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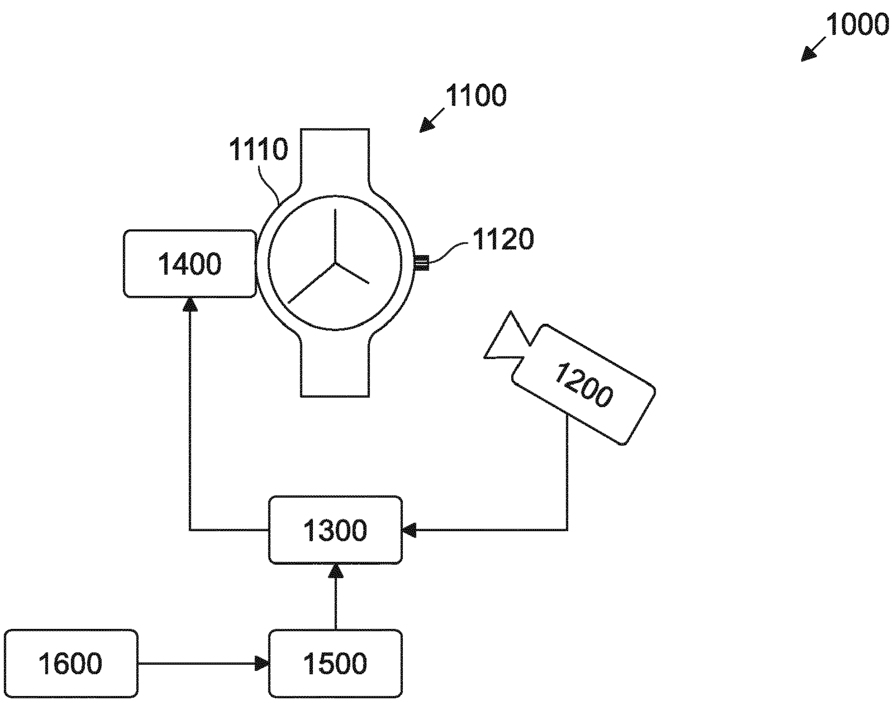
(54) TIME SETTING DEVICE

(57) The present invention relates to a time setting device (1000) for setting time of a mechanical watch (1100), the time setting device (1000) comprising: time reading means (1200) for reading a time indicated by a mechanical watch (1100), a time tracking means (1500) for indicating a reference time, moving means (1400) for acting on an escapement (3130) of the mechanical watch (1100) by applying a movement (M) to a case (1110) of the mechanical watch (1100), controlling means (1300) connected to the time reading means (1200) and to the time tracking means (1500), and controlling the moving means (1400) so as to reduce a difference between the time indicated by the mechanical watch (1100) and the reference time.

Fig. 1



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Description

[0001] The present invention relates to a device for setting time of a mechanical watch. In particular, the invention relates to a device capable of setting the time of a mechanical watch to a reference time, retrieved from a more precise clock, or to correct deviation of a frequency of oscillation of the escapement of a mechanical watch from a reference frequency. Even more specifically, the invention relates to a device capable of setting or correcting the time of a mechanical watch in an automated manner by applying movement to the case of the mechanical watch.

Prior art

[0002] Mechanical watches have been developed for centuries to achieve higher and higher precision, accuracy and stability. However manufacturing and design constraint limit the precision of mechanical watches and, compared to electronic watches, this remains too approximate for several users. To correct the inherent lack of precision, in the past it was common to set one's watch several times per month, or even per week. However such operation is nowadays considered troublesome.

[0003] It would therefore be beneficial to provide a supporting device which is capable of setting or maintaining the correct time on a mechanical watch so as to relieve the user from performing this operation. As of today, no such device exists on the market.

Summary of the invention

[0004] The present invention generally relies on the concept that the application of movement, such as rotations, translations, vibrations, oscillations and shocks or more generally any other kind of movement, to the case of a mechanical watch can be used to influence the operation of the watch's escapement so as to increase or decrease the frequency of the escapement operation.

[0005] In this manner, by controlling the type and/or intensity and/or and duration of the movement applied to the case of the watch, it is possible to slow down or accelerate the operation of the escapement and therefore modify the time shown by the watch and/or the frequency of oscillation of the escapement. This allows a user to position the watch into the time setting device of the invention and recover it with a correctly set time.

[0006] In particular, the invention can be used to maintain a correctly set time, or even to correct a wrongly set time. In the first case, the invention monitors the frequency of oscillation of the escapement and act on it to correct any mistake the frequency may exhibit. In the second case the invention can further act on the escapement to force a correction of the time indicated by the watch.

[0007] An embodiment of the invention can relate to a time setting device for setting time of a mechanical watch, the time setting device comprising: time reading means for reading a time indicated by a mechanical watch, time tracking means for indicating a reference time, moving means for acting on an escapement of the mechanical watch by applying a movement to a case of the mechanical watch, controlling means connected to the time reading means and to the time tracking means, and controlling the moving means so as to reduce a difference between the time indicated by the mechanical watch and the reference time.

[0008] In some embodiments, the time reading means can comprise a camera.

[0009] In some embodiments, the time setting device can further comprise a sensor, for sensing vibrations and/or sound of the escapement, wherein the sensor is connected to the controlling means.

[0010] In some embodiments, the sensor can comprise an accelerometer, preferably configured to be in contact with a crown of the mechanical watch, and/or wherein the sensor can comprise a microphone.

[0011] In some embodiments, the controlling means can be configured to measure oscillations of the escapement based on an output of the sensor, and to control the moving means based on the measured oscillations.

[0012] A further embodiment of the invention can relate to a time setting device for correcting a frequency of oscillation of the escapement of a mechanical watch, the time setting device comprising: time tracking means for indicating a reference frequency, a sensor, for sensing vibrations and/or sound of the escapement, moving means for acting on an escapement of the mechanical watch by applying a movement to a case of the mechanical watch, controlling means connected to the sensor and to the time tracking means, and controlling the moving means so as to reduce a difference between the frequency of oscillation of the escapement and the reference frequency.

[0013] In some embodiments, the time tracking means can comprise a digital clock, or a receiver configured to receive a clock signal from an external clock.

[0014] In some embodiments, the moving means can be configured to apply the movement with a first predetermined frequency, wherein the first predetermined frequency is within +/-10% of a frequency of the escapement, or of a multiple or a submultiple of the frequency of the escapement.

[0015] In some embodiments, the moving means can be configured to apply the movement during a first predetermined time interval, wherein the first predetermined time interval, is smaller than 50% of a period of the escapement, more preferably smaller than 20% of the period of the escapement, even more preferably smaller than 10% of the period of the escapement.

[0016] In some embodiments, the moving means can be configured to apply the movement substantially synchronously with an oscillation of the escapement, wherein the movement is applied substantially synchronously if a difference between a period of the movement and a multiple or submultiple of a period of the oscillation of the escapement is smaller than 20% of the period of the movement, more preferably smaller than 10% of the period of the movement, even more preferably smaller than 5% of the period of the movement.

[0017] In some embodiments, the moving means can be configured to apply the movement substantially prior to an lock point in time at which an impulse pin of the escapement engages with a fork arm of the escapement, wherein the movement is applied substantially prior to the lock point if a difference between a time of application of the movement and the lock point is smaller than 20% of the period of the movement, more preferably smaller than 10% of the period of the movement, even more preferably smaller than 5% of the period of the movement.

[0018] In some embodiments, the movement can be a rotation with amplitude of less than 180 degrees, preferably comprised between 1 and 30 degrees, preferably between 5 and 10 degrees.

[0019] In some embodiments, the moving means can comprise a movement generating point, watch holding means, translating means for translating a position of the watch holding means with respect to the movement generating point.

[0020] In some embodiments, the translating means can be configured to translate the position of the watch holding means with respect to the movement generating point so that a position of the escapement corresponds to the movement generating point.

[0021] In some embodiments, the translating means can be configured to translate the position of the watch holding means with respect to the movement generating point so that a position of a rotation axis of a balance wheel of the escapement corresponds to the movement generating point.

Short description of the figures

[0022]

Figure 1 schematically illustrates a time setting device 1000 in accordance with one embodiment of the present invention;

figure 2 schematically illustrates a time setting device 2000 in accordance with one embodiment of the present invention;

figure 3 schematically illustrates an escapement 3130;

figure 4A schematically illustrates operation of the escapement 3130;

figure 4B schematically illustrates operation of the escapement 3130 with the application of a movement M to watch case 1110;

figure 4C schematically illustrates a possible movement M resulting in the behavior illustrated in figure 4B;

figure 5A schematically illustrates a side view of moving means 5400 in accordance with one embodiment of the present invention;

figure 5B schematically illustrates several top views of parts of the moving means 5400 of figure 5A;

figure 6 schematically illustrates portions of an escapement 3130 for illustrating the effect of the application of a movement M in form of a vibration to watch case 1110;

Figures 7A-7C schematically illustrates portions of an escapement 3130 for illustrating the effect of the application of a movement M in form of a translation to watch case 1110.

Detailed description of preferred embodiments

[0023] Figure 1 schematically illustrates a time setting device 1000 in accordance with one embodiment. As can be seen in figure 1, a time setting device 1000 for setting time of a mechanical watch 1100, not comprised in the time setting device 1000, comprises time reading means 1200, time tracking means 1500, moving means 1400 and controlling means 1300.

[0024] The time reading means 1200 are configured for reading a time indicated by the mechanical watch 1100. In general any device which allows reading of the time indicated by the mechanical watch 1100 can be used to implement the time reading means 1200. The position of the time reading means can be chosen freely, provided it allows reading the time indicated the mechanical watch 1100. In some embodiments, the time reading means 1200 can comprise a camera. The signal treatment from deriving the indicated by the mechanical watch 1100 from the images taken by the camera will depend on the specific model of mechanical watch 1100 and will be clear to those skilled in the art of image recognition. In other embodiments, the time reading means 1200 could be implemented, for instance, by a combination of a light emitter and a light detector and by using them to measure the passage of the watch hands.

