March 21, 1961 J. A. VAN HORN ET AL 2,976,435

ELECTRIC WATCHES

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Fig. 1

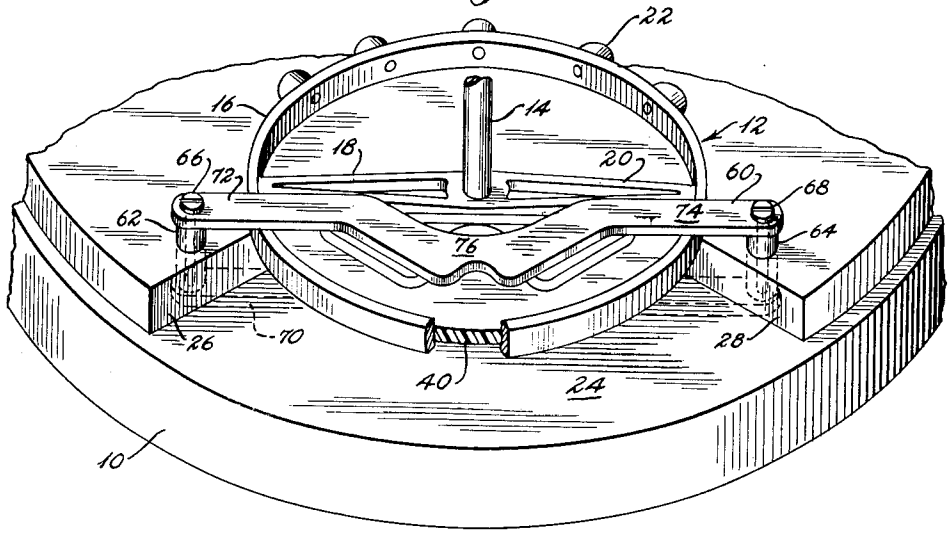
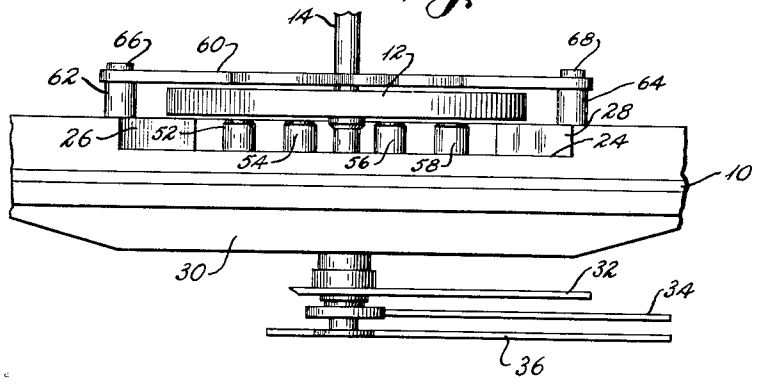


