Dec. 4, 1962 H. S. DETWILER 3,066,474

CONTACT AND INDEX MECHANISM

Filed March 29, 1960 2 Sheets-Sheet 1

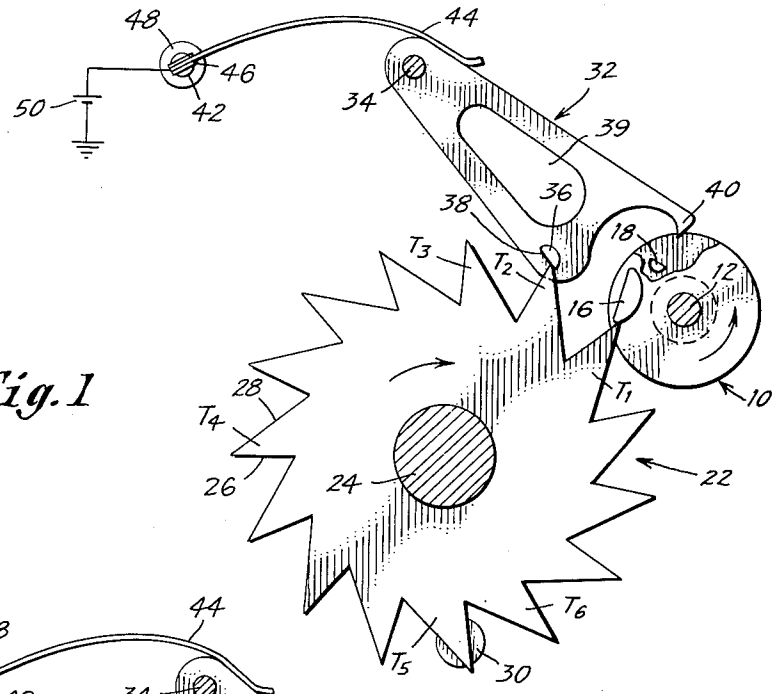


Fig. 1

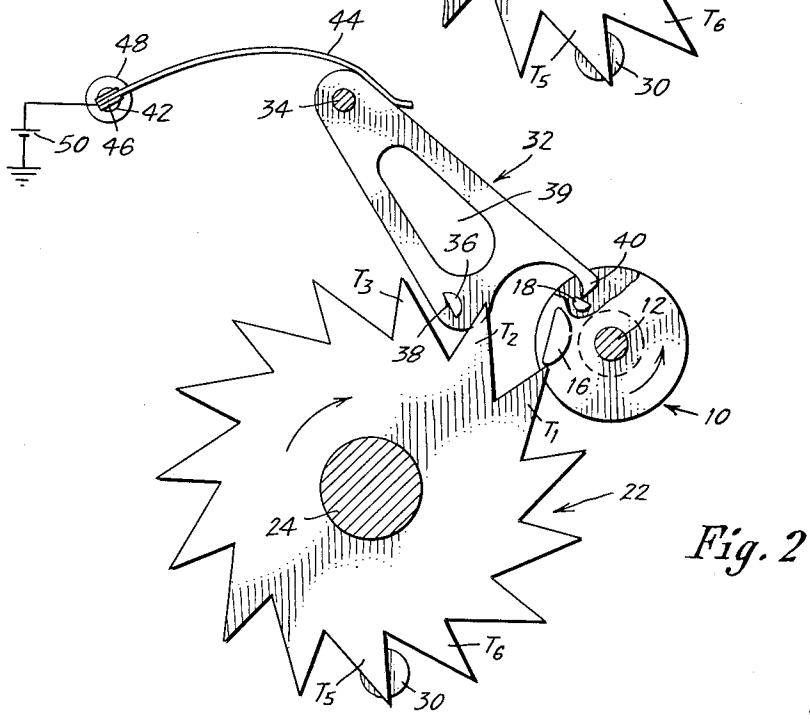


Fig. 2

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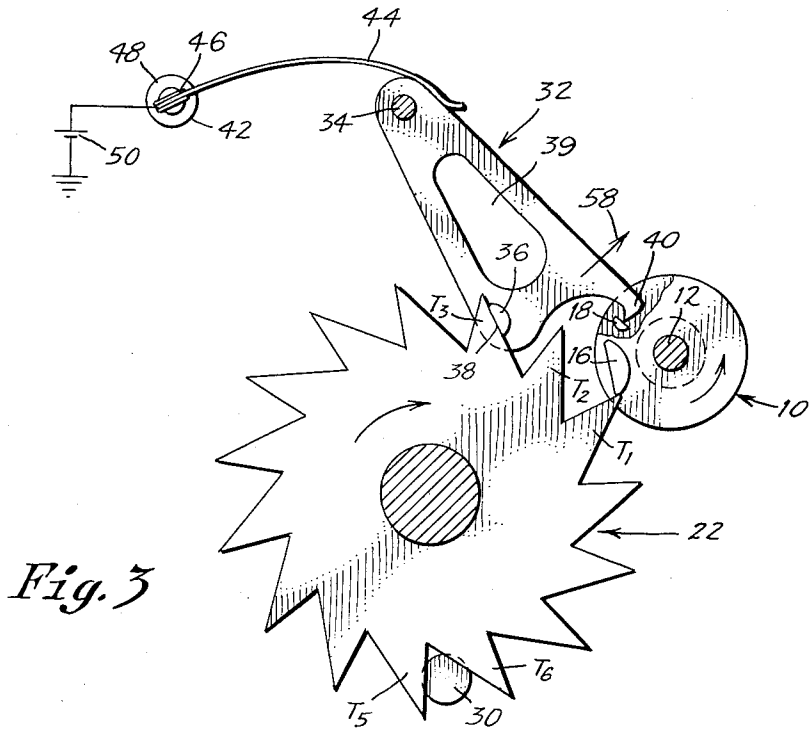


Fig. 3

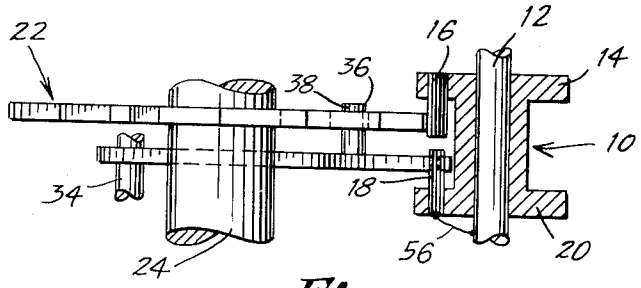


Fig. 4

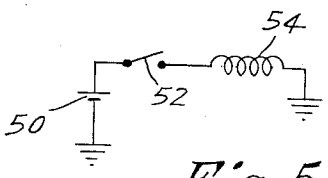


Fig. 5

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3,066,474

CONTACT AND INDEX MECHANISM

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Filed Mar. 29, 1960, Ser. No. 18,326
6 Claims. (Cl. 58—28)

This invention relates to a contact and index mechanism for a battery driven electric watch and more particularly relates to a contact and index mechanism in which the duration of the electrical contact is controlled directly by the position of the wheel to be indexed.

In self-contained, battery operated electric watches of the type having an oscillating balance wheel serving to transmit the motive power, it is necessary to provide an indexing mechanism which will receive the power from the oscillating movement of the balance wheel and transform these oscillations into rotary motion in a single direction. A preferred source of motive power is that shown in Van Horn Patent No. 2,888,797, in which an oscillating coil is passed through intensified regions of a magnetic field to interact wtih the intensified magnetic regions and pulse the balance wheel which carries the coil.

Generally speaking, indexing is performed by utilizing a toothed wheel which is advanced in step-by-step fashion by means of periodic electrical contact through a portion of the arc traversed by the oscillating balance wheel. Heretofore, difficulty has been experienced in controlling the duration of the electrical contact which, in turn, is a measure of the impulse imparted to the balance wheel. In previous indexing systems, the duration of the electrical contact, if controlled at all, has been controlled by the rotation of the balance staff which carries the oscillating balance wheel. Since oscillation of the balance staff and balance wheel must be maintained constant in order for the watch to keep accurate time, there is effectively no control over the time during which the coil is energized as it passes through the magnetic field.

It will be appreciated that when the battery is new, the magnitude of the electrical field about the coil is at a maximum and as the battery grows older the magnitude decreases. Thus, in the ideal situation, the duration of the electrical contact to the coil should be a minimum when the battery is new and should approach a maximum as the battery grows older. Lack of control over the duration of electrical contact is accordingly extremely disadvantageous from the standpoint of efficient utilization of the available energy in the electric watch.

