Nov. 21, 1961 J. A. VAN HORN ET AL 3,010,037

ELECTRIC WATCHES

Filed Jan. 28, 1957 3 Sheets-Sheet 1

Fig. 1

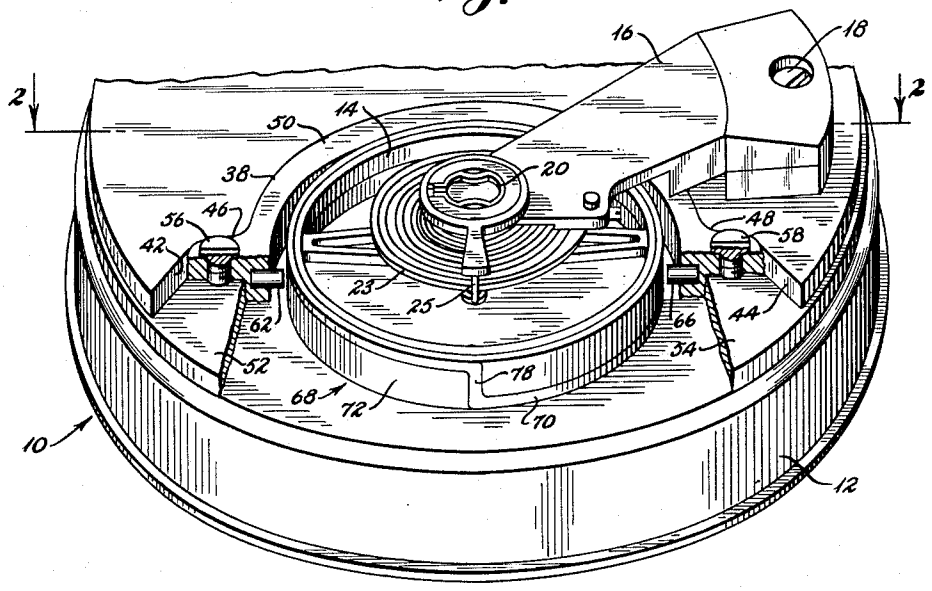
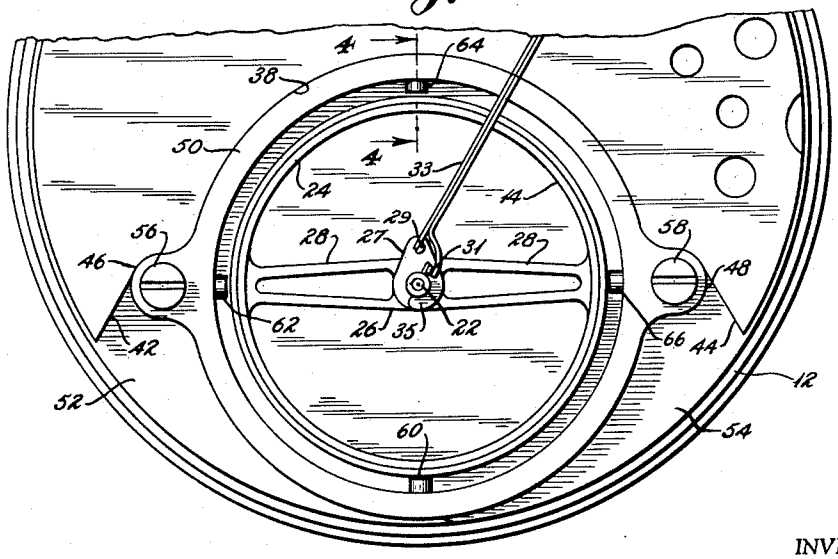


