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(54) DRIVE MECHANISM FOR A SWITCHGEAR

(57) A drive mechanism (10) and an associated method for charging a switchgear (100) are presented. The drive mechanism (10) includes a cam disc (18) including a protrusion (52), a charging shaft (12) coupled to a spring (26) such that the spring (26) is compressed by a rotary motion (70) of the charging shaft (12), a follower plate (20), an intermediate shaft (14), and a drive shaft (16). The cam disc (18) is mounted on the charging shaft (12) and the follower plate (20) is mounted on the intermediate shaft (14). The intermediate shaft (14) is engaged with the drive shaft (16) and the charging shaft (12) for transferring the rotary motion from the drive shaft (16) to the charging shaft (12). The protrusion (52) pushes the follower plate (20) along a longitudinal axis (2) when the spring (26) is compressed, such that the drive shaft (16) is disengaged from the intermediate shaft (14) to discontinue transferring of the rotary motion (70) to the charging shaft (12).

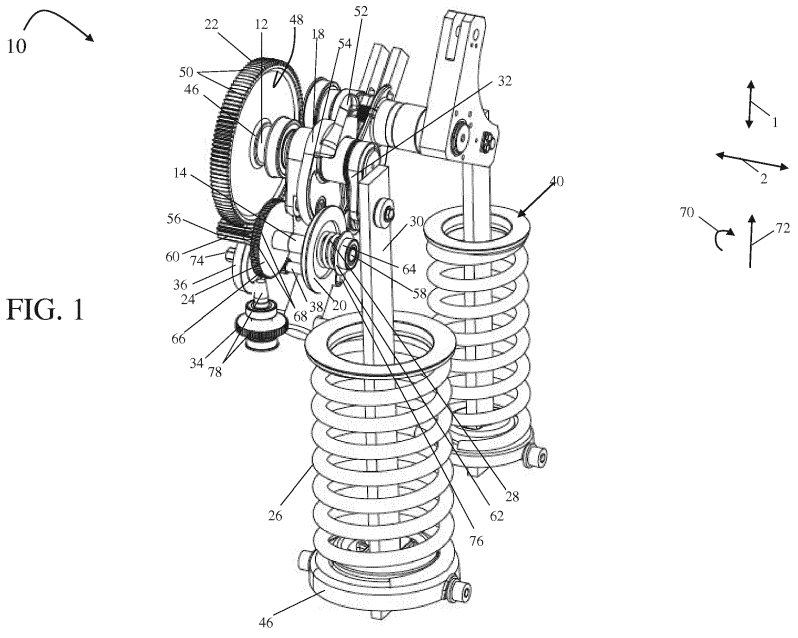

FIG. 1

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Description

[0001] The present invention relates to a drive mechanism for switchgear and more particularly to a drive mechanism for a circuit breaker.

[0002] Switchgear is a combination of electrical disconnect switches, fuses, or circuit breakers for controlling, protecting, and isolating electrical equipment. A circuit breaker is designed to protect an electrical circuit from an overload or short-circuit. Typically, the circuit breakers are automatically operated electrical switch. The circuit breaker responds to a fault condition and immediately discontinues electrical flow by interrupting continuity in the electrical flow.

[0003] Circuit breakers use drive mechanism to tension a relatively strong spring, with sufficient energy potential to turn the circuit breaker open and close again either manually or with an aid of a motor. The drive mechanism can function as a step drive in which after the motor is turned on, the spring is tensioned far enough to store the required energy for the subsequent release of a switch mechanism. Alternatively, the drive mechanism can operate as a storage drive, in which the energy stored by the spring can be released in any desired manner at a desired moment for switching.

[0004] Drive mechanism typically use a free-wheel which is a subassembly used to operate a high voltage circuit breaker. In the drive mechanism, closing spring is charged by the motor by means of free-wheel assembly. Initially closing spring is in discharged condition. A charging shaft is rotated by means of the motor connected to a shaft and gear, through a gear train to charge the closing spring. A transport lever, engages in the cam on the charging shaft and rotates the cam till the transport lever reaches the upper dead center. At this point transport lever gets disengaged from the cam due to the positioning of a triangular plate on fixed drive housing. Thus, the motor is disengaged from the cam after the spring is completely charged to discontinue torque transmission between the gearing system. If the drive mechanism fails to discontinue the torque transmission the closing spring may get into a solid-state condition.

[0005] Such an arrangement typically employs a number of components thereby increasing the cost. It is therefore an object of the present invention to provide a drive mechanism for switchgear and particularly for a circuit breaker which employs less components and is additionally cost effective.

[0006] The object is achieved by providing a drive mechanism for a switchgear according to claim 1.

[0007] According to the present invention a drive mechanism and a method of charging a switchgear are provided. The drive mechanism includes a cam disc, a charging shaft, a follower plate, an intermediate shaft, and a drive shaft. The charging shaft, the intermediate shaft, and the drive shaft are positioned parallel to each other. The charging shaft is coupled to a first spring such that the first spring is compressed by a rotary motion of the charging shaft. The cam disc includes a protrusion extending outwardly from a peripheral portion of the cam disc. Further, the cam disc is mounted on the charging shaft and the follower plate is mounted on the intermediate shaft. The intermediate shaft is engaged with the charging shaft for transferring the rotary motion to the charging shaft. Further, the drive shaft is engaged with the intermediate shaft for transferring the rotary motion to the charging shaft via the intermediate shaft. In such embodiments, the protrusion pushes the follower plate along a longitudinal axis when the first spring is compressed, such that the drive shaft is disengaged from the intermediate shaft to discontinue transferring of the rotary motion to the charging shaft.

