

United States Patent

Saito et al.

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- [54] **MECHANICALLY SWITCHED
ELECTRIC TIMEPIECE**
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- [22] Filed: July 27, 1971
- [21] Appl. No.: 166,499

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July 29, 1970 Japan.....45/66014
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- [51] Int. Cl.G04c 3/04, G04c 23/12
- [58] Field of Search.....58/23 R, 28 R, 28 A; 318/127,
318/132, 134

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[57] ABSTRACT

An electric timepiece switched by a mechanical contact point including a pair of spaced balance wheels having at least two pairs of permanent magnets mounted thereon in spaced facing relation. Coil means are fixedly mounted between said two balance wheels. Mechanical contact means are provided including actuating means mounted on said balance wheels for closing a circuit between said coil and an electric source during a certain range of one reciprocation of said balance wheels to apply a driving energy to said magnet.

11 Claims, 11 Drawing Figures

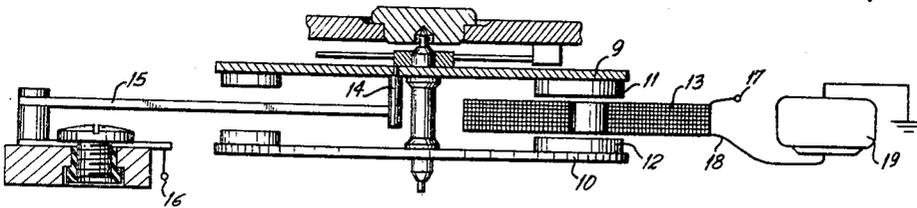


FIG. 1

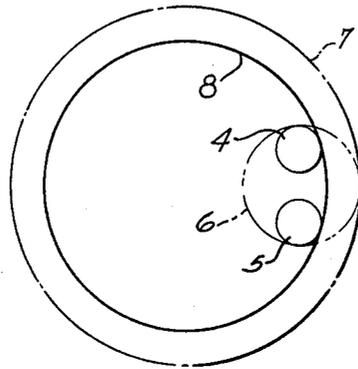
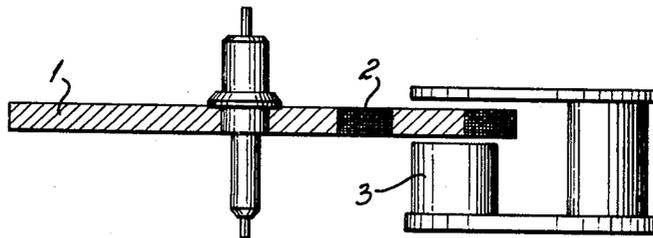


