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(54) **ANTEROGRADE DISPLAY MECHANISM FOR TIMEPIECE**

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See application file for complete search history.

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(57) **ABSTRACT**

An anterograde display mechanism including: a first wheel driven by a horological movement; a second wheel coaxial with the first wheel and linked to the first wheel by an elastic organ; a first intermediate wheel driven directly by the first wheel and which directly drives a third wheel bearing a display organ; the third wheel including a smooth angular sector where at least two teeth are truncated; a fourth wheel coaxial and rigidly connected in rotation with the third wheel, the fourth wheel meshing the second wheel via a second intermediate wheel; the anterograde display mechanism being configured so that the rotational speed of the second wheel is less than the rotational speed of the first wheel when the display organ is driven in the angular movements thereof by successive short jumps of an angle (α) between two guide-marks separated by the first angle (α).

16 Claims, 7 Drawing Sheets

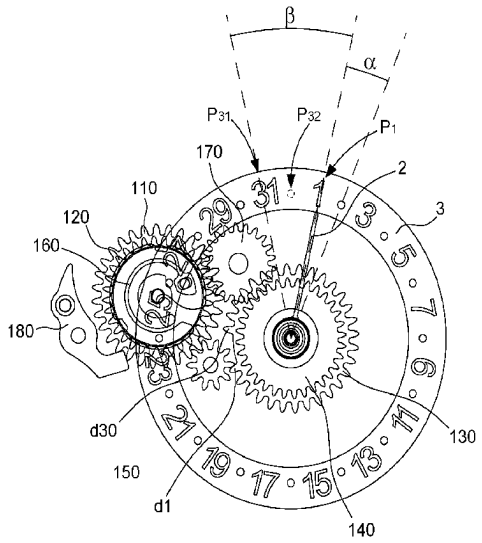

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Fig. 1

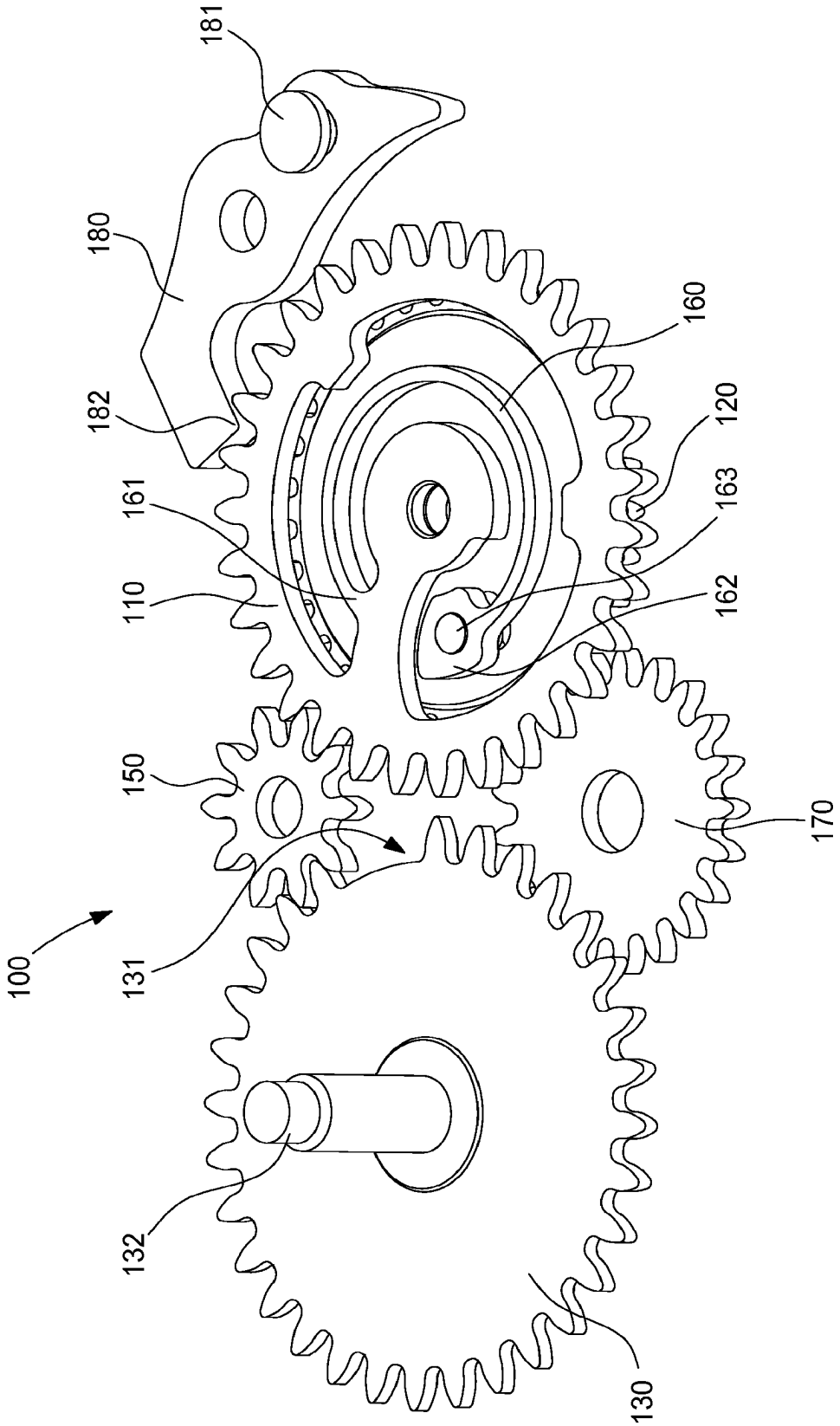


Fig. 2

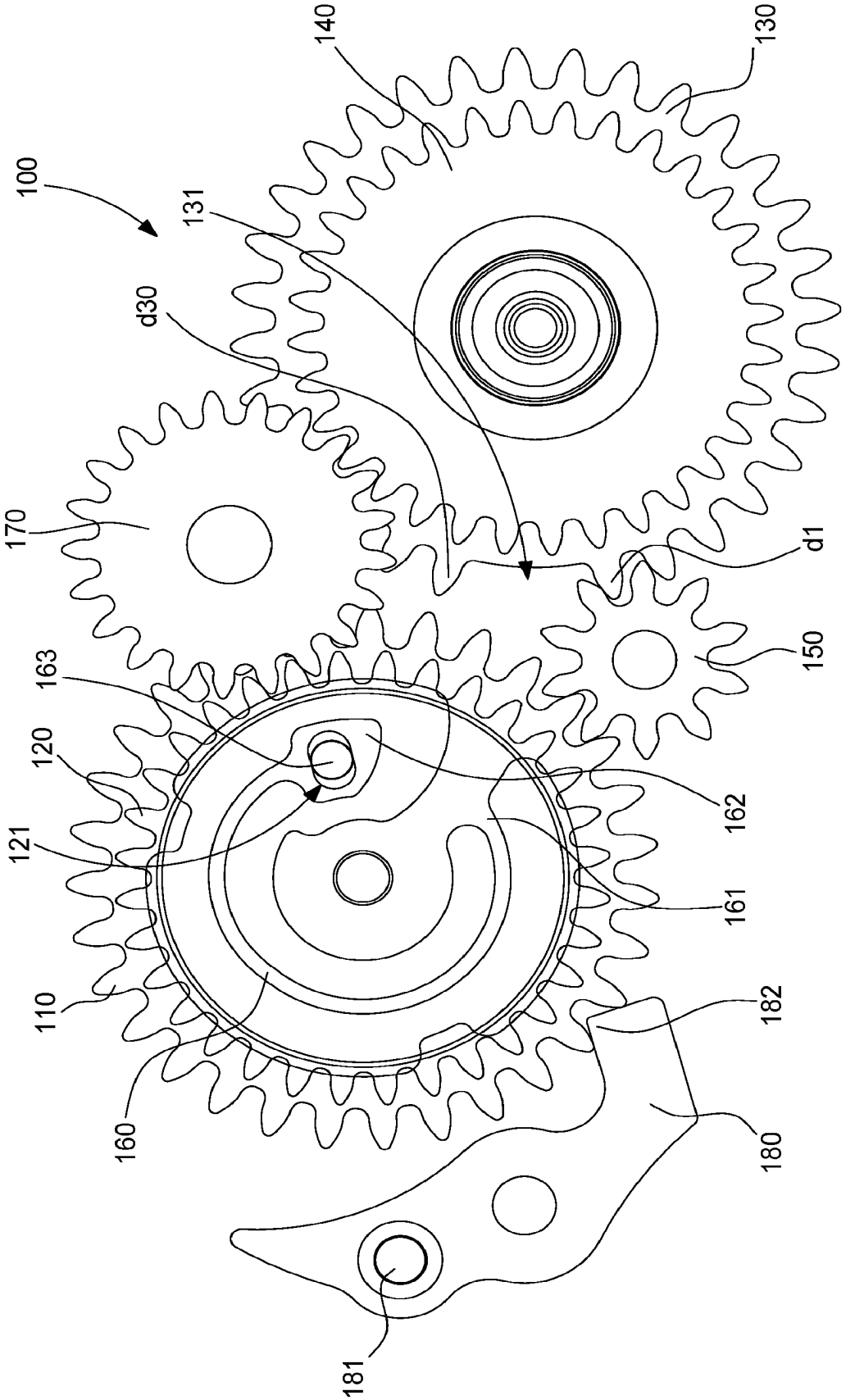

100
110
120
121
130
131
140
150
160
161
162
163
170
180
181
182
d1
d30

Fig. 4

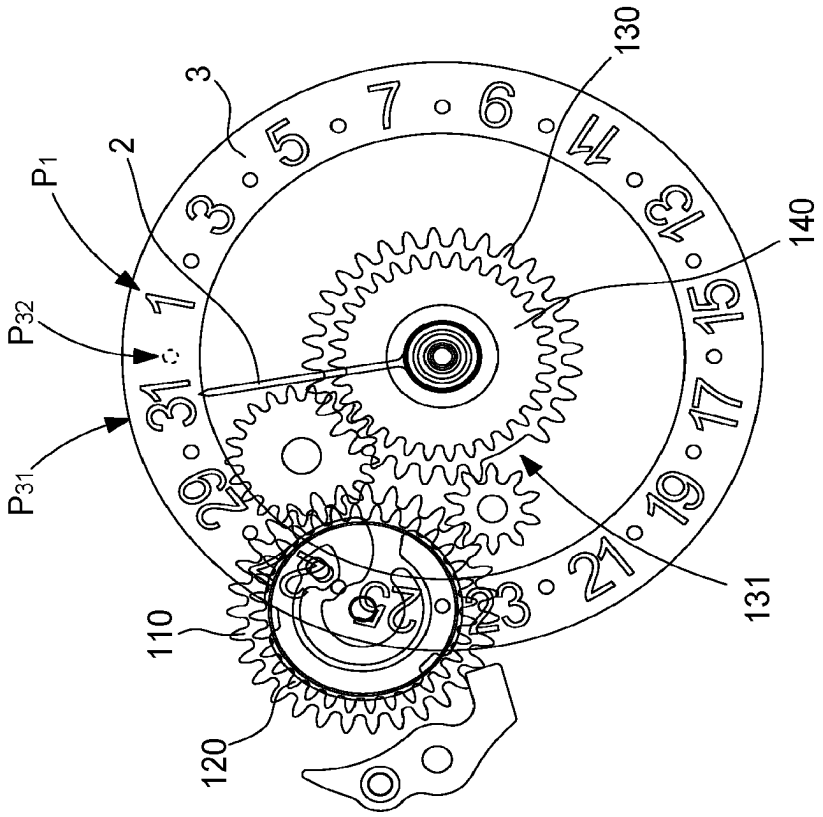

130
3
2
P1
140
P32
P31
131
110
120

Fig. 3

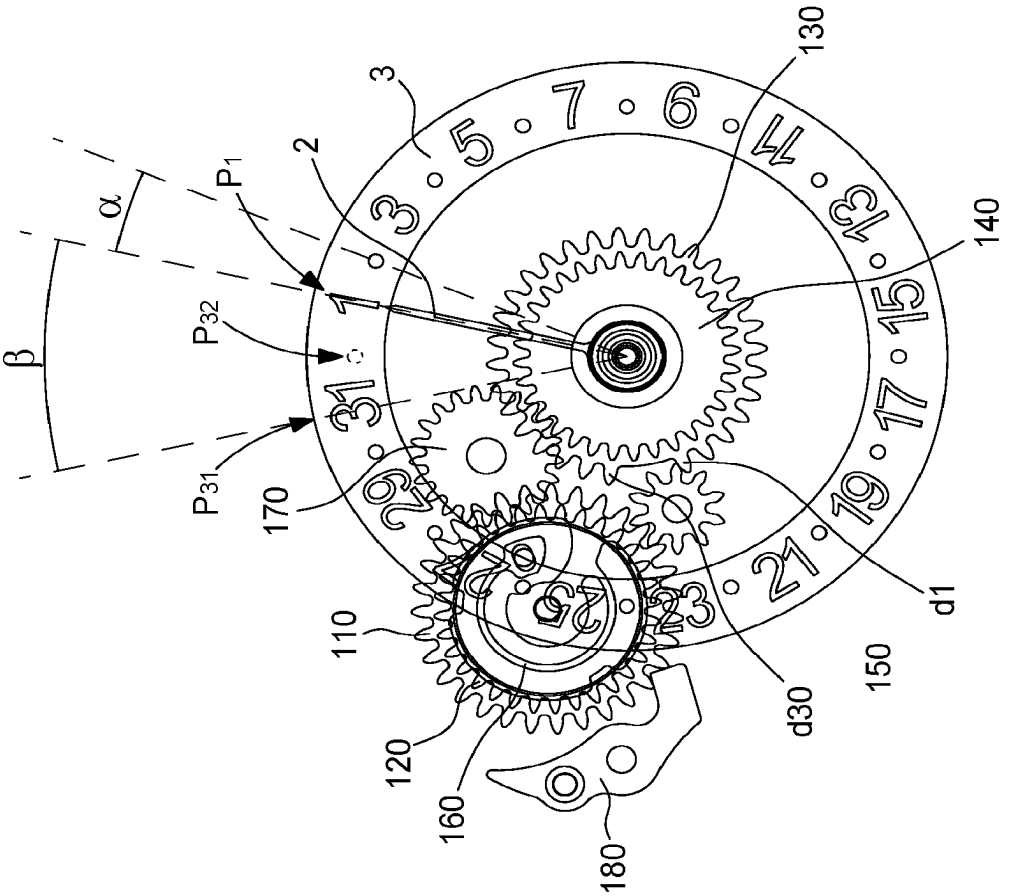

α
β
130
3
2
P1
140
P32
P31
170
d1
110
d30
150
120
160
180

Fig. 6

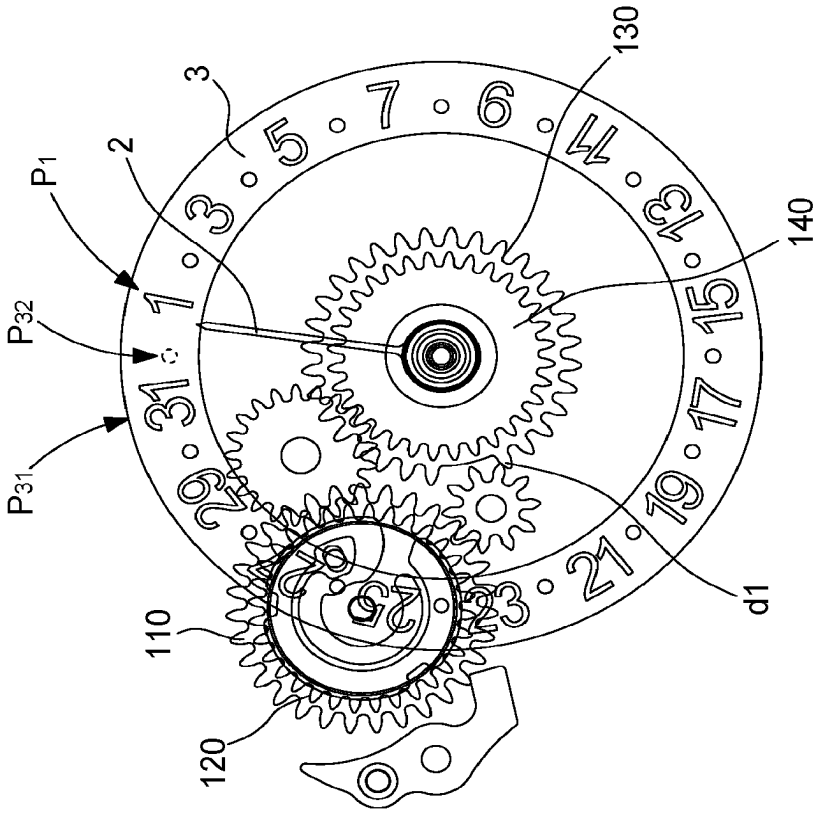


Fig. 5

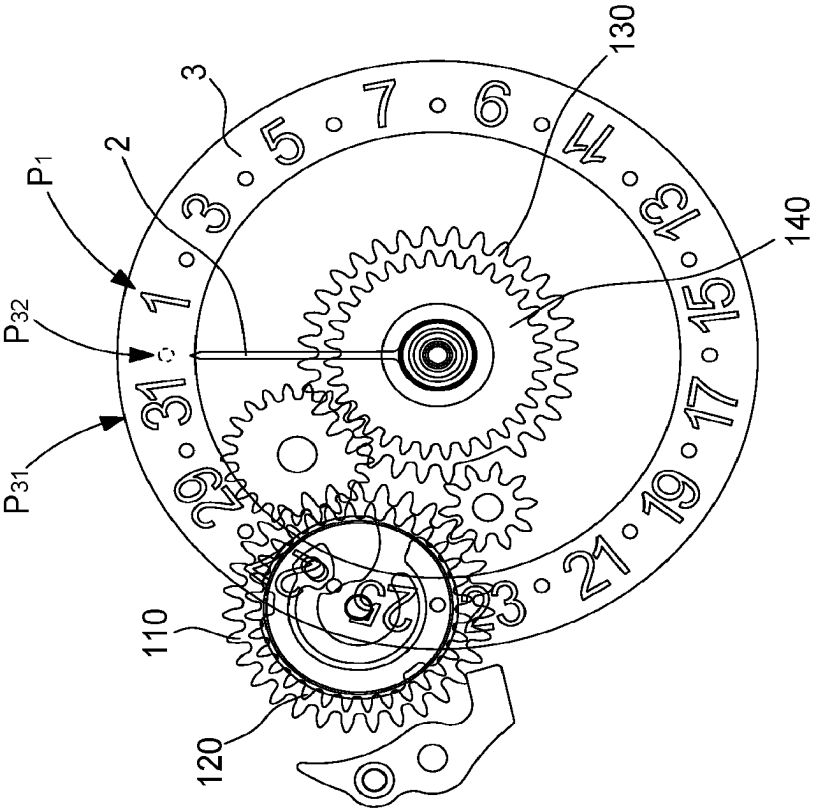


Fig. 7b

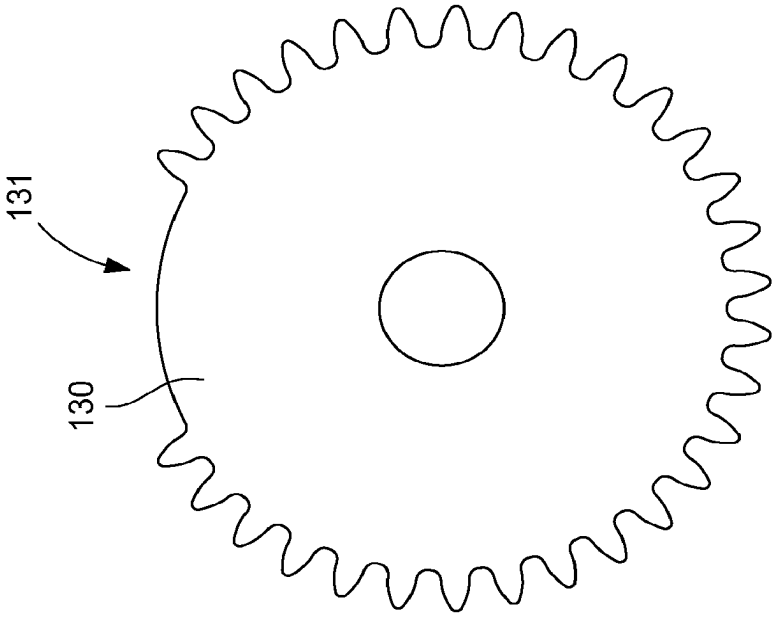


Fig. 7a

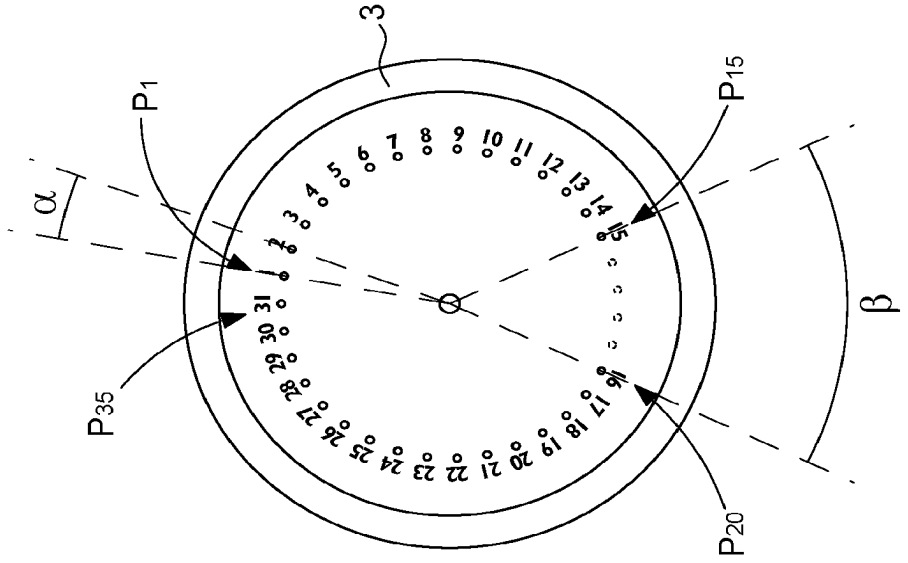


Fig. 8b

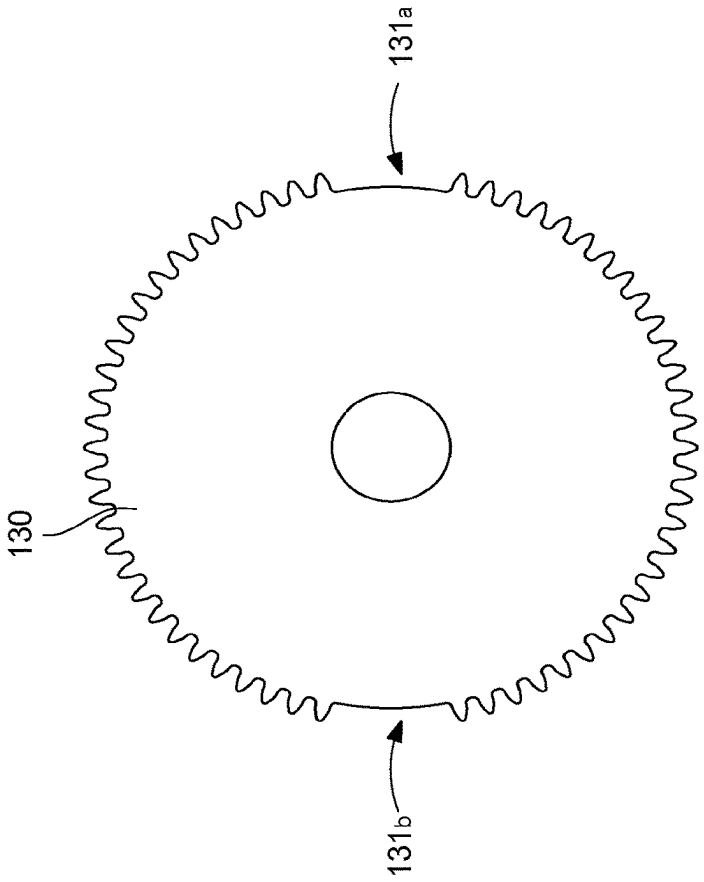


Fig. 8a

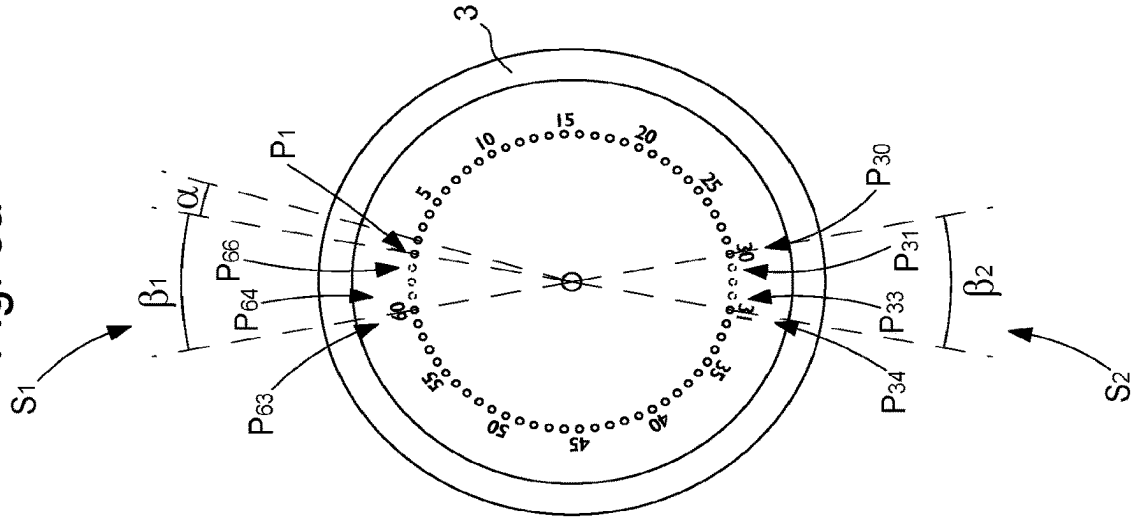


Fig. 9b

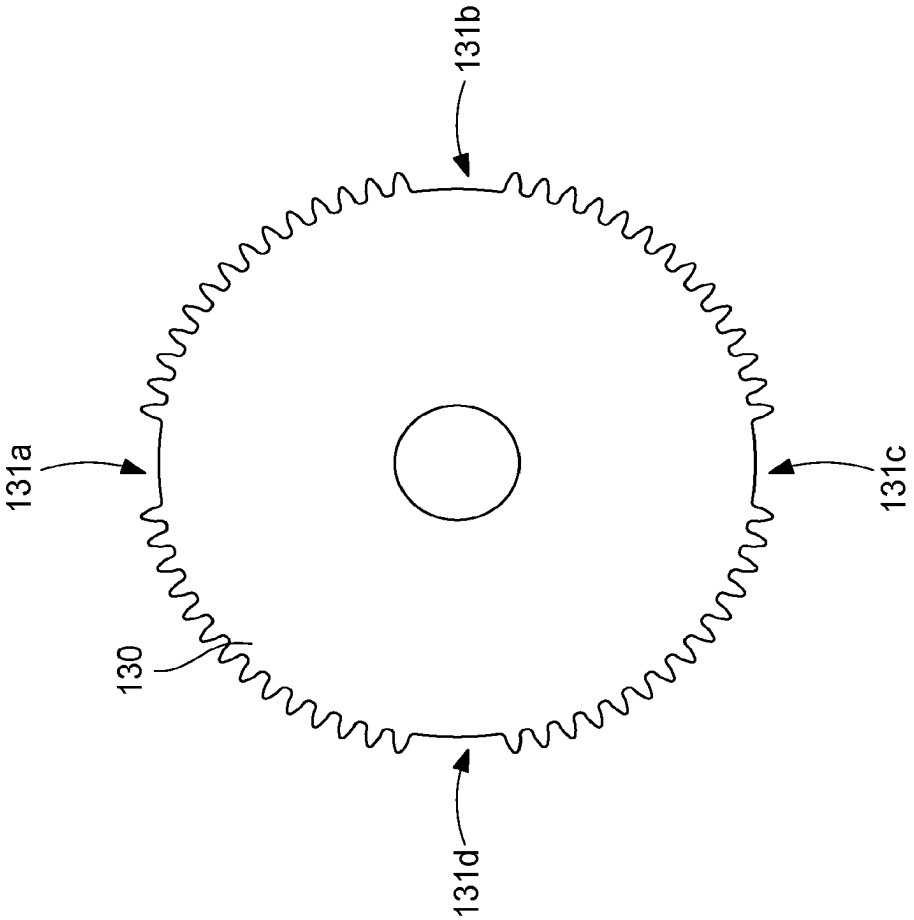
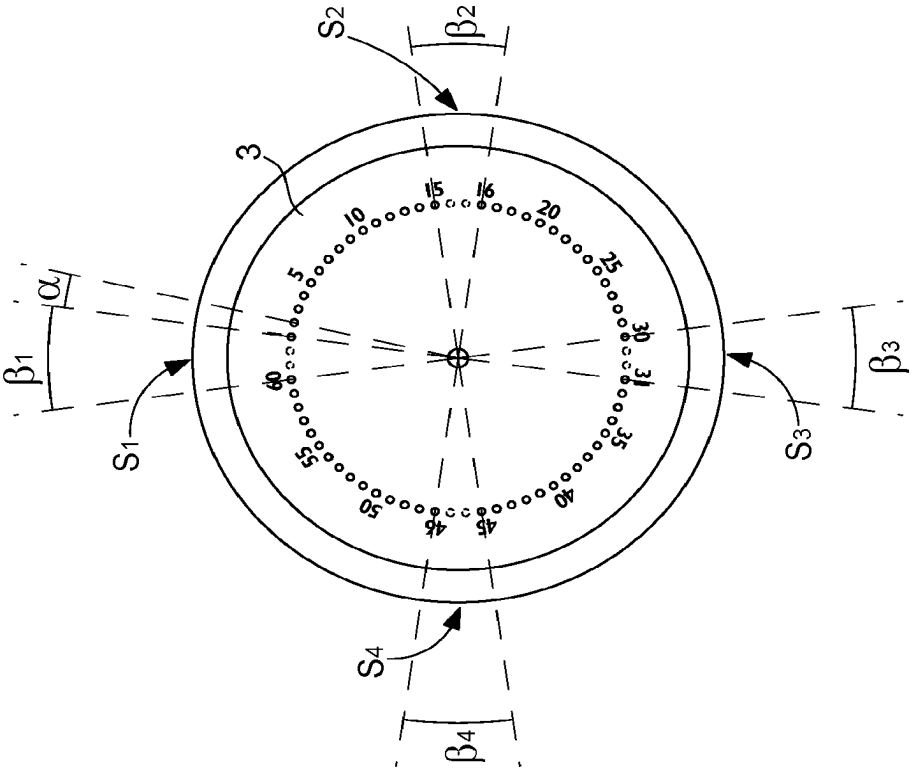


Fig. 9a



