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(54) A SWITCHING SYSTEM

(57) The invention relates to a switching system (1) comprising a low, medium or high voltage switch and a charging device, comprising:
- a main spring (10) of the switch;
- a spring support (20) of the switch;
- a main shaft (30) of the switch; and
- a motor (40) of the charging device;

wherein, a first end (11) of the main spring is connected to the spring support;
wherein, a second end (12) of the main spring is connected to the main shaft;
wherein, the spring support is configured to rotate about an axis of the main shaft;
wherein, at least part of a circumference of the spring support comprises a thread (22);
wherein, the motor comprises a worm thread configured to engage with the thread of the spring support;
wherein, the motor is configured to rotate the worm thread, and wherein rotation of the worm thread is configured to rotate the spring support to store energy in the main spring;
wherein, the motor is configured not to rotate the worm thread when the energy stored in the main spring has reached a threshold level; and
wherein, energy release from the main spring is configured to rotate the main shaft.

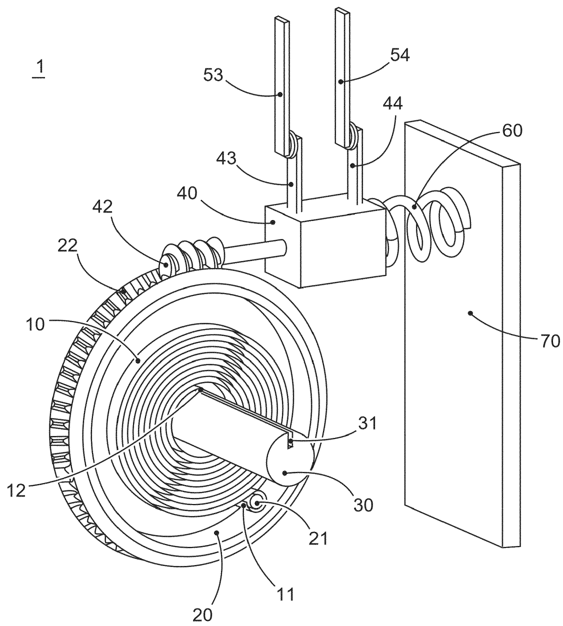

Fig. 1

EP 3 965 130 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a switching system that comprises a low, medium or high voltage switch (such as a circuit breaker or that forms part of a circuit breaker) and a charging device, as well as to a low, medium or high voltage switchgear that comprises such a switching system.

BACKGROUND OF THE INVENTION

[0002] Most medium voltage (MV) circuit breakers (CB) are driven by a mechanical drive that contains a main spring to store and release the energy for an operation. The main spring can either be charged manually or by use of an electric drive, usually an electric motor. This also applies to low and high voltage circuit breakers and other switching systems.

[0003] The electric motor requires some mechanism or means to switch it on when it is needed to charge the spring and to switch it off when the spring is charged. This control of the switching on and off of the motor to turn the motor on to charge the spring when required and to turn the motor off when the spring is charged, is via a mechanism that checks the mechanical position of the spring. This is control of the motor is therefore via an additional mechanism that increases the complexity of the CB drive system, and that could potentially fail.

[0004] There is a need to address these problems.

SUMMARY OF THE INVENTION

[0005] Therefore, it would be advantageous to have an improved technique to charge the main spring of a switch such as a circuit breaker.

[0006] The object of the present invention is solved with the subject matter of the independent claims, wherein further embodiments are incorporated in the dependent claims.

[0007] In a first aspect, there is provided a switching system comprising a low, medium or high voltage switch and a charging device, comprising:

- a main spring of the switch;
- a spring support of the switch;
- a main shaft of the switch; and
- a motor of the charging device.

[0008] A first end of the main spring is connected to the spring support. A second end of the main spring is connected to the main shaft. The spring support is configured to rotate about an axis of the main shaft. At least part of a circumference of the spring support comprises a thread. The motor comprises a worm thread configured to engage with the thread of the spring support. The motor is configured to rotate the worm thread. Rotation of the worm thread is configured to rotate the spring support to store energy in the main spring. The motor is configured not to rotate the worm thread when the energy stored in the main spring has reached a threshold level. Energy release from the main spring is configured to rotate the main shaft.

[0009] In other words, a completely new and surprising mechanism has been developed for charging the mainspring of a switch system where the power is turned off to the motor that charges the spring based on the energy stored in the mainspring itself. This provides a self-contained charging system, with no further external complex monitoring systems or devices required.

