Feb. 16, 1965 P. E. BIEMILLER 3,169,364

ELECTRIC TIMEPIECE

Filed July 19, 1963

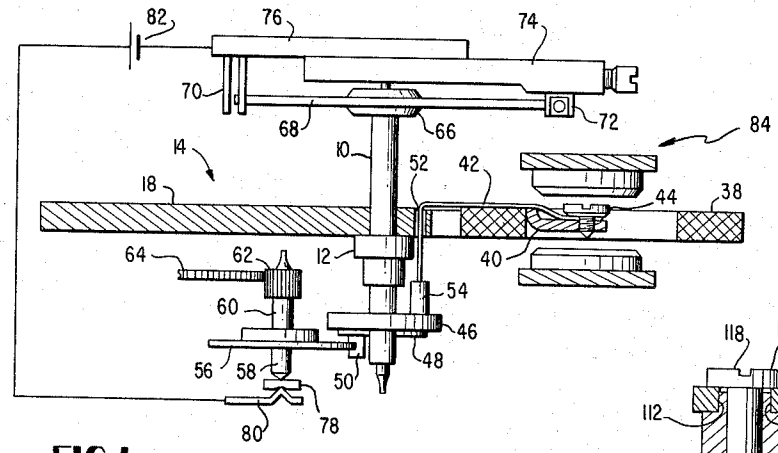


FIG. 1

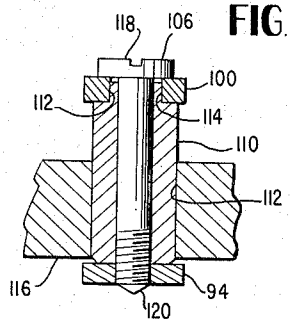
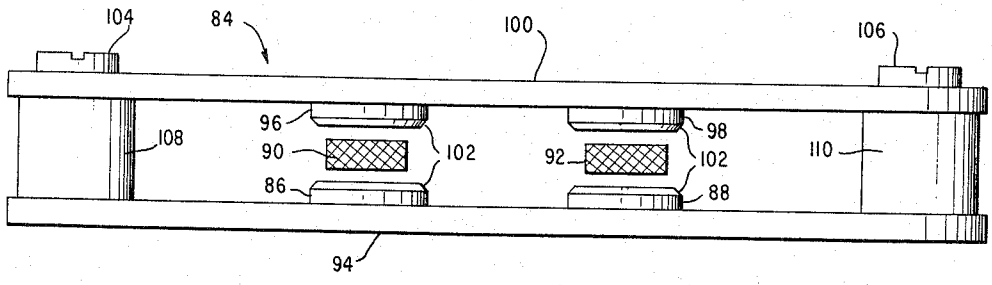


FIG. 2

FIG. 3



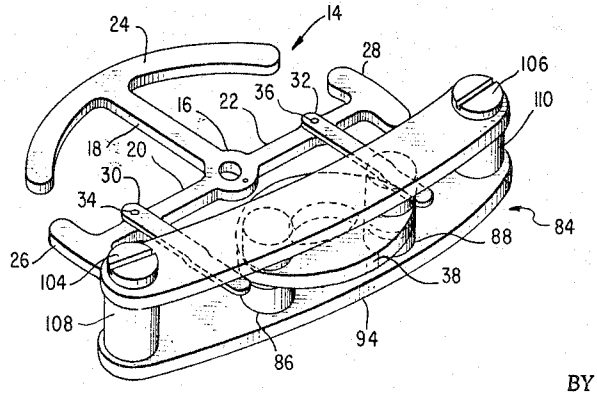


FIG. 4

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ELECTRIC TIMEPIECE

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7 Claims. (Cl. 58—28)

This invention relates to battery operated electric timepieces and more particularly relates to a battery operated electric wrist watch.

Within recent years, the assignee of this application successfully commercially marketed a battery operated electric wrist watch which is generally described in United States Patent Nos. 2,888,797, 2,954,664 and 2,972,745. As is now known, this accomplishment involved the solution of a number of problems, including the provision of a source of motive power having an operational efficiency permitting extended timepiece operation from a source of electro-chemical energy of a size which could be incorporated within a wrist watch casing of average size. In addition to this, stray magnetic fields within the watch casing had to be minimized and controlled in a unique fashion in order to maintain high quality isochronal characteristics in the timepiece.

The present invention relates to improvements in battery-operated electric wrist watches of the foregoing type and more particularly relates to improvements which permit the construction of smaller watches at a reduced cost for the permanent magnets involved and with a reduced energy requirement so that the watch may run longer on a battery of the same size. Thus, according to the present invention it is possible to provide watches of this type which are thinner, lower in cost and which will operate for a greater period of time from the same battery.

