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(54) RATCHET FEED MECHANISM

(71) We, KABUSHIKI KAISHA SEIKOSHA, a Japanese Company of 5, 2-chome Kyobashi, 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 relates to a ratchet feed mechanism and, although the invention is not so restricted, it relates more particularly to a ratchet feed mechanism for shifting a time indication from a seconds drum of a digital timepiece, such as a clock, to a minutes drum thereof.

A conventional digital clock has at least one seconds drum provided with seconds indicia, at least one minutes drum provided with minutes indicia, at least one hour drum provided with hour indicia, and shift means for shifting the time indication from one drum to the next so that, for instance, when a seconds drum, which continuously indicates the seconds from 0 to 59, has been rotated from a 0 seconds position and through a complete revolution to indicate 0 seconds again, an adjacent "one minute" drum, which indicates 0–9 minutes, will be stepped through a one minute space, e.g. from 0 to 1 minutes. In such a digital clock, it is impossible to correct the time during the time shaft operation from the seconds drum to the one minute drum. If a time correction is forcibly made during this time shift operation, gears and other parts of the clock are liable to be damaged.

According to the present invention, there is provided a ratchet feed mechanism comprising a rotary shaft; an eccentric secured to the rotary shaft; a ratchet wheel which is rotatably mounted on the rotary shaft; a member secured to the rotary shaft and having an operating pin which is spaced from the axis of the rotary shaft, and a forked lever which is mounted for rocking movement about an axis which is spaced from said rotary shaft, the forked lever also being mounted for sliding movement to-

wards and away from the rotary shaft, the forked level having two forks which are respectively engageable with opposite sides of the eccentric cam so that rotation of the latter by the rotary shaft causes the said rocking movement; first and second abutments mounted respectively on said forks and engageable with the operating pins so that rotation of the latter about the axis of the rotary shaft effects the said sliding movement; and a feed pawl which is mounted on a said fork and is engageable with the ratchet to effect angular movement of the latter during a minor portion only of each complete rotation of the rotary shaft, the said rocking and sliding movements maintaining the feed pawl out of driving engagement with the ratchet wheel during the remaining portion of each complete rotation of the rotary shaft.

Preferably there are adjustment means for effecting angular movement of the ratchet wheel independently of that effected by the feed pin.

The said two forks may be resiliently movable away from one another during operation of the adjustment means to permit the ratchet wheel to ride over the feed pin.

Alternatively, biasing means may be provided for urging the forked lever towards a predetermined position, the biasing means permitting the forked lever to be moved during operation of the adjustment means to a further position in which the ratchet wheel can ride over the feed pin.

The forked lever may be rockingly and slidably mounted on a stationary shaft which extends through an elongated hole in the forked lever.

The biasing means may comprise a spring whose opposite ends are respectively connected to the forked lever and to the stationary shaft.

The said member secured to the rotary shaft may be a seconds member of a digital timepiece movement, the said ratchet operating a minutes member of the movement.

The invention also comprises a digital time-

piece provided with a ratchet feed mechanism as set forth above.

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

Figure 1 is a broken away plan view of a ratchet feed mechanism according to the present invention,

Figures 2a to Figure 2f are cross sectional views showing respectively the relative positions of the parts of the ratchet feed mechanism at various stages of its operation, each of Figures 2a to 2f being taken on the line II—II of Figure 1,

Figure 3 shows the orbit of a feed pawl of the said ratchet feed mechanism,

Figure 4 is a schematic cross sectional view corresponding to those shown in Figures 2a to 2f, but illustrating the relative positions of the parts of the ratchet feed mechanism when the time indication provided by the timepiece is corrected at the same time as a time shift operation is occurring, and

Figure 5 is a view similar to Figure 4 but illustrating a modification.

Terms such as "left", "right", "clockwise" and "counter-clockwise", as used in the description below, are to be understood to refer to directions as seen in the accompanying drawings.