[0010] In an example, the spring support comprises a cup.

[0011] In an example, at least part of an outer circumference of the spring support comprises the thread.

[0012] In an example, a mounting of the motor is configured to enable the motor to move. When the energy stored in the main spring has reached the threshold level the motor is configured not to rotate the worm thread when the motor has moved a threshold distance.

[0013] Thus, simple mechanism is provided based on a lateral movement of the motor resulting from energy stored in the mainspring reaching a threshold level. This movement of the motor can then be utilised to switch the power off to the motor.

[0014] In an example, the mounting of the motor comprises a spring configured to resist the movement of motor to the threshold distance.

[0015] By using a spring in this manner, simple mechanism is provided to adjust the resisting power of the spring, either by changing the spring, or put in for example spaces between the mounting of the spring and the spring itself to put it under tension.

[0016] In an example, movement of the motor to the threshold distance is configured to trigger a switch to stop the motor from rotating the worm thread.

[0017] Thus, a simple microswitch or switch can be triggered based on a lateral movement of the motor then turns the motor off.

[0018] In an example, the motor comprises at least one power connection. The at least one power connection of the motor is configured to be in electrical connection with at least one fixed connection to provide power to the motor to rotate the worm thread. When the motor has moved a threshold distance the at least one power connection of the motor is configured to be electrically disconnected from the at least one fixed connection.

[0019] In this manner, simple in effect mechanical system is provided where movement of the motor itself laterally leads to a disconnection of power to the motor in a completely self-contained manner.

[0020] In an example, the motor is configured not to rotate the worm thread in response to a threshold torque being applied from the spring support to the worm thread when the energy stored in the main spring has reached the threshold level.

[0021] Thus, as the mainspring is charged an increasing torque is developed in the spring support or cup and this in effect pushes against the worm thread. An internal sensor within the motor can for example sense this increasing pushing force and when a threshold torque has developed, the motor can be switched off. Alternatively, the motor is fixed and only the worm thread moves itself laterally with respect to the body of the motor, and this movement can be utilised to turn off the motor when for example a threshold movement distance has occurred. The switch or sensor that detects the lateral movement of the worm thread can be outside of the housing of the motor, or it can also be integrated in the motor.

[0022] In an example, application of the threshold torque from the spring support to the worm thread is configured to move the motor the threshold distance.

[0023] In an example, the motor is configured to continuously rotate the worm thread when a power source is connected to the motor.

[0024] In this manner, a very simple charging mechanism is provided, where when the mainspring is not fully charged the charging system continuously challenges the mainspring until the mainspring is fully charged at which point charging of the mainspring automatically stops. When the mainspring has been discharged, the motor will automatically turn back on and charging continue again.

[0025] In an example, the motor is configured not to rotate the worm thread when the power source is disconnected from the motor.

[0026] In an example, the worm thread is configured to engage with the thread of the spring support to stop the spring support from rotating when the energy stored in the main spring has reached the threshold level.

[0027] In an example, the motor is configured to rotate the worm thread upon energy release from the main spring that has reached the threshold energy level.

[0028] In an example, a circuit breaker comprises the low, medium or high voltage switch.

[0029] In a second aspect, there is provided a low, medium or high voltage switchgear comprising a switching system according to the first aspect.

[0030] The above aspects and examples will become apparent from and be elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] Exemplary embodiments will be described in the following with reference to the following drawing:

Fig. 1 shows an example of a switching system with a discharged main spring;

Fig. 2 shows an example of the switching system of Fig. 1 with a charged main spring;

Fig. 3 shows a schematic view of three instances of the closing operation of a CB drive using a charged main spring.

DETAILED DESCRIPTION OF EMBODIMENTS

[0032] Figs. 1-2 relate to a switching system 1 that has a low, medium or high voltage switch, or at least part of such a switch, and a charging device, and to a switchgear that has such a switching system.

[0033] An example of a switching system 1 comprises a low, medium or high voltage switch and a charging device. In more detail, the switching system comprises a main spring 10 of the low, medium or high voltage switch, a spring support 20 of the low, medium or high voltage switch, a main shaft 30 of the low, medium or high voltage switch and a motor 40 of the charging device. A first end 11 of the main spring is connected to the spring support. A second end 12 of the main spring is connected to the main shaft. The spring support is configured to rotate about an axis of the main shaft. At least part of a circumference of the spring support comprises a thread 22. The whole circumference can have the thread in certain examples. The motor comprises a worm thread configured to engage with the thread of the spring support. The motor is configured to rotate the worm thread, and rotation of the worm thread is configured to rotate the spring support to store energy in the main spring. The motor is configured not to rotate the worm thread when the energy stored in the main spring has reached a threshold level. Energy release from the main spring is configured to rotate the main shaft.