Fig. 2



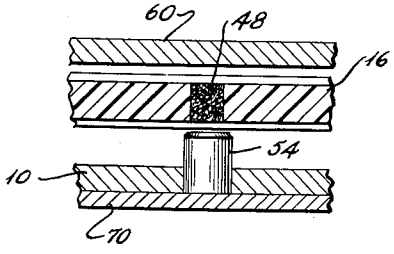


Fig. 4

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Fig. 3

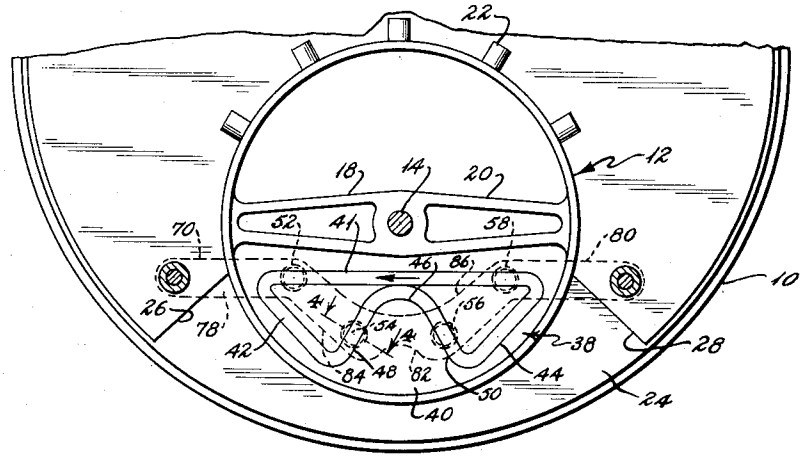


Fig. 5

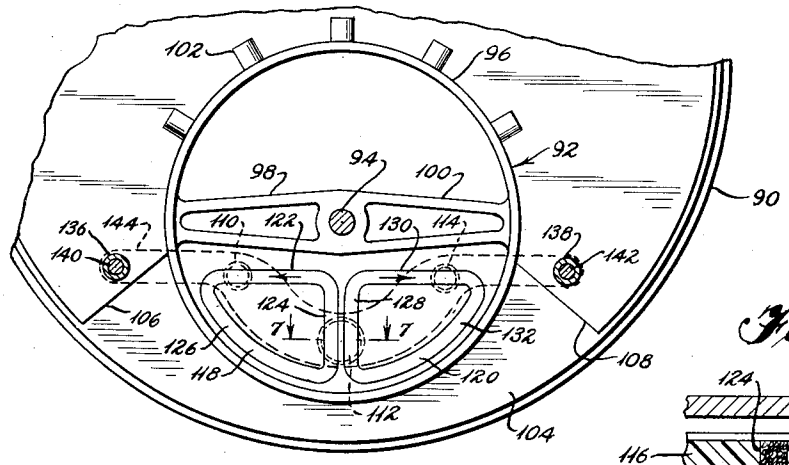


Fig. 7

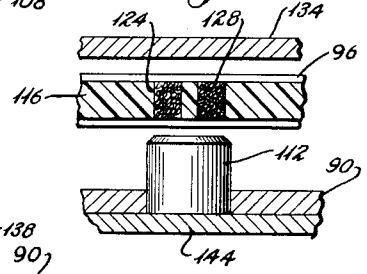
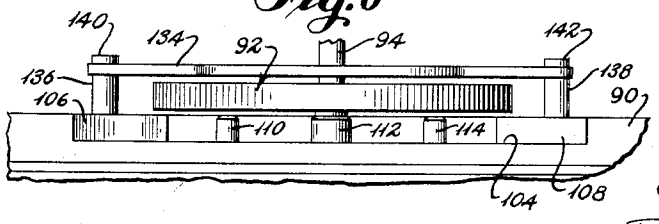


Fig. 6



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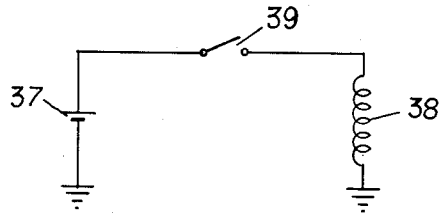


