United States Patent

Inoki et al.

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[54] COIL CARRIER MEANS IN AN ELECTRONIC TIMEPIECE MOVEMENT

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[51] **Int. Cl.**.....**G04c 3/00,** G04c 3/00

[58] **Field of Search**.....58/23, 23 A, 23 BA, 23 TF, 58/23 V, 28

[56] **References Cited**

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[57] **ABSTRACT**

In an electronic timepiece the electromagnet coils which cooperate with the movable magnets mounted on the balance wheel are mounted on a frame pivoted to the base of the timepiece so as to arrange the coils for movement into and out of operative relation with the magnets. The electrical connections for the coils are made thru complimentary sliding contact members mounted about the pivot point for the frame.

5 Claims, 9 Drawing Figures

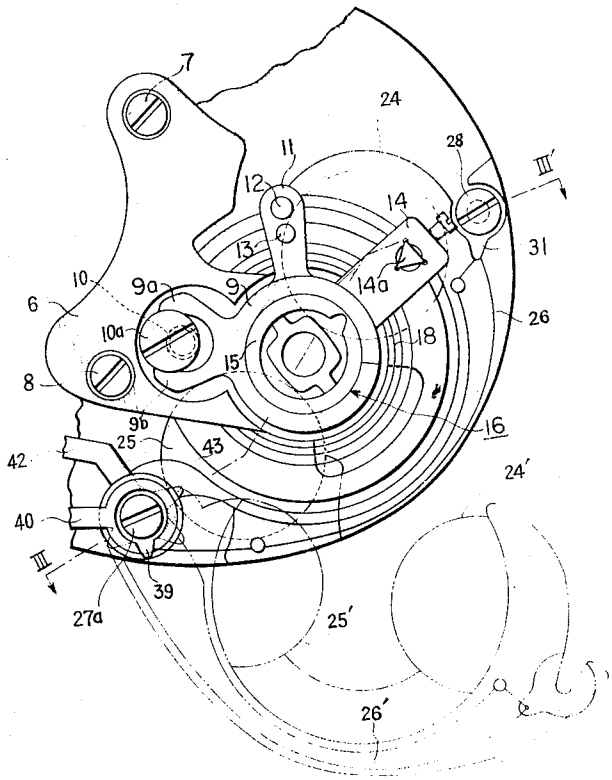

FIG. 1

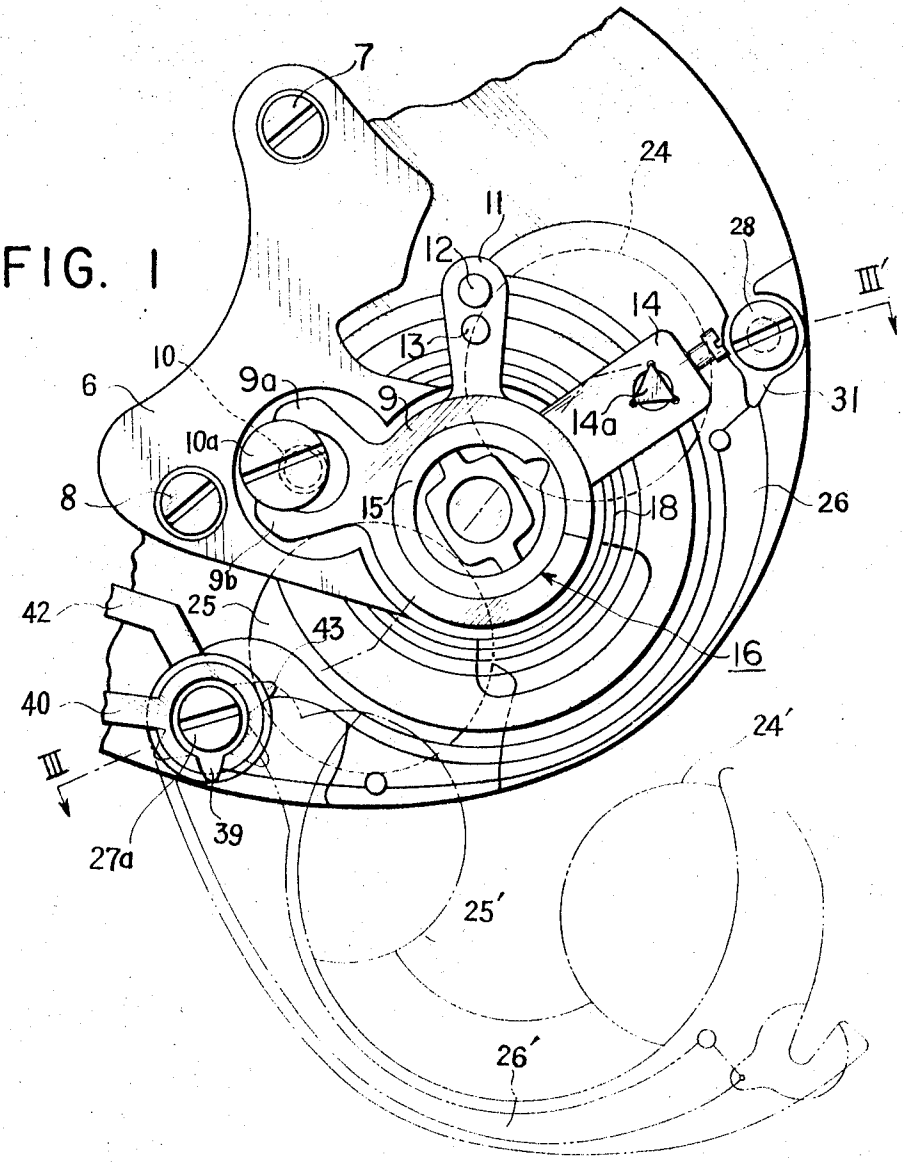

FIG. 2

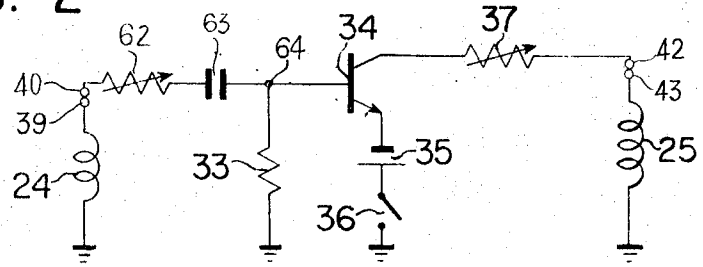

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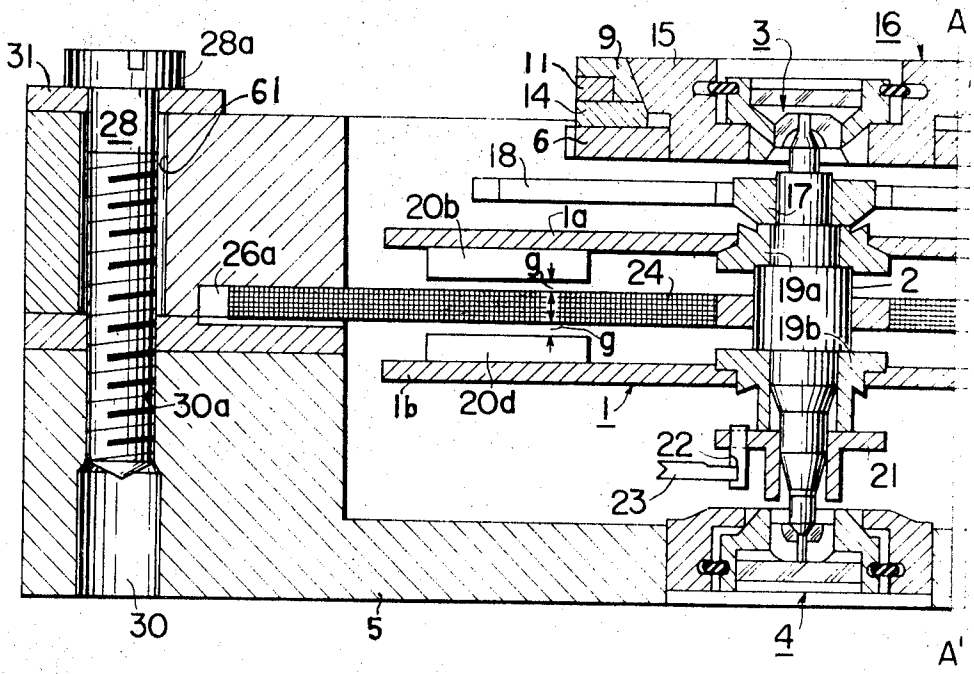
FIG. 3


31
28a
61
28
9
15
3
16
A
11
14
6
18
17
20b
1a
26a
g
24
19a
2
19b
30a
1b
20d
1
22
21
23
30
5
4
A'