[0034] In an example, the spring support comprises a cup.

[0035] In an example, at least part of an outer circumference of the spring support comprises the thread.

[0036] In an example, a mounting of the motor is configured to enable the motor to move. When the energy stored in the main spring has reached the threshold level the motor is configured not to rotate the worm thread when the motor has moved a threshold distance.

[0037] In an example, the mounting of the motor comprises a spring 60 configured to resist the movement of motor to the threshold distance.

[0038] In an example, movement of the motor to the threshold distance is configured to trigger a switch to stop the motor from rotating the worm thread.

[0039] In an example, the motor comprises at least one power connection 43, 44. The at least one power connection of the motor is configured to be in electrical connection with at least one fixed connection 53, 54 to provide power to the motor to rotate the worm thread. When the motor has moved a threshold distance the at least one power connection of the motor is configured to be electrically disconnected from the at least one fixed connection 53, 54.

[0040] In an example, the motor is configured not to rotate the worm thread in response to a threshold torque being applied from the spring support to the worm thread when the energy stored in the main spring has reached the threshold level.

[0041] In an example, application of the threshold torque from the spring support to the worm thread is configured to move the motor the threshold distance.

[0042] In an example, the motor is configured to continuously rotate the worm thread when a power source is connected to the motor.

[0043] In an example, the motor is configured not to rotate the worm thread when the power source is disconnected from the motor.

[0044] In an example, the worm thread is configured to engage with the thread of the spring support to stop the spring support from rotating when the energy stored in the main spring has reached the threshold level.

[0045] A circuit breaker can be or comprise the low, medium or high voltage switch as described above.

[0046] In an example, the motor is configured to rotate the worm thread upon energy release from the main spring that has reached the threshold energy level.

[0047] In this manner, a simple and effective system is provided to charge the main spring of a drive for a circuit breaker for example, that continuously charges the mainspring until it reaches a threshold charge level, where charging stops, and upon discharge of the main spring the charging of the mainspring again begins.

[0048] A low, medium or high voltage switchgear can have a switching system as described above.

[0049] The switching system is now described in specific detail with respect to a circuit breaker (CB), where again reference is made to Figs. 1-2.

[0050] Fig. 1 shows the switching system 1 that CB main spring charging device with a discharged main spring 10 of a CB. The main spring 10 is installed in a cup 20. The main spring 10 has an outer end 11 that is connected to the pin 21 in the cup 20 and an inner end 12 that is connected to the groove 31 in the main shaft 30 of the CB. Unless the CB is operating, the main shaft 30 is not rotating, so that the main spring 10 can be charged when its outer end 11 is rotated counter clockwise. For that purpose, a charging motor 40 is provided. The charging motor 40 is movable from the left to right. Its worm thread 42 engages with the thread 22 of the cup 20, which provides a self-locking function based on the worm thread principle. In this way no back movement will take place after the charging is done. The auxiliary spring 60 pushes the motor 40 to the leftmost position shown in Fig. 1. When the motor 40 operates the worm thread 42, the cup 20 is rotated counter clockwise to charge the main spring 10. The torque that is building up in the main spring 10 pushes the motor 40 with a corresponding force to the right. During charging, this force is lower than the force of the auxiliary spring 60, so that the charging motor 40 stays in the leftmost position shown in Fig 1. The leftmost position of the motor 40 can be defined with a mechanical stop (not shown). In this leftmost position, the motor 40 is connected to its electrical supply via the electrical contacts 43, 53 and 44, 54, where 43 and 44 are fixed to the motor 40 while 53 and 54 are fixed to the environment.

[0051] In Fig. 2, the switching system is shown where charging of the main spring 10 is complete. The torque that was built up in the main spring 10 is now strong enough to push the motor 40 to the right, against the force of the auxiliary spring 60, to the rightmost position of the motor 40. This rightmost position can be defined with a mechanical stop (not shown). In this rightmost position, the electrical contacts 43 and 44 are away from their fixed counterparts 53 and 54, so that the electrical feeding circuit of the motor 40 is interrupted and the charging process is terminated.

