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(54) **Mainspring device, timepiece, and method of controlling the mainspring device and the timepiece**

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Description

[0001] The present invention relates to a mainspring device, a timepiece, and a method of controlling the mainspring device and the timepiece. The present invention can be applied to a mechanical timepiece including a mainspring, which is wound up either by hand or automatically, and a timed annular balance, and to an electronic control type mechanical timepiece in which hands, affixed to a wheel train, are moved precisely by converting mechanical energy, output when the mainspring is unwound, into electrical energy by a generator in order to actuate a rotation control means by the electrical energy and control the rotation period of the generator.

[0002] A mechanical timepiece whose hands are moved by utilizing mechanical energy of a mainspring is conventionally known.

[0003] As shown in Fig. 22, at the stage of winding up a mainspring (that is, when the number of windings is equal to or greater than a predetermined number of windings A), the torque, which has been accumulating in the mainspring, suddenly becomes large, so that a very large torque is output when unwinding of the mainspring is started. The large torque is exerted onto a controlling portion, of, for example, a speed regulator or an escapement, which controls the rotational speed of a wheel train which rotates the mainspring. This may cause the component parts thereof to break.

[0004] On the other hand, at the last stage of unwinding a mainspring (that is, when the number of windings is equal to or less than a predetermined number of windings B), the torque, output from the mainspring, becomes very small, causing the hands to gradually slow down. This may cause the timepiece to show the wrong time. Therefore, the hands do not move precisely, causing the timepiece to indicate the wrong time.

[0005] Consequently, a winding-up and unwinding stop mechanism which stops winding up or unwinding of the mainspring when a certain number of windings is reached is provided particularly in a clock. In general, for the winding-up and unwinding stop mechanism, a Maltese Cross type winding-up and unwinding stop mechanism, such as that shown in Fig. 23, is used, which includes a finger 102, affixed to a barrel arbor 101, and a gear 103, called a Maltese Cross, mounted to a barrel drum.

[0006] As shown in Fig. 23(A), in the mechanism, a finger head 102a of the finger 102 engages a cut in the gear 103, which can rotate freely at that place and move along the circumference of the finger 102 by progressively sliding therealong.

[0007] When the timepiece is wound, the barrel arbor 101 rotates, causing the finger 102 to rotate, so that one tooth of the gear 103 advances upon one rotation. Eventually, a flat tooth 103a of the gear 103 bumps into the finger head 102a, thereby stopping the rotation of the barrel arbor 101 and locking the winding-up operation.

[0008] During operation of the timepiece (that is, when the mainspring is being unwound), the finger 102 is fixed, and the gear 103 rotates along with the barrel drum, with the barrel arbor 101 as center, such that one tooth advances upon one rotation, as shown in Fig. 23 (B). After the barrel drum rotates four times, the flat teeth 103a and the finger head 102a bump into each other, as shown in Fig. 23(C), thereby locking the unwinding operation.

[0009] The Maltese Cross type winding-up and unwinding stop mechanism has a simple structure and requires fewer parts. However, since the winding operation is stopped by bringing a flat tooth of a gear into contact with a finger head, they must have sufficient strength, which is realized by making them relatively large. In addition, the finger and the gear must be placed upon a barrel drum.

[0010] This causes the barrel drum to become thicker, so that the above-described Maltese Cross winding-up and unwinding stop mechanism can only be used in a clock which has a large space for disposing component parts in its interior, and cannot be used in watches which only has a small space therein.

[0011] Therefore, in watches, it is difficult to stop the winding up and unwinding of the mainspring, as a result of which breakage of parts still occurs when a very large torque is exerted onto the parts, and the wrong time is indicated when the torque becomes very small. Consequently, there has been a demand for a way to output a torque whose value lies within a set range at all times.

[0012] US 3294198 discloses a winding barrel arrangement for transmitting torque from a power source, such as an electric motor, to the clockwork mechanism. An object of US 3294198 is to provide transmission, including a winding barrel, which has a constant output torque regardless of irregular operation.

[0013] Accordingly, it is a first object of the present invention to provide a mainspring device and a timepiece incorporating the mainspring, wherein even when the mainspring device is used in a watch having a small space for disposing component parts in its interior, a very large or a very small torque is not output, that is, a torque that is within a set range is output at all times.

[0014] Since the electronic control type mechanical timepiece can control with high precision the rotation period of a generator, that is, the rotational period of the hands, as a result of driving a rotation control circuit, which includes a crystal oscillator, by using electrical energy that has been generated, it can indicate time more accurately than a conventional mechanical timepiece.

[0015] However, since it is necessary to stop the hands during hand adjustniertts, the wheel train, as well as the generator, must be stopped. Therefore, when the generator is stopped so that generation of electrical power is stopped, driving of the rotation control circuit can be continued for a certain period of time using the electrical power used to charge the capacitor. However, when the capacitor has discharged electricity, the rotation control circuit stops.

[0016] After the rotation control circuit has stopped, when hand adjustments are completed and driving of the generator is started, hand movements cannot be controlled until driving of the control circuit is started. Therefore, there has been an attempt to preset the time during which hand movements cannot be controlled in order to correct the starting time of the control operation. Here, when the magnitude of the torque, output from the mainspring, changes, the amount of time until which the generator drives the control circuit also changes, so that the amount of correction is set in accordance with the magnitude of a predetermined output torque.

[0017] However, at the last stage of mainspring winding-up operations, the torque, accumulated in the mainspring, suddenly becomes large, and a slight change in the winding amount greatly changes the magnitude of the torque, causing the torque to change greatly with every winding operation. Therefore, the corrections, even when they are made, are not sufficient.

[0018] It is a second object of the present invention to provide a mainspring device and a timepiece incorporating the mainspring, wherein when, for example, an electronic control type mechanical timepiece is used, corrections can be made very precisely even when the rotation control circuit has been stopped.

[0019] According to Claim 1 of the present invention, there is provided a mainspring device constructed so as to drive a wheel train by mechanical energy of a mainspring, comprising: a winding-up portion for accumulating energy in the mainspring; an addition and subtraction wheel train for adding and subtracting the amount by which the mainspring is wound up and unwound; an addition and subtraction wheel, disposed in the addition and subtraction wheel train, for adding and subtracting the amount by which the mainspring is wound up and unwound; and a lock mechanism, which is actuated in response to the rotation of the addition and subtraction wheel, for preventing transmission of torque with a value that lies outside a set range from the mainspring to the wheel train.

[0020] According to this invention, since the amount by which the mainspring is wound up and unwound is detected by using an addition and subtraction wheel train, and the lock mechanism is actuated in response to the rotation of the addition and subtraction wheel to which a torque produced during the winding or unwinding operation is exerted, the winding operation can be locked before the torque on the mainspring becomes very large, or the wheel train can be stopped before rotation of the wheel train becomes imprecise as a result of a reduction in the output torque. Therefore, a torque whose value lies within a set range can be output at all times.

[0021] The addition and subtraction wheel train is constructed using a plurality of gears or the like, making it unnecessary to construct it like the Maltese Cross type winding stop mechanism which is constructed using only two members that are directly mounted to the barrel arbor and the movement barrel. Therefore, the addition and subtraction wheel, or the like, can be disposed in the space around the movement barrel through the wheel train. Consequently, even when the mainspring device is used as a watch having only a small space for arranging component parts, the addition and subtraction wheel train can be disposed in ample space, making it possible to stop the winding up of the mainspring.

[0022] By virtue of such a construction, the first object is achieved.

[0023] Although not exclusive, the lock mechanism may comprise a winding-up lock mechanism portion which, when the mainspring is wound up to a number of windings equal to or greater than a predetermined number of windings, locks a winding-up wheel train, to which torque produced during winding-up operations is transmitted in the addition and subtraction wheel train, and/or the winding-up portion, in order to stop the winding up of the mainspring.

[0024] In this form, when the mainspring is wound up to a number of windings that is equal to or greater than the predetermined number of windings, the winding-up wheel train and the winding-up portion are locked (stopped) by the winding-up lock mechanism portion in response to the rotation of the addition and subtraction wheel, so that the winding-up operation can be more reliably stopped, thus making it possible to prevent, in particular, overwinding of the mainspring.

[0025] Here, the winding-up lock mechanism portion is not required to perform locking operations by disengaging a gear. Although not exclusive, the winding-up lock mechanism portion may stop the winding up of the mainspring by locking a torque transmitting component part which has a torque equal to or less than a gear directly connected to a torque input side of the mainspring and which is disposed in the winding-up wheel train and/or the winding-up portion.

[0026] Locking a torque transmitting part (for example, a gear) with a smaller torque allows the winding-up operation to be performed with a smaller force. Therefore, the strength of the component parts of the winding-up lock mechanism portion can be made small, which allows the parts to be made smaller and thinner.

[0027] Although not exclusive, the winding-up lock mechanism portion may perform a locking operation by stopping torque transmission to the winding-up wheel train or to the winding-up portion.

[0028] Although not exclusive, the lock mechanism may have an unwinding lock mechanism portion which, when the mainspring is unwound to a number of windings equal to or less than a predetermined number of windings, stops the rotation of the wheel train by locking an unwinding wheel train, to which torque produced during unwinding operations is transmitted in the addition and subtraction wheel train, and/or the wheel train.

[0029] In this form, the unwinding lock mechanism portion, which operates in response to the rotation of the addition and subtraction wheel, locks the wheel train when the mainspring is unwound to a number of windings equal to or less than the predetermined number of windings, so that the wheel train can be forced to stop before it becomes incapable of rotating precisely as a result of reduced output torque in the mainspring.

[0030] Although not exclusive, the unwinding lock mechanism portion may stop hand movement by disengagement of a gear in the wheel train.

[0031] For example, disengaging a gear, when the number of windings of the mainspring is equal to or less than the predetermined number of windings, by, for example, a lever which is actuated in response to the number of windings of the mainspring, does not allow the torque on the mainspring to be transmitted, thereby allowing the wheel train to be reliably stopped.

[0032] The unwinding lock mechanism portion is not required to perform a locking operation by disengaging gears. Although not exclusive, the unwinding lock mechanism portion may stop the rotation of the wheel train by locking a torque transmitting component part which has a torque equal to or less than a gear directly connecting to a torque output side of the mainspring and which is disposed in the unwinding wheel train and/or the wheel train.

[0033] By locking a gear with a small torque, the unwinding operation can be stopped with less force to stop hand movements than the case where the torque on the movement barrel is directly received to stop the unwinding operation. Therefore, the required strength of the component parts of the unwinding lock mechanism is reduced, which allows these component parts to be made small and thinner.

[0034] Although not exclusive, it is desirable that the winding-up lock mechanism portion lock a gear in the winding-up wheel train, with any gear in a torque transmission path formed at the mainspring side with reference to the gear being driven by rotation of an oscillating weight in order to cause the torque from the oscillating weight to wind up the mainspring and to drive the winding-up wheel train; and that the winding-up lock mechanism portion comprise a slip mechanism section, which is provided in the torque transmission path, for preventing transmission of torque, during actuation of the winding-up lock mechanism, from the oscillating weight to the mainspring and the addition and subtraction wheel.

[0035] In this case, when a gear is locked by the winding-up lock mechanism portion, a slip mechanism portion is actuated to cause the oscillating weight to rotate idly, so that when the oscillating weight is locked the oscillating weight itself is not broken, and rotation is not transmitted from the oscillating weight towards the addition and subtraction wheel, thereby preventing breakage of the winding-up lock mechanism portion in a locked state due to undue force exerted thereon, and ensuring that the hand of the addition and subtraction wheel indicates the exact time. Therefore, the winding-up lock mechanism portion can be applied to an automatic winding type mainspring device without any problem.

[0036] It is preferable that the winding-up lock mechanism portion comprise a winding-up lock lever which is lockable by engagement with at least one of the component parts to which torque is transmitted during a winding up operation; and that the unwinding lock mechanism comprise an unwinding lock lever which is lockable by engagement with at least one of the component parts to which torque is transmitted during an unwinding operation. These lock levers ensure proper locking operations.

[0037] It is preferable that the winding-up lock lever have a stopper portion which is etigageable with at least one gear in the winding-up wheel train and the winding-up portion; and that the unwinding lock lever have a stopper portion which is engageable with at least one gear in the unwinding wheel train and the wheel train.

[0038] Although the winding-up wheel train, the winding-up portion, the unwinding wheel train, and the wheel train can be locked by braking the wheel trains that are torque transmitting component parts, by, for example, frictional force, the winding-up wheel train and the winding-up portion can be reliably and easily locked by engaging the lever stopper portion with the teeth of a gear.

[0039] One wheel or a plurality of wheels may be brought into engagement with the stopper portion in order to perform a locking operation.

[0040] When the lock mechanism comprises the aforementioned winding-up lock mechanism portion and the unwinding lock mechanism portion, they may be integrally formed into one multilock lever in order to reduce the number of component parts and to allow more efficient use of space.

[0041] It is preferable that the rotational center of the winding-up lock lever, the unwinding lock lever, and the multilock lever be disposed between corresponding component parts, with which the lock levers engage, and the corresponding addition and subtraction wheels. In this case, the distance from the rotational centers to the corresponding component parts and the distance from the rotational centers to the corresponding addition and subtraction wheels can be made shorter, so that each of the lock levers can be made more rigid by a corresponding degree.

[0042] It is desirable that the addition and subtraction wheel have an operation engaging portion, being a groove or a protrusion, at the outer periphery thereof; and the lock lever press-contact the addition and subtraction wheel, and have an engaging protrusion which is engageable with the operation engaging portion of the addition and subtraction wheel; and that when the engaging protrusion is brought into engagement with the operation engaging portion of the addition and subtraction wheel, the lock lever engages and stops the component part associated thereto.

[0043] When the engaging protrusion of the lock lever is made to press-contact the addition and subtraction wheel, the engaging protrusion can reliably be brought into engagement with the operation engaging portion, such as a groove, or can be kept in contact with the outer periphery of the addition and subtraction wheel, allowing the lock lever to be stably actuated without any vibration, and thus making the winding-up lock mechanism portion and the unwinding lock mechanism portion more reliable.

[0044] It is preferable that the lock lever press and clamp the sides of the addition and subtraction wheel in a diametrical direction thereof. This prevents the rotational shaft of the addition and subtraction wheel from falling over frequently.

[0045] Although not exclusive, the portion of the lock lever that engages the associated component part may be made resilient. In this case, even when a force is further exerted onto the engaging portion of the lock lever in engagement with its associated component part, this exerted force is absorbed by the resilient engaging portion, so that undue force does not act on the component part, thereby preventing breakage thereof.

[0046] Although not exclusive, the portion of the lock lever which engages the associated component part may be made rigid; and the addition and subtraction wheel, which actuates the lock lever, may be mounted on a same rotational shaft with respect to a gear, which transmits torque to the addition and subtraction wheel, such that backlash is provided between the gear and the addition and subtraction wheel, the addition and subtraction wheel rotating ahead of the gear by an amount corresponding to the amount of backlash when the lock lever is being actuated.

[0047] In this case, the lock lever, which is rigid, can reliably perform a locking operation with a large amount of dragging force. Since, at the moment the lock lever engages its associated component part, the addition and subtraction wheel (or operation engaging portion) rotates ahead, the lock lever can be instantaneously brought into engagement with its associated component part, so that even when the lock lever is made rigid, less wear, or the like, occurs in the associated component part.

[0048] In Claims 12 to 16, when the winding-up lock lever and the unwinding lock lever are separately formed, the term "the lock lever" may refer to one of these lock levers or both of these lock levers, whereas when the winding-up lock lever and the unwinding lock lever are integrally formed to form one multilock lever, the term "the lock lever" refers to the multilock lever.

[0049] It is preferable that the timepiece of the present invention comprise a remaining life indicating means which is driven by the addition and subtraction wheel.

[0050] In this case, the remaining life indicating means allows the life of the timepiece to be easily read.

[0051] Although not exclusive, the remaining life indicating means may be provided at the outer side of a wheel train bridge which supports the wheel train.

[0052] Since the remaining life indicating means is provided at the back side of the timepiece, the design at the front side can be kept simple, while providing a remaining life confirmation function.

[0053] It is preferable that the mainspring device be an electronic control type which comprises a generator for converting mechanical energy of the mainspring transmitted through the wheel train into electrical energy, and a rotation control means, which is driven by the electrical energy, for controlling the rotation period of the generator.

[0054] The mainspring device of the present invention may be a timepiece.

[0055] In this invention, the winding up of the mainspring can be locked when it is unwound to a predetermined number of windings, so that when the output torque of the mainspring is reduced to a low value and precise hand movements cannot be achieved, the wheel train, that is the hand, can be forced to stop, whereby torque whose value lies within a set range can be output at all times.

[0056] Embodiments of the present invention will be described in more detail and by way of further example only with reference to the drawings; in which:-

Fig. 1 is a plan view of a first embodiment of the electronic control type mechanical timepiece in accordance with the present invention.

Fig. 2 is a sectional view of the main portion of the electronic control type mechanical timepiece of Fig. 1.

Fig. 3 is a sectional view of the main portion of the electronic control type mechanical timepiece of Fig. 1.

Fig. 4 is a sectional view of the main portion of the electronic control type mechanical timepiece of Fig. 1.

Fig. 5 is a schematic view of the main portion of each lock mechanism, used in the first embodiment of the present invention.

Fig. 6 is a sectional view of a second embodiment of the electronic control type mechanical timepiece in accordance with the present invention.

Fig. 7 is a schematic view of the main portion of each lock mechanism, used in the second embodiment of the present invention.

Fig. 8 illustrates the operation of each lock mechanism, used in the second embodiment of the present invention.

Fig. 9 is an enlarged view of the component parts of each lock mechanism, used in the second embodiment of the present invention.

Fig. 10 is a plan view of the main portion of the timepiece, in accordance with a third embodiment of the present invention.

Fig. 11 is a sectional view of the main portion of the timepiece, in accordance with the third embodiment of the present invention.

Fig. 12 is a plan view of component parts of the timepiece, in the third embodiment of the present invention.

Fig. 13 is a plan view of a modification of the aforementioned component parts of the timepiece, in the third embodiment of the present invention.

Fig. 14 is a sectional view of the main portion of the timepiece, in accordance with a fourth embodiment of the present invention.

Fig. 15 is a plan view of component parts of the timepiece, in the fourth embodiment of the present invention.

Fig. 16 is a sectional view of the main portion of the timepiece, in accordance with a fifth embodiment of the present invention.

Fig. 17 is a plan view of a modification of the electronic control type mechanical timepiece in accordance with the present invention.

Fig. 18 is a plan view of another modification of the electronic control type mechanical timepiece in accordance with the present invention.

Fig. 19 is a plan view of still another modification of the electronic control type mechanical timepiece in accordance with the present invention.

Fig. 20 is a plan view of still another modification of the electronic control type mechanical timepiece in accordance with the present invention.

Fig. 21 is a sectional view of still another modification of the electronic control type mechanical timepiece in accordance with the present invention.

Fig. 22 is a graph showing mainspring characteristics.

Fig. 23 is a schematic view of a conventional Maltese Cross type winding-up and unwinding stop mechanism.

[0057] Fig. 1 is a schematic plan view of an embodiment of the electronic control type mechanical timepiece used as a mainspring device in accordance with the present invention; and Figs. 2 to 4 are sectional views of the main portion of the electronic control type mechanical timepiece.

[0058] In Figs. 1 to 4, the electronic control type mechanical timepiece comprises a movement barrel 1 composed of a mainspring 1a, a barrel wheel gear 1b, a barrel arbor 1c, and a barrel cover 1d. The mainspring 1a has its outer end affixed to the barrel wheel gear 1b and its inner end affixed to the barrel arbor 1c. The barrel arbor 1c is supported by a main plate 2 and is capable of rotating integrally with a ratchet wheel 4.

[0059] The ratchet wheel 4 meshes a detent 3 so that it rotates clockwise and does not rotate counterclockwise. The ratchet wheel 4 is constructed such that when a winding stem 31, connected to a crown which is not shown, is operated, it rotates through a winding pinion 32, a crown wheel 33, and an intermediate ratchet wheel 34, and causes the barrel arbor 1c to rotate in order to wind up the mainspring 1a. Accordingly, a winding-up portion 30, in which energy accumulates, is formed by the winding stem 31, the winding pinion 32, the crown wheel 33, the intermediate ratchet wheel 34, and the ratchet wheel 4.