According to the present invention, a novel contact and index mechanism has been devised which eliminates the control problem presented by the above-described prior art mechanisms by permitting the duration of the electrical contact to be determined by the position of the wheel to be indexed rather than by the balance staff. When the battery is new and the magnitude of the impulse the greatest, the index wheel moves its prescribed amount in a shorter period of time, the position of the index wheel being used directly to interrupt the electrical contact to the coil and thereby providing electrical contact for a minimum period of time. Conversely, as the magnitude of the impulse from the battery decreases with age, the time that it takes the index wheel to move through its prescribed angular distance will correspondingly increase, and since the position of the index wheel is used to control the duration of electrical contact, the duration of contact is increased proportionately.

As an ancillary feature of the present invention, magnetic indexing of the type shown in assignee's copending application Serial No. 632,176, filed January 2,

1957, now Patent No. 2,977,750, issued April 4, 1961, is used to minimize the amount of power that must be supplied by the battery

Accordingly, it is a primary object of the present invention to provide a contact and index mechanism for a battery operated watch in which the duration of the electrical contact is controlled directly by the position of the wheel to be indexed.

It is another object of the present invention to provide a contact and index mechanism for a battery operated watch in which the duration of the electrical contact is effectively varied in accordance with the strength of the battery.

It is still another object of the present invention to provide a contact and index mechanism for a battery operated watch which magnetically positions the index wheel in its rest position for proper indexing.

These and further objects and advantages of the present invention shall become more apparent upon reference to the following specification, claims and appended drawings wherein:

FIGURE 1 is a plan view, partially broken away for purposes of clarity, of the index mechanism showing the position of the elements at the beginning of the indexing cycle;

FIGURE 2 is a plan view, partially broken away for purposes of clarity, of the index mechanism showing the position of the elements at the time electrical contact is made;

FIGURE 3 is a plan view, partially broken away for purposes of clarity, of the index mechanism showing the position of the elements at the time electrical contact is broken;

FIGURE 4 is an end elevational view, partly in section, of the index mechanism with parts removed for purposes of clarity; and

FIGURE 5 is a schematic diagram of the electrical circuit.

As best illustrated in FIGURES 1 and 4, an index roller indicated generally at **10** is fixedly mounted on a balance staff **12** for rotation therewith and is provided with upper and lower flanges **14** and **20**. Depending from upper flange **14**, as best seen in FIGURE 4, is a semicircular insulated index jewel pin or pawl **16**. Upper flange **14** has been partially broken away in FIGURES 1–3 to more clearly indicate an upstanding contact post **18** which is carried by a lower flange **20** of the index roller **10**.

An index wheel is indicated generally at **22** and is mounted for rotation on a staff **24**. The latter is mounted on jewels in the frame of the watch in the customary manner and is therefore electrically insulated from the frame of the watch. A typical tooth **T4** is shown to consist of one radial side **26** and a slanting side **28** which forms an acute angle with the radial side of the tooth. A permanent magnet **30** is mounted in the frame of the watch directly beneath another tooth **T5** and functions to aid in the indexing operation in the manner described in assignee's aforementioned U.S. Patent No. 2,977,750. Magnet **30** determines the rest position for the index wheel **22**, and, as pointed out in assignee's U.S. Patent No. 2,977,750, more than one magnet **30** may be employed, each associated with a different tooth. The particular position for the mounting of magnet **30** may of course, be varied.

A contact lever indicated generally at **32** is pivotally mounted on a staff **34**. This is also mounted on jewels and is thereby electrically insulated from the frame of the watch. An actuating jewel pin **36**, which functions as a cam follower, is mounted on contact lever **32** and is provided with a flat surface **38**. Contact lever **32** is slotted at **39** to provide a webbed portion which reduces its

weight. A pointed electrical contact **40** is integral with contact lever **32** and separated from actuating jewel pin **36** by a predetermined, fixed distance.

A post **42** carries one end of an elongated spring **44** in a slot **46**. The free end of elongated spring **44** engages the contact lever **32** and constantly urges it in a clockwise direction toward the index wheel. This action of spring **44** tends to maintain the flat camming surface **38** of actuating jewel pin **36** in contact wtih the slanting sides **28** of the teeth of the index wheel **22**. Post **42** is electrically insulated from the frame of the watch by means of an insulating bushing **48**. One terminal of a battery **50** makes electrical contact with the end of elongated spring **44**, the other terminal being grounded to the watch case.

As shown in FIGURE 5, battery **50** is wired in series with a switch **52**, which schematically represents the electrical contact that is made between pointed contact **40** and contact post **18**. One side of a coil **54** is connected in series with switch **52** and the opposite side is grounded. Contact is made to the coil **54** from upstanding contact post **18** by electrical lead **56** (FIGURE 4) to balance staff **12** and then to the coil, which may conveniently be carried by the balance wheel (not shown).