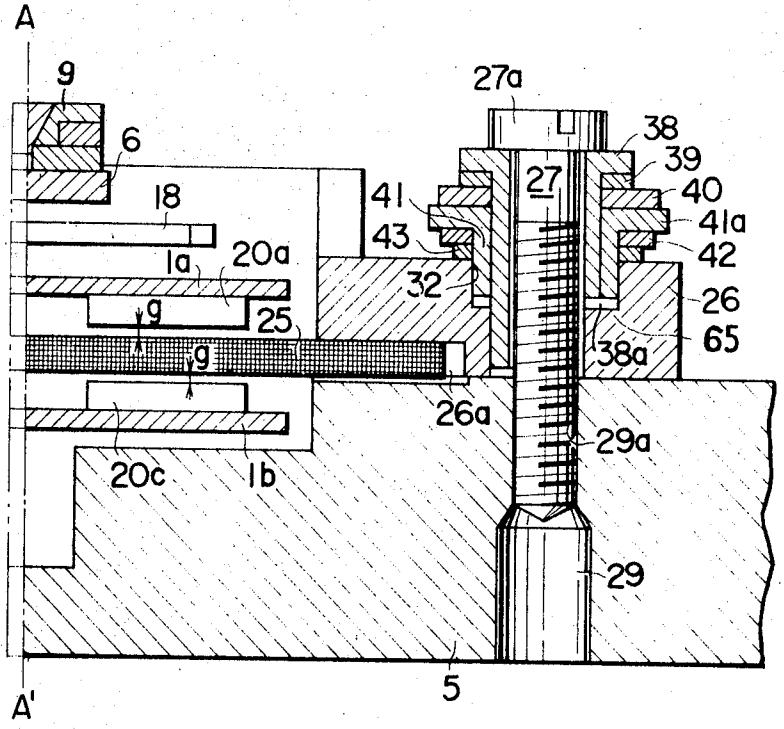

A
9
6
18
1a
20a
g
25
41
43
27a
38
39
27
40
41a
42
32
26
65
38a
26a
29a
20c
1b
29
5
A'

