

# PATENT SPECIFICATION

## DRAWINGS ATTACHED.

1,064,230

1,064,230



Date of Application and filing Complete Specification:  
Feb. 9, 1966. No. 5752/66.  
Application made in United States of America (No. 431,676) on  
Feb. 10, 1965.  
Complete Specification Published: April 5, 1967.

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Index at Acceptance :—G3 T(A5X, AIOC2).  
Int: CL—G 04b.

### COMPLETE SPECIFICATION.

## Improvements in or relating to a Time-Setting Mechanism in an Electronic Timepiece.

We, BULOVA WATCH COMPANY, INC., a corporation organized under the laws of the State of New York, one of the United States of America, of 630 Fifth Avenue City and State of New York, United States of America, 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 generally to time-setting mechanisms for electronic timepieces, and more particularly to a mechanism which when actuated immediately arrests the motion of the seconds hand in a tuning-fork type of electronic timepiece, normal motion of the seconds hand being resumed the moment the setting mechanism is released.

In British Patent Specification No. 854,196 there is disclosed an electronic timepiece including a tuning fork having a relatively high frequency and a battery-powered transistorized drive circuit to sustain the vibratory motion of the fork. The reciprocating motion of the fork, which acts as a timekeeping standard, is transformed into rotary motion by means of a ratchet and pawl mechanism whose pawl or index finger is attached to one tine of the fork. The pawl engages and advances a ratchet wheel provided with a pinion for operating the timepiece hands through a train of gears. In British Patent Specification No. 955559 there is disclosed an improved form of a motion converter for a timepiece of the above-described type, whereby the ratchet wheel is caused to advance only one tooth for each forward stroke of the index finger attached to the tine, regardless of

minor variations in the length of the stroke arising from changes in the amplitude of fork vibration. This is accomplished by means of an auxiliary pawl attached to the framework or pillar plate of the timepiece, this pawl engaging the ratchet wheel at a position relative to the index finger at which the phase between the linger and pawl is several ratchet teeth plus one-half tooth.

Various forms of setting mechanisms have heretofore been developed for tuning-fork electronic watches of the type having an index finger to advance an index wheel and a pawl to prevent retrograde motion of the wheel. Such mechanisms, when the setting stem is pulled up, act to effect disengagement both of the pawl and the index finger from the index wheel. Such disengagement is accomplished by means of a lever coupled to the setting stem, the lever being provided with lifting pins which when the stem is raised, serve to lift the index finger and pawl away from the ratchet teeth of the index wheel.

Inasmuch as the pawl which acts to prevent retrograde motion of the wheel is attached to the fixed frame of the watch, the lifting thereof has no adverse effects. However, the index finger is attached to one tine of the tuning fork and when this element is lifted, the index finger continues to reciprocate, the finger then proceeding to drag back and forth across the lifting pin. This drag imposes a relatively heavy load on the tuning fork, thereby reducing its vibratory amplitude and increasing battery drain. When thereafter the index finger is returned to its operative position, its action is initially relatively sluggish until such time as the fork is able to regain its original amplitude. As a consequence, the timepiece

does not immediately resume its proper functioning when restarted, by the setting mechanism and some degree of accuracy is lost in the setting operation. In view of the foregoing, it is the main object of this invention to provide a setting mechanism in an electronic timepiece which is adapted to stop, set and precisely restart the timepiece hands. More specifically, it is an object of this invention to provide a setting mechanism which acts to disengage the pawl of the timepiece without, however, disengaging the index finger, whereby rotation of the index wheel is nevertheless arrested, the mechanism also acting to brake the seconds hand to permit precise setting of the timepiece.

