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TIMEKEEPING MAGNETIC-ESCAPEMENT AND ROTOR-UNIT THEREFOR

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TIMEKEEPING MAGNETIC ESCAPEMENT
AND ROTOR UNIT THEREFOR

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The present invention relates to improvements in timekeeping magnetic-escapements and rotor-units therefor, i. e., escapements and rotor-units which are controlled by magnetism rather than by mechanical means.

Broadly speaking, magnetic-escapements of the general character above referred to have been previously devised, but the present invention is concerned with and has for its primary object the provision of a magnetic-escapement which will reliably self-start under the urge of rotary force applied to its rotor-unit and thereafter under the control of its vibrating magnetic-member, continue to operate to keep accurate time.

Another and more specific object of the present invention is to provide a superior rotor-unit which will serve to initiate the vibratory movement at low amplitude of a vibratory magnetic-member, and thereafter progressively increase the amplitude of the movement of the said member until the said amplitude has reached the desired maximum.

With the above and other objects in view, as will appear to those skilled in the art from the present disclosure this invention includes all features in the said disclosure which are novel over the prior art.

In the accompanying drawings, in which certain modes of carrying out the present invention are shown for illustrative purposes:

Fig. 1 is an elevational view of one form of timekeeping magnetic-escapement which the present invention may assume;

Fig. 2 is an elevational view of the showing of Fig. 1 but viewing the same in the direction of the arrow 3 of Fig. 1;

Fig. 3 is a broken detail sectional view taken on the line 3—3 of Fig. 1, but on a larger scale;

Fig. 4 is a similar view but taken on the line 4—4 of Fig. 1;

Fig. 4A is a diagrammatic view of a part of an escape wheel and an associated pole-salient of the magnetic escapement shown in Fig. 1;

Fig. 5 is an elevational view similar to Fig. 1, but showing another form which the present invention may assume and showing the permanent magnet in section; and

Fig. 6 is an elevational view of the showing of Fig. 5 but viewing the same in the direction of the arrow 6 of Fig. 5.

The showing of Figs. 1 to 4 inclusive

In the structure of Figs. 1, 2, 3 and 4 there is employed a vibrating magnetic-member or -unit which comprises a U-shaped permanent magnet

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generally designated by the reference character 10 and in turn comprising two parallel but laterally-spaced-apart side arms 11 and 12 integrally connected together by a base-reach 13. The magnetic-member or -unit also includes a pair of similar complemental pole-salients 14—14 one of which is located at the end of each of the side-arms 11 and 12 of the permanent magnet 10 and remote from the base-reach 13. The said pole-salients extend in parallelism with each other in planes perpendicular with respect to the flatwise plane of the permanent magnet 10. The said pole-salients 14—14 have their inner faces spaced from each other sufficiently to freely accommodate a rotor-unit between them as will be presently described.

The permanent magnet 10 above referred to may be formed of any suitable magnetic material having high retentivity such, for instance, as high carbon or cobalt steel, as may also the pole-salients 14—14. The pole-salients 14—14, however, may be of soft iron or its equivalent and are preferably brazed or otherwise rigidly secured to the inner edge of the adjacent ends of the side arms 11 and 12.

The magnetic member or -unit also includes a flexible reed 15 which is rigidly secured at one end in any suitable manner to the base-reach 13 of the permanent magnet 10. The said reed is located intermediate the side arms 11 and 12 and has its end opposite the base-reach 13 rigidly secured to any suitable support such, for instance, as the fixed support 16 indicated in Figs. 1 and 2. The said reed 15 is preferably formed of non-magnetic material such as Phosphor bronze or beryllium copper, and is so related as to permit the permanent magnet 10 and the parts carried thereby to vibrate at the desired frequency and through the desired amplitude.

Positioned so as to rotate between the pole-salients 14—14 of the permanent magnet 10 is a control-ring generally designated by the reference character 17 and preferably formed of soft iron or other highly-permeable magnetic material to thus minimize hysteresis losses. In a circumferential direction, the said control-ring is of sinusoidal or serpentine form with respect to both its inner and outer peripheral edges. As thus shaped, the said control-ring may be said to have an annular series of inwardly-directed rounded peaks or apices 18 each of which is located circumferentially about midway between a pair of outwardly-directed rounded peaks or apices 19 also forming an annular series, with each peak or

apex being substantially equidistant from adjacent peaks or apices.

In the instance shown, the control-ring 17 is force-fitted over the outer peripheral edge of a mounting-plate or mounting-member 20 which latter has its said outer peripheral edge conforming to the inner peripheral edge of the said control-ring, as is especially well shown in Fig. 1. The said mounting-plate 20 is formed of material which is relatively nonmagnetic as compared to the material from which the control-ring 17 is formed such for instance, as brass, bronze or aluminum.