FIG. 2

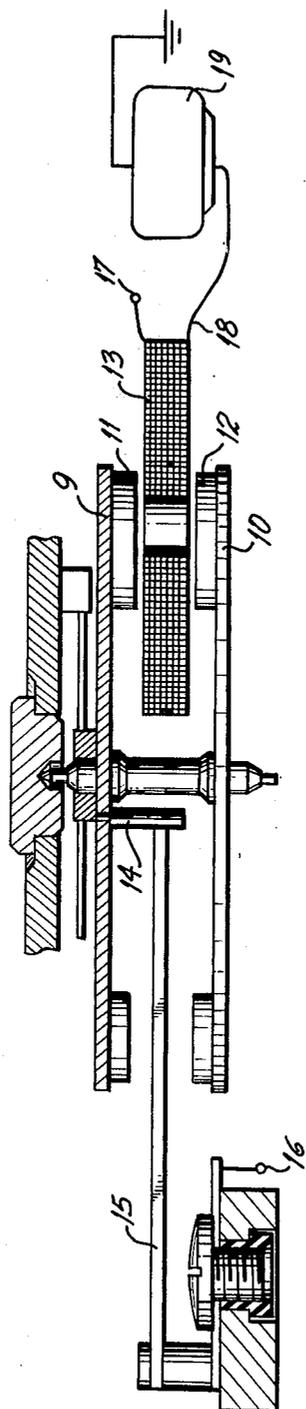


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FIG. 3



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FIG. 4

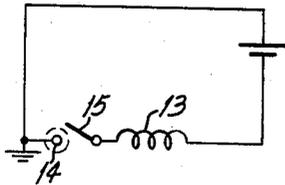


FIG. 5

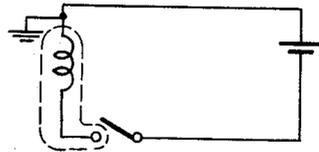


FIG. 6

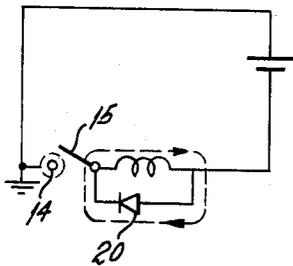


FIG. 7

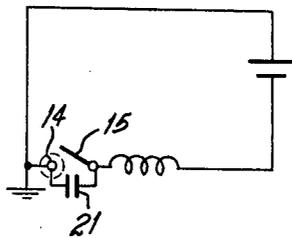
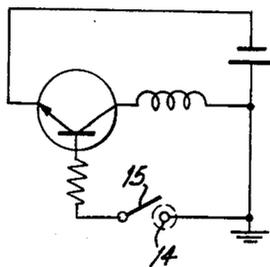


FIG. 8



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FIG. 9

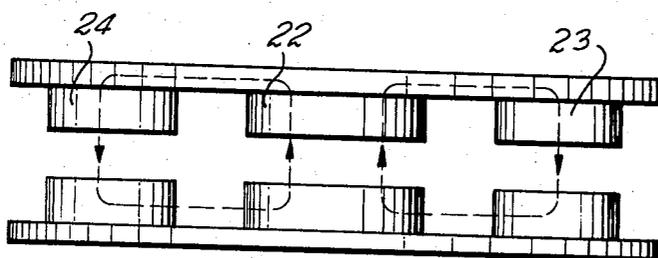
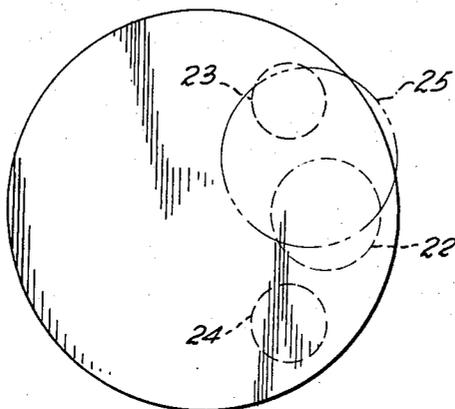


FIG. 10

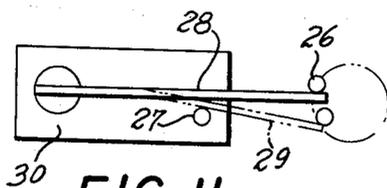


FIG. 11

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MECHANICALLY SWITCHED ELECTRIC TIMEPIECE

BACKGROUND OF THE INVENTION

Generally speaking, in accordance with the invention, mechanically switched electric timepieces have been provided with the coil mounted on the balance wheel and the permanent magnet structure being fixed. However, such arrangements have resulted in abrasion and other wear of the contact point providing electrical contact to the coil due to the difficulties in providing protection against arcing with this arrangement. Further, such arrangements require relatively large amounts of space, are relatively inefficient electro-mechanical converters, and involve large air losses. Further, such watches are affected by external magnetic fields such as terrestrial magnetism, since the magnetic circuit thereof is not a perfectly closed circuit.

By fixing the coil and mounting the permanent magnets on a pair of spaced balance wheels, and by the provision of a novel contact arrangement, the foregoing deficiencies are avoided.

SUMMARY OF THE INVENTION

Generally speaking, in accordance with the invention, an electric timepiece switched by a mechanical contact point is provided including a pair of spaced balance wheels, at least two pairs of permanent magnets mounted in facing relation on said pair of balance wheels, a coil fixedly mounted intermediate said pair of balance wheels in the path of said permanent magnets, electric source means, and mechanical means for electrically connecting said coil to said electric source means in response to the rotation of said balance wheels in a certain range of reciprocation of said balance wheels for the supply of driving energy to said magnets.

