

Sept. 30, 1969

AKIRA NAKAI ET AL

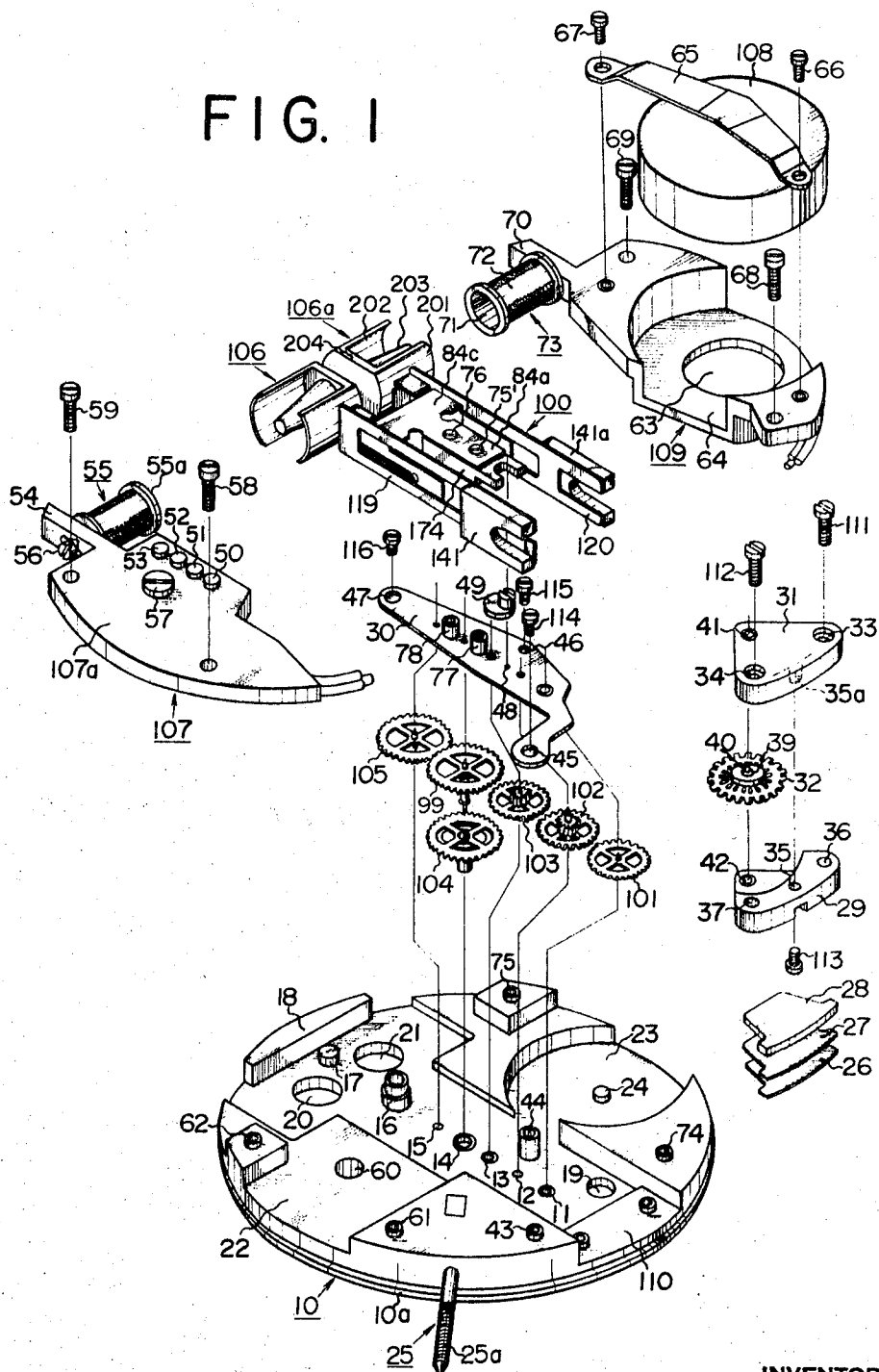
3,469,389

ELECTROMECHANICAL VIBRATOR ASSEMBLY FOR A TIMEPIECE

Filed Dec. 27, 1966

6 Sheets-Sheet 1

FIG. 1

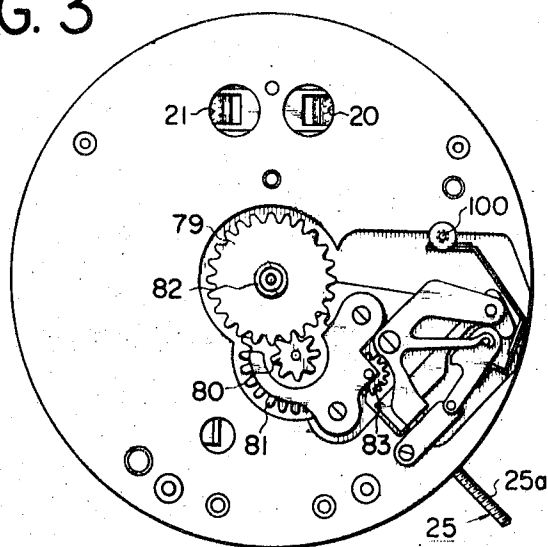
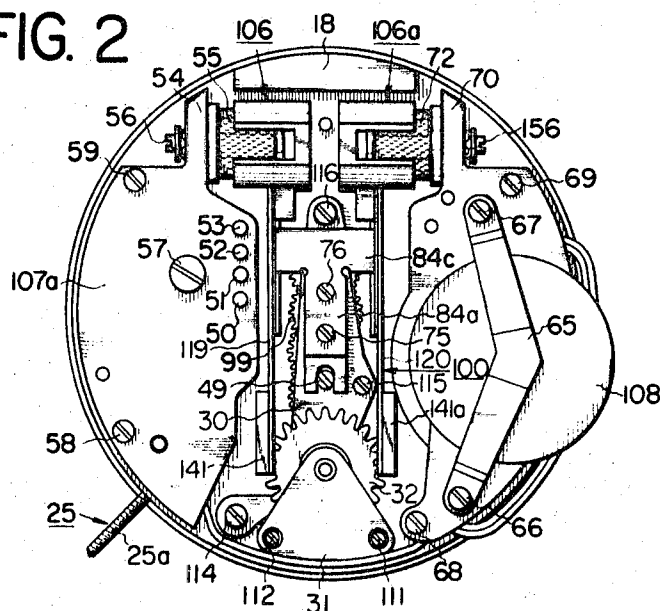