Referring to the drawings, a digital clock or other digital timepiece comprises a seconds drum 1 which is marked with seconds indicia (not shown) from 0 to 29, a "one minute" drum (not shown) which is marked with minutes indicia (not shown) from 0 to 9, a "ten minute" drum (not shown) which is marked with indicia (not shown) representing 0, 10, 20, 30, 40 and 50 minutes, and an hour drum or drums (not shown) marked with hour indicia (not shown).

The seconds drum 1 is secured to a rotary shaft 2 which rotates through 360° once per minute. An operating pin 3 is mounted on and projects from the seconds drum 1, the operating pin 3 being spaced from the axis of the rotary shaft 2. An eccentric cam 4 is secured to the rotary shaft 2. A ratchet wheel 5 is rotatably mounted on the rotary shaft 2, the ratchet wheel 5 being arranged to step the "one minute" drum through one minute steps.

A forked shift lever 6 has forks 6a, 6b whose internal surfaces are respectively engageable with opposite sides of the eccentric cam 4. A stationary shaft 8, which is spaced from the rotary shaft 2, passes through an elongated hole 7 that is formed at a base section 6c of the forked shift lever 6. The fixed shift lever 6 is thus mounted for rocking movement about the axis of the stationary shaft 8, and also for sliding movement about the stationary shaft 8 towards and away from the rotary shaft 2. Rotation of the eccentric cam 4 by the rotary shaft 2 causes successive clockwise and counter-clockwise rocking movement of

the forked shift lever 6 about the stationary shaft 8.

The fork 6a has a feed pin 9 mounted thereon which protrudes from one surface thereof and which is engageable with the ratchet wheel 5. The fork 6a also has mounted thereon a first abutment 10 which protrudes from its opposite surface and which is engageable with the opening pin 3. The fork 6b has a second abutment 11 mounted thereon which protrudes therefrom and which is engageable with the operating pin 3. The parts 10, 11 are engageable with the operating pin 3 so that, when the latter is rotated about the axis of the rotary shaft 2, the forked shift lever 6 is subjected to sliding movement towards and away from the rotary shaft 2.

In order to assemble the above-mentioned ratchet feed mechanism, all one has to do is to push the forked shift lever 6 from the left of the drawing. Namely, while the stationary shaft 8 is positioned between the forks 6a and 6b, the forked shift lever 6 is pushed rightward until the tips of the forks 6a, 6b are brought into contact with the eccentric 4.

The mode of operation of the ratchet feed mechanism is as follows. Figure 2a schematically illustrates the operating position when the seconds drum 1 indicates 0 seconds and the ratchet wheel 5 has just been shifted angularly through one tooth pitch so as to shift the "one minute" drum through a one minute step. Taking the position of the parts shown in Figure 2 as the start position, the shift operation for a subsequent ratchet tooth will be explained with reference to Figures 2a to 2f which respectively show the position of the parts at 0, 10, 20, 30, 40 and 50 seconds.

From the start position shown in Figure 2a, in which the forked shift lever 6 is in its most leftward position, the rotary shaft 2, and hence the operating pin 3, rotates counter-clockwise in unison with the rotation of the seconds drum 1. The operating pin 3 thus passes by the first abutment 10. The counter-clockwise rotation of the rotary shaft 2 causes the eccentric 4 to abut and push the tip of the fork 6a of the forked shift lever 6. As a result, at the end of ten seconds, the forked shift lever 6 has rocked counter-clockwise about the axis of the stationary shaft 8 to the position shown in Figure 2b. The operating pin 3 further continues to rotate counter-clockwise until it reaches the position shown in Figure 2c in which it starts to abut and push the second abutment 11 of the fork 6b towards the right. In the Figure 2c position, i.e. the 20 seconds position, moreover the portion of the eccentric 4, which is furthest from the axis of the rotary shaft 2 engages the fork 6a so that the forked shift lever 6 is rotated to the maximum extent in the counter-clockwise direction.