FIG. 3A

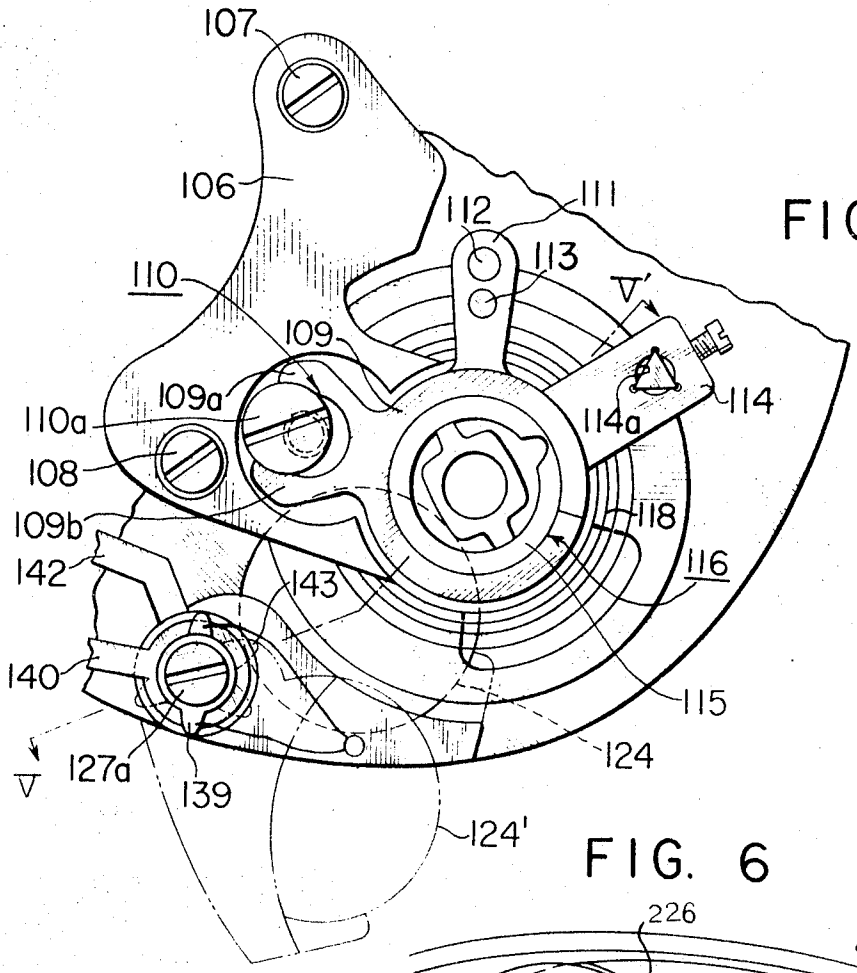


FIG. 4

FIG. 6

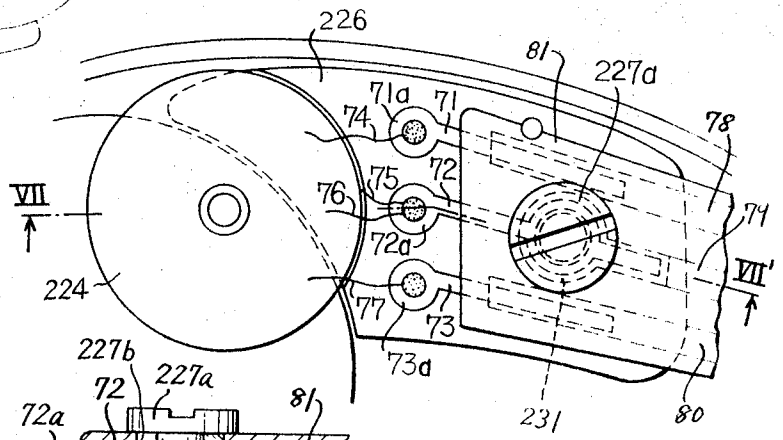


FIG. 7

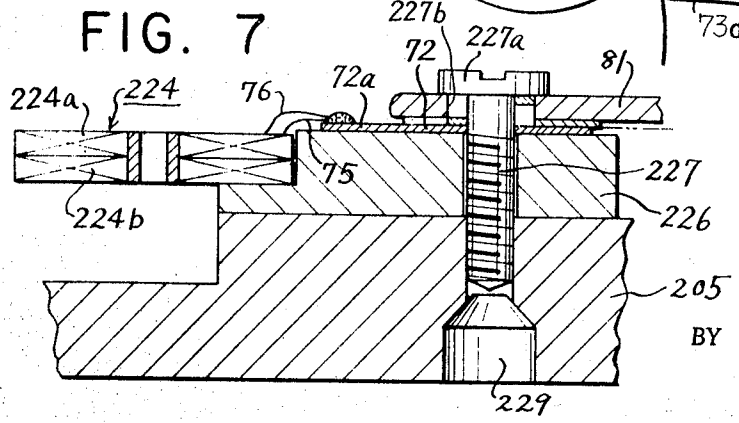


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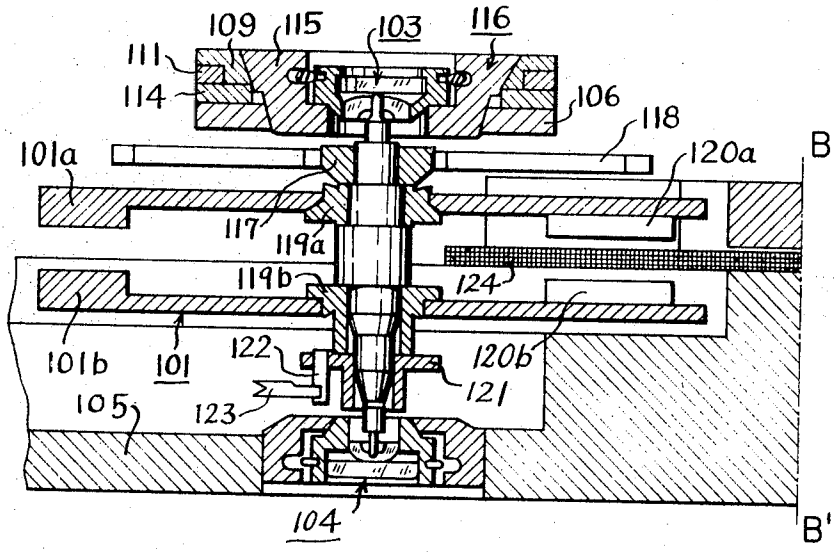
FIG. 5


109
115
103
116
111
114
106
118
101a
120a
B
117
119a
119b
124
101b
101
122
120b
121
105
123
104
B'

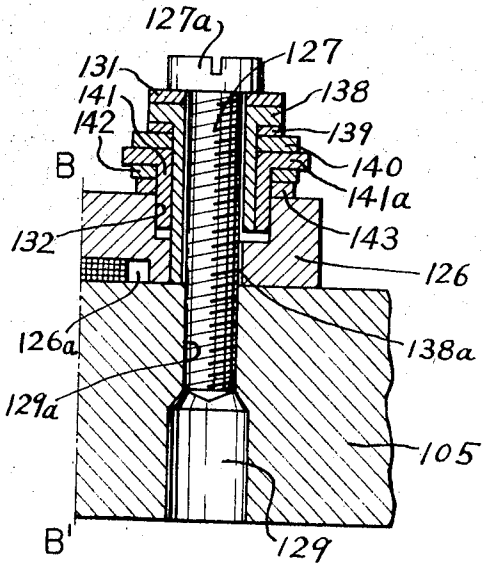

127a
127
131
141
142
138
139
140
141a
B
132
143
126
126a
138a
129a
105
B'
129

FIG. 5A

COIL CARRIER MEANS IN AN ELECTRONIC TIMEPIECE MOVEMENT

This invention relates generally to improvements in and relating to battery-driven electronic timepieces comprising movable magnet means and stationary coil means relative to the casing of the timepiece and arranged to electromagnetically cooperating with each other. More specifically, it concerns with a device for mounting the normally stationary coil means.

