

PATENT SPECIFICATION

DRAWINGS ATTACHED

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(54) WATCH BALANCE ASSEMBLY

(71) We, TIMEX CORPORATION, a Corporation organised under the Laws of the State of Delaware, United States of America, of Waterbury 20, Connecticut, 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:—

The present invention relates to a balance assembly for an electrically powered horological instrument, for example an electric wrist watch.

Various types of electric and electronic watches have been suggested. For example, watches are being produced in which a battery, within the watch case, is connected to a circuit using transistors. The circuit is connected to two hairsprings which transmit electrical pulses to a coil carried by a balance wheel. The coil moves through a number of magnetic fields created by fixed magnets. It has also been suggested that higher timekeeping accuracy could be obtained by using a piezoelectric crystal oscillator as a time base in the watch. The crystal oscillator would synchronize a balance wheel type of motor which would drive the time display hands. The balance assemblies of both of these types of watch may be called moving coil balances, because in them the coil is carried by a metal balance wheel.

For both these types of watch, it is desirable that the balance assembly used be sturdy, inexpensive, small in size and that it does not create eddy currents. The mounting of a coil on a metal balance wheel gives rise to eddy currents as the metal of the balance wheel moves through the magnetic fields. Such eddy currents are a waste of power.

It is an object of the present invention to provide a moving coil balance assembly which is sturdy, low in cost, has few parts, and which does not create undesirable eddy currents.

It is the further objective of the present invention to provide a moving coil balance assembly which is small in size, so that it

may fit in a ladies watch, and yet which may be exactly poised by conventional methods.

According to this invention there is provided a balance assembly for an electrically powered horological instrument, comprising a balance staff; a hub, including a member from which material may be removed for poising, fixed to the staff; and a rim supported from and surrounding the hub, the rim consisting only of a coil comprised by a plurality of turns of fine wire adhesively secured together so as to be self-supporting.

Also according to this invention there is provided an electronic watch comprising a frame plate, an electrically powered drive circuit, time display means, means mechanically connected to said frame plate for creating a magnetic field, and a balance assembly electrically connected to said drive circuit and driving said time display means, said balance assembly including a balance staff pivoted in the frame plate, a hub fixed to the staff and a rim supported from and surrounding the hub, the rim consisting only of a coil comprised by a plurality of turns of fine wire adhesively secured together so as to be self-supporting.

The invention will be further described with reference to the accompanying drawings in which:—

Fig. 1 is a plan view, partly cut away, of an electronic wrist watch incorporating a balance assembly according to the present invention;

Fig. 2 is a side elevation, to an enlarged scale, showing details of the balance assembly;

Fig. 3 is a front elevation of the coil of the balance assembly; and

Fig. 4 is a plan view showing the coil and magnets creating a magnetic field through which the coil moves, and, superimposed on the showing of the coil, the position of pins of a jig used when winding the coil.

With reference to Figure 1, a wrist watch includes a case 1 having a bezel 2. A crystal 3 covers a dial 4 having, on its face, conventional numerals 5. The time is indicated

[Price 25p]

in conventional manner by a seconds hand 6, a minutes hand 7 and an hours hand 8 which rotate from a common centre 9. Electric power to operate the watch is derived from a small battery cell 10 which is fitted inside the watch casing 1. It is possible as an alternative that a solar cell or other electrical power source may be used.

The watch hands are rotated by a motor unit which includes a balance assembly shown in Figure 1 and in greater detail in Figures 2 to 4. The balance assembly includes a balance staff 33 pivoted between a frame plate and a bridge (not shown) of the watch. Fixed to the balance staff 33 is a hub comprising a lower disc 31 and an upper disc 36; the two discs may be part of a unitary hub member. The upper disc may have material removed therefrom for poising of the balance assembly as further explained below. A coil 20 is supported in a slot between the two discs 31 and 36; the coil 20 constitutes the only rim of the balance assembly.