Next, the second abutment 11 is pushed rightward by the counter-clockwise rotating

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operating pin 3 towards the position shown in Figure 2d, while the eccentric 4, by engagement with the fork 6b, will start moving the forked shift plate 6 clockwise.

5 Further counter-clockwise rotation of the operating pin 3 causes the second abutment 11, and hence the forked shaft lever 6, to move to its maximum rightward extent, after which the operating pin 3 leaves the second abutment 11 to reach the Figure 2e position at the end of 40 seconds. In the Figure 2e position, the stationary shaft 8 touches the left hand edge of the elongated hole 7, while the clockwise movement of the forked shift lever 6 continues.

15 The operating pin 3 then further rotates counter-clockwise and, at the end of 50 seconds, it reaches the position shown in Figure 2f in which it abuts the first abutment 10 of the fork 6a and starts to move the latter, and hence the forked shift lever 6, leftwards. In Figure 2f, moreover, the fork 6b engages the portion of the eccentric 4 which is furthest from the axis of the rotary shaft 2 and thus the forked shift lever 6 will be turned clockwise to its maximum extent. In the Figure 2f position, moreover, the feed pin 9 on the fork 6a is positioned on the right side of a tooth of the ratchet wheel 5.

25 During the passage of time from 50 seconds to one minute, the operating pin 3 pushes the first abutment 10 towards the left and thus causes the forked shift lever 6 to move leftward to its maximum extent so that the feed pawl 9 turns the ratchet wheel 5 counter-clockwise through one tooth pitch, whereby the "one minute" drum is moved through a one minute space. At the same time, the eccentric 4 turns the forked shift lever 6 counter-clockwise, so that the parts are restored to the Figure 2a position.

40 The above-mentioned operation of the ratchet feed mechanism may be summarized as follows. The feed pin 9 is subjected both to angular rocking motion of the forked shift lever 6, such rocking motion being caused by the rotation of the eccentric cam 4, and also to the linear sliding motion to the right and left of the forked shift lever 6 due to the operating pin 3. In consequence the orbit of feed pin 9 is as shown in Figure 3, where the points a, b, c, d, e and f respectively correspond to the positions of the feed pin 9 shown in Figures 2a to 2f. This orbit of the feed pin 9 is such that when it is moving from point a to point f it does not engage the teeth of the ratchet wheel 5, whereas when it moves linearly from point f to point a, i.e. during the passage of time from 50 seconds to 1 minute, it does engage a ratchet tooth and thus moves the "one minute" drum through a one minute space. Thus, the feed pin 9 effects angular movement of the ratchet wheel 5 during a minor portion only of each complete rotation of the rotary shaft 2, while the rocking and sliding movements of the forked shift lever 6 maintain the feed pin 9 out of driving engage-

ment with the ratchet wheel 5 during the remaining portion of each complete rotation of the rotary shaft 2.

The above-mentioned operation concerns a normal time shift operation i.e. without simultaneous time correction. However, it is possible to effect correction of the minute display simultaneously with the time shift operation. Since the ratchet wheel 5 does not engage the feed pin 9 at any time during the positions shown in Figures 2a to 2e, time correction, e.g. correction of the "one minute" drum, can be made at any such time by turning the ratchet wheel 5 manually by adjustment means (not shown) either in the normal direction or in the reverse direction. Such adjustment means enable the ratchet wheel 5 to be moved angularly independently of the angular movement thereof effected by feed pawl 9. When, however, the ratchet 5 is engaged with the feed pin 9 as shown in Figure 2f, it is possible only to correct the minute display in the normal direction. That is to say, when the feed pin 9 engages the ratchet wheel 5 as shown in Figure 2f, if the ratchet wheel 5 is manually turned in the normal direction (i.e. counter-clockwise direction) a tooth thereof pushes the feed pin 9 and this causes the forked shift lever 6 to move to the left. In consequence, when the stationary shaft 8 engages the right hand end of the elongated hole 7 and the forked shift lever 6 cannot move leftward any further, the said tooth pushes the feed pawl 9 and hence the fork 6a upwardly, whereby the feed pin 9 overrides the said tooth and thereby allows the ratchet wheel 5 to rotate in its normal direction. Such upward pushing of the feed pin 9 is possible because the forks 6a, 6b are resiliently movable away from one another.