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FIG. 4

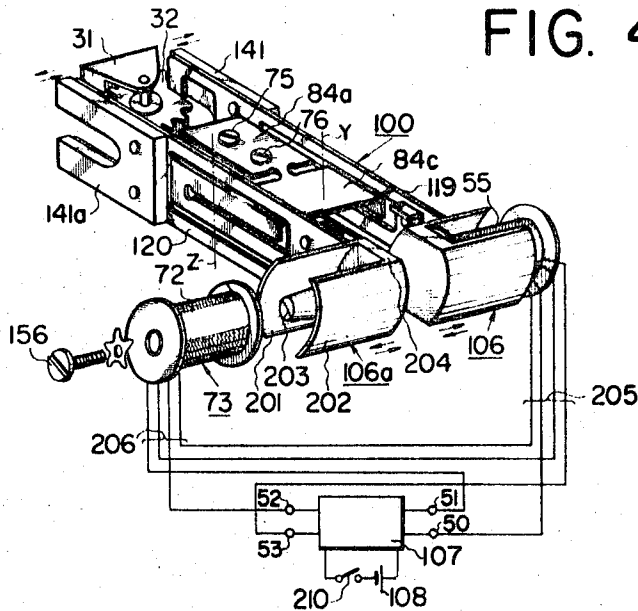


FIG. 5

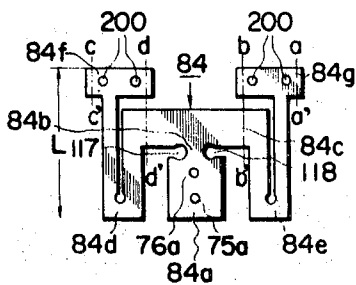


FIG. 10

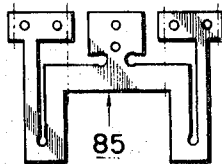


FIG. 12

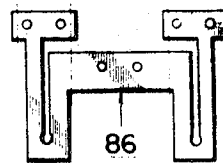


FIG. 6

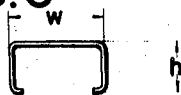


FIG. 11

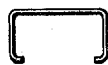


FIG. 13

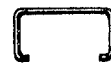
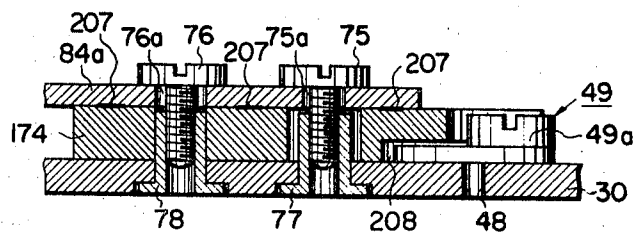


FIG. 7



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FIG. 8

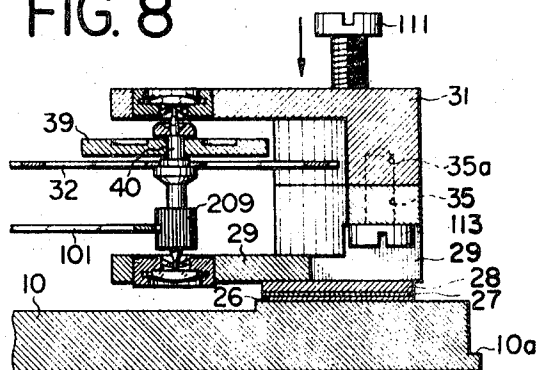


FIG. 19

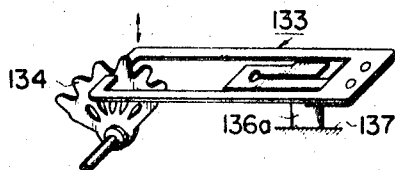


FIG. 9

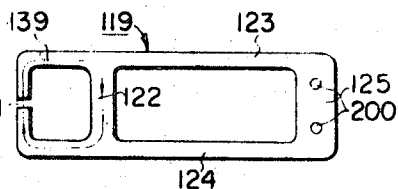


FIG. 20

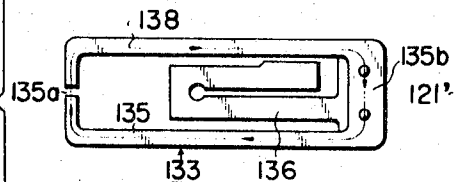


FIG. 14

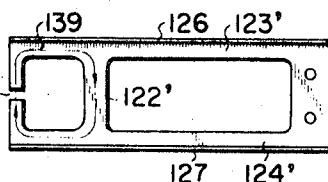


FIG. 15



FIG. 21

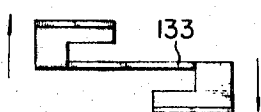


FIG. 16

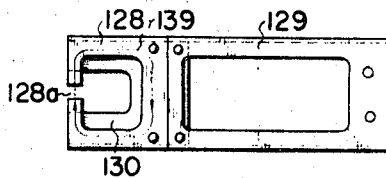


FIG. 18

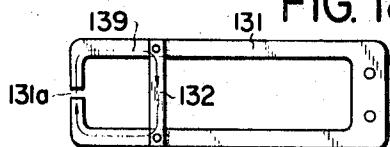
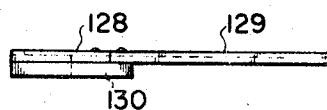