[0060] As shown in Fig. 3, the rotation of the barrel wheel gear 1b, which has been transmitted to a second wheel 6, is increased in value and successively transmitted to a third wheel 7, a second hand wheel 8, a fourth wheel 9, a fifth wheel 10, a sixth wheel 11, and then to a rotor 12. A minute hand, which is not shown, is affixed to the second wheel 6 through a cannon pinion 6a, while a second hand is affixed to the second hand wheel 8. An hour wheel 6b is affixed to the cannon pinion 6a through a minute wheel 38, with an hour hand being affixed to the hour wheel 6b.

[0061] The wheels 6 to 11 and the rotor 12 are supported by a wheel train bridge 14, a center wheel bridge 15, and the main plate 2. The wheels 6 to 11 form a wheel train 13 for transmitting the mechanical energy of the mainspring 1a to the hour hand, the minute hand, and the second hand.

[0062] As shown in Fig. 1, the electronic control type mechanical timepiece comprises a generator 20 including the rotor 12 and coil blocks 21 and 22. The rotor 12 comprises a rotor magnet 12a, a rotor pinion 12b, and a rotor inertia disk 12c. Of the component parts of the rotor 12, the rotor inertia disk 12c is provided for reducing the amount of variation in the rotational speed of the rotor 12 due to variations in the driving torque from the movement barrel 1.

[0063] The coil blocks 21 and 22 are each formed by winding a coil 24 around its associated core 23. Each core 23 comprises a core stator portion 23a, disposed adjacent to the rotor 12; a core winding portion 23b, upon which is wound the associated coil 24; and a core magnetism conducting portion 23c. The core magnetism conducting portions 23c, which are linked together, are integrally formed.

[0064] In the above-described electronic control type mechanical timepiece, alternating current output from the generator 20 is input to a rectifying circuit comprising a voltage increasing and rectifying portion, a full-wave rectifying portion, a half-wave rectifying portion, a transistor rectifying portion, etc., causing the alternating current output to be increased in amplitude and be rectified. The resulting alternating current causes an output smoothing capacitor to be charged. The electrical power from the capacitor causes a rotation controlling circuit (rotation controlling means), which is not shown, to control the rotation of the generator 20. It is to be noted that the rotation control circuit comprises an integrated circuit (IC), which includes, for example, an electromagnetic brake control means, an oscillation circuit portion, a frequency dividing portion, a rotation detecting circuit, and a rotational speed comparing circuit. For the oscillation circuit, a crystal vibrator is used.

[0065] Adjustments of the minute hand and the hour hand are performed by axially moving the winding stem 31 as a result of pulling out the crown, and by moving a sliding portion 35 towards a setting wheel 36 and engaging it therewith by the action of a setting lever 40, a detent spring 41, and a yoke 42. Then, the cannon pinion 6a and the hour wheel 6b are rotated through the setting wheel 36, an intermediate minute wheel 37, and the minute wheel 38. Accordingly, a hand adjusting mechanism 44 is formed by the crown, the winding stem 31, the sliding portion 35, the setting wheel 36, the intermediate minute wheel 37, the minute wheel 38, the setting wheel 40, the detent spring 41, and the yoke 42.

[0066] The electronic control type mechanical timepiece comprises a wheel train 50 used for adding and subtracting the amount by which the mainspring 1a is wound up and unwound.

[0067] The wheel train 50 comprises an eightieth wheel 52 affixed to a power reserve needle 51 serving as remaining life indicating means; a power reserve wheel 53 affixed to a shaft of the eightieth wheel 52; an eighty-first wheel 54 comprising a first planetary wheel portion 54a, which engages the power reserve wheel 53, and a second planetary wheel portion 54b, which is formed integrally with the first planetary wheel 54a; a planetary intermediate wheel 55 which engages the second planetary wheel portion 54b of the eighty-first wheel 54; an eighty-second wheel 56 which rotates integrally with the planetary intermediate wheel 55; an eighty-third wheel 57 which engages the eighty-second wheel 56; an eighty-fourth wheel 58 which engages the eight-third wheel 57; an eight-fifth wheel 59 serving as a sun wheel mounted to the eighty-first wheel 54 being a planetary wheel; an eighty-sixth wheel 60 which engages the eighty-fifth wheel 59; an eight-seventh wheel 61 which engages the eighty-sixth wheel 60; and an eighty-eighth wheel 62 which engages the eighty-seventh wheel 61. The eighty-fourth wheel 58 engages the aforementioned ratchet wheel 4, while the eighty-eighth wheel 62 engages the movement barrel 1.

[0068] When the ratchet wheel 4 is rotated by winding up the mainspring 1a, the torque on the ratchet wheel 4 is progressively reduced as it is transmitted from the eighty-fourth wheel 58 to the eighty-third wheel 57, the eighty-second wheel 56, and the eighty-first wheel 54. Here, when the mainspring 1a is being wound up, since the barrel wheel gear 1b rotates very slowly so that it is virtually stationary, the wheels 59 to 62 are stationary. Therefore, the torque, transmitted to the eighty-first wheel 54, is such as to be transmitted from the power reserve wheel 53, the eightieth wheel 52, and the power reserve needle 51.

[0069] On the other hand, when unwinding of the mainspring 1a is being performed, the ratchet wheel 4 is not moving, so that the wheels 55 to 58 are stationary. When the barrel wheel gear 1b rotates, the torque on the barrel wheel gear 1b is progressively reduced as it is transmitted from the eighty-seventh wheel 61, the eighty-sixth wheel 60, and the eighty-fifth wheel 59. At this time, since the planetary intermediate wheel 55, which engages the eighty-first wheel 54, is stationary, the eighty-first wheel 54 revolves around the planetary intermediate wheel 55 as it rotates. This causes the power reserve wheel 53, which meshes the eighty-first wheel 54, to rotate in a direction opposite to the direction in which it rotates when the mainspring 1a is being wound up, causing the eightieth wheel 52 and the power reserve needle 51 to also rotate in the opposite direction.

[0070] In the embodiment, the speed reduction ratio from the movement barrel 1 (or the ratchet wheel 4) to the eightieth wheel 52 is set at 1/12, so that when the number of windings of the mainspring 1a is set at six (the angle of rotation is 360° x 6 = 2160°), the eightieth wheel 52, that is the power reserve needle 51, rotates 180 degrees.

[0071] The wheel train 50 comprises a winding-up wheel train 50a, formed by the eighty-fourth wheel 58, the eighty-third wheel 57, the eighty-second wheel 56, the planetary intermediate wheel 55, the eighty-first wheel 54, and the power reserve wheel 53, for transmitting torque from the ratchet wheel to the eightieth wheel 52. The wheel train 50 also comprises an unwinding wheel train 50b, formed by the eighty-eighth wheel 62, the eighty-seventh wheel 61, the eighty-sixth wheel 60, the eighty-fifth wheel 59, the eighty-first wheel 54, and the power reserve needle 53, for transmitting torque from the barrel wheel gear 1b to the eightieth wheel 52.

[0072] When the ratchet wheel 4 rotates, an amount of torque corresponding to the amount by which the mainspring 1a is wound up is transmitted to the eightieth wheel 52 and added as rotation in a predetermined direction, whereas when the mainspring 1a is unwound and the barrel wheel gear 1b rotates, an amount of torque corresponding to the amount by which the mainspring 1a is unwound is transmitted to the eightieth wheel 52 and subtracted as rotation in the opposite direction. Accordingly, an addition and subtraction wheel is formed by the eightieth wheel 52.

[0073] As shown in Fig. 5, the eightieth wheel 52 is a disk-shaped wheel without any teeth along its outer periphery thereof, and has a groove 52a, serving as an actuation engaging portion, in a portion of its outer periphery so as to extend in a diametrical direction.

[0074] Around the eightieth wheel 52 are provided a winding-up lock mechanism 70 for locking (or stopping) rotation of the winding-up wheel train 50a; a hand lock mechanism 80, serving as an unwind lock mechanism, for locking (or stopping) rotation of the unwind wheel train 50b; and a hand-adjusting lock mechanism 90 for locking the hand adjusting mechanism 44.

[0075] The winding-up lock mechanism 70 includes a winding-up lock lever 71 which engages the eighty-fourth wheel 58. The lever 71 can rotate with a rotation shaft 71a, disposed between the eighty-fourth wheel 58 and the eightieth wheel 52, as center. The lever 71 comprises a stopper portion 72, which can engage the teeth of the eighty-fourth wheel 58, and an engaging protrusion 73, which can engage the groove 52a of the eightieth wheel 52. A spring portion 74, which extends from the body of the lever 71 so as to form a substantially U shape, contacts a stopper pin 75. The engaging protrusion 73 can press-contact the eightieth wheel 52 by the action of the spring portion 74. Therefore, when the engaging protrusion 73 engages the groove 52a of the eightieth wheel 52, the stopper portion 72 engages the eighty-fourth wheel 58, as indicated by the alternate long and two short dashed lines in Fig. 5, thereby locking, or stopping, the rotation of the eighty-fourth wheel 58, that is the rotation of the winding-up wheel train 50a, the ratchet wheel 4, and the winding-up portion 30, as a result of which the winding up of the mainspring 1a is stopped.

[0076] On the other hand, when the engaging protrusion 73 is press-contacting a location of the outer periphery of the eightieth wheel 52 other than the groove 52a, the stopper portion 72, as shown by the solid line in Fig. 5, is separated from the eighty-fourth wheel 58, allowing the mainspring 1a to be wound up.

[0077] As mentioned above, the eightieth wheel 52 is set so that it rotates 180 degrees when the mainspring 1a is wound six times, that is, when the ratchet wheel 4 rotates six times. Therefore, in the case where locking of the winding operation is to be performed when the desired number of windings has been reached (for example, when the number of windings A has been reached, which is the number of windings before the output torque changes significantly for a mainspring 1a having the characteristics illustrated in Fig. 22), the eightieth wheel 52 is set at an angle which causes the engaging protrusion 73 to engage the groove 52a of the eightieth wheel 52.

[0078] Similarly, as shown in Fig. 5, the hand lock mechanism 80 includes a hand lock lever 81, serving as an unwinding lock lever, which engages the eighty-seventh wheel 61. The lever 81 can rotate with a rotation shaft 81a, disposed between the eighty-seventh wheel 61 and the eightieth wheel 52, as center. The hand lock mechanism 81 comprises a stopper portion 82, which can engage the teeth of the eighty-seventh wheel 61, and an engaging protrusion 83, which can engage the groove 52a of the eightieth wheel 52. A spring portion 84, which extends from the body of the lever 81 so as to form a substantially U shape, press-contacts a stopper pin 85. The stopper portion 82 and the engaging protrusion 83 can press-contact the eighty-seventh wheel 61 and the eightieth wheel 52, respectively, by the action of the spring portion 84.

[0079] Accordingly, when the engaging protrusion 83 engages the groove 52a of the eightieth wheel 52, the stopper portion 82, as indicated by the alternate long and two short dashed lines of Fig. 5, engages the eighty-seventh wheel 61, thereby locking the rotation of the eighty-seventh wheel 61, that is, the rotation of the unwind wheel train 50b, so that the unwinding of the mainspring 1a, that is, hand movement is stopped.

[0080] On the other hand, when the engaging protrusion 83 press-contacts a portion of the outer periphery of the eightieth wheel 52 other than the groove 52a, the stopper portion 82, as indicated by the solid line of Fig. 5, is separated from the eighty-seventh wheel 61, allowing rotation of the unwind wheel train 50b, that is, hand movement.

[0081] The hand lock lever 81 is set so that the engaging protrusion 83 engages the groove 52a of the eightieth wheel 52 when locking of the unwinding operation (or stopping the hand movement) at the time the desired number of unwinding operations is performed. For example, in the case where a mainspring 1a having the characteristics illustrated in Fig. 22 is used, unwinding is locked at the moment the number of windings B is reached, which is the number of windings at which the output torque is greatly reduced.

[0082] In the present embodiment, locking of the winding operation needs to be performed at the moment the winding operation is completed, that is, when the number of windings is six, whereas locking of the unwinding operation (or stopping of hand movement) needs to be performed at the moment the output torque is reduced to a low value as a result of unwinding of the mainspring 1a, that is, when the number of windings of the mainspring 1a approaches zero. Therefore, the difference in the number of windings between the time the mainspring 1a is completely wound and the time the output torque is reduced to a low value as a result of unwinding the mainspring 1a is approximately six, that is, the difference in the rotational angles of the eightieth wheel 52 between these times is nearly 180 degrees. Therefore, the levers 71 and 81 are disposed such that their respective engaging protrusions 73 and 83 are positioned on opposite sides of the eightieth wheel 52 and separated by approximately 180 degrees. More specifically, they are separated by an angle of approximately 160 to 180 degrees.

[0083] As shown in Fig. 5, the hand-adjusting lock mechanism 90 includes a hand-adjusting lock lever 91 which engages the sliding pinion 35. The base end side of the lever 91 is formed integrally with the lever 71. A stopper portion 92, which can engage a groove 35a formed along the outer periphery of the sliding pinion 35, is formed at the other end, which extends along the outer periphery of the ratchet wheel 4, of the lever 71.

[0084] When the engaging protrusion 73 engages the groove 52a of the eightieth wheel 52, the stopper portion 92, as indicated by the alternate long and two short dashed lines, is separated from the sliding pinion 35, allowing the sliding pinion 35 to move towards the setting wheel 36, that is, allowing the hand adjusting mechanism 44 to start operating.

[0085] On the other hand, when the engaging protrusion 73 press-contacts a location of the eightieth wheel 52 other than the groove 52a, the stopper portion 92 engages the sliding pinion 35 in order to lock the movement of the sliding pinion 35 towards the setting wheel 36. that is, the hand adjusting mechanism 44, so that hand adjusting operations, themselves, such as pulling out of the winding stem, cannot be carried out.

[0086] Therefore, until the winding-up operation is locked by the winding-up lock lever 71, that is, until the mainspring 1a is sufficiently wound up, the hand adjusting mechanism 44 is locked by the hand adjusting lock lever 91, so that hand adjusting operations cannot be carried out.

[0087] According to the present invention, the following effects are produced.

1) The winding-up lock mechanism 70 allows winding operations to be stopped before the torque on the mainspring 1a becomes considerably large, and the hand lock mechanism 80 allows a hand to be stopped before precise hand movement becomes impossible as a result of reduced output torque from the mainspring 1a, so that a torque within a set range can always be output from the mainspring 1a.

2) In particular, the winding-up lock mechanism 70 prevents overtightening of the mainspring 1a. Therefore, it is possible to prevent a very high torque, caused by overtightening of the mainspring 1a, from being exerted onto the wheel train 13, or the like, at the initial stage of the unwinding operation, and to prevent breakage of the wheel train 13, or the like.

The winding-up lock mechanism 70, the hand lock mechanism 80, and the hand-adjusting lock mechanism 90 make use of the wheel train 50 disposed at the outer peripheral side of the movement barrel 1 and the ratchet wheel 4, making it possible to effectively use the same around the movement barrel 1, so that the timepiece can always be made small in size and made thin. In particular, the aforementioned Maltese Cross type winding-up and unwinding stop mechanism requires that gears be directly mounted to the barrel arbor 1c and the movement barrel 1, making the timepiece thicker by a proponionale amount, and more difficult to design as a result of less freedom with which component parts can be accommodated. In contrast to this, according to the present embodiment, the timepiece can be designed with greater freedom, and space can be used effectively. As a result, even for a watch with a small space for disposing component parts in its interior, a mechanism for stopping winding-up operations and unwinding operations (mechanism for stopping hand movement) and a hand-adjusting lock mechanism can be realized.

4) Since the winding-up lock lever 71 is accelerated with respect to the ratchet wheel 4, its rotation is controlled as a result of engagement of the winding-up lock lever 71 with the eighty-fourth wheel 58, having a torque which becomes smaller, so that the winding-up operation can be locked with a smaller force. Therefore, it is possible to reduce the required strength of the winding-up lock lever 71 and the eighty-fourth wheel 58, thereby allowing the component parts to be made smaller and thinner.

Similarly, since the hand lock lever 81 is accelerated with respect to the movement barrel 1, its rotation is controlled as a result of engagement of the hand lock lever 81 with the eighty-seventh wheel 61, having a torque which becomes smaller, so that the winding-up operation can be locked with a smaller force. Therefore, it is possible to reduce the required strength of the hand lock lever 81 and the eighty-seventh wheel 61, thereby allowing the component parts to be made smaller and thinner.

In order to lock the eighty-fourth wheel 58 and the eighty-seventh wheel 61, the wheels 58 and 61 may be braked as a result of, for example, frictional force. Since the stopper portion 72 of the lock lever 71 and the stopper portion 82 of the lock lever 81 engage the wheels 58 and 61, respectively, the winding-up wheel train 50a and the unwind wheel train 50b can be reliably and easily locked.

5) Since the engaging protrusion 73 of the winding-up lock lever 71 and the hand adjusting lock lever 91 and the engaging protrusion 83 of the hand lock lever 81 press-contact the eightieth wheel 52 by the action of the spring portion 74 and 84, respectively, the engaging protrusions 73 and 83 can be made to reliably engage the groove 52a and press-contact locations of the eightieth wheel 52 other than the groove 52a, so that they can operate stably without any vibration, making it possible to increase the reliability of the winding-up lock mechanism 70, the hand lock mechanism 80, and the hand-adjusting lock mechanism 90.

6) The rotation shaft 71a of the winding-up lock lever 71 is disposed between the eighty-fourth wheel 58 and the eightieth wheel 52, so that the distance from the rotation shaft 71a to the stopper portion 72, which engages the wheel 58, and the distance from the rotation wheel 71 a to the engaging protrusion 73, which engages the wheel 52, can be made short, thereby allowing the winding-up lock lever 71 to become more rigid by a proportionate degree.

Similarly, the rotation shaft 81a of the hand lock lever 81 is disposed between the eighty-seventh wheel 61 and the eightieth wheel 52, so that the distance from the rotation shaft 81a to the stopper portion 82, which engages the wheel 61, and the distance from the rotation shaft 81 to the engaging protrusion 83, which engages the wheel 52, can be made short, thereby allowing the hand lock lever 81 to become more rigid by a proportionate degree.

The rotation shaft 71a of the hand-adjusting lock lever 91 is disposed between the sliding pinion 35 and the eightieth wheel 52, so that the distance from the rotation shaft 71a to the stopper portion 92, which engages the pinion 35, and the distance from the rotation shaft 71a to the engaging protrusion 73, which engages the wheel 52, can be made short, thereby allowing the hand-adjusting lock lever 91 to become more rigid by a proportionate degree.

It is to be noted that when the rotation shafts 71a and 81a are disposed between their associated wheels, the distance from the center of rotation of each of the wheels to their associated rotation shafts 71a and 81a is smaller than the distance between the centers of rotation of their associated wheels.

7) Since the winding-up operation of the mainspring 1a can be locked when the mainspring 1a is wound a predetermined number of times, the output torque at the start of unwinding of the mainspring 1a is not very large, so that it can be maintained at a virtually constant value. Therefore, when the rotor 12 starts immediately after hand adjustments, it is possible to precisely predict when controlling operations can be performed after starting driving of the control circuit. Consequently, even when the rotation control circuit is not operating when hand adjustments have been performed after locking of the winding-up operation, precise corrections can be made during the time the control circuit is not operating, making it possible for the electronic control type mechanical timepiece to indicate time even more precisely.

8) Since a considerably high output torque is not produced, the speed regulating braking range, that is, the torque to be controlled can be limited. Thus, the precision during speed regulation can be increased, making it possible to increase the precision with which time is indicated. In addition, since untlecessery braking controlling operations carried out when an extremely high output torque is exerted are not performed, the timepiece life can be made longer by the mainspring 1a.

9) Since a wheel train 50 for adding and subtracting input winding-up torque and input unwinding torque in order to produce one output is provided, when a power reserve needle 51 is provided at the eightieth wheel 52, the power reserve, that is, the remaining life of the timepiece can be indicated.