ANTEROGRADE DISPLAY MECHANISM FOR TIMEPIECE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to European Patent Application No. 22173340.5 filed on May 13, 2022, the entire disclosure of which is hereby incorporated herein by reference.

TECHNICAL FIELD OF THE INVENTION

The field of the invention relates to anterograde, or "anti-retrograde", display mechanisms, i.e. display mechanisms configured to pivot a display organ, in the running direction, by a first angular distance greater than a second angular distance.

The invention also relates to a horological movement including such an anterograde display mechanism, as well as a timepiece including such a horological movement.

TECHNOLOGICAL BACKGROUND

Anterograde display mechanisms are conventionally used to display information relating to the current hour or information relating to the date.

In a conventional timepiece, the guide-marks for graduating the current hour or the date are generally distributed uniformly on a circumference of the dial. However, in certain situations, it is desirable that the display organ not remain in a stable position on a particular sector of the dial to prevent the display organ from concealing, at a certain time, for example a complication (for example a tourbillon) or another display (for example a moon phase) positioned in the particular sector of the dial in question.

To prevent a display organ from remaining indexed in a predefined dial sector, it is known to use anterograde display mechanisms enabling the display organ to jump forwards by a greater angular distance than for the other graduations, on a predefined angular sector, such that the display organ does not stop in this angular sector.

Patent CH 699 736 describes an embodiment example of such an anterograde display mechanism applied to a date, in which the date graduation guide-marks are not distributed uniformly on a circumference but are disposed such that the angular distance separating the guide-marks 15 and 16 is greater than the angular distance separating the other guide-marks from 1 to 31. Thus, between the guide-marks 15 and 16, an