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(54) **TRANSMISSION MECHANISM FOR AN AUTOMATIC WINDING CHAIN**

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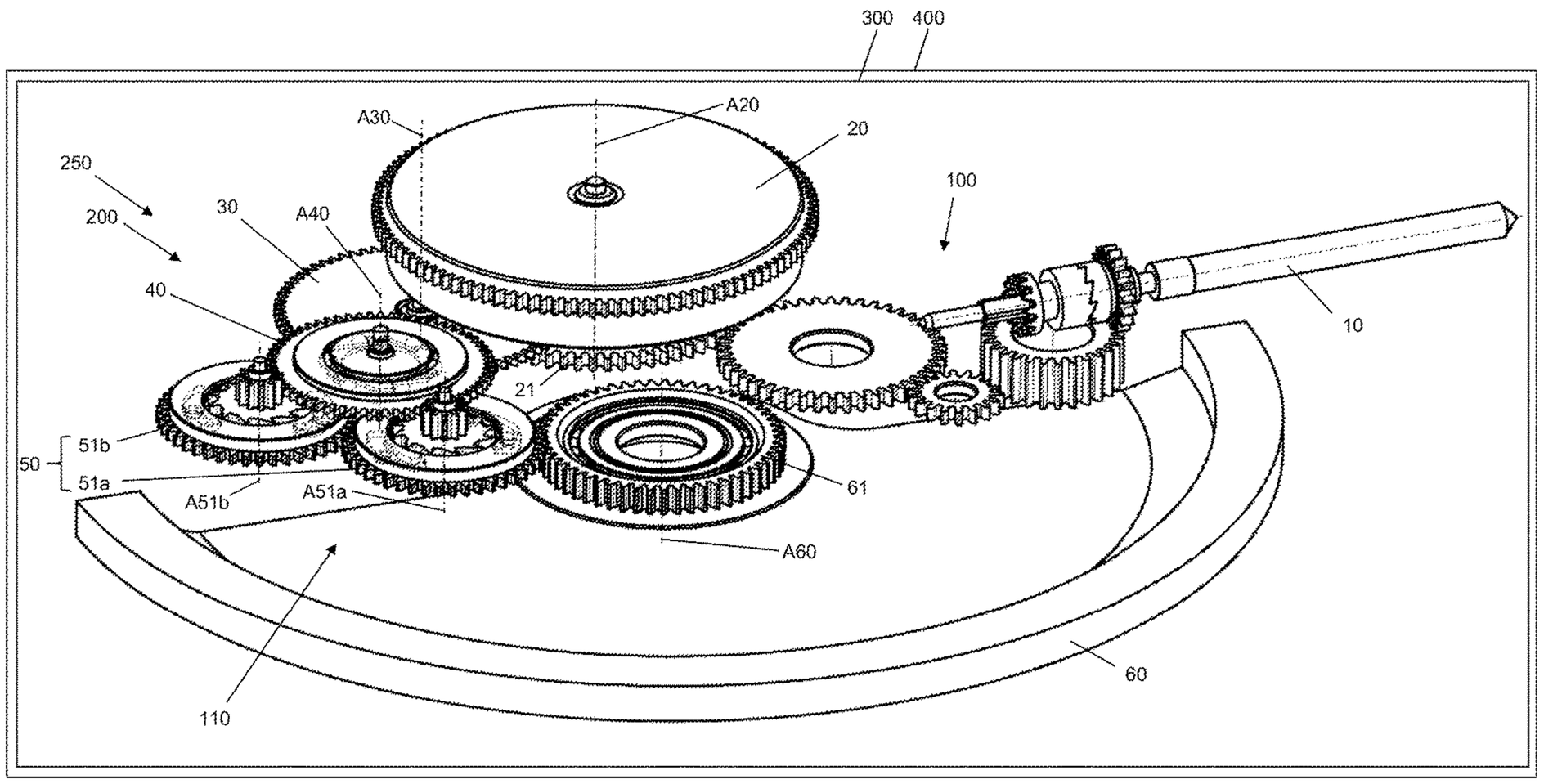
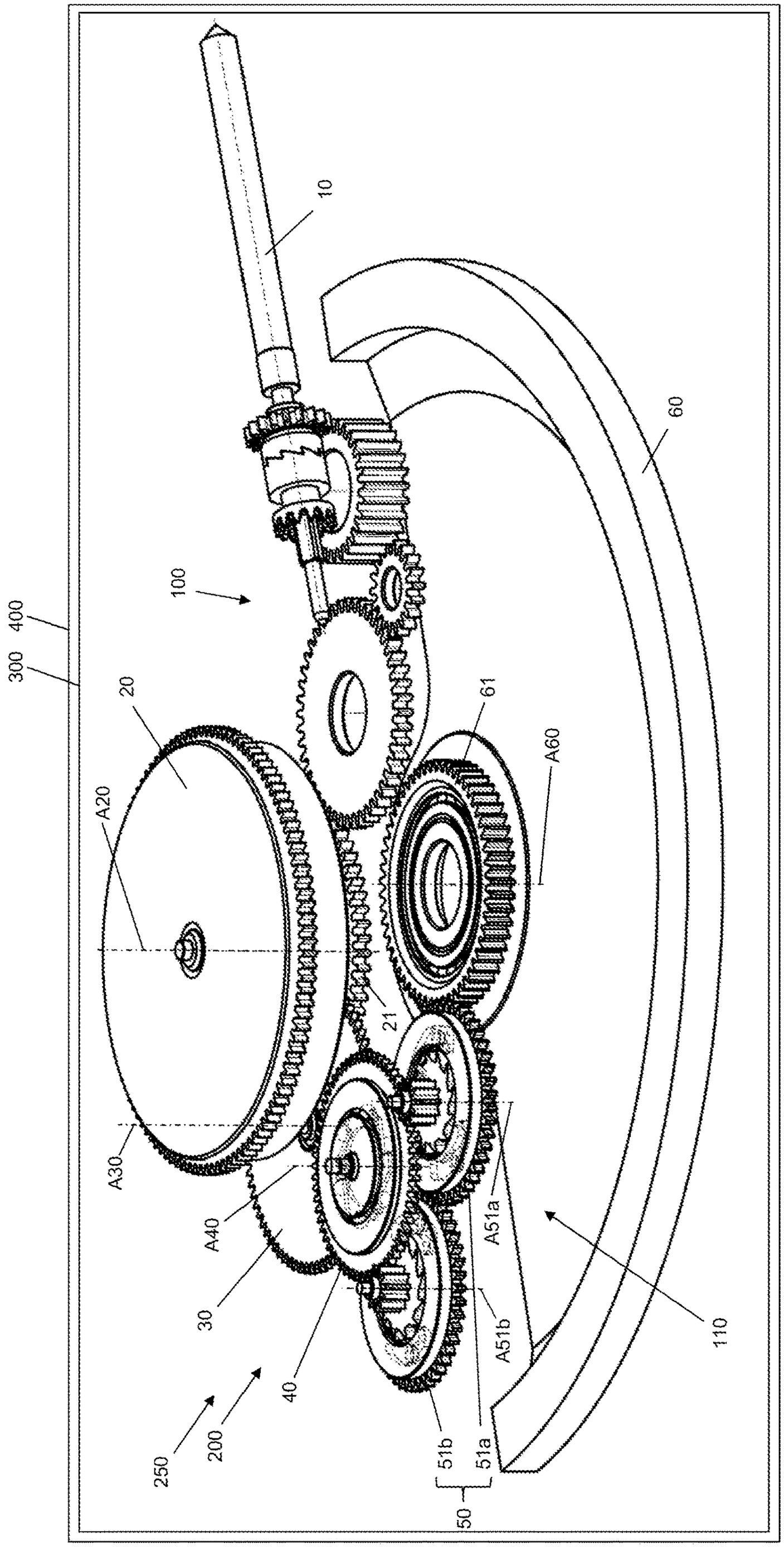
(57) **ABSTRACT**