[0025] The time tracking means 1500 are configured for indicating a reference time. In general any device which allows a reference time to be tracked, even for a short period of time necessary of setting the time of the mechanical watch 1100 can be used to implement the time tracking means 1500. In some embodiments, the time tracking means 1500 can comprise a digital clock, or a receiver configured to receive a clock signal from an external clock 1600, such as an radio atomic clock, or an external digital clock. In some embodiments, the time tracking means 1500 can also comprise a quartz oscillator, having a precision of at least 1 second/day, which can also be expressed as 11.6 ppm, preferably 1 ppm, even more preferably 0,1 ppm. The advantage of proving a quartz oscillator is that, in some cases, the external clock 1600 may not provide a precise time indication but only a minute indication. In those cases the quartz oscillator can be used to increase the precision of the time provided by the external clock 1600. Moreover, the quartz oscillator can be used as a reference against which the oscillations from the escapement of the mechanical watch are compared, in order to determine if the escapement is operating at the correct frequency or if it is too fast or too slow, and if so, by how much.

[0026] The moving means 1400 are configured for acting on an escapement 3130 of the mechanical watch 1100 by applying a movement M to a case 1110 of the mechanical watch 1100. Different possible kinds of movement M which can act on the escapement 3130 will be described in the following. In general, however, any kind of movement M which can alter the normal functioning of the escapement 3130 so as to either increase or reduce the frequency of oscillation of the escapement 3130 can be implemented.

[0027] The controlling means 1300 are connected to the time reading means 1200 and to the time tracking means 1500, and configured for controlling the moving means 1400 so as to reduce a difference between the time indicated by the mechanical watch 1100 and the reference time.

[0028] In some embodiments, the controlling means 1300 can control the moving means 1400 so as to apply a given movement M for a predetermined time duration, for instance 30 seconds, and then measure the impact of the application of the movement M on the escapement 3130. In particular, the application of the movement M can result in a faster or slower operation of the escapement 3130 and this can be measured by measuring the time indicated by the mechanical watch 1100 prior and subsequently to the application of the movement, compared to the reference time. As will be described later, the effect of the movement M can also be measured by a sensor 2700 and/or by the time reading means 1200. Once it has been determined if the movement M has accelerated or slowed down the operation of the escapement 3130, the movement M can be further applied to the watch 1100 as needed, if it corresponds to the necessary correction.

[0029] That is, for instance, if the comparison of the reference time and of the time indicated by a mechanical watch 1100, indicates that the watch 1100 is late by, for instance, 2 minutes, a given movement M can be applied to the watch to determine if the application of the movement M results in a faster or slower operation of the escapement 3130. Assuming for instance that the escapement 3130 operates faster when the movement M is applied, so as to reduce the difference between the reference time and the time indicated by the mechanical watch 1100 to, for instance, 1 minute and 58 second, the movement M can be further applied to the mechanical watch 1100 until the difference between the reference time and the time indicated by the mechanical watch 1100 is brought below an acceptable tolerance, for instance less than 30 seconds, preferably less than 5 seconds, even more preferably less than 1 second. If, on the other hand, it is determined that the movement M resulted in a slower operation of the escapement 3130, a different type of movement M can be selected, or the previously selected movement M can be applied with different characteristics, such as different phase, different frequency, different period, to the mechanical watch 1100.

[0030] The variation of types of movement M, and/or of the characteristics thereof can be continued until an appropriate movement and an appropriate set of characteristics are determined, which influence the operation of the escapement 3130 in the manner necessary for correcting the difference between the reference time and the time indicated by a mechanical watch 1100.

[0031] In some embodiments, the movement M can have a predetermined frequency which is within +/-10% of a frequency of the escapement 3130 or of a multiple such as 1, 2, 4, etc, or of a submultiple, such as 1, 1/2, 1/3, etc. of the frequency of the escapement 3130.

[0032] The frequency of the escapement 3130 can be measured by means of vibrations and/or sounds measurements, for instance by using the sensor 2700, which will be described in the following. Alternatively, or in addition, the frequency of the escapement 3130 can be computed from the frequency of the second hand, as measured by the time reading means 1200. In particular, for performing the computation it is only necessary to know the ratio defined as frequency of the second hand over the frequency of the escapement 3130. This ratio, for instance 1, 1/2, 2/5, 1/3, 1/4, or 1/5, can be inserted by a user of the time setting device 1100 or can be preprogrammed into the time setting device 1100, in particular when the time setting device 1100 is designed for a specific mechanical watch. Still alternatively, or in addition, the frequency of the escapement 3130 can be selected among one or more predetermined values of 1Hz, 2Hz, 2.5Hz, 3Hz, 4Hz, 5Hz and 100Hz. In particular, if the frequency of the escapement 3130 is not known in advance, it will be possible for the device to select different values of frequencies, among those indicated above, one after the other and evaluate their effect on the escapement. Once a frequency is identified as resulting in a movement M which has the desired effect on the escapement 3130, the device can further operate with the given frequency.

[0033] In some embodiments, the movement M can be applied during a first predetermined time interval which is smaller than 50% of a period of the escapement 3130, more preferably smaller than 20% of the period of the escapement 3130, even more preferably smaller than 10% of the period of the escapement 3130. During the remaining part of the period, the device can be configured to apply no further movement to the watch. The period of the escapement 3130 can be measured or computed as described above, in particular as the inverse of the various frequencies described above.

[0034] In some embodiments, the movement M can be applied substantially synchronously with an oscillation of the escapement 3130. Substantially synchronously can be intended such that a difference between the phase of the movement M and the phase of the oscillation of the escapement 3130 is kept within an acceptable limit. In particular, the movement M can be considered to be applied substantially synchronously if a difference between a period of the movement M and a multiple or submultiple of a period of the oscillation of the escapement 3130 is smaller than 20% of the period of the movement M, more preferably smaller than 10% of the period of the movement M, even more preferably smaller than 5% of the period of the movement M. The phase of the escapement 3130 can be measured or computed as described above.

[0035] In some embodiments, the movement M can be applied substantially prior to an lock point, that is, a point in time at which an impulse pin 3135 of the escapement 3130 engages with a fork arm 3136, 3137 of the escapement 3130. In particular, the movement M can be considered to be applied substantially prior to the lock point if a difference between a time of application of the movement M and the lock point is smaller than 20% of the period of the movement M, more preferably smaller than 10% of the period of the movement M, even more preferably smaller than 5% of the period of the movement M. The lock point can be measured or computed, by knowing the design of the escapement 3130, as described above.

[0036] The movement M can be a rotation, a translation, a vibration, an oscillation, a shock, or a combination of those, of the mechanical watch 1100. In the above, reference is made to changing the characteristics of the movement M; for instance, the direction and/or amplitude and/or frequency and/or phase and/or duration of the movement M can be changed. In general the time setting device 1000 can be provided with a plurality of predefined movements M, such as rotations, translations or combinations of both. Each predefined movement M can be further divided in a plurality of second predefined movements M, each having different sets of characteristics. The time setting device 1000 can start applying a given type of movement M with a predefined set of characteristics and then measure the effect of the movement M. If the movement M results in the desired acceleration or deceleration of the escapement 3130, the time setting device 1000 can continue the application of the movement M until necessary. If, on the other hand, the movement M does not result in the intended correction, the time setting device 1000 can change type of movement, or can change one or more of its characteristics, until the application of the movement M results in the intended correction. Once the appropriate movement and characteristics are identified, the application of the movement M can be continued until necessary.

[0037] That is, by an approach based on trial and error, the time setting device 1000 can identify the appropriate movement M for correcting the time indicated by the mechanical watch 1100.

[0038] Figure 2 schematically illustrates a time setting device 2000 in accordance with a further embodiment. In particular, the time setting device 2000 differs from time setting device 1000 due to the additional presence of a sensor 2700, for sensing vibrations and/or sound of the escapement 3130, connected to the controlling means 2300. The presence of the sensor 2700 allows a direct measurement of the characteristics of the escapement 3130, such as the frequency, and/or period, and/or phase and/or interaction between an impulse pin 3135 and fork arms 3136, 3137 of the escapement 3130, which will be described below. The signal analysis for obtaining those characteristics of the escapement from the measured vibrations and/or sound will be clear to those skilled in the art of watch measurements. Thanks to the sensor 2700, a computation based on the movement of the second hand can be avoided and instead a direct measurement can be used. Alternatively, the result of such computation can be combined with the measurement by the sensor 2700, so as to increase precision of operation. The sensor 2700 further provides the advantage that the effect of the movement M on the escapement 3130 can be measured in real time. In some embodiments this allows the characteristics of the movement M to be adapted based on the measured effect.

[0039] In some embodiments, the sensor 2700 can comprise an accelerometer. The accelerometer can measure vibrations from the mechanical watch and from those vibrations the characteristics of the escapement 3130 can be retrieved. Moreover, in some embodiments, the accelerometer can be positioned so as to be in contact with a crown 1120 of the mechanical watch 1100, as illustrated in figure 2. This has in fact been identified by the inventors as being an ideal placement for the accelerometer in terms of precision of readings of the vibrations from the accelerometer. Alternatively, the accelerometer can be in contact with the case 1110. It will be clear that more than one accelerometer can be used in combination. In some embodiments, one or more of the accelerometer can be replaces by a piezoelectric sensor.

[0040] In some embodiments, the sensor 2700 can comprise a microphone. The microphone can measure sound from the mechanical watch and from the sound the characteristics of the escapement 3130 can be retrieved. It will be clear that more than one microphones can be used in combination. It will further be clear that the one or more microphones can be used in combination with the one or more accelerometers.