10) When the output torque on the mainspring 1a is reduced, so that the amount of electrical power that allows driving of the control circuit in the electronic control type mechanical timepiece cannot be uhtained to control hand movement (called a free-run state), the hand lock mechanism 80, in particular, can force the wheel train 13, that is the hands, to stop, making it possible to prevent indication of a wrong time.

When the output torque is reduced to a low value, and the hand lock mechanism 80 operates, the barrel wheel gear 1b also stops, causing the hour hand, the minute hand, and the second hand to stop. Therefore, when the output torque is low and the timepiece is operating abnormally, this can be easily recognized by anyone using the timepiece, making it possible to prevent the user from incorrectly reading the time.

11) Since the mainspring 1a can be prevented from being unwound more than is necessary by the hand lock mechanism 80, the mainspring 1a is not unwound more than is necessary (the mainspring 1a is unwound more than is necessary when the number of windings lies in the range of from O to B in Fig. 22), so that the winding-up operations can be carried out for a shorter time.

12) Since the hand-adjusting lock mechanism 90 does not allow hand adjustments until the mainspring 1a is sufficiently wound up, the time from completion of hand adjustments to restopping of the timepiece can be maximized, thereby allowing an easily usable electronic control type mechanical timepiece to be provided.

13) Since the hand-adjusting lock mechanism 90 is provided, when the output torque on the mainspring 1a is reduced, and the electronic control type mechanical timepiece stops, the system stopping time which continues until the mainspring 1a is sufficiently wound up, that is, until hand adjustments can be performed, can be made sufficiently long. Here, while the mainspring 1a is being wound up by hand, torque is intermittently output from the mainspring 1a, causing actuation of the generator, so that when the time which continues until the winding up of the mainspring 1a is completed is long, the generator 20 causes a charging portion, such as a capacitor, to be charged with a high voltage. Therefore, in order to perform hand adjustments, when the hands are stopped, that is, when the generator 20 is stopped, the system can be kept driven by means of the capacitor for a longer period of time, so that if hand adjustments can be completed within the usual amount of time, the system can be kept driven until the generator starts to operate.

Accordingly, the system can be controlled from immediately after hand adjustments, so that hand movement can be controlled with high precision.

When hand adjustments are completed within a predetermined amount of time, a certain amount of electrical power remains in the capacitor, so that when the generator 20 is actuated after hand adjustments are completed, the capacitor can be charged more quickly than in conventional timepieces. Therefore, time lag of control circuit driving can be made short, thereby reducing errors in time control to allow more precise hand adjustments.

14) The lock mechanism 70 and 90 are automatically actuated in response to the winding up of the mainspring 1a, so that the operator does not have to worry about operating them, making it possible to facilitate operation. Similarly, the hand lock mechanism 80 is automatically actuated in response to the winding up of the mainspring 1a, so that the operator does not have to operate it by hand, as a result of which the timepiece can be op-

erated more easily.

15) The levers 71 and 91 of their respective lock mechanisms 70 and 90 are made integral, so that the number of parts and costs can be reduced.

16) The hand-adjusting lock mechanism 90 locks the hand adjusting mechanism 44 so that it cannot operate as a result of engagement of the hand-adjusting lock lever 91 with the sliding pinion 35, so that the crown (winding stem 31) is in itself locked and cannot be pulled. This allows the user to easily recognize that the hand adjusting mechanism 44 is locked, making it possible for the user to intuitively and easily operate the hand-adjusting lock mechanism 90.

Figs. 6 and 7 illustrate a second embodiment of the timepiece in accordance with the present invention.

In the present embodiment, parts having the same operations as those of the first embodiment are given the same reference numerals, and will not he described below.

The present embodiment differs from the first embodiment in that the winding-up lock lever 71 and the hand lock lever 81 are integrally formed into a multilock lever 111. In other words, locking of the winding up operations and hand movements are performed by the multilock lever 111 alone.

In addition, the present embodiment differs from the first embodiment in that a hand-adjusting lock mechanism is not provided. Further, it differs from the first embodiment in that a speed reduction gear 115 meshes the eightieth wheel 52, with the power reserve needle 51 being mounted to a rotation shaft of the speed reduction gear 115. Still further, the form of arrangement of the eighty-second wheel 56 and the eighty-fifth wheel 59, and the form of arrangement of the wheels 60 to 62 are slightly different from those in the first embodiment.

The multilock lever 111 comprises a first stopper portion 112a which engages the eighty-fourth wheel 58; a second stopper portion 112h which engages the eighty-eighth wheel 62; and a spring 114 which extends to a side of the rotation shaft 111a opposite to the side where the stopper portions 112a and 112b are disposed.

The first stopper portion 112a of the multilock lever 111 is a rigid lever similarly with the body. The angle 9 of the force of the engaging portion thereof is set so that it is at least 70° with respect to a rotation center 111b of the rotation shaft 111a, allowing the engaging portion to properly engage the eighty-fourth wheel 58.

The second stopper portion 112b is resilient, so that even when it is pushed towards the eighty-eighth wheel 62 while it engages the eighty-eighth wheel 62, it absorbs the pushing force, thereby preventing breakage of, for example, the teeth or shaft of the eighty-eighth wheel 62 or the rotation shaft 111a.

The spring portion 114 is greatly bent towards the eightieth wheel 52, and one end of the spring portion 114 and the engaging protrusion 113 press and clamp both sides of the eightieth wheel 52 in a circumferential direction thereof.

The eightieth wheel 52 has a groove 52a which engages the engaging protrusion 113 of the multilock lever 111, a protuberance 52b with a predetermined length in the diametrical direction, and a groove 52c provided therebetween. The groove 52a, the protuberance 52b, and the groove 52c constitute a cam.

When the eightieth wheel 52 is used, the multilock lever 111 is installed, as shown in Fig. 8(A), with the multilock lever 111 operating in response to the rotation of the eightieth wheel 52, as shown in Figs. 8(B) to 8(C).

More specifically, as shown in Fig. 8(A), when the mainspring 1a is not wound up at all so that the torque is zero, the multilock lever 111 is installed on the rotation shaft 111a, with the engaging protrusion 113 and the groove 52a of the eightieth wheel 52 engaging each other. As shown in Fig. 8(B), the eightieth wheel 52 is then rotated in the direction of the arrow by winding up the mainspring 1a. During the rotation, the engaging protrusion 113 moves onto one end of the protuberance 52b. In response to this, the multilock lever 111 progressively rotates towards the eightieth wheel 62, causing the second stopper portion 112b to slowly engage the teeth of the eighty-eighth wheel 62. When the engaging protrusion 113 drops down from the other end of the protuberance 52b, the second stopper portion 112b separates from the eighty-eighth wheel 62.

Here, the length of the protuberance 52b in the peripheral direction is in correspondence with the number of windings O to B, illustrated in Fig. 22. From the time the engaging protrusion 113 moves onto the protuberance 52b to the time it drops down therefrom, torque by an amount equal to the lower limit of the set range is accumulated in the mainspring 1a by winding up the mainspring 1a.

Thereafter, as shown in Fig. 8(C), when the mainspring 1a is further wound up, the eightieth wheel 52 rotates further, causing the groove 52a to move towards the engaging protrusion 113. When, during the rotation, the number of windings of the mainspring 1a reaches the number of windings A in Fig. 22, the groove 52a and the engaging protrusion 113, and, at the same time, the first stopper portion 112a of the multilock lever 111 and the eighty-fourth wheel 58 engage each other, as shown in Fig. 8(D). This locks the rotation of the winding-up wheel train 50a (of Fig. 6), so that the winding up of the mainspring 1a is stopped.

In this case, as shown in Fig. 9, a prismatic portion 52d, provided at the rotation shaft of the eightieth wheel 52, is fitted, with a predetermined amount of backlash, into a square hole 53a of the power reserve wheel 53 that transmits torque to the prismatic portion 52d. Therefore, when the mainspring 1a is being wound up, the eightieth wheel 52 and the power reserve wheel 53 rotate integrally, with the backlash being occupied, as shown in Fig. 9(A). Just before the engaging protrusion 113 of the multilock lever 111 engages the groove 52a of the engaging protrusion 113, a moment (indicated by an alternate long and two short dashed line arrow in Fig. 9), which acts on the engaging portion of the eightieth wheel 52 and tries to rotate it, is produced, so that, as shown in Fig. 9(B) the eightieth wheel 52 rotates, without stopping, more than the power reserve wheel 53 in correspondence with the amount of backlash. As a result, engagement of the engaging protrusion 113 with the groove 52a, as well as engagement of the first stopper portion 112a with the teeth of the eighty-fourth wheel 58, takes place instantaneously.

Referring back to Fig. 8, after the winding up operation of the mainspring 1a is stopped, when the mainspring 1a is unwound as the hands of the timepiece move during ordinary use thereof, the eightieth wheel 52 rotates in the direction of the arrow in Fig. 8(D), and torque is output from the mainspring 1a, during rotation from the position of Fig. 8(C) to the position of Fig. 8(B). At the moment the eightieth wheel 52 rotates to the position of Fig. 8(B), the multilock lever 111 locks the rotation of the unwind wheel train 50b, so that the unwinding of the mainspring 1a, that is, movement of the hands stops.

In other words, when the timepiece is ordinarily used, the eightieth wheel 52 rotates in a reciprocative manner.

The part of the timepiece of the second embodiment that is structured in essentially the same way as the timepiece of the first embodiment produces similar effects to those of the timepiece of the first embodiment. The part of the timepiece of the second embodiment which is structured differently from the timepiece of the first embodiment produces the following characteristic effects.

17) Since the multilock lever 111 is an integral structure of the winding-up lock lever 71 and the hand lock lever 81 of the first embodiment, fewer parts are required and more efficient use of space can be made, as compared with the first embodiment.

18) Since the engaging protrusion 113 and one end of the spring portion 114 of the multilock lever 111 press and clamp both sides of the eightieth wheel 52 in a diametrical direction, the rotation shaft of the eightieth wheel 52 does not easily fall over, making it possible to increase durability.

19) Since the spring portion 114 of the multilock lever 111 presses the eightieth wheel 52, the stopper pins 75 and 85, used in the first embodiment, can be eliminated, thereby reducing the number of parts.

20) After the second stopper portion 112b has started to contact the eighty-eighth wheel 62, the multilock lever 111 rotates a small amount at a time towards the eighty-eighth wheel 62 until the engaging protrusion 113 completely moves onto the protuberance 52b. This means that during the rotation the second stopper portion presses the teeth of the eighty-eighth wheel 62. However, since the second stopper portion 112b is resilient, the pressing force is reliably absorbed by the resilient second stopper portion 112b, making it possible to prevent undue pressing force from acting on the teeth of the eighty-eighth wheel 62 and thus breakage of the teeth or shaft.

21) The first stopper portion 112a of the multilock lever 111, which is rigid, can reliably lock the eighty-fourth wheel 58 with greater drag force.

The eightieth wheel 52 is mounted with backlash on the power reserve wheel 53, for transmitting torque to the eightieth wheel 52, so as to be provided on the same rotation shaft as the power reserve wheel 53, and, when the multilock lever 111 is operating, it rotates ahead of the power reserve wheel 53 in correspondence with the amount of backlash, so that the engaging protrusion 113 of the multilock lever 11 can instantaneously drop into the groove 52a. In response to this, the first stopper portion 112a instantaneously engages the teeth of the eighty-fourth wheel 58. Therefore, the first stopper portion 112a and the teeth of the eighty-fourth wheel 58 do not rub against each other, so that even when the first stopper portion 112a is a rigid, friction, or the like, at the teeth of the eighty-fourth wheel 58 can be reduced.

22) A speed reduction gear 115 meshes the eightieth wheel 52, and power reserve needle 51 is mounted to the rotation shaft of the speed reduction gear 115. Therefore, the range of rotation of the power reserve needle 51 can be restricted to within predetermined angles, a cam can be formed along nearly the entire circumference of the eightieth wheel 52, so that the precision with which torque is detected can be increased in correspondence with the amount by which the cam forming range is made larger.

Figs. 10 to 13 each illustrate the main portion of an automatic winding type timepiece, in accordance with a third embodiment of the present invention.

The timepiece of the third embodiment is an automatic winding type timepiece, and comprises an automatic winding mechanism 130 of Fig. 10. The automatic winding type mechanism 130 is conventionally known the automatic winding type timepiece field, in which automatic winding type mechanism rotation of an oscillating weight 131 is transmitted to a pawl lever 132 in order to allow a transmission wheel 133 to rotate unidirectionally at all times regardless of the direction of rotation of the oscillating weight 131. Reference numeral 134 denotes a transmission receiver.

The timepiece of the present embodiment comprises the aforementioned winding-up lock mechanism 70, in which the winding-up lock lever (or the multilock lever 111) engages the eighty-fourth wheel 58 of the winding-up wheel train 50a. The transmission wheel 133 is coupled to the eighty-fourth wheel 58, so that rotation of the oscillating weight 131 is transmitted to the eighty-fourth wheel 58 through the transmission wheel 133 to rotate the ratchet wheel 4 and winding-up the mainspring 1a. Here, a slip mechanism (or a first slip mechanism), which is not shown and generally used in an automatic winding type timepiece, is provided between the ratchet wheel 4 and the barrel arbor 1c.

The eighty-fourth wheel 58 engages the winding-up lock lever 71. It includes a screw pin 58a which is erected at the main plate 2; a screw 58b which is screwed into the screw pin 58a; a first gear 58c which is rotatably fitted to the screw pin 58a and engages the ratchet wheel 4; and a second gear 58d which is fitted to the shaft of the first gear 58c and engages the eighty-third wheel 57. The first gear 58c engages the transmission wheel 133, and the teeth of the second gear 58d and the stopper portion of the winding-up lock lever 71 engage each other.

Of these parts, the second gear 58d has a cutout portion 58e, which causes the second gear 58d to have a net-like form, as shown in Figs. 12 and 13. It also has a contact portion 58f, which contacts the first gear 58c, is made resilient, and presses and supports the shaft of the first gear 58c in a diametrical direction thereof. In other words, the resilient contact portion 58f forms a second slip mechanism.

According to such a timepiece, when the mainspring 1a is not wound to the number of windings A of Fig. 22 (that is, the second gear 58d of the eighty-fourth wheel 58 is not locked by the winding-up lock lever 71), the second gear 58d rotates with the first gear 58c, so that the mainspring 1a is wound up as a result of the rotation of the oscillating weight 131, and the rotation is transmitted from the eighty-third wheel 57 through the winding-up wheel train 50a, thereby allowing the power reserve needle 51 (of Fig. 4) to rotate.

On the other hand, when the mainspring 1a is wound up to the number of windings A of Fig. 22, the second gear 58d is locked by the winding-up lock lever 71, so that the first gear 58c overcomes the force supporting the contact portion 58f and rotates, causing slipping to occur between the first gear 58c and the second gear 58d. As a result, although the first gear 58c rotates, the rotation of the oscillating weight 131 is not transmitted to the winding-up wheel train 50a. As the first gear 58c rotates, the ratchet wheel 4 rotates, but since the first slip mechanism is actuated when the mainspring 1a is wound to the number of windings A, the rotation of the ratchet 4 is not transmitted to the mainspring 1a. In other words, while the winding-up lock mechanism 70 is being actuated, the oscillating weight 131 rotates idly as the first gear 58c and the ratchet wheel 4 rotate.

The part of the timepiece of the third embodiment that is structured in essentially the same way as the timepieces of the first and second embodiments produces similar effects to those of the first and second embodiments. The part of the timepiece of the third embodiment that is structured differently from the timepieces of the first and second embodiments produces the following characteristic effects.

23) When the eighty-fourth wheel 58 is locked by the winding-up lock mechanism 70, each of the slip mechanisms is actuated, thereby preventing the oscillating weight from breaking as a result of locking operations. In addition, since the rotation of the oscillating weight 131 is not transmitted towards the eightieth wheel 52, excessive force does not act on the winding-up lock mechanism 70 in a locked state, thereby preventing breakage of the winding-up lock mechanism 70, or reliably preventing transmission of the rotation of the oscillating weight 131 to the eightieth wheel 52. Therefore, it is possible to prevent the power reserve needle 51 (of Fig. 4), which is provided at the eightieth wheel 52, from rotating beyond the predetermined rotation range, so that correct indications can be reliably made. Consequently, the winding-up lock mechanism 70 can be applied to an automatic winding type timepiece, without any problem.

Fig. 14 illustrates a timepiece of a fourth embodiment of the present invention, showing a slip mechanism, which is a modification of the second slip mechanism used in the third embodiment of the present invention.

In the present embodiment, although the second gear 58d of the eighty-fourth wheel 58 is rotatably fitted to the shaft of the first gear 58c, but the contact portion 58f, which is provided in the third embodiment, is not provided. The second gear 58d, used in the present embodiment, is formed such that it is pressed in the axial direction by a holding spring 58g affixed to the shaft of the first gear 58c, and rotates with the first gear 58c as a result of this pressing force.

As shown in Fig. 15, the holding spring 58g has a plurality of arms 58h that extend outward in a diametrical direction, with the arms 58h being bent towards the second gear 58d. When the arms 58h are brought into contact with the second gear 58d, they are moved back so as to extend virtually in a straight line, with the aforementioned pressing force being produced by the resilient (spring) force generated at this time. In other words, in the present embodiment, the holding spring 58g forms a second slip mechanism in accordance with the present invention. The holding spring 58g is affixed to the aforementioned shaft by a spring seat 58i.

According to this timepiece, when the second gear 58d of the eighty-fourth wheel 58 is not locked by the winding-up lock lever 71, the second gear 58d is pressed by the holding spring 58g, so that it rotates with the first gear 58c in order to transmit the rotation of the oscillating weight, which is not shown, to the winding-up wheel train 50a, causing the power reserve needle (of Fig. 4) to rotate.

On the other hand, when the second gear 58d is locked by the winding-up lock lever 71, it overcomes the pressing force of the holding spring 58g and the first gear 58c tries to rotate, so that slipping occurs between the second gear 58d and the holding spring 58g, as a result of which only the first gear 58c rotates integrally with the holding spring 58g and the spring seat 58i. Consequently, the rotation of the oscillating weight is not transmitted to the wheel train 50a.

According to the present embodiment, since the timepiece comprises a second slip mechanism as with the timepiece of the third embodiment, the timepiece of the fourth embodiment, though the detailed structure of its second slip mechanism differs slight from that of the second slip mechanism of the third embodiment, produces essentially the same effects.

Fig. 16 illustrates a timepiece of a fifth embodiment of the present invention, showing the power reserve needle 51 indicating the remaining life of the timepiece at a different location.

In the present embodiment, the power reserve needle 51 is not disposed at the outer side of the main plate 2, but at the outer side of a wheel train bridge 14, between the wheel train bridge 14 and a back cover 16. A dial 17, used specifically for the power reserve needle 51, is provided at the outer side face of the wheel train bridge 14, and a date indicator 18 is provided at the outer side of the main plate 2. For the remaining life indicating means (indicator), in addition to the power reserve needle 51, a disk or a mechanism, such as a hologram whose color tone, pattern, or form changes, may also be used.

The back cover 16 is made of a metal material, such as stainless steel, platinum, titanium, gold (18K, 24K, etc.), hard alloy (such as Tic), or synthetic resin (such as ABS or polycarbonate (PC)), or ceramic. It has an opening 16a formed in correspondence with the range of rotation of the power reserve needle 51. A transparent material 19, made of, for example, inorganic glass, sapphire, or acryl, is fitted into the opening 16a, through a packing 19a. It allows the power reserve needle 51 to be seen. It is to be noted that the transparent member 19 can be eliminated by forming the entire back cover 16 with a transparent material.

In the present embodiment, when anyone wants to know, for example, when the mainspring 1a is to be wound or how much the mainspring 1a is wound (the remaining life), he or she can turn the timepiece over and confirm the position of the power reserve needle 51.

The present invention produces the following effects.

24) Since the power reserve needle 51 is provided at the back side, the design of the front side can be kept simple, while providing a remaining life confirmation function. In addition, by using the proper color tone or form for the remaining life indicating means, the back side can be more properly designed.