The transmission mechanism (**110**) for an automatic winding chain for a timepiece (**400**) includes a series assembly of a first freewheel (**40**) functioning by wedging, a reverser (**50**) including at least one unidirectional coupling functioning by obstacle or at least one second freewheel (**51***a*, **51***b*) functioning by obstacle, and a winding mobile mass (**60**).




10
60
100
400
300
20
61
A60
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21
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40
A51a
A51b
110
250
200
51b
51a
50

Figure 1

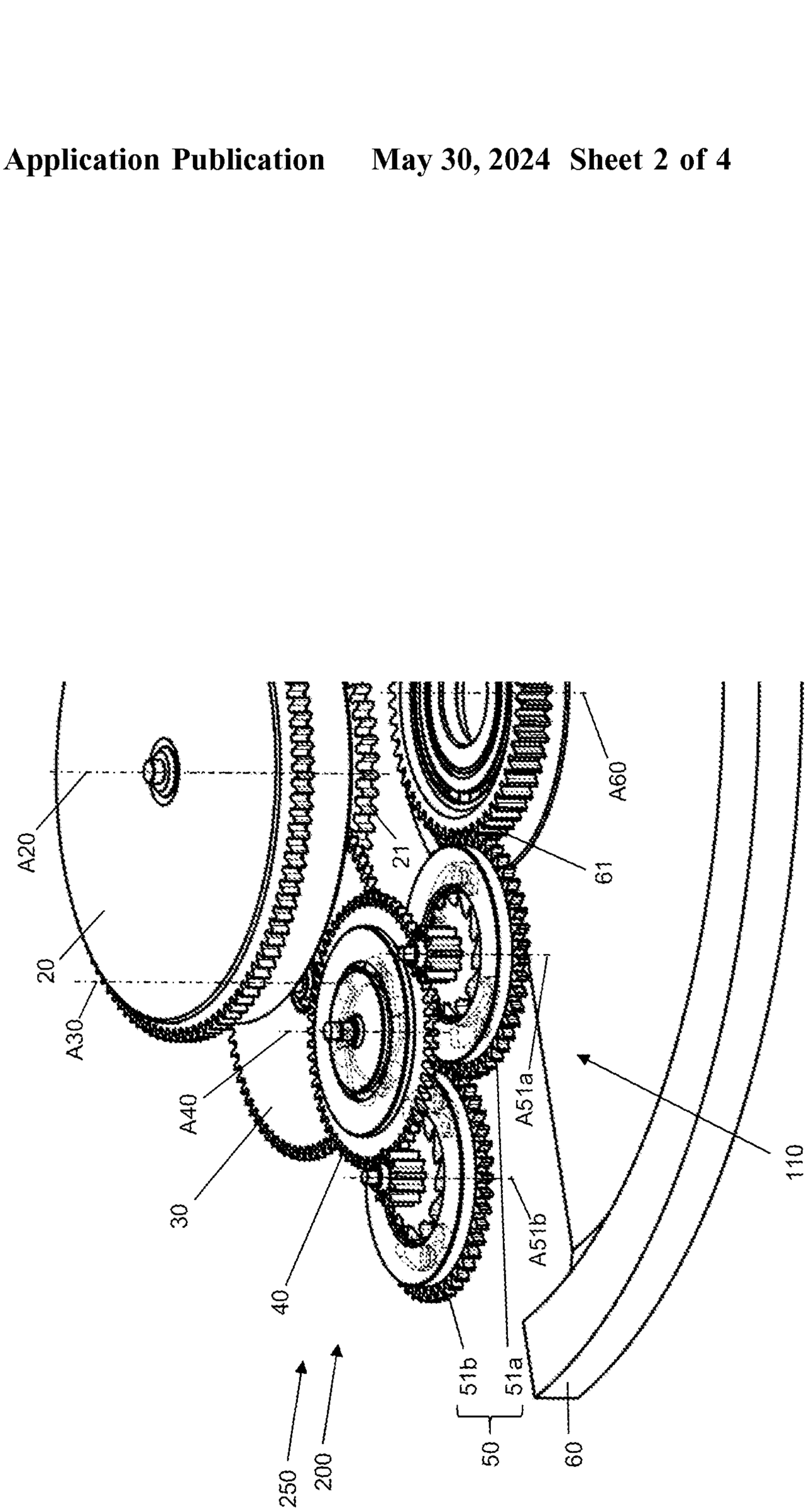
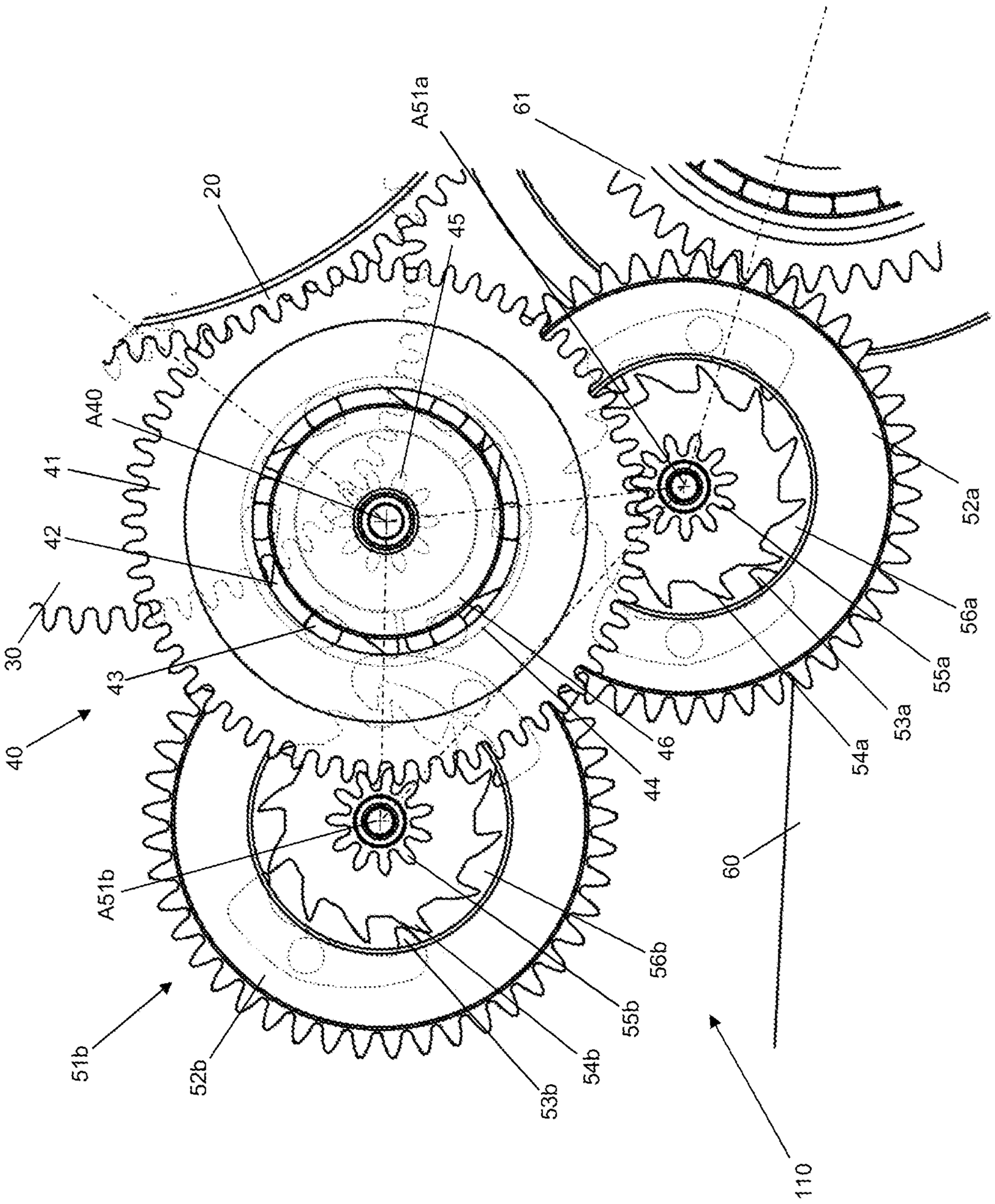