Fig. 2



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ELECTRIC WATCHES

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Fig. 3

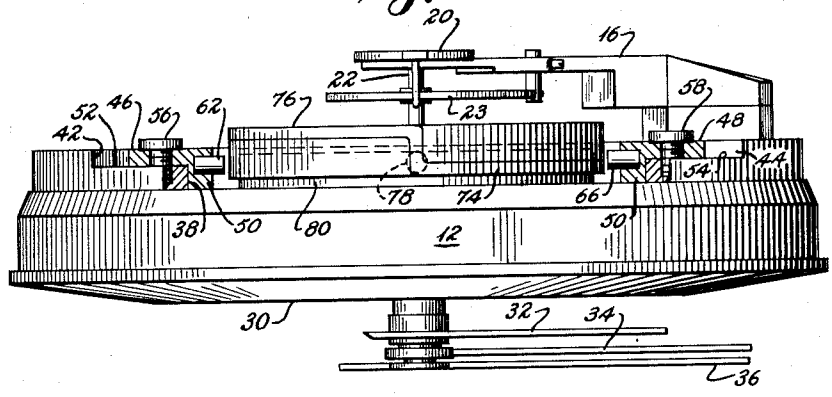


Fig. 4

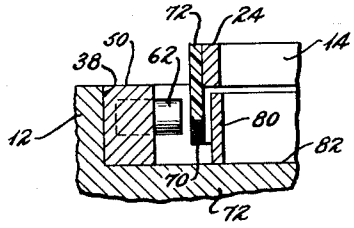


Fig. 5

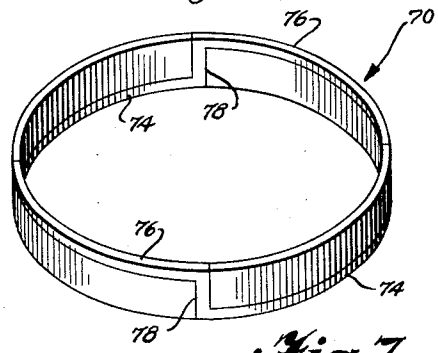


Fig. 6

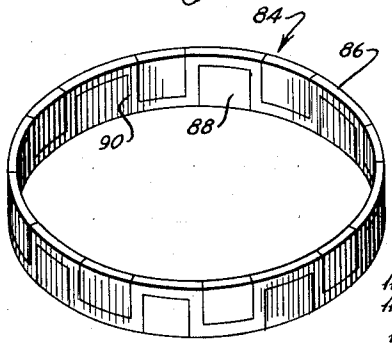


Fig. 7

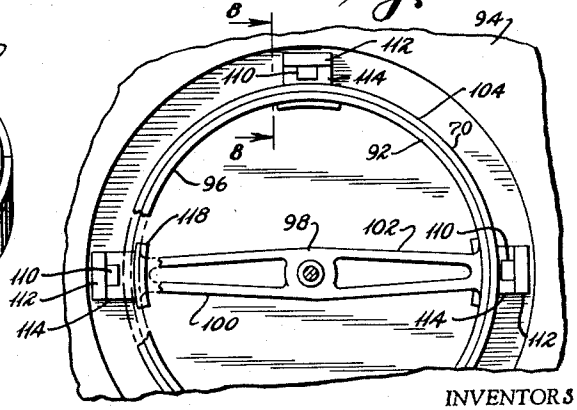
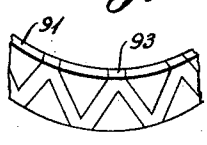