As thus mounted, the control-ring 17 is firmly supported without employing integral magnetic spokes which are apt to cause a lock-in tendency with the permanent magnet 10 or its equivalent, and thus interfere with desirable self-starting characteristics.

The mounting-plate 20 above referred to is, in turn, rigidly mounted on the hub 21 of a drive-pinion 22. The hub 21, together with its integral drive-pinion 22, is, in turn, rigidly mounted upon a shaft 23 formed at each of its respective opposite ends with one of two similar trunnions 24—24. The said trunnions may be supported for rotation in any suitable manner such, for instance, as in the movement-plates of a clock or other instrument.

The drive-pinion 22 above referred to is designed and adapted to be meshed into by a drive-gear (not shown) or other suitable drive device, propelled by a clock-spring or other suitable source of power so as to tend to rotate the unit comprising the parts 17 to 24 inclusive in either direction, though preferably in the direction of the arrow in Fig. 1.

As will be observed by reference to Fig. 1, the pole-salients 14—14 both have a dimension, in a direction radially of the control-ring 17, which exceeds the width of the serpentine magnetic track provided by the said control-ring, so that when either the inner or outer apices 18 or 19 come into registry therewith, the said pole-salients 14—14 will overlap the track. While the width of either pole-salient 14 in comparison to the width of the track must be as just explained to accomplish self-starting, it is equally imperative for the achievement of the self-starting feature that the width of the pole salients is smaller than the radial distance between the outermost and innermost edges of successive outer and inner apex portions, respectively, of the track, and greater than the radial distance between the outermost and innermost edges of successive inner and outer apex portions, respectively, of the track. The instant invention solves the problem of self-starting a magnetic escapement of which the innermost and outermost edges of the outer and inner apex portions of the wavy track on the escape member are outside and inside, respectively, of a median circle of the wavy track. These limitations are demonstrated in Fig. 4A, in which the innermost and outermost edges *a* and *b* of the outer and inner apex portions 19 and 18, respectively, of the track are shown as lying outside and inside, respectively, of the median circle *c*. Fig. 4A further shows that the pole salient 14 has a width *W* which is smaller than the radial distance *W'* between the outermost and innermost edges *f* and *g* of successive outer and inner apex portions 19 and 18, respectively, of the track and larger than the radial distance *W''* between the outermost and innermost edges *b* and *a* of successive inner and outer

apex portions 18 and 19, respectively, of the track.

The permanent magnet 10 is magnetized to such an extent that the flux flowing between its two pole-salients 14—14 (respectively of opposite polarities) will be such as to give a magnetic lock-in or coupling-effect with the control-ring 17, all for purposes as will hereinafter appear.

It may now be assumed that the vibratable permanent magnet 10 is at rest as shown in Fig. 4A, and that rotating force is now applied to the unit comprising the elements 17 to 24 inclusive, to turn the same relative to the pole-salients 14—14. As the control-ring 17 starts to rotate, the pole-salients 14—14, which are still in their repose position (Fig. 4A), will have initial movement to the left as the nearest inner apex portion 18 of the track approaches. The initial motion of the pole-salients from their repose position will be very slight, but will be increased gradually in opposite directions until the full desired amplitude is reached, whereupon the said pole-salients will track substantially with the serpentine form of the track and the control-ring (together with the parts connected thereto) will remain in step with the vibrations of the magnetic unit comprising the elements 10 to 15 inclusive.

By having the control-ring 17 or its equivalent substantially free of inwardly-projecting magnetic spokes or the like and by having the pole-salients 14—14 of the magnet 10 exceed the width of the control-ring, the said control-ring is enabled to initiate the vibration of the magnet 10 with a progressively-increasing amplitude, until the full desired amplitude is reached. In this manner, one of the main uncertainties of prior escapements of the present basic character is overcome and self-starting is assured, followed by a magnetic lock-in between the magnet 10 and the control-ring 17 such as to maintain the said control-ring in correct time relationship with respect to the tuning-fork effect of the said vibrating permanent magnet.

It is to be borne in mind in this connection that the energy applied to the drive-pinion 22 or its equivalent, must not be in an amount which will cause the control-ring 17 to break its magnetic interlock with the pole-salients 14—14 or their equivalent.

The showing of Figs. 5 and 6

In the structure of Figs. 5 and 6, there is employed a vibrating magnetic-member which is not itself a permanent magnet rather than a permanent magnet magnetic-member as in the showing of Figs. 1 to 4 inclusive.

The structure shown includes a vibrating magnetic-member or -unit which includes a flexible reed 26 and a pair of complementary pole-salients 27—27 carried thereby. The said pole-salients may be formed of soft-iron or the like while the said reed 26 may be formed of Phosphor-bronze, beryllium copper, or other suitable springy material. The said reed is rigidly secured at its end remote from the pole-salients 27—27, to a fixed support 28. At its end remote from the support 28, the reed 26 is bifurcated to provide it with two laterally-spaced-apart parallel side arms 29—29, to the outer end of each of which is brazed or otherwise rigidly attached one of the aforesaid pole-salients 27—27.