Figure 2


A51a
61
20
45
A40
41
42
30
43
40
46
44
54a
53a
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56a
52a
60
A51b
56b
55b
54b
53b
52b
51b
110

Figure 3

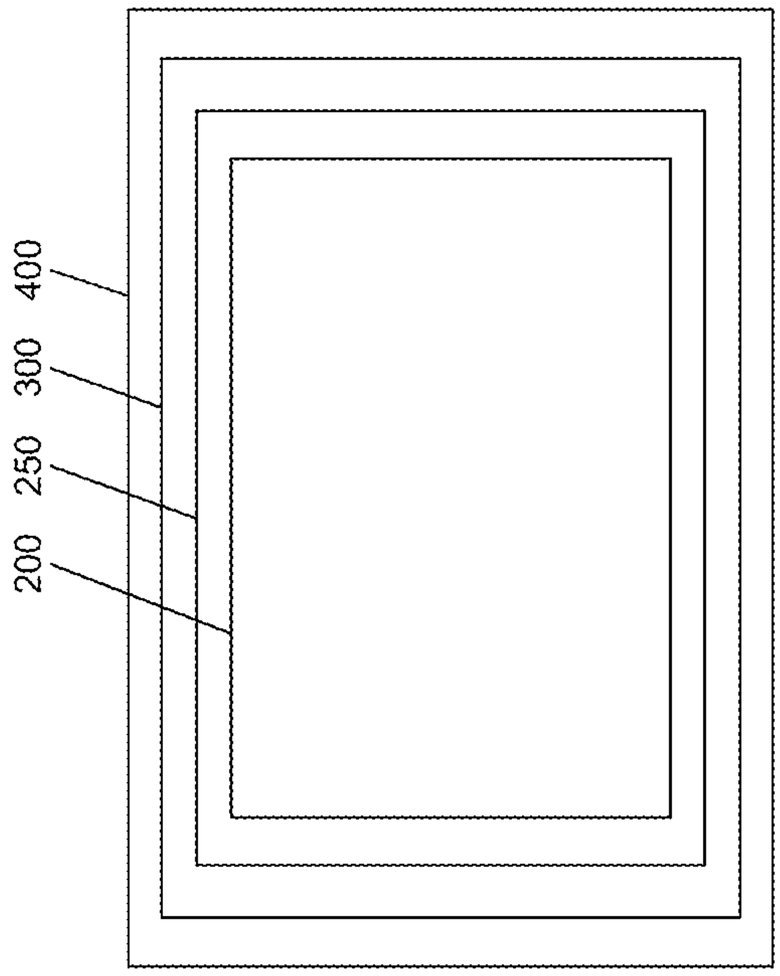

Figure 4

TRANSMISSION MECHANISM FOR AN AUTOMATIC WINDING CHAIN

[0001] This application claims priority of European patent application No. EP22209734.7 filed Nov. 25, 2022, the content of which is hereby incorporated by reference herein in its entirety.