FIG. 17



PRIOR
ART

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FIG. 22

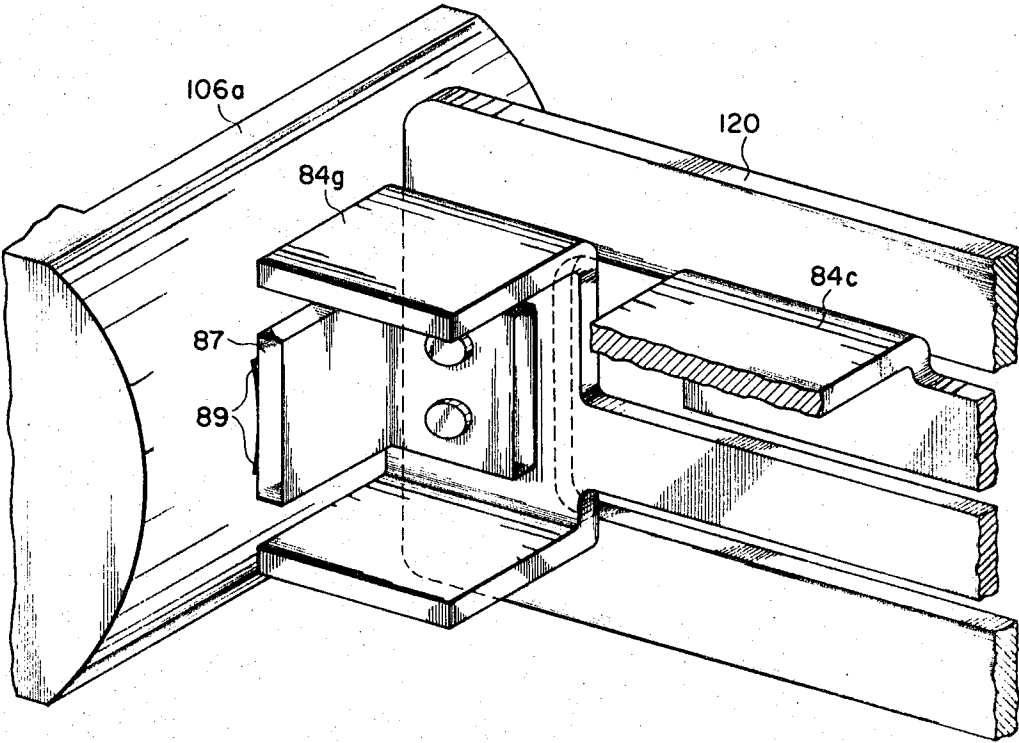
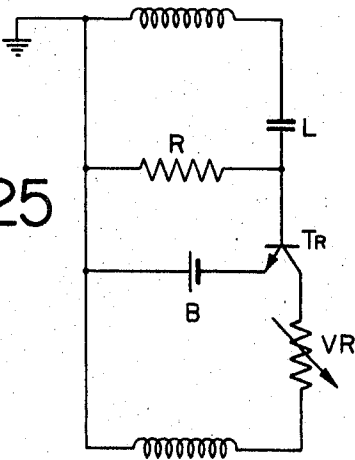