angular sector of the dial of the timepiece without a guide-mark is created wherein the date hand does not stop, but jumps by a second angle greater than a first angle separating the other graduation guide-marks. The anterograde display mechanism described in this patent is based on the use of several toothed sectors and the complex cooperation thereof.

Patent document CH 713 209 describes another embodiment example of an anterograde display mechanism also applied to a date. In this document, the angular distance separating the guide-marks 31 and 1 is greater than the angular distance separating the other guide-marks between 1 and 31. To tip the date hand of the guide-mark 31 to the guide-mark 1 without stopping, the document proposes the use of a snail-shaped cam rigidly connected to the date wheel bearing the date hand, said date wheel being put forward by one step per day by a date actuator. The snail-shaped cam cooperates with a lever and a spring to ensure the stable angular position of the cam between the guide-marks 1 to 31. The snail-shaped cam includes a toothed portion comprising 30 teeth for the 30 stable positions between the guide-mark 1 and 31, and a smooth portion extending in an angular sector corresponding to the angular sector of the dial devoid of graduation (between the guide-mark 31 and 1) making it possible, under the action of the lever, to pivot the cam and the date wheel by an angle corresponding to the angle between the guide-marks 31 to 1.

However, either these anterograde mechanisms are complex to manufacture and to integrate in a watch case, or these mechanisms are very sensitive to manufacturing, and particularly machining, variations, giving rise to lags in the jumps in respect of the graduations, which renders these mechanisms difficult to industrialize.

Consequently, there is a need to improve anterograde display mechanisms, particularly to render them easier to industrialize, and therefore less sensitive to dimensional variations of the parts, compact, easy to use, and more reliable.

SUMMARY OF THE INVENTION