[0041] In some embodiments, the controlling means 2300 can therefore be configured to measure oscillations of the escapement 3130 based on an output of the sensor 2700 and control the moving means 1400 based on the measured oscillations.

[0042] Although the above embodiments have been described with reference to a movement M which can be applied to correct a wrongly indicated time, the present invention is not limited thereto. In particular, an embodiment of the invention can further relate to a time setting device for correcting a frequency of oscillation of the escapement of a mechanical watch 1100, without necessarily correcting the time indicated by the watch 1100. That is, the invention can be used to simply maintain a reference frequency of oscillation of a mechanical watch 1100, in particular in those cases in which the mechanical watch 1100 has already an acceptably correct time set.

[0043] In other words, it is often the case that mechanical watches, even if set to a correct time, may drift away from the correct time due to inherent imprecision in the escapement. This is particularly disadvantageous when the watch 1100 is not worn for a longer period of times, during which they may drift significantly from the previously correctly set time. For those cases it may therefore not be necessary to correct the time indicated by the mechanical watch 1100, but it is sufficient to ensure that the mechanical watch does not drift away from this time, due to an imprecise frequency of oscillation of the escapement.

[0044] To address this issue, a time setting device according to a further embodiment of the invention can be generally similar to the time setting device 2000, except that it can also operate without the time reading means 1200. In those embodiments, the time setting device can thus comprise the time tracking means 1500, configured for indicating a reference frequency, for instance by the provision of the quartz oscillator, as previously described. The time setting device can further comprise the sensor 2700, for sensing vibrations and/or sound of the escapement 3130, thus allowing the frequency of oscillation of the escapement to be measured.

[0045] In such embodiment the moving means 1400 can then be configured for acting on the escapement 3130 of the mechanical watch 1100 by applying the movement M to the case 1110 of the mechanical watch 1100. The controlling means 1300, 2300 can then be connected to the sensor 2700 and to the time tracking means 1500, as previously described, and can be configured so as to control the moving means 1400 so as to reduce a difference between the frequency of oscillation of the escapement and the reference frequency.

[0046] In alternative embodiments, instead of the sensor 2700, the frequency of oscillation of the escapement can be measured from one or more readings of the time reading means 1200, as previously described.

[0047] In the description above it has been described how a plurality of movements can be evaluated to alter the operation of the escapement 3130 by a trial and error approach. In the following a more detailed description of several exemplary movements M will be provided which allows the operation of the escapement 3130 to be controlled in a desired manner, avoiding, or at least reducing, the number of trials.

[0048] Figure 3 schematically illustrates an example for an escapement 3130 and figure 4A schematically illustrates operation of the escapement 3130. The escapement illustrated in figure 3 is a classic Swiss lever escapement. It will be clear that the invention can also work with other types of escapement, and the specific illustration is therefore not limiting.

[0049] As can be seen in figure 3, the escapement 3130 comprises at least a balance wheel 3134 which oscillates in direction B among a maximum angular position Bmax and a minimum angular position Bmin, as visible in figure 4A. In some embodiments, Bmax could be comprised between 100 and 330 degrees, preferably between 150 and 300 degrees, while Bmin could be comprised between -100 and -330 degrees, preferably between -150 and -300 degrees. The balance wheel 3134 comprises an impulse pin 3135, which moves together with the balance wheel 3134 and acts on a lever 3133. The lever 3133 is released by the impulse pin 3135 at a point R1. The movement of the lever releases the pallet 3132 from the escape wheel 3131, which then pushes the pallet 3132. This results in the lever 3133 to accelerate and hit the impulse pin 3135. At a lock point E1 the opposite pallet 3132 locks with the escape wheel 3131. In this manner the escape wheel 3131 transfers energy to the balance wheel 3134, thereby causing it to oscillate. The oscillating movement of the balance wheel 3134 is ensured by a hairspring 7175 connected thereto, illustrated for instance in figure 7A.

[0050] As visible in figure 4A, schematically illustrating the angular position O of the impulse pin 3135 with respect to the time T on the graph, and also providing two enlarged views of parts of the escapement 3130, the balance wheel 3134 moves in an anticlockwise direction when the angular position of the impulse pin 3135 moves downward from the value Bmax. At a release point R1, the impulse pin 3135 engages with the right fork arm 3137 of the lever 3133, and at the lock point E1 the escape wheel 3131 is again locked against a pallet. Between the release point R1 and the lock point E1 the lever 3133 accelerates, hits the impulse pin 3135 and transfers energy to the balance wheel 3134.

[0051] Figure 4B schematically illustrates operation of the escapement 3130 with the application of a movement M to watch case 1110. Figure 4C schematically illustrates a possible movement M resulting in the behavior illustrated in figure 4B.

[0052] The exemplary movement M illustrated in figure 4B is a rotation substantially centered on the rotation axis of the balance wheel 3134. Furthermore, the rotation plane substantially corresponds to the plane in which the balance wheel 3134 lies. It will however be clear to those skilled in the art that a similar behavior can be obtained by a rotation also centered in a different position, or by a translation, or by a combination of a translation and of a rotation, eventually along a different plane. The choice of the specific rotation for figure 4B has been done as this provides a movement M which can be easily described but the invention is not to be intended as being limited to such specific implementation only.

[0053] The graph in figure 4B indicates the angular position of the impulse pin 3135 in the coordinate system of the mechanical watch 1100, wherein the angle 0 corresponds to the position of the impulse pin 3135 illustrated in figure 3. The graph in figure 4B indicates the angular position of watch case 1110, subjected to the movement M, in the coordinate system of the time setting device 1000. The enlarged portions of the escapement 3130 are illustrated in the same plane Z-X used for figure 3.

[0054] As can be seen in figure 4B, the balance wheel 3134 moves in an anticlockwise direction when the impulse pin 3135 moves downward from the value Bmax as previously described. At a first acting point, preferably prior to release point R1, a movement ΔM is applied to the case 1110. Since the balance wheel 3134 is supported by bearings 6141, 6142, the change in position of the case 1110 does not significantly impact the position in space of the balance wheel 3134. On the other hand, the change in position of the case 1110 results in a different position of the lever 3133, and in particular of the fork arm 3137, with respect to the impulse pin 3135. Namely, the fork arm 3137, which at the first acting point was close to the impulse pin 3135 is pushed away from it. This, in the coordinate system of the mechanical watch 1100, corresponds to an increased angular position ΔO of the impulse pin 3135, as illustrated in figure 4B. In some embodiments, ΔO could be comprised between 1 and 30 degrees, preferably between 5 and 10 degrees. This increase changes the oscillation of the balance wheel 3134. In particular, without application of the movement ΔM, the balance wheel 3134, more specifically the impulse pin 3135, would have continued along the dotted line. On the contrary, the solid line indicates the new operation of the balance wheel after the application of the movement ΔM. In some embodiments, ΔM is less than 180 degrees and could be comprised between 1 and 30 degrees, preferably between 5 and 10 degrees.

[0055] In an exemplary embodiment in which the balance wheel 3134 operates at 4 Hz, thus has a period P of 250 ms, the application of the movement ΔM can begin at approximately 10-20 ms before point R1. It will be clear that by changing the frequency of the balance wheel, a similar operation can be obtained by maintaining a corresponding angular timing. Moreover, in some embodiments, the value of ΔT can be in the range of 10-50 ms, preferably 20-40 ms, as it has been found that this range provides sufficient time for operation of a motor applying the movement ΔM in a controlled and precise manner. It will be clear that although the movement ΔM is represented as a substantially linear change of angular position with respect to time, the invention is not limited thereto and it is possible to have a movement ΔM which comprises an acceleration phase and a deceleration phase.

[0056] As can be understood from the above, the operation of the escapement 3130 is slowed down by the application of the movement ΔM. A subsequent, analogous, application of a movement ΔM' has a similar result. The combination of the effect of the movement ΔM and of the movement ΔM' results in a change in period of the escapement 3130 from a value P to, respectively, a value P' and P". In this manner the period of the escapement 3130 can be increased by a total value of ΔP. It will be clear that by applying a movement in the opposite direction, for instance by replacing movement ΔM with movement ΔM' and vice versa, the opposite result can be obtained, namely the period of the escapement 3130 can be reduced.

[0057] Although in the embodiment above the movement ΔM is applied substantially prior to the release point R1, the invention is not limited thereto. In some alternative embodiments, the application of ΔM could be comprised at any time between the time position corresponding to the value of Bmax and R1.

[0058] In some further embodiments, the movement ΔM could also be applied after the release point R1, and in particular between the release point R1 and the lock point E1. Depending on the time of application of the movement ΔM and the duration ΔT, this approach can be used to modify the conditions, such as relative speed and direction, with which the fork arm 3136, 3137 hit the impulse pin. This has an impact on the operation of the escapement which can be designed, by appropriately timing the movement ΔM, to speed up or slow down the operation of the escapement. For instance, by modifying the time at which the lever 3133 hits the impulse pin 3135, it is possible to reduce or increase the amount of energy which is transferred to the balance wheel 3134. This has a known effect on the frequency of oscillation of the escapement since it is known that the balance wheel tends to have a higher frequency of oscillation at higher values of Bmax.

[0059] In general, by timing the characteristics of the movement ΔM based on the timing of the release point R1 and/or of the lock point E1 and/or of the point at which the lever 3133 hits the impulse pin 3135, it is possible to modify the frequency of oscillation of the escapement 3130. It will be clear that the release point R1 and/or of the lock point E1 and/or of the point at which the lever 3133 hits the impulse pin 3135 can be measured, for instance by means of the sensor 2700, in known manners. Thus, by timing the characteristics of the movement ΔM based on the output of the sensor 2700 it is possible to accelerate or slow down the frequency of oscillation of the escapement in different ways.