Fig. 15



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Fig. 8

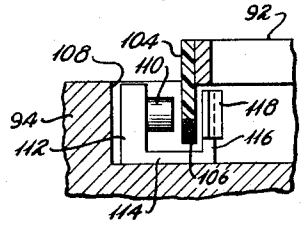


Fig. 9

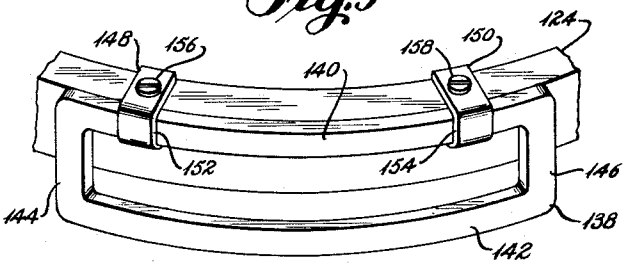


Fig. 10

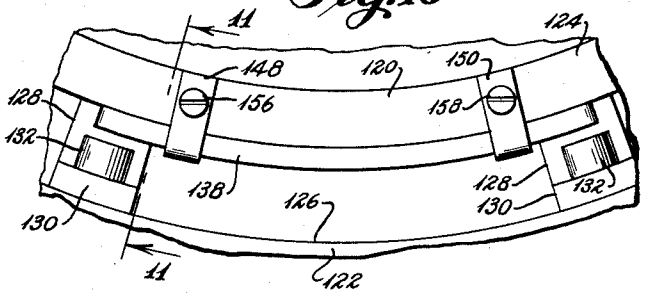


Fig. 11

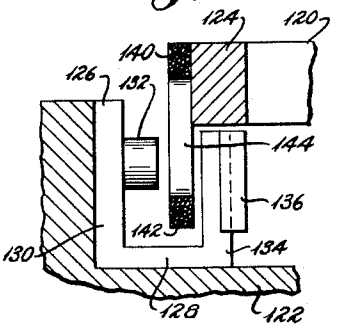
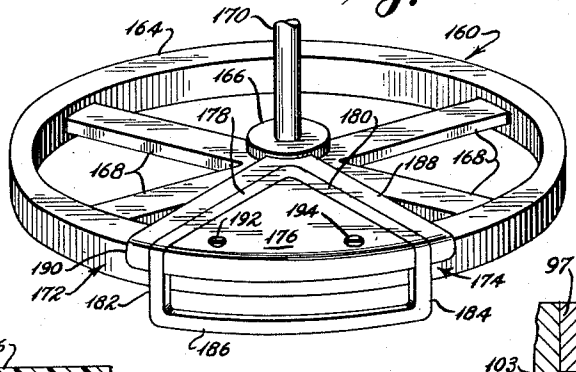


Fig. 12



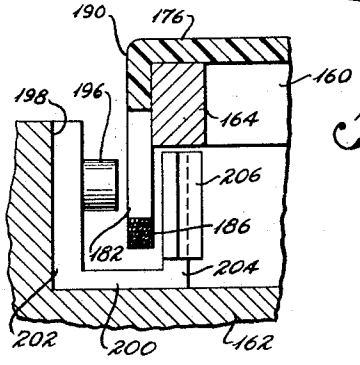


Fig. 13

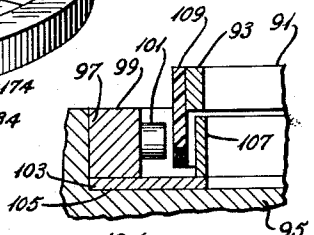


Fig. 14

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United States Patent Office 3,010,037 Patented Nov. 21, 1961

3,010,037

ELECTRIC WATCHES

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Filed Jan. 28, 1957, Ser. No. 636,835
1 Claim. (Cl. 310—39)

This invention relates to an electric wrist watch and more particularly relates to the source of motive power for a watch wherein the balance wheel serves as the frequency controlling element which is periodically impulsed during passage through a magnetic field.

The limited space within the case of a wrist watch imposes stringent limitations upon both the primary electric source and the means for converting the electrical energy into mechanical energy. Further, it is obvious that the amount of electrochemical energy which can be built into a wrist watch size battery is limited. This requires that the available electrical energy must be converted into mechanical energy as efficiently as possible so that an extended battery life can be obtained. It is also necessary that the component parts of the electric and the mechanical movement be kept to a minimum size. While many attempts have been made to solve this problem satisfactorily, we are not aware that any electric wrist watch has ever been successfully marketed.