Figure 5 illustrates a modification which is generally similar to the construction of Figures 1 to 4 and which for this reason will not be described in detail, like reference numerals indicating like parts.

In the Figure 5 construction, however, the forked shift lever 6 has an elongated hole 7a whose length is longer than that required merely for a time shift operation, and a spring 12 extends between the left hand end of the forked shift lever 6 and the stationary shaft 8 so as to urge the forked shift lever 6 towards a predetermined position, i.e. towards a position corresponding to that of Figure 2a. The spring 12 has a strength such that during normal operation, i.e. during a time shift operation unaccompanied by a time correction, there is a certain play between the shaft 8 and the right hand end of the elongated hole 7a. When the ratchet wheel 5 is moved in the normal direction during a time shift operation, this arrangement causes the spring 12 to extend and thus moves the lever 6 to a position such that the respective tooth of the ratchet wheel 5 pushes the feed pin 9 leftwardly and moves

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the forked shift lever further leftwardly. Consequently, the teeth of the ratchet 5 can pass by or ride over the feed pin 9 smoothly without any hindrance, thereby enabling a time correction to be effected simultaneously if desired

In this instance, since the forked shift lever 6 is placed in a position slightly to the rear of its normal operating condition, it is necessary for the lever 6 to return by means of the force of the spring 12 through a corresponding distance as soon as it passes the feed pin 9, whereby to permit a subsequent time shift operation.

Means for returning the lever 6 are not restricted to the use of the spring 12. For example, the weight of the forked shift lever 6 itself may be used for that purpose.

The ratchet feed mechanism shown in the drawings is easy to assemble and enables the time shift operation to the ratchet to be made smoothly, tooth by tooth, by the combination of the rocking motion in the vertical direction of the forked shift lever 6 due to the eccentric 4 and its sliding motion to the right and left due to the operating pin 3. It is also possible in the ratchet feed mechanism shown in the drawings to make a time correction in the normal direction even during the course of a time shift operation. The ratchet feed mechanism shown in the drawings, moreover, can be actuated in all positions of the parts since it has no dead point.

WHAT WE CLAIM IS:-

1. A ratchet feed mechanism comprising a rotary shaft; an eccentric secured to the rotary shaft; a ratchet wheel which is rotatably mounted on the rotary shaft; a member secured to the rotary shaft and having an operating pin which is spaced from the axis of the rotary shaft; a forked lever which is mounted for rocking movement about an axis which is spaced from said rotary shaft, the forked lever also being mounted for sliding movement towards and away from the rotary shaft; the forked lever having two forks which are respectively engageable with opposite sides of the eccentric cam so that rotation of the latter by the rotary shaft causes the said rocking movement; first and second abutments mounted respectively on said forks and engageable with opposite sides of the operating pin so that rotation of the latter about the axis of the rotary shaft effects the said sliding movement; and a feed pin 1 which is mounted on a said fork and is engageable with the ratchet to

effect angular movement of the latter during a minor portion only of each complete rotation of the rotary shaft, the said rocking and sliding movements maintaining the feed pin out of driving engagement with the ratchet wheel during the remaining portion of each complete rotation of the rotary shaft.

2. A ratchet feed mechanism as claimed in claim 1 comprising adjustment means for effecting angular movement of the ratchet wheel independently of that effected by the feed pin.

3. A ratchet feed mechanism as claimed in claim 2 in which the said two forks are resiliently movable away from one another during operation of the adjustment means of permit the ratchet wheel to ride over the feed pin.