25) Since the power reserve needle 51 is not provided at the outer side of the main plate 2, the eightieth wheel 52, etc., do not protrude at the outer side of the main plate 2, thereby allowing efficient use of space to a corresponding degree, allowing the date indicator 18, etc., to be disposed. Therefore, a calendar function can be provided. In addition, when the power reserve needle 51 is provided in the space between the wheel train bridge 14 and the back cover 16, that space can be efficiently used.

[0088] The present invention is not limited to the above-described embodiments, so that various modifications and changes can be made within the scope which allows the objects of the present invention to be achieved.

[0089] Although in the foregoing description, three lock mechanisms, that is, the winding-up lock mechanism 70, the hand lock mechanism 80, and the hand-adjusting lock mechanism 90, are provided, only the winding-up lock mechanism 70 may be provided, as shown in Fig. 17, or only the winding-up lock mechanism 70 and the hand-adjusting lock mechanism 90 may be provided, as shown in Fig. 18. In addition, as shown in Fig. 19, only the winding-up lock mechanism 70 and the hand lock mechanism 80 may be provided. Further, as shown in Fig. 20, only the hand lock mechanism 80 may be provided. Although not illustrated, only the hand lock mechanism 80 and the hand-adjusting lock mechanism 90 may be provided. In short, the timepiece of the present invention only needs to include at least one of the winding-up lock mechanism 70 and the hand lock mechanism 80.

[0090] Although in the foregoing description the lever 71 of the winding-up lock mechanism 70 and the lever 91 of the hand-adjusting lock mechanism 90 are integrally formed, they may be separately formed. When the levers 71 and 91 are formed separately, the operation timing of the levers 71 and 91 may be made different by varying the location of engagement of the engaging protrusions 73 and 93 of their respective levers 71 and 91 with the groove 52a of the eightieth wheel 52. For example, although in the above-described embodiments hand adjustments cannot be made until the winding-up operation is locked by the winding-up lock lever 71, the levers may be set such that hand adjustments can be made before the winding-up operation is locked if the number of windings of the mainspring 1a is more than the predetermined number of windings.

[0091] The detailed structure of the wheel train 50 is not limited those of the above-described embodiments, so that any structure, such as that incorporating a planetary mechanism, may be used as long as it can be used for adding and subtracting what is input from the ratchet wheel during winding-up operations and what is input from the movement barrel 1 during unwinding operations.

[0092] Although the winding-up lock mechanism 70 is described as employing the addition and subtraction wheel train 50, it may also be constructed so that it can lock the winding up of the mainspring 1a when the detected number of windings of the mainspring 1a exceeds a predetermined number of windings.

[0093] Similarly, although the hand lock mechanism is described as employing the addition and subtraction wheel train 50, it may also be constructed so that it can lock the unwinding of the mainspring 1a when the detected number of windings of the mainspring 1a becomes less than a predetermined number of windings.

[0094] Although in the foregoing description the winding-up lock mechanism 70 performs a locking operation as a result of engagement of the winding-up lock lever 71 with the eighty-fourth wheel 58, it may also perform a locking operation as a result of engagement of the lever 71 with a wheel of the winding-up portion 30 or a different wheel of the winding-up wheel train 50a. It is preferable to engage the lever 71 with a wheel that has a smaller torque than the ratchet wheel 4.

[0095] Similarly, although in the foregoing description the hand lock mechanism 80 stops the eighty-seventh wheel 61, it may stop either one of a wheel of the unwinding wheel train, and a wheel of the wheel train 13 that engages the generator 20. It is preferable to engage the lever 81 with a wheel that has a smaller torque than the movement barrel 1.

[0096] Although in the foregoing description the lock mechanisms 70 and 80, perform locking operations as a result of engagement of the stopper portions 72 and 82 of the levers 71 and 81 with their associated gears, respectively, it is possible to use a lock mechanism which press-contacts the outer periphery of a wheel of the wheel train 50 to perform a braking operation by, for example, frictional force generated by the press-contacting.

[0097] Although in the foregoing description the winding-up lock mechanism 70 locks the winding-up operation by controlling the rotation of a wheel, serving as torque transmitting part, of the winding-up portion 30 or a winding-up wheel train, it may lock the unwinding operation by engaging a component part of the winding-up portion 30 and disengaging gears of the winding-up portion 30, such as a winding pinion 32 and a crown wheel 33, so that unwinding operations cannot be performed.

[0098] Although in the foregoing description the hand-adjusting lock mechanism 90 locks the sliding pinion 35 to make it unmovable for preventing operation of the winding stem 31, it may allow the winding stem 31 to be pulled out, but prevent hand adjustments from being performed as a result of separating parts, such as the setting wheel 36, of the hand-adjusting mechanism. In this case, the outer operating member, such as the crown (winding stem 31), itself, cannot be operated, so that unlike the case where the outer operating member is locked, an undue force will not be exerted onto the outer operating member by a user operating it by force. Therefore, such a hand-adjusting lock mechanism has the advantage that an excessive force will not be exerted onto the outer operating member, etc.

[0099] Although as a mechanism for driving a member which engages a component part of, for example, the winding-up portion 30 or the wheel train 13 it is preferable to use the so-called cam mechanism in which the levers 71, 81, and 91 rotate as the eightieth wheel 52 rotates, other types of actuating mechanisms may also be used.

[0100] Although in the first embodiment the groove 52a of the eightieth wheel 52 serves as an operation engaging portion, a protrusion, such as the protuberance 52b in the second embodiment, may be formed on the outer periphery of the eightieth wheel 52 so as to serve as the operation engaging portion. In short, the operation engaging portion is formed such that the levers 71, 81, and 91 are actuated at a predetermined timing as the eightieth wheel 52 rotates.

[0101] The present invention may also be applied, in addition to an electronic control type mechanical timepiece, to a mechanical timepiece including an escape wheel, a pallet fork, a timed annular balance, etc. Since the electronic control type mechanical timepiece performs hand movement control using a liquid crystal oscillator more precisely than the mechanical timepiece, it is required to indicate time more precisely than the mechanical timepiece. Therefore, it is preferable that the electronic control type mechanical timepiece, in which effects due to changes in outside torque become noticeable, be provided with the winding-up lock mechanism of the present invention.

[0102] In the first and second embodiments, although the mainspring 1a is formed so as to be wound up at the winding-up portion by hand, it may be formed, as in the third and fourth embodiments, by an automatic winding-up device employing an oscillating weight. A movement barrel in which a slip mechanism (first slip mechanism) is actuated during automatic winding may also be used. In this case, it is preferable to provide a second slip mechanism at, for example, the eighty-fourth wheel 58.

[0103] As shown in Fig. 21, when the eighty-third wheel 57 is brought into engagement with the first gear 58c of the eighty-fourth wheel 58 having a slip mechanism, the winding-up lock lever 71 is brought into engagement with the first gear 58c, and the transmission wheel 133 is brought into engagement with the second gear 58d, so that they are in a locked state, the oscillating weight can be rotated idly with the rotation of the second gear 58d. In this case, the eighty-fourth wheel 58, as mentioned above, may be provided with the function of the aforementioned slip mechanism, so that the movement barrel can be formed with a simple structure. The slip mechanism may also be provided at the pinion portion, at the main plate 2 side, of the transmission wheel 133 to provide a slip mechanism function.

[0104] A separate lever, or the like, may also be provided, which operates in correspondence with the state of the winding-up lock mechanism and the winding-up lock lever 71 such that whether or not the winding-up operation is locked can be determined by an IC. A signal may be applied to the IC in correspondence with whether or not the winding-up operation is locked by, for example, turning on a switch as a result of actuating this lever. By virtue of such a structure, since whether or not the winding-up operation is locked can be determined by the IC, whether or not the mainspring torque is high or low can be determined. Therefore, the IC can be used to control for example, a pace-measuring pulse output only when mainspring torque, the power generating capacity, and the capacitor voltage are high. The pace-measuring pulse is used for confirming the precision of a circuit which draws electrical power other than for ordinary control operations.

[0105] Although the mainspring device of the present invention is used as a timepiece, it may also be used in, for example, a toy minicar, a metronome, or a music box, or anything else which employs a mainspring as a driving source.

[0106] As can be understood from the foregoing description, according to the present invention, a lock mechanism that employs an addition and subtraction wheel train is provided, so that even when small timepieces, such as watches, which have only a small space for disposing component parts in its interior, or other types of mainspring devices are used, the winding up of the mainspring or the unwinding of the mainspring can be stopped, so that it is possible to output at all times a torque within a set range from the mainspring.

[0107] In addition, according to the present invention, in electronic control type mechanical timepieces or other types of electronic control type mainspring devices, variations in output torque can be controlled, so that while the control circuit is not operating, precise corrections can be made, and, as mentioned above, torque within the set range can be output from the mainspring at all times.

Claims

1. A mainspring device which is constructed so as to drive a wheel train (13) by mechanical energy of a mainspring (1a), comprising:

    a winding-up portion (30) for accumulating energy in the mainspring (1a), the device **characterized by** further comprising:
    an addition and subtraction wheel train (50) for adding and subtracting the amount by which the mainspring (1a) is wound up and unwound;
    an addition and subtraction wheel (52), disposed in the addition and subtraction wheel train (50), for adding and subtracting the amount by which the mainspring (1a) is wound up and unwound; and
    a lock mechanism, adapted to be actuated in response to the rotation of the addition and subtraction wheel (50), for preventing transmission of torque with a value that lies outside a set range from the mainspring (1a) to the wheel train (13).

2. A mainspring device according to Claim 1, wherein the lock mechanism comprises a winding-up lock mechanism portion (70) which, when the mainspring (1a) is wound up to a number of windings equal to or greater than a predetermined number of windings, locks a winding-up wheel train (50a), to which torque produced during winding-up operations is transmitted in the addition and subtraction wheel train (52), and/or the winding-up portion (30), in order to stop the winding up of the mainspring (1a).

3. A mainspring device according to Claim 2, wherein the winding-up lock mechanism portion (70) stops the winding up of the mainspring (1a) by stopping torque transmission to the winding-up wheel train (50a) or the winding-up portion (30).

4. A mainspring device according to Claim 2, wherein the winding-up lock mechanism portion (70) stops the winding up of the mainspring (1a) by locking a torque transmitting component part which has a torque equal to or less than a gear directly connected to a torque input side of the mainspring (1a) and which is disposed in the winding-up wheel train (50a) and/or the winding-up portion (30).

5. A mainspring device according to any one of Claims 1 to 4, wherein the lock mechanism comprises an unwinding lock mechanism portion (80) which,

when the mainspring (1a) is unwound to a number of windings equal to or less than a predetermined number of windings, stops the rotation of the wheel train (13) by locking an unwinding wheel train (50b), to which torque produced during unwinding operations is transmitted in the addition and subtraction wheel train (50), and/or the wheel train (13).

6. A mainspring device according to Claim 5, wherein the unwinding lock mechanism portion (80) stops the wheel train (13) as a result of disengagement of a gear in the wheel train (13).

7. A mainspring device according to Claim 5, wherein the unwinding lock mechanism portion (80) stops the rotation of the wheel train (13) by locking a torque transmitting component part which has a torque equal to or less than a gear directly connected to a torque output side of the mainspring (1a) and which is disposed in the unwinding wheel train (50b) and/or the wheel train (13).

8. A mainspring device according to any one of Claims 2 to 7, wherein the winding-up lock mechanism portion (70) locks a gear in the winding-up wheel train (50a), with any gear in a torque transmission path formed at the mainspring side with reference to the gear being driven by rotation of an oscillating weight in order to cause the torque from the oscillating weight to wind up the mainspring (1a) and to drive the winding-up wheel train (50a); and wherein the winding-up lock mechanism portion (70) comprises a slip mechanism section, which is provided in the torque transmission path, for presenting transmission of torque, during actuation of the winding-up lock mechanism portion (70), from the oscillating weight to the mainspring (1a) and the addition and subtraction wheel (52).

9. A mainspring device according to any one of Claims 2 to 8, wherein the winding-up lock mechanism portion (70) comprises a winding-up lock lever (71) which is lockable by engagement with at least one of the component parts to which torque is transmitted during a winding up operation; and wherein the unwinding lock mechanism (80) comprises an unwinding lock lever (81) which is lockable by engagement with at least one of the component parts to which torque is transmitted during an unwinding operation.

10. A mainspring device according to Claim 9, wherein the winding-up lock lever (71) has a stopper pvrtivn (72) which is engageable with at least one gear in the winding-up wheel train (50a) and the winding-up portion (30); and wherein the unwinding lock lever (81) has a stopper portion (82) which is engageable with at least one gear in the unwinding wheel train (50b) and the wheel train (13).

11. A mainspring device according to Claim 9 or Claim 10, wherein the lock mechanism comprises the winding-up lock mechanism portion (70) and the unwinding lock mechanism portion (80); and wherein the winding-up lock lever (71) and the unwinding lock lever (81) are integrally formed into a multilock lever (111).

12. A mainspring device according to any one of Claims 9 to 11, wherein the rotational center of the lock lever (71, 81) is disposed between the associated component part, to which the lock lever engages, and the addition and subtraction wheel (52).

13. A mainspring device according to any one of Claims 9 to 12, wherein the addition and subtraction wheel (52) has an operation engaging portion at the outer periphery thereof; and wherein the lock lever press-contacts the addition and subtraction wheel (52), and has an engaging protrusion (83) which is engageable with the operation engaging portion of the addition and subtraction wheel (52); and wherein when the engaging protrusion (83) is brought into engagement with the operation engaging portion of the addition and subtraction wheel (52), the lock lever engages and stops the component part associated thereto.

14. A mainspring device according to any one of Claims 9 to 13, wherein the lock lever presses and clamps the sides of the addition and subtraction wheel (52) in a diametrical direction thereof.

15. A mainspring device according to any one of Claims 9 to 14, wherein the portion of the lock lever (71, 81) which engages the associated component part is resilient.

16. A mainspring device according to any one of Claims 9 to 14, wherein the portion of the lock lever which engages the associated component part is made rigid; and wherein the addition and subtraction wheel (52), which actuates the lock lever (71, 81), is mounted on a same rotational shaft with respect to a gear, which transmits torque to the addition and subtraction wheel(52), such that backlash is provided between the gear and the addition and subtraction wheel (52), the addition and subtraction wheel (52) rotating ahead of the gear by an amount corresponding to the amount of backlash when the lock lever (71, 81) is being actuated.

17. A mainspring device according to any one of Claims 1 to 16, further comprising a remaining life indicating means which is driven by the addition and subtraction wheel (52).

18. A mainspring device according to Claim 17, wherein the remaining life indicating means is provided at the outer side of a wheel train bridge which supports the wheel train (13).

19. A mainspring device according to any one of Claims 1 to 18, wherein the mainspring device is an electronic control type mainspring device comprising a generator for converting the mechanical energy of the mainspring transmitted through the wheel train into electrical energy, and a rotation control means, which is driven by the electrical energy, for controlling the rotational period of the generator.

20. A mainspring device according to any one of Claims 1 to 19, wherein the mainspring device is a timepiece with a hand connected to the wheel train.

Patentansprüche

1. Zugfedervorrichtung, die aufgebaut ist, ein Räderwerk (13) durch mechanische Energie einer Zugfeder (1a) anzutreiben, umfassend:

einen Aufwickelabschnitt (30) zum Sammeln von Energie in der Zugfeder (1a), wobei die Vorrichtung **dadurch gekennzeichnet ist, dass** sie ferner umfasst:

ein Additions- und Subtraktionsräderwerk (50) zum Addieren und Subtrahieren des Betrages, um den die Zugfeder (1a) aufgewickelt und abgewickelt wird;

ein Additions- und Subtraktionsrad (52), das im Additions- und Subtraktionsräderwerk (50) angeordnet ist, zum Addieren und Subtrahieren des Betrages, um den die Zugfeder (1a) aufgewickelt und abgewickelt wird; und

einen Sperrmechanismus, der ausgeführt ist, in Reaktion auf die Drehung des Additions- und Subtraktionsrades (50) betätigt zu werden, um die Übertragung von Moment mit einem Wert, der außerhalb eines eingestellten Bereichs liegt, von der Zugfeder (1a) auf das Räderwerk (13) zu verhindern.

2. Zugfedervorrichtung nach Anspruch 1, wobei der Sperrmechanismus einen Aufwickel-Sperrmechanismus-Abschnitt (70) umfasst, der, wenn die Zugfeder (1a) bis zu einer Anzahl von Wicklungen aufgewickelt ist, die größer oder gleich einer vorgegebenen Anzahl von Wicklungen ist, ein Aufwickelräderwerk (50a) sperrt, auf das Moment, das während Aufwickelvorgängen erzeugt wird, im Additions- und Subtraktionsräderwerk (52) bzw, im Aufwickelabschnitt (30) übertragen wird, um das Aufwickeln der Zugfeder (1a) zu stoppen.

3. Zugfedervorrichtung nach Anspruch 2, wobei der Aufwickel-Sperrmechanismus-Abschnitt (70) das Aufwickeln der Zugfeder (la) stoppt, indem Momentenübertragung auf das Aufwickelräderwerk (50a) oder den Aufwickelabschnitt (30) gestoppt wird.

4. Zugfedervorrichtung nach Anspruch 2, wobei der Aufwickel-Sperrmechanismus-Abschnitt (70) das Aufwickeln der Zugfeder (1a) stoppt, indem er ein momentübertragendes Komponententeil sperrt, das ein Moment aufweist, das kleiner oder gleich einem Zahnrad ist, das direkt mit einer Momenteneingangsseite der Zugfeder (1a) verbunden ist und das im Aufwickelräderwerk (50a) bzw. im Aufwickelabschnitt (30) angeordnet ist.

5. Zugfedervorrichtung nach einem der Ansprüche 1 bis 4, wobei der Sperrmechanismus einen Abwickel-Sperrmechanismus-Abschnitt (80) umfasst, der, wenn die Zugfeder (1a) bis zu einer Anzahl von Wicklungen abgewickelt ist, die kleiner oder gleich einer vorgegebenen Anzahl von Wicklungen ist, die Drehung des Räderwerks (13) durch Sperren eines Abwickelräderwerks (50b) stoppt, auf das Moment, das während Abwickelvorgängen erzeugt wird, im Additions- und Subtraktionsräderwerk (50) bzw. im Räderwerk (13) übertragen wird.

6. Zugfedervorrichtung nach Anspruch 5, wobei der Abwickel-Sperrmechanismus-Abschnitt (80) das Räderwerk (13) als Folge des Ausrückens eines Zahnrades im Räderwerk (13) stoppt.

7. Zugfedervorrichtung nach Anspruch 5, wobei der Abwickel-Sperrmechanismus-Abschnitt (80) die Drehung des Räderwerks (13) stoppt, indem er ein momentübertragendes Komponententeil sperrt, das ein Moment aufweist, das kleiner oder gleich einem Zahnrad ist, das direkt mit einer Momentenausgangsseite der Zugfeder (la) verbunden ist und das im Abwickelräderwerk (50b) bzw. im Räderwerk (13) angeordnet ist.

8. Zugfedervorrichtung nach einem der Ansprüche 2 bis 7, wobei der Aufwickel-Sperrmechanismus-Abschnitt (70) ein Zahnrad im Aufwickelräderwerk (50a) sperrt, wobei es sich um ein beliebiges Zahnrad in einem Momentenübertragungsweg handelt, der auf der Zugfederseite bezüglich des Zahnrades gebildet ist, das durch Drehung eines oszillierenden Gewichts angetrieben wird, um zu bewirken, dass das Moment vom oszillierenden Gewicht die Zugfeder (la) aufwickelt und das Aufwickelräderwerk

(50a) antreibt; und wobei der Aufwickel-Sperrmechanismus-Abschnitt (70) einen Rutschmechanismus-Abschnitt umfasst, der im Momentenübertragungsweg bereitgestellt ist, um Übertragung von Moment während Betätigung des Aufwickel-Sperrmechanismus-Abschnitts (70) vom oszillierenden Gewicht auf die Zugfeder (1a) und das Additions- und Subtraktionsrad (52) zu verhindern.