FIG. 8

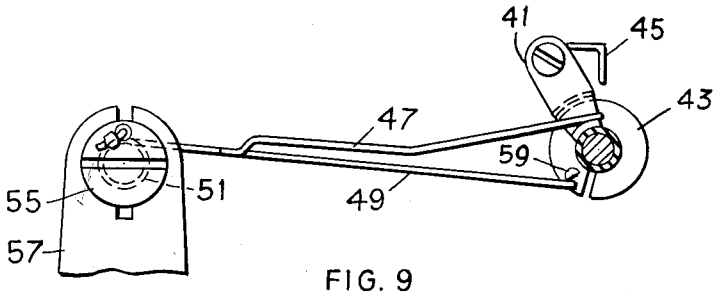


FIG. 9

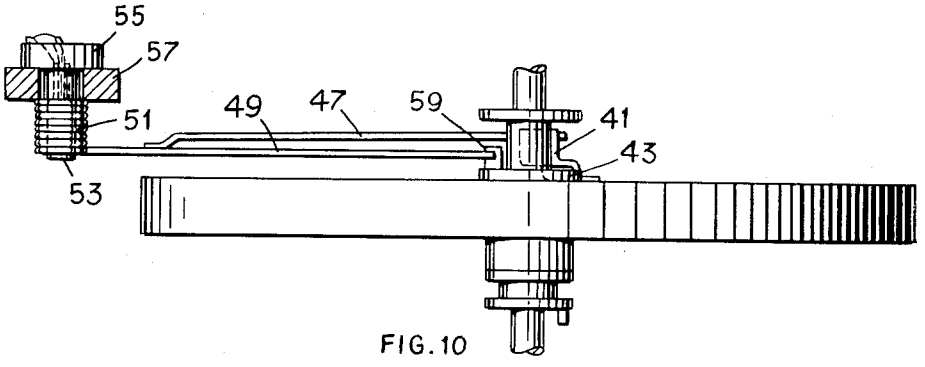


FIG. 10

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ELECTRIC WATCHES

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Filed Dec. 31, 1956, Ser. No. 631,687

11 Claims. (Cl. 310—39)

This invention relates to an electric watch and more particularly relates to an electric watch having a moving coil associated with a balance wheel and passing through stationary magnetic fields.

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 accommodated in a battery which will fit within a wrist watch casing is quite limited. This requires that the available electric energy be converted into mechanical energy as efficiently as possible so that an extended battery life can be obtained.

Various types of electric motors for converting electrical energy into mechanical energy in electric time pieces have been heretofore proposed by prior workers. These have been both of the moving coil and stationary coil type and have used both stationary and movable permanent magnets of various shapes. While certain of these prior designs were feasible clocks, we have found that generally these constructions are unsatisfactory when an attempt is made to reduce their size to fit them within the case of a wrist watch. The magnetic circuits generally result in extensive flux leakage which deleteriously affects other watch components. Attempts to control or limit this flux leakage generally result in low efficiency motors.

In assignee's copending application Serial No. 578,843, there is disclosed an electric wrist watch wherein the electrical power of the battery is transformed into mechanical drive for the train by means of a coil carried by the balance wheel and having sides passing through spaced magnetic fields created by small cylindrical magnets. The sides of the coil and the magnetic fields are so arranged that the two coil sides are simultaneously centered in the magnetic fields so that when the coil is energized, the balance wheel receives a drive force which is the sum of the two impulses on the coil sides. This arrangement has proven very satisfactory and a large number of wrist watches have been constructed in this manner.

We have now found that the efficiency of the driving arrangement in watches of the type disclosed in assignee's aforementioned copending application and the battery drain may be materially improved if the coil is so shaped that at least three coil sides simultaneously are impulsed by three-spaced magnetic fields. With such an arrangement, a higher torque may be obtained for substantially the same battery drain so that the increased motor power is available, or, on the other hand, if this increase in motor power is not necessary, a smaller battery may be used, or increased battery life may be obtained.

It is accordingly a primary 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 watch having a coil means mounted on the balance wheel assembly on one side of the balance staff and having at least three coil sides which simultaneously pass through three-spaced magnetic fields.

It is another object of the invention to provide an electric watch having a coil means carried by the balance assembly and having at least three coil sides which simultaneously pass through spaced magnetic fields which have magnetic axes substantially parallel to the axis of the balance staff.

It is another object of the invention to provide an electric watch including a small but powerful source of permanent magnetism arranged in a magnetic circuit which provides a maximum usable flux density in spaced air gaps, but which minimizes stray fields.

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

Figure 1 is a partial perspective view of a watch constructed according to the present invention showing the balance assembly and drive mechanism;

Figure 2 is a side elevation of the watch shown in Figure 1;

Figure 3 is a plan view of the watch shown in Figures 1 and 2;

Figure 4 is a partial vertical section taken along the line 4—4 of Figure 3;

Figure 5 is a plan view of a watch constructed according to another embodiment of our invention;

Figure 6 is a partial side elevation of the watch of Figure 5;

Figure 7 is a partial vertical section taken along the line 7—7 of Figure 5;

Figure 8 is a circuit diagram of the electrical circuit of an electric watch constructed according to the invention;

Figure 9 is a plan view of a suitable contact system for an electric watch constructed according to the invention; and

Figure 10 is a side elevation of the contact system of Figure 9.