In this conventional type of electronic timepiece, it is a representative arrangement that the movable magnets are mounted on the balance wheel comprised in the timepiece movement and the stationary coil or coils are mounted on a certain support means which is mounted in turn on the housing of the timepiece, said coil or coils being positioned between the two balance wheels of the balancer maintaining small gaps between the coil means and the balance wheels for allowing their relative movement and for obtaining a maximum possible conversion efficiency.

Even upon assembly of the magnet-carrying balance wheel into the timepiece movement, a redismantling job thereof may frequently be required for performing various and mostly delicate mechanical corrections.

As an example, the oscillation movement of the balance wheel may be found as defective so that the mechanical feed through the time-indicating gear train is out of order. On the other hand, the hair spring may be defective or at least in a fouled condition so that a correction and/or purification job is required. For performing such correction or other job, the balance wheel must be dismantled from its assembled position. In each time for performing the balance wheel dismantling job, the coil carrier must also be dismantled from the timepiece movement which means naturally a troublesome and costly additional job.

As is commonly known, the balance wheel is so delicate that it must be assembled or dismantled with highest care and caution. On the other hand, the sensing and drive coils used for the electronic timepiece are composed of very fine gauge wires, such as, of 15 microns, and thus, fatal wire breakages may be always feared in the course of the balance wheel dismantling job, even when the sincerest caution has been paid therefor.

The main object of the present invention is to provide an improved electronic timepiece, capable of substantially obviating the aforementioned conventional drawbacks.

A further object is to provide an improved electronic timepiece of the type wherein fear of coil breakage can be avoided in case of receding and re-attaching the coil means thereof from and to the operating position relative to the timepiece movement.

For fulfilment of the aforementioned object the basic and novel teaching of the present invention resides in such improved structure of the coil-carrying means that by loosening the fixing screw for the latter and swivelling the carrying means together with the mounted coil or coils to a sufficiently off-set position, the balance wheel or the like timebase and electromagnetic drive means can be brought into its ready-for-dismantling position from the timepiece movement.

These and further objects, features and advantages of the invention will become more apparent when read the following detailed description of the invention by reference to the accompanying drawings illustrative of several preferred embodiments of the invention.

In the drawings:

FIG. 1 is a plan view of a part of a timepiece movement provided with a pivotable coil carrier according to a first embodiment of the invention.

FIG. 2 is a schematic wiring diagram of the electronic circuit embodied in the first embodiment.

FIGS. 3 and 3A is a sectional view taken substantially along the section line III—III' in FIG. 1.

FIG. 4 is a similar view to FIG. 1, showing a second embodiment of the invention.

FIGS. 5 and 5A are an enlarged sectional view taken substantially along the section line V—V' shown in FIG. 4.

FIG. 6 is a plan view of a part of a third embodiment of the invention.

FIG. 7 is a sectional view of the third embodiment shown in FIG. 6, being taken substantially along a section line VII—VII' shown therein.

Referring now to FIGS. 1 – 3 and 3A, the first embodiment will be described in detail.

In these figures, numeral **1***a* and **1***b* denote a pair of balance wheels of a conventional balance shown generally at **1** which wheels are fixedly attached to an oscillatable staff **2** rotatably mounted at its upper and lower ends as known per se in respective conventional bearings **3** and **4**. The upper bearing **3** is designed as a conventional shock-proof type and the lower bearing **4** is designed as a conventional plain thrust and radial combined type, as will be moist clearly seen from FIGS. **3** and **3A** which has been drawn on a slightly enlarged scale only for clarity and divided into two upper and lower parts to be conjoined together at a partition line A—A'. The lower bearing is mounted in a conventional plate **5** of the timepiece movement, not shown, said plate mounting a balance bridge **6** rigidly attached thereto by means of a pair of set screws **7** and **8** shown in Fig. **1**.