[0060] One advantage of this approach is that the movement ΔM can have a first direction for a first period of time and a second direction, opposite the first direction, for a second period of time. This advantageously allows the position of the watch 1100 to be contained in a limited range, as the movements in the two directions compensate each other.

[0061] In the embodiments in which the movement M is applied as a rotation, the moving means 1400 can also be advantageously configured to apply a rotation, preferably a continuous rotation, resulting in the charging of the mechanical watch, if the mechanical watch is an automatic watch. The application of the charging rotation can be done at times other than the application of the movement M. This is particularly advantageous since is allows a single device to be used both for charging and setting the time of the mechanical watch.

[0062] Figure 5A schematically illustrates a side view of moving means 5400 in accordance with one embodiment of the present invention. Figure 5B schematically illustrates several top views of parts of the moving means 5400 of figure 5A. This device is particularly advantageous in case a rotation is applied as movement M in order to center the axis of rotation at a predetermined point within the watch 1100. In the illustrated embodiment, the moving means 5400, which can implement the moving means 1400, comprise a movement generating point 5411. This can be, for instance, the axle of as motor 5410, but in general it can be any point to which a movement is applied resulting in the movement of the movement generating point 5411.

[0063] The moving means further comprise a watch holding means 5440, which provide means for holding the watch. In the illustrated embodiment, a cavity 5441 is provided for inserting the watch, such that the cavity has a shape complementary to that of the watch. It will be however clear that any means for holding the watch, such as straps, magnets, springs, or generally any mechanical device for holding the watch substantially stable with respect to the watch holding means 5440 can be used.

[0064] The moving means further comprise translating means 5430 for translating a position of the watch holding means 5440 with respect to the movement generating point 5411. A detailed implementation of the translating means 5430 is described in the following and illustrated in the figures. In general it will however be clear that several mechanical way exists for setting the position of the watch holding means with respect to the movement generating point 5411.

[0065] This implementation allows the watch to be precisely positioned with respect to the movement generating point 5411. This can be relevant, in some embodiments, if the movement is more effective when applied to a certain position of the watch. For instance, with reference to the exemplary movement illustrated in figure 4B, it is advantageous to position the watch such that the movement M, in form of a rotation, is centered substantially at the center of the balance wheel. That is, in some embodiments, the translating means 5430 can be configured to translate the position of the watch holding means 5440 with respect to the movement generating point 5411 so that a position of a rotation axis of a balance wheel 3134 of the escapement 3130 corresponds to the movement generating point 5411.

[0066] More generally, since the movement is designed to have an impact on the escapement, in some embodiments the translating means 5430 can be configured to translate the position of the watch holding means 5440 with respect to the movement generating point 5411 so that a position of the escapement 3130 corresponds to the movement generating point 5411.

[0067] The description above provides several examples of movement M in the form of a rotation. It will however be clear that other movements can be applied to the watch case 1110 so as to result in a modification of the operation of the escapement 3130. In the following, examples will be provided, for instance, for the use of translations, vibrations, oscillations or shocks as movement M.

[0068] Figure 6 schematically illustrates portions of an escapement 3130 for illustrating the effect of the application of a movement M in form of a vibration to watch case 1110.

[0069] In particular, figure 6 illustrates the top pivot 6138 of the balance wheel 3134 and the corresponding bearings, which usually comprise a pierced jewel 6141,acting as a bearing in the XZ plane, and a cap jewel 6142, acting as a bearing in the Y axis. It will be clear that, although not illustrated, a similar configuration can apply to the bottom pivot of the balance wheel 3134.

[0070] By applying a vibration as movement M the contact of the top pivot 6138 with the jewel 6141 and with the jewel 6142 can be controlled as required. For instance, the top pivot 6138 can be forced to apply more pressure on jewel 6141, resulting in an increased friction and thus a reduced oscillation frequency. Conversely, the top pivot 6138 can be controlled so as to reduce the friction with jewel 6141, thus increasing the oscillation frequency.

[0071] Thus, in some embodiments, the moving means 1400, 5400 can be configured to apply the movement M as a vibration with a predetermined frequency, preferably between 1 kHz and 40 kHz, more preferably between 10 kHz and 30 kHz. Alternatively, or in addition, the moving means 1400, 5400 can be configured to apply the movement M as a vibration with a predetermined acceleration, preferably between 0.1 G and 10 G, more preferably between 0.5 G and 2 G. Alternatively, or in addition, the moving means 1400, 5400 can be configured to apply the movement M as a vibration along the plane containing the balance wheel 3134, or along the plane perpendicular to the balance wheel 3134.

[0072] Figures 7A-7C schematically illustrates portions of an escapement 3130 for illustrating the effect of the application of a movement M in form of a translation to watch case 1110.

[0073] In particular, figure 7A illustrates a hairspring 7151 connected to the balance wheel 3134. The hairspring 7151 causes the balance wheel 3134 to return to a predetermined angular position, thus causing it to oscillate in response to the force exerted by the lever 3133 on the impulse pin 3135.

[0074] The operation of the hairspring 7151 can be impacted by applying a movement M in the form of a lateral translation along the plane containing the hairspring 7151, as illustrated in figures 7B and 7C. In particular, while the hairspring 7151 is attached on its extremities to anchoring points 7152 and 7153, the body of the hairspring 7151 can be moved in space by applying a movement M. As visible for instance in figure 7B, the application of a movement M toward the right can cause a compression of the right part of the hairspring 7151 and an extension of the left part of the hairspring 7151. Such compression and extension result in a change of direction of the force of the hairspring 7151.This in turns impact the amplitude of oscillation of the balance wheel 3134 which, as explained above, results in a change of oscillation frequency.

[0075] By applying the movement M with the appropriate direction and frequency, the movement of the balance wheel can thus be accelerated or slowed down, as needed.

[0076] Thus, in some embodiments, the moving means 1400, 5400 can be configured to apply the movement M as a translation, preferably an oscillation, with a predetermined frequency, preferably between 1 Hz and 40 Hz, more preferably between 10 Hz and 30 Hz. Alternatively, or in addition, the moving means 1400, 5400 can be configured to apply the movement M as a translation, preferably an oscillation, with a predetermined acceleration, preferably between 0.1 G and 10 G, more preferably between 0.5 G and 2 G. Alternatively, or in addition, the moving means 1400, 5400 can be configured to apply the movement M as a translation, preferably an oscillation, along the plane containing the hairspring 7151.

[0077] In the embodiments above, reference is made to the plane containing the balance wheel 3134 and to the plane containing the hairspring 7151. It will be clear to those skilled in the art that, for most mechanical watches, those planes substantially correspond to each other. It will further be clear for those skilled in the art that the time setting device 1000, 2000, can be adapted to the configuration of a specific mechanical watch by considering the position and orientation of the escapement within the watch so that the watch is positioned in the time setting device 1000, 2000 so as to apply the movement M in the intended direction with respect to the escapement. In those cases where the mechanical watch is unknown, it can most commonly be assumed that the plane containing the balance wheel 3134 and/or the plane containing the hairspring 7151 is the plane on which the case 1110 of the mechanical watch has its largest area.

[0078] Similarly in the embodiments above, reference is made to the frequency of oscillation of the escapement, or the respective period. It will be clear for those skilled in the art that the time setting device can be adapted to the configuration of a specific mechanical watch by considering the specific frequency of operation of the escapement. In those cases where the mechanical watch is unknown, it can most commonly be assumed that the escapement will operate with a frequency having a value among 1Hz, 2Hz, 2.5Hz, 3HZ, 4HZ, 5Hz and 100Hz, so that the movement characteristics depending on the frequency or period of the escapement can be computed based on those values.

[0079] Although different embodiments have been described above as separate and various features have been described in combination with any given embodiment, the present invention in not limited to the embodiments described. To the contrary, singular features from any given embodiment can result into alternative embodiments. Moreover singular features from a plurality of embodiments can be combined so as to result into further alternative embodiments. The scope of the invention is thereby not limited by the illustrated drawing and the described embodiments but is instead defined by the claims.

List of reference numerals

[0080]

Figure 1

1000: time setting device
1100: mechanical watch
1110: case
1120: crown
1200: time reading means
1300: controlling means
1400: moving means
1500: time tracking means
1600: external clock

Figure 2

2000: time setting device
2300: controlling means
2700: sensor

Figures 3

3130: escapement
3131: escape wheel
3132: pallets
3133: lever
3134: balance wheel
3135: impulse pin
3136, 3137: fork arm
B: balance wheel oscillation direction
E: escape wheel rotation direction
L: lever swing direction

Figures 4A, 4B, 4C

E1, E1', E2: lock point
M: movement
ΔM, ΔM': movement
P, P', P": period
P/2, P'/2: half period
ΔP: period variation
R1, R1', R2, R2': release point
O: angular position

ΔO, ΔO': angular position variation
T: time
ΔT, ΔT': time interval

Figures 5A, 5B

5400: moving means
5410: motor
5411: movement generating point
5420: base
5421: cavity
5430: translating means
5431: rail
5432: rail
5440: watch holding means
5441: cavity

Figure 6

6138: top pivot
6141: pierced jewel
6142: cap jewel

Figures 7A/7C

7151: hairspring
7152: anchoring point
7153: anchoring point

Claims

1. A time setting device (1000, 2000) for setting time of a mechanical watch (1100), the time setting device (1000, 2000) comprising:

time reading means (1200) for reading a time indicated by a mechanical watch (1100),
time tracking means (1500) for indicating a reference time,
moving means (1400, 5400) for acting on an escapement (3130) of the mechanical watch (1100) by applying a movement (M) to a case (1110) of the mechanical watch (1100),
controlling means (1300, 2300) connected to the time reading means (1200) and to the time tracking means (1500), and controlling the moving means (1400) so as to reduce a difference between the time indicated by the mechanical watch (1100) and the reference time.