BACKGROUND ART

[0002] The invention concerns a transmission mechanism for an automatic winding chain. The invention also concerns an automatic winding chain including a transmission mechanism of this kind. The invention also concerns a timepiece movement including a transmission mechanism of this kind or an automatic winding chain of this kind. The invention finally concerns a timepiece including a transmission mechanism of this kind or an automatic winding chain of this kind or a timepiece movement of this kind.

[0003] Reversing systems employing pawl freewheels are today widely used in horology for automatic winding of a barrel spring. Pawl freewheels constitute a reliable and robust solution enabling the benefit of:

[0004] high-performance automatic winding thanks in particular to a low dead angle,

[0005] low sensitivity to pollution, and

[0006] low intrinsic friction.

[0007] For the dead angle of the reversing system relative to the oscillating mass to be as low as possible, it is preferable to arrange the reversing system as close as possible to the latter. However, because of the high transmission ratio of the automatic winding chain, an arrangement of this kind generates extreme mechanical loads on the wheels of the reversing system during manual winding. In fact, the closer the reversing system is to the oscillating mass, the higher the transmission ratio from the winding stem and therefore the faster the wheels forming part of the reversing system turn during manual winding. With an arrangement of this kind the rotation speed of the wheels of the reversing system can generate oscillation of the pawls at a frequency greater than 3 000 Hz, or even greater than 5 000 Hz. These extreme loads are liable to degrade the pawl freewheels through premature wear of the pawls and/or the complementary teeth. Moreover, during manual winding oscillation of the pawls of the pawl freewheels closest to the oscillating mass generate a high torque transmitted to the winding stem. Because of this, the torque that the kinematic systems have to withstand is also higher, which can also cause premature ageing of the various wheel sets.

[0008] From a sensory point of view, these loads can generate a sensation of scraping on the winding stem and a disagreeable noise for the user of the watch.

[0009] Freewheel solutions are known enabling disengagement of the automatic winding chain during manual winding which alleviates the premature wear of the reversing system. Given that disengagement is effected only during manual winding, that is to say by the effect of a torque exerted by the user, the freewheel known from the prior art is of simpler design and offers lower performance than those that constitute a reversing system. Said freewheel may have a rudimentary shape with one or more leaf springs or pawls adapted to cooperate by obstacle with a toothed wheel and able to generate a high disengagement torque. It is generally disposed as close as possible to the barrel ratchet so as to prevent too high a rotation speed during manual winding and thus to prevent premature wear.

[0010] Because of its relatively simple design, the freewheel known from the prior art can generate the following disadvantages:

[0011] Variations of torque on the winding stem felt by the user during manual winding.

[0012] A scraping sensation and/or noise caused by the oscillation of the leaf springs or the pawls.

[0013] Reduced efficacy of automatic winding following manual winding.

[0014] In Théorie d'horlogerie (Reymondin et al., éditions de la Fédération des Écoles Techniques, 1998), disengaging an automatic winding chain during manual winding is described. A freewheel is arranged in a ratchet drive mobile. This freewheel includes, for example, a spring with arms secured to a pinion, intended to cooperate with a ratchet drive wheel around the pinion. The torque needed to disengage this type of freewheel may be relatively high. This high disengagement torque may constitute a problem if it is greater than the reversing system disengagement torque simply because the freewheel will be only partially or not at all functional. In fact, it might not disengage except in the case of severe wedging or scraping of the reversing system and would then inevitably generate variations of noise and of sensation on the winding stem potentially uncomfortable for the user. Disposing this freewheel near the ratchet also implies that the torque that it has to withstand during automatic winding is high.

[0015] Disengaging an automatic winding chain using an elastic pawl is also described in the document CH277730A. As in the previous solution, this freewheel is arranged in a ratchet driver engaged with a ratchet.

[0016] The document EP2392975A2 discloses a particular construction of a freewheel with elastic pawls intended to cooperate with internal teeth. The arrangement of the freewheel in the automatic winding chain remains similar to the previous solutions described.

[0017] The document EP2634650A2 discloses a solution using a freewheel arranged in a mobile of a Pellaton-type reversing system. This enables disengagement of the reversing system during manual winding with a freewheel functioning by obstacle.

SUMMARY OF THE INVENTION

[0018] The object of the invention is to provide a transmission mechanism solving the problems mentioned above and enabling improvement of the transmission mechanism known from the prior art. In particular the invention proposes a transmission mechanism enabling optimisation of performance and what the user feels during manual winding.

[0019] A transmission mechanism according to the invention is defined by point 1 below.

[0020] 1. Transmission mechanism for an automatic winding chain for a timepiece including a series assembly of:

[0021] a first freewheel functioning by wedging,

[0022] a reverser including at least one unidirectional coupling functioning by obstacle or at least one second freewheel functioning by obstacle, and

[0023] a winding mobile mass.

[0024] Embodiments of a transmission mechanism according to the invention are defined by points 2 to 7 below.

[0025] 2. Transmission mechanism according to point 1 wherein the reverser and the first freewheel are mechanically connected directly to one another, in particular directly connected by direct meshing of an output of the reverser with an input of the first freewheel.

[0026] 3. Transmission mechanism according to point 1 or 2 wherein a first reduction ratio between:

[0027] an output of the reverser, and

[0028] an input of the first freewheel is less than 8, or even less than 6, or even less than 5.

[0029] 4. Transmission mechanism according to any one of the preceding cla points ims wherein at least one second freewheel is a freewheel with at least one pawl.

[0030] 5. Transmission mechanism according to the preceding point wherein the at least one pawl is made of ceramic.

[0031] 6. Transmission mechanism according to any one of the preceding points wherein the first freewheel includes at least one blocking element functioning by wedging, in particular:

[0032] rolling elements such as balls or rollers or runners, in particular ceramic rolling elements such as ceramic balls or ceramic rollers or ceramic runners, or

[0033] sliding elements such as shape runners or cams, in particular ceramic sliding elements such as ceramic shape runners or ceramic cams.

[0034] 7. Transmission mechanism according to any one of the preceding points wherein the reverser includes two second freewheels so that an output of the reverser turns in the same given direction whatever the direction of an input of the reverser.

[0035] An automatic winding chain or an automatic winding module according to the invention is defined by point 8 below.

[0036] 8. Automatic winding chain or automatic winding module including a transmission mechanism according to any one of the preceding points.

[0037] Embodiments of an automatic winding chain or an automatic winding module according to the invention are defined by points 9 and 10 below.