The shock-proof type upper bearing **3** is assembled with a conventional fine-adjusting regulator **9** having fork arms **9***a* and **9***b* which are kept in engagement with an adjusting screw **10** studded on the balance bridge **6** and formed with an eccentric head **10***a* for adjusting the oscillating frequency of the balance **1** through the regulator as known per se. The fine-adjusting regulator **9** mounts elastically a conventional regulator proper **11** carrying rigidly boot **12** and curb pin **13**. Numeral **14** denotes a conventional hair spring stud carrier which is elastically attached to a casing frame **15** of the shock proofer generally shown at **16** for the balance staff **2** as conventionally. The shock-proofer **16** is of the conventional single cone type as seen from FIGS. **3** and **3A** which is shown into two parts only for drawing convenience; said parts are to be joined together along the partition line A—A'. Numeral **14***a* represents the stud.

Balance wheel staff **2** mounts fixedly a collet **17** attached by press fit thereto and carrying the outer end of a hair spring **18** shown only schematically.

Balance wheels **1***a* and **1***b* are mounted on the staff **2** by means of respective mounts **19***a* and **19***b* press-fit thereon, the upper mount **19***a* being positioned directly below the collet **17**.

A pair of permanent magnets **20***a* and **20***b* is fixedly attached on to the lower surface of the upper balance wheel **1***a l and a further pair of permanent magnets 20c* and **20***d* is fixedly mounted on the upper surface of the lower balance wheel **1***b*, magnets **20***a* and **20***b* being positioned in a vertical registration with each other, as shown in FIGS. **3** and **3A**; a similar registration can be found between the remaining magnets **20***b* and **20***c* in the same figure.

Nearly at the lower end of the balance staff **2**, a conventional roller **21** is mounted fixedly thereon and an impulse pin **22** fixedly depends from the roller **21**, so as to actuate upon a conventional escapement **23** shown only partially and schematically on account of its very popularity.

Lower plate **5** is made of a conducting material and serves as the earth conductor for an electronic sensing and drive circuit shown in Fig. **2** only in its main constituents.

Sensing and driving coils **24** and **25** are mounted on a pivotable support lever **26**, being made of an insulating material, by partially inserting snugly into a recess **26***a* and held in position by glueing. This support lever **26** thus, constitutes a kind of an elongated frame member and is normally fixed in its operating position shown in FIGS. **3** and **3A** by means of a pair of fixing bolts **27** and **28** which are screwed into partially tapped holes **29** and **30** in the lower plate **5** and having respective threaded bore parts **29***a* and **30***a*, respectively. For this purpose, the lever **26** is formed with a bolt-

receiving opening **61** for the latter bolt **28** and a stepped bolt hole **32** for the former bolt **27**. The positioning level of the coils **24** and **25** is so selected that in their working position shown in Fig. **3**, they are positioned between the magnet pairs **20***a*; **20***c* and **20***b*; **20***d* with small idle gaps denoted by reference symbols *g*.

In Fig. **1**, coils **24** and **25** and their carrier lever **26** are shown, on the one hand, in full lines, so long as they may be seen from above in their operating position, and shown, on the other hand, in chain dotted lines when they are swivelled out about its pivot bolt **27** into their off-service position for allowing easy dismantling the balance wheel assembly. These chain-dotted position is shown with corresponding same reference numerals, each being, however, attached with a prime for easy comparison and prompt understanding.

Bolt **28** is formed with an enlarged head **28***a* and a connecting terminal **31** is kept in pressure contact between bolt head **28***a* and the upper surface of support lever **26** when the related bolt **28** has been tightly screwed in, for providing earth connection from the circuit shown in Fig. **2** to the lower plate **5**.

In the circuit shown in Fig. **2**, there are provided sensing coil **24** and drive coil **25**, each of one end being earthed through said connecting terminal **31**. The opposite end of coil **24** is connected through terminal contacts **39** and **40**, and adjustable resistor **62** and a condenser **63** to a junction **64** which is earthed through a fixed resistor **33** and said terminal **31**, said junction **64** being connected to the base of an amplifier transistor **34**.

Collector of the transistor **34** is connected through an adjustable resistor **37** to the opposite end of the drive coil **25**, while emitter of the transistor **34** is earthed through battery **35** and main switch **36** to the terminal **31** (Fig. **3**) as the earth conductor.

A flanged first insulator sleeve **38** encloses concentrically a substantial upper part of bolt **27** and is rotatably supported at its lower end in the lower reduced part of the stepped opening **32**. Below the upper end flange of insulator sleeve **38**, there is provided said terminal **39** which is kept in pressure and conductive contact with a further terminal **40** for establishing an electrical connection between these terminals. A second flanged insulator sleeve **41** is mounted around the first insulator for keeping the both terminals in position around the bolt **27**, on the one hand, and said further pair of connection terminals **42** and **43** to be held in position between the head flange **44***a* of sleeve **44** and the upper surface of the plate **5** when the pivot bolt **27** has been tightened as shown, on the other hand. The lower end of first sleeve **38** is recessed at **38***a* with which a projection **65** formed on the lever **26** is kept in a mutually engaging position, so as to prevent any turning of the sleeve **38**. Connecting terminals **39** and **43** are preferably fixedly attached, for instance, by glueing to the first insulator sleeve **38** and the coil carrier lever **26**, respectively, for avoiding otherwise possible breakage of the fine coil wires in case of swivelling movement of the pivotable lever **26**.