2. The time setting device (1000, 2000) according to claim 1, wherein
the time reading means (1200) comprise a camera.

3. The time setting device (2000) according to any previous claim, further comprising
a sensor (2700), for sensing vibrations and/or sound of the escapement (3130),
wherein the sensor (2700) is connected to the controlling means (2300).

4. The time setting device (2000) according to claim 3, wherein
the sensor (2700) comprises an accelerometer, preferably configured to be in contact with a crown (1120) of the mechanical watch (1100), and/or
wherein the sensor (2700) comprises a microphone.

5. The time setting device (2000) according to claim 6, wherein the controlling means (2300) are configured to
measure oscillations of the escapement (3130) based on an output of the sensor (2700), and
control the moving means (1400, 5400) based on the measured oscillations.

6. A time setting device (2000) for correcting a frequency of oscillation of the escapement of a mechanical watch (1100), the time setting device (1000, 2000) comprising:

time tracking means (1500) for indicating a reference frequency,
a sensor (2700), for sensing vibrations and/or sound of the escapement (3130),
moving means (1400, 5400) for acting on an escapement (3130) of the mechanical watch (1100) by applying a movement (M) to a case (1110) of the mechanical watch (1100),
controlling means (1300, 2300) connected to the sensor (2700) and to the time tracking means (1500), and controlling the moving means (1400) so as to reduce a difference between the frequency of oscillation of the escapement and the reference frequency.

7. The time setting device (1000, 2000) according to any previous claim, wherein
the time tracking means (1500) comprise a digital clock, or a receiver configured to receive a clock signal from an external clock (1600).

8. The time setting device (1000, 2000) according to any previous claim, wherein
the moving means (1400, 5400) are configured to apply the movement (M) with a first predetermined frequency,
wherein the first predetermined frequency is within +/-10% of a frequency of the escapement (3130), or of a multiple or a submultiple of the frequency of the escapement (3130).

9. The time setting device (1000, 2000) according to any previous claim, wherein
the moving means (1400, 5400) are configured to

apply the movement (M) during a first predetermined time interval (ΔT, ΔT'), wherein the first predetermined time interval (ΔT, ΔT'), is smaller than 50% of a period of the escapement (3130), more preferably smaller than 20% of the period of the escapement (3130), even more preferably smaller than 10% of the period of the escapement (3130).

10. The time setting device (1000, 2000) according to any previous claim, wherein the moving means (1400, 5400) are configured to apply the movement (M) substantially synchronously with an oscillation of the escapement (3130), wherein the movement (M) is applied substantially synchronously if a difference between a period of the movement (M) and a multiple or submultiple of a period of the oscillation of the escapement (3130) is smaller than 20% of the period of the movement (M), more preferably smaller than 10% of the period of the movement (M), even more preferably smaller than 5% of the period of the movement (M).

11. The time setting device (1000, 2000) according to any previous claim, wherein the moving means (1400, 5400) are configured to apply the movement (M) substantially prior to an lock point (E1, E1', E2) in time at which an impulse pin (3135) of the escapement (3130) engages with a fork arm (3136, 3137) of the escapement (3130), wherein the movement (M) is applied substantially prior to the lock point (E1, E1', E2) if a difference between a time of application of the movement (M) and the lock point (E1, E1', E2) is smaller than 20% of the period of the movement (M), more preferably smaller than 10% of the period of the movement (M), even more preferably smaller than 5% of the period of the movement (M).

12. The time setting device (1000, 2000) according to any previous claim, wherein the movement (M) is a rotation (ΔM) with amplitude of less than 180 degrees, preferably comprised between 1 and 30 degrees, preferably between 5 and 10 degrees.

13. The time setting device (1000, 2000) according to any previous claim, wherein the moving means (5400) comprise a movement generating point (5411), watch holding means (5440), translating means (5430) for translating a position of the watch holding means (5440) with respect to the movement generating point (5411).

14. The time setting device (1000, 2000) according to claim 13, wherein the translating means (5430) are configured to translate the position of the watch holding means (5440) with respect to the movement generating point (5411) so that a position of the escapement (3130) corresponds to the movement generating point (5411).

15. The time setting device (1000, 2000) according to claim 13, wherein the translating means (5430) are configured to translate the position of the watch holding means (5440) with respect to the movement generating point (5411) so that a position of a rotation axis of a balance wheel (3134) of the escapement (3130) corresponds to the movement generating point (5411).

Fig. 1

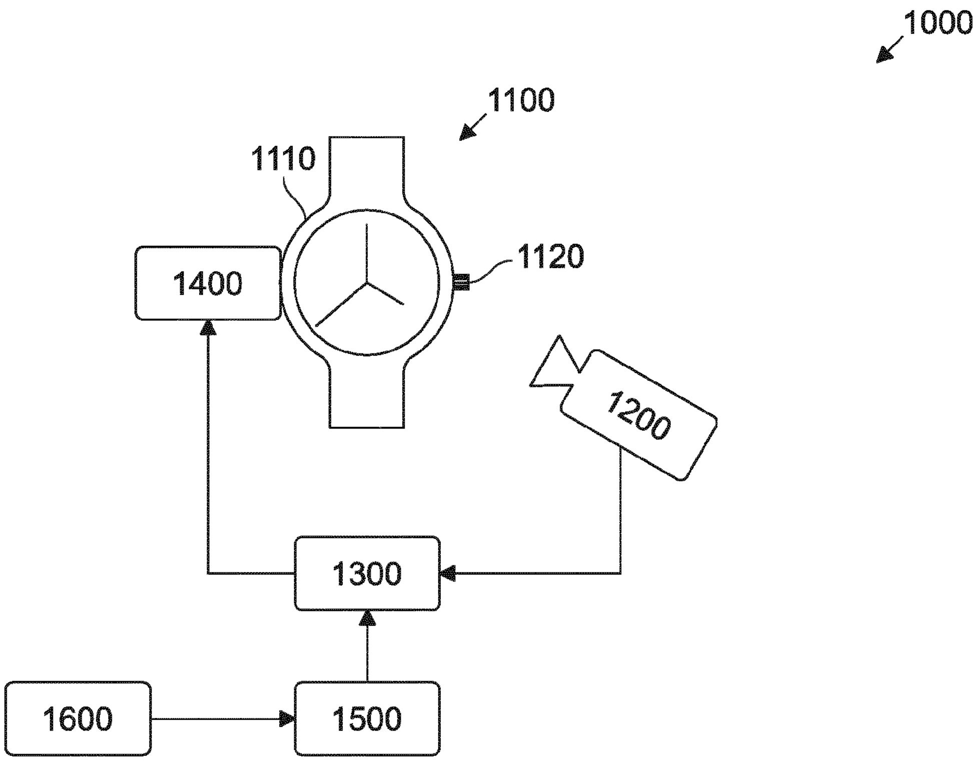
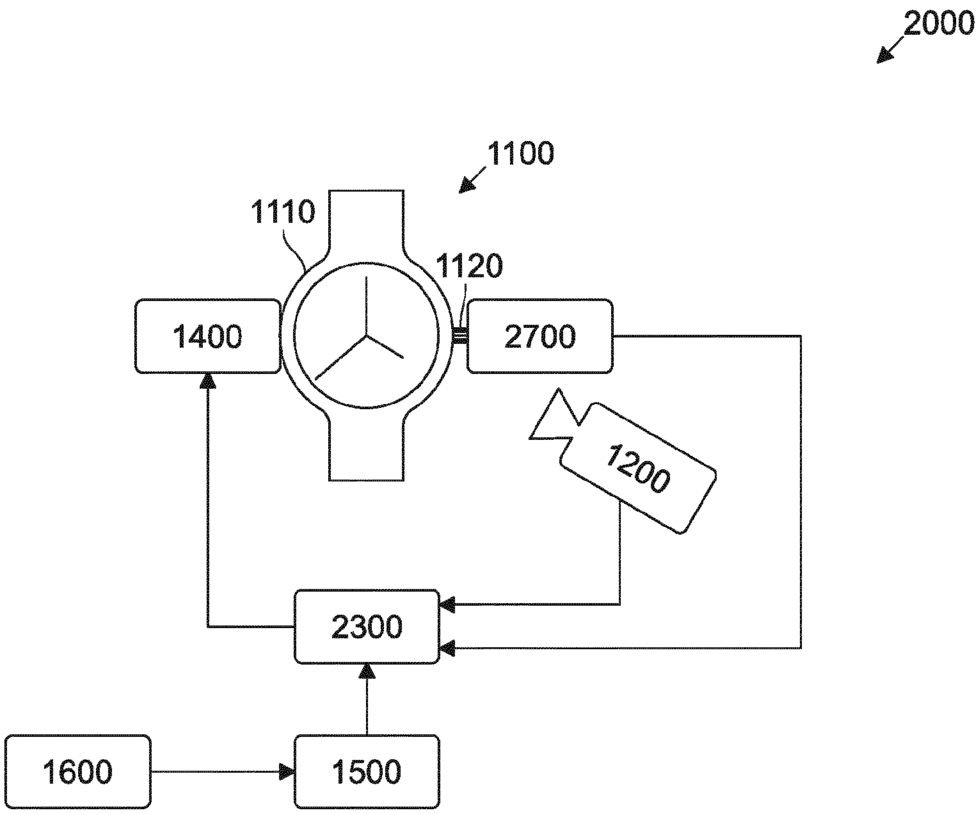

1000
1100
1110
1120
1400
1200
1300
1600
1500

Fig. 2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1100
1110
1120
1400
2700
1200
2300
1600
1500