[0008] In accordance to embodiments of the present invention, the protrusion formed in the cam disc, and the follower plate of the drive mechanism are able to disengage the intermediate shaft from the drive shaft when the charging shaft is completely charged, thereby discontinuing the transfer of the rotary motion from the drive shaft to the charging shaft. Accordingly, the present invention may not require to have the special subassembly having components, such as the freewheel, and the transport lever and cam mechanism (i.e., a ratchet and pawl mechanism) to disengage the gear wheels. Thus, the drive mechanism of the present invention has a simple design, because it employs less components and is additionally cost effective.

[0009] In one embodiment, the drive mechanism includes a first wheel mounted spaced apart from the cam disc on the charging shaft, wherein the first wheel includes a first rim having teeth thereon. The intermediate shaft includes an end portion having splines thereon, wherein the teeth of the first wheel are engaged with the splines of the intermediate shaft to transfer the rotary motion from the intermediate shaft to the charging shaft.

[0010] In one embodiment, the drive mechanism further includes a second wheel mounted spaced apart from the follower plate on the intermediate shaft, wherein the second wheel includes a second rim having teeth thereon. In such embodiments, the drive mechanism further includes a sprocket mounted on the drive shaft, wherein the teeth of the second wheel are engaged with the sprocket to transfer the rotary motion from the drive shaft to the charging shaft via the intermediate shaft.

[0011] In one embodiment, the charging shaft includes a crankshaft disposed at an end portion of the charging shaft to enable the crankshaft to convert the rotary motion of the charging shaft into a linear motion of a tie rod coupled to the first spring, thereby enabling the tie rod to charge (i.e., compress) the first spring.

[0012] In one embodiment, the follower plate is positioned downstream relative to the cam disc, and coupled to a second spring mounted at an end portion of the intermediate shaft. In such embodiments, after the charging shaft rotates about 180 degrees to charge the first spring, the protrusion pushes the follower plate along the longitudinal axis such that the second spring is com-

pressed by a linear motion of the intermediate shaft to disengage the intermediate shaft from the drive shaft, thereby discontinuing the transfer of the rotary motion to the charging shaft. Further, in such embodiments, the second spring gets uncompressed to push back the follower plate along the longitudinal axis when the first spring is uncompressed, such that the linear motion of the intermediate shaft re-engages the second wheel with the drive shaft, thereby restoring the transfer of the rotary motion to the charging shaft.

[0013] In one embodiment, the drive shaft is driven by a motor drive mechanism to generate the rotary motion. Further, the charging shaft rotates about 180 degrees to compress the first spring.

[0014] The above-mentioned and other features of the invention will now be addressed with reference to the accompanying drawings of the present invention. The illustrated embodiments are intended to illustrate, but not limit the present invention. The drawings contain the following figures, in which like numbers refer to like parts, throughout the description and drawings.

FIG. 1 is a schematic diagram depicting an exemplary drive mechanism;

FIG. 2 is a schematic diagram of a cam disc of the drive mechanism of FIG. 1;

FIG. 3 is a schematic diagram of a follower plate of the drive mechanism of FIG. 1;

FIG. 4 is a schematic diagram depicting a front view of the drive mechanism of FIG. 1, with a first spring in discharged state;

FIG. 5 is a schematic diagram depicting a side view of the drive mechanism of FIG. 4;

FIG. 6 is a schematic diagram depicting a front view of the drive mechanism of FIG. 1, with the spring in charged state;

FIG. 7 is a schematic diagram depicting a side view of the drive mechanism of FIG. 6;

FIG. 8 is a schematic diagram depicting a circuit breaker having the drive mechanism of FIGs. 1-7; and

FIG. 9 is a flow chart illustrating a method of charging a spring of a switchgear, in accordance with aspects of the present technique.

[0015] Embodiments of the present invention relate to a drive mechanism (10) for switchgear, such as but not limited to gas insulated switchgear. The exemplary drive mechanism (10) may also be used in circuit breakers, such as but not limited to a high voltage circuit breaker or a medium voltage circuit breaker. Typically, these circuit breakers are employed in switchgears as mentioned above. Referring to FIG. 1, the drive mechanism (10) for switchgear and particularly for a circuit breaker is depicted. The drive mechanism (10) includes a charging shaft (12), an intermediate shaft (14), a drive shaft (16), a cam disc (18), and a follower plate (20). The drive mechanism (10) further includes a first wheel (22), a second wheel (24), a first spring (26), a second spring (28), a tie rod (30), a crankshaft (32), a motor drive mechanism (34), a bevel gear wheel (36), and a sprocket (38). It should be noted herein, that the first spring (26) may also be referred to as a "closing spring" or "charging spring".

[0016] The illustrated embodiment of FIG. 1, further includes a trip spring (40) configured to open main contacts (not shown) of the circuit breaker in an event of overload or short circuit condition, for interrupting power supply to an electrical circuit (not shown). In one or more embodiments, the closing spring (26) is configured to close the main contacts for restoring the power supply to the electrical circuit. Particularly, the closing spring (26) is used to store the energy and later release the stored energy to close the main contacts and simultaneously charge (or store energy in) the trip spring (40). In such embodiments, upon overload or short circuit condition, the trip spring (40) is used to release the stored energy for opening the main contacts, thereby interrupting the power supply to the electrical circuit. The function of the closing spring (26) and the trip spring (40) are discussed in greater detailed below.