4. A ratchet feed mechanism as claimed in claim 2 which biasing means are provided for urging the forked lever towards a predetermined position, the biasing means permitting the forked lever to be moved during operation of the adjustment means to a further position in which the ratchet can ride over the feed pin.

5. A ratchet feed mechanism as claimed in any preceding claim in which the forked lever is rockingly and slidably mounted on a stationary shaft which extends through an elongated hole in the forked lever.

6. A ratchet feed mechanism as claimed in claim 4 and claim 5 in which the biasing means comprises a spring whose opposite ends are respectively connected to the forked lever and to the stationary shaft.

7. A ratchet feed mechanism as claimed in any preceding claim in which the said member secured to the rotary shaft is a seconds member of a digital timepiece movement, the said ratchet wheel operating a minutes member of the movement.

8. A ratchet feed mechanism substantially as hereinbefore described with reference to and as shown in Figures 1 to 4 or in Figure 5 of the accompanying drawings.

9. A digital timepiece provided with a ratchet feed mechanism as claimed in any preceding claim.

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Means for returning the lever 6 are not restricted to the use of the spring 12. For example, the weight of the forked shift lever 6 itself may be used for that purpose.

The ratchet feed mechanism shown in the drawings is easy to assemble and enables the time shift operation to the ratchet to be made smoothly, tooth by tooth, by the combination of the rocking motion in the vertical direction of the forked shift lever 6 due to the eccentric 4 and its sliding motion to the right and left due to the operating pin 3. It is also possible in the ratchet feed mechanism shown in the drawings to make a time correction in the normal direction even during the course of a time shift operation. The ratchet feed mechanism shown in the drawings, moreover, can be actuated in all positions of the parts since it has no dead point.

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1. A ratchet feed mechanism comprising a rotary shaft; an eccentric secured to the rotary shaft; a ratchet wheel which is rotatably mounted on the rotary shaft; a member secured to the rotary shaft and having an operating pin which is spaced from the axis of the rotary shaft; a forked lever which is mounted for rocking movement about an axis which is spaced from said rotary shaft, the forked lever also being mounted for sliding movement towards and away from the rotary shaft; the forked lever having two forks which are respectively engageable with opposite sides of the eccentric cam so that rotation of the latter by the rotary shaft causes the said rocking movement; first and second abutments mounted respectively on said forks and engageable with opposite sides of the operating pin so that rotation of the latter about the axis of the rotary shaft effects the said sliding movement; and a feed pin 1 which is mounted on a said fork and is engageable with the ratchet to

effect angular movement of the latter during a minor portion only of each complete rotation of the rotary shaft, the said rocking and sliding movements maintaining the feed pin out of driving engagement with the ratchet wheel during the remaining portion of each complete rotation of the rotary shaft.

2. A ratchet feed mechanism as claimed in claim 1 comprising adjustment means for effecting angular movement of the ratchet wheel independently of that effected by the feed pin.

3. A ratchet feed mechanism as claimed in claim 2 in which the said two forks are resiliently movable away from one another during operation of the adjustment means of permit the ratchet wheel to ride over the feed pin.

4. A ratchet feed mechanism as claimed in claim 2 which biasing means are provided for urging the forked lever towards a predetermined position, the biasing means permitting the forked lever to be moved during operation of the adjustment means to a further position in which the ratchet can ride over the feed pin.

5. A ratchet feed mechanism as claimed in any preceding claim in which the forked lever is rockingly and slidably mounted on a stationary shaft which extends through an elongated hole in the forked lever.

6. A ratchet feed mechanism as claimed in claim 4 and claim 5 in which the biasing means comprises a spring whose opposite ends are respectively connected to the forked lever and to the stationary shaft.

7. A ratchet feed mechanism as claimed in any preceding claim in which the said member secured to the rotary shaft is a seconds member of a digital timepiece movement, the said ratchet wheel operating a minutes member of the movement.

8. A ratchet feed mechanism substantially as hereinbefore described with reference to and as shown in Figures 1 to 4 or in Figure 5 of the accompanying drawings.

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