The present invention refers to a time setting mechanism in an electronic timepiece, wherein an index finger attached to a vibratory element engages ratchet teeth on an index wheel operatively coupled to a gear train having a seconds wheel and wherein a pawl also engages said teeth to prevent retrograde motion the index wheel, the mechanism comprising first means arranged to lift the pawl away from the ratchet wheel to prevent effective rotation of the index wheel without disengagement of the index finger, second means arranged to brake the seconds wheel, third means arranged to engage and turn the minute wheel to adjust the minute and hour hands of the timepiece, and control means operatively coupled to said first, second and third means to actuate same without interfering with the action of the index finger, the control means being arranged to stop the timepiece and to permit setting thereof by rendering the first, second and third means operative in the named sequence, and arranged to restart the timepiece after the setting thereof by rendering third, second and first means inoperative in the named sequence. For a better understanding of the invention, as well as other objects and further features thereof, reference is made to the detailed description to be read in with the accompanying drawings, wherein:—

Fig. 1 is a perspective of a tuning fork and motion converter of the type disclosed in the aforementioned British Patent Specification No. 955559;

Fig. 2 separately shows the motion converter;

Fig. 3 schematically shows the setting mechanism in accordance with the invention, when the stem is fully pushed in and the timepiece is operative;

Fig. 4 schematically shows the same time setting mechanism when the stem is pulled out to permit manual time setting of the minute and hour hands; Fig. 5 is an enlarged elevational view of that portion of the time setting mechanism which lifts the pawl and brakes the seconds hand;

Fig. 6 is a section taken along the plane indicated by line 6—6 in Fig. 5; and

Fig. 7 diagrammatically shows the sequence of events when operating the setting mechanism.

#### MOTION TRANSFORMER

Referring now to Figs. 1 and 2, there is shown a timepiece of the type disclosed more fully in the above-identified patent specifications, including a tuning fork, generally designated by numeral 10, a rotary movement of conventional design in the form of a gear train 11 for turning the hands of the timepiece, and a motion

transformer, generally designated by numeral 15, operatively inter-coupling the fork 10 and the rotary movement 11 and acting 'to convert the vibratory action of the fork into rotary motion. The tuning fork has no pivots or bearings and its timekeeping action is therefore relatively independent of the effects of friction.

Tuning fork 10 is provided with a pair of flexible tines 14A and 14B interconnected by a relatively inflexible base 15, the base being provided with an upwardly extending stem 16 secured to the pillar plate or the framework by suitable screws. The central area of the pillar plate is cut out to permit unobstructed vibration of the tines.

The tuning fork is electromagnetically actuated through an electronic circuit of the type disclosed in the above-noted British Patent Specification No.854,196 including a magnetic element 17 secured to the free end of tine 14A, and a magnetic element 18 secured to the free end of tine 14B. The manner in which the fork or other vibratory member is sustained in vibration forms no part of the present invention.

The vibratory motion of the tuning fork is converted by motion transformer 13 into rotary motion. This transformer is constituted by a ratchet and pawl mechanism operated by the tuning fork to drive an index wheel 19 having ratchet teeth 20 thereon. In a working embodiment, the wheel has a large number of teeth (300) and yet a diameter of only 95/100(1 of an inch (228.6 x . 10<sup>-3</sup> cm.), the 'length of each' tooth being 8/10,000 of an inch (20.34 x 10<sup>-4</sup>cm.).

Index wheel 19 acts as the actuator for rotary movement 11, and it is therefore intended that this wheel be advanced by the vibratory fork at a constant rate. This is effected by means of the main pawl or index finger 21, one end of which is secured to a post 22 projecting laterally from the tine 14B.

Index finger 21 is in the form of a light leaf spring and carries a tip 23 which may be of precious or semi-precious stone, such as sapphire. The tip engages the teeth 20 of index wheel 19, so that the oscillations of the tine transmit turning impulses to the wheel. The shaft of wheel 19 is provided with a pinion 24 which intermeshes with the first gear in the gear train 11.

Operating in conjunction with index wheel 19 is an auxiliary pawl 25 whose design is similar to that of the index finger 21, the pawl being secured to a bridge 26 pivotally attached to the pillar plate. The position of bridge 26 may be adjusted by means of cam member 27 and locked by locking screw 28. Bridge 26 pivots about screw 29.