FIG. 25



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FIG. 23

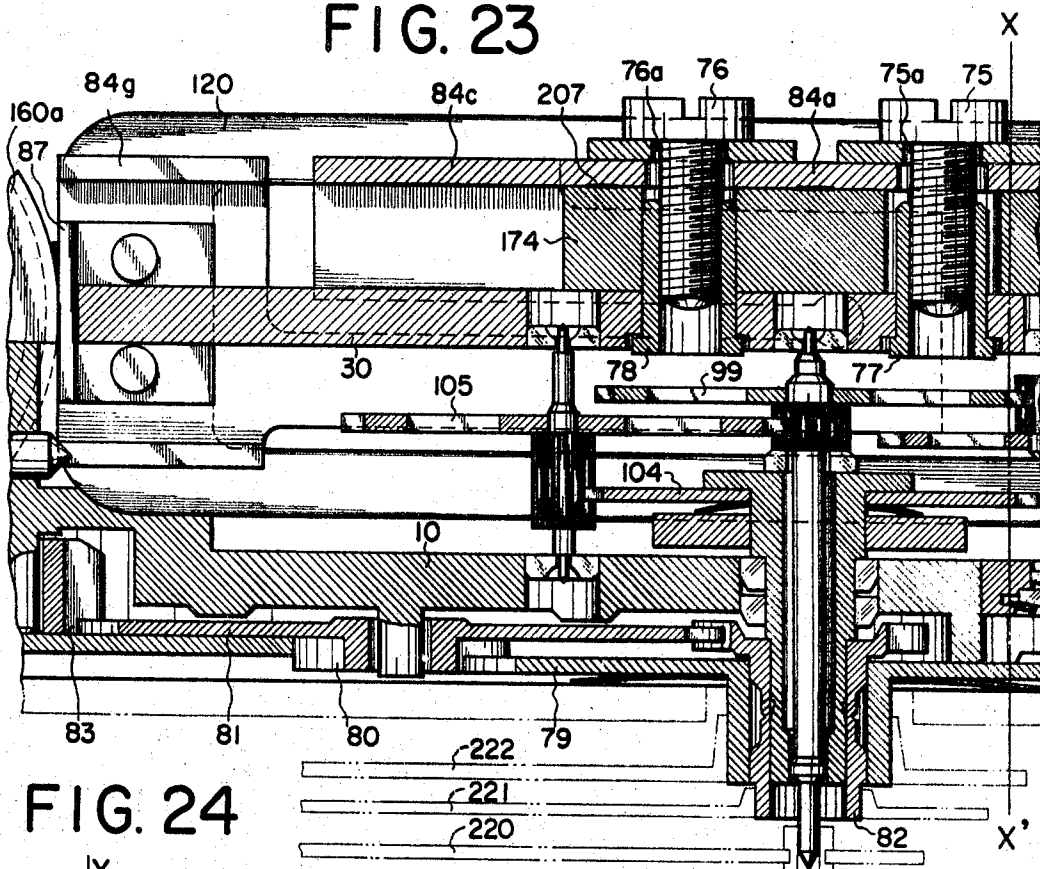
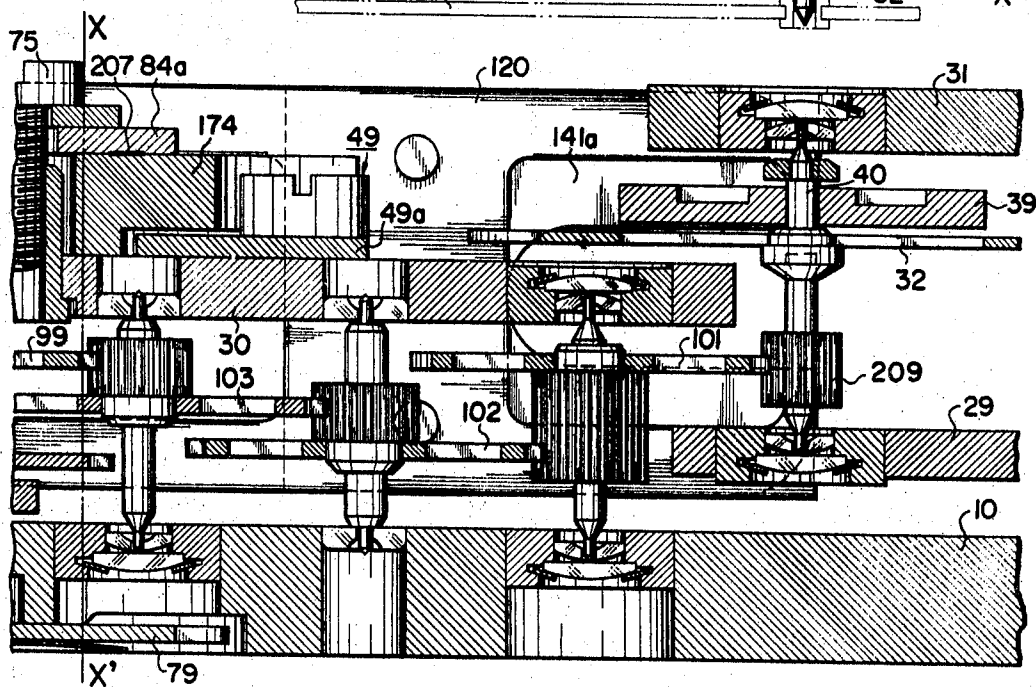


FIG. 24



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ELECTROMECHANICAL VIBRATOR ASSEMBLY FOR A TIMEPIECE

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Claims priority, application Japan, Dec. 30, 1965,
40/108,403; July 12, 1966, 41/66,386

Int. Cl. G04c 3/04

U.S. Cl. 58—23

10 Claims

ABSTRACT OF THE DISCLOSURE

An improved vibrator assembly for an electronic timepiece which has a substantially modified W-shaped element upon which are mounted the feed magnets, yoke assemblies, and the counterweights. These elements form the main or central units of the timepiece with the battery package mounted on one side thereof and the electronic drive circuit mounted on the other side thereof.

This invention relates to improvements in and relating to electronic timepieces, especially watches. More specifically, it relates to an electronic watch comprising a battery as its power source, a transistor drive circuit fed thereby, a vibrator acting as a timebase and electromagnetically driven by said drive circuit in resonance therewith, feed magnet means carried by said vibrator, a magnetic wheel magnetically coupled with said feed magnet means, a gear train mechanically coupled with said magnetic wheel, and a time indicator mechanism driven by said gear train.

Now commercially available electronic watches are predominantly fitted with either the balance wheel type or the tuning fork type oscillator as the timebase. These oscillators are liable to represent a considerable amount of position error, which is caused by various and different degrees of influence by the earth's magnetism upon the oscillator, depending upon the positioning of the watch in space. Other electronic watches are fitted with vibrating leads in place of the balance wheels or tuning forks for the above purpose. This kind of vibrator is also subjected to considerable position error to the same or even larger degree than that met with the foregoing kinds of conventional vibrators.

Another difficulty caused by the employment of the aforementioned conventional vibrators resides in the grave limitation on space imposed by: the relatively voluminous self-contained power source or battery, the electronic circuit unit, and the conventional gear train, which all must be positioned within the limited available space of the timepiece.

It is the main object of the invention to provide an electronic watch having an optimum combination of: a three dimensional, well-balanced vibrator and feed magnet assembly and gear train, with the battery and the drive circuit unit positioned on either side of said combination and at the same level with that of said combination.

A further object is to provide an electronic watch of the above kind, capable of functioning regularly even

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when it is subjected to an outside physical disturbing force.

Still further object is to provide an electronic watch of the above kind, capable of minimizing possible adverse effects of the feed magnetic means upon the vibrator proper.

Still another object is to provide an electronic watch of the above kind, capable of easily and finely adjusting the practical oscillating frequency of the vibrator.

Still further object is to provide an electronic watch of the above kind, capable of adjustment of the coupling phase between said feed magnet means and said magnetic wheel, so as to provide an optimum motion-converting efficiency therebetween.

These and further objects, features and advantages of the invention will become more clear when the following detailed description of the invention is read by reference to the accompanying drawings illustrative of a preferred embodiment of the invention, shown by way of example and thus in no limiting sense of the invention.