Referring to Figures 1 through 4, there is shown a watch of the same general type as that disclosed in assignee's copending application Serial No. 578,843, filed April 17, 1956, and inasmuch as the watch differs only in the means for transforming electrical into mechanical energy, only that portion of the watch is illustrated. Further details may be found in assignee's aforementioned copending application and also in assignee's earlier application Serial No. 409,934, now Patent No. 2,888,-791, filed February 12, 1954.

Referring to Figures 1 through 4, there is shown a watch having a pillar plate **10** and balance wheel **12** mounted on a balance staff **14**. The balance wheel **12** has a rim **16** supported by arms **18** and **20**. Conventional counterbalance weights **22** are carried at one side of the rim **16** to counterbalance a coil means presently to be described. Pillar plate **10** is provided with a sector shaped recess **24** beneath the balance wheel, defined by vertical faces **26** and **28**. The watch is provided with a face **30**, hour hand **32**, minute hand **34** and sweep second hand **36**.

Mounted within the balance wheel **12** is a coil shown generally at **38** which is carried within a sheet of synthetic resin **40**, which is shown as being transparent for ease of illustration. The synthetic resin **40** is molded within the balance wheel **12** between arms **18** and **20** and rim **16**, as best seen in Figures 1 and 3. Referring to Figure 3, it will be seen that the coil **38** comprises a

straight rear side 41, a pair of diagonal sides 42 and 44 connected to rear side 41, and a generally U-shaped side 46 having radial legs 48 and 50 connected to diagonal sides 42 and 44. One end of this coil is connected to the balance wheel while the other end is connected to a suitable contact mechanism, such as, for example, that described in assignee's copending application Serial No. 551,791, filed December 8, 1955.

Beneath the balance wheel 12 in the sector shaped slot 24, the pillar plate is apertured to receive four cylindrical magnets 52, 54, 56 and 58 which are press fitted therein. The magnetic flux emanates from the ends of the magnets perpendicular thereto. The location of these magnets is such that magnet 52 underlies one end of rear side 41 of coil 38, magnet 54 underlies radial leg 48, magnet 56 underlies radial leg 50, and magnet 58 underlies the other end of rear side 41. The upper poles of magnets 52 and 56 are like magnetic poles and are opposite to the upper poles of magnets 54 and 58 in order that the impulse provided by each magnetic field tends to rotate the coil and balance in the same direction.

An upper shunt 60 is disposed over the lower half of the balance wheels and is supported by a pair of pillars 62 and 64 of soft magnetic material which extend through the pillar plate 10. Screws 66 and 68 pass through the upper shunt and pillars 62 and 64 and engage a lower shunt 70 which extends beneath the lower half of the balance wheel on the under side of the pillar plate. The pillar plate is formed of a suitable non-magnetic material, such as brass or nickel silver, while the shunts 60 and 70 and pillars 62 and 64 are formed of a magnetic material such as low carbon steel. The screws 66 and 68 may be of either a magnetic or a non-magnetic material.

The upper shunt 60 has a pair of outwardly extending legs 72 and 74 supported on the pillars 62 and 64 and these legs are joined at their inner ends by means of a W-shaped portion 76. The lower shunt 70 is similarly shaped and comprises legs 78 and 80 joined by W-shaped section 82, as seen in Figure 3. The lower faces of magnets 52 and 54 engage the leftmost leg 84 of the W-shaped portion 82 of the lower shunt while the lower faces of magnets 56 and 58 engage the leg 86 of W-shaped portion 82 of the lower shunt.

Assuming that current flow in coil 38 is in the direction of the arrow shown in the rear side 41 in Figure 3; when the upper face of magnet 52 is a north pole, the left end of rear side 41 is impulsed upwardly, perpendicular to the current flow. This same current flow in the coil produces a current flowing inwardly towards the balance staff in radial leg 48 over magnet 54. When the upper end of magnet 54 is a south pole, this produces an impulse upon coil leg 48 to the left, perpendicular to the coil leg and current flow therethrough. Current at the same time flows radially outward through leg 50 of coil 38 over magnet 56, and when this magnet has a north pole at its upper end, the leg 50 is impulsed to the left, perpendicular to leg 50 and to the current flow therethrough. The current flow in the right end of rear side 41 cooperates with a south pole at the upper end of magnet 58 to produce a downward impulse in the right end of rear side 41 perpendicular thereto. It will thus be seen that the impulses produced by all four magnets tend to rotate the coil and balance in a clockwise direction. The actual polarities of the magnet poles can, of course, be reversed provided the relative polarities are similar to produce additive impulses upon the coil.