The operation of the contact and index mechanism will now be explained with reference to FIGURES 1–3. FIGURE 1 represents the beginning of the indexing cycle and the index roller **10** is shown as it begins its oscillation in a counterclockwise direction. At this time, the index jewel pin **16** is just beginning to contact tooth T1 to drive the index wheel in a clockwise direction. Actuating jewel pin **36** is shown to be in contact with the pointed end of the next succeeding tooth **T2**. In this position of the lever **32**, pointed contact **40** does not engage upstanding contact post **18** and the coil is de-energized. Tooth T5 is shown in its rest position, attracted by permanent magnet **30**.

As the indexing proceeds, and as shown in FIGURE 2, the semicircular index jewel pin **16** will slide down the radial face of tooth T1 and actuating jewel pin **36** will slip past the pointed end of tooth **T2**. Lever **32**, under the influence of elongated spring **44**, will pivot about staff **34** and pointed contact **40** will then engage upstanding contact post **18**, thereby completing the electrical circuit to energize the coil. This circuit comprises grounded battery **50**, elongated spring **44**, pivoted lever **32**, pointed contact **40**, upstanding contact post **18**, electrical lead **56**, balance staff **12** and coil **54**, one end of which is grounded by a suitable connection (not shown). In this position, tooth T5 is being moved away from the influence of permanent magnet **30**.

With continued counterclockwise oscillation of the index roller **10** and corresponding clockwise rotation of index wheel **22**, the flat surface **38** of actuating jewel pin **36** will be engaged by the slanted side of tooth T3, and ultimately resulting in the counterclockwise rotation of pivoted lever **32** towards its original position under the camming action of tooth T3. Pointed contact **40** will in turn be moved out of engagement with contact post **18**, thereby breaking the electrical circuit and de-energizing the coil. At this point, tooth **T6** has advanced sufficiently close to permanent magnet **30** to be attracted and pulled toward the magnet, thereby establishing a new rest position for index wheel **22**. Semicircular index jewel pin **16** has at this point become disengaged from the radial face of tooth T1.

On the return oscillation of index roller **10** (i.e., clockwise rotation), index jewel pin **16** will contact the slanted side of tooth T2 and actuating jewel pin **36** will remain in contact with the slanted side of tooth T3 to prevent electrical contact from being established between pointed contact **40** and contact post **18**. During its return movement, the index jewel pin **16** will contact the slanted side of tooth **T2** and urge the index wheel in a counterclockwise direction sufficiently to permit the jewel pin to clear tooth **T2**, but the index wheel will not be moved sufficiently for tooth T6 to escape the magnetic attraction of permanent magnet **30** so as to cause retrograde or counterclockwise movement of the index wheel **22** after the index jewel pin **16** has passed tooth T2. The index mechanism is now ready for another cycle.

By virtue of the shape of the teeth on the index wheel **22**, index jewel pin **16** will drive the wheel through a greater angular distance in the driving direction than in the opposite direction before sliding past the tooth. It will also be apparent that since the duration of the electrical impulse is controlled directly by the position of the index wheel, which is the element sought to be moved, the impulse will be of a duration sufficient to produce the desired movement, notwithstanding decreases in the magnitude of the available magnetic field. Indeed the most significant aspect of the instant invention is the fact that the duration of impulse will vary in inverse proportion to the change in magnitude of the available magnetic field. Also, lower magnitude impulses may be used since the duration is controlled. The supplemental attractive force of the permanent magnet also permits lower magnitude impulses to be imparted to move the index wheel through an arc sufficient to bring the next succeeding tooth under the influence of the permanent magnet.

Although the parts are light in weight their reliability is very high especially in view of the fixed distance between the actuating jewel pin **36** and pointed contact **40**. Hence, it is virtually impossible for double indexing to occur, which is a situation which develops when electrical contact is accidentally made in both the forward and reverse oscillations of the balance staff.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. In a battery operated electric timepiece, a balance staff, electromagnetic means for causing said balance staff to oscillate, a roller mounted on said balance staff and oscillatable therewith, an index pin carried by said roller, a contact pin carried by said roller, an index wheel having a plurality of teeth on its outer periphery, said teeth having a radial side and another side at an acute angle thereto, said index pin carried by said roller cooperating with said radial side of said teeth to cause said index wheel to rotate upon oscillation of said balance staff in a first direction, a pivoted lever electrically insulated from the frame of the timepiece and carrying an electrical contact thereon, said electrical contact engaging said contact pin after said index wheel has rotated through a predetermined angle thereby completing an electrical circuit to said electromagnetic means, cam follower means carried by said pivoted lever and cooperating with said other sides of said teeth of said index wheel to disengage said contact and said contact pin after said index wheel has rotated through a further predetermined angle, and spring means constantly urging said pivoted lever toward said index wheel.