In the drawings:

FIG. 1 is an exploded perspective view of the movement of an electronic watch embodying the principles of the invention.

FIG. 2 is a plan view of the watch movement, shown in FIG. 1, after assembly when seen from the upper or back cover side of the watch.

FIG. 3 is a plan view of the assembled watch movement when seen from the bottom of FIG. 1, or from the dial side of the watch.

FIG. 4 is a perspective view of the vibrator assembly with the electronic drive circuit unit shown schematically in block form.

FIG. 5 is a plan view of a mechanical vibrator contained in the vibrator assembly shown in FIGS. 1 and 4.

FIG. 6 is an end view of the vibrator shown in FIG. 5.

FIG. 7 is an enlarged sectional view of the mounting of the vibrator assembly relative to the frame plate of the watch.

FIG. 8 is an enlarged sectional view of the magnetic wheel assembly.

FIG. 9 is a top plan view of a feed magnet.

FIG. 10 is a similar view to FIG. 5, illustrative of a slightly modified vibrator.

FIG. 11 is an end view of the modified vibrator of FIG. 10 when finished.

FIG. 12 is a similar view to FIG. 10, illustrating a still further modified vibrator.

FIG. 13 is a similar view to FIG. 11, illustrating the finished shape of the modified vibrator of FIG. 12 in its end view.

FIG. 14 is a similar view to FIG. 9, illustrating a slightly modified form of feed magnet from that shown therein.

FIG. 15 is an end view of the feed magnet of FIG. 14.

FIG. 16 is a top plan view of a still further modified feed magnet, attached with a U-shaped counter weight mass.

FIG. 17 is a side view thereof of the feed magnet of FIG. 16.

FIG. 18 is a top plan view of a still further modified feed magnet.

FIGS. 19, 20 and 21 are a perspective view, a top plan

view and an end view, respectively, of conventional vibrator assemblies shown in a highly simplified schematic form.

FIG. 22 is a perspective view of a part of the vibrator assembly shown in FIGS. 1 and 4.

FIG. 23 is an enlarged sectional view of a part of the watch movement according to this invention.

FIG. 24 is a similar enlarged sectional view of the adjoining part of the watch movement, relative to that shown in FIG. 23, the adjoining plane being shown by a chain line X-Y in the both figures.

FIG. 25 is a schematic diagram of an electronic drive circuit that can be employed in this invention.

Now referring to the accompanying drawings, especially FIGS. 1-8 thereof, numeral 10 denotes a base or frame plate of a watch movement embodying the principles of the invention. The frame plate being made of a conductive metal and circular in its top plan view and having a circular flange 10a for accurately positioning said plate in relation to a watch casing, not shown, which may be of any conventional design.

Along a diameter of the frame plate 10, and thus in line, there are provided successively a bearing opening 11 for the seventh wheel 101, an opening at 12 for the sixth wheel 102, an opening at 13 for the fifth wheel 103, an opening at 14 for the second wheel 104, an opening at 15 for the third wheel 105, a stepped and tapped sleeve 16 for wheel mounting plate 30, and a stop pin 17 for the prevention of excessive vibrating amplitude of vibrator assembly 100. An elongated projection 18 is made integral with the frame plate 10, extending in the crosswise direction relative to said specific diameter, to protect the two yokes 106 and 106a of said vibrator assembly. In close proximity to said stop pin 17, on either side of said specific diameter, are a pair of viewing openings 20 and 21 separated by a small distance from each other, the purpose to be set forth hereinafter. An opening 19 is also provided, whose purpose will be given hereinafter.

On the frame plate 10, there is an intermediate platform 22 which is adapted for receiving an electronic drive circuit unit 107 as will be later described in detail. Substantially opposite to said platform 22, relative to said specific diameter, is a recess 23 substantially in the form of a circle, adapted to receive a battery 108 through the intermediary of its detachable mount 109.

At the center of the recess 23, there is a cylindrical projection 24, integral with the frame plate 10, to act as a negative stationary contact for said battery 108.

Numeral 25 is a conventional stem shaft rotatably mounted in the frame plate 10, said shaft being formed with male screw threads at 25a for receiving a stem, not shown.

There are provided a plurality of stems 26-28 with three shown by way of example, preferably of different thicknesses, so as to maintain the height of a lower mount 29 and an upper mount 31, with a magnetic wheel rotatably mounted therebetween, when they are attached to the frame plate 10 at its intermediate shoulder 110. For this purpose, set screws 111, 112, and 113 are inserted through openings 33, 34, 35 and 36, 37, 35a, respectively.

Magnetic wheel 32 is formed integrally with a flywheel mass 39 and a wheel shaft 40, the latter being mounted at its ends in bearing openings 41 and 42, which are formed in the upper and lower mounts 31 and 29, respectively.

The gear train comprising said wheels 101, 102, 103, 104, 105, and 99, is rotatably mounted between the wheel mounting plate 30 and the frame plate 10 by three set screws 114, 115 and 116 received in tapped openings 43, 44 and tapped sleeve 16 in frame plate 10, through the three screw openings 45, 46 and 47, respectively, which are bored through the wheel mounting plate 30. The latter plate is further provided with a bearing opening 48

for rotatably receiving an eccentric cam 49, the purpose and function of which will be described hereinafter.

Electronic drive circuit unit 107 comprises a conventional drive circuit comprising, as shown in FIG. 25, at least a transistor, several capacitors and resistors, as disclosed in copending U.S. application Ser. No. 528,614, filed Feb. 18, 1966, commonly assigned. The components of unit 107 are preferably embedded in moulded plastic, although the present invention is not absolutely limited to such a moulded configuration.

The plastic mass 107a is provided with four terminals 50-53 and an arm 54 adjustably carrying a coil assembly, generally shown by 55. This assembly 55 comprises, although not shown, a sensing coil and a drive coil, which coils are wound on a cylindrical bobbin 55a. There is provided a magnetic screw 56. By screwing this magnetic screw in or out, the magnetic properties of the electro-magnet comprising this coil assembly can be modified as will be described more in detail hereinafter.