Fig. 3

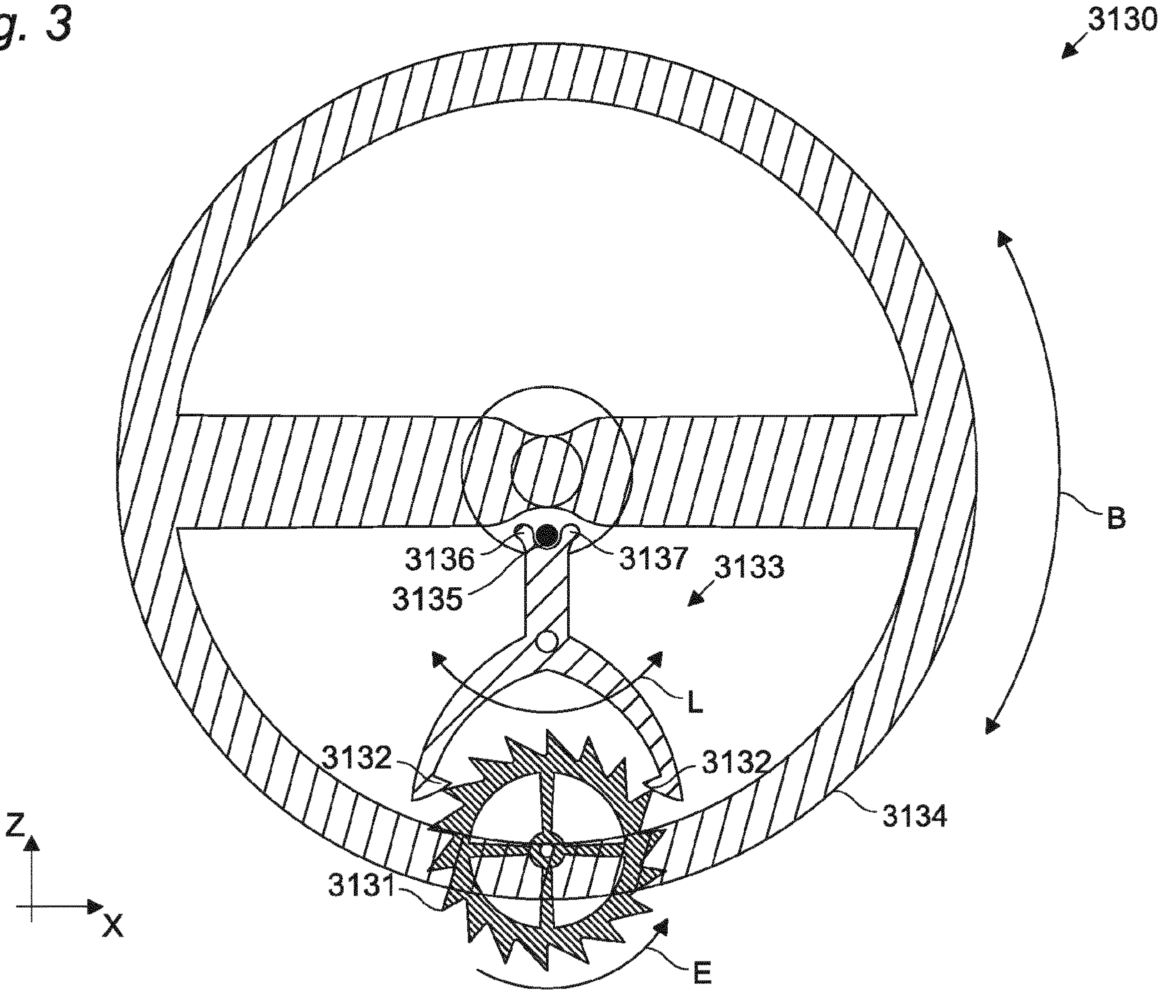

3130
B
3136
3137
3133
3135
L
3132
3132
3134
Z
X
3131
E

Fig. 4A

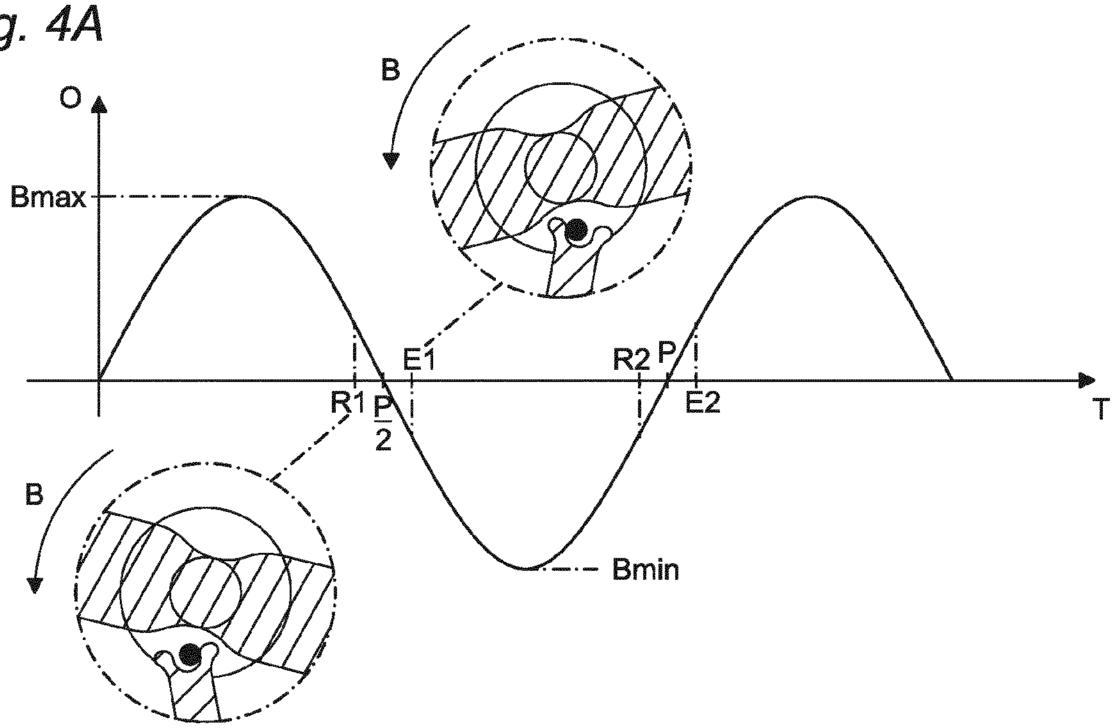
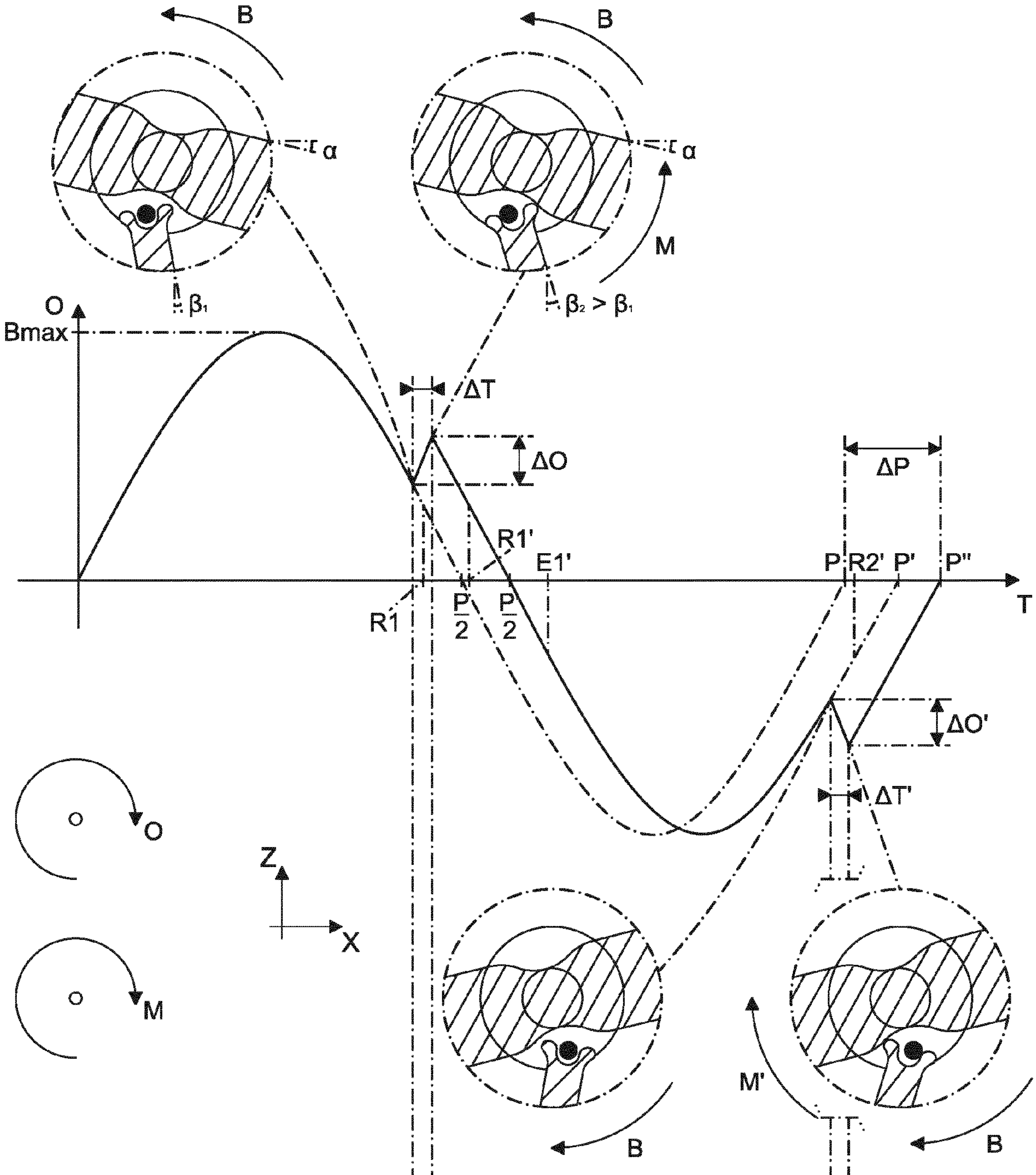