It is, accordingly, a primary object of the present invention to provide an improved battery operated horological device of small size.

It is another object of the invention to provide an improved battery-operated electric wrist watch.

It is another object of the invention to provide an improved battery operated wrist watch which may be made thinner than prior models.

It is another object of the invention to provide an improved battery operated electric wrist watch which may be constructed at a lower cost and particularly which involves the use of a smaller amount of permanent magnet material.

It is another object of the invention to provide an improved battery operated electric wrist watch with a lower energy requirement.

It is another object of the invention to provide an improved battery-operated electric wrist watch wherein the magnetic circuit in the impulsing mechanism is characterized by a thinner construction and lower volume of permanent magnet material.

It is another object of the invention to provide an improved battery-operated electric wrist watch wherein the impulsing mechanism exhibits reduced loss characteristics.

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

FIGURE 1 is a partial vertical elevation of a battery operated electric wrist watch constructed according to the invention showing the balance, coil and magnetic circuit assembly along with the indexing and contacting mechanism;

FIGURE 2 is a partial vertical section showing one means of mounting the magnetic circuit of the watch of FIGURE 1;

FIGURE 3 is a partial vertical elevation showing the relationship of the coil and magnetic circuit of the watch of FIGURE 1; and

FIGURE 4 is a perspective view showing the relationship of the balance assembly to the magnetic circuit.

Referring to FIGURE 1, there is seen a balance assembly consisting of a balance staff 10 having a shoulder 12 on which is mounted a skeletal balance generally indicated at 14. Referring to FIGURE 4, the balance 14 comprises a hub 16, a first radial arm 18, and opposed radial arms 20 and 22. The arm 18 supports an arcuate rim 24 while the arms 20 and 22 support shorter arcuate rim sections 26 and 28. The arms 20 and 22 are provided with widened portions intermediate the end thereof and resilient brackets 30 and 32 are attached to these widened sections as by means of screws 34 and 36. The other ends of the resilient brackets 30 and 32 are cemented or otherwise secured to a sector shaped coil 38 to resiliently support the coil on the balance 14.

One terminal of the coil 38 at the outer periphery thereof is connected to one of the brackets 30 or 32 so that this terminal is grounded to the balance 14 and its staff 10. The other terminal of the coil 38 at the inner periphery thereof is connected to a terminal lug 40, best seen in FIGURE 1, which is cemented or otherwise secured inside of the coil. A connecting wire 42 is connected to the lug 40 by means of the screw 44.

The balance staff 12 carries at its lower end an index roller 46 which may comprise a split collar. A contact plate 48 is attached to the underside of the index roller 14 by any suitable insulating adhesive, such as an epoxy resin. A semi-cylindrical contact 50 depends from the contact plate 48 and has mounted at the back side thereof in FIGURE 1, a semi-circular jewel pin (not shown). The wire 42 passes through an aperture 52 in the hub 16 of balance 14 and thence through a tube 54 attached to index roller 46. The end of the wire 42 is soldered or otherwise connected to the contact plate 48 and thence to the contact 50. The contact 50 and the insulating jewel mounted therebehind alternately engage the teeth of an index wheel 56 which is mounted on a two-piece staff 58–60, the two pieces 58 and 60 being insulated from one another, and the index wheel 56 being electrically connected to the lower portion 58.

The upper portion of the staff 60 carries a pinion 62, which drives the fourth wheel 64 of the train of the watch, such as the train of the Hamilton 505 electric watch illustrated and described in Hamilton Service Bulletin 220. The index wheel 56 is preferably magnetically detented in the manner also described in the same bulletin as well as in United States Patent No. 3,016,685,

The upper end of the balance staff 10 carries a collet 66 to which is attached one end of a hairspring 68. The other end of a hairspring 68 passes through curb pins 70 carrier by regulator arm 76, and terminates in a stud 72 carried by the balance cock 74, all in conventional fashion. The curb pins 70 carried by the regulator arm 76 may be rotated in a conventional manner to adjust the rate of the timepiece. It will be understood that while no bearings are shown in FIGURE 1, these are provided in a conventional fashion.