Said mechanical means may include a contact pin mounted on said balance wheels and a resilient contact point member fixedly mounted in said timepiece in the path of said contact pin for interconnecting said electric source means and said coil. Said mechanical means may also include a hairspring for electrically connecting said contact pin to the circuit including said coil and electric source means. Said contact pin may be positioned intermediate said two balance wheels. A protective circuit means may be provided in the circuit including said mechanical contact means, said coil and said electric source means for preventing damage to said electrical contact means. Said protective circuit means may include a diode connected in parallel with said coil, a condenser connected in parallel with said mechanical contact means, or a transistor connected with its base connected to said mechanical contact means and said coil connected in the emitter to collector path thereof.

Three spaced pairs of permanent magnets may be mounted on said balance wheel, the middle pair of said permanent magnets having an area of about twice the dimensions of the other two pairs of said magnets.

Said displaceable means may include a contact spring displaced by said contact pin into and out of engagement with said contact point member. In an alternate embodiment, said contact pin is not a part of the electric circuit including the electric source means and said coil, but rather, serves to deflect a movable contact member connected in said circuit into engagement with a fixed contact pin to close said circuit.

Accordingly, the object of this invention is to provide an electric timepiece switched by a mechanical device wherein wear of the contact points of said mechanical device is minimized, the mechanism is compact, and power consumption is small.

A further object of this invention is to provide a mechanically switched electric timepiece the components of which are interchangeable with contactless electric timepieces.

Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification and drawings.

The invention accordingly comprises the features of construction, combinations of elements, and arrangement of parts which will be exemplified in the constructions hereinafter set

forth, and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a schematic representation of the relative sizes of balance wheels of mechanically switched electric timepieces wherein the permanent magnet is fixed, and wherein the permanent magnet is mounted on the balance wheel;

FIG. 2 is a cross-sectional view showing an electric timepiece wherein the coil is mounted on the balance wheel;

FIG. 3 is a cross-sectional view of a mechanically switched electric timepiece according to the invention;

FIG. 4 is a circuit diagram of the basic circuit of the arrangement of FIG. 3;

FIG. 5 is a circuit diagram of the basic circuit of the arrangement of FIG. 2;

FIGS. 6, 7 and 8 are circuit diagrams showing the circuit of FIG. 4 modified to incorporate protective circuits for the mechanical contact point;

FIGS. 9 and 10 are plan and side elevational views respectively of the balance wheels and magnets mounted thereon of an embodiment of the arrangement according to the invention; and

FIG. 11 is a partial plan view of another embodiment of the arrangement according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 2, the prior art mechanically switched electric watches include a balance wheel 1 having a coil 2 mounted in the periphery thereof. A permanent magnet 3 is mounted on a fixed base such as the plate of the watch. This arrangement requires contact points between the coil and the power source of the electric watch, but such prior art contact points were subject to substantial wear by abrasion, since it is difficult to provide a protective circuit for such contact points as more particularly shown in FIG. 5.

In FIG. 5, the region surrounded by the dashed line represents the portion of the circuit mounted on the oscillating balance wheel, which portion includes the coil. In order to prevent sparking at the contact point, it would be necessary to position a diode at both ends of the coil, which would require mounting a diode on the balance wheel, an approach which would render unstable the moment of inertia of the balance wheel. The use of a capacitor as a protective device is also nearly impossible, since the capacitor must be connected between the fixed and moving contacts, and only one terminal of the balance wheel can be connected to earth through a hairspring.

Still a further disadvantage of the arrangement of FIG. 2 is the relative size of the balance wheel thereof, as exemplified in FIG. 1. In FIG. 1, a balance wheel structure having permanent magnets mounted on the balance wheel as shown in solid lines, wherein the permanent magnets 4 and 5 are mounted on the balance wheel 8. This must be compared with the balance wheel structure shown in phantom lines wherein the coil 6 is mounted on the balance wheel 7. The relative sizes are shown for the case where the same driving energy is to be achieved, in other words, where the balance wheels are to have the same moment of inertia. Thus, the mounting of the coil on the balance wheel increases the size of the timepiece. Still a further difficulty with the arrangement of FIG. 2, is the air losses, and the relative inefficiency of the electro-mechanical conversion thereof.