The index finger and pawl are both tensioned downwardly the jewelled tips thereof being parallel with the teeth of the index wheel. The tension is such that when the finger is retracted, there is sufficient reverse torque to cause the wheel to reverse direction. This backup, however, is arrested by the pawl which is phased several teeth plus one-half tooth from the finger. It would not be practical to maintain an exact amplitude for vibrations of the tuning fork in a wrist timepiece and the operation of the motion transformer is such that this is not necessary. It will be noted that the spring forces on the index finger 21 and pawl 25 not only hold them in firm contact with the index wheel 19, but they also exert a torque on this wheel, in the direction opposite to its

forward motion. This torque causes the index wheel to back up during the first portion of the return stroke of the index jewel, until it is engaged by the pawl jewel. This torque is the result of the geometry of the system and is similar to the "draw" in a conventional escapement which tends to hold the pallet fork against the banking pin.

### THE TIME-SETTING MECHANISM

Referring now to Fig. 3, the time-setting mechanism is shown in its pushed-in or inactive position, in which state the timepiece operates normally with all hands in motion. Thus the reciprocating index finger 21 engages the ratchet teeth of index wheel 19 to advance same. Retrograde motion of the wheel is prevented by pawl 25 which also engages the ratchet teeth of the wheel at a point thereon displaced from that of the index finger which is adjusted to provide the proper phase relationship there between in the manner disclosed in the aforementioned British Patent Specification No. 955559.

The gearworks 11, which is of conventional design and hence will not be described in complete detail, acts to turn an hour hand HH, a minute hand MN, and a sweep second hand SH. The regulated driving power to operate these hands is transmitted through pinion 24 on the shaft of the index wheel 19, this pinion engaging wheel 30. The pinion 31 on the shaft of the wheel 30 engages the seconds wheel 32. The pinion 33 on the shaft of the seconds wheel engages the third wheel 34, and its pinion 35 engages the centre wheel 36. The cannon pinion 37 of the center wheel engages a minute wheel 38, and its pinion (not shown) engages an hour wheel (not shown) with its hour hand tube or pipe. The cannon pinion, or the minute hand shaft, is held by friction in the usual way to the center wheel. Hence as the ratchet wheel turns, this motion is transmitted through the gear train to the seconds, minute and hour hands, whereby for each full sweep of the seconds hand, the minute hand moves one-sixtieth of a full revolution, and for each full revolution of the minute hand, the hour hand moves one-twelfth of a revolution.

The time-setting mechanism includes a stem assembly constituted by a slidable stem 39 whose upper end extends through an opening in the watch casing 40 and terminates in a crown 41. A hack lever 42 is mounted on a pivot 43 and is tensioned by a spring 44 such that projection 42A thereon bears against the lower portion of stem 39 when the stem is in its inactive position, whereby when the stem is retracted from projection 42A, the hack lever is free to swing in the manner shown in Fig. 4, to cause a shoe portion 45 thereof to engage a brake disc 46 mounted on the shaft of the seconds wheel and to cause a lifting pin 47 to engage the pawl 25 and to lift it away from the teeth on ratchet wheel 19.

Mounted on a square portion of the stem 39 is a clutch wheel 48 which is free to slide but not to rotate thereon. Clutch wheel 48 is caused by clutch lever 49. when the stem is fully raised to its pull-out or active position, to engage a setting wheel 50. Setting wheel 50 intermeshes with minute wheel 38, hence when the crown 41 is manually rotated, the minute wheel is caused turn to set the minute and hour hands in the usual manner. Clutch lever 49 is operated by a setting lever 51

which rocks about a pivot 52, the nose 53 of this lever being received within an annular groove 54 on the stem, such that when the stem is raised, a projection 55 on the setting lever rides on the cam surface of the clutch lever 49, forcing the clutch lever down against the action of the setting lever spring 56, thereby putting clutch wheel 48 into mesh with the setting wheel 50. A detent (not shown) is provided to hold setting lever 51 in its operative position.