In this context, the invention proposes an anterograde display mechanism for a timepiece including a display having a graduation having a plurality of guide-marks distributed on a circumference of the display, the graduation being configured such that the angular distance separating two successive guide-marks corresponds to a second angle β greater than a first angle α separating two of the other successive guide-marks, the anterograde display mechanism being configured to drive a display organ in the angular movements thereof by successive short jumps of an angle α between two guide-marked separated by the first angle α and by a long jump of an angle β between two graduation guide-marks separated by the second angle β, the anterograde display mechanism being characterised in that it includes:

- a first wheel, referred to as drive wheel, capable of being driven by a horological movement;
- a second wheel coaxial with the first wheel and linked to the first wheel by an elastic organ;
- a first intermediate wheel driven directly by the first wheel and which directly drives a third wheel, referred to as display wheel, cooperating with said display organ; said third wheel including a smooth angular sector where at least two teeth are truncated;
- a fourth wheel coaxial and rigidly connected in rotation with the third wheel, said fourth wheel meshing said second wheel via a second intermediate wheel;

the anterograde display mechanisms being configured so that the rotational speed of the second wheel is less than the rotational speed of the first wheel when the display organ is driven in the angular movements thereof by successive short jumps of an angle α between two guide-marks separated by the first angle α, so as to progressively wind the elastic organ during these successive short jumps, and so that when the teeth of the intermediate wheel encounter the smooth angular sector of the third wheel, the elastic organ is let down inducing the instantaneous passage of the smooth angular sector and inducing the angular movement by a long jump of an angle β of said display organ.