The operation of the electronic timepiece proper is substantially similar to those which have been commonly used.

For initiating the oscillating movement of the balance, switch **36** is closed. In this case, normally, magnets **20***a*–**20***d* are positioned somewhat off-set position from that shown in Figs. **1**, **3** and **3A** in accordance with the initial design condition of the present electronic timepiece. Then, current is supplied from battery **35** to transistor **34**, thence through variable resistor **37** and drive coil **25**, thereby magnets **20***a* and **20***c* being electromagnetically attracted for initiation of the oscillation of the balance.

During oscillation, the magnets **20***b* and **20***d* are correspondingly moved and currents are induced in the sensing coil **24** and transmitted to the transistor **34**, thus the amplified current being fed to the drive coil **25** for maintaining the balance oscillation and so on. Motion is thus transmitted from the impulse pin **22** to the escapement **23**, so as to drive the time-indicating gear train, not shown of the timepiece, and so on.

When it is desired to recede the coils **24**, **25** and its carrier lever **26** from their working position to their off-service position shown in Fig. **1** by chain-dotted lines, switch **36** is opened and coil-carrying lever **26** is pivoted outwardly and manually by a proper tool, upon loosening the both attaching bolts **27** and **28**. By loosening the bolt **27** as aforementioned, first insulator sleeve **38** is loosened and coil-side terminals **39** and **43** become loosened relative to the respectively mating terminals **40** and **42**. Rotation of coil-carrying lever **26** will accompany the first insulator sleeve **38**, thus the terminals **39** and **43** being rotated in unison with the lever **26**. This feature contributes substantially for the prevention of otherwise possible coil wire breakage in case of the receding movement of the lever **26** together with the coils **24** and **25**.

Main components such as **33**–**35** of the circuit shown in Fig. **2** are embodied into a rigid mass, and indeed, in a mass of synthetic resin, so as to provide a circuit block, although not shown. The relatively rotatable construction of the circuit-side terminal **40** and **42** will contribute naturally for the same purpose to avoid otherwise possible wire breakage.

A return movement of the coils from their off-service position to their operating position can be performed in the reverse order. In this case, also, the fear of wire breakage can be avoided in the similar manner.

Although the foregoing description had been substantially directed to a balance wheel type electronic timepiece, the invention can be equally applied to other kinds of electronic timepieces for receding easily and conveniently the coils and coil-carrying member, so as to provide a chance for easy and safe dismantling of the magnet-carrying member or members in the similar manner, and with assurance of the prevention of otherwise possible coil wire breakage.

In a modification to be described, said coils are united into one piece, preferably in the form of a disc. In this case, two pairs of connection terminals may be reduced to only a pair.

Next, referring to Figs. **4**, **5** and **5A**, the second embodiment of the invention will be described in detail. It should be, however, noted that similar parts of the present embodiment to those in the foregoing first embodiment are denoted respective same reference numerals added each with 100.

In this second embodiment, the number of coils has been reduced to only one or more specifically to that denoted **124**. This single coil **124** has been shaped into a disc which comprises two sensing and drive coil elements united into one piece, although not specifically shown. In response thereto, the number of permanent magnets has been reduced to only two, or more specifically to those denoted **120***a* and **120***c*. In place of the permanent magnets **120***b* and **120***d*, the balance wheels **101***a* and **101***b* are formed respectively with counter or galance weight parts **101***a*′ and **101***b*′ for attaining a favorable dynamic balance.

In the present embodiment, the fixing bolt **28** employed in the foregoing embodiment has been dispensed with. The earth terminal **131** which corresponds to that **31** in the first embodiment, is positioned underneath the blot head **127***a* of bolt **127**. It should be noted that the bolt **127** has left-handed threads, so as to make the tightening direction of the bolt coincident of the direction of return pivoting direction of the coil carrier lever **126** from its off-service to its operating position. Thus, the tightening operation on the bolt **127** will automatically swivel the lever **126** from its off-service to its operating position. Under circumstances, a slight manual assistance may be required additionally for doing the lever-return operation. Conversely, the loosening operation on the bolt **127** will bring the lever **126** to swivel from its operating position to its off-service one. But, under certain occasion, a slight manual assistance may be required to initiate or accelerate the lever-receding operation.