[0052] When the CB is operating, the main shaft 30 is released for rotation and it will therefore reduce the torque of the main spring 10. Then, 40 will be pushed to the left, the electrical contacts will close and the main spring 10 will be recharged. This also applies in case the CB should operate during the charging process.

[0053] As an alternative to the electrical contacts 43, 53 and 44, 54 an off-the-shelf switch or microswitch can be used that is operated by the change of the position of the motor 40.

[0054] As an alternative to two electrical contacts 43, 53 and 44, 54, that realise a bipolar connection / disconnection of the electrical feeding circuit of the motor 40, one of the two electrical contacts 43, 53 or 44, 54 may be replaced by a solid electrical connection, e.g. a cable. This would save one electrical contact while the switching function of the motor is still provided.

[0055] For the adjustment of the charging torque, the pre-load of the auxiliary spring 60 may be adapted for example by changing the position of the fixed plate 70 towards or away from the auxiliary spring 60, or by inserting distance plates of a certain thickness between the auxiliary spring 60 and the fixed 70 or between the auxiliary 60 and the motor 40.

[0056] Fig. 3 shows an example of a planetary drive system for a circuit breaker, that utilizes a main spring 10 charged as described above with respects to Figs. 1-2, and where rotation of the main shaft is utilized.

[0057] Fig. 3 shows three instants of the closing operation, from left to right: OFF position, intermediate position, ON position. The energy for the operation is stored in the closing or main spring 10.

[0058] In the OFF position, both the planetary cogwheel carrier 500 and the hollow cogwheel ring 600 are locked against rotation by their relevant locking features shown as 520, 620 and locking devices shown as 900, 1000.

[0059] The closing spring 10 is charged to drive the closing operation while the opening spring 800 is discharged.

[0060] For closing, the locking device 900 is unlocked, so that the closing spring 10 can drive the carrier 500 counter-clockwise. The outer end 21 of the closing spring 10 is currently locked in the shown position. The counter-clockwise rotation of 500, while the hollow cogwheel ring

600 is locked, results in a counter clockwise rotation of the sun cogwheel 300.

[0061] The sun cogwheel 300 is connected or coupled to the pushrod 100 by for example a high helix thread 200 (or another thread type) so that a counter-clockwise rotation of the sun cogwheel 300 shifts the pushrod 100 away from the OFF-position towards the ON-position. This motion of the pushrod 100 charges the opening spring 800, as its upper end 820 is permanently locked in the shown position while the lower end of 800 is connected to the pushrod 100.

[0062] The sun cogwheel 300 can have a male thread and the pushrod 100 have a female thread, or the sun cogwheel 300 can have a female thread and the pushrod 100 have a male thread.

[0063] In the intermediate position shown in the centre of Fig. 3, the closing spring 10 has rotated the carrier 500 by 45° counter-clockwise. According to the chosen number of teeth, this corresponds to a counter-clockwise rotation of 180° of the sun cogwheel 300. Due to the high helix thread 200, the pushrod was moved half of its way upwards from OFF to ON. The opening spring was charged by the movement of the pushrod. In the ON-position shown at the right side of Fig. 3, the closing spring 10 has rotated the planetary carrier 500 by 90° counter-clockwise. According to the chosen number of teeth, this corresponds to a rotation of 360° counter-clockwise of the sun cogwheel 300. Due to the high helix thread 200 (or another thread type), the pushrod was moved its complete way upwards from OFF to ON. The opening spring was fully charged. Now the next locking feature 520 is in a position where the locking device 900 can push a pin, e.g. driven by a spring, into the locking feature 520 and so stop and latch the closing operation. Alternatively, the closing operation can also be stopped and latched by separate devices.

[0064] In Fig. 3, where the closing operation is shown, locking features 520 are not only provided at the OFF and the ON positions of the cogwheel planetary carrier 500, but also in the intermediate position.

[0065] It is to be noted that in a different embodiment, not shown, the pushrod 100 is again threaded but is not connected or coupled to the sun cogwheel 300. Rather, the hollow cogwheel ring 600 has a top cover that can be for example a disk, and a centre of this disk is threaded. Thus looking at Fig. 3, the sun cogwheel 300 and planetary cogwheels 400 in this example are underneath the top cover of the cogwheel ring 600.