The electric motors or sources of motive power heretofore proposed for converting electrical energy to mechanical energy in an electric wrist watch have generally been of two types. In one arrangement a stationary electromagnet is energized to impulse a soft magnetic rotor. The other type utilizes a stationary permanent magnet and a moving coil. The first type has been generally unsatisfactory because, among other things, the electrical efficiency of such a motor is low. The second type can have this same defect and in addition the permanent magnets can produce extensive stray magnetic fields. Stray magnetic fields are detrimental in that they magnetize steel parts within the watch and make it necessary to provide non-magnetic balance staffs to prevent a magnetic influence which will alter the isochronal behavior of the frequency controlling element. Stray magnetic fields also affect hairsprings. This gives rise to an additional problem since hairsprings must be temperature compensated for quality time pieces and this is commonly accomplished by using alloys having certain magnetic characteristics.

In assignee's copending applications Serial No. 409,934, filed February 12, 1954, now Patent No. 2,888,797, and Serial No. 578,843, filed April 17, 1956, now allowed there are disclosed certain constructions which we have found are satisfactory in electric wrist watches. In addition to the constructions shown in those applications, we have now found that it is also possible to provide satisfactory electric watch movements utilizing a coil carried by the balance staff or balance wheel and having portions thereof substantially perpendicular to the balance wheel intersecting stationary magnetic fields to provide balance wheel impulsing. Actually these coil portions need not be perpendicular to the balance wheel but must extend in the general direction of the staff. That is to say, the coil portions must lie in directions having components parallel to the balance staff.

According to a preferred embodiment of our new arrangement, the stationary magnetic fields are provided by permanent magnets which have stationary shunt members in contact therewith and which cooperate with additional stationary shunt members spaced from the magnets and on the far side of active coil sections movably mounted adjacent the magnets. According to a further embodiment of our present invention, a large plurality of active coil sections are used in conjunction with a large plurality of magnetic fields to secure a high motor efficiency for watch use.

It is accordingly a primary object of the present invention to provide an electric wrist watch operating from a self-contained battery and having a high efficiency of conversion of electrical to mechanical energy.

It is another object of the invention to provide an electric wrist watch including a moving coil having portions thereof substantially perpendicular to the balance wheel of the watch and cooperating with spaced magnetic fields which have magnetic axes substantially radial with respect to the movement of the balance wheel.

It is another object of the invention to provide an electric wrist watch of the foregoing type which embodies a shunt and magnet arrangement which minimizes stray magnetic fields.

It is still another object of the present invention to provide an electric wrist watch including a movable coil mounted for movement with the balance wheel and having a plurality of portions thereof substantially perpendicular to the balance wheel and moving through intensified portions of magnetic fields.

These and further objects and advantages of the invention will become apparent upon reference to the following specification and claim and appended drawings wherein:

FIGURE 1 is a perspective view of an electric watch constructed according to one embodiment of our invention;

FIGURE 2 is a plan view of the watch shown in FIGURE 1 taken along the line **2—2** in FIGURE 1;

FIGURE 3 is a side elevation of the watch shown in FIGURE 1;

FIGURE 4 is a partial vertical section of the watch of FIGURES 1 and 2 taken along the line **4—4** of FIGURE 2;

FIGURE 5 is a perspective view of the coil assembly utilized in the watch of FIGURES 1, 2 and 3;

FIGURE 6 is a perspective view of another embodiment of a coil assembly;

FIGURE 7 is a plan view of another embodiment of a source of motive power for an electric wrist watch according to our invention;

FIGURE 8 is a partial vertical section of the watch of FIGURE 7 taken along the line **8—8** of FIGURE 7;

FIGURE 9 is a perspective view of a portion of a balance wheel incorporating a coil according to still another embodiment of our invention;

FIGURE 10 is a plan view of the portion of the balance wheel and coil shown in FIGURE 9;

FIGURE 11 is a partial vertical section of the balance wheel and coil shown in FIGURE 10 taken along the line **11—11** of FIGURE 10;

FIGURE 12 is a perspective view of a balance wheel having a coil mounted thereon according to still a further embodiment of our invention;

FIGURE 13 is a partial vertical section of the balance wheel and coil of FIGURE 12 taken along the line **13—13** of FIGURE 12;

FIGURE 14 is a partial vertical section of a watch constructed according to still another embodiment of our invention; and

FIGURE 15 is a partial perspective view of a coil assembly according to still a further embodiment of our invention.