9. Zugfedervorrichtung nach einem der Ansprüche 2 bis 8, wobei der Aufwickel-Sperrmechanismus-Abschnitt (70) einen Aufwickelsperrhebel (71) umfasst, der durch Eingriff mit mindestens einem der Komponententeile sperrfähig ist, auf die während eines Aufwickelvorgangs Moment übertragen wird; und wobei der Abwickel-Sperrmechanismus-Abschnitt (80) einen Abwickelsperrhebel (81) umfasst, der durch Eingriff mit mindestens einem der Komponententeile sperrfähig ist, auf die während eines Abwickelvorgangs Moment übertragen wird.

10. Zugfedervorrichtung nach Anspruch 9, wobei der Aufwickelsperrhebel (71) einen Anschlagsabschnitt (72) aufweist, der mit mindestens einem Zahnrad im Aufwickelräderwerk (50a) und im Aufwickelabschnitt (30) eingriffsfähig ist; wobei der Abwickelsperrhebel (81) einen Anschlagsabschnitt (82) aufweist, der mit mindestens einem Zahnrad im Abwickelräderwerk (50b) und im Räderwerk (13) eingriffsfähig ist.

11. Zugfedervorrichtung nach Anspruch 9 oder Anspruch 10, wobei der Sperrmechanismus den Aufwickel-Sperrmechanismus-Abschnitt (70) und den Abwickel-Sperrmechanismus-Abschnitt (80) umfasst; und wobei der Aufwickelsperrhebel (71) und der Abwickelsperrhebel (81) einstückig als ein Mehrfachsperrhebel (111) gebildet sind.

12. Zugfedervorrichtung nach einem der Ansprüche 9 bis 11, wobei das Drehzentrum des Sperrhebels (71, 81) zwischen dem zugeordneten Komponententeil, in das der Sperrhebel eingreift, und dem Additions- und Subtraktionsrad (52) angeordnet ist.

13. Zugfedervorrichtung nach einem der Ansprüche 9 bis 12, wobei das Additions- und Subtraktionsrad (52) am äußeren Umfang desselben einen Betätigungseingriffsabschnitt aufweist und wobei der Sperrhebel das Additions- und Subtraktionsrad (52) unter Druck berührt und einen Eingriffsvorsprung (83) aufweist, der mit dem Betätigungseingriffsabschnitt des Additions- und Subtraktionsrades (52) eingriffsfähig ist; und wobei, wenn der Eingriffsvorsprung (83) mit dem Betätigungseingriffsabschnitt des Additions- und Subtraktionsrades (52) in Eingriff gebracht wird, der Sperrhebel eingreift und das demselben zugeordnete Komponententeil stoppt.

14. Zugfedervorrichtung nach einem der Ansprüche 9 bis 13, wobei der Sperrhebel in diametraler Richtung der Seiten des Additions- und Subtraktionsrades (52) auf dieselben drückt und diese festklemmt.

15. Zugfedervorrichtung nach einem der Ansprüche 9 bis 14, wobei der Abschnitt des Sperrhebels (71, 81), der in das zugeordnete Komponententeil eingreift, elastisch ist.

16. Zugfedervorrichtung nach einem der Ansprüche 9 bis 14, wobei der Abschnitt des Sperrhebels, der in das zugeordnete Komponententeil eingreift, starr hergestellt ist und wobei das Additions- und Subtraktionsrad (52), das den Sperrhebel (71, 81) betätigt, auf derselben Drehwelle bezüglich eines Zahnrades angebracht ist, das Moment auf das Additions- und Subtraktionsrad (52) überträgt, sodass Spiel zwischen dem Zahnrad und dem Additions- und Subtraktionsrad (52) bereitgestellt ist, wobei das Additions- und Subtraktionsrad (52) sich um einen Betrag dem Zahnrad voraus bewegt, der dem Betrag des Spiels entspricht, wenn der Sperrhebel (71, 81) betätigt worden ist.

17. Zugfedervorrichtung nach einem der Ansprüche 1 bis 16, die ferner ein Restzeitanzeigemittel umfasst, das vom Additions- und Subtraktionsrad (52) angetrieben wird.

18. Zugfedervorrichtung nach Anspruch 17, wobei das Restzeitanzeigemittel an der Außenseite einer Räderwerkbrücke bereitgestellt ist, die das Räderwerk (13) hält.

19. Zugfedervorrichtung nach einem der Ansprüche 1 bis 18, wobei die Zugfedervorrichtung eine Zugfedervorrichtung des elektronisch gesteuerten Typs ist, die einen Generator zum Umwandeln der mechanischen Energie der Zugfeder, die durch das Räderwerk übertragen wird, in elektrische Energie und ein Rotationssteuerungsmittel, das durch die elektrische Energie angetrieben wird, zum Steuern der Drehperiode des Generators umfasst.

20. Zugfedervorrichtung nach einem der Ansprüche 1 bis 19, wobei die Zugfedervorrichtung eine Uhr mit einer Hand ist, die mit dem Räderwerk verbunden ist.

Revendications

1. Dispositif de ressort moteur qui est construit de manière à entraîner un rouage (13) par l'énergie mécanique d'un ressort moteur (1a), comprenant :

une portion d'enroulement (30) pour accumuler de l'énergie dans le ressort moteur (1a), le dispositif étant **caractérisé en ce qu'**il comprend en outre :

un rouage d'addition et de soustraction (50) pour ajouter et soustraire la proportion dans laquelle le ressort moteur (1a) est enroulé et désenroulé ;

une roue d'addition et de soustraction (52), disposée dans le rouage d'addition et de soustraction (50), pour additionner et soustraire la proportion dans laquelle le ressort moteur (la) est enroulé et désenroulé ; et

un mécanisme de verrouillage adapté pour être actionné en réponse à la rotation de la roue d'addition et de soustraction (50), pour empêcher la transmission d'un couple ayant une valeur non comprise dans une plage déterminée du ressort moteur (1a) au rouage (13).

2. Dispositif de ressort moteur selon la revendication 1, dans lequel le mécanisme de verrouillage comprend une portion de mécanisme de verrouillage d'enroulement (70) qui, lorsque le ressort moteur (1a) est enroulé en un nombre d'enroulements égal ou supérieur à un nombre prédéterminé d'enroulements, verrouille un rouage d'enroulement (50a), auquel un couple produit pendant les opérations d'enroulement est transmis dans le rouage d'addition et de soustraction (52), et/ou la portion d'enroulement (30), afin d'arrêter l'enroulement du ressort moteur (1a).

3. Dispositif de ressort moteur selon la revendication 2, dans lequel la portion de mécanisme de verrouillage d'enroulement (70) arrête l'enroulement du ressort moteur (1a) en arrêtant la transmission d'un couple au rouage d'enroulement (50a) ou à la portion d'enroulement (30).

4. Dispositif de ressort moteur selon la revendication 2, dans lequel la portion de mécanisme de verrouillage d'enroulement (70) arrête l'enroulement du ressort moteur (1a) en verrouillant un composant de transmission de couple qui a un couple égal ou inférieur à un engrenage directement connecté à un côté d'entrée de couple du ressort moteur (1a) et qui est disposé dans le rouage d'enroulement (50a) et/ou la portion d'enroulement (30).

5. Dispositif de ressort moteur selon une quelconque des revendications 1 à 4, dans lequel le mécanisme de verrouillage comprend une portion de mécanisme de verrouillage de désenroulement (80) qui, lorsque le ressort moteur (1a) est désenroulé en un nombre d'enroulements égal ou inférieur à un nombre prédéterminé d'enroulements, arrête la rotation du rouage (13) en verrouillant un rouage de désenroulement (50b), auquel un couple produit pendant les opérations de désenroulement est transmis dans le rouage d'addition et de soustraction (50) et/ou le rouage (13).

6. Dispositif de ressort moteur selon la revendication 5, dans lequel la portion de mécanisme de verrouillage de désenroulement (80) arrête le rouage (13) en conséquence du désengagement d'un engrenage dans le rouage (13).

7. Dispositif de ressort moteur selon la revendication 5, dans lequel la portion de mécanisme de verrouillage de désenroulement (80) arrête la rotation du rouage (13) en verrouillant un composant de transmission de couple qui a un couple égal ou inférieur à un engrenage directement connecté à un côté de sortie de couple du ressort moteur (1a) et qui est disposé dans le rouage de désenroulement (50b) et/ou le rouage (13).

8. Dispositif de ressort moteur selon une quelconque des revendications 2 à 7, dans lequel la portion de mécanisme de verrouillage d'enroulement (70) verrouille un engrenage dans le rouage d'enroulement (50a) avec n'importe quel engrenage sur un trajet de transmission de couple formé du côté du ressort moteur en ce qui concerne l'engrenage qui est entraîné par la rotation d'un poids oscillant pour amener le couple du poids oscillant à enrouler le ressort moteur (1a) et à entraîner le rouage d'enroulement (50a) ; et dans lequel la portion de mécanisme de verrouillage d'enroulement (70) comprend une section de mécanisme de glissement, qui est prévue sur le trajet de transmission de couple, afin d'empêcher la transmission d'un couple, pendant l'actionnement de la portion de mécanisme de verrouillage d'enroulement 70), du poids oscillant au ressort moteur (1a) et à la roue d'addition et de soustraction (52).

9. Dispositif de ressort moteur selon une quelconque des revendications 2 à 8, dans lequel la portion de mécanisme de verrouillage d'enroulement (70) comprend un levier de verrouillage d'enroulement (71) qui peut être verrouillé en s'engageant dans au moins un des composants auxquels un couple est transmis pendant une opération d'enroulement ; et dans lequel le mécanisme de verrouillage de désenroulement (80) comprend un levier de verrouillage de désenroulement (81) qui peut être verrouillé en s'engageant dans au moins un des composants auxquels un couple est transmis pendant une opération de désenroulement.

10. Dispositif de ressort moteur selon la revendication 9, dans lequel le levier de verrouillage d'enroulement (71) possède une portion de butoir (72) qui peut s'engager dans au moins un engrenage dans le rouage d'enroulement (50a) et la portion d'enroulement (30) ; et dans lequel le levier de verrouillage de désenroulement (81) possède une portion de butoir (82) qui peut s'engager dans au moins un engrenage dans le rouage de désenroulement (50b) et le rouage (13).

11. Dispositif de ressort moteur selon la revendication 9 ou 10, dans lequel le mécanisme de verrouillage comprend la portion de mécanisme de verrouillage d'enroulement (70) et la portion de mécanisme de verrouillage de désenroulement (80) ; et dans lequel le levier de verrouillage d'enroulement (71) et le levier de verrouillage de désenroulement (81) sont formés en un seul bloc dans un levier de multiverrouillage (111).

12. Dispositif de ressort moteur selon une quelconque des revendications 9 à 11, dans lequel le centre rotationnel du levier de verrouillage (71, 81) est disposé entre le composant associé, dans lequel le levier de verrouillage s'engage, et la roue d'addition et de soustraction (52).

13. Dispositif de ressort moteur selon une quelconque des revendications 9 à 12, dans lequel la roue d'addition et de soustraction (52) possède une portion d'engagement fonctionnel à la périphérie externe de celle-ci ; et dans lequel le levier de verrouillage contacte par pressement la roue d'addition et de soustraction (52) et possède une protubérance d'engagement (83) qui peut être engagée dans la portion d'engagement fonctionnel de la roue d'addition et de soustraction (52) ; et dans lequel, lorsque la protubérance d'engagement (83) est amenée à s'engager dans la portion d'engagement fonctionnel de la roue d'addition et de soustraction (52), le levier de verrouillage s'engage dans et arrête le composant qui lui est associé.

14. Dispositif de ressort moteur selon une quelconque des revendications 9 à 13, dans lequel le levier de verrouillage presse et serre les côtés de la roue d'addition et de soustraction (52) dans une direction diamétrale de celle-ci.

15. Dispositif de ressort moteur selon une quelconque des revendications 9 à 14, dans lequel la portion du levier de verrouillage (71, 81) qui s'engage dans le composant associé est résiliente.

16. Dispositif de ressort moteur selon une quelconque des revendications 9 à 14, dans lequel la portion du levier de verrouillage qui s'engage dans le composant associé est rigide ; et dans lequel la roue d'addition et de soustraction (52), qui actionne le levier de verrouillage (71, 81) est montée sur un même axe de rotation qu'un engrenage, qui transmet un couple à la roue d'addition et de soustraction (52), de telle sorte qu'un jeu entre dents soit fourni entre l'engrenage et la roue d'addition et de soustraction (52), la roue d'addition et de soustraction (52) entrant en rotation en avance sur l'engrenage dans une proportion correspondant à la proportion de jeu entre dents lorsque le levier de verrouillage (71, 81) est actionné.

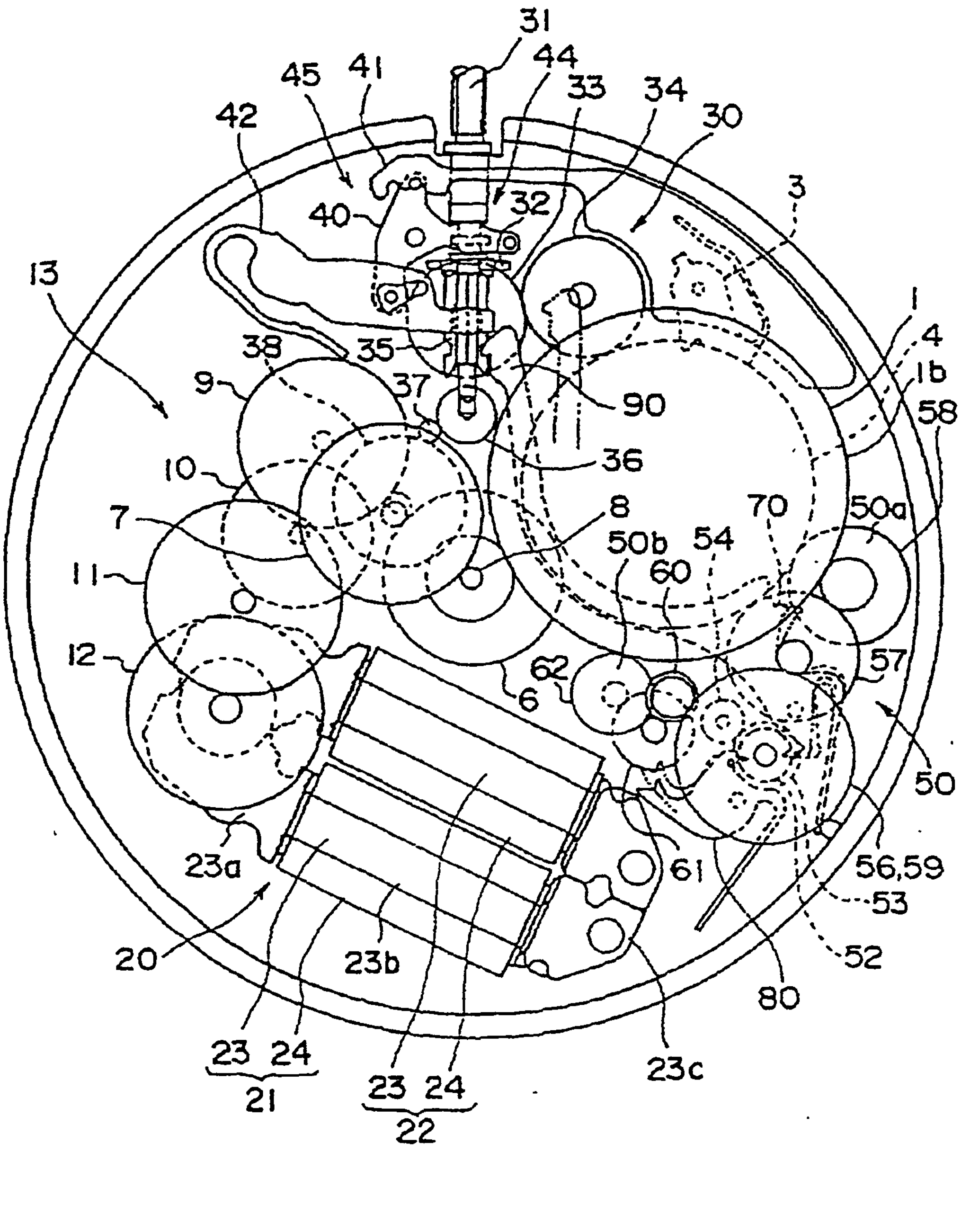
17. Dispositif de ressort moteur selon une quelconque des revendications 1 à 16, comprenant en outre un moyen d'indication de la durée de vie restante qui est entraîné par la roue d'addition et de soustraction (52).

18. Dispositif de ressort moteur selon la revendication 17, dans lequel le moyen d'indication de la durée de vie restante est fourni sur le côté externe d'un pont de rouage qui supporte le rouage (13).

19. Dispositif de ressort moteur selon une quelconque des revendications 1 à 18, dans lequel le dispositif de ressort moteur est un dispositif de ressort moteur du type à commande électronique comprenant un générateur pour convertir l'énergie mécanique du ressort moteur transmise à travers le rouage en énergie électrique et un moyen de commande de rotation, qui est entraîné par l'énergie électrique, afin de commander la période rotationnelle du générateur.

20. Dispositif de ressort moteur selon une quelconque des revendications 1 à 19, dans lequel le dispositif de ressort moteur est un appareil d'horlogerie avec une aiguille connectée au rouage.