[0017] In the presently contemplated configuration, the charging shaft (12), the intermediate shaft (14), and the drive shaft (16) are disposed parallel to each other. Particularly, the charging shaft (12), the intermediate shaft (14), and the drive shaft (16) are disposed spaced apart from each other along a radial axis (1).

[0018] In one embodiment of the present invention, the charging shaft (12) is a cylindrical component having a first end portion (42, refer to FIG. 5) and a second end portion (44). In such an embodiment, the cam disc (18), the first wheel (22), and the crankshaft (32) are mounted spaced apart from each other on the charging shaft (12) between the first and second end portions (42, 44). Particularly, the first wheel (22) is mounted at the first end portion (42) of the charging shaft (12). More particularly, the first wheel (22) is mounted on a bearing (46) disposed at the first end portion (42) of the charging shaft (12). The crankshaft (32) is mounted at the second end portion (44) of the charging shaft (12). Particularly, the second end portion (44) of the charging shaft (12) is coupled to the first spring (26) via the tie bar (30) and the crankshaft (32). In the illustrated embodiment, the tie bar (30) has a detent (46) and the first spring (26) bears on the detent (46). The cam disc (18) is mounted directly on the charging shaft (12). Particularly, the cam disc (18) is splined to the charging shaft (12) and positioned between the first wheel (22) and the crankshaft (32). The first wheel (22) includes a first rim (48) having teeth (50) thereon.

The cam disc (18) includes a protrusion (52) extending outwardly from a peripheral portion (54) of the cam disc (18). The cam disc (18) is discussed in greater details below.

[0019] Further, the intermediate shaft (14) is also a cylindrical component having a first end portion (56) and a second end portion (58). The first end portion (56) has splines (60) thereon and the second end portion (58) includes the second spring (28) mounted thereon. In such an embodiment, the follower plate (20) and the second wheel (24) are mounted spaced apart from each other on the intermediate shaft (14) between the first and second end portions (54, 56). Particularly, the follower plate (20) is coupled to the second spring (28) mounted at the second end portion (56) of the intermediate shaft (14). More particularly, the second spring (28) is further coupled to a detent (62) attached to a bearing (64) located at the second end portion (56). In the illustrated embodiment, the follower plate (20) mounted on the intermediate shaft (14), is positioned downstream relative to the cam disc (18) mounted on the charging shaft (12). The second wheel (24) includes a second rim (66) having teeth (68) thereon. The follower plate (20) is discussed in greater details below.

[0020] Similar to the charging shaft (12) and the intermediate shaft (14), the drive shaft (16) is also a cylindrical component having a first end portion (74) and a second end portion (76). In such an embodiment, the bevel gear wheel (36) and the sprocket (38) are mounted spaced apart from each other on the drive shaft (16) between the first and second end portions (74, 76) of the dive shaft (16).

[0021] In one or more embodiments, the motor drive mechanism (34) includes a motor (not shown) and gear subsystems (78) drivably engaged to the motor. The motor drive mechanism (34) is selectively driven by electric power to generate a rotary motion (70). Particularly, the motor drive mechanism (34) drives the drive shaft (16) to generate the rotary motion (70). More particularly, at least one gear in the gear subsystems (78) of the motor drive mechanism (34), is engaged with the bevel gear wheel (36) for driving the drive shaft (16). Further, the drive shaft (16) is engaged with the intermediate shaft (14) for transferring the rotary motion (70) to the intermediate shaft (14). Particularly, the sprocket (38) mounted on the drive shaft (16) is engaged with the teeth (68) of the second wheel (24) for transferring the rotary motion (70) to the intermediate shaft (14). Further, the intermediate shaft (14) is engaged with the charging shaft (12) for transferring the rotary motion (70) to the charging shaft (12). Particularly, the teeth (50) of the first wheel (22) are engaged with the splines (60) of the intermediate shaft (12) for transferring the rotary motion (70) to the charging shaft (12). In such embodiments, the first spring (26) is compressed (charged) by the rotary motion (70) of the charging shaft (12). More particularly, the crankshaft (32) coupled to the charging shaft (12), converts the rotary motion (70) of the charging shaft (12) into a linear motion (72) of the tie bar (30) to compress or charge the first spring (26). In some embodiments, the charging shaft (12) rotates about 180 degrees to compress the first spring (26). In such an embodiment, the protrusion (52) pushes the follower plate (20) along a longitudinal axis (2) when the first spring (26) is compressed, such that the drive shaft (16) is disengaged from the intermediate shaft (14) to discontinue transferring of the rotary motion (70) to the charging shaft (12). Thus, the drive mechanism (10) of the present invention, discontinues the transmission of the rotary motion (70) from the drive shaft (16) to the charging shaft (12), when the first spring (26) is compressed, thereby avoiding the first spring (26) getting into a solid-state condition.