The electronic drive circuit employable in the present second embodiment is similar in its principle to that shown in Fig. **2**. As was referred to hereinbefore, sensing and drive coils **24** and **25** have been embodied into two coil elements, not shown, which has been formed into the single disc coil assembly **124** shown schematically in Figs. **4** and **5**. In the

present case, the earth connection from the sensing and drive circuit to the lower plate **105** is made through the connecting terminal and the pivot bolt **127**.

Further operation of the present embodiment is substantially similar to that of the first embodiment.

Next, referring to Figs. **6** and **7**, the third embodiment will be described in detail. In this embodiment, the fixing screw **28** employed in the first embodiment has been again dispensed with, and, as in the case of the foregoing second embodiment, sensing and drive coils have been embodied in a single disc coil assembly **224**. It should be noted that in these Figs. **6** and **7**, similar parts to those employed in the first embodiment are denoted respective same reference numerals, each thereof, however being added with **200**, irrespective of occasional difference in their physical configuration.

In Figs. **6** and **7**, the single coil assembly **224** is fixedly mounted on a carrier member formed again into a pivotable lever **226** about the pivot bolt **227** which is held in position in the similar way as disclosed with reference to the second embodiment. On the upper surface of this lever **226**c, three conductor strips **71**, **72** and **73** having respective connecting terminals **71***a*, **72***a* and **73***a* are formed by the printed circuit technology, said terminals being electrically connected by respective leads **74**, **75**, **76** and **77** with respective wire ends, not shown, of coil elements **224***a* and **224***b* of the disc coil assembly **224**. These coil elements **224***a* and **224***b* correspond in principle in their function and electric connection mode to those denoted **24** and **25** in the first embodiment. The respective right-hand ends of these strips **71** and **73** are kept in pressure contact with the respective inner mating strips **78** and **80** form on the back surface of a flexible insulator sheet **81** connected mechanically with the molded circuit block embedded therein with several circuit elements **32** – **34**, said block being fixedly mounted on he plate **205**, although not shown. This last-mentioned feature is also employed in the foregoing first and second embodiments. The strips **78** and **80** are connected respective points such as shown at **40** and **42** of the circuit shown in Fig **2**. The right-hand end of the central conductor **72** is formed into a conductive spring washer **231** which is mounted under pressure between the bolt head **227**a and the printed conductive strips **71**–**73** formed of the coil carrier lever **226** and around the latter in conductive contact therewith. The washer **231** is positioned within a bore **227***b* formed through the flexible carrier sheet **81**. By this arrangement, a satisfactory earth connection is provided between the coil assembly **224** and the plate **205** further through the pivot bolt **227**.

Adjustable resistor **37** serves as a manual adjuster for modifying the oscillation angle of the balance, as at **1** shown in the first embodiment, although not shown in the present embodiment only for simplicity.

For maintaining the coil carrier **226** in the required operating position relative to the plate **205**, a proper stopper pin, not shown, on the plate **205**.

As will be easily understood from the foregoing, it would be clear that the pivotable function for attaining the desired objects of the invention is substantially similar to that of the second embodiment.

What is claimed is

1. In an electronic timepiece having frame means, movable magnet means, carrier means and coil means mounted on said carrier means for electromagnetic cooperation with said magnet means, the improvements comprising pivot means for pivotally mounting said carrier means on said frame means for movement between a first position locating said coil means in operative position relative to said movable magnet means and a second position to facilitate servicing, and sliding electrical connection means for said coils disposed adjacent said pivot means.

2. In an electronic timepiece as set forth in claim **1** wherein said coil means is comprised of two separate coils, and said electrical connection means is comprised of at least one movable electrical contact connected to each coil and mounted for movement with said carrier means adjacent said pivot means and a plurality of stationary electrical contacts mounted adjacent said pivot means and disposed in sliding engagement with each of said movable electrical contacts.

3. In an electronic timepiece as set forth in claim **1** wherein said coil means is comprised of a single coil having a driving and sensing portion and each electrical connection means is comprised of at least one movable electrical contact connected to each position of said coil and mounted for movement with said carrier means adjacent said pivot means and disposed in sliding engagement with each of said movable electrical contacts.

4. In an electronic timepiece as set forth in claim **1** wherein three contact strips electrically connected to said coil means are mounted on said carrier means substantially parallel to each other with the middle strip thereof intersecting the pivot means, support means overlying said carrier means and provided with three additional contact strips superimposed in sliding contact on the three contact strips 'n said carrier means, said middle strips being electrically connected to said pivot means.

5. In an electronic timepiece as set forth in claim **4** wherein said support means in a flexible strip.

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