B
O
Bmax
E1
R2
P
R1
P/2
E2
T
B
Bmin

Fig. 4B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B
α
α
M
β₁
β₂ > β₁
O
Bmax
ΔT
ΔO
ΔP
R1'
E1'
P
R2'
P'
P''
T
R1
P/2
P/2
ΔO'
ΔT'
O
Z
X
M
M'
B
B

Fig. 4C

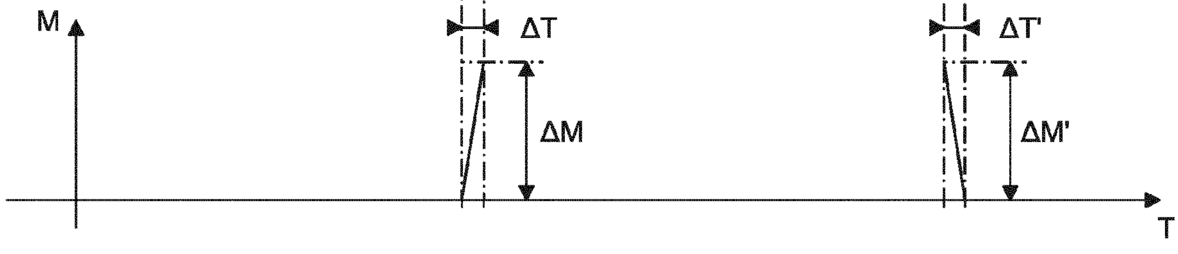

M
ΔT
ΔT'
ΔM
ΔM'
T

Fig. 5A

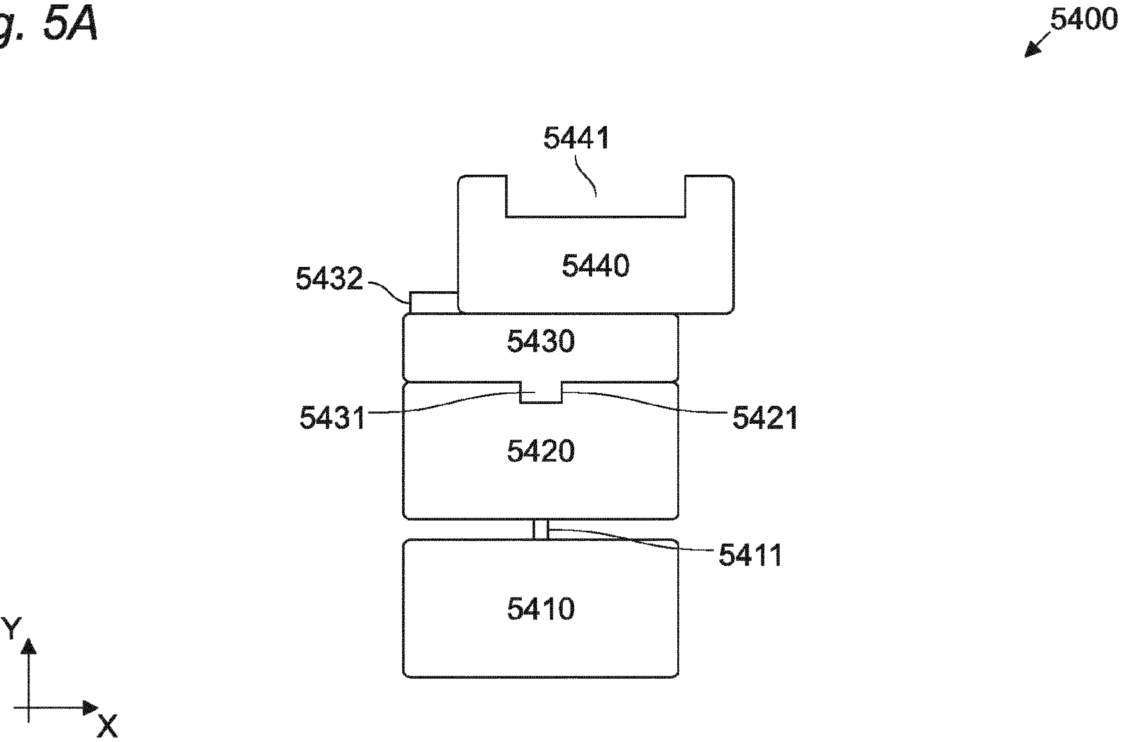
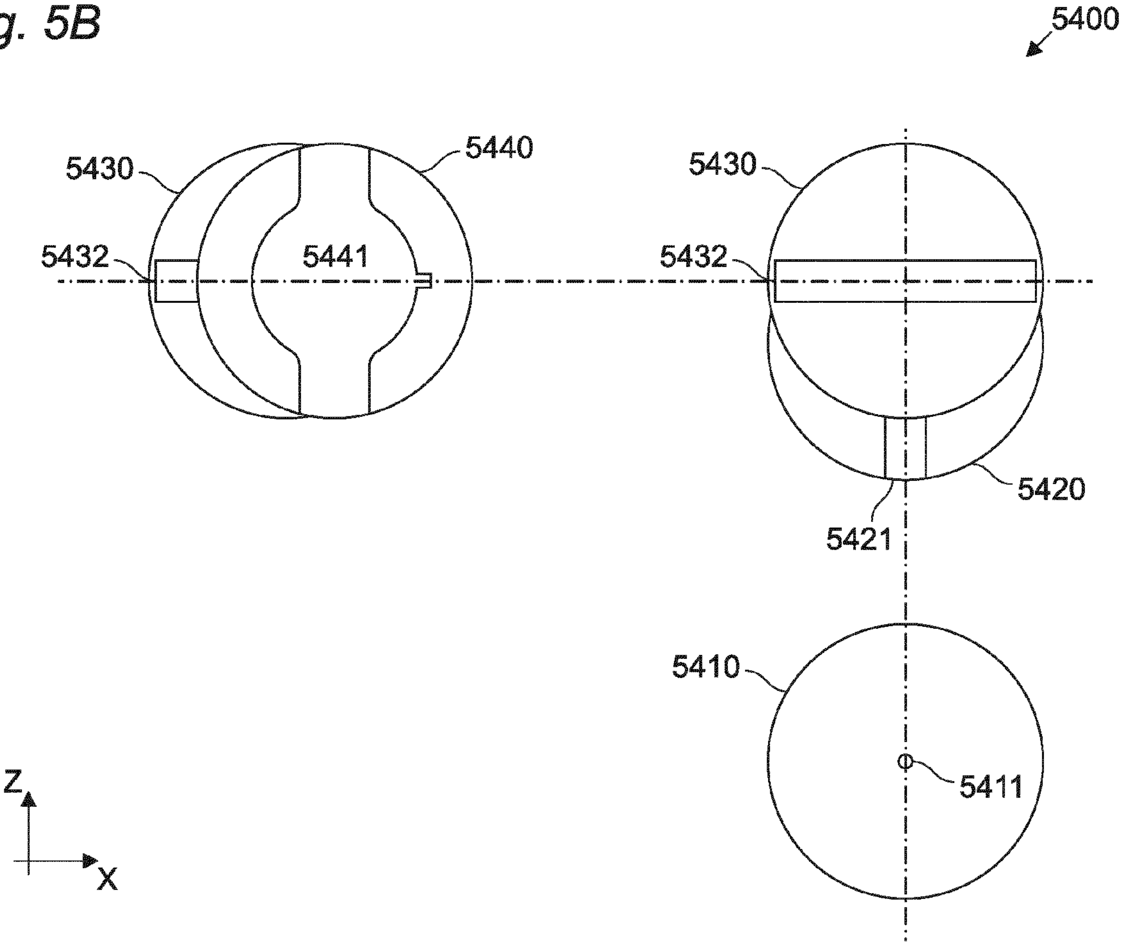

5400
5441
5440
5432
5430
5431
5421
5420
5411
5410
Y
X

Fig. 5B


5400
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5440
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5441
5430
5432
5420
5421
5410
5411
Z
X