[0066] Then, the closing spring 10 can again drive the carrier 500 and the planetary cogwheels 400 around the axis of the sun cogwheel 300. However, the sun cogwheel 300 can then be locked in position and not rotate and the hollow cogwheel ring 600 then rotates in a clockwise direction. The pushrod 100 can then be threaded in the opposite direction to that described above, and again the pushrod moves away from the off position towards the on position. Rather than having pushrod 100 threaded in the opposite direction, the closing spring 10 can be in effect rotated 180° and the energy release can rotate the carrier in the opposite direction to that described above and again rotation of the cogwheel ring 600 now again in the counter clockwise direction leads to movement of the pushrod from the opposition to the on position.

[0067] The cogwheel ring 600 can have a male thread and the pushrod 100 have a female thread, or the cogwheel ring 600 can have a female thread and the pushrod 100 have a male thread.

[0068] Also, in a different embodiment, the pushrod 100 is again threaded and connected or coupled to the sun cogwheel 300. However now, the closing spring 10 is coupled to the cogwheel ring 600 and now drives rotation of the cogwheel ring 600 rather than driving rotation of the carrier 500 of the planetary cogwheels 400. The carrier 500 of the planetary cogwheels 400 is then held in a fixed position, and does not rotate, but the individual planetary cogwheels 400 then rotate about their axes with rotation of the cogwheel ring 600 then rotating the sun cogwheel 300, which then drives the pushrod 100.

[0069] While the invention has been illustrated and described in detail in the drawing and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive. The invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing a claimed invention, from a study of the drawings, the disclosure, and the dependent claims.

Reference Numerals

[0070]

1 switching system with a CB main spring and charging device
10 Main spring
11 Outer end of 10
12 Inner end of 10
20 Cup
21 Pin in 20
22 Thread at the outside of 20
30 Main shaft of the CB
31 Groove in 30
40 Electrical charging motor
42 Worm thread of 40
43, 44 Electrical contacts connected to 40
53, 54 Fixed electrical contacts
60 Auxiliary spring
70 Fixed plate
100 Pushrod incl. contact pressure springs
200 High-Helix thread
300 Sun cogwheel
400 Planetary cogwheels
500 Carrier of 400
520 Locking feature in 500
600 Hollow cogwheel ring

620 Locking feature in 600
800 Opening spring
820 Upper end of 800
840 Lower end of 800
900 Locking devices for 500
1000 Locking devices for 600

Claims

1. A switching system (1) comprising a low, medium or high voltage switch and a charging device, comprising:

- a main spring (10) of the switch;
- a spring support (20) of the switch;
- a main shaft (30) of the switch; and
- a motor (40) of the charging device;

wherein, a first end (11) of the main spring is connected to the spring support;
wherein, a second end (12) of the main spring is connected to the main shaft;
wherein, the spring support is configured to rotate about an axis of the main shaft;
wherein, at least part of a circumference of the spring support comprises a thread (22);
wherein, the motor comprises a worm thread configured to engage with the thread of the spring support;
wherein, the motor is configured to rotate the worm thread, and wherein rotation of the worm thread is configured to rotate the spring support to store energy in the main spring;
wherein, the motor is configured not to rotate the worm thread when the energy stored in the main spring has reached a threshold level; and
wherein, energy release from the main spring is configured to rotate the main shaft.

2. Switching system according to claim 1, wherein the spring support comprises a cup.

3. Switching system according to any of claims 1-2, wherein at least part of an outer circumference of the spring support comprises the thread.

4. Switching system according to any of claims 1-3, wherein a mounting of the motor is configured to enable the motor to move, and wherein when the energy stored in the main spring has reached the threshold level the motor is configured not to rotate the worm thread when the motor has moved a threshold distance.

5. Switching system according to claim 4, wherein the mounting of the motor comprises a spring (60) configured to resist the movement of motor to the threshold distance.

6. Switching system according to any of claims 4-5, wherein movement of the motor to the threshold distance is configured to trigger a switch to stop the motor from rotating the worm thread.

7. Switching system according to any of claims 4-5, wherein the motor comprises at least one power connection (43, 44), wherein the at least one power connection of the motor is configured to be in electrical connection with at least one fixed connection (53, 54) to provide power to the motor to rotate the worm thread, and wherein when the motor has moved a threshold distance the at least one power connection of the motor is configured to be electrically disconnected from the at least one fixed connection (53, 54).