Referring now to FIG. 3, the arrangement according to the invention is depicted, wherein balance wheels 9 and 10 formed of magnetic material are mounted for common oscillation. Two pairs of circumferentially spaced permanent magnets 11 and 12 are mounted in facing relation on the inner surfaces of balance wheels 9 and 10 (see permanent magnets 4

and 5 or FIG. 1). The spacing between the permanent magnets on each balance wheel substantially corresponds to the spacing of the arms of the coil 13 which is fixedly mounted in the region intermediate said balance wheels in the path of said permanent magnets.

A contact pin 14 is secured to balance wheel 9 and projects into the space intermediate the spaced balance wheels. A contact spring 15 is positioned for engagement by contact pin 14 once during each reciprocation of the balance wheel. The contact spring is insulated from the plate of the watch and is electrically connected to a terminal 16. Terminal 16 is electrically connected (not shown) to one end 17 of coil 13. The other end 18 of said coil is connected to the negative pole of battery 19, the positive pole of which is grounded, contact pin 14 also being connected to ground through a hairspring. When contact pin 14 engages contact spring 15, an electric current flows from the positive pole of the battery to said hairspring which is grounded through a stud. The current then flows to the coil through the contact pin and contact spring, and from the coil to the negative pole of the battery. In this manner, driving energy is applied to the magnets 9 and 12, and the oscillation of the balance wheel is maintained.

The electric circuit of the arrangement of FIG. 3 is shown in FIG. 4, the portion of the circuit mounted on the balance wheel being encircled by a dashed line. As is seen in FIG. 4, only the contact pin 14 is mounted on the balance wheel. FIGS. 6, 7 and 8 show various embodiments of protective circuits for protecting the contact points of the arrangement according to the invention. Since only one terminal of the circuit must be connected to a hairspring to the balance wheel the defects in the prior arrangements can be avoided.

Referring now to FIG. 6, diode 20 is connected across the coil so that the over current produced when the contact point is released passes in the direction of the arrows through said diode, to reduce the spark at the contact point and to protect said contact point. The diode, being compact in size, requires little space and is particularly favorable for use in wrist watches.

In FIG. 7, a condenser 21 is provided between the contact pin 14 and the spring contact 15, to provide low cost protection to the contact point. In FIG. 8, a transistor is connected at its base to the contact lead, the coil being connected in the emitter-collector path of the transistor. When the contact point is closed, the base current flows in the transistor, and the transistor is turned on to apply a driving current to the coil. Since the base current is very small, the wear on the contact pin is very small, so that even if the resistance of the contact point is somewhat increased, the current is sufficient to drive the balance wheel due to the amplification of the transistor.

Mechanically switched electric timepieces are subject to substantial energy loss due to braking of the balance wheel at the mechanical contact point, so that a high driving efficiency is required to compensate for such losses. In the arrangement according to the invention of FIG. 3, a closed magnetic circuit is provided, permitting a reduction in size of the balance wheel, a high frequency of oscillation, and a resistance to external magnetic fields. The provision of the mechanical contact point intermediate the pair of spaced balance wheels serves to reduce the thickness of the structure. A further advantage of the arrangement according to the invention is that the components thereof are also adapted for use in electrically switched electric wrist watches which utilize driving circuits incorporating transistors or the like for switching the driving current into the driving coil, and which do not include mechanical contacts. Thus, where the driving coil is mounted on the balance wheel, it is difficult to modify a mechanically switched electric watch into a contact with an electric watch, since two separate hairsprings are required for providing electrical connection to the two terminals or the driving coil, and the use of two separate hairsprings increases the thickness of the watch. On the other hand, where the coil is fixed and the magnets are mounted on the balance wheel, conversion is relatively easy, so that similar components can be used in both contactless and mechanically switched watches.