[0038] 9. Automatic winding chain or automatic winding module according to the preceding point includes a first reduction chain extending from the winding mobile mass (**60**) to the first freewheel having a second reduction ratio less than 6, or even less than 5, or even less than 4, and/or including a second reduction chain extending from the first freewheel to a ratchet of the barrel having a third reduction ratio greater than 20, or even greater than 25, or even greater than 30.

[0039] 10. Automatic winding chain or automatic winding module according to either one of points 8 or 9 wherein an input of the reverser and the winding mobile mass are mechanically connected directly to one another, in particular directly connected by an input of the reverser meshing with teeth of the winding mobile mass.

[0040] A timepiece movement according to the invention is defined by point 11 below.

[0041] 11. Timepiece movement including a transmission mechanism according to any one of points 1 to 7 and/or an automatic winding chain according to any one of points 8 to 10 and/or an automatic winding module according to any one of points 8 to 10.

[0042] Embodiments of a timepiece movement according to the invention are defined in points 12 and 13 below.

[0043] 12. Timepiece movement according to the preceding point including a manual winding chain, in particular a manual winding chain that can be manipulated by a user via an actuator member, in particular a stem.

[0044] 13. Timepiece movement according to point 11 or 12 including an automatic winding chain adapted to be disengaged during manual winding by manipulating the stem.

[0045] A timepiece according to the invention is defined by point 14.

[0046] 14. Timepiece including:

[0047] a movement according to points 11 to 13, and/or

[0048] an automatic winding chain according to points 8 to 10, and/or

[0049] an automatic winding module according to points 8 to 10, and/or

[0050] a transmission mechanism according to any one of points 1 to 7.

BRIEF DESCRIPTION OF THE DRAWINGS

[0051] The appended drawings represent by way of example one embodiment of a timepiece according to the invention.

[0052] FIG. **1** is a schematic view of one embodiment of a timepiece according to the invention.

[0053] FIG. **2** is a perspective view of part of an embodiment of a transmission mechanism.

[0054] FIG. **3** is a view from above of part of the embodiment of the transmission mechanism.

[0055] FIG. **4** is a schematic view of an embodiment of a timepiece according to the invention.

DETAILED DESCRIPTION OF PARTICULAR EMBODIMENTS

[0056] A first embodiment of a timepiece **400** is described in detail hereinafter with reference to FIGS. **1** to **4**.

[0057] The timepiece **400** is for example a watch, in particular a wristwatch. The timepiece **400** includes a timepiece movement **300** intended to be mounted in a timepiece case in order to protect it from the external environment.

[0058] The timepiece movement **300** is an automatic movement or a hybrid movement.

[0059] The timepiece movement **300** includes an automatic winding chain **200**. This automatic winding chain may be included in an automatic winding module **250** mounted on the rest of the timepiece movement, in particular an automatic winding module **250**:

[0060] fixed to a plate or to at least one bridge of a frame of the timepiece movement **300**, and

[0061] mechanically connected to a barrel **20** of the timepiece movement **300**.

[0062] The automatic winding chain **200** includes a transmission mechanism **110**.

[0063] The transmission mechanism **110** includes a series assembly of:

[0064] a first freewheel **40** functioning by wedging,

[0065] a reverser **50** including at least one unidirectional coupling functioning by obstacle or at least one second freewheel **51***a*, **51***b* functioning by obstacle, and

[0066] a winding mobile mass **60** or oscillating mass **60**.

[0067] By "freewheel functioning by wedging" is meant a freewheel the engagement function of which is achieved by wedging or jamming caused by the friction of rolling elements such as balls or rollers or runners, or sliding elements such as cams or shape runners.

[0068] By "unidirectional coupling functioning by obstacle" is meant a reverser as described in particular on pages **178** and **179** of the book "Théorie d'horlogerie" (Reymondin et al., éditions de la Fédération des Ecoles Techniques, 1998), that is to say:

[0069] a mechanism employing cams or pawl-levers functioning in the manner of an obstacle, or

[0070] a mechanism with alternately engaged toothed wheels functioning in the manner of an obstacle, or

[0071] a mechanism using engagement mobiles functioning by obstacle.

[0072] By "freewheel functioning by obstacle" is meant a freewheel the engagement function of which is assured by elements constituting obstacles to one another (and therefore functioning even in the absence of friction between these elements).

[0073] By "freewheel" is meant an assembly comprising:

[0074] an input mounted rotatable relative to the frame,

[0075] an output mounted rotatable relative to the frame, and

[0076] a linked mechanism enabling the input and the output to be linked or secured together when a relative movement between the input and the output in a first direction is requested, and allowing a free relative movement between the input and output in a second direction, opposite to the first direction.

[0077] The reverser **50** is a direction reverser or a reversing system **50** and enables conversion of:

[0078] the movement of the winding mobile mass **60** that may in particular include, when the timepiece is worn, random movements in rotation, into

[0079] a unidirectional movement in rotation.

[0080] To this end the winding mobile mass is mechanically connected to an input of the reverser and the unidirectional movement in rotation is obtained at an output of the reverser.

[0081] The first freewheel **40** enables disengagement of the reverser **50** during manual winding, that is to say when a user arms or winds the barrel **20** by exerting action on a manual winding member, for example by applying a movement in rotation to a stem **10** via a crown. This disengagement enables decoupling or unfastening of the reverser and of the part of the system downstream of the first freewheel.

[0082] The automatic winding chain or automatic winding kinematic system **200** enables arming or automatic winding of a barrel **20** thanks to transmission of energy from the movements of the winding mobile mass **60**.

[0083] The barrel **20** can also be wound manually by a winding stem **10** via a manual winding kinematic chain **100**.

[0084] In the embodiment represented the at least one second freewheel **51***a*, **51***b* forms a unidirectional coupling advantageously functioning by obstacle. In other words, this unidirectional coupling includes at least one element able to drive a first mobile by constituting an obstacle to it, such as a pawl, a hook, a leaf spring or a mobile pinion. This type of unidirectional coupling is advantageously very robust and able to withstand very numerous reversals of the rotation direction of the winding mobile mass **60**, with a low dead angle and a low sensitivity to pollution that might degrade its performance. On the other hand, it may have some sensitivity to wear during high rotation speeds induced by manual winding (in the absence of a first freewheel **40** as in this embodiment). This is in particular the case when the freewheels are directly engaged with the winding mobile mass. Alternatively, the reverser **50** may include at least one mobile pinion, that is to say a pinion movable between:

[0085] a first configuration fastening together the input and the output of the reverser, and

[0086] a second configuration disengaging the input of the reverser from the output.