8. Switching system according to any of claims 1-7, wherein the motor is configured not to rotate the worm thread in response to a threshold torque being applied from the spring support to the worm thread when the energy stored in the main spring has reached the threshold level.

9. Switching system according to claim 8 when dependent upon any of claims 4-7, wherein application of the threshold torque from the spring support to the worm thread is configured to move the motor the threshold distance.

10. Switching system according to any of claims 1-9, wherein the motor is configured to continuously rotate the worm thread when a power source is connected to the motor.

11. Switching system according to claim 10, wherein the motor is configured not to rotate the worm thread when the power source is disconnected from the motor.

12. Switching system according to any of claims 1-11, wherein the worm thread is configured to engage with the thread of the spring support to stop the spring support from rotating when the energy stored in the main spring has reached the threshold level.

13. Switching system according to any of claims 1-12, wherein a circuit breaker comprises the low, medium or high voltage switch.

14. Switching system according to any of claims 1-13, wherein the motor is configured to rotate the worm thread upon energy release from the main spring that has reached the threshold energy level.

15. A low, medium or high voltage switchgear comprising a switching system according to any of claims 1-14.

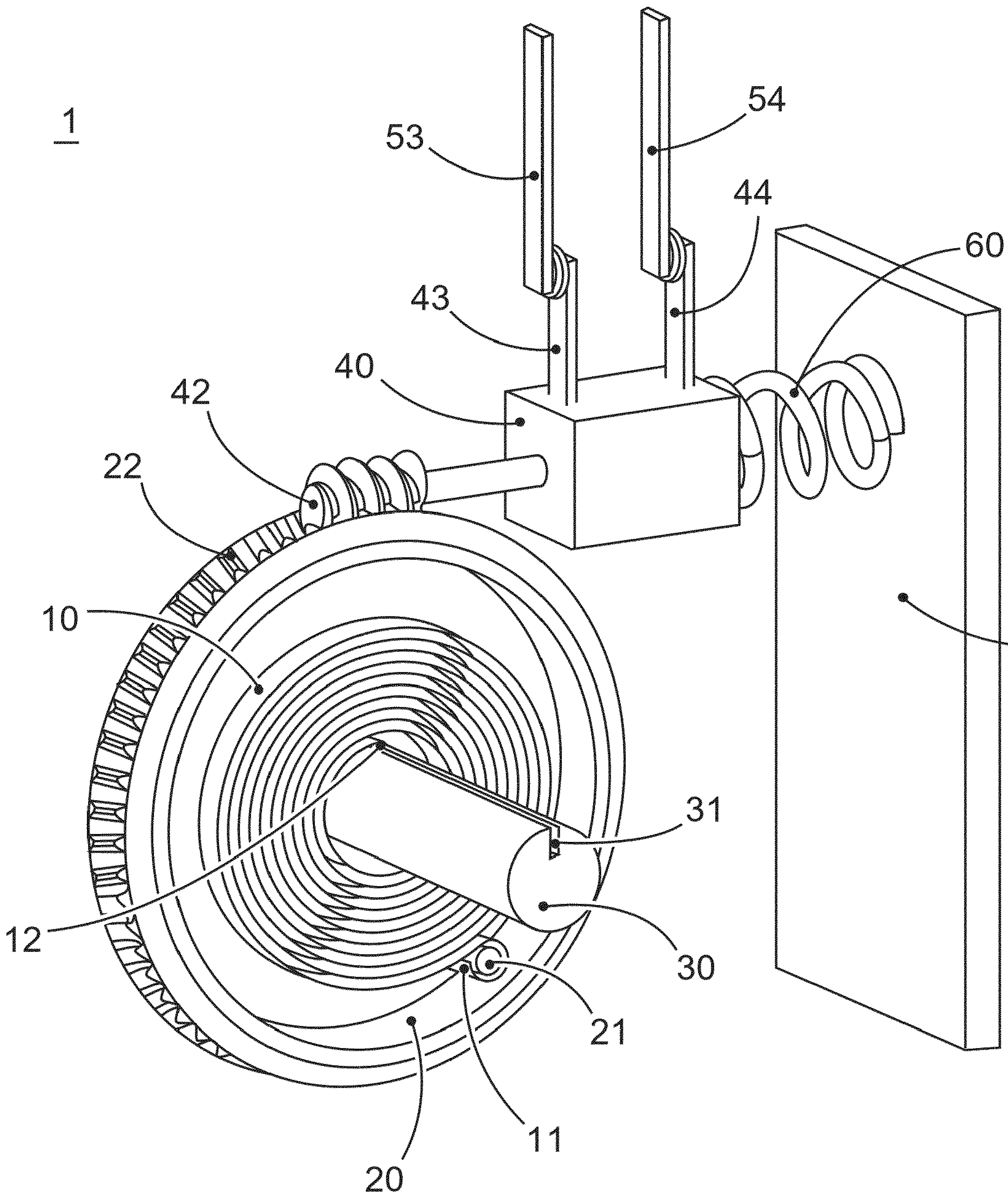

Fig. 1

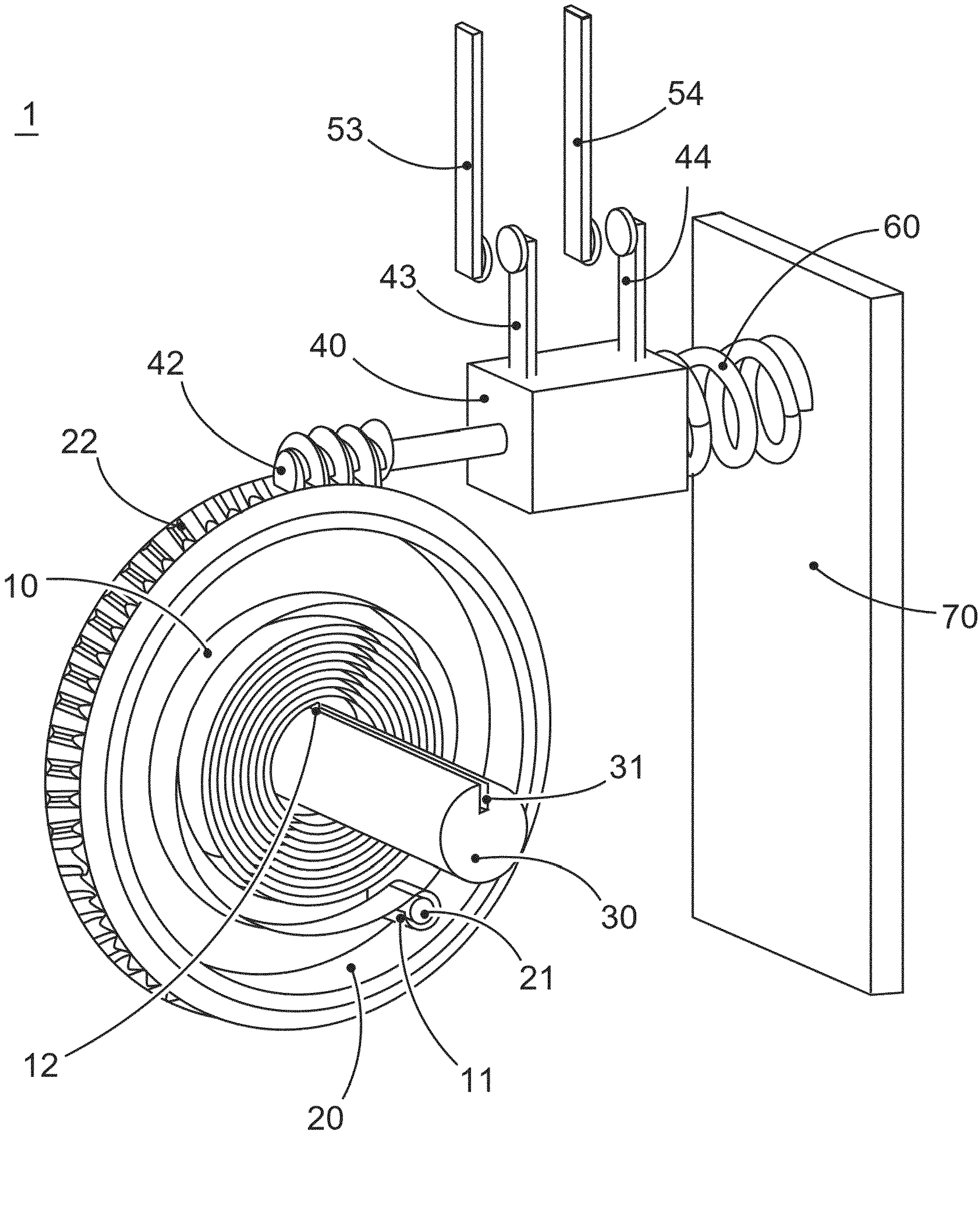

Fig. 2

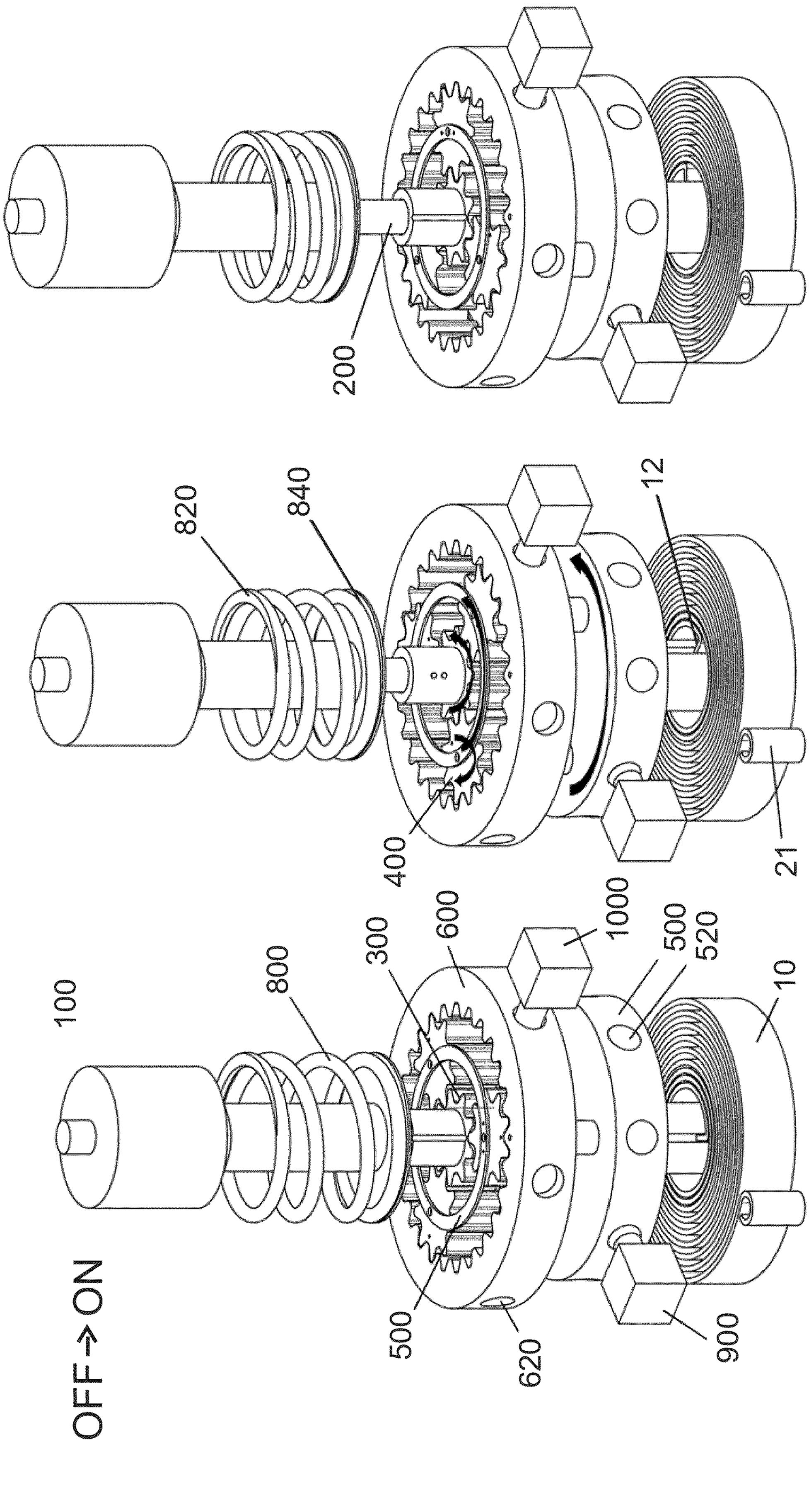
OFF→ON
100
800
300
600
1000
500
520
10
500
620
900
820
840
400
12
21
200

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 20 19 4853

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 February 2021	Ernst, Uwe

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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2

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 19 4853

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