In addition to the features mentioned in the preceding paragraph, the anterograde display mechanism according to the invention can have one or more complementary features

from among the following, considered either on an individual basis or according to any technically possible combinations:

- the first wheel is capable of being driven by jumps by said horological movement;
- the first wheel includes a number of teeth n_1, the number of teeth n_1 being equal to the number of graduation guide-marks of the display;
- the second wheel includes a number of teeth n_2 greater than the number of teeth n_1 of the first wheel;
- the third wheel includes an effective number $n_{3\ eff}$ of teeth distributed on a toothed portion and a number of truncated teeth $n_{3\ tronq}$ on the smooth angular sector, the whole forming an equivalent number $n_{3\ equi}$ of teeth on the full circumference of the third wheel, the equivalent number $n_{3\ equi}$ of teeth on the full circumference of the third wheel being equal to the number of teeth n_2 of the second wheel;
- the number of truncated teeth $n_{3\ tronq}$ on the smooth angular sector of the third wheel is an integer corresponding to the ratio of the second angle β over the first angle α;
- the fourth wheel includes a number of teeth n_4 equal to the number of teeth n_2 of the second wheel;
- the number of teeth n_2 of the second wheel is determined by the following relation:

$$n_2=n_1+\Sigma_{i=1}^{j}((\beta_i/\alpha)-1),$$

where:

- α is the first angle corresponding to a first angular distance separating at least two successive graduation guide-marks;
- β_i is the second angle, greater than the first angle α, corresponding to a second angular distance, different from the first angular distance, separating at least two other successive graduation guide-marks at a sector S_i of the graduation;
- i is an integer between 1 and j;
- j is an integer corresponding to the total number of sectors S_i of the graduation where two successive graduation guide-marks are spaced apart by a second angle β_i greater than the first angle α;
- the elastic organ is a strip spring, a sheet, a flat spring, or a spiral spring;
- the elastic organ is integral with the first wheel such that it includes a first one-piece end with said first wheel and a second end connected to the second wheel, or the elastic organ is integral with the second wheel such that it includes a first one-piece end with said second wheel and a second end connected to the first wheel;
- the display includes a date graduation with 31 guide-marks and in that the display organ is a date hand;
- the date graduation comprises the numerals 1 to 31 and/or indexes corresponding to the numerals, the successive numerals from 1 to 31 being separated by the first angle α and the numerals 31 and 1 being separated by the second angle β greater than said first angle α;
- the first wheel includes 31 teeth and is configured to perform one turn in 31 days, and the anterograde display mechanism is configured to progressively wind the elastic organ for 31 days;
- the display includes a minute or second graduation with 60 guide-marks, and the display organ is respectively a minute or second hand.

The invention also relates to a horological movement characterised in that it includes an anterograde display mechanism according to the invention.

The invention also relates to a timepiece including a horological movement moving an anterograde display mechanism according to the invention.

Preferably, the timepiece is a wristwatch.

BRIEF DESCRIPTION OF THE FIGURES

The purposes, advantages and features of the present invention will be better understood upon reading the detailed description given below with reference to the following figures:

FIG. **1** illustrates a schematic perspective representation of a first embodiment example of an anterograde display mechanism according to the invention;

FIG. **2** is a schematic bottom view representation of the anterograde display mechanism illustrated in FIG. **1**;

FIGS. **3** to **6** schematically illustrate different positions of the anterograde display mechanism illustrated in FIG. **1**;

FIGS. **7***a* and **7***b* schematically illustrate a second embodiment example of the anterograde display mechanism according to the invention, and more specifically a second embodiment example of a display dial in FIG. **7***a* and a second embodiment example of a corresponding display wheel, in FIG. **7***b*;

FIGS. **8***a* and **8***b* schematically illustrate a third embodiment example of the anterograde display mechanism according to the invention, and more specifically a third embodiment example of a display dial in FIG. **8***a* and a third embodiment example of a corresponding display wheel, in FIG. **8***b*;

FIGS. **9***a* and **9***b* schematically illustrate a fourth embodiment example of the anterograde display mechanism according to the invention, and more specifically a fourth embodiment example of a display dial in FIG. **9***a* and a fourth embodiment example of a corresponding display wheel, in FIG. **9***b*.

In all figures, common elements bear the same reference numerals unless indicated otherwise.

DETAILED DESCRIPTION OF THE INVENTION

The anterograde display mechanism **100** according to the invention is intended to be housed in a timepiece, for example in a wristwatch.

The anterograde display mechanism **100** according to the invention is configured to be actuated by a horological movement (not shown), i.e. by a mechanism in which the functioning is dependent on the division of time.

The anterograde display mechanism **100** is configured to produce a jump display of a display organ (or indicator), for example a hand, facing a display, for example a dial, having a peripheral graduation formed by a plurality of guide-marks distributed on a circumference of the display, the angular distance separating two of these consecutive guide-marks corresponding to a second angle β greater than a first angle α separating two of the other consecutive guide-marks of the graduation. The graduation includes at least two consecutive guide-marks separated by a second angle β greater than a first angle α.

In an alternative embodiment (not shown), the anterograde display mechanism **100** is configured to produce a display by jumping of a display organ, for example a disk having a plurality of guide-marks, forming a peripheral graduation, distributed on the circumference of the disk, cooperating with an opening arranged in a dial forming a window revealing a portion of the display organ.

The anterograde display mechanism **100** is configured to drive the display organ with successive short jumps between the graduation guide-marks separated by a first angle α and by a long jump between the two consecutive graduation guide-marks separated by the second angle β.

In a first embodiment example of the anterograde display mechanism **100** illustrated specifically in FIGS. **1** to **6**, the anterograde display mechanism **100** is applied to a specific example of date display. However, the anterograde display mechanism according to the invention is also applicable for the display of all time-based information. Thus, the anterograde display mechanism according to the invention can equally well be an anterograde display mechanism of the date, hour, minute, second, or chronograph, moon phase, counter, power reserve, etc.

In a first example represented in FIGS. **1** to **6**, the anterograde display mechanism **100** includes a dial **3** (represented in FIGS. **3** to **6**) bearing a plurality of guide-marks forming a date graduation. The dial **3** therefore includes 31 guide-marks distributed on the circumference of the dial **3**.

In the example shown, the date graduation comprises the odd numerals 1 to 31 distributed on a circumference of the dial **3** as well as indexes located between two odd numerals. The indexes located between the odd numerals here represent even numerals. They replace the numerals of the graduation particularly for better readability of the display. Thus, in the present application, for more clarity, reference will only be made to numerals, the even numerals being indexes here.

The angular distance separating the consecutive numerals 31 and 1 corresponds to a second angle β greater than a first angle α separating the other numerals between 1 and 31 of the date graduation.

FIG. **1** illustrates a schematic perspective view of the anterograde display mechanism **100** according to the invention for driving the display organ in the angular movements therefore by successive short jumps between the guide-marks separated by an angle α and by a long jump between the graduation guide-marks separated by an angle β.

FIG. **2** schematically illustrates a bottom view of the anterograde display mechanism **100** illustrated in FIG. **1**.

With reference to FIGS. **1** and **2**, the anterograde display mechanism **100** according to the invention includes a first wheel **110**, referred to as drive wheel, driven in rotation directly by the horological movement (not shown).

In the embodiment example shown, the rotational speed of the drive wheel **110** is 1 turn in 31 days, and the drive wheel is moved once per day by the horological movement. The drive wheel **110** therefore is put forward by one step per day.

For this purpose, the drive wheel **110** includes a number of teeth n_1, here equal to 31 teeth for 31 indexing positions of the drive wheel **110** corresponding to 31 indexed positions of the date display device, with respect to the 31 guide-marks of the date graduation of the dial **3**.

Each indexing position of the drive wheel **110** is indexed by a jumper **180** cooperating with the drive wheel **110**. The jumper **180** is rotatable about a pivot **181** and constrained by an elastic element (not shown) tending to return a jumper beak **182** to the axis of rotation of the drive wheel **110**, such that the jumper beak **182** cooperates with the teeth and the inter-tooth spaces of the drive wheel **110** to ensure that the drive wheel **110** is held in position between each step.

The anterograde display mechanism **100** further includes a second wheel **120** mounted coaxial with the drive wheel **110**. The second wheel **120** includes a different number of teeth n_2 from the number of teeth n_1 of the drive wheel **110**.

Advantageously, the second wheel **120** includes a number of teeth n_2 greater than the number of teeth n_1 of the drive wheel **110**.