[0022] Referring now to FIG. 2, the cam disc (18) includes a first end portion (80), a second end portion (82), and a through-hole (84) extending there between the first and second end portions (80, 82). In the illustrated embodiment of FIG. 2, the through-hole (84) has splines (86) thereon, where the splines slidably engages with counter splines (not shown) formed on the charging shaft (12). Thus, the splined attachment secures the cam disc (18) to the charging shaft (12). Further, the splined attachment of the cam disc (18) to the charging shaft (12) may only allow the cam disc (18) to rotate and prevent the cam disc (18) to move laterally along the longitudinal axis (2). It should be noted herein that the second end portion (82) of the cam disc (18) may also be referred to as a "peripheral portion of the cam disc". In one embodiment, the cam disc (18) further includes a protrusion (52) extending outwardly from the peripheral portion (54, 82) of the cam disc (18) along the longitudinal axis (2). In one embodiment, the protrusion (52) extends outwardly only from a half portion of the cam disc (18). In the presently contemplated configuration, the protrusion (52) has a "tongue" shaped profile. In some other embodiments, the protrusion (52) may have different profiles, depending on the design requirement. Further, the protrusion (52) includes an extended portion (52a) at a radial end section (88) of the protrusion (52). During operation of the drive mechanism (10), the extended portion (52a) of the protrusion (52) may push the follower plate (20, as shown in FIG. 1) along the longitudinal axis (2). It should be noted herein, that the cam disc (18) can be manufactured by the casting or forging or machining process. In such embodiments, the surface of the cam disc (18) may be case hardened or surface hardened.

[0023] Referring now to FIG. 3, the follower plate (20) includes a first end portion (90), a second end portion (92), and a through-hole (94) located at a center of the follower plate (20) and extending there between the first and second end portions (90, 92). In one embodiment, the follower plate (20) is a flat and round shaped component, which is friction fitted to the intermediate shaft (16, as shown in FIG. 1). In some other embodiments, the follower plate (20) may be welded or brazed to the intermediate shaft (16), depending on the design requirement. The first end portion (90) of the follower plate (20)

has a fillet edge (20a) to engage with the extended portion (52a, as shown in FIG. 2) of the cam disc (18) for getting pushed along the longitudinal axis (2). Further, the second end portion (92) of the follower plate (2) includes a circular groove (not shown) for receiving and coupling the second spring (28, as shown in FIG. 1) to the follower plate (20). Similar to the cam disc (18), the follower plate (20) can be manufactured by the casting or forging or machining process. In such embodiments, the surface of the follower plate may be case hardened or surface hardened.

[0024] Referring now to FIGS. 4 and 5, the drive mechanism (10) with the first spring (26, as shown in FIG. 1) in discharged or uncompressed condition is depicted. It should be noted herein that the embodiments of FIGS. 4 and 5 do not depict the first spring (26) for ease of illustration purpose only and such an illustration should not be construed as a limitation of the present invention. In FIG. 4 the front view of the drive mechanism (10) is depicted and in FIG. 5, the side view of the drive mechanism (10) is depicted, along with various components, such as, a charging shaft (12), an intermediate shaft (14), a drive shaft (16), a cam disc (18), and a follower plate (20). FIGS. 4 and 5 further depicts a first wheel (22), a second wheel (24), a first spring (26), a second spring (28), a tie rod (30), a crankshaft (32), a motor drive mechanism (34), a bevel gear wheel (36), and a sprocket (38).

[0025] As previously noted, the first wheel (12) is mounted at the first end portion (42) of the charging shaft (12) and the second end portion (44) of the charging shaft (12) is connected to the first spring (26) via the tie bar (30) and the crankshaft (32). The cam disc (18) is splined to the charging shaft (12) and disposed there between the first wheel (22) and the crankshaft (32). The follower plate (20) is friction fitted to the intermediate shaft (14) and the second wheel (24) is splined to the intermediate shaft (14). As previously noted, the follower plate (20) is positioned downstream relative to the cam disc (18). The first end portion (56) of the intermediate shaft (14) has splines (60) thereon. Further, the second end portion (58) of the intermediate shaft (14) has the second spring (28) mounted thereon and coupled to the second end portion (92) of the follower plate (20) and the detent (62) attached to the bearing (64). The sprocket (38) and the bevel gear wheel (36) are mounted on the drive shaft (16). In such an configuration, during the discharged or uncharged condition of the first spring (26), the motor drive mechanism (34) is engaged with the bevel gear wheel (36), the sprocket (38) are engaged with the teeth of the second wheel (24), and the splines (60) are engaged with the teeth of the first wheel (22). Such an arrangement of the drive mechanism (10) is ready for transferring the rotary motion (70) from the drive shaft (16) to the charging shaft (12) via the intermediate shaft (14).

[0026] As depicted in FIG. 4, the protrusion (52) in the cam disc (18) is at a first position (96), which is at an angle "α" from an axis "X" of the protrusion (52) to a vertical axis "Y". In some embodiments, the angle "α" is about 5 degrees to about 10 degrees. The first spring (26) is generally precompressed, resulting in the small deviation of cam disc (18) from the vertical axis "Y" during the discharged condition. Further, as depicted in FIG. 5, during the discharged or uncharged condition of the first spring (26), the crankshaft (32) is at a bottom dead center position (98). Further, the second spring (28) is also under uncompressed or uncharged condition.