FIG. 1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8
70
50a
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50b
54
60
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12
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53
20
52
23b
80
23c
23 24
21
23 24
22

FIG. 2

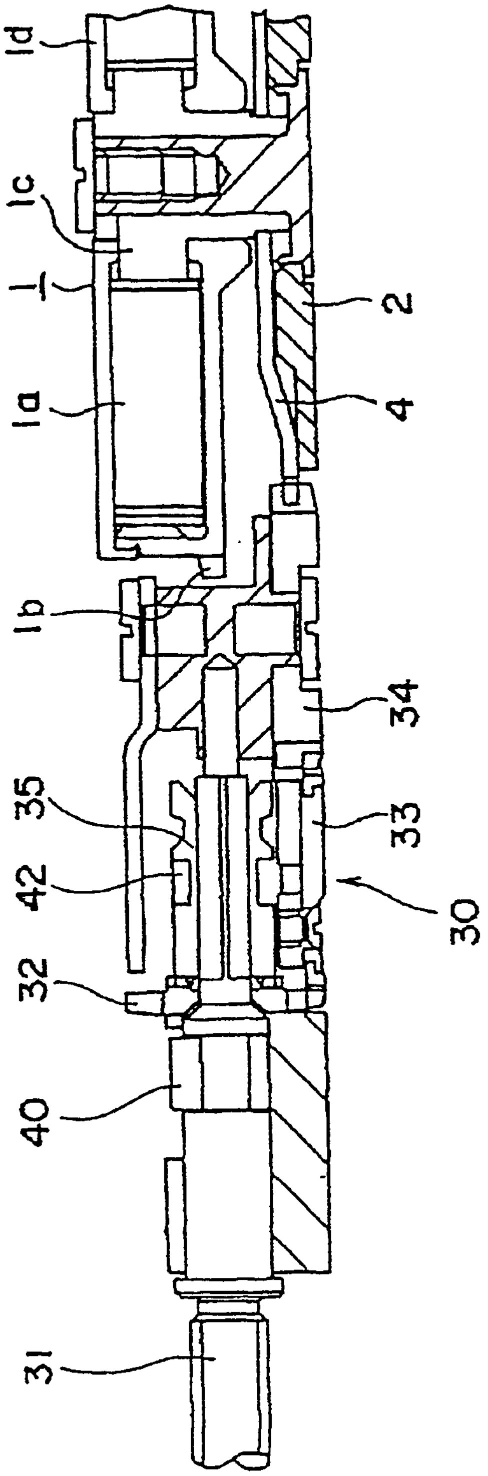


FIG. 3

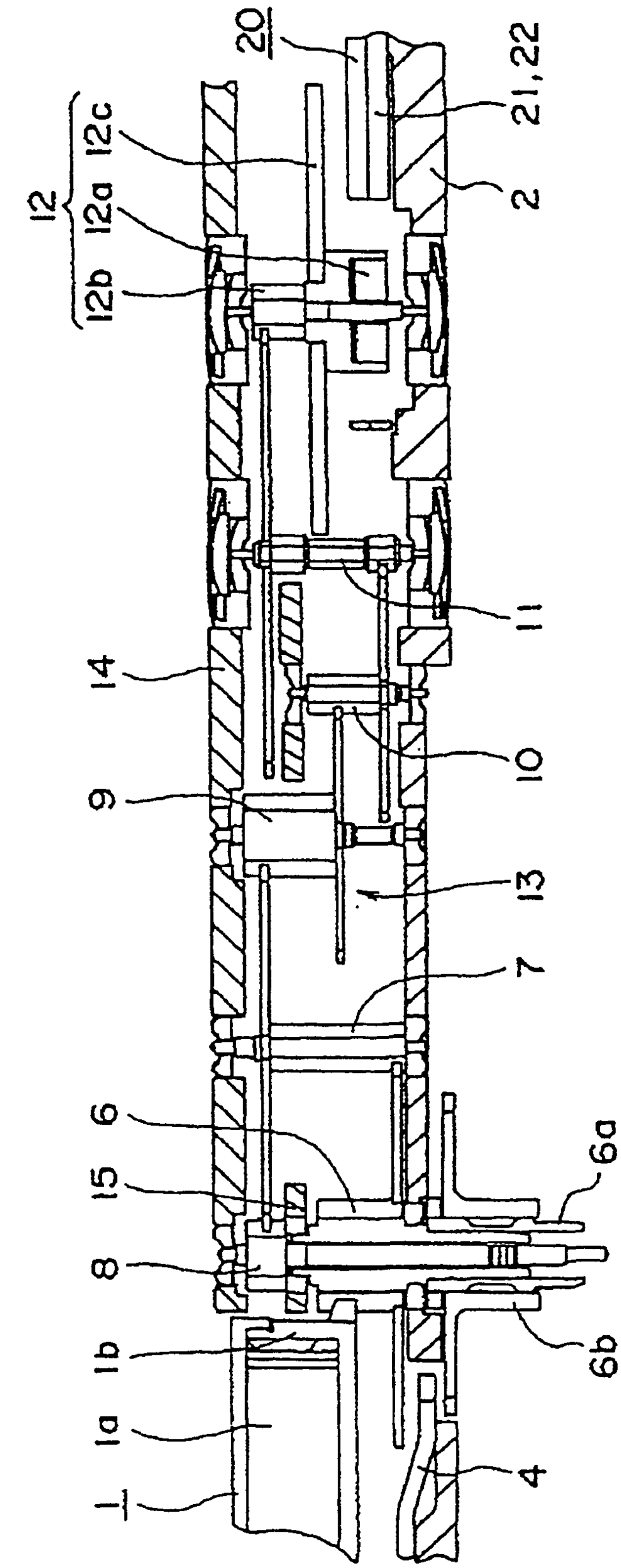


FIG. 4

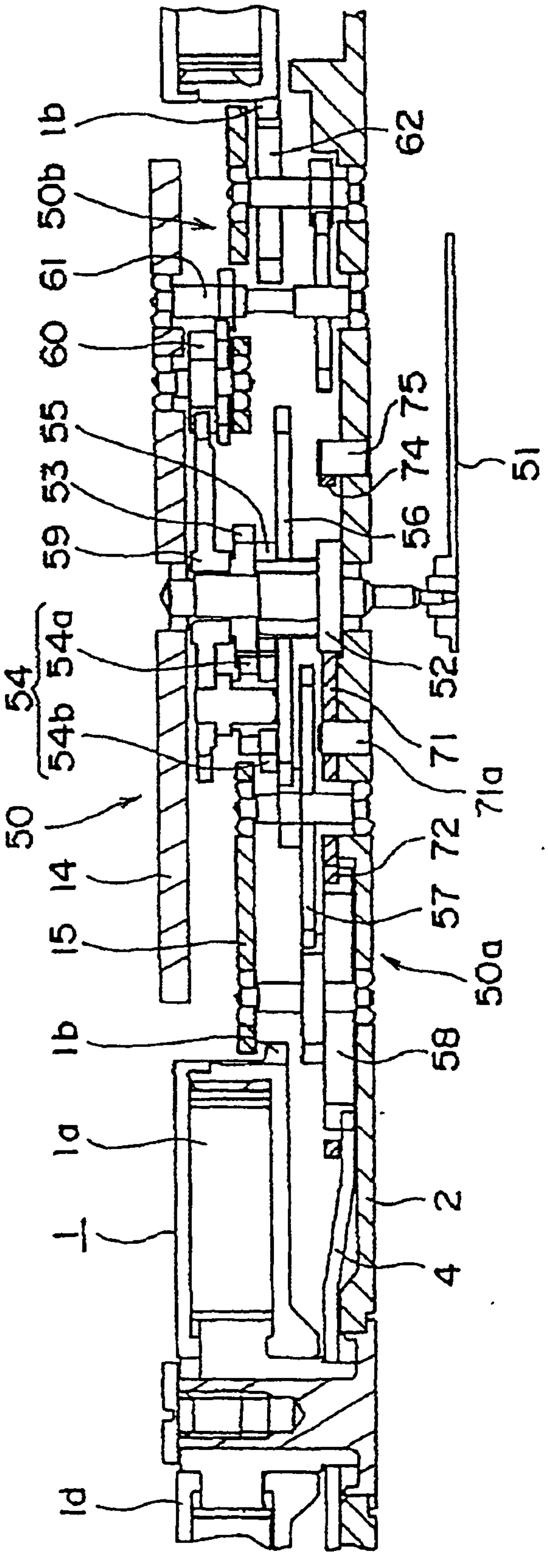
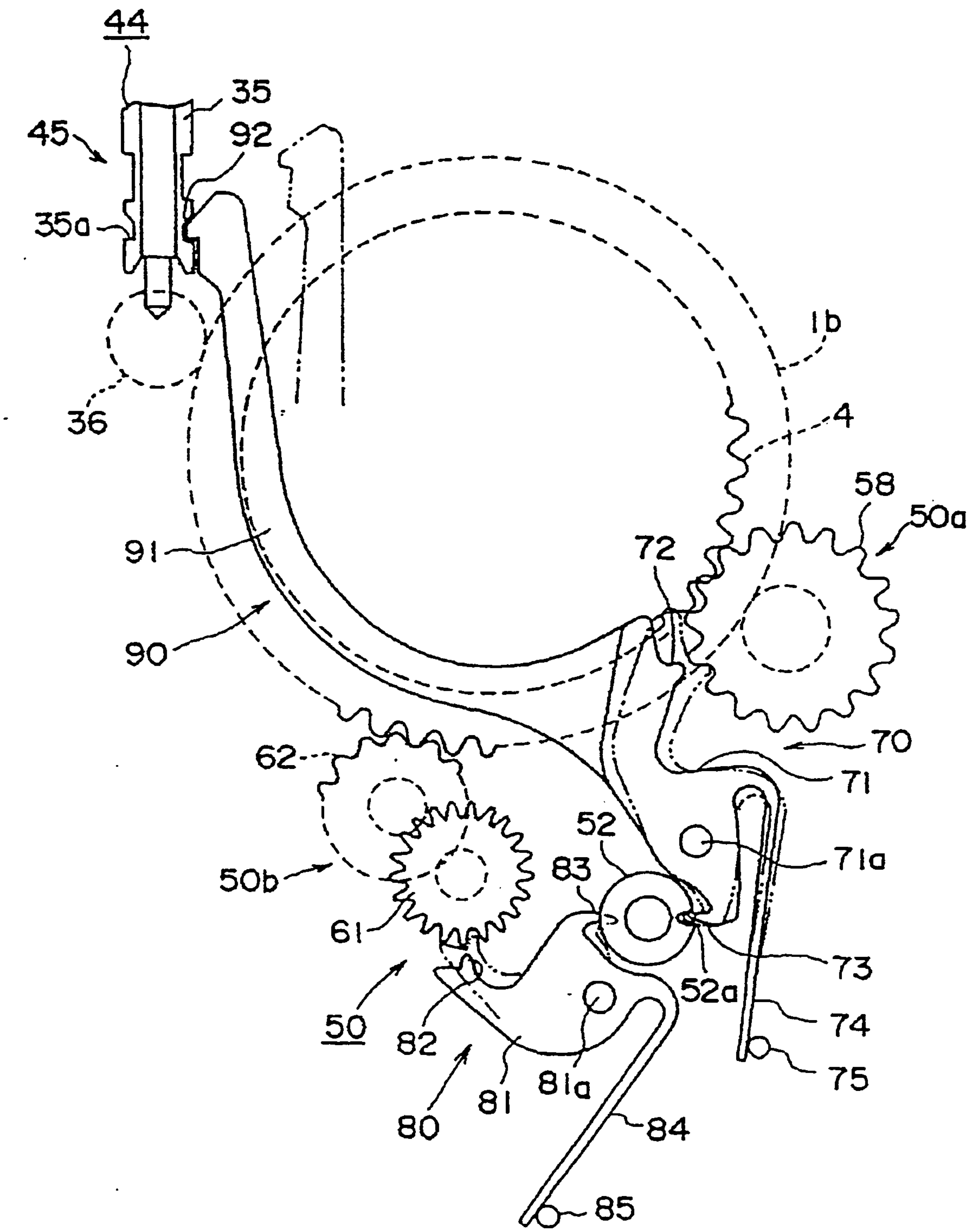

1b
62
50b
61
60
55
75
74
53
51
56
59
54
54a
54b
52
71
71a
50
72
14
57
15
50a
1b
58
1a
2
1
4
1d

FIG. 5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35
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92
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1b
36
4
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50a
72
91
90
70
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71
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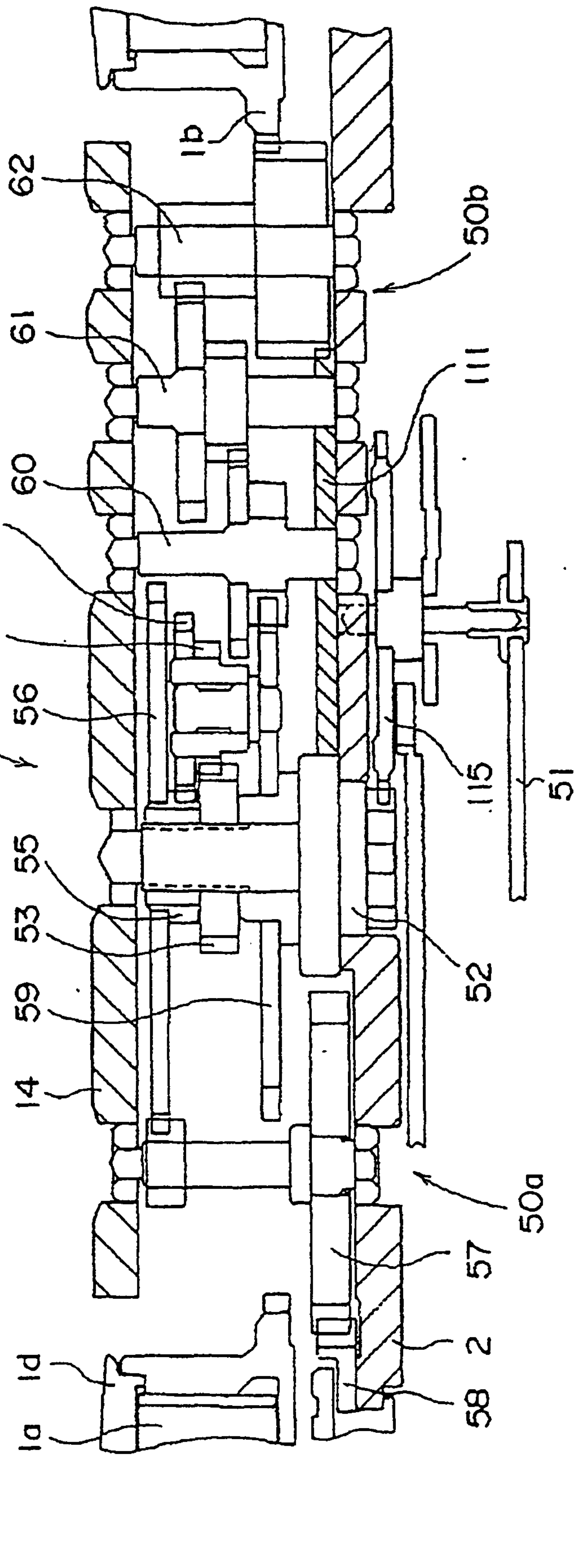
50b
83
61
73
52a
74
50
82
75
81a
81
80
84
85

FIG. 6


1b
62
61
60
54
54b
54a
50
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59
14
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1a
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115
51
52
50a
57
2
58

FIG. 7

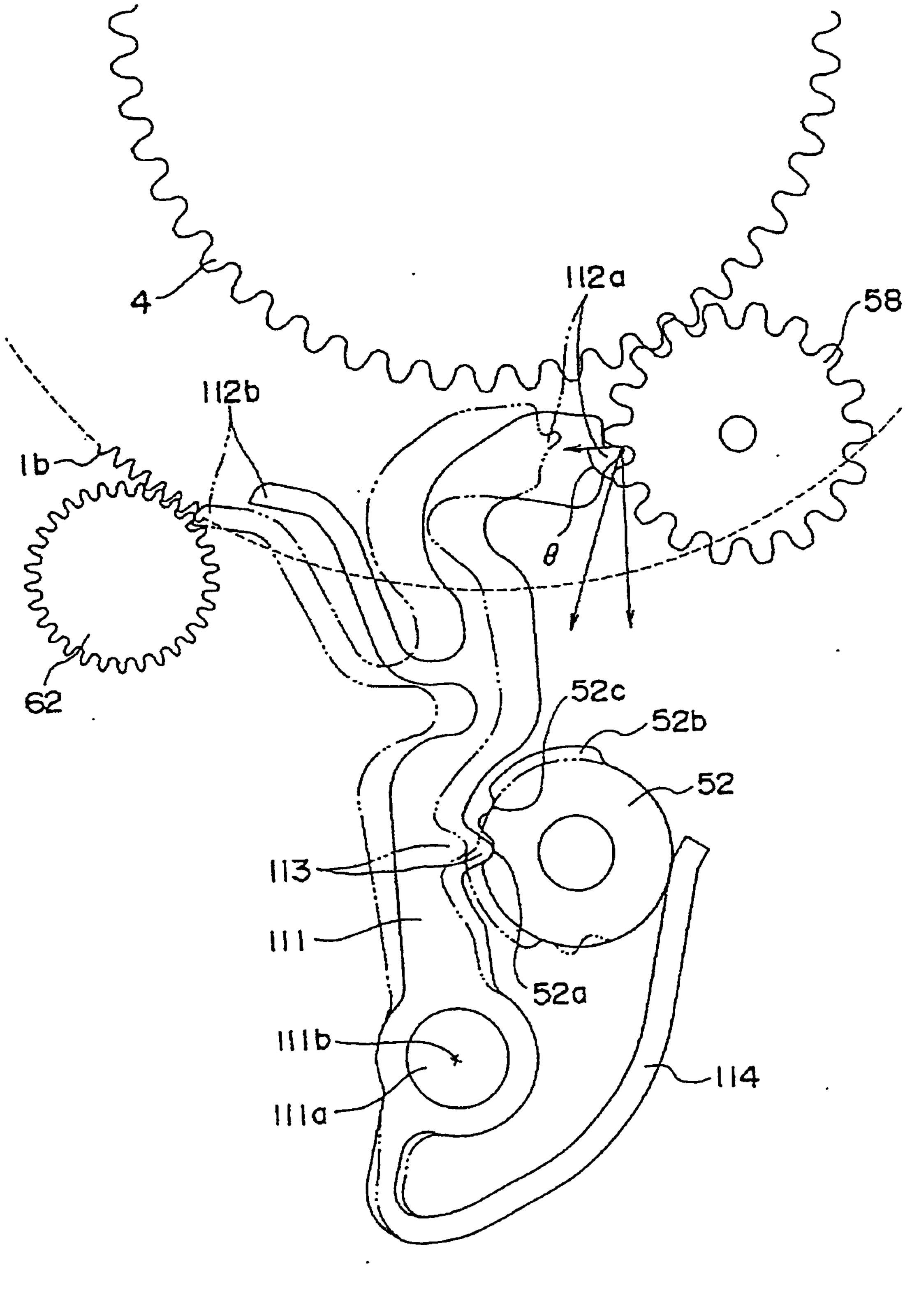
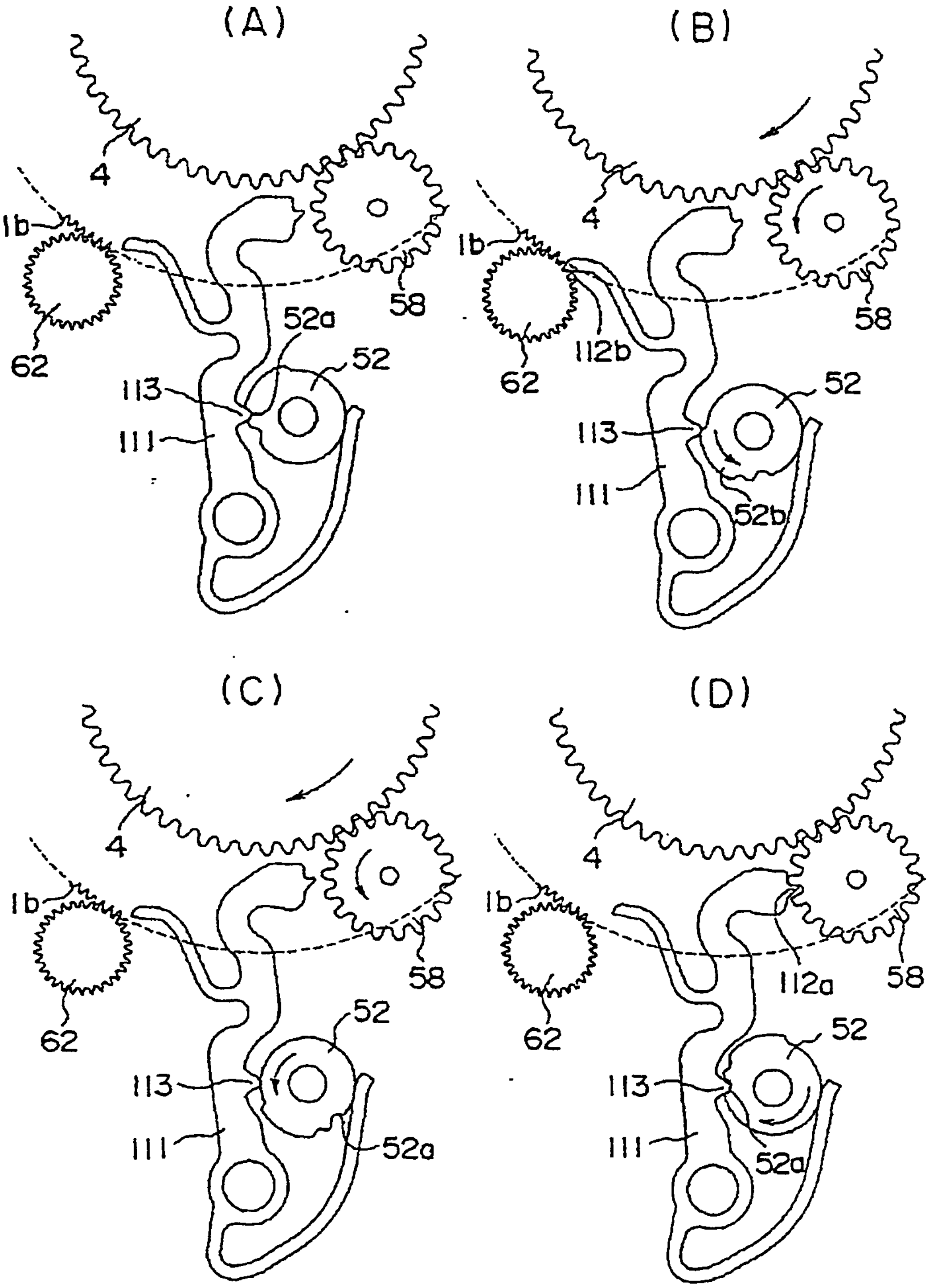