[0087] In the embodiment represented the first freewheel **40** advantageously functions:

[0088] by wedging at least one rolling element **43** such as a ball, a roller, a runner, or

[0089] by wedging at least one sliding element such as in particular a shape runner, a cam. All of these components may optionally be prestressed in the engaged position by an elastic return means. Differing from the mobile pinion or a second freewheel **51***a*, **51***b*, this first freewheel **40** constitutes or forms part of a unidirectional coupling not including any element liable to oscillate during disengagement. Consequently, this type of freewheel advantageously generates no or little variation of torque and of noise. On the other hand, the dead angle of a freewheel functioning by wedging is directly dependent on the intrinsic coefficient of friction. Consequently, the first freewheel **40** is more sensitive to pollution. It is therefore preferable not to use this kind of freewheel structure in the reverser. However, this aspect is of secondary importance for the disengagement of a winding system because once the first freewheel **40** has been engaged said dead angle does not influence or no longer influences automatic winding performance.

[0090] The elements **43** of the freewheel are blocking elements. These blocking elements may advantageously be made of ceramic, in particular technical ceramic.

[0091] As already mentioned, the automatic winding kinematic chain **200** enables winding of a spring of the barrel **20** thanks to the energy induced by the movements of the winding mobile mass **60**. Winding can be directional, that is to say effective whatever the direction of rotation of the winding mobile mass **60**. The winding mobile mass **60** can pivot in a ball bearing on the frame of the movement or on a frame of the automatic winding module. The automatic winding chain **200** includes a plurality of mobiles including, from the upstream side (the winding mobile mass) to the downstream side (the barrel):

[0092] the winding mobile mass **60**,

[0093] the reverser **50**,

[0094] the first freewheel **40**, and

[0095] a ratchet driver **30** meshing with a ratchet **21** connected to the spring of the barrel **20**.

[0096] The various mobiles or elements are preferably mechanically connected to one another by meshing with one

another. The mechanical connections may be direct or indirect. In the case of two elements indirectly connected to one another, one or more intermediate wheels may be provided between the elements. These intermediate wheels may contribute to producing an optimised transmission ratio between the elements.

[0097] One or more intermediate wheels may be disposed between:

[0098] the winding mobile mass **60** and the reverser **50**, and/or

[0099] the reverser **50** and the first freewheel **40**, and/or

[0100] the first freewheel **40** and the driver **30**.

[0101] The reverser **50** and the first freewheel **40** are advantageously mechanically connected to one another, in particular directly connected by direct meshing of an output of the reverser **50**, or of the outputs of the reverser **50**, with an input of the first freewheel **40**.

[0102] An input of the reverser **50**, or inputs of the reverser **50**, and the winding mobile mass **60** are advantageously mechanically connected directly to one another, in particular directly connected by of an input of the reverser **50** or inputs of the reverser **50** meshing with teeth **61** on the winding mobile mass **60**.

[0103] It is preferable if:

[0104] the winding mobile mass is mobile in rotation about an axis A**60**,

[0105] the reverser **50** includes two unidirectional couplings **51***a*, **51***b* mobile in rotation about axes A**51***a*, A**51***b*,

[0106] the first freewheel **40** is mobile in rotation about an axis A**40**,

[0107] the ratchet driver **30** is mobile in rotation about an axis A**30**, and

[0108] the barrel **20**, in particular the ratchet **21**, is mobile in rotation about an axis A**20**.

[0109] The various axes A**60**, A**51***a*, A**51***b*, A**40**, A**30** and A**20** are preferably parallel to one another.

[0110] The winding mobile mass, the unidirectional couplings **51***a*, **51***b*, the first freewheel **40**, the ratchet driver **30** and the barrel **20** are preferably guided in rotation on the frame of the movement and/or on a frame of the automatic winding module.

[0111] The transmission or reduction ratio between the winding mobile mass **60** and the ratchet **21** is of the order of 110 to 180. In other words, it is necessary for the winding mobile mass **60** to turn 110 to 180 times to induce rotation of the ratchet **21** by one turn.

[0112] The timepiece **400** preferably includes the winding stem **10** connected to the ratchet **21** by a manual winding chain **100** in order to enable manual winding or arming of the spring of the barrel **20**.

[0113] The reverser **50** preferably includes two pawl freewheels **51***a*, **51***b*. The reverser **50** is advantageously directly engaged with the winding mobile mass **60**, in particular with teeth **61** on the winding mobile mass **60**, so that the dead angle of the reverser **50** relative to the winding mobile mass **60** is as small as possible, thus optimising automatic winding performance. Furthermore, in the embodiment shown the inputs **52***a*, **52***b* of the two second freewheels are advantageously rotationally coupled to one another directly by meshing. Only one input **52***a* of the two inputs **52***a*, **52***b* is connected directly in rotation to the winding mobile **60** by meshing therewith.

[0114] Alternatively, the two outputs of the two second freewheels may be rotationally coupled to one another directly by meshing and the two inputs may each be rotationally coupled directly to the winding mobile mass by meshing therewith.

[0115] The pawl freewheels **51***a*, **51***b* respectively include a pawl carrier wheel **52***a*, **52***b*, a cover **56***a*, **56***b* and two pawls **53***a*, **53***b*. The pawls **53***a*, **53***b* pivot on the pawl carrier wheel **52***a*, **52***b* and/or the cover **56***a*, **56***b*. Cooperation of the cover **56***a*, **56***b* and the pawl carrier wheel **52***a*, **52***b* enables retention of the pawls **53***a*, **53***b* in the at least one second freewheel **51***a*, **51***b*. The pawls **53***a*, **53***b* are advantageously made of ceramic, in particular technical ceramic.

[0116] The pawls **53***a*, **53***b* are designed to cooperate with a sawtooth toothed wheel **54***a*, **54***b* secured to a pinion **55***a*, **55***b*. The toothed wheel **54***a*, **54***b* is able to pivot relative to the pawl carrier wheel **52***a*, **52***b*. The respective asymmetric shapes of the pawls **53***a*, **53***b* and the toothed wheel **54***a*, **54***b* enable unidirectional coupling. The toothed wheels **54***a*, **54***b* are for example made of ceramic, in particular technical ceramic. The operation of a freewheel of this type is described for example in the document EP3285123A1.