Referring to the figures of the drawing, and more particularly to FIGURES 1 through 5, there is seen an electric watch **10** which, as seen from the train side in FIGURES 1 and 2, comprises a pillar plate **12** on which a

balance wheel 14 is mounted by means of a balance cock 16 secured to pillar plate 12 by means of a screw 18. The balance cock 16 supports an end stone and olived jewel assembly 20 in which is journaled one end of a balance staff 22. The balance staff carries the usual hair spring 23 controlled by the usual regulating pins 25. A roller table 27 is carried on the balance staff 22 above the balance wheel 14 and carries a pin 29 and contact 31 for making periodic electrical contact with a contact spring arm assembly 33, described in detail in assignee's copending application Serial No. 551,791, filed December 8, 1955, now Patent No. 2,954,663. The contact 31 is carried by a strip 35 mounted on and insulated from the roller table 27 and one end of the coil presently to be described is connected to this strip. The balance wheel 14 consists of a rim 24 secured to a hub 26 by means of arms 28. The watch may be provided with a train, not shown, and with a dial 30, hour hand 32, minute hand 34, and sweep second hand 36, as best seen in FIGURE 3.

The pillar plate 12 is provided with a cylindrical recess 38 beneath the balance wheel 14. The pillar plate is slotted to provide side faces 42 and 44 and bottom surfaces 52 and 54. These surfaces receive the ears 46 and 48 of a ring 50 of magnetic material mounted within the cylindrical recess 38. The ears 46 and 48 are attached to the upper portion of the ring 50 and are secured to the bottom surfaces 52 and 54 of pillar plate 12 by means of screws 56 and 58. The ring 50 is apertured to receive four small cylindrical magnets 60, 62, 64 and 66 which are press-fitted therein and which preferably have a length to diameter ratio of substantially no greater than one. Suitable magnetic materials are described in detail in assignee's copending application Serial No. 578,843, filed April 17, 1956. While these magnets are referred to as being cylindrical, it is to be understood that this term is used in its broad geometrical sense and is not restricted to right circular cylinders. The ring 50 is formed of any suitable magnetic material such as low carbon steel and the magnets 60, 62, 64 and 66 are so placed that adjacent magnets have opposite magnetic poles facing inwardly when a coil of the type illustrated is used.

Mounted on the rim 24 of balance wheel 14 is a coil assembly generally indicated at 68, which consists of a coil 70 preferably encased in a plastic material 72. Referring to FIGURES 1, 5 and 7, the coil 70 is electrically wound in a zigzag fashion and consists of a plurality of arcuate lower horizontal portions 74 and through that strip to arcuate upper horizontal portions 76 connected by vertical portions 78. The details of how such electrical connections are made are well known to those skilled in the art and are not illustrated. It will be noted that the coil 70 has four vertical sections 78 which are simultaneously positionable adjacent magnets 60, 62, 64 and 66. One end of the coil 70 is grounded to the balance wheel 14 while the other end of the coil is connected to the strip 35 and contact 31 on contact roller 27. The balance wheel is in electrical contact with the pillar plate which has one terminal of a suitable battery connected thereto while the other terminal of this battery is connected to the contact spring arm assembly 33 in a manner disclosed in detail in assignee's copending application Serial No. 551,791, filed December 8, 1955, now Patent No. 2,954,663.

Referring to FIGURES 3 and 4, a ring 80 of magnetic material is concentrically mounted within the lower portion of the coil assembly 68 and is secured to the floor 82 of the recess 38 in pillar plate 12. It will thus be seen that by means of the stationary rings 50 and 80 the flux or magnetic field from the magnets 60, 62, 64 and 66 is concentrated at the inwardly extending faces of the magnets so that relatively little stray field is produced. These magnetic fields are stationary and arranged to simultaneously intersect the vertical portions 78 of coil 70.