FIG. 8


(A)
4
1b
62
52a
52
58
113
111
(B)
4
1b
112b
62
52
58
113
111
52b
(C)
4
1b
62
52
58
113
111
52a
(D)
4
1b
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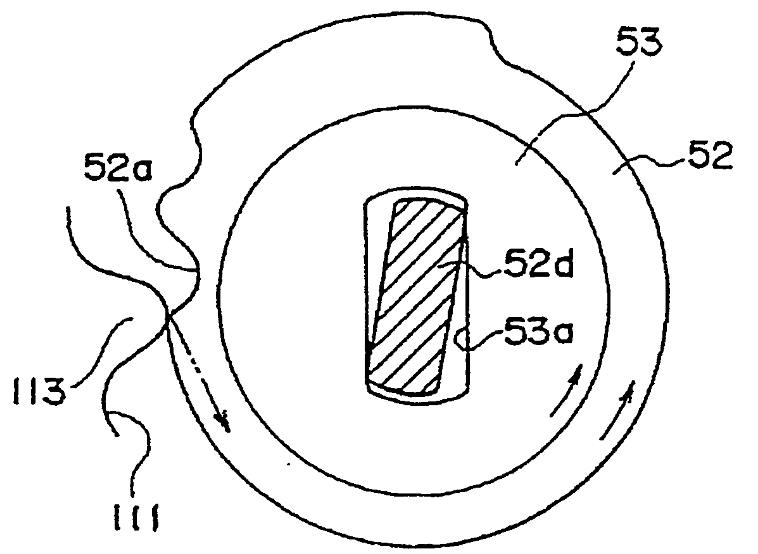
112a
58
52
113
111
52a

FIG. 9

(A)



(B)

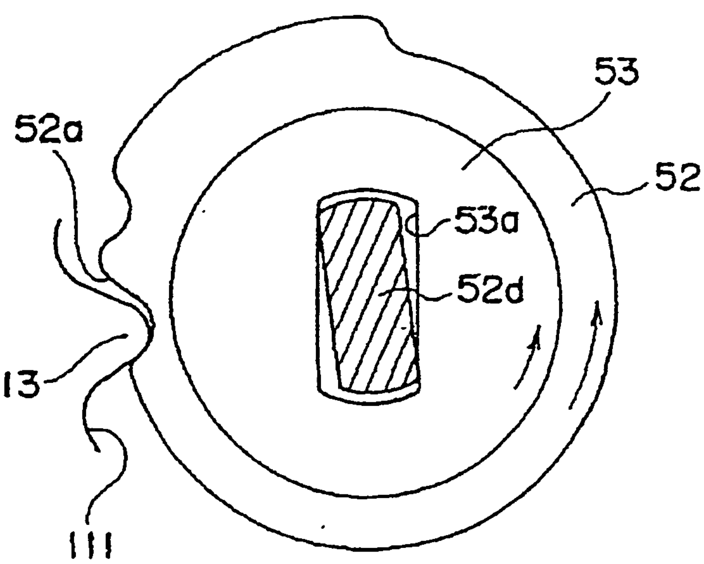


FIG. 10

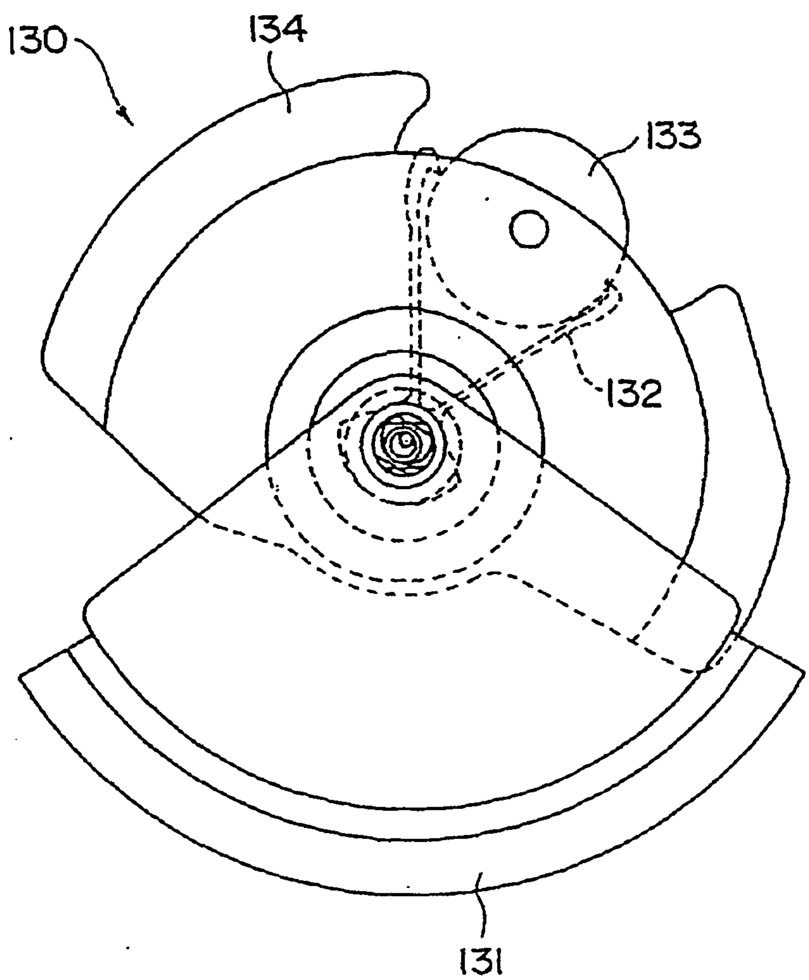
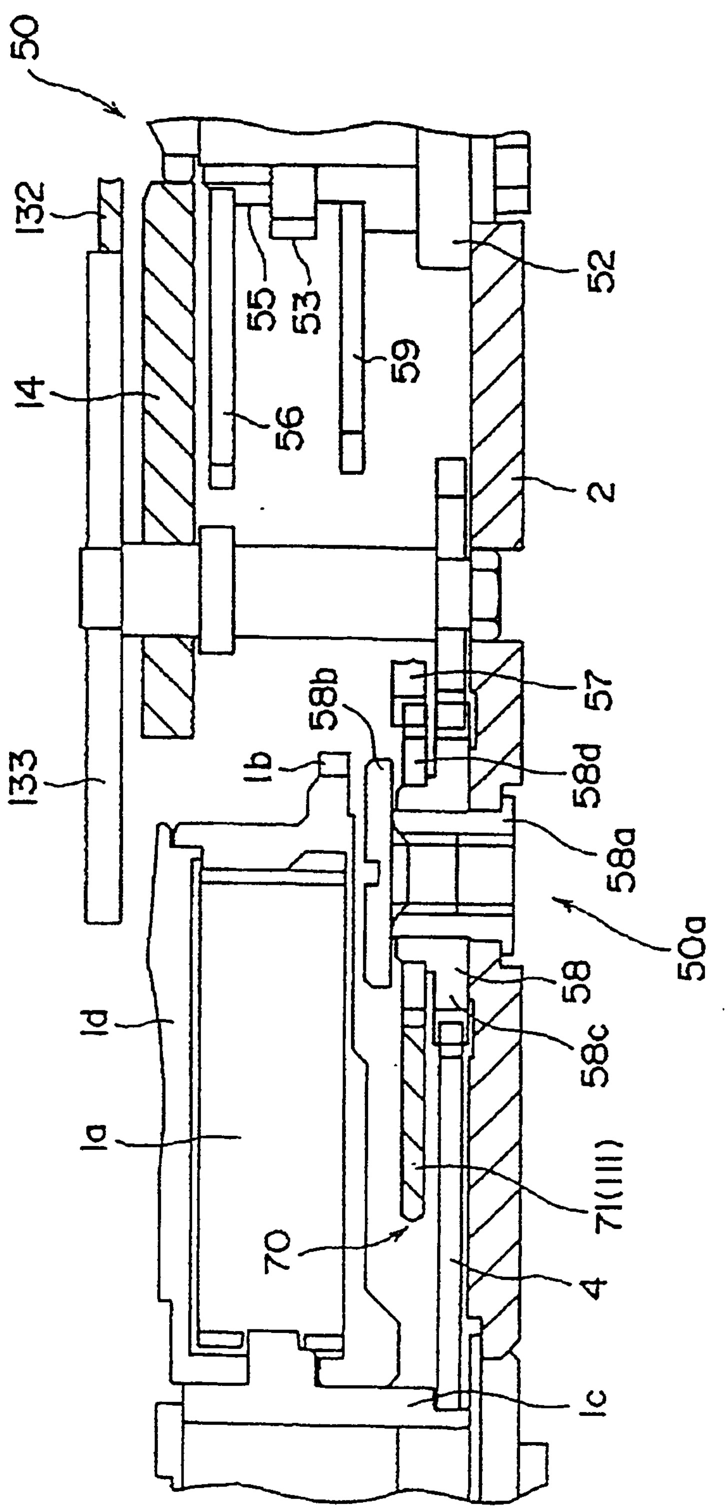


FIG. 11


50
132
52
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53
59
14
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2
57
58b
58d
1b
133
58a
50a
58
1d
58c
1a
71(111)
70
4
1c

FIG. 12

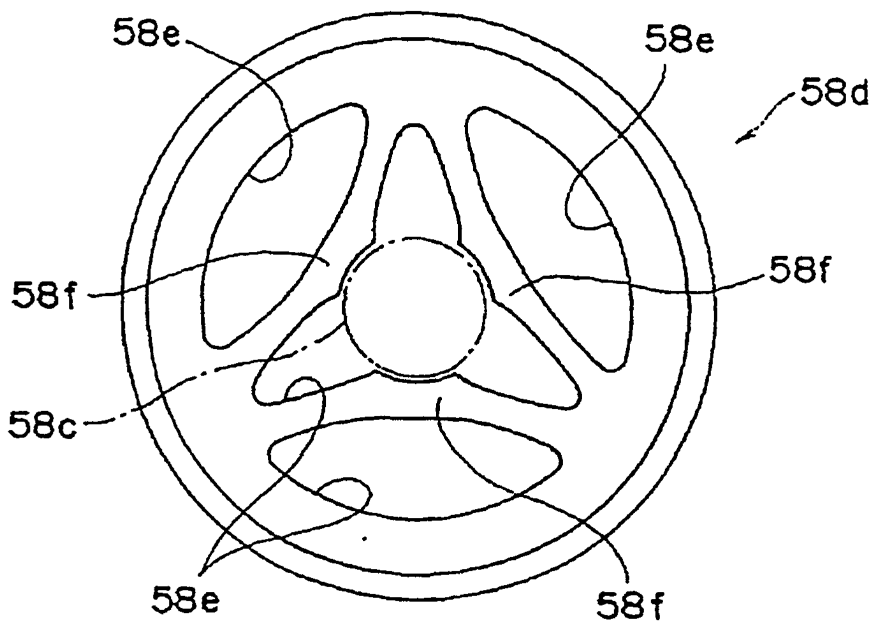

FIG. 13

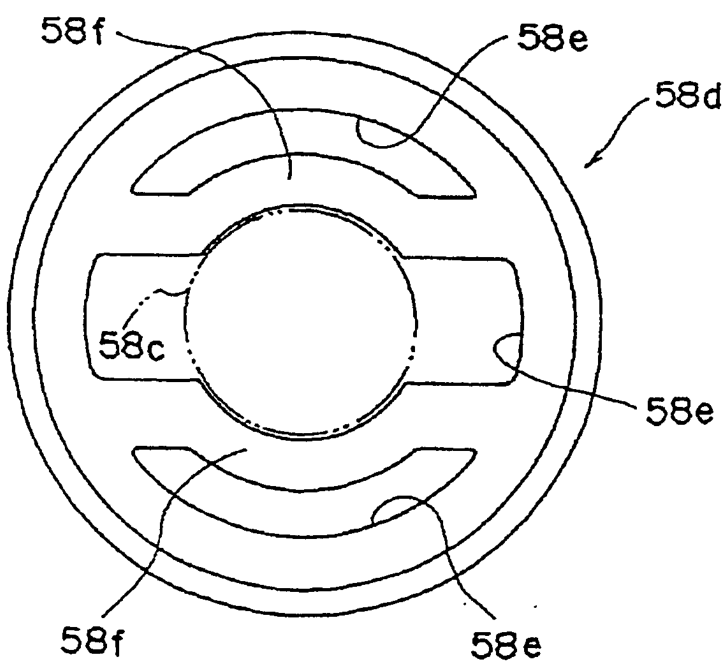

FIG. 14

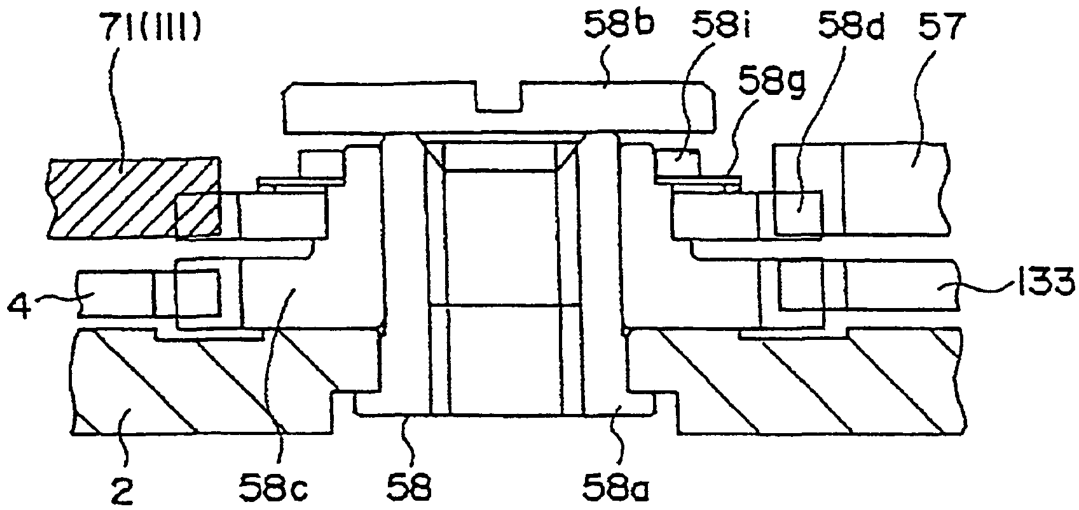
71(111)
58b
58i
58d
57
58g
4
133
2
58c
58
58a

FIG. 15

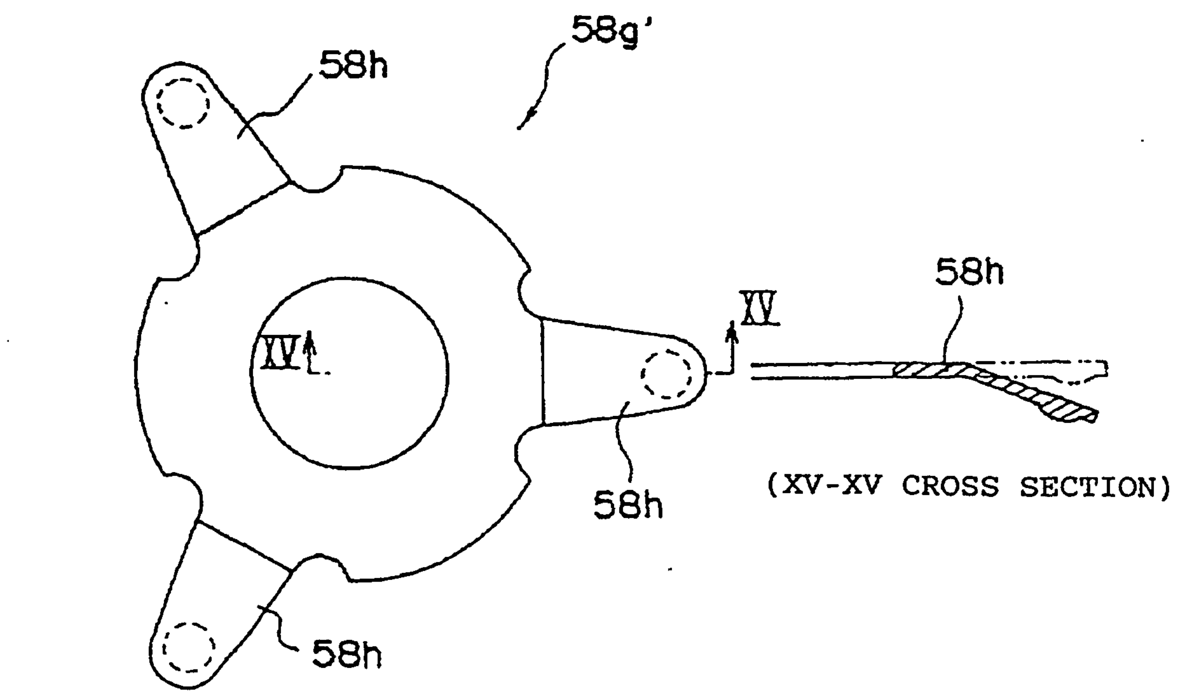
58g'
58h
XV
XV
58h
58h
58h
(XV-XV CROSS SECTION)