The lower end 58 of the composite staff 58–60 engages a metal disc 78 which is urged into engagement with the staff by means of a contact spring 80. Connected to the contact spring 80 is one terminal of a small battery, indicated diagrammatically at 82, which has its other terminal connected to the frame of the watch, here indicated as the regulator arm 76 and balance cock 74. It will be appreciated that with this connection the circuit to the

coil 38 may be periodically closed to impulse the balance assembly. Briefly stated, when the balance assembly 14 rotates in a counter clockwise direction, the contact 50 engages a tooth on the contact index wheel 56 thereby completing a circuit from the battery 82 to the coil 38 in the following manner: From the lug 40 through wire 42, contact plate 48, contact 50, index wheel 56, staff 58, disc 78, spring 80, battery 82, watch frame 76–74, stud 72, hairspring 68, balance staff 10, balance wheel 14, radial arm 22, resilient bracket 32 to the outer terminal of the coil 38. When the balance assembly rotates in a clockwise direction, the insulating back side of the contact 50 engages the index wheel so that no energization of the coil occurs during backswing, all as is now known and described in detail in Hamilton Service Bulletin 220 and United States Patent No. 3,016,685.

The coil 38 carried by the balance 14 comprises one portion of the electromagnetic impulsing mechanism for the electric watch. The other portion of the electromagnetic impulsing system constitutes the magnetic circuit which is indicated generally at 84 in FIGURES 1, 3 and 4. Referring to those figures, it will be seen that this magnetic circuit consists of a pair of lower disc shaped magnets 86 and 88 mounted immediately below the radial legs 90 and 92 of the coil 38. These magnets 86 and 88 are carried on a lower shunt 94 formed of a ferromagnetic material of high permeability, such as soft iron. A pair of upper disc shaped magnets 96 and 98 are similarly mounted above the radial legs 90 and 92 of the coil 38 on an upper shunt 100 also of high permeability material.

The magnets 86–88 and 96–98 are preferably provided with slightly tapered ends, as indicated at 102, to provide for field concentration. The magnets may be attached to the shunts 94 and 100 by a suitable adhesive or simply by means of magnetic attraction. According to one embodiment of the invention the shunts 94 and 100 may be provided with slight circular indentations to receive the ends of the magnets which are then held in the indentations by magnetic attraction, the indentations serving solely as means for proper positioning of the magnets.

The shunts 94 and 100 are connected together by means of ferromagnetic screws 104 and 106 and bushings 108 and 110. Details of one such connection are shown in FIGURE 2. Here it will be seen that the upper shunt 100 is provided with apertures 112 which receive the reduced diameter ends 114 of bushings 110. The bushing 110 is itself friction fitted in an opening 112 in the pillar plate 116 of the watch. The bushing 110 may be formed of an insulating material or of a metallic material which may be either magnetic or non-magnetic. The shunts are connected together both mechanically and magnetically by means of the ferromagnetic screws 104 and 106 which have heads 118 engaging the upper shunt 100 and have lower ends 120 screw threadedly engaging the lower shunt 94.

The magnets 86, 88, 96 and 98 are preferably formed of the same preferred materials set out in assignee's United States Patent No. 2,972,745, namely, cobalt-platinum, iron-platinum, or $Ba.6Fe_2O_3$ magnets (sold under the trade name Indox I). Other materials having similar characteristics are also satisfactory. The coercive force of such materials should be not less than approximately 750 oersteds and the flux density at the center of the magnets should be about 1000 gausses. However, while it has been previously preferred to use cobalt-platinum magnets with a length to diameter ratio of approximately 1 in the magnetic circuit shown in United States Patent Nos. 2,954,664 and 2,972,745, it will be appreciated from the foregoing description of the new magnetic circuit that the length to diameter ratio of the plural magnets which replace the older single magnets is considerably less and is preferably less than ¼.

As a specific illustration, in the commercial embodiment of the magnetic circuit illustrated in United States Patent Nos. 2,954,664 and 2,972,745, the nominal length of the magnets was .083 inch and the nominal diameter was .090 inch. The thickness of each shunt was nominally .020 inch while the air gap in which the coil rotated was nominally .042 inch. According to the present invention, in a preferred exemplary embodiment, the length of each magnet 86, 88, 96 and 98 was nominally .015 inch and the nominal diameter of each magnet was .090 inch. The space in which the coil rotated was nominally .042 inch while the thickness of each shunt was nominally .020 inch. Comparing these two arrangements, it will be seen that the older magnetic circuit had a total nominal height of shunts, magnet and air gap of .165 inch compared to .112 inch with the new arrangement. Thus, the new arrangement produces a saving in height of approximately 32%. This is quite important inasmuch as the height of the magnetic circuit imposes a limitation on the minimum thickness of electric watch which can be produced.