In operation, the contact spring arm assembly 33 and contact 31 effect an energization of the coil 70 each time that the balance wheel and coil passes through the position shown in FIGURE 2 moving in a counterclockwise direction. At this moment, the vertical legs 78 are within the concentrated magnetic fields at the faces of magnets 60, 62, 64 and 66 so that the energization of the coil causes four simultaneous impulses to be imparted to the coil and balance wheel to move it in a counterclockwise direction. With this arrangement it is possible to obtain a larger impulse torque than is obtained in the two-field arrangement shown in assignee's copending application, Serial No. 578,844, now Patent No. 2,954,664 hereinbefore mentioned. This permits either a reduction in battery size or an increase in battery life. Alternatively, the number of coil turns may be reduced thereby decreasing coil cost.

While the embodiment of the invention shown in FIGURES 1 through 5 utilizes four vertical sections on the coil and four magnets, it will be appreciated that with the construction of our invention it is possible to utilize a larger number of magnets without increasing the size of the watch. Thus, referring to FIGURE 6, there is shown another embodiment of a coil assembly 84 consisting of a zigzag coil 86 encased within a synthetic resin ring 88. According to this embodiment of the invention the coil 86 is provided with sixteen vertical portions 90 which may cooperate with sixteen concentrated magnetic fields. With a shunt arrangement consisting of rings such as 50 and 80, as shown in FIGURE 4, the impulsing mechanism utilizes no more space in the watch than does the embodiment of the invention shown in FIGURES 1 through 5. While the coils shown in FIGURES 5 and 6 utilize parallel vertical sides 78 and 90, it is also possible to use other shapes such as that shown in FIGURE 15. Referring to this figure there is seen a coil assembly 91 having a saw-tooth coil 93 encased therein. Other coil shapes can be used so long as the coil has legs having a component parallel to the balance staff.

In both of the foregoing embodiments of the invention the clearance between the inner surface of the coil assembly 68 and the inner stationary shunt 80, and the clearance between the inner faces of magnets 60, 62, 64 and 66 and the outer surface of the coil assembly may be made so small as to provide a shockproof mounting of the balance wheel 14. This same small spacing which provides shockproof mounting intensifies the magnetic fields through which the active vertical coil sections pass and minimizes stray field.

While it has been stated that the inwardly facing surfaces of adjacent magnets are of opposite polarity, this condition is not essential and a converse arrangement may be used. It will be understood by those skilled in the art that the polarity of the magnetic field is determined by the direction of current flow in the coil portions within the field, and that with an appropriately shaped coil and magnetic circuit adjacent magnetic fields may be of the same polarity.

An arrangement of this type is shown in FIGURE 14. Referring to that figure, there is shown a balance wheel 91 having a rim 93 and mounted on a balance staff (not shown) and pillar plate 95 as in the embodiment of our invention shown in FIGURES 1–3. The pillar plate 95 is provided with a circular recess 97 in which is mounted a magnetic ring 99 carrying small cylindrical magnets 101. Beneath the ring an annulus 103 is mounted on the floor 105 of recess 97 and extends inwardly toward the center of the recess. This annulus is formed of magnetic material and carries a ring 107 at its inner edge. The ring 107 is also of magnetic material to thereby form with ring 99 and annulus 103 a C-shaped magnetic circuit which produces intense magnetic fields at the faces of the magnets with very little stray field.

Carried by rim 93 of balance wheel 91 is a coil assembly 109 of the type shown in FIGURE 6. This coil possesses sixteen portions perpendicular to the balance wheel and may be used with eight magnets having similar poles inwardly directed. While the magnetic circuit

of FIGURE 14 is here described in connection with magnetic fields which are all of like polarity, it will be clear to those skilled in the art that the converse arrangement may be used. Thus the magnetic circuit of FIGURE 14 may be used with the coil and magnet arrangement of FIGURES 1–3.