The unit 107 together with the coil assembly 55 is fixed detachably upon frame plate 10 and above platform 22 by means of positioning and fixing screws 57-59. For this purpose, the plate 10 is formed with a tapped opening 60 and provided with a pair of tapped sleeves 61 and 62.

Battery mount 109, made of an insulating material such as synthetic resin, is formed with an opening 63 and a concentric recess 64, the latter being adapted for receiving the battery 108. For positioning the battery, there are provided a resilient pressure strip 65 and two set screws 66 and 67.

The mount 109 is formed with a projecting arm 70, similar to that denoted 54, adapted for positioning a coil assembly 73 comprising a bobbin 71 and a sensing and a driving coil, commonly denoted by a single reference numeral 72. This assembly 73 is similar in its design and function to that shown at 55, so that no further description in this respect will be necessary. But, it is to be noted that the battery mount 109 together with its coil assembly 73 is detachably fixed to the frame plate 10 by means of set screws 68 and 69 which are threaded into correspondingly tapped sleeves 74 and 75, respectively. These sleeves are embedded in the plate 10 as shown.

Vibrator assembly 100, the details of which are to be described hereinafter by reference to FIGS. 4-9, is detachably attached through a mounting piece 174 to mounting plate 30 by means of two set screws 75 and 76 which pass through said piece 174 and are received in tapped sleeves 77 and 78, respectively, studded on said plate 30.

The thus assembled electronic timepiece movement is shown in its top plan view in FIG. 2 which is, however, in practice, the rear view of the timepiece with its back cover removed, although the latter is not shown in the drawings.

When seen from the bottom of the movement positioned as in the case of FIG. 2 it will represent a view shown in FIG. 3, wherein the dial of the timepiece has been removed therefrom, for illustrating inner working parts of the movement. In this figure, numeral 79 denotes a conventional cannon wheel; 80 a minute pinion engaging therewith; 81 a minute wheel made integral with said pinion 80; 82 a cannon pinion engaging with said wheel 81 and mounted rotatably and concentrically with said cannon wheel; and 83 a setting wheel kept in engagement with said minute wheel.

Next, referring to FIGS. 4-9, the vibrator assembly 100 will be described more in detail. In FIG. 5, a sheet element 84 having substantially the configuration of an elongated and modified W, comprises a fixing part 84a formed with two openings 75a and 76a adapted for the reception of set screws 75' and 76, respectively. The part 84a integrally connected through a reduced neck 84b, formed with side recesses 117 and 118, with a connecting part 84c having a broader width and forming a T-shape configuration. The part 84c has vibratory arms 84d and 84e in-

tegrally connected at either end thereof, each having an elongated U-shape and enlarged at its free end so as to form lateral extensions 84f and 84g for fixedly mounting feed magnets 119 and 120. Sheet element 84, or vibrator proper, is fabricated such as by punching from a permanently elastic material frequently and commonly used by those skilled in the art. Among others, an Ni-Cr-Fe alloy such as "Elinvar," having substantially a constant temperature co-efficient with respect to elasticity, is highly recommendable. The lateral extensions 84f and 84g of punched sheet 84 are bent down twice, when seen at each side thereof at right angles, about the parallel axes *a-a'* and *b-b'*, and *c-c'* and *d-d'*, respectively, so as to form a channel-shaped end view, as illustrated in FIG. 6. This fabricated vibrator proper could have dimensional sizes of: 2.5 (height: *h*) x 5.0 (width: *W*) x 9.95 mm. (length: *L*), as a preferred example. In this respect, reference should be had to FIGS. 5 and 6. The thickness of the sheet may preferably amount to 0.22 mm.

In FIGS. 10 and 11, a slight modified shape of punched sheet is shown at 85. This modification can be used in place of the foregoing sheet element 84, if the related mounting parts and procedure are correspondingly modified.

A still further modified sheet element is shown at 86 in FIGS. 12 and 13, in a manner similar to FIGS. 5 and 6.

A preferred configuration of a feed magnet 119 is illustrated in FIG. 9, said magnet being preferably punched out of conventional permanent magnet sheet stock such as magnetic ferrite, 0.24 mm. thick, and having a generally rectangular shape, 3.75 x 15.85 mm. The magnet is formed with a small gap 121 at its free end and with a bridge 122 connecting the side chords 123 and 124 of the magnet together at a point near the gap. This bridge 122 acts as a short circuiting member for suppressing stray fluxes emanating from the main magnetic circuit and passing laterally through the neighboring part of the related vibratory arm 84d or 84e. In addition, this bridge 122 acts as a lateral reinforcing member for increasing the physical rigidity of the feed magnet in the neighborhood of the gap 121. Said side chords 123 and 124 are connected rigidly together by the root portion at 125 of the magnet. When assembling a vibrator a pair of such magnets are attached rigidly at their roots 125 to said lateral extensions 84f and 84g of said vibrating arms 84d and 84e, respectively, of the vibrator proper 84, by riveting, screwing or welding. For easy identification of this attaching mode, a plurality of small circles commonly illustrated by only a single reference numeral 200 are shown in FIGS. 5 and 9.

A slightly modified feed magnet is shown in FIGS. 14-15. In this case, the magnet is formed with side flanges 126 and 127 along the side chords 123' and 124', respectively, of the feed magnet, for improving the rigidity thereof. Gap 121' and connecting bridge 122' are provided also in this case.

A still further modified feed magnet from that shown in FIGS. 14-15, is illustrated in FIGS. 16-17. In this case, the magnet comprises: a magnetic C-piece 128 having a gap 128a similar to that denoted 121' in FIG. 14, and a hollow rectangular support 129 made of similar material as that used for the vibratory sheet element 84, 85 and 86. The parts 128 and 129 are rigidly attached to a counter weight 130, for instance, by spot welding. Welded spots are denoted, in this case, by small circles shown in FIGS. 16-17.

