is generated. After the seconds hand has been returned to indicate zero seconds, if the resetting switch 51 is released, the seconds hand will move from indicating zero seconds to indicating one second after a period of one second. Consequently if the timepiece is set in synchronism with a time signal, e.g. over the telephone or on a radio, the timepiece will thereafter act in synchronism with such time signal.

The above explanation has been given with respect to a seconds hand which is arranged to move from an even numbered second to an odd numbered second when a positive pulse is generated. However, it is also possible to arrange that the seconds hand is returned to an odd numbered second and that the seconds hand is moved by one second simultaneously with the release of the resetting switch 51. Thus in this case the seconds hand will move from an odd numbered second to an even numbered second when a positive pulse is generated.

In the construction described above, the seconds hand can be returned to indicate zero seconds without the need to adjust the drive connection between the heart-shaped cam 31 and the rotor 13. There is thus no need to regulate the gear train between these parts e.g. by the use of a second jumper. Moreover, the construction is simple, and the number of parts employed are small.

The construction described above, moreover, is especially suitable for a high precision timepiece such as a quartz timepiece since it enables the seconds hand to be returned to zero seconds simply and with certainty, without the need to adjust the position of any related member and without having to provide a clutch mechanism in the gear train constituted by the wheels 17, 26, 27, 30.

In the construction shown in Figures 1, 5 and 6, a two-pole stepping motor is employed. However, it is also possible to employ a motor having a different number of poles e.g. six, and to employ a continuously rotating motor instead of a stepping motor. Additionally, it is possible to eliminate the wheels 26, 27, which constitute a deceleration gear between the fourth wheel 30 and the rotor 13, and to employ the stem 45 both as a conventional stem and as a stem for effecting hand return.

It is also possible to arrange that the hand which is returned to such a datum position is not the seconds hand but is a minute hand or an hour hand.

In the embodiment described above, the seconds hand is returned to indicate zero seconds. However, in a high precision time-

piece such as a quartz timepiece, where the timepiece error is only of the order of a few seconds a month, the timepiece will in practice rarely differ from the correct time by more than a few seconds. It is therefore possible to arrange that the heart-shaped cam 31 is replaced by a hexagonal cam so that the seconds hand may be returned to a plurality of angularly spaced apart datum positions, i.e. 0, 10, 20, 30, 40 and 50 seconds respectively.

Moreover, in the case of such a high precision timepiece, it may not be satisfactory to arrange that the seconds hand is necessarily returned to indicate zero seconds, since if the time signal is, as over the telephone, given at intervals of 10 seconds, this can involve waiting for up to one minute before being able to adjust the timepiece. This problem is, however, dealt with by the embodiments of Figures 7 and 8.

Figures 7 and 8 thus show embodiments of timepieces according to the present invention which are generally similar in construction to that of Figure 1, and which for this reason will not be described in detail, like reference numerals indicating like parts.

In the Figure 7 construction, however, the heart-shaped cam 31, instead of being mounted on the fourth wheel 30, is mounted on the fifth wheel 26, which, as indicated above, constitutes a deceleration wheel disposed between the rotor 13 and the fourth wheel 30 which drives the seconds hand. In the construction of Figure 7, if it is desired that the seconds hand will be returned to the appropriate 0, 10, 20, 30, 40 or 50 seconds indication when the stem 45 is pressed radially inwardly, this may be achieved by arranging that the ratio of the number of teeth of the fourth wheel 30 to that of the fifth pinion 27, and the ratio of the number of teeth of the fifth wheel 26 to that of the rotor pinion 17, is arranged to be 6:1 and 5:1 respectively. Accordingly, when the head 46 of the stem 45 is pressed inwardly, the hammer 42 will hit the heart-shaped cam 31 and will thus move the fourth wheel 30, to one of the six equi-angularly spaced apart datum positions corresponding to the 0, 10, 20, 30, 40 or 50 second indications of the seconds hand.

In the construction of Figure 8, the construction is the same as in Figure 1 except that the heart-shaped cam 31 is replaced by a star shaped cam 55 having six equi-angularly spaced apart projecting portions 56, a recess 57 being disposed between each pair of adjacent projecting portions 56. The end 41a of the arm 41 of the hammer 42 is adapted, as shown in dashed lines in Figure 8, to enter each of the equi-angularly spaced apart recesses 57. As in the case of the

Figure 7 construction, when the stem 45 is moved radially inwardly, the arm 41 of the hammer 42 will cause the star shaped cam 55 to move to the appropriate one of its six equi-angularly spaced apart datum positions and thus set the seconds hand to the 0, 10, 20, 30, 40 or 50 seconds indication as the case may be.

As will be appreciated, even if the hand return mechanism is operated many times, the time indications given by the minute and seconds hands will not be in disagreement with each other.

As will be appreciated, moreover, by appropriate design of the cam 55, or by appropriate selection of the number of teeth employed on the wheels 17, 26, 27, 30 in the Figure 7 construction, it may be arranged that the hand return, instead of being effected at 10 second intervals, is effected at 20 second or 30 second intervals.