The drive wheel **110** and the second wheel **120** are not rigidly connected in rotation. The two wheels **110**, **120** are connected to one another by an elastic organ **160**. The elastic organ **160** includes a first end **161** rigidly connected to the drive wheel **110** and a second end **162** rigidly connected to the second wheel **120**.

Rigidly connected means a mechanical connection of which at least a degree of freedom is locked.

The anterograde display mechanism **100** further includes a third wheel **130**, referred to as display wheel, which drives the display organ for displaying the date on a dial **3**.

For example, as represented in FIGS. **3** to **6**, the display organ can be formed by a date hand **2** mounted on a barrel **132** of the display wheel **130**.

According to an alternative embodiment (not shown), the display organ is a disk rigidly connected in rotation to the display wheel **130**, the disk having a plurality of guide-marks forming the date graduation, and being configured to cooperate with an opening of the dial to reveal a portion of the disk.

The drive wheel **110** directly drives an intermediate wheel **150**, which directly drives the display wheel **130**. The intermediate wheel **150** makes it possible advantageously to create a setting-wheel between the drive wheel **110** and the display wheel **130**.

The display wheel **130** includes at least one toothed portion and at least one angular sector **131** wherein a plurality of teeth are truncated so as to form a "smooth" angular sector without teeth. Thus, momentarily, on each full rotation of the display wheel **130**, the display wheel **130** is not directly engaged with the drive wheel **110** when the smooth angular sector **131** of the display wheel **130** will be facing the toothing of the intermediate wheel **150**.

In the specific case illustrated in FIGS. **1** to **6**, the smooth angular sector **131** is bordered by a first tooth d**1** of the toothing and a by a last tooth d**30** of the toothing, the display wheel **130** including 30 teeth.

In the example presented in FIGS. **1** to **6**, the display wheel **130** includes a single smooth angular sector **131** defining a zone wherein at least two teeth are truncated.

Thus, the display wheel **130** includes an effective number $n_{3\,eff}$ of teeth distributed on the toothed portion and a number $n_{3\,tronq}$ of truncated teeth on the smooth angular sector **131**. Thus, a number $n_{3\,equi}$ is obtained, corresponding to an equivalence of teeth on the circumference of the wheel.

For the display wheel **130**, we have the following relation:

$$n_{3\,equi}=n_{3\,eff}+n_{3\,tronq}$$

It will be noted that the display wheel **130** can also comprise several toothed portions and several smooth angular sectors **131**, having a more or less great angular distance, an equal angular distance or not, which can be distributed uniformly, or not, on the circumference of the display wheel **130**, according to needs. Further embodiment examples will be described hereinafter with reference to FIGS. **7** to **10**.

The anterograde display mechanism **100** further includes a fourth wheel **140** coaxial with the display wheel **130** and rigidly connected in rotation with the wheel with the display wheel **130**. The fourth wheel includes a number of teeth n_4.

The fourth wheel **140** meshes directly with a second intermediate wheel **170** which meshes directly with the second wheel **120**, such that the second wheel **120** is driven in rotation by the second intermediate wheel **170**.

Advantageously, the second wheel **120** has a greater number of teeth n_2 than the number of teeth n_1 of the drive wheel **110**, so as to have a rotational speed less than the rotation speed of the drive wheel **110**, and thus progressively wind, or charge, the elastic organ **160** during the rotation of the drive wheel **110**.

Advantageously, the second wheel **120** and the display wheel **130** respectively have a number of teeth n_2, $n_{3\ equi}$ greater than the number of teeth n_1 of the drive wheel **110**. Advantageously, the second wheel **120** and the display wheel **130** have the same number of teeth ($n_2=n_{3\ equi}$).

Advantageously, the second wheel **120**, the display wheel **130**, and the fourth wheel **140** respectively have a number of teeth n_2, $n_{3\ equi}$, n_4 greater than the number of teeth n_1 of the drive wheel **110**. Advantageously, the second wheel **120**, the display wheel **130**, and the fourth wheel **140** have the same number of teeth ($n_2=n_{3\ equi}=n_4$).

In the embodiment example illustrated in FIGS. **3** to **6**, the dial **3** includes the date graduation. The date graduation includes 31 guide-marks which are not distributed uniformly at the circumference of the dial **3**, since the second angle β between the numeral 31 and 1 is greater than the first angle α separating the other numerals between 1 and 31.

In this example, the angle β is two times greater than the angle α.

Thus, the dial **3** is divided into 32 equidistant divisions, of which two consecutive divisions are separated by the first angle α.

These divisions form indexable positions P_x, where x ranges from 1 to 32.

The 31 numerals forming the date graduation guide-marks are distributed at 31 indexable positions of the dial **3**, positions P_1 to P_{31}.

The indexable position P_{32} (fictitious, hence represented with a dotted line) has no guide-mark and is intended to be jumped directly by the date hand **2** making a long jump of an angle β between the numeral 31 (indexable position P_{31}) and the numeral 1 (indexable position P_1).

The drive wheel **110** includes 31 teeth corresponding to the 31 indexed positions of the date hand **2**, and therefore 31 guide-marks of the dial **3** of the date graduation.

Advantageously, the second wheel **120** includes a number of teeth n_2 defined by the following relation:

$$n_2=n_1+\Sigma_{i=1}^{j}((\beta_i/\alpha)-1)$$

where:

- α is a first angle corresponding to a first angular distance separating at least two successive graduation guide-marks,
- β_i is a second angle, greater than the first angle α, corresponding to a second angular distance, different from the first angular distance, separating at least two other successive graduation guide-marks at a sector S_i of the graduation,
- i is an integer between 1 and j;
- j is an integer corresponding to the total number of sectors S_i of the graduation where two successive graduation guide-marks are spaced apart by a second angle β_i greater than the first angle α.

As seen above, the second angle β is two times greater than the first angle α.

$$n_1=31$$

$$\beta/\alpha=2$$

$$n_2=32=n_{3\ equi}=n_4$$

The number $n_{3\ tronq}$ of truncated teeth at the smooth angular sector **131** of the display wheel **130** is equivalent to the ratio between the second angle β and the first angle α.

$$n_{3\,tronq}=\frac{\beta}{\alpha}$$

Thus, in the embodiment example represented in FIGS. **1** to **6**, the display wheel **130** is equivalent to a wheel of 32 teeth whereon two consecutive teeth are truncated at the smooth angular sector **131**. The display wheel **130** therefore has 30 effective teeth $n_{3\ eff}$.

For a full rotation of the drive wheel **110**, the second wheel **120** will have an angular loss of 1/32° with respect to the drive wheel **110** which completes a turn in 31 days. The relative rotational speed difference between the drive wheel **110** and the second wheel **120** will progressively charge, or wind, the elastic organ **160**, by elastic deformation, throughout a given period, here 31 days.

The elastic organ **160** can be a strip spring, a sheet, a flat spring, a spiral spring or any other elastic element conventionally used in the field of watchmaking.

In the embodiment example illustrated in FIGS. **1** to **6**, the elastic organ **160** is integral with the drive wheel **110**. Consequently, the first end **161** is made of one piece with the drive wheel **110** and the second end **162** is connected to the second wheel **120**.

For example, the second end **162** forms a hooking head including a pin **163** cooperating with an oblong loop **121** arranged on the second wheel **120** to rigidly connect the second end **162** of the elastic organ **160** in rotation to the second wheel **120**.

According to an embodiment example not shown, the elastic organ is integral with the second wheel **120**, such that the second end **162** made of one piece with the second wheel **120** and that the first end **161** is connected to the drive wheel **110**.

Functioning of the Anterograde Display Mechanism

The functioning of the anterograde display mechanism **100** will be described hereinafter with reference to FIGS. **3** to **6**, representing the functioning of the embodiment example described with reference to FIGS. **1** to **2**.

FIG. **3** illustrates the anterograde display mechanism **100** when the date hand **2** is indexed on the numeral 1 of the date graduation of the dial **3**, corresponding to the indexable position P_1.

From this initial position of the anterograde display mechanism **100**, the display wheel **130** is driven by the drive wheel **110** for 31 days, at each step of the drive wheel **110**. During this period of 31 days, the date hand **2** is moved angularly once per day by successive short jumps of an angle α. The date hand **2** is therefore indexed day by day at the different date graduation guide-marks corresponding to the different divisions, or indexable positions P_x, of the dial **3** separated by an angle α; i.e. between the numeral 1 and the numeral 31, until the numeral 31 of the date graduation of the dial **3** (position P_{31}) is reached, as illustrated in FIG. **4**.

During this period of 31 days, the gear ratio between the drive wheel **110** and the other wheels **120**, **130**, **140** of the mechanism induces an angular lag between the drive wheel **110** and the second wheel **120**. This lag, increasing at each incrementation by the drive wheel **110**, will progressively charge the elastic organ **160**.

When the date hand **2** is indexed on the position P_{31} of the dial **3** (numeral 31 of the date graduation), the relative

angular difference between the drive wheel **110** and the second wheel **120** is maximum, and the elastic organ **160** is in the maximum wound position thereof.