Referring to FIGURES 7 and 8, there is shown an alternative embodiment of our invention wherein a balance wheel **92** is mounted on a pillar plate **94** in a manner similar to that shown in the embodiment of the invention illustrated in FIGURES 1 through 3. The balance wheel **92** consists of a rim **96** supported from a collar **98** by means of arms **100** and **102**. A coil assembly **104** similar to that shown in the preceding embodiments of the invention is secured to the outer surface of the rim **96** and depends therefrom as seen in FIGURE 8. The coil assembly **104** contains a zigzag coil **106** of the same type as shown in FIGURES 5 or 6, as an example. In this embodiment of the invention, the pillar plate **94** is provided with a recess **108** of a larger diameter than the coil assembly **104**, and adjacent to the portions of the coil **106** which are perpendicular to the balance wheel **92**, are a plurality of small cylindrical magnets **110**. These magnets, however, are not mounted in a ring such as shown in the preceding embodiments of the invention, but are mounted in the vertical outer legs **112** of C-shaped keepers **114**, as is best seen in FIGURE 8.

The keepers **114** are provided with vertically upstanding inner legs **116** having arcuate laterally extending upper shunt portions **118**, as seen in both FIGURES 7 and 8. By providing a small clearance between the inner surface of the coil assembly **104** and the surface of the arcuate laterally extending shunt members **118** and a small clearance between the inner surface of the magnets **110** and the outer surface of the coil assembly **104**, a shockproof mounting can be provided while at the same time obtaining an intense localized magnetic field with a very limited stray field.

Referring to FIGURES 9, 10 and 11, there is shown still a further embodiment of our invention wherein a balance wheel **120** is mounted on a pillar plate **122** in a manner similar to that disclosed in the preceding embodiments of the invention. The balance wheel **120** is provided with a rim **124** which is supported by means of a collar and support arms as were the balance wheels in the preceding embodiments of the invention. The pillar plate **122** is provided with a circular recess **126**. Within the recess **126** are mounted a plurality of C-shaped keepers **128**, similar to those shown in the embodiment of the invention illustrated in FIGURES 7 and 8. The C-shaped keepers **128** have outer vertical legs **130** in which are mounted small cylindrical magnets **132**. The keepers also are provided with vertical inner legs **134** having arcuate laterally extending shunt portions **136** which underlie the rim **124** of the balance wheel **120**.

Mounted on the rim **124** of the balance wheel **120** is an elongated arcuate coil **138** having long arcuate sides **140** and **142** lying in planes parallel to the plane of the balance wheel, and having end portions **144** and **146** which are perpendicular to the plane of the balance wheel. The coil may be secured to the balance wheel in any suitable manner, as, for instance, by means of clips **148** and **150** which are provided with hooked portions **152** and **154** clamping the upper arcuate side **140** of the coil. The clips **148** and **150** may be secured to the balance wheel by means of screws **156** and **158**. The C-shaped keepers **128** and small cylindrical magnets provide intensified magnetic fields intersected by the depending sides **144** and **146** of the coil **138**. While a large number of keepers and magnets may be utilized, it is also possible to use two relatively closely spaced magnets and keepers, as shown in FIGURE 10, so as to provide a localized impulsing mechanism for the balance wheel **120**, to obtain the benefits of the construction disclosed in assignee's copending application, Serial No. 409,934, filed February 12, 1954. It will be apparent to those skilled in the art that where such a single coil **138** is utilized, the balance wheel must be counter-balanced as shown in the said aforementioned copending application.

Referring to FIGURES 12 and 13, there is shown still another embodiment of our invention wherein a balance wheel **160** is mounted in a pillar plate **162** in a manner similar to that utilized in the foregoing embodiments of our invention. The balance wheel **160** consists of a rim **164** supported from a collar **166** by means of support arms **168**. Collar **166** is secured to a balance staff **170** in a conventional manner.