It will thus be seen that for a given current in coil 38, four additive impulses are obtained to move the balance wheel thereby producing a high torque and providing a more efficient impulsing mechanism than heretofore available. The magnetic circuit is still isolated in one sector of the watch, as was the case in the watch described in assignee's copending application Serial No. 578,843, filed April 17, 1956. This minimizes stray field problems, while the use of small cylindrical magnets and the shunt circuit disclosed further provides for intense magnetic fields in highly localized areas.

The electrical circuit which produces the current in the coil is diagrammatically illustrated in Figure 8 wherein the battery 37 is connected to the coil 38 through the contact arrangement 39 and through the watch frame as a ground connection. Referring to Figures 9 and 10, the contact arrangement may consist of a contact 41 carried by a contact roller 43 which is mounted just above the balance wheel 12 and synthetic resin 40. The coil 38 has one end grounded by connection to the body of the balance wheel. The other end 45 is connected to the contact 41. The contact 41 oscillates with the balance wheel and is periodically brought into engagement with a spring contact arm 47 secured to the extended end 49 of a coil spring 51.

The spring 51 is carried on a pin 53 having an enlarged head 55. The pin is carried by friction in a suitable insulated portion of the watch frame 57 which is connected to the battery by a wire, not shown. The end of the wire spring 51 is soldered to the head 55 of pin 53.

Carried by contact roller 43 is a non-conducting jewel pin 59 which is adapted to contact the end portion of the extended end 49 of the spring 51 during oscillating motion of the balance assembly. When motion is in a clockwise direction in Figure 9 the jewel pin 59 pushes spring end 49 and contact spring 47 upward so that the coil is not energized. However, on the return counterclockwise oscillation of the balance wheel the jewel pin 59 pulls contact spring 47 into wiping engagement with contact 41 to close the circuit between the battery and coil and thereby impulse the balance wheel. This contact system is the same as that disclosed in application Serial No. 409,934 mentioned hereinbefore (now Patent No. 2,888,797) and further details may be had by reference to that specification.

Referring to Figures 5, 6 and 7, there is shown another embodiment of our invention wherein the single coil utilized in the embodiment of Figures 1 through 4 is replaced by a pair of coils carried by the balance wheel. Thus referring to Figure 5, there is shown a watch consisting of a pillar plate 90 having a balance wheel 92 mounted thereon on a balance staff 94. As was the case with the preceding embodiment of our invention, this watch is of the same type as that disclosed in more detail in assignee's aforementioned copending applications.

The balance wheel 92 is comprised of a rim 96 supported by arms 98 and 100. Counterbalancing weights 102 are mounted in the rim to counterbalance the coils presently to be described. The pillar plate is provided with a sector shaped recess 104 defined by side faces 106 and 108. The pillar plate is apertured to receive three cylindrical magnets 110, 112 and 114 which are press fitted therein.

Mounted in the balance wheel 92 by means of a sheet 116 of synthetic resin are a pair of coils 118 and 120. Coil 118 consists of generally radial legs 122 and 124 which are connected together by an arcuate side 126. Coil 120 is similarly constructed of radial legs 128 and 130 which are connected together by an arcuate side 132. Radial legs 124 and 128 of coils 118 and 120 respectively are arranged parallel and side by side over the upper surface of the central magnet 112, as is seen in Figures 5 and 7. This magnet is preferably of a larger diameter than magnets 110 and 114 to provide a uniform field for both coil legs 124 and 128. Radial legs 122 and 130 in coils 118 and 120 are respectively disposed over the upper surfaces of magnets 110 and 114. Coils 118 and 120 may be either connected in series or in parallel, but are connected to have the current flow in opposite directions in the upper radial legs 122 and 130, as shown by the arrows. This produces current flow in the same direction through parallel coil legs 124 and 128 over magnet 112.