WHAT WE CLAIM IS:—

1. An electric timepiece provided with hand setting means for setting a hand of the timepiece to at least one datum position, the hand setting means having an operating member which is disposed externally of the timepiece, a first abutment member movement of which effects corresponding movement of said hand, and a second abutment member which is normally out of engagement with said first abutment member, said operating member being movable to cause the second abutment member to engage the first abutment member and move the latter to a predetermined position such that the hand is returned to the or a said datum position, and adjusting means for adjusting the said predetermined position of the first abutment member.

2. An electric timepiece as claimed in claim 1 in which the hand is a seconds hand.

3. An electric timepiece as claimed in claim 1 or 2 in which the hand setting means is adapted to set the hand to the nearest one of a plurality of angularly spaced apart datum positions.

4. An electric timepiece as claimed in any preceding claim in which the operating member is axially movable, axial movement of said operating member effecting setting of the said hand to the or a datum position.

5. An electric timepiece as claimed in claim 4 in which the second abutment member is a pivotally mounted hammer having

arms which are respectively engageable with the operating member and first abutment member.

6. An electric timepiece as claimed in claim 5 in which the hammer is resiliently urged towards a position in which one of said arms always engages the said operating member.

7. An electric timepiece as claimed in any preceding claim in which the first abutment member is a cam.

8. An electric timepiece as claimed in claim 7 in which the cam is so shaped that, when fully engaged by the second abutment member, it is always moved thereby into one single predetermined position only.

9. An electric timepiece as claimed in claim 7 in which the cam is provided with a plurality of equi-angularly spaced apart recesses into each of which the second abutment member may extend.

10. An electric timepiece as claimed in any preceding claim in which the first abutment member is mounted, by way of the said adjusting means, on a wheel which is drivingly connected to said hand.

11. An electric timepiece as claimed in any preceding claim in which the timepiece is provided with an electric motor having a rotor which drives the said hand, the electric motor being connected in an electrical circuit which includes a resetting switch, operation of said operating member causing actuation of said resetting switch such that the rotor returns to a rest position.

12. An electric timepiece as claimed in claim 11 in which the motor is an electrical stepping motor having a stator the polarities of portions of which are periodically inverted by alternating pulses from an oscillator, the rotor comprising at least one permanent magnet disposed adjacent to said stator.

13. An electric timepiece as claimed in claim 12 in which the oscillator is a quartz oscillator.

14. An electric timepiece substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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Figure 7 construction, when the stem 45 is moved radially inwardly, the arm 41 of the hammer 42 will cause the star shaped cam 55 to move to the appropriate one of its six equi-angularly spaced apart datum positions and thus set the seconds hand to the 0, 10, 20, 30, 40 or 50 seconds indication as the case may be.

As will be appreciated, even if the hand return mechanism is operated many times, the time indications given by the minute and seconds hands will not be in disagreement with each other.

As will be appreciated, moreover, by appropriate design of the cam 55, or by appropriate selection of the number of teeth employed on the wheels 17, 26, 27, 30 in the Figure 7 construction, it may be arranged that the hand return, instead of being effected at 10 second intervals, is effected at 20 second or 30 second intervals.

WHAT WE CLAIM IS:—

1. An electric timepiece provided with hand setting means for setting a hand of the timepiece to at least one datum position, the hand setting means having an operating member which is disposed externally of the timepiece, a first abutment member movement of which effects corresponding movement of said hand, and a second abutment member which is normally out of engagement with said first abutment member, said operating member being movable to cause the second abutment member to engage the first abutment member and move the latter to a predetermined position such that the hand is returned to the or a said datum position, and adjusting means for adjusting the said predetermined position of the first abutment member.

2. An electric timepiece as claimed in claim 1 in which the hand is a seconds hand.

3. An electric timepiece as claimed in claim 1 or 2 in which the hand setting means is adapted to set the hand to the nearest one of a plurality of angularly spaced apart datum positions.

4. An electric timepiece as claimed in any preceding claim in which the operating member is axially movable, axial movement of said operating member effecting setting of the said hand to the or a datum position.

5. An electric timepiece as claimed in claim 4 in which the second abutment member is a pivotally mounted hammer having

arms which are respectively engageable with the operating member and first abutment member.

6. An electric timepiece as claimed in claim 5 in which the hammer is resiliently urged towards a position in which one of said arms always engages the said operating member.

7. An electric timepiece as claimed in any preceding claim in which the first abutment member is a cam.

8. An electric timepiece as claimed in claim 7 in which the cam is so shaped that, when fully engaged by the second abutment member, it is always moved thereby into one single predetermined position only.

9. An electric timepiece as claimed in claim 7 in which the cam is provided with a plurality of equi-angularly spaced apart recesses into each of which the second abutment member may extend.

10. An electric timepiece as claimed in any preceding claim in which the first abutment member is mounted, by way of the said adjusting means, on a wheel which is drivingly connected to said hand.

11. An electric timepiece as claimed in any preceding claim in which the timepiece is provided with an electric motor having a rotor which drives the said hand, the electric motor being connected in an electrical circuit which includes a resetting switch, operation of said operating member causing actuation of said resetting switch such that the rotor returns to a rest position.

12. An electric timepiece as claimed in claim 11 in which the motor is an electrical stepping motor having a stator the polarities of portions of which are periodically inverted by alternating pulses from an oscillator, the rotor comprising at least one permanent magnet disposed adjacent to said stator.

13. An electric timepiece as claimed in claim 12 in which the oscillator is a quartz oscillator.

14. An electric timepiece substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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