Thus in the pushed-in or inactive position of the stem 39, as shown in Fig. 3, the stem extends beneath the projection 42A of the hack lever 42, thereby holding this lever in angular position about its pivot 43, at which position brake disc 46 is disengaged, lifting pin is displaced from the pawl 25, and the setting wheel 50 is decoupled from clutch wheel 48, so that the timepiece is free to operate in its usual manner.

When the stem is raised from its inactive position, as shown in Fig. 4, three events occur in the course of the upward movement of the stem. These events take place in a programmed sequence which is determined by the physical parameters of the stem assembly and hack lever. These events and their sequence are shown in Fig. 7 and will now be described.

Event I. When the stem is partially lifted from its inactive position and before it is sufficiently raised to its active position to cause clutch wheel 48 to engage the setting wheel 50, the Stem is retracted from projection 42A to release the hack lever 42. The position of lifting pin 47 relative to pawl 25. as against the position of shoe 45 relative to brake disc 46, is such that the first event, which occurs in the course of the swing of the back lever, is the lifting of the pawl. As a consequence, retrograde motion of the index wheel is no longer prevented, and even though the wheel is still driven by the index finger 21, the downward tension of this finger imposes a reverse torque on the wheel and the wheel is caused to oscillate rather than to turn. Hence the tuning fork is effectively decoupled and the timepiece bands cease turning upon occurrence of the first event.

Event II. In Event I, the stem is only partially raised, and while the setting wheel is not yet operative, the hack lever has been released and has swung to a degree sufficient to effect lifting of the pawl. With the completion of the hack-lever swing, the shoe 45 engages brake disc 46, which is mounted on the shaft of the seconds wheel, and arrests further movement of the seconds hand. Hence the indication of the seconds hand will not thereafter be changed while the minute and hour hands are adjusted.

Event III. Finally, when the stem is pulled up fully to the active position where the clutch wheel 48 on the stem meshes with setting wheel 50, rotation of the crown 41 will bring about rotation of the minute wheel 38 and hence setting of the minute and hour hands, without however changing the held position of the seconds hand. In 'this way it becomes possible to precisely set the watch. It is important to note that the hack lever completes its swing to carry out the first and second events before the third event takes place.

After the watch is set and the stem is returned from its pulled-out (active) to its pushed-in (inactive) position, the above events occur in reverse order, the setting wheel first being disengaged, the seconds wheel then being

released, and finally the pawl returned to the ratchet teeth on the index wheel to cause resumption of operation.

While there has been shown and described a preferred embodiment of time-setting mechanism for electronic timepieces in accordance with the invention, it will be appreciated that many changes and modifications may be made therein without however, departing from the essential scope of the invention.

WHAT WE CLAIM IS:—

1. A time-setting mechanism in an electronic timepiece, wherein an index finger attached to a vibratory element engages ratchet teeth on an index wheel operatively coupled to a gear train having a minute wheel and a seconds wheel and wherein a pawl also engages said teeth to prevent retrograde motion of the index wheel, the mechanism comprising first means arranged to lift the pawl away from the ratchet wheel to prevent effective rotation of the index wheel without disengagement of the index finger, second means arranged to brake the seconds wheel, third means arranged to engage and turn the minute wheel to adjust the minute and hour hands of the timepiece, and control means operatively coupled to said first, second and third means to actuate same without interfering with the action of the index finger, the control means being arranged to stop the timepiece and to permit setting thereof by rendering the first, second and third means operative in the named sequence, and arranged to restart the timepiece after the setting thereof by rendering the third, second and first means inoperative in the named sequence.

2. An electronic timepiece as claimed in claim 1, wherein the control means is a time-setting mechanism for precisely setting the timepiece, the mechanism including, a setting wheel operatively coupled to the minute wheel, a stem assembly provided with a stem which is slidable from an inactive to an active position and having a clutch wheel thereon which is caused to engage the setting wheel only when the stem occupies the active position to permit adjustment of the minute and hour hands, a pivoted hack lever having a brake shoe and a lifting pin thereon, the pin being arranged to lift the pawl from the ratchet wheel when the lever occupies a first angular position, without interfering with the action of the index finger and the shoe being arranged to brake the seconds wheel when the lever occupies a second angular position, and means maintaining the lever in an inactive position when the stem is in an inactive position and releasing the lever to swing

sequentially into the first and second angular positions when the stem is partially raised but before the stem occupies its active position.