[0027] During operation of the drive mechanism (10) to charge or compress the first spring (26) from the discharged or uncompressed condition, the motor drive mechanism (34) drives the drive shaft (16) as the motor is switched on, to generate a rotary motion (70). As previously noted, the sprocket (38) is continuously engaged with the second wheel (24) to transfer the rotary motion (70) from the drive shaft (16) to the intermediate shaft (14). Further, the splines (60) is continuously engaged with the first wheel (22) to transfer the rotary motion (70) from the intermediate shaft (14) to the charging shaft (12). Hence, as the drive shaft (16) rotates, the charging shaft (12) is also rotated via the intermediate shaft (14), which causes the first spring (26) to compress or charge via the tie rod (30) connected to the crankshaft (32) mounted/ coupled to the charging shaft (12).

[0028] Referring now to FIGS. 6 and 7, the drive mechanism (10) with the first spring (26, as shown in FIG. 1) in charged or compressed condition is depicted. It should be noted herein that all components represented in FIGS. 6 and 7 are substantially similar to the components represented/ discussed in FIGS. 4 and 5 respectively. Accordingly, the like/ similar components in FIGS. 4 and 6, and FIGS. 5 and 7 carry the same reference numerals.

[0029] During operation of the drive mechanism (10), to charge or compress the first spring (26) from the discharged or uncompressed condition, the charging shaft (12) is rotated by the transfer of the rotary motion (70) from the drive shaft (16) via the intermediate shaft (14). It should be noted herein that the charging shaft (12) is rotated along a clockwise direction, as indicated by reference numeral (70). As the charging shaft (12) rotates, the crankshaft (32) and the cam disc (18) are also rotated along with the charging shaft (12). Thus, the crankshaft (32) coupled to the second end of the charging shaft (12), converts the rotary motion (70) of the charging shaft (12) into a linear motion (72) of the tie rod (30), thereby compressing or charging the first spring (26). Particularly, as depicted in FIG. 7, the crankshaft (32) reaches a top dead center position (98a), while converting the rotary motion (70) of the charging shaft (12) into the linear motion (72) of tie rod (30) along the radial direction (1), thereby compressing the first spring (26). In such an embodiment, the protrusion (52) in the cam disc (18) also simultaneously passes the vertical axis "Y" and reaches a second position (96a), which is at an angle "β" from the axis "X" of the protrusion (52) to the vertical axis "Y". In some embodiments, the angle "β" is about 5 degrees to about 10 degrees. In such embodiments, while the first spring (26) is getting charged, the protrusion (52) in the cam

disc (18) rotates to reach the second position (96a). Thus, the protrusion (52) pushes the follower plate (20) along the longitudinal axis (2) for disengaging the drive shaft (16) from the intermediate shaft (14), thereby discontinuing transfer of the rotary motion (70) from the drive shaft (16) to the charging shaft (12). particularly, the protrusion (52) pushes the follower plate (20) along the longitudinal axis (2) such that the second spring (28) is compressed by a linear motion of the intermediate shaft (14) along the longitudinal axis (2), which results in disengaging the second wheel (24) from the sprocket (38) to discontinue transferring the rotary motion (70) to the charging shaft (12). Such an arrangement of the drive mechanism (10) may not require to have the special subassembly having components, such as the freewheel, and transport lever and cam mechanism (i.e., a ratchet and pawl mechanism) to disengage the gear wheels to stop the charging of the first spring (28) when it is fully compressed. Thus, the drive mechanism (10) of the present invention has a simple design, because it employs less components and is additionally cost effective.

[0030] Additionally, when the close command is provided to the first spring or the closing spring (26), it releases the stored energy to close main contacts (not shown) for restoring power supply to an electrical circuit, and simultaneously charging (or store energy in) the trip spring (40, as shown in FIG. 1). During such an event, the second spring (28) gets uncompressed to push back the follower plate (20) along the longitudinal axis (2) when the first spring (26) is uncompressed, such that the linear motion of the intermediate shaft (14) re-engages the second wheel (24) with the sprocket (38) of the drive shaft (16) to restore transferring the rotary motion (70) to the charging shaft (12).

[0031] Referring now to FIG. 8, a circuit breaker (100) having a drive mechanism (10) is depicted. The circuit breaker (100) may be a high voltage circuit breaker or a medium voltage circuit breaker. It should be noted herein that the drive mechanism (10) as discussed in embodiments of FIGS. 1-7 are used in such circuit breaker (100) for switching. In some embodiments, such circuit breaker (100) may be deployed in a switchgear, such as a gas insulated switchgear.

[0032] In the illustrated embodiment, the circuit breaker (100) is mounted on pillars (102) and has three pole columns (A, B, and C) coupled to top of a base component (104), and a control cabinet (106) fastened to bottom of the base component (104). Each of the three pole columns (A, B, and C) includes an interrupter (108) and a support column (110). In some embodiments, the support column (110) may also be referred to as a "post insulator". The drive mechanism (10) is disposed within the control cabinet (106). Further, the circuit breaker (100) may additionally include a mounting plate (112) integrated in the control cabinet (106) and containing equipment's for controlling and monitoring of the circuit breaker (100). Further, the mounting plate (112) may include terminal blocks required for electrical connections to the circuit breaker (100). The pole columns (A, B, and C) may be filled with SF6 for arc-quenching and insulating purposes. Further, the three pole columns (A, B, and C) may be connected by tubes to a gas compartment. The gas density is monitored by a density monitor (not shown) and the pressure can be displayed by a pressure gauge or a pressure display on the density monitor. Each of the pole columns (A, B, and C) are actuated by the drive mechanism (10) to close main contacts located within the interrupter unit (108) of the respective pole columns (A, B, and C). Particularly, the pole column (B) is actuated by the drive mechanism (10) via a corner gear (not shown) and is connected with the corner gears of the pole columns (A and C) by means of coupling rods (not shown). As discussed, in the embodiments of FIGS. 1-7, the energy required for switching the circuit breaker (100) is stored in a closing spring (26), which is common to all three pole columns (A, B, and C) and a trip spring (28).