[0117] In the automatic winding chain **200** the wedging type first freewheel **40** is advantageously a ball type freewheel **40** directly engaged with the reverser **50**, between the latter and the ratchet **21**. The first freewheel **40** more particularly includes a wheel **41** that is directly engaged with at least one of the two pinions **55***a*, **55***b* of the two second wheels **51***a*, **51***b*. The first freewheel **40** is moreover engaged with the ratchet driver **30** via a pinion **45** of the first freewheel **40**.

[0118] In the automatic winding chain **200** the first freewheel **40** disposed in this way in direct engagement with the reverser **50** obtains the benefit of a dead angle relative to the winding mobile mass **60** that is minimised. With a disposition of this kind, after manual winding fewer turns of the winding mobile mass are therefore needed to make up said dead angle and to render automatic winding effective again. Moreover, this disposition of the first freewheel **40** also makes it possible to reduce the transmission torque that said first freewheel must withstand compared to a disposition of the first freewheel **40** close to the ratchet **21**, for example.

[0119] In this embodiment, like a ball bearing, the first freewheel **40** includes six balls **43** guided in a sliding or rolling track **44** defining the interface between a wheel **41** and a ring **46** secured to the pinion **45**. Furthermore, in a first configuration, upon immobilisation of the wheel **41** and the ring **46** to secure them to one another, the balls also make it possible, in a second configuration, to guide rotation of the ring **46** relative to the wheel **41** or to participate in such guidance.

[0120] Each ball **43** takes its place in a housing provided with an inclined plane machined in a separator **42**. The separator **42** may comprise a plurality of parts, here three parts. Said inclined plane participates in the unidirectional coupling. In fact, in a first so-called engagement relative rotation direction the balls cooperate with the inclined plane so as to become wedged in the housing and to constrain the wheel **41** to rotate with the ring **46** by means of the separators **42**. The latter are then tighten again around the ring **46**, like a radial engagement or a radial action brake on the ring **46**. In a second so-called free relative rotation direction (second direction opposite the first direction), the balls are out of reach of the portions of the inclined planes

adapted to wedge the balls **43** so as to disengage the wheel **41** from the ring **46** and enable relative rotation between these two elements.

[0121] During an automatic winding phase the ball type first freewheel **40** is in an engaged configuration or goes from a disengaged configuration to an engaged configuration. In fact, during this phase the reverser **50** still drives the wheel **41** in the engagement relative direction, i.e. the anticlockwise direction in FIG. **3**. The rotation of the wheel **41** generates the engagement of the pinion **45** thanks to the wedging of the balls **43** on the inclined planes of the housings of the separators **42**.

[0122] The first freewheel **40** remains engaged whatever the direction of rotation of the winding mobile mass **60**. In fact, when the winding mobile mass **60** turns in the clockwise direction in FIG. **3**, as a consequence of the meshing thereof:

[0123] the pawl carrier wheel **52***a* meshed directly with the winding mobile mass **60** turns in the anticlockwise direction in FIG. **3**,

[0124] the pawl carrier wheel **52***b* meshed indirectly with the winding mobile mass **60** turns in the clockwise direction in FIG. **3**.

[0125] The pinion **55***a* associated with the pawl carrier wheel **52***a* meshed directly with the winding mobile mass **60** is able to turn freely in the clockwise direction (wheel **51***a* disengaged) and the pinion **55***b* associated with the pawl carrier wheel **52***b* meshed indirectly with the winding mobile mass **60** turns in the clockwise direction (wheel **51***b* engaged). Here it follows that the wheel **41** turns in the anticlockwise direction. The two second freewheels **51***a*, **51***b* are respectively disengaged and engaged.

[0126] When the winding mobile mass **60** turns in the anticlockwise direction in FIG. **3**, as a consequence of the meshing thereof:

[0127] the pawl carrier wheel **52***a* meshed directly with the winding mobile mass **60** turns in the clockwise direction in FIG. **3**,

[0128] the pawl carrier wheel **52***b* meshed indirectly with the winding mobile mass **60** turns in the anticlockwise direction in FIG. **3**,

[0129] The pinion **55***b* associated with the pawl carrier wheel **52***b* meshed indirectly with the winding mobile mass **60** is able to turn freely in the clockwise direction (wheel **51***b* disengaged) and the pinion **55***a* associated with the pawl carrier wheel **52***a* meshed directly with the winding mobile mass **60** turns in the clockwise direction (wheel **51***a* engaged). It follows that the wheel **41** turns in the anticlockwise direction. Here the two second wheels **51***a*, **51***b* are respectively engaged and disengaged.

[0130] As mentioned above, the reverser advantageously includes two second freewheels **51***a*, **51***b*. The output of the reverser therefore turns in the same given direction whatever the direction of rotation of the input of the reverser.

[0131] Only manual winding enables disengagement of the first freewheel **40** via the driver **30** and the pinion **45**.

[0132] During a manual winding phase the first freewheel is disengaged and the reverser **50** is advantageously disengaged from the driver **30** by the first freewheel **40**. In fact, in this phase the pinion **45** and the ring **46** secured together are driven in the free relative direction (the anticlockwise rotation direction of the pinion **45** relative to the wheel **41** in FIG. **3**). The rotation of the ring **46** fastened to the pinion **45** drives the balls **43** out of reach of the portions of the inclined planes of the housings of the separators **42** adapted to wedge them. The balls **43** are then released and the separators are loosened from the ring **46**. During this phase the first freewheel **40** therefore behaves as a guide for rotation of the pinion **45** relative to the ring **46**. In other words, when it is disengaged the intrinsic functioning of the first freewheel **40** enables free rotation of the pinion **45** substantially as if it were assembled onto a guide, such as a bearing, with a substantially negligible torque, friction and wear, with no scraping noise or oscillation of elements.

[0133] This advantageously results in a sensation and a winding torque on the winding stem **10** equivalent to a movement with no automatic winding system whilst preserving the second wheels **51***a*, **51***b* of the reverser **50**.

[0134] As the first freewheel **40** is directly engaged with the reverser **50**, the automatic winding torque generated by the winding mobile mass **60** that said first freewheel has to withstand is lower than if that first freewheel were arranged close to the ratchet **21**. This arrangement therefore offers a more favourable transmission ratio and advantageously enables use of an optimised ball type first freewheel **40** with much better performance in terms in particular of dead angle and intrinsic friction than those known from the prior art used to disengage an automatic winding chain.