Mounted on balance wheel **160** is a coil assembly **172** consisting of a coil shown generally at **174** partially encased in a sheet of synthetic resin **176**. The coil **174** has a generally V-shaped portion comprising legs **178** and **180** which lie in the plane of the balance wheel. These legs **178** and **180** are joined at the inner ends thereof, while the outer ends of these legs are bent downwardly to form depending legs **182** and **184** which extend generally perpendicular to the plane of the balance wheel and depend therebelow. The bottom of legs **182** and **184** are connected by an arcuate coil side **186** which lies in a plane parallel to the balance wheel **160**. The V-shaped portion of coil **174** is encased within the synthetic resin sheet **176** which may be pie-shaped, as shown in FIGURE 12, and which may have a depending lip **190** which extends down over the outer edge of the rim **164** of balance wheel **160**. The sheet **176** may be secured to the balance wheel in any suitable manner, such as by means of screws **192** and **194**.

With a coil of the type shown in FIGURE 12, a pair of small cylindrical magnets **196** are provided in a recess **198** in the pillar plate **162**. The magnets **196** are mounted in C-shaped keepers **200** which may be of the same type shown in the embodiments of the invention illustrated in FIGURES 7 through 11. These keepers may thus consist of vertical inner legs **202** which receive the magnets **196** and vertical inner legs **204** having arcuate laterally extending shunt members **206**. The magnets **196** are so spaced that they lie opposite the vertical sections **182** and **184** of coil **174**. It will thus be seen that the C-shaped keepers and magnets **196** provide intensified magnetic fields through these vertical portions of the coil while minimizing stray magnetic fields. A localized impulsing mechanism is provided, as in the embodiment of the invention shown in FIGURES 9 through 11, and balance wheel counter-balancing is necessary.

It will be apparent from the foregoing that we have provided an electric watch mechanism having a source of motive power possessing adequate efficiency to provide long service with a limited electrochemical energy source and which produces negligible or at least unobjectionable stray magnetic fields. The source of motive power utilized in the watches of our invention are capable of simultaneously providing shockproof mounting of the balance wheel and high efficiency driving power and also, according to other embodiments of the invention, may be localized in only a sector of the balance wheel. With certain embodiments of our invention no counter-balancing is necessary.

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

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

In a battery operated electric watch, a balance wheel and staff assembly, coil means carried by said assembly

and having two spaced portions thereof extending in directions substantially parallel to said staff, said two portions being spaced about said staff less than 180° apart, a magnetic sub-assembly for creating spatially limited magnetic fields comprising an annular member of magnetic material having a U-shaped cross section, said annular member comprising a first magnetic ring member fixedly mounted between said coil means and said staff concentrically with said staff, a second magnetic ring member fixedly mounted exterior of said coil means concentric with said staff, and a magnetic washer shaped member interconnecting the edges of said first and second magnetic ring members, a plurality of small cylindrical permanent magnets attached to one of said ring members and extending radially of said staff toward the other of said ring members, said cylindrical magnets having a diameter less than the dimension of said ring members parallel to said staff and being mounted substantially midway of this dimension so as to be enclosed within the U-shaped portion of said annular magnetic

assembly to establish intensified radial magnetic fields between said ring members, the extent of said fields being defined and limited by said washer shaped member and said ring members to limit the stray magnetic field in said watch, and means for periodically connecting said coil means to a battery, said coil means being mounted for oscillation through said intensified magnetic fields so as to receive plural impulses instantaneously from said intensified fields.

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2,806,344	Schoenrock	Sept. 17, 1957

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1,006,640	France	Jan. 30, 1952
1,134,560	France	Dec. 3, 1956

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,010,037 November 21, 1961

John A. Van Horn et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 45, strike out "electrically"; lines 47 and 48, strike out "through that strip to"; lines 49, 50 and 51, strike out "The details of how such electrical connections are made are well known to those skilled in the art and are not illustrated."; line 54, after "is" insert -- electrically --; line 56, after "and" insert -- through that strip to --; line 56, after "roller 27." insert -- The details of how such electrical connections are made are well known to those skilled in the art and are not illustrated. --; column 6, line 39, for "inner" read -- outer --.

Signed and sealed this 28th day of August 1962.

(SEAL)
Attest:

ESTON G. JOHNSON
Attesting Officer

DAVID L. LADD
Commissioner of Patents

UNITED STATES PATENT OFFICE

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