[0033] During operation of the circuit breaker (100), the closing spring (26) is charged (compressed) by the charging shaft (12) by using the rotary motion generated by a motor drive mechanism (34). At the end of charging operation of the first spring (26), the drive shaft (16) is disengaged from the charging shaft (12) and a closing latch (not shown) holds the first spring (26) to keep it in charged condition. The closing spring (26) is now ready for the closing operation of main contacts for establishing/ restoring power supply to an electrical circuit.

[0034] The closing latch is released based on control signal issued from the control equipment's, thus the energy stored in closing spring (26) is transferred to the trip spring (40) via some interconnected components, thereby charging the trip spring (40). An opening latch interconnected to the trip spring (40) holds the trip spring (40) in charged condition. In the process, the movement of the interconnected components actuates the corner gear of the center pole column (B) and corner gears of other two pole columns (A and C) by means of the coupling linkage. At the same time, the main contacts of each of the interrupter unit (108) are closed. Thus, the circuit breaker (100) establish/ restore the power supply to the electrical circuit.

[0035] The closing spring (26) is then charged again using the drive mechanism (10) to store the energy and keep the first spring (26) ready for closing operation. During an overload or short circuit condition, the opening latch is released automatically, thereby allowing the trip spring (40) to separate the main contacts of each interrupter unit (108). Thus, interrupting the power supply to the electrical circuit.

[0036] Now referring to FIG. 9, a method (200) of charging a switchgear, particularly, a circuit breaker using a drive mechanism is depicted. The method (200) includes a step (202) of transferring a rotary motion from a drive shaft to a charging shaft via an intermediate shaft. In such embodiments, the drive shaft, intermediate shaft, and the charging shaft are disposed parallel to each other. The intermediate shaft is engaged with the drive shaft

and the charging shaft. Where the drive mechanism includes a cam disc mounted on the charging shaft and a follower plate mounted on the intermediate shaft. The cam disc includes a protrusion extending outwardly from a peripheral portion of the cam disc. In one or more embodiments, the step (202) of transferring the rotary motion from the drive shaft to the charging shaft includes rotating the charging shaft about 180 degrees for compressing the first spring.

[0037] The method (200) further includes a step (204) of compressing a first spring coupled to the charging shaft by converting the rotary motion of the charging shaft into a linear motion of a tie rod via a crankshaft mounted at an end portion of the charging shaft. Further, the method (200) includes a step (206) of pushing the follower plate along a longitudinal axis via the protrusion for disengaging the drive shaft from the intermediate shaft when the first spring is compressed, so as to discontinue transferring the rotary motion from the drive shaft to the charging shaft.

[0038] In one or more embodiments, the step (204) of pushing the follower plate includes compressing a second spring by a linear motion of the intermediate shaft, where the follower plate is coupled to the second spring disposed at an end portion of the intermediate shaft. The method (200) may further include a step of uncompressing the second spring to push back the follower plate along the longitudinal direction when the first spring is uncompressed, such that the linear motion of the intermediate shaft re-engages the intermediate shaft with the drive shaft to restore transferring the rotary motion to the charging shaft.

[0039] In accordance to one or more embodiments of the present invention, the protrusion of the cam disc, and the follower plate of the drive mechanism are configured to disengage the intermediate shaft from the drive shaft when the charging shaft is completely charged, thereby discontinuing the transfer of the rotary motion from the drive shaft to the charging shaft. Accordingly, the present invention may not require to have a special subassembly having components, such as the freewheel, and transport lever and cam mechanism (i.e., a ratchet and pawl mechanism) to disengage the gear wheels. Thus, the drive mechanism of the present invention has a simple design, because it employs less components and is additionally cost effective.

[0040] While the present disclosure has been described in detail with reference to certain embodiments, it should be appreciated that the present disclosure is not limited to those embodiments. In view of the present disclosure, many modifications and variations would be present themselves, to those skilled in the art without departing from the scope of the various embodiments of the present disclosure, as described herein. The scope of the present disclosure is, therefore, indicated by the following claims rather than by the foregoing description. All changes, modifications, and variations coming within the meaning and range of equivalency of the claims are to be considered within their scope.

Component list

[0041]

10 - Drive mechanism;
12 - charging shaft;
14 - intermediate shaft;
16 - drive shaft;
18 - cam disc;
20 - follower plate;
22 - first wheel;
24 - second wheel;
26 - first spring;
28 - second spring;
30 - tie rod;
32 - crankshaft;
34 - motor drive mechanism;
36 - bevel gear wheel;
38 - sprocket;
40 - trip spring;
42 - first end portion of charging shaft;
44 - second end portion of charging shaft;
46 - bearing;
48 - first rim of first wheel;
50 - teeth of first rim;
52 - protrusion of cam disc;
54 - peripheral portion of the cam disc;
56 - first end portion of intermediate shaft;
58 - second end portion of intermediate shaft;
60 - splines;
62 - detent;
64 - bearing;
66 - second rim of second wheel;
68 - teeth of second rim;
70 - rotary motion;
72 - linear motion;
74 - first end portion of drive shaft;
76 - second end portion of drive shaft;
78 - gear subsystems;
80 - first end portion of cam disc;
82 - second end portions of cam disc;
84 - through-hole of the cam disc;
86 - splines of the cam disc;
88 - radial end section of the protrusion;
90 - first end portion of follower plate;
92 - second end portion of follower plate;
94 - through-hole of the follower plate;
96 - first position of the protrusion;
96a - second position of the protrusion
98 - bottom dead center position of the crankshaft;
98a - top dead center position of the crankshaft;
100 - circuit breaker;
102 - pillars;
104 - base component;
106 - control cabinet;
108 - interrupter;