Fig. 6

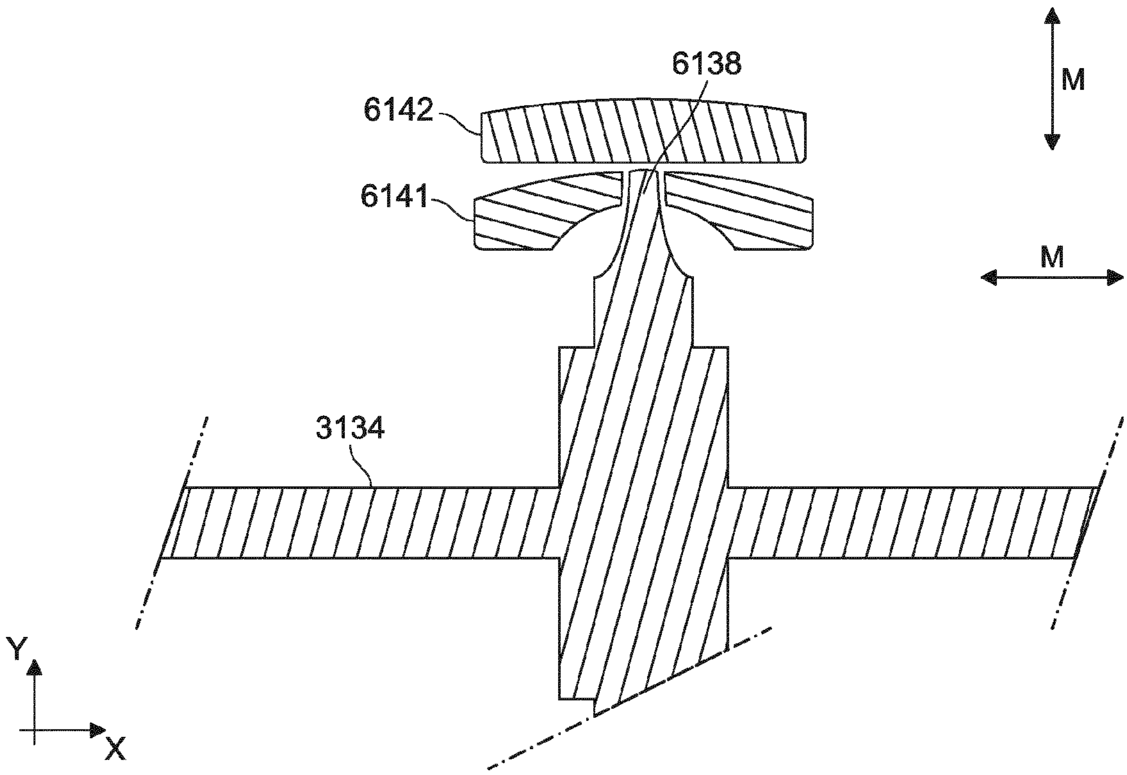


Fig. 7A

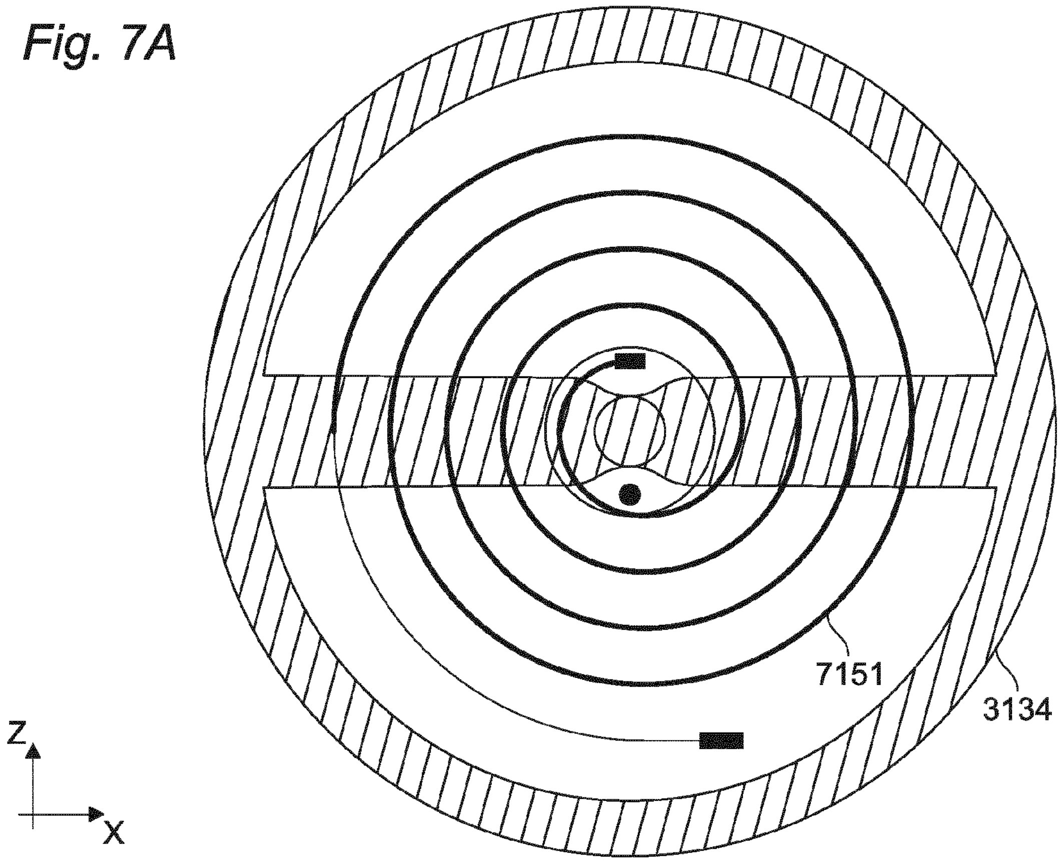


Fig. 7B

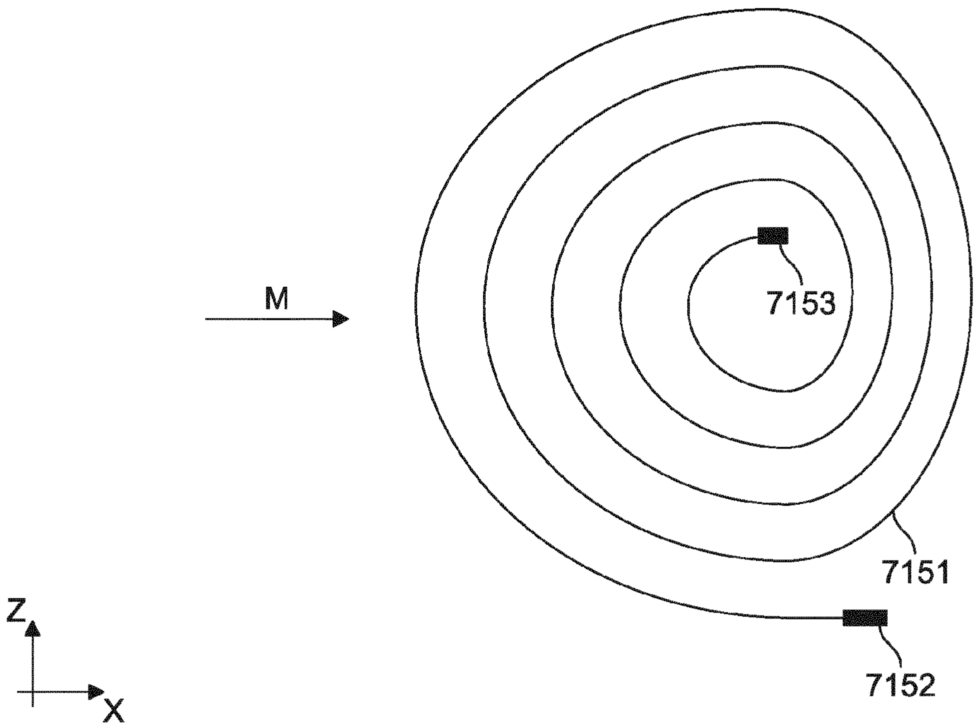
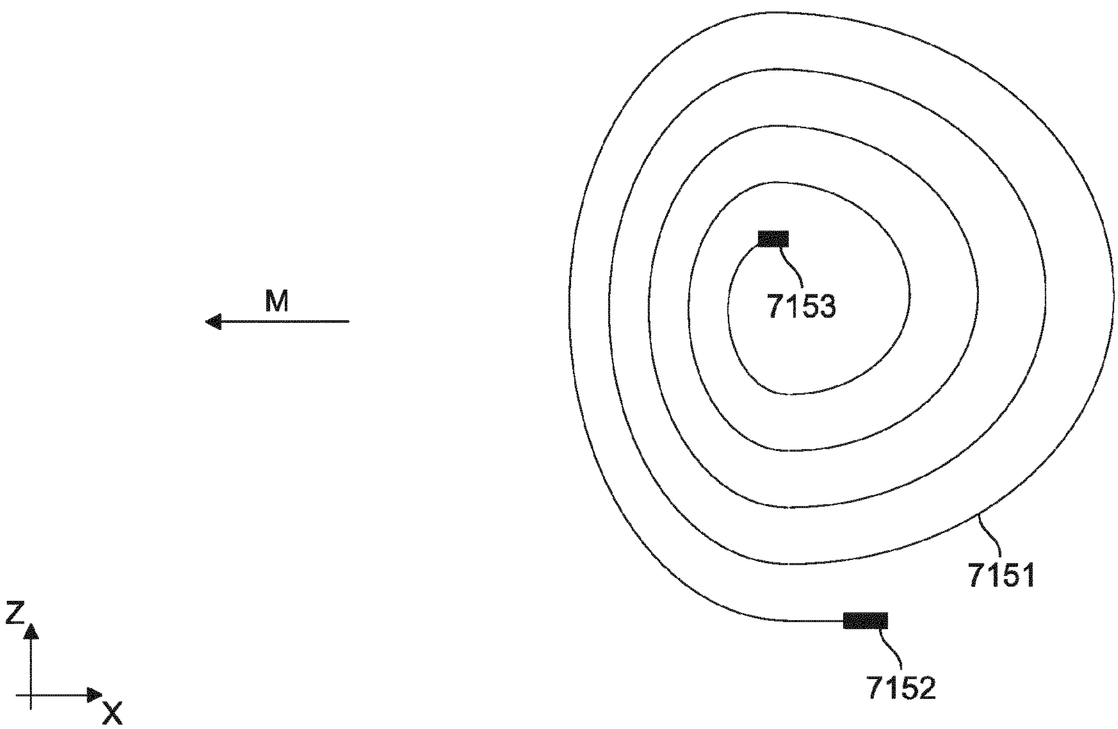


Fig. 7C



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EUROPEAN SEARCH REPORT

Application Number
EP 18 16 0793

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	DE 10 2013 012854 B3 (GODER REINHARD [DE]) 22 May 2014 (2014-05-22) * paragraphs [0010] - [0016]; figures 1-3 * -----	1-7 8-15	INV. G04D7/12
X A	EP 3 096 191 A1 (SWATCH GROUP RES & DEV LTD [CH]) 23 November 2016 (2016-11-23) * paragraphs [0013] - [0058]; figures 2,5,6 * -----	6,7 1-5,8-15	

TECHNICAL FIELDS SEARCHED (IPC)

G04D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	5 September 2018	Cavallin, Alberto

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05-09-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102013012854 B3	22-05-2014	NONE	
EP 3096191 A1	23-11-2016	EP 3096191 A1	23-11-2016
		WO 2016184736 A1	24-11-2016

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