At the same time that this saving in height of the magnetic circuit is being effected, there is also a saving of better than 60% in the volume of magnetic material utilized, along with a concomitant saving in magnet cost. Further, the new arrangement has been found to reduce materially the energy dissipated in the impulsing mechanism by a reduction in eddy current losses alone. While the exact theoretical reason for these unexpected results is not completely understood at this time, tests indicate that the described results very definitely can be attained.

So far as can be determined, the important feature of the arrangement is the disposition of the small disc-like magnets immediately adjacent to the opposed coil sides with the shunts preferably in engagement with the magnets and closing the magnetic circuit out beyond the edges of the coil and between the magnets. Not only does the reduced volume of magnetic material provide adequate power for running the impulsing mechanism, but stray magnetic fields are reduced with the previously mentioned reduction in eddy current losses in the metal in the balance assembly. It will be noted that in the preferred embodiment of FIGURE 3 the length of the magnets is approximately equal to the thickness of the shunt. While individual magnets are illustrated and described, it will be apparent to those skilled in the art that the same effect may be achieved through the use of a ceramic magnetic material, such as the Indox I described, as a unitary member constituting two or more magnetically distinct magnets. That is to say, the upper magnets 96 and 98 might be formed of a single thin slab of magnetic material magnetized to provide the same magnetic result as the two magnets 96 and 98 illustrated in FIGURE 3. A similar arrangement may be utilized for the lower magnets 86 and 88. It will also be apparent that while the contact arrangement described provides for impulsing of the balance in one direction only, impulsing in both directions is feasible as is well understood by those skilled in the art.

It will be apparent from the foregoing that the improved battery operated timepiece of this invention provides a thinner impulsing mechanism which operates at reduced energy requirement and with a considerably lower volume of permanent magnet material, so that the cost of the unit is significantly reduced. These advantages permit the construction of thinner timepieces such as wrist watches at a reduced cost while the lower energy requirements permit either a longer operation of the timepiece from the same battery or the use of a smaller battery with a still further reduction in the size of the timepiece.

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 foreging 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. A battery operated electric wrist watch comprising a watch casing enclosing, a balance assembly carrying a coil having a pair of coil sides, a battery, contact means associated with said balance assembly for periodically connecting said coil to said battery, a first pair of permanent magnets disposed immediately above said coil sides, a second pair of permanent magnets disposed immediately below said coil sides in alignment with said first pair of magnets, said magnets having magnetic axes substantially parallel to the axis of rotation of said balance, said magnets having a length along their magnetic axes which is no more than one fourth of their dimension perpendicular to their magnetic axes, upper shunt means engaging said first pair of magnets, lower shunt means engaging said second pair of magnets, and further shunt means connecting said upper shunt means and said lower shunt means.

2. A battery operated electric wrist watch as set out in claim 1, wherein the thickness of the upper shunt means and the thickness of the lower shunt means is approximately equal to the length of the magnets along their magnetic axes.

3. A battery operated electric wrist watch as set out in claim 2 wherein said permanent magnets have a coercive force of no less than 750 oersteds and a flux density at their center of no less than 1000 gausses.

4. A battery operated electric wrist watch comprising a watch casing enclosing, a balance assembly carrying a coil having a pair of coil sides, a battery, contact means associated with said balance assembly for periodically connecting said coil to said battery, a first pair of permanent magnets disposed immediately above said coil sides, a second pair of permanent magnets disposed immediately below said coil sides in alignment with said

first pair of magnets, said magnets having magnetic axes substantially parallel to the axis of rotation of said balance, said magnets having a length along their magnetic axes which is no more than one fourth of their dimension perpendicular to their magnetic axes, an upper shunt plate engaging said first pair of magnets and extending generally chordally over and beyond the outermost circle travelled by said coil, a lower shunt plate engaging said second pair of magnets and extending generally chordally over and beyond said circle, and shunt means connecting said upper and lower shunt plates beyond said circle.

5. A battery operated electric wrist watch as set out in claim 4, wherein the thickness of the shunt plates is approximately equal to the length of the magnets along their magnetic axes.

6. A battery operated electric wrist watch as set out in claim 5 wherein said permanent magnets have a coercive force of no less than 750 oersteds and a flux density at their center of no less than 1000 gausses.

7. A battery operated electric wrist watch wherein the dimension of the coil and magnetic assemblage parallel to the axis of rotation of the balance assembly is less than three times the air gap between opposing magnets.

References Cited by the Examiner

UNITED STATES PATENTS

1,755,649	4/30	Holden	58—28
2,976,435	3/61	Van Horn et al.	310—39

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