110 - support column;
112 - mounting plate;
A, B, C - pole columns;
2 - longitudinal axis;
1 - radial axis;
200 - method;
202 - transferring a rotary motion from a drive shaft to a charging shaft via an intermediate shaft;
204 - compressing a first spring coupled to the charging shaft by converting the rotary motion of the charging shaft into a linear motion of a tie rod via a crankshaft mounted at an end portion of the charging shaft;
206 - pushing the follower plate along a longitudinal axis via the protrusion for disengaging the drive shaft from the intermediate shaft when the first spring is compressed, so as to discontinue transferring the rotary motion from the drive shaft to the charging shaft.

Claims

1. A drive mechanism (10) for charging a switchgear (100), comprising:

a cam disc (18) comprising a protrusion (52) extending outwardly from a peripheral portion (54) of the cam disc (52) ;
a charging shaft (12) coupled to a first spring (26) such that the first spring (26) is compressed by a rotary motion (70) of the charging shaft (12), wherein the cam disc (18) is mounted on the charging shaft (12);
a follower plate (20);
an intermediate shaft (14) positioned parallel to the charging shaft (12), wherein the intermediate shaft (14) is engaged with the charging shaft (12) for transferring the rotary motion (70) to the charging shaft (12), wherein the follower plate (20) is mounted on the intermediate shaft (14); and
a drive shaft (16) positioned parallel to the intermediate shaft (14), wherein the drive shaft (16) is engaged with the intermediate shaft (14) for transferring the rotary motion (70) to the charging shaft (12) via the intermediate shaft (14), wherein the protrusion (52) pushes the follower plate (20) along a longitudinal axis (2) when the first spring (26) is compressed, such that the drive shaft (16) is disengaged from the intermediate shaft (14) to discontinue transferring of the rotary motion (70) to the charging shaft (12).

2. The drive mechanism (10) according to claim 1, further comprising a first wheel (22) mounted spaced apart from the cam disc (18) on the charging shaft (12), wherein the first wheel (22) comprises a first rim (48) having teeth (50) thereon, wherein the first wheel (22) is mounted on a bearing (46) disposed at a first end portion (42) of the charging shaft (12).

3. The drive mechanism (10) according to claim 2, wherein the charging shaft (12) is coupled to the first spring (26) via a tie bar (30) and a crankshaft (32) mounted at a second end portion (44) of the charging shaft (12).

4. The drive mechanism (10) according to claim 2, wherein the intermediate shaft (14) comprises a first end portion (56) having splines (60) thereon, wherein the teeth (50) of the first wheel (22) are engaged with the splines (60) of the intermediate shaft (14).

5. The drive mechanism (10) according to claim 4, further comprising a second wheel (24) mounted spaced apart from the follower plate (20) on the intermediate shaft (14), wherein the second wheel (24) comprises a second rim (66) having teeth (68) thereon.

6. The drive mechanism (10) according to claim 5, further comprising a sprocket (38) mounted on the drive shaft (16), wherein the teeth (68) of the second wheel (24) are engaged with the sprocket (38).

7. The drive mechanism (10) according to claim 5, wherein the follower plate (20) is positioned downstream relative to the cam disc (18), and coupled to a second spring (28) mounted at a second end portion (58) of the intermediate shaft (14).

8. The drive mechanism (10) according to claim 7, wherein the protrusion (52) pushes the follower plate (20) along the longitudinal axis (2) such that the second spring (28) is compressed by a linear motion (72) of the intermediate shaft (14) .

9. The drive mechanism (10) according to claim 8, wherein the second spring (28) gets uncompressed to push back the follower plate (20) along the longitudinal axis (2) when the first spring (26) is uncompressed, such that the linear motion (72) of the intermediate shaft (14) re-engages the second wheel (24) with the drive shaft (16) to restore transferring the rotary motion (70) to the charging shaft (12) .

10. The drive mechanism (10) according to claim 1, wherein the drive shaft (16) is driven by a motor drive mechanism (34) to generate the rotary motion (70).

11. The drive mechanism (10) according to claim 1, wherein the charging shaft (12) rotates about 180 degrees to compress the first spring (26).