In the embodiment of the invention of FIG. 3, two pairs of permanent magnets are provided, and the electric current flows through the coil in only one direction, since the balance wheel is driven in only one direction in one reciprocation of the balance wheel. If three pairs of magnets are provided, the balance wheel can be driven in both directions during one reciprocation of the balance wheel. Such an arrangement is shown in FIGS. 9 and 10, wherein three pairs of permanent magnets 22, 23 and 24 are positioned in facing relation on the inner surfaces of the balance wheels. The respective magnetic circuits between the adjacent pairs of permanent magnets is shown by the arrows of FIG. 10. If the area of the central magnet 22 is twice as large as the area of magnets 23 and 24, the magnetic flux is most efficiently utilized, and the lightest configuration of the balance wheel is produced. Note that the spacing between the adjacent pairs of the permanent magnets is such as to encompass the arms of the coil 25, as shown in FIG. 9.

A further embodiment of the arrangement according to the invention as shown in FIG. 11, wherein the contact pin mounted on the balance wheel is not utilized to directly provide an electrical contact through a hairspring. Rather, contact pin 26 on the balance wheel serves only to displace contact spring 28, but not as an electrical contact itself. The electrical connection is made between contact spring 28 and a second contact pin 27 disposed on base plate 30, when contact spring 28 is displaced to the position 29 shown in phantom lines by contact pin 26. Since both the contact spring and the second contact pin are positioned on the base plate 30, even if the contact point is worn and poor contact results, the balance wheel need not be replaced in order to correct the defect, it being sufficient merely to change the contact point mechanism, an arrangement particularly advantageous for after-sales service.

It will thus be seen that the objects set forth above, and those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above constructions without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween. W

What is claimed is:

1. A mechanically switched electric timepiece comprising a pair of spaced balance wheels mounted for common oscillation; at least two pairs of permanent magnets mounted in facing relation on said pair of balance wheels; a coil fixedly mounted intermediate said pair of balance wheels in the path of said permanent magnets; electric source means; circuit means for electrically connecting said coil to said electric source means; and mechanical means for selectively closing said circuit means in response to the rotation of said balance wheel in a certain range of reciprocation of said balance wheel for the supply of driving energy to said magnets.

2. A mechanically switched electric timepiece as recited in claim 1, wherein said mechanical means includes a contact pin mounted on said balance wheel and forming a part of said circuit means and a resilient contact point member fixedly in the path of said contact pin and forming a part of said circuit means for engagement by said contact pin in said certain range of reciprocation of said balance wheels.

3. A mechanically switch electric timepiece as recited in claim 2, wherein said circuit means includes a hairspring coupled to said contact pin.

4. A mechanically switched electric timepiece as recited in claim 2, wherein said contact pin is mounted on said balance wheel so as to project into the space intermediate said balance wheel.

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5. A mechanically switched electric timepiece as recited in claim 2, including protective circuit means in said circuit means for protecting the contact point between said contact pin and said contact point member.

6. A mechanically switched electric timepiece as recited in claim 5, wherein said protective circuit means includes diode means connected in parallel with said coil.

7. A mechanically switched electric timepiece as recited in claim 5, wherein said protective circuit means includes condenser means connected between said contact pin and said contact point member.

8. A mechanically switched electric timepiece as recited in claim 5, wherein said protective circuit means includes transistor means having a base, emitter and collector, said coil being connected in the emitter to collector path of said transistor, the portion of said circuit means including the contact point between said contact pin and said contact point member being in the base circuit of said transistor means.

9. A mechanically switched electric timepiece as recited in claim 1, including three pairs of permanent magnets mounted

in facing relation on said balance wheel, each of the outer pairs of said permanent magnets being positioned relative to the middle of said pairs of permanent magnets so as to define a magnetic circuit therewith for receiving driving energy from said coil during said certain range or reciprocation of said balance wheels.

10. A mechanically switched electric timepiece as recited in claim 9, wherein said middle pair of permanent magnets is formed with a surface area of about twice as large as the surface area of the outer pairs of permanent magnets.

11. A mechanically switched electric timepiece as recited in claim 1, wherein said mechanical means includes a first contact pin mounted on said balance wheels, a resilient contact point member fixedly mounted in the path of said contact pin for displacement thereby, and a second contact pin fixedly mounted in the path of displacement of said resilient contact point member, said contact point member and said second contact pin forming part of said circuit means for closing said circuit to supply driving energy to said magnets.

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