Conversely, as illustrated in FIG. **3**, when the date hand **2** is indexed on the indexable position P_1 of the dial **3** (numeral 1 of the date graduation), the relative angular difference between the drive wheel **110** and the second wheel **120** is minimum, and the elastic organ **160** is in the discharged position thereof.

After the indexing of the display organ on the indexable position P_{31}, illustrated in FIG. **4**, the next step of the drive wheel **110** drives the additional rotation of the display wheel **130** until arriving at a position where the smooth angular sector **131** is facing the intermediate wheel **150**, such that the display wheel **130** is no longer engaged with the drive wheel **110**, as illustrated in FIG. **5**. As the display wheel **130** is momentarily no longer meshed with the drive wheel **110**, the elastic organ **160** is free to discharge the energy accumulated over the previous 31 days.

Under the discharge of the elastic organ **160**, the second wheel **120** tends to make up for the angular loss thereof accumulated over the previous 31 days, with respect to the drive wheel **110**, and drives the display wheel **130** in rotation (in the same direction of rotation as the drive wheel **110**) so as to put the date hand **2** forward (in the clockwise direction) until the passage of the smooth angular sector **131** and until the intermediate wheel **150** comes into contact with the tooth d**1** bordering the smooth angular sector **131**, as illustrated in FIG. **6**.

The elastic organ is then discharged instantaneously whereas the drive wheel **110** has not yet completed the rotation thereof corresponding to the daily angular step. This phase is particularly illustrated by FIG. **6**. In this figure, it is noted that the date hand **2** is not yet facing the guide-mark 1 of the dial **3**.

Indeed, at this stage, the step of the drive wheel **110** is not yet complete as the jumper **180** is not yet positioned between two teeth of the drive wheel **110**. With the return force of the elastic element acting upon the jumper **180**, the jumper **180** tends to finalise the rotation of the drive wheel **110** to the next indexing position. The additional rotation of the drive wheel **110** under the effect of the jumper **180** will make it possible to throw the first intermediate wheel **150** and therefore the display wheel **130** out of step to finalise the jump of the date hand **2** and bring the date hand **2** facing the numeral 1 of the date graduation of the dial **3**, as illustrated in FIG. **3** described above.

Thus, the long jump of an angle β of the date hand **2** between the numeral 31 and the numeral 1 of the date graduation corresponds to the rotation of an angle α conventionally generated by the daily step of the drive wheel **110** and by the discharging of the elastic member **160** causing an additional rotation of an angle $\varepsilon=\beta-\alpha$ to directly reach the numeral 1 of the date graduation.

Obviously, the rotation of the display wheel **130** and therefore of the date hand **2** due to the discharge of the elastic organ **160** is dependent on the energy accumulated during the previous indexing period and the angular distance of the smooth angular sector **131** of the display wheel **130**. Thus, different configurations are possible, and the long jump of an angle β can be greater than twice the angle α.

Alternative Embodiments

FIGS. **7***a* and **7***b* illustrate a second embodiment example of the anterograde display mechanism according to the invention for the display of a date. FIG. **7***a* illustrates a second embodiment example of a dial **3** bearing a date graduation, and FIG. **7***b* illustrates a second embodiment example of a corresponding display wheel.

In this second embodiment example, the dial **3** is divided into 35 equidistant divisions, of which two consecutive divisions are separated by the first angle α.

These divisions form indexable positions P_x, where x ranges from 1 to 35.

The 31 numerals forming the date graduation guide-marks are distributed at 31 indexable positions P_x of the dial **3**, positions P_1 to P_{15} and positions P_{16} to P_{35}.

In this embodiment example, four successive divisions or indexable positions of the dial **3**, here positions P_{16} to P_{19} are fictitious and do not have a date guide-mark. Consequently, these divisions are not intended to be indexed by the date hand **2**.

Indeed, between the numeral 15 and the numeral 16, the date hand **2** here performs a long jump of an angle β, from the numeral 15 (indexable position P_{15}) to the numeral 16 (indexable position P_{20}), five times greater than the angle α between the other numerals of the date graduation.

The drive wheel **110** includes 31 teeth corresponding to the 31 indexed positions of the date hand **2**, and therefore 31 guide-marks of the dial **3** of the date graduation.

The second wheel **120** includes a number of teeth n_2 defined by the following relation:

$$n_2=n_1+\Sigma_{i=1}^{j}((\beta_i/\alpha)-1), \text{ where } j=i=1$$

$$n_2=31+(5-1)=35$$

Thus, in this second embodiment example, the second wheel **120** and the fourth wheel have 35 teeth, and the display wheel **130** is equivalent to a wheel of 35 teeth.

The number of truncated teeth $n_{3\ tronq}$ at the smooth angular sector **131** of the display wheel **130** is equal to 5:

$$n_{3\,tronq}=\frac{\beta}{\alpha}=5$$

Consequently, in this second embodiment example, the display wheel **130** is equivalent to a wheel of 35 teeth whereon five consecutive teeth are truncated at the smooth angular sector **131**. The display wheel **130** therefore has 30 effective teeth.

FIGS. **8***a* and **8***b* illustrate a third embodiment example of the anterograde display mechanism according to the invention for the display of minutes. FIG. **8***a* illustrates a third embodiment example of a dial **3** bearing a minute graduation, and FIG. **8***b* illustrates a third embodiment example of a corresponding display wheel.

In this third embodiment example, the dial **3** is divided into 66 equidistant divisions, of which two consecutive divisions are separated by the first angle α.

These divisions form indexable positions P_x, where x ranges from 1 to 66.

In this third embodiment, the 60 guide-marks of the minute graduation are distributed on 60 indexable positions P_x of the dial **3**, positions P_1 to P_{30} and positions P_{34} to P_{63}.

The dial **3** includes two sectors S_1 and S_2 including three successive divisions, here positions P_{31} to P_{33} and P_{64} to P_{66}, which are fictitious and have no minute guide-mark. Consequently, these divisions are not intended to be indexed by the minute hand.

Thus, at the first sector S_1, between the numeral 30 and the numeral 31, the minute hand performs here a first long

jump of an angle β_1, four times greater than the angle α corresponding to the short jump between the minute graduation numerals.

At the second sector S_2, between the numeral 60 and the numeral 1, the minute hand performs here a second long jump of an angle β_2, four times greater than the angle α corresponding to the short jump between the minute graduation numerals.

In this embodiment example, the drive wheel includes 60 dents for the 60 minutes indexed by the minute display organ.

The second wheel **120** includes a number of teeth n_2 defined by the following relation:

$$n_2=n_1+\Sigma_{i=1}^{j}((\beta_i/\alpha)-1), \text{ where } j=2$$

$$n_2=n_1+((\beta_1/\alpha)-1)+((\beta_2/\alpha)-1$$

$$n_2=60+(4-1)+(4-1)=66$$

Thus, in this third embodiment example, the second wheel **120** and the fourth wheel have 66 teeth, and the display wheel **130** is equivalent to a wheel of 66 teeth.

The display wheel **130**, illustrated in FIG. **8***b*, here includes two smooth angular sectors **131***a*, **131***b* opposite one another to make it possible to perform the indexing of the display organ at the minute graduation of the dial **3** illustrated in FIG. **8***a*, as well as the short jumps of an angle α and the two long jumps of an angle β_1 and β_2.

The number $n_{3\ tronq}$ of truncated teeth at the first smooth angular sector **131***a* of the display wheel **130** is equal to 4:

$$n_{3\,tronq}=\frac{\beta_1}{\alpha}=4$$

The number $n'_{3\ tronq}$ of truncated teeth at the second smooth angular sector **131***b* of the display wheel **130** is equal to 4:

$$n'_{3\,tronq}=\frac{\beta_2}{\alpha}=4$$

Consequently, in this third embodiment example, the display wheel **130** is equivalent to a wheel of 66 teeth whereon four consecutive teeth are truncated at a first smooth angular sector **131***a* and four consecutive teeth are truncated at a second smooth angular sector **131***b*.

The display wheel **130** therefore has 58 effective teeth, either 29 consecutive teeth between each smooth angular sector **131***a*, **131***b*, or 29 consecutive teeth on a first toothed portion and 29 consecutive teeth on a second toothed portion.

FIGS. **9***a* and **9***b* illustrate a fourth embodiment example of the anterograde display mechanism according to the invention, particularly for the display of minutes. FIG. **9***a* illustrates a fourth embodiment example of a dial **3** bearing a minute graduation, and FIG. **9***b* illustrates a fourth embodiment example of a corresponding display wheel.

In this fourth embodiment example, the dial **3** is divided into 68 equidistant divisions, of which two consecutive divisions are separated by the first angle α.

These divisions form indexable positions P_x, where x ranges from 1 to 68.

In this fourth embodiment example, the 60 minute graduation guide-marks are distributed on 60 indexable positions P_x.

The dial **3** includes four sectors S_1, S_2, S_3 and S_4 of two successive divisions, here positions P_{16}, P_{17}, P_{33}, P_{34}, P_{50}, P_{51}, P_{67}, P_{68}, which are fictitious and have no minute guide-mark. Consequently, these divisions are not intended to be indexed by the minute hand.