FIG. 16

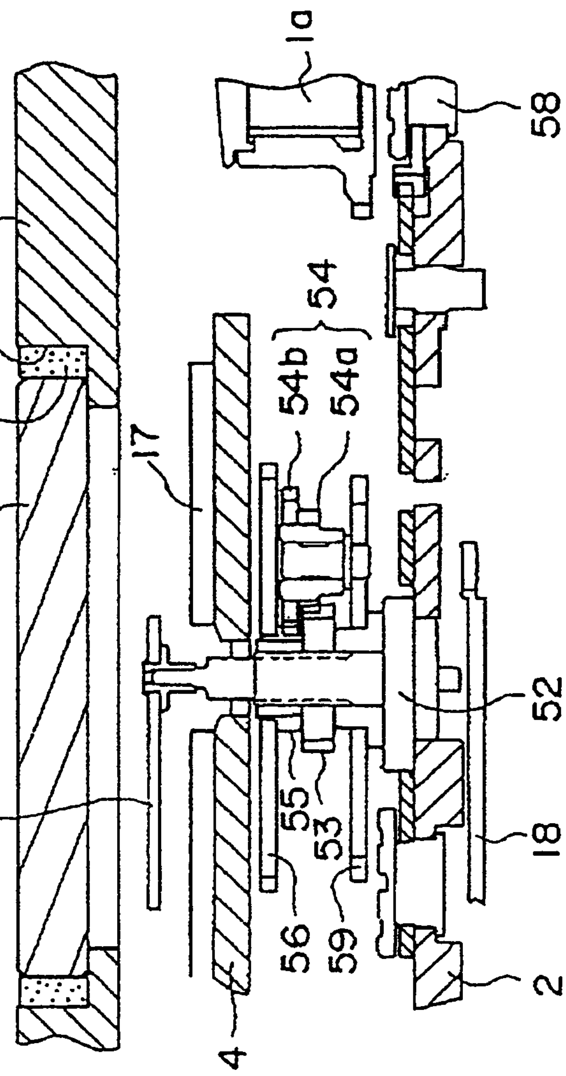

FIG. 17

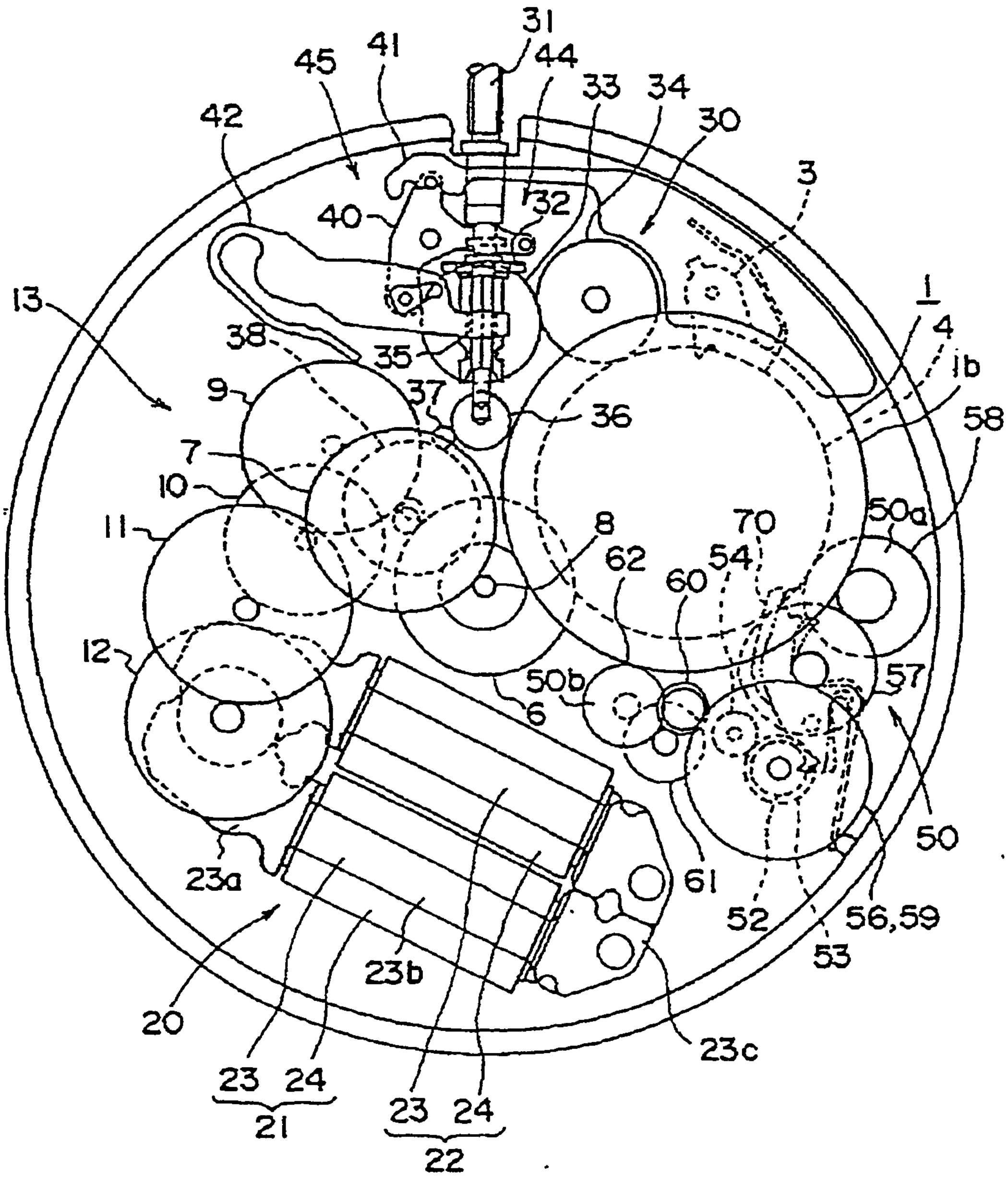
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FIG. 18

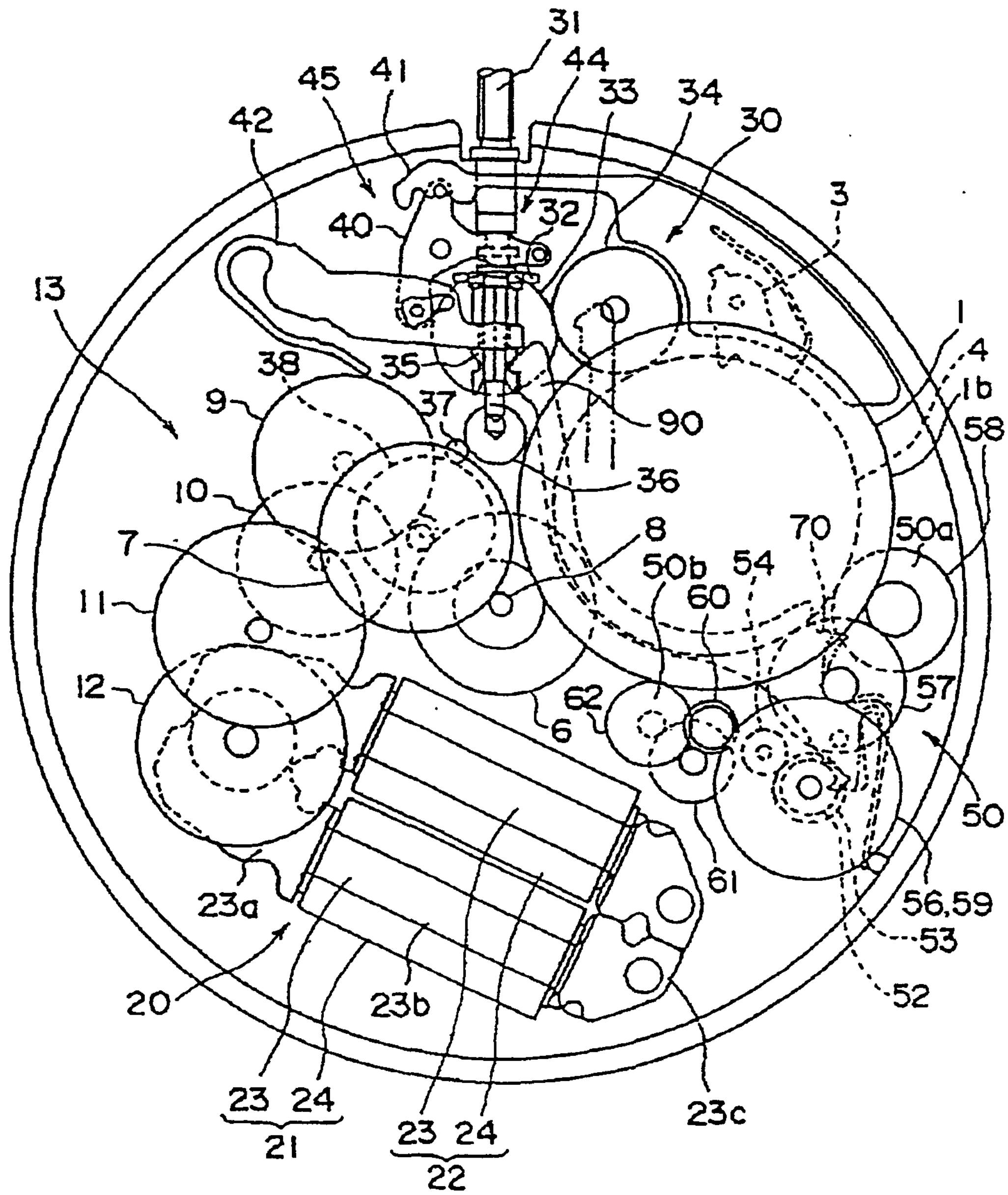
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FIG. 19

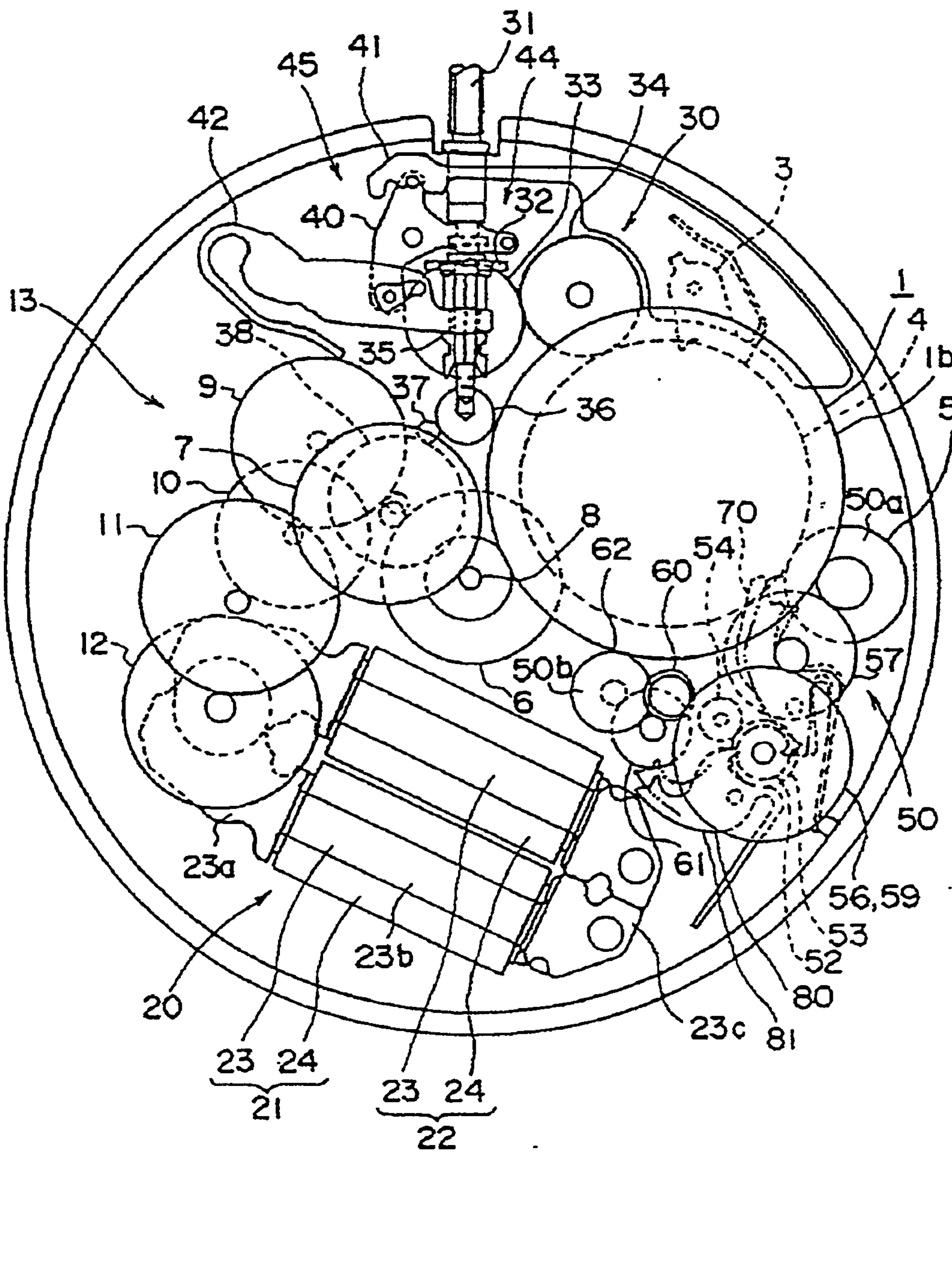
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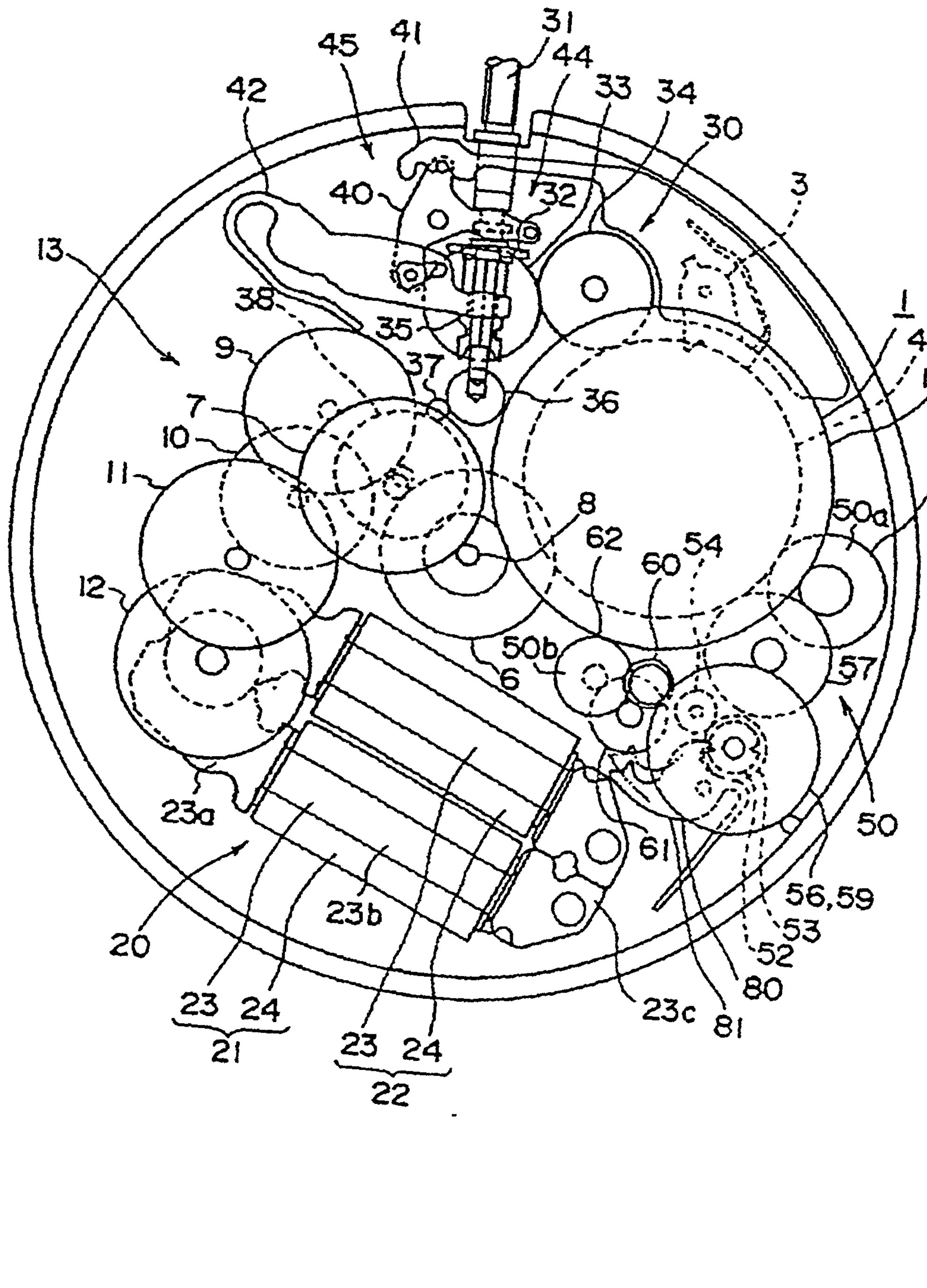
FIG. 20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50a
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12
50b
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23c
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23 24
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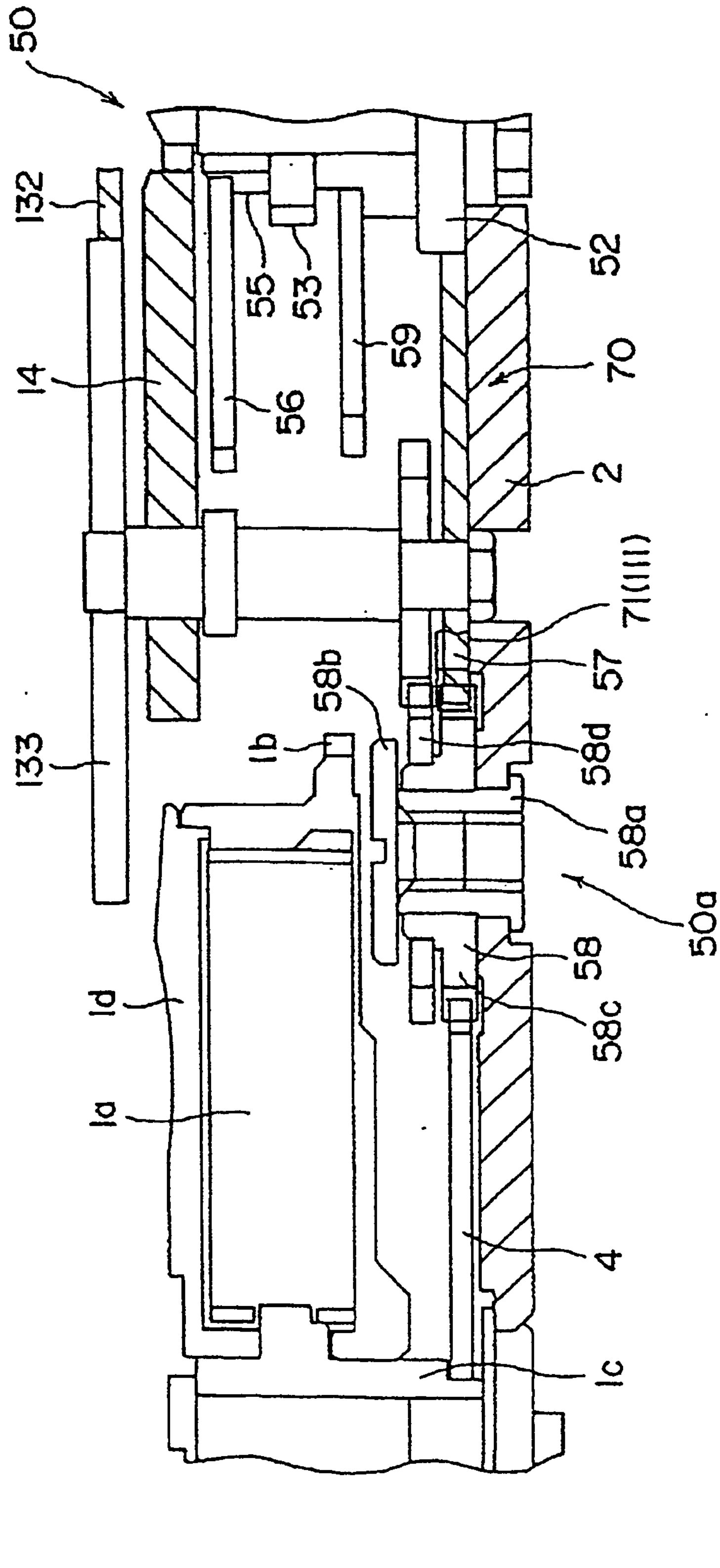
FIG. 21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1d
58c
1a
4
1c

FIG. 22

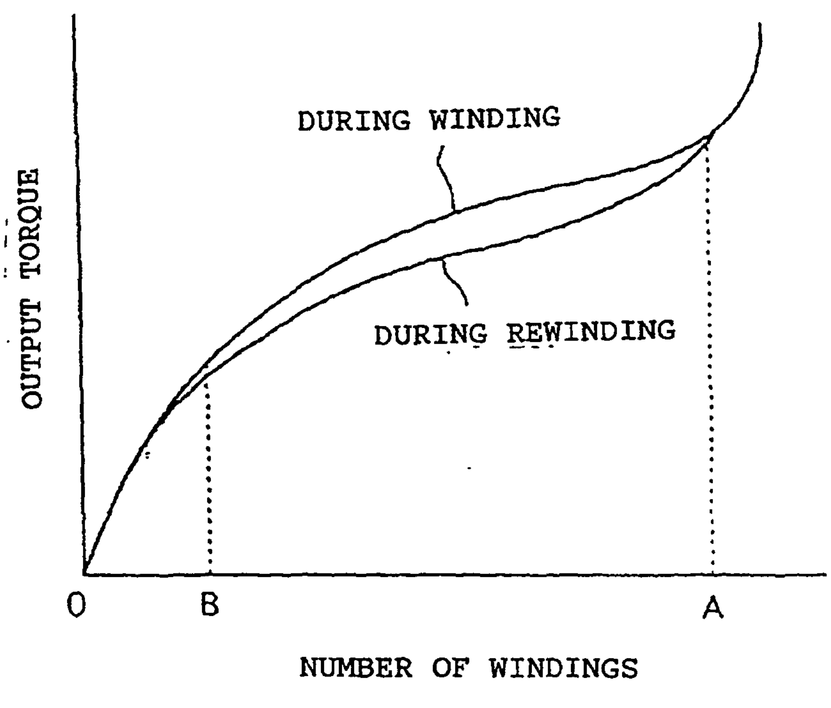
DURING WINDING
DURING REWINDING
OUTPUT TORQUE
0
B
A
NUMBER OF WINDINGS

FIG. 23