12. A method (200) of charging a switchgear (100) using a drive mechanism (10), comprising:

transferring (202) a rotary motion (70) from a drive shaft (16) to a charging shaft (12) via an intermediate shaft (14) ;
wherein the drive shaft (16), intermediate shaft (14), and the charging shaft (12) are disposed parallel to each other, wherein the intermediate shaft (14) is engaged with the drive shaft (16) and the charging shaft (12), wherein the drive mechanism (10) comprises a cam disc (18) mounted on the charging shaft (12) and a follower plate (20) mounted on the intermediate shaft (14), and wherein the cam disc (18) comprises a protrusion (52) extending outwardly from a peripheral portion (54) of the cam disc (18);
compressing (204) a first spring (26) coupled to the charging shaft (12) by converting the rotary motion (70) of the charging shaft (12) into a linear motion (72) of a tie rod (30) via a crankshaft (32) mounted at an end portion (44) of the charging shaft (12); and
pushing (206) the follower plate (20) along a longitudinal axis (2) via the protrusion (52) for disengaging the drive shaft (16) from the intermediate shaft (14) when the first spring (26) is compressed, so as to discontinue transferring the rotary motion (70) from the drive shaft (16) to the charging shaft (12).

13. The method (200) according to claim 12, wherein pushing (206) the follower plate (20) comprises compressing a second spring (28) by a linear motion (72) of the intermediate shaft (140, wherein the follower plate (20) is coupled to the second spring (28) mounted at an end portion (58) of the intermediate shaft (14).

14. The method (200) according to claim 13, further comprising uncompressing the second spring (28) to push back the follower plate (20) along the longitudinal direction (2) when the first spring (26) is uncompressed, such that the linear motion (72) of the intermediate shaft (14) re-engages the intermediate shaft (14) with the drive shaft (16) to restore transferring the rotary motion (70) to the charging shaft (120.

15. The method (200) according to claim 12, wherein transferring (202) the rotary motion from the drive shaft (16) to the charging shaft (14) comprises rotating the charging shaft (12) about 180 degrees for compressing the first spring (26).

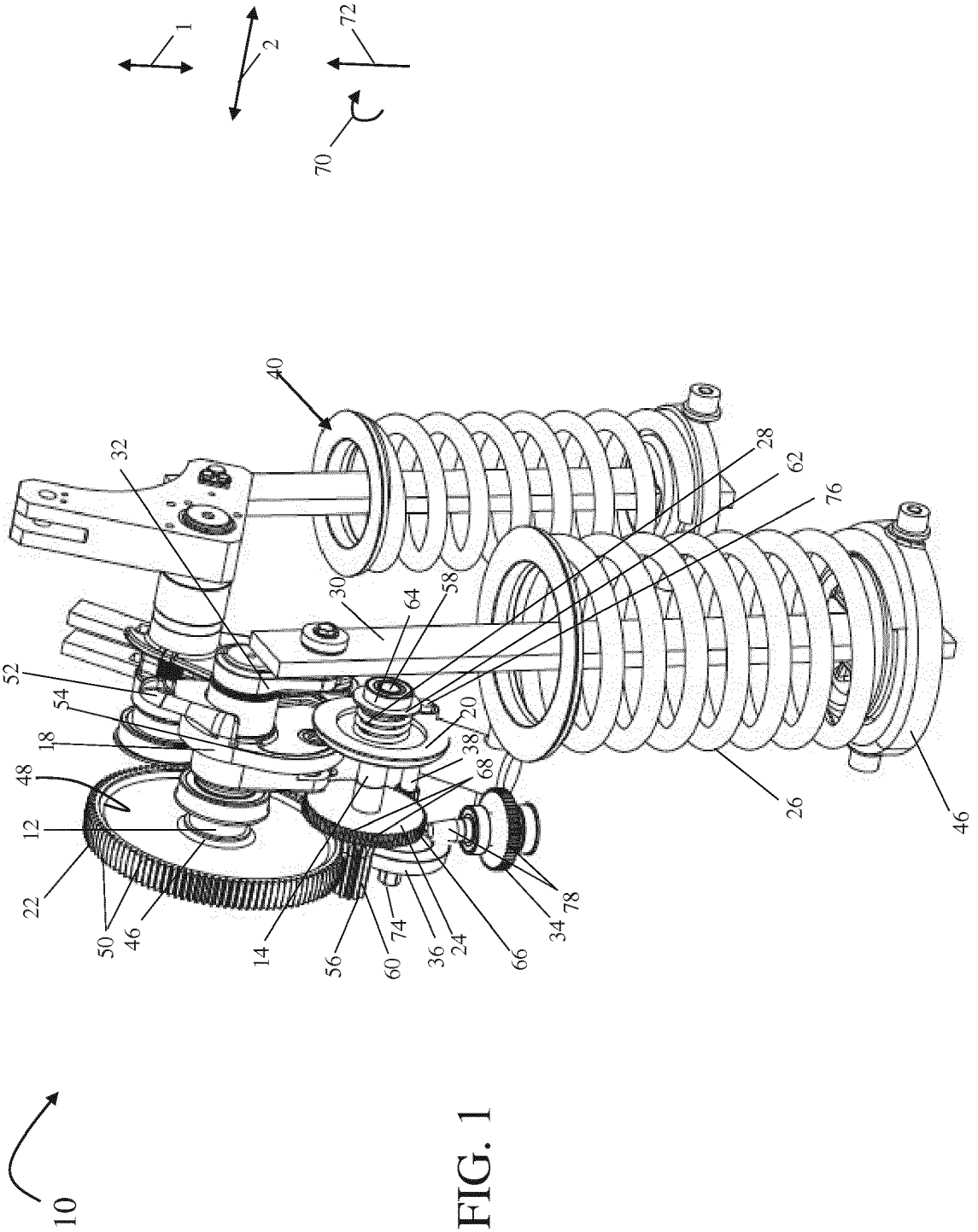
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FIG. 1