The coil 20 consists of a plurality of turns of fine wire and is preferably wound in the following manner using a jig. Shown in Figure 4 is a front positioning pin 34 and rear positioning pins 35a, 35b and 35c which are parts of the removable jig. The fine wire is wound around the pins 34, 35a, 35b and 35c and also around the hub. Preferably the coil is directly wound into the slot between the discs 31 and 36 using conventional coil winding machinery. The turns of wire which constitute the coil are joined together by an adhesive material so that the coil 20 is self-supporting. For example, the wire may be coated with a heat-activated resin and the coil, after winding but before the pins are removed, placed in an oven to melt the resin coating on the wire and form the coil into a unitary mass. After the resin has hardened, the coil is lifted from the pins 34, 35a, 35b and 35c and will retain its shape and form.

The shape of the coil 20, as best seen in Fig. 4, is preferably that of a sector of a circle with the corners rounded off, and this shape is selected to initially poise the balance assembly about the staff 33. The depoising caused by the tolerances of the positioning pins 34, 35a, 35b and 35c can be kept to a low value, for example about 0.0008 inches, so that final poising of the assembly can be accomplished by removing material from the disc 36 such as by drilling or cutting away material from the disc.

An electrically powered drive circuit 16 is provided to drive the balance assembly. The drive circuit 16 is powered from the battery 10 through a line 27. A suitable drive circuit is the circuit shown in United States Patent No. 3,046,460. The coil 20 passes through the air gap between two axially

poled magnets 21a and 21b which are of opposite polarity and fixed on a shunt 22 which is attached to the frame plate, and an upper shunt 30. The output of the drive circuit 16 is connected by a line 17 to the outer end of a hair-spring 19. The inner end of the hair-spring is mechanically secured to the balance staff 33 and electrically connected to one end of the coil 20. The opposite end of the coil 20 is connected either to a second hair-spring (not shown) or to other electrical connection means which establish an electrical connection to the frame plate of the watch which acts as an electrical ground.

The operation of the drive circuit 16 is explained in the above-mentioned United States Patent No. 3,046,460. The drive circuit 16 is a regenerative feed-back astable multi-vibrator. Preferably, it is a relaxation oscillator utilising a complementary pair of transistors. The circuit 16 pulses the coil 20 and the circuit and balance assembly form a complete oscillatory mechanism which need not be synchronised. As the balance assembly oscillates, it indexes a rotatable index wheel 24 by means of a fork 23 pivotally mounted on the frame plate. A pinion (not shown) on the index wheel 24 rotates a wheel 25 which in turn is connected to other gears to rotate the hands 6, 7 and 8.

It will be appreciated that, with the balance assembly described, no metallic part other than the wire of the coil 20, moves through the magnetic field established by the magnets 21a and 21b.

Figure 1 also shows included in the watch case a high frequency time base 11 and a dividing circuit 14. The time base 11, preferably a high frequency piezo electric oscillator, is connected to the battery cell 10 by means of a line 12. The high output frequency of the time base 11 is supplied by a line 13 to the dividing circuit 14, which divides the high frequency. The output of the dividing circuit 14 is connected by a line 15 to the drive circuit 16. The time base 11 and dividing circuit need not be used, and may be omitted from the watch, because the drive circuit 16 and balance assembly form a complete oscillatory mechanism which need not be synchronised, but the provision of the time base 11 and dividing circuit 14 gives the watch high time keeping accuracy.

It will be understood that whereas the balance assembly of the invention is herein illustrated as applied to a wrist watch, it is also applicable to other types of horological instruments. Also, the term "time display" as used herein is intended to embrace, in addition to the rotatable hands shown in Fig. 1, electro-optical display means such as a series of bulbs arranged on the dial of the

watch, and other types of time indicating mechanisms.