2. In a battery operated electric timepiece a contact and index mechanism comprising: a balance staff; electromagnetic means for causing said balance staff to oscillate; cam means and a first contact means mounted on and oscillatable with said balance staff; a toothed index wheel for imparting motion to the train of said timepiece; said cam means engaging the teeth of said index wheel for imparting rotational movement to said index wheel; a pivoted lever; a second contact means mounted on said pivoted lever; said second contact means engaging said first contact means after said index wheel has rotated a

first predetermined angle for energizing said electromagnetic means; cam follower means mounted on said pivoted lever; said teeth on said index wheel engaging said cam follower means for disengaging said first and second contact means after said index wheel has additionally rotated a second predetermined angle; and spring means constantly biasing said pivoted lever toward said index wheel.

3. In a battery operated electric timepiece, a contact and index mechanism comprising: a balance staff; electromagnetic means for causing said balance staff to oscillate; a toothed index wheel for imparting motion to the train of said timepiece; cam means mounted on and oscillatable with said balance staff; said cam means intermittently engaging the teeth of said index wheel for imparting intermittent rotational movement to said index wheel; first contact means mounted on and oscillatable with said balance staff; a battery; a pivoted lever; a second contact means mounted on said pivoted lever; said second contact means engaging said first contact means after said index wheel has rotated a first predetermined angle for closing a circuit between said battery and said electromagnetic means; cam follower means mounted on said pivoted lever; said teeth on said index wheel intermittently engaging said cam follower means for disengaging said first and second contact means after said index wheel has additionally rotated a second predetermined angle; and spring means constantly biasing said pivoted lever toward said index wheel.

4. A contact and index mechanism in accordance with claim 3 and further including: magnetic means for attracting one tooth of said index wheel to assist in the rotation of said index wheel in one direction and to retard rotation of said index wheel in a direction opposite to said one direction; said teeth of said index wheel each having a radial side and a non-radial side which form an acute angle; said cam means on said balance staff engaging only said radial side of said teeth of said index wheel and said cam follower means engaging only said non-radial side of said teeth of said index wheel; and said first and second contact means engaging each other only during oscillation of said balance staff in one direction.

5. In a battery operated electric timepiece, a contact and index mechanism comprising: a balance staff; a source of electromagnetic energy for causing said balance staff to oscillate; a balance roller mounted on and oscillatable with said balance staff; a rotatable toothed index wheel for imparting motion to the train of the timepiece; the

teeth of said index wheel each having a radial and a non-radial side which form an acute angle; a cam and a first electrical contact mounted on and oscillatable with said balance roller; a pivoted lever insulated from the frame of said timepiece; a cam follower and a second electrical contact mounted on and pivoting with said pivoted lever; said cam engaging said radial side of said index wheel for causing said first and second contacts to engage; said non-radial sides of said teeth subsequently engaging said cam follower for causing disengagement of said first and second contacts; magnetic detent means for attracting at least one tooth of said index wheel to assist in the rotation of said index wheel in one direction and to retard rotation of said index wheel in the opposite direction; and spring means constantly biasing said pivoted lever toward said index wheel.

6. In a battery operated electric timepiece having an electromagnetically controlled oscillatable balance staff and a rotatable toothed index wheel, a contact and index mechanism comprising: a balance roller mounted on and oscillatable with said balance staff; cam means and first contact means mounted on and oscillatable with said balance roller; a pivoted lever; cam follower means and second contact means mounted on said pivoted lever; said cam means engaging a first tooth of said index wheel for causing said index wheel to rotate a predetermined distance; said first contact means engaging said second contact means when said index wheel has rotated a first portion of said predetermined distance for closing a circuit; a second tooth of said index wheel engaging said cam follower means when said index wheel has rotated a second portion of said predetermined distance and causing said lever to pivot in a direction opposite to the direction of oscillation of said balance roller for disengaging said first and second contacts and opening said circuit; magnetic detent means for attracting a third tooth of said index wheel to assist rotation of said index wheel in one direction and retard rotation of said index wheel in the opposite direction; and spring means constantly biasing said pivoted lever toward said index wheel.

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