3. An electronic timepiece as claimed in claim 2, wherein the second means includes a brake shoe and a brake disc, the brake disc being coupled to the shaft of the seconds wheel, the brake shoe of the pivoted hack lever being arranged to engage the brake disc.

4. An electronic timepiece as claimed in claim 3, wherein the first means includes a lifting pin to lift the pawl, and the third means includes a clutch to engage and turn the minute wheel.

5. An electronic timepiece as claimed in claim 1, wherein the control means includes a slidable stem slidable from an inactive to an active position for stopping and setting the timepiece.

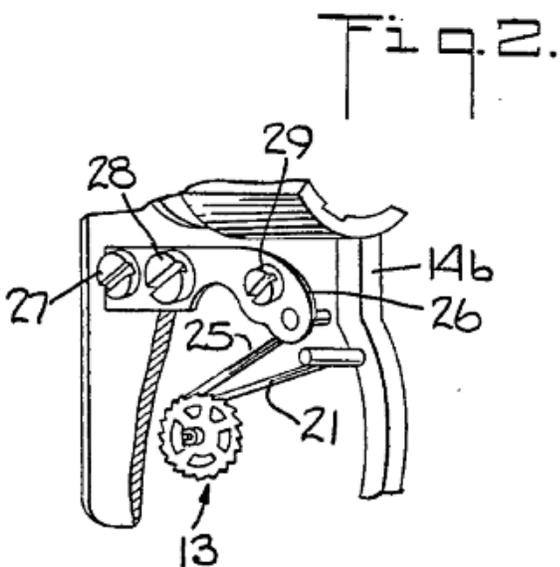
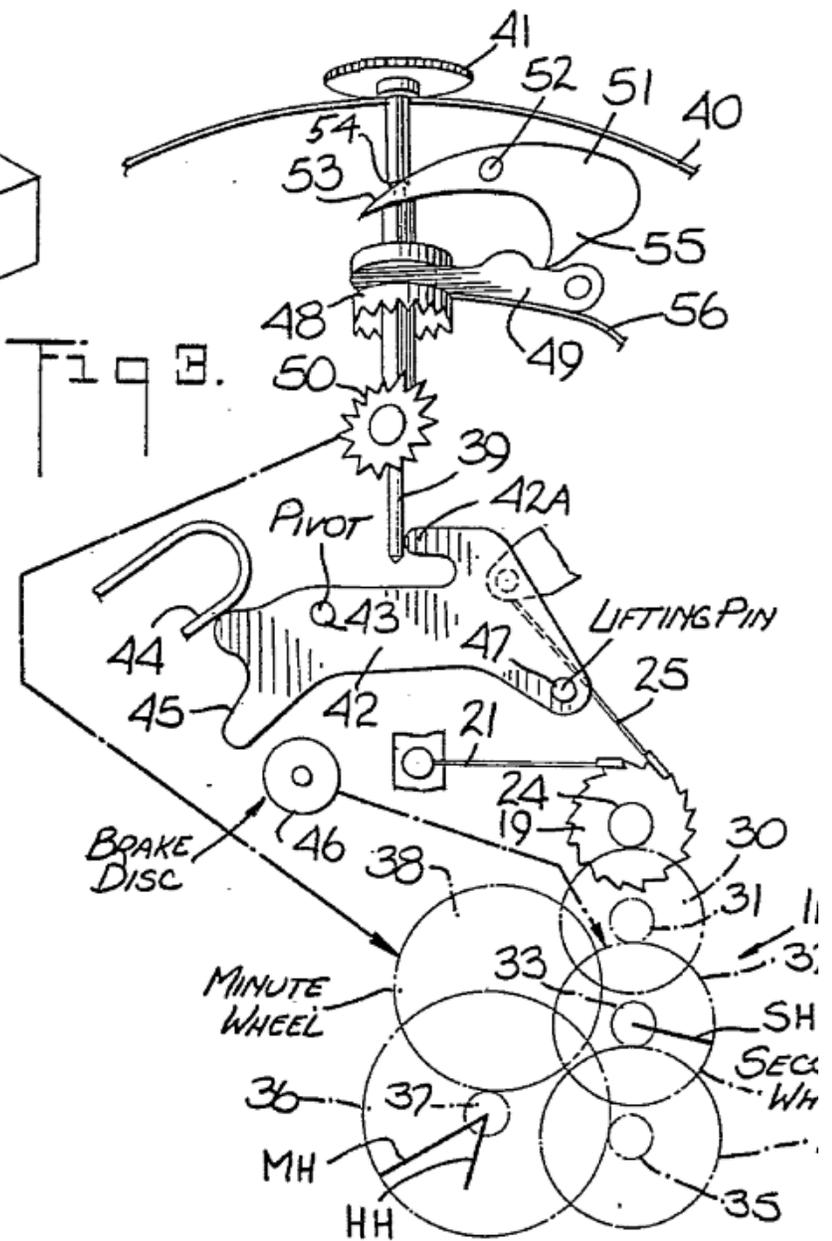
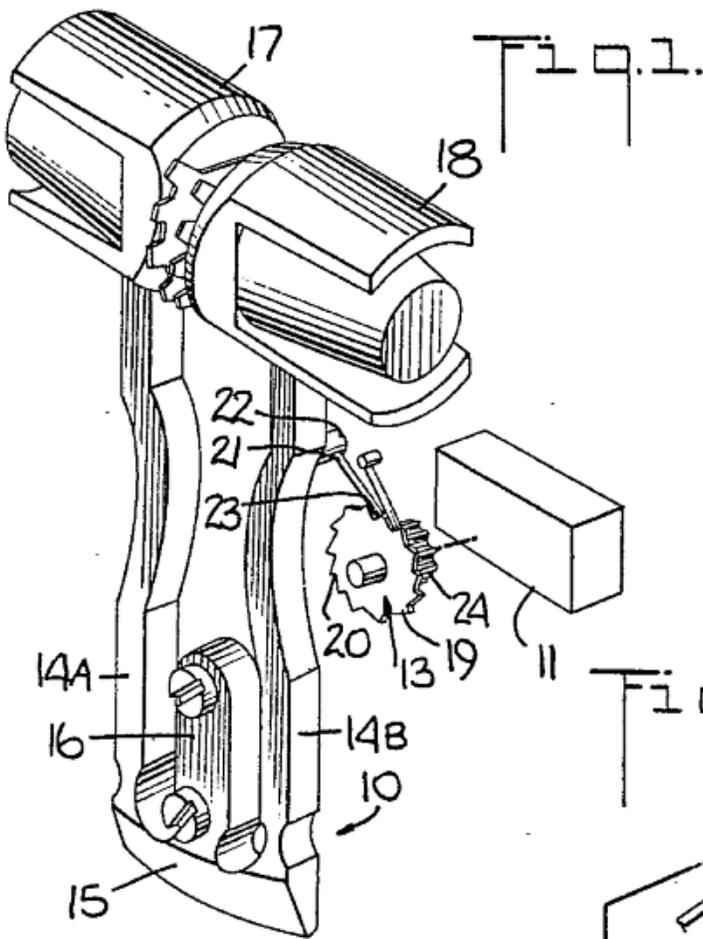
6. An electronic timepiece as claimed in claim 3, 4 or 5, wherein when the stem slides from the inactive to active position, the pawl is lifted, then the second wheel is braked and finally the minute wheel is engaged to permit setting of the timepiece.