Thus, at the first sector S_1, between the numeral 15 and the numeral 16, the minute hand performs here a first long jump of an angle β_1, three times greater than the angle α corresponding to the short jump between the minute graduation numerals.

At the second sector S_2, between the numeral 30 and the numeral 31, the minute hand performs here a second long jump of an angle β_2, three times greater than the angle α corresponding to the short jump between the minute graduation numerals.

At the third sector S_3, between the numeral 45 and the numeral 46, the minute hand performs here a third long jump of an angle β_3, three times greater than the angle α corresponding to the short jump between the minute graduation numerals.

At the fourth sector S_4, between the numeral 60 and the numeral 1, the minute hand performs here a fourth long jump of an angle β_4, three times greater than the angle α corresponding to the short jump between the minute graduation numerals.

In this embodiment example, the drive wheel includes 60 dents for the 60 minutes indexed by the minute display organ.

The second wheel **120** includes a number of teeth n_2 defined by the following relation:

$$n_2=n_1+\Sigma_{i=1}^{j}((\beta_i/\alpha)-1), \text{ where } j=4$$

$$n_2=n_1+((\beta_1/\alpha)-1)+((\beta_2/\alpha)-1)+((\beta_3/\alpha)-1)+((\beta_4/\alpha)-1)$$

$$n_2=60+(3-1)+(3-1)+(3-1)+(3-1)=68$$

Thus, the second wheel **120** and the fourth wheel have 68 teeth, and the display wheel **130** is equivalent to a wheel of 68 teeth.

The display wheel **130**, illustrated in FIG. **9***b*, here includes four smooth angular sectors **131***a*, **131***b*, **131***c*, **131***d* distributed equidistantly on the display wheel **130** to make it possible to perform the indexing of the display organ at the minute graduation of the dial **3** illustrated in FIG. **9***a*, as well as the short jumps of an angle α and the four long jumps of an angle β_1, β_2, β_3, β_4.

The number of truncated teeth $n_{3\ tronq}$ at the first smooth angular sector **131***a* of the display wheel **130** is equal to 3:

$$n_{3\,tronq}=\frac{\beta_1}{\alpha}=3$$

The number of truncated teeth $n'_{3\ tronq}$ at the second smooth angular sector **131***b* of the display wheel **130** is equal to 3:

$$n'_{3\,tronqu}=\frac{\beta_2}{\alpha}=3$$

The number of truncated teeth $n''_{3\ tronq}$ at the third smooth angular sector **131***c* of the display wheel **130** is equal to 3:

$$n''_{3\,tronq} = \frac{\beta_3}{\alpha} = 3$$

The number of truncated teeth $n'''_{3\ tronq}$ at the fourth smooth angular sector **131***d* of the display wheel **130** is equal to 3:

$$n'''_{3\,tronq} = \frac{\beta_4}{\alpha} = 3$$

Consequently, in this fourth embodiment example, the display wheel **130** is equivalent to a wheel of 68 teeth whereon two consecutive teeth are truncated at four smooth angular sectors **131***a*, **131***b*, **131***c*, **131***d*.

The display wheel **130** therefore has 56 effective teeth, i.e. 14 consecutive teeth between each smooth angular sector **131***a*, **131***b*, **131***c*, **131***d*. Thus, the display wheel **130** includes a first toothed portion of 14 teeth, a second toothed portion of 14 teeth, a third toothed portion of 14 teeth and a fourth toothed portion of 14 teeth, each of the toothed portions being separated by a smooth angular sector **131***a*, **131***b*, **131***c*, **131***d* corresponding to an angular sector equivalent to three teeth.

The invention also relates to a horological movement including such an anterograde display mechanism.

The invention also relates to a timepiece, such as a wristwatch, including such a horological movement.

The invention claimed is:

1. An anterograde display mechanism for a timepiece comprising a display having a graduation having a plurality of guide-marks distributed on a circumference of the display, the graduation being configured such that the angular distance separating at least two successive guide-marks corresponding to a second angle (β) greater than a first angle (α) separating two of the other successive guide-marks, the anterograde display mechanism being configured to drive a display organ in the angular movements thereof by successive short jumps of an angle (α) between two guide-marks separated by the first angle (α) and by a long jump of an angle (β) between two graduation guide-marks separated by the second angle (β), wherein the anterograde display mechanism comprises:

a first wheel, referred to as drive wheel, capable of being driven by a horological movement;

a second wheel coaxial with the first wheel and linked to the first wheel by an elastic organ;

a first intermediate wheel driven directly by the first wheel and which directly drives a third wheel, referred to as display wheel, cooperating with said display organ; said third wheel including a smooth angular sector where at least two teeth are truncated;

a fourth wheel coaxial and rigidly connected in rotation with the third wheel, said fourth wheel meshing said second wheel via a second intermediate wheel;

the anterograde display mechanism being configured so that the rotational speed of the second wheel is less than the rotational speed of the first wheel when the display organ is driven in the angular movements thereof by successive short jumps of an angle (α) between two guide-marks separated by the first angle (α), so as to progressively wind the elastic organ during these successive short jumps, and so that when the teeth of the intermediate wheel encounter the smooth angular sector of the third wheel, the elastic organ is let down inducing the instantaneous passage of the smooth angular sector and inducing the angular movement by a long jump of an angle (β) of said display organ.

2. The timepiece anterograde display mechanism according to claim **1**, wherein the first wheel is capable of being driven by jumps by said horological movement.

3. The timepiece anterograde display mechanism according to claim **1**, wherein the first wheel comprises a number of teeth (n_1), the number of teeth (n_1) being equal to the number of guide-marks of the graduation of the display.

4. The timepiece anterograde display mechanism according to claim **3**, wherein the second wheel comprises a number of teeth (n_2) greater than the number of teeth (n_1) of the first wheel.

5. The timepiece anterograde display mechanism according to claim **4**, wherein the third wheel comprises an effective number ($n_{3\ eff}$) of teeth distributed on a toothed portion and a number of truncated teeth ($n_{3\ tronq}$, $n'_{3\ tronq}$, $n''_{3\ tronq}$, $n'''_{3\ tronq}$) on the smooth angular sector, the whole forming an equivalent number ($n_{3\ equi}$) of teeth on the full circumference of the third wheel, the equivalent number ($n_{3\ equi}$) on the full circumference of the third wheel being equal to the number of teeth (n_2) of the second wheel.

6. The timepiece anterograde display mechanism according to claim **5**, wherein the number of truncated teeth ($n_{3\ tronq}$, $n'_{3\ tronq}$, $n'_{3\ tronq}$, $n'\rightarrow_{3\ tronq}$) on the smooth angular sector of the third wheel is an integer corresponding to the ratio of the second angle (β) over the first angle (α).

7. The timepiece anterograde display mechanism according to claim **4**, wherein the fourth wheel comprises a number of teeth (n_4) equal to the number of teeth (n_2) of the second wheel.

8. The timepiece anterograde display mechanism according to claim **4**, wherein the number of teeth (n_2) of the second wheel is determined by the following relation:

$$n_2 = n_1 + \Sigma_{i=1}^{j}((\beta_i/\alpha) - 1)$$

α is the first angle corresponding to a first angular distance separating at least two successive graduation guide-marks;

β_i is the second angle, greater than the first angle α, corresponding to a second angular distance, different from the first angular distance, separating at least two other successive graduation guide-marks at a sector S_i of the graduation;

i is an integer between 1 and j;

j is an integer corresponding to the total number of sectors S_i of the graduation where two successive graduation guide-marks are spaced apart by a second angle β_i greater than the first angle α.

9. The timepiece anterograde display mechanism according to claim **1**, wherein the elastic organ is a strip spring, a sheet, a flat spring, or a spiral spring.

10. The timepiece anterograde display mechanism according to claim **1**, wherein the elastic organ is integral with the first wheel such that the elastic organ comprises a first one-piece end with said first wheel and a second end connected to the second wheel, or the elastic organ is integral with the second wheel such that it includes a first one-piece end with said second wheel and a second end connected to the first wheel.

11. The timepiece anterograde display mechanism according to claim **1**, wherein the display comprises a date graduation with 31 guide-marks and wherein the display organ is a date hand.

12. The timepiece anterograde display mechanism according to claim **11**, wherein the date graduation com-

prises the numerals 1 to 31 and/or indexes corresponding to the numerals, the successive numerals from 1 to 31 being separated by the first angle (α) and the numerals 31 and 1 being separated by the second angle (β) greater than said first angle (α).

13. The timepiece anterograde display mechanism according to claim **12**, wherein the first wheel comprises 31 teeth and is configured to perform one turn in 31 days, and wherein the anterograde display mechanism is configured to progressively wind the elastic organ for 31 days.

14. The timepiece anterograde display mechanism according to claim **1**, wherein the display comprises a minute or second graduation with 60 guide-marks, and in that the display organ is a minute or second hand respectively.

15. A horological movement comprising a display mechanism according to claim **1**.

16. A timepiece comprising a horological movement comprising an anterograde display mechanism according to claim **1**.

* * * * *