WHAT WE CLAIM IS:—

1. A balance assembly for an electrically powered horological instrument, comprising a balance staff; a hub, including a member from which material may be removed for poising, fixed to the staff; and a rim supported from and surrounding the hub, the rim consisting only of a coil comprised by a plurality of turns of fine wire adhesively secured together so as to be self-supporting.
2. An assembly as claimed in claim 1, wherein the hub comprises two discs and the coil is supported in a slot formed between the two discs, one of the discs constituting the said member.
3. An assembly as claimed in claim 1 or claim 2 wherein the shape of the coil in plan is substantially that of a sector of a circle, the sector having rounded-off corners.
4. An electronic watch comprising a frame plate, an electrically powered drive circuit, time display means, means mechanically connected to said frame plate for creating a magnetic field; and a balance assembly electrically connected to said drive circuit and driving said time display means, said balance assembly including a balance staff pivoted in the frame plate, a hub fixed to the staff and a rim supported from and surrounding the hub, the rim consisting only of a coil comprised by a plurality of turns of fine wire adhesively secured together so as to be self-supporting.

5. An electronic watch as claimed in claim 4, wherein the means to create a magnetic field consists of two axially poled magnets of opposite polarity.

6. An electronic watch as claimed in claim 4 or claim 5 wherein the hub comprises two discs and the coil is supported in a slot formed between the two discs.

7. An electronic watch as claimed in claim 4, claim 5 or claim 6 wherein the shape of the coil in plan is substantially that of a sector of a circle, the sector having rounded-off corners.

8. An electronic watch as claimed in any one of claims 4 to 7 wherein no metallic parts other than the wire of the coil move through the magnetic field.

9. An electronic watch as claimed in any one of claims 4 to 8, further comprising a piezoelectric crystal oscillator and a frequency dividing circuit connected to said oscillator and driving said drive circuit.

10. A balance assembly for an electrically powered horological instrument substantially as hereinbefore described with reference to Figures 2 to 4 of the accompanying drawings.

11. An electronic watch substantially as hereinbefore described with reference to the accompanying drawings.

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watch, and other types of time indicating mechanisms.

WHAT WE CLAIM IS:—

1. A balance assembly for an electrically
5 powered horological instrument, comprising
a balance staff; a hub, including a member
from which material may be removed for
poising, fixed to the staff; and a rim sup-
ported from and surrounding the hub, the
10 rim consisting only of a coil comprised by a
plurality of turns of fine wire adhesively
secured together so as to be self-supporting.
2. An assembly as claimed in claim 1,
15 wherein the hub comprises two discs and the
coil is supported in a slot formed between
the two discs, one of the discs constituting
the said member.
3. An assembly as claimed in claim 1 or
20 claim 2 wherein the shape of the coil in
plan is substantially that of a sector of a
circle, the sector having rounded-off corners.
4. An electronic watch comprising a
25 frame plate, an electrically powered drive
circuit, time display means, means mecha-
nically connected to said frame plate for
creating a magnetic field; and a balance as-
sembly electrically connected to said drive
circuit and driving said time display means,
30 said balance assembly including a balance
staff pivoted in the frame plate, a hub fixed
to the staff and a rim supported from and
surrounding the hub, the rim consisting only
35 of a coil comprised by a plurality of turns of
fine wire adhesively secured together so as
to be self-supporting.

5. An electronic watch as claimed in
claim 4, wherein the means to create a mag-
netic field consists of two axially poled mag-
nets of opposite polarity.

6. An electronic watch as claimed in 40
claim 4 or claim 5 wherein the hub com-
prises two discs and the coil is supported in
a slot formed between the two discs.

7. An electronic watch as claimed in 45
claim 4, claim 5 or claim 6 wherein the
shape of the coil in plan is substantially
that of a sector of a circle, the sector hav-
ing rounded-off corners.

8. An electronic watch as claimed in 50
any one of claims 4 to 7 wherein no metallic
parts other than the wire of the coil move
through the magnetic field.

9. An electronic watch as claimed in 55
any one of claims 4 to 8, further comprising
a piezoelectric crystal oscillator and a fre-
quency dividing circuit connected to said
oscillator and driving said drive circuit.

10. A balance assembly for an elec- 60
trically powered horological instrument sub-
stantially as hereinbefore described with re-
ference to Figures 2 to 4 of the accompany-
ing drawings.

11. An electronic watch substantially as 65
hereinbefore described with reference to the
accompanying drawings.

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