In a still further modified embodiment shown in FIG. 18, the sheet magnet at 131 is formed as an elongated C, having a gap 131a, a separate bridge element 132, made of a ferro-magnetic material, being provided so as to establish a short-circuiting member for the magnetic circuit of the magnet, including said gap 131a.

The prior art, shown in FIGS. 19-21, utilizes comparative vibrator lead 133 adapted for magnetic driving of a magnetic wheel at 134. An elongated C-shaped feed mag-

net 135, having a coupling gap 135a, is fixed at its root 135b to the free end of a U-shaped vibrator lead 136 by spot-welding or similar fixing technique. This lead is formed with a depending leg 136a rigidly mounted at its lowermost end to a frame plate 137 shown schematically in FIG. 19. With the use of such a conventional arrangement, magnetic fluxes will flow through the feed magnet 135 as shown by a chain-dotted line 138 in FIG. 20. These fluxes, however, affect the neighboring vibrator lead 136 adversely in that the design resonant frequency of the lead is thereby disturbed considerably, resulting in an inaccurate steppingly driven movement of the magnet wheel 134 coupled magnetically through the gap 135a with the feed magnet. On the other hand, the vibrator unit may frequently perform spurious vibration as shown by the arrows in FIG. 21, which vibration is caused by the unsymmetrical space configuration of the vibrator assembly. The first disadvantage is substantially avoided by the provision of a bridging part 122, 122' or 132 on each of the vibratory elements, as shown in FIGS. 9, 14 or 18. In these cases, a highly concentrated magnetic circuit will be established including both the magnetically coupling gap and the bridging part. This effect will be easily seen by reference to the short circuited magnetic circuit denoted by 139. It will be clear that similar effect can be attained with use of the modified vibratory element shown in FIGS. 16-17. In contrast to the unsymmetrical space configuration of the conventional vibratory element, the possible spurious vibration may substantially be suppressed by the employment of a pair of the unique vibratory elements proposed by this invention, providing a highly improved symmetrical and well-balanced space configuration.

After the vibrator, having integral components 84a-84g, has been fabricated as was described hereinbefore by reference to FIGS. 5 and 6, a pair of feed magnets 119 and 120 are fixedly attached on the outside of the lateral extensions 84f and 84g of the vibratory arms 84d and 84e. This attaching mode will be most clearly seen from FIG. 22. At the same time, an angular intermediate piece 87 is fixedly attached to the lateral projections 84f and 84g, for rigidly mounting the yokes 106a and 106. The desired rigid connection between the intermediate pieces 87 and the yokes 106a and 106 is attained by welding or fusing as illustrated in FIG. 22 at 89. At the opposite end of the feed magnet 119 remote from the end mounting the yoke 106, a U-shaped counter weight 141 is rigidly attached thereto, such as by welding, fusing, riveting or the like attaching means. In a similar way, the other feed magnet 120 is provided at its corresponding end with a similar counter weight 141a. The arrangement, dimensions and mass of the yokes 106 and 106a, and counter weights 141 and 141a are so selected that they are dynamically balanced for performing oppositely phased vibrating movements with the two vibratory arms 84d and 84e, and the respective feed magnets 119 and 120 carried thereby. The directions of the two vibrating elements of the vibrator assembly 100 are shown by small arrows in FIG. 4.

The yoke 106a made from a ferro-magnetic material, comprises a pair of oppositely arranged arcuate segments 201 and 202 and a cone 203 integral with a base 204. The details of yoke 106a being set forth, it is understood that yoke 106 is identical thereto.

The relative position of the magnetic yoke 106a and its related coil assembly 73 and the yoke 106 and its related coil assembly 55, when the vibrator occupies its neutral position, is most clearly seen in FIG. 2.

The periphery of a magnetic wheel 32 passes through the gap 121 of the feed magnets 119 and 120, said wheel being formed into a perforated wheel similar to the conventional magnetic escape wheel known per se, but the working operation is just in the reverse order to that of the latter, as will become more clear as the description proceeds.

The coil assemblies 55 and 73 comprise, as already described, a sensing or search coil and a drive coil. The search coil may comprise 2500 turns of insulated copper wire of 12 microns, while the drive coil may consist of 8500 turns of insulated copper wire of the same strength.

The coils 55 and 73 are electrically connected through four wire conductors denoted 205 and 206, to the four terminals 50-53 of the electronic circuit unit 107, schematically shown by a block in FIG. 4. The battery 108, adapted to feed the necessary energy to the unit 107, may be a mercury battery, 1.3 volts, 80-100 milliampere hours.

According to our experiments, the coupling relation or relative phase between the coupling gap 121 of the related feed magnets 119 and 120, and the magnetic wheel 82 is highly important, for self-starting this kind of electronic timepiece. If there is a minor phase difference from the designed optimum coupling condition between them, the turning torque imposed on the magnetic wheel 32, upon the initiation of energization of the battery-driven vibrator assembly 100, will not be great enough to drive the gear train and the time-indicating mechanism of the watch movement.