An upper shunt 134 is mounted over the balance wheel

and coils and is supported by a pair of pillars **136** and **138** of soft magnetic material. These pillars extend through the pillar plate **90**, as in the preceding embodiment of the invention. Screws **140** and **142** pass through the upper shunt and pillars **136** and **138** and engage a lower shunt **144** mounted beneath the balance wheel on the under side of the pillar plate. As in the preceding embodiment of the invention, the pillar plate is formed of a suitable non-magnetic material such as brass or nickel silver, while the shunts **134** and **144** are formed of a magnetic material such as low carbon steel. The screws **140** and **142** may be of either a magnetic or non-magnetic material.

With the current flows in coils **118** and **120** in the directions shown by the arrows in Figure 5; when the upper end of the central magnet **112** is a south pole, the coil sides **124** and **128** are both impulsed to the left, perpendicular to the coil sides **124** and **128** and to the current flow therein. Under these conditions, magnet **110** is mounted with a north pole at its upper end so as to impulse leg **122** of coil **126** upward in Figure 5, perpendicular to the coil side and to the flow of current therein. Magnet **114** is also mounted with a north pole at its upper end so that leg **130** of coil **120** is impulsed downwardly in Figure 5, perpendicular to the coil side and flow of current therein. It will thus be seen that four separate impulses are provided each tending to rotate the balance wheel **92** in a clockwise direction. It will be apparent that the directions of current flow may be reversed so long as current flow is in the same direction in the parallel legs **124** and **128** which lie in the same magnetic field. The polarities of the magnets may also be reversed so long as magnets **110** and **114** present similar upper poles which are opposite to the upper pole of magnet **112**.

In this embodiment of our invention, as in the preceding embodiment, the magnetic circuit and impulsing mechanism is localized in one sector of the watch and the magnetic circuit minimizes stray fields. A high degree of impulse torque is obtained for a given current flow to produce an efficient means of translating electrical to mechanical power to provide for minimum drain on the battery.

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 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 the United States Letters Patent is:

1. In a battery operated timepiece containing a balance wheel and staff assembly and having a movably mounted coil means for causing said balance wheel to oscillate, and means for periodically connecting said coil means to said battery to create a magnetic flux about the coil means; means attaching said coil means to said assembly so that it lies in a plane perpendicular to said staff and the entire coil means associated with said assembly is contained within a 180° area about said staff, said coil means having at least three spaced coil sides generally radially disposed with respect to said balance staff, means establishing a magnetic field having at least three spaced intensified regions having magnetic axes parallel to said staff, said sides being arranged to pass through said intensified regions simultaneously, said intensified regions being of such magnetic polarity that when current flows through said coil means to create said magnetic flux, the magnetic flux about said coil sides reacts with said intensified regions to produce three torque impulses in the same rotational direction, the intensified regions about said staff and the coil sides associated therewith being assymetrically located relative to said staff whereby the means establishing said magnetic field is localized at one area about said staff.

2. A device as set out in claim 1 wherein said magnetic field is created by a plurality of magnets each having its magnetic axis parallel to said staff.

3. A device as set out in claim 2 wherein there is one such magnet for each intensified regions and said magnets cooperate with a first shunt member thereabove and a second shunt member therebelow.

4. A device as set out in claim 1 wherein said coil means are carried by said balance wheel.

5. A device as set out in claim 1 wherein said coil means comprises a single coil.

6. A device as set out in claim 5 wherein said coil is contained within 180° with respect to said staff.

7. A device as set out in claim 6 wherein said coil comprises a rear side generally radially disposed with respect to said balance staff, a pair of diagonal sides connected to the ends of said rear side, a pair of radial sides connected at one end to said diagonal sides and connected together at said other ends.

8. A device as set out in claim 7 including four intensified regions intersecting the extremities of said rear side and said radial sides.

9. A device as set out in claim 1 wherein said coil means comprises a plurality of coils.

10. A device as set out in claim 9 wherein said coil means includes two coils with one leg of one coil parallel to and adjacent one leg of the other coil so that both said legs simultaneously lie within one of said intensified regions.

11. A device as set out in claim 10 wherein each of said coils also includes an additional radially disposed leg, said radially disposed legs being disposed to lie in spaced intensified regions when said parallel legs lie in one of said intensified regions.

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