[0135] During manual winding it is preferable to guarantee that the first freewheel **40** is disengaged at all times and consequently for it to be impossible to load the reverser **50**. To achieve this, the torque for disengaging the first freewheel **40** mounted on the reverser **50** must be lower than the disengagement torque of the latter. Now, the low transmission ratio between:

[0136] the first freewheel **40**, and

[0137] the reverser **50**

[0138] achieved by the solutions described above and the use of a first freewheel **40** make it possible to guarantee a very low disengagement torque whatever the speed of rotation. A freewheel functioning by wedging, such as a ball type first freewheel **40**, advantageously offers a very low disengagement torque.

[0139] The dead angle at the first freewheel **40** has no or little influence on manual winding performance. The dead angle of the first freewheel **40** is the maximum angle that the wheel **41** must travel relative to the ring **46** before the wheel **41** and the ring **46** are again secured to one another.

[0140] However, if the ratchet **21** is immobilised by a ratchet pawl after manual winding automatic winding is effective only once the dead angle of the first freewheel **40** has been caught up. Consequently, the first movements of the winding mobile mass **60** will serve only to make up said dead angle, leading to momentary ineffective automatic winding.

[0141] The type of first freewheel **40** adopted and the architecture proposed here enable this disadvantage to be limited. In fact, the intrinsic functioning of the first freewheel **40** advantageously enables a very small dead angle to be achieved. Furthermore, given that the first freewheel **40** is directly engaged with the reverser **50**, it is advantageously located where the transmission ratio with the winding mobile mass **60** is the lowest.

[0142] Consequently, the dead angle of the first freewheel **40** is more rapidly caught up by the movements of the winding mobile mass **60** than if the first freewheel **40** had been placed closer to the ratchet **21**.

[0143] Once the first freewheel **40** is engaged, the dead angle of the first freewheel **40** no longer has any influence on the performance of automatic winding, because it then remains constantly engaged until the next manual winding.

[0144] A first reduction ratio between:

[0145] an output of the reverser **50**, and

[0146] an input of the first freewheel **40** is preferably less than 8, or even less than 6, or even less than 5.

[0147] The automatic winding chain **200** preferably includes a first reduction chain extending from the winding mobile mass **60** to the first freewheel **40**, in particular the wheel **41**, having a second reduction ratio less than 6, or even less than 5, or even less than 4.

[0148] The automatic winding chain **200** preferably includes a second reduction chain extending from the first freewheel **40**, in particular of the pinion **45**, to the ratchet **21** of the barrel **20** having a third reduction ratio greater than 20, or even greater than 25, or even greater than 30.

[0149] The ratio of the second reduction ratio to the first reduction ratio is preferably less than 3, or even less than 2, or even less than 1.

[0150] The solution described uses a pawl or obstacle type reverser directly engaged with a winding mobile mass and advantageously includes a unidirectional bearing of ball freewheel type enabling optimisation of performance and the sensations of the user during manual winding.

[0151] The proposed solution finally enables disengagement of an automatic winding chain with the aid of a freewheel advantageously functioning by wedging, such as a unidirectional ball bearing. The freewheel is advantageously directly engaged with the reverser equipped with freewheels functioning by obstacle, such as pawl type freewheels. This solution enables the benefit to be obtained of a low and constant manual winding torque. In fact, as disengagement is achieved with no oscillating components, the variation of torque and wear problems are solved. Furthermore, this unidirectional bearing enables the benefit to be obtained of a low dead angle that can be caught up by a much lower number (of the order of 5 to 8 times lower) of winding mobile mass turns than in the known solutions, thanks also to arranging it as close as possible to the reverser.

[0152] The connections, in particular the teeth, adapted to cooperate directly with upstream elements in the automatic winding chain **200** are or constitute inputs and the connections, in particular the teeth, adapted to cooperate directly with elements situated downstream in the automatic winding chain **200**, are or constitute outputs.

[0153] In a series assembly the input of one element is connected to the output of a preceding element or upstream element and the output of the element is connected to the input of a following or downstream element.

1. A transmission mechanism for an automatic winding chain for a timepiece including a series assembly of:

a first freewheel functioning by wedging,

a reverser including at least one unidirectional coupling functioning by obstacle or at least one second freewheel functioning by obstacle, and

a winding mobile mass.

2. The transmission mechanism according to claim **1**, wherein the reverser and the first freewheel are mechanically connected directly to one another.

3. The transmission mechanism according to claim **1**, wherein a first reduction ratio between:

an output of the reverser, and

an input of the first freewheel is less than 8.

4. The transmission mechanism according to claim **1**, wherein at least one second freewheel is a freewheel with at least one pawl.

5. The transmission mechanism according to claim **4**, wherein the at least one pawl is made of ceramic.

6. The transmission mechanism according to claim **1**, wherein the first freewheel includes at least one blocking element functioning by wedging.

7. The transmission mechanism according to claim **1**, wherein the reverser includes two second freewheels so that an output of the reverser turns in the same given direction whatever the direction of an input of the reverser.

8. An automatic winding chain or automatic winding module including the transmission mechanism according to claim **1**.

9. The automatic winding chain or automatic winding module according to claim **8**, including

a first reduction chain extending from the winding mobile mass to the first freewheel having a second reduction ratio less than 6, and/or a second reduction chain extending from the first freewheel to a ratchet of the barrel having a third reduction ratio greater than 20.

10. The automatic winding chain or automatic winding module according to claim **8**, wherein an input of the reverser and the winding mobile mass are mechanically connected directly to one another.

11. A timepiece movement including a transmission mechanism according to claim **1**.

12. The timepiece movement according to the claim **11**, including a manual winding chain.

13. The timepiece movement according to claim **11**, including an automatic winding chain adapted to be disengaged during manual winding by manipulating an actuator member which is a stem.

14. A timepiece including:

a transmission mechanism according to claim **1**.

15. The transmission mechanism according to claim **2**, wherein the reverser and the first freewheel are mechanically connected directly to one another by direct meshing of an output of the reverser with an input of the first freewheel.

16. The transmission mechanism according to claim **3**, wherein an input of the first freewheel is less than 6.

17. The transmission mechanism according to claim **16**, wherein an input of the first freewheel is less than 5.

18. The transmission mechanism according to claim **6**, wherein the at least one blocking element functioning by wedging includes roller elements or sliding elements.

19. The transmission mechanism according to claim **18**, wherein the at least one blocking element functioning by wedging includes roller elements which are balls or rollers or runners.

20. The transmission mechanism according to claim **18**, wherein the at least one blocking element functioning by wedging includes sliding elements which are shape runners or cams.

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