7. An electronic timepiece as claimed in any one of the preceding claims, wherein the vibratory element is a tuning fork and the index finger is attached to one tine of the tuning fork.

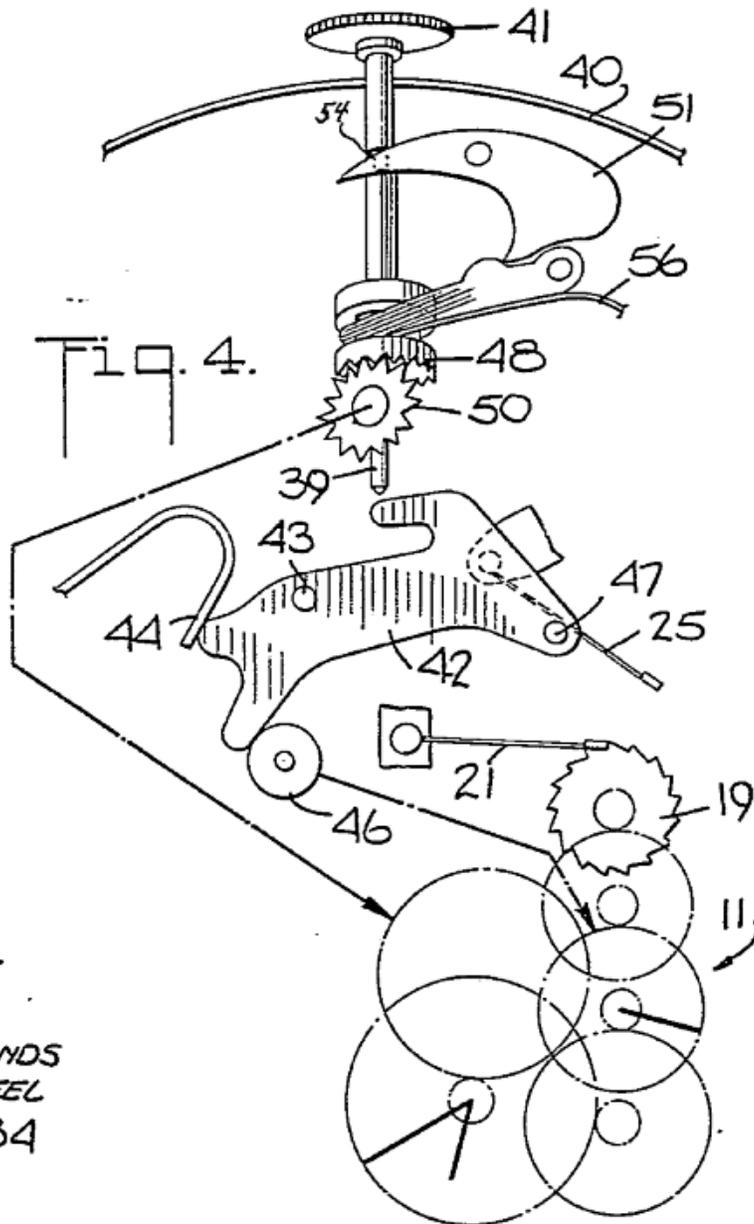
8. An electronic timepiece as claimed in any one of the preceding claims, wherein the gear train is arranged to operate the hour, minute and seconds hands of the timepiece, the minute wheel upon rotation thereof effecting adjustment of the minute and hour hands, the seconds wheel upon rotation thereof effecting adjustment of the seconds hand, the vibratory motion of the vibratory element being converted by a motion transformer into rotary motion for driving the gear trains and including, the index wheel having ratchet teeth, the wheel being operatively coupled to the train, the index finger, and the pawl fixedly attached on the timepiece and engaging the teeth of the index wheel at another point thereon to prevent the retrograde motion of the wheel.

9. A time-setting mechanism in an electronic timepiece having its parts constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

HASELTINE, LAKE & Co.,  
Chartered Patent Agents,  
28 Southampton Buildings,  
Chancery Lane,  
London, W.C.2.  
Agents for the Applicants.



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