According to the present invention, the vibrator assembly 100 can be adjusted in its general orientation with the set screw 76 as its pivot. In FIG. 7, the parts denoted 30, 48, 49, 75, 75a, 76, 76a, 77, 78, 84a, and 174 are the same as those described above. As seen, the fixing part 84a of vibrator proper 84 is, in practice, spot-welded to mounting piece 174 at several places, as at 207, and the eccentric cam 49 is positioned so as to exert a turning force in one or another direction to a surrounding arcuate recess 208, as the case may be, by rotating the cam manually in a corresponding turning direction by means of a screw driver, not shown, applied to the screw head 49a. By this adjustment, the general orientation of the vibrator assembly 100 may be finely regulated about set screw 76 so as to establish an optimum phase relation, in the above-mentioned sense, between the coupling gaps 121, say 0.28 mm. long, of feed magnets 119 and 120 with the magnetic wheel 32. This wheel may have an O.D. of 6.2 mm.; thickness of 0.1 mm.; and number of teeth 20. In addition, if necessary, one or more of the shims 26-28 may be replaced by others having different thicknesses from those of the prevailing shims, so as to modify the height of the magnetic wheel 32 relative to the gaps 121, so as to attain an optimum phase relation.

Each of the two vibrating systems is so designed that the center of mass of the two extreme masses, formed by the magnetic yokes 106 and 106a and counter weights 141 and 141a, lie substantially at the center of deflection of the vibratory arm 84d or 84e, due to its U-shape. The accurate maintenance of the design standard frequency is further assured by the provision of the two oppositely working vibrating systems. Due to the U-shape of the vibratory arm, the working frequency of the whole vibrator assembly 100 can be kept as low as at 100 cycles per second, as was already mentioned, which is highly suitable for the magnetic drive of the wheel 32.

When there is a slight difference between the working frequencies of the two vibrating systems, it is only necessary to advance or retract the magnetic screws 56 and 156 of the coil assemblies 55 or 73, respectively. When one or both of the screws are advanced, the vibration of the magnetic yoke or yokes will be altered and thus the vibrating frequency can be changed in a finely adjusted manner.

The optimum relative position of the yoke 106 and 106a relative to the coil assemblies 55 or 73, respectively, can be observed through the related inspection openings 20 or 21.

In FIG. 8, where the mounting details of magnetic wheel 32 can be easily understood, it should be noted that the flywheel mass 39 is freely rotatable with the wheel shaft 40. Thus, motion is transmitted from the magnetic wheel 32 through its shaft 40 to a pinion 209, mounted rigidly thereon, to the seventh wheel 101. The pinion 209

and seventh wheel 101 are fitted with non-reversible teeth so that any adverse foreign shock or the like, transmitted from outside through the gear train, may be checked at this point and the vibrator assembly protected therefrom. Thus spurious vibration can be positively prevented from reaching the vibrator assembly.

The operation of the aforementioned electronic watch is as follows:

When the stem shaft 25 is manually pushed inwards so as to close the switch 210 (FIG. 4) through a commonly known transmission, not shown, current is thereby fed from the battery 108 to the electronic drive unit 107, and thus, both vibratory arms 84d and 84e of the vibrator assembly 100, each carrying the related: feed magnet, magnetic yoke and counter weight are caused to vibrate, preferably at 100 cycles per second, through the electromagnetic coupling of the yokes 106 and 106a with the respective coil assemblies 55 and 73, in the opposite senses about their axes of oscillation Y and Z, respectively (see also FIG. 4).

Thus, the magnetic wheel 32 is magnetically driven by the vibrator assembly 100 as explained hereinbefore and the seventh wheel 101 is rotated.

Further transmission of the driving torque is carried out in the conventional manner, viz. through sixth wheel 102, fifth wheel 103, fourth wheel 99, third wheel 105 and second wheel 104 to the conventional time-indicating mechanism, including: second hand 220, minute hand 221 and hour hand 222, as will be seen from FIGS. 23 and 24 with the indicator hands being shown schematically by chain-dotted lines.

We claim:

1. In an electronic timepiece having a frame plate and a mounting plate removably attached thereto, a battery as its power source, a transistor drive circuit fed thereby, a vibrator acting as a timebase and electromagnetically driven by said drive circuit, feed magnet means carried by said vibrator, a magnetic wheel magnetically coupled with said feed magnet means, a gear train mechanically coupled with said magnetic wheel, and a time indicator mechanism driven by said gear train, the improvement comprising: said vibrator is fabricated from an elastic metallic sheet having a central mounting portion, a pair of vibratory arms each having two parallel extending legs joined together at one end thereof, each of said arms being connected at the other end of one of the said legs to said portion in a plane perpendicular thereto and said mounting plate having a cam assembly mounted thereon and operatively connected between the vibrator and the feed magnet means to adjust the relative position therebetween.

2. A timepiece as set forth in claim 1 wherein a feed magnet is attached in overlying relationship to each of said vibratory arms with one end of said feed magnets coinciding with the one end of the parallel legs and the other end of said feed magnet coinciding with the other end of said legs.

3. A timepiece as set forth in claim 2, wherein a counter weight is attached to the one end of each of the feed magnets and a magnetic yoke assembly is fixed to the other ends of each of the feed magnets.

4. A timepiece as set forth in claim 3, wherein said transistor drive circuit includes a search coil and a drive coil with the coil assembly being arranged to cooperate electromagnetically with one of said magnetic yokes.

5. A timepiece as set forth in claim 4, wherein said transistor drive circuit is made in a single moulded unit.

6. A timepiece as set forth in claim 4, wherein said coil assembly further includes a magnetic screw whose adjustment modifies the magnetic properties of the coil assembly and thereby modifies the electromagnetic cooperation with said magnetic yoke.

7. A timepiece as set forth in claim 1, whereby said magnetic wheel has adjustable mounting means to adjust the position of said magnetic wheel relative to the co-operating feed magnet means carried by the vibrator.

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8. A timepiece as set forth in claim 3, wherein the gears of the gear train are contained in the space underlying the vibrator assembly.

9. A timepiece as set forth in claim 2, wherein said feed magnets are generally U-shaped with the base of the U being attached to the other end of one of the legs of said vibratory arms and the free ends of said feed magnet extend beyond said one end of said vibratory arm assembly.

10. A timepiece as set forth in claim 9, wherein said U-shaped feed magnet is magnetically bridged at a point remote from the base thereof.

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