For the purpose of causing magnetic flux to flow through and between the nonpermanent magnet pole-salients 27—27, there is employed a U-shaped permanent magnet 30 having its com-

plemental arms respectively located closely adjacent but slightly spaced from the respective outer ends of the said pole-salients 27—27 as is shown in Fig. 6.

The permanent magnet 30 above referred to may be formed of any one of the well known ferrous alloys capable of retaining magnetism and capable of imparting such magnetism to the pole-salients 27—27. The said magnet may be fixed in any suitable manner to an instrument structure.

The respective inner ends of the pole-salients 27—27 of the reed 26 are spaced from each other sufficiently to permit the rotation therebetween of a control-ring generally designated by the reference character 31 and preferably formed of soft iron or other suitable magnetic material of a nonpermanent-magnet character. The said control-ring has a serpentine or substantially sinusoidal configuration in a circumferential direction, similar to the control-ring 17 previously described.

The control-ring 31, therefore, includes inwardly-directed peaks 32 and outwardly-directed peaks 33 respectively similar to the peaks 18 and 19 before described, save that each of the inner peaks 32 is formed with an inwardly-directed integral coupling-lug 34 of very small dimensions, which tightly fit into complemental notches formed in the outer peripheral edge of a mounting-plate 35, as is indicated in Fig. 5. The coupling-lugs 34 serve to mechanically connect the control-ring 31 to the mounting-plate 35 without-however, providing magnetic salients of such magnitude as would materially interfere with the self-starting characteristics of the device.

The mounting-plate 35 may be conveniently formed of brass, bronze, aluminum or other relatively-nonmagnetic material as compared to the material from which the control-ring 31 is formed. The said mounting-plate is rigidly mounted upon the hub 36 of a drive-pinion 37 similar to the drive-pinion 22 previously referred to. The hub 36, the drive-pinion 37 and the unit comprising the mounting-plate 35 and control-ring 31, are rigidly mounted upon a shaft 38 similar to the shaft 23 before described. The said shaft is provided at its respective opposite ends with trunnions 39—39.

The pole-salients 27—27 of the reed 26 preferably have an extent in a direction toward and away from the shaft 38 which is greater than the width of the control-ring 31 at the peaks 32 and 33, and while the said pole-salients are not in themselves of permanent-magnet material, they will, in effect, be constantly polarized by the adjacent permanent magnet 30.

Now, when turning force is applied to the unit comprising the element 31 to 39 inclusive, the control-ring 31 will initiate the vibration of the reed 26 at first with a relatively-small amplitude and then ultimately to its full designed amplitude, whereupon the control-ring 31 will remain in step with the timed vibrations of the said reed in a manner similar to that described in connection with the showing of Figs. 1 to 4 inclusive.

The invention may be carried out in other spe-

cific ways than those herein set forth without departing from the spirit and essential characteristics of the invention, and the present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

What is claimed is:

1. In a timekeeping magnetic escapement having a rotary escape member and an oscillatory member, the combination of an endless wavy magnetic band-like element disposed on said escape member concentrically thereof and forming a track thereon; and a polar element on said oscillatory member, one of said elements being permanently magnetized and magnetically coupled with the other element, said track element having inner and outer apex portions disposed alternately on the inside and outside, respectively, of a circle at substantially equal distances therefrom so that the innermost and outermost edges of said outer and inner apex portions, respectively, are outside and inside said circle, respectively, and said apex portions are curved substantially as the apices of a sine wave, and said polar element being of a width, radially of said escape member, which is smaller than the radial distance between the outermost and innermost edges of successive outer and inner apex portions, respectively, and greater than the radial distance between the outermost and innermost edges of successive inner and outer apex portions, respectively.

2. The combination in a timekeeping magnetic escapement as set forth in claim 1, in which the width of said polar element comes much closer to the radial distance between the outer and inner edges of successive outer and inner apex portions, respectively, than to the radial distance between the outer and inner edges of successive inner and outer apex portions, respectively.

3. The combination in a timekeeping magnetic escapement as set forth in claim 1, in which said track element is of substantially uniform band width throughout and shaped similar to a sine wave.

4. The combination in a timekeeping magnetic escapement as set forth in claim 1, in which the dimension of said polar element, measured circumferentially of said escape member, is several times smaller than said width thereof.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,825,382	Baker	Sept. 29, 1931
2,373,429	Straumann	Apr. 10, 1945
2,554,523	Clifford	May 29, 1951
2,571,085	Clifford	Oct. 9, 1951

FOREIGN PATENTS

Number	Country	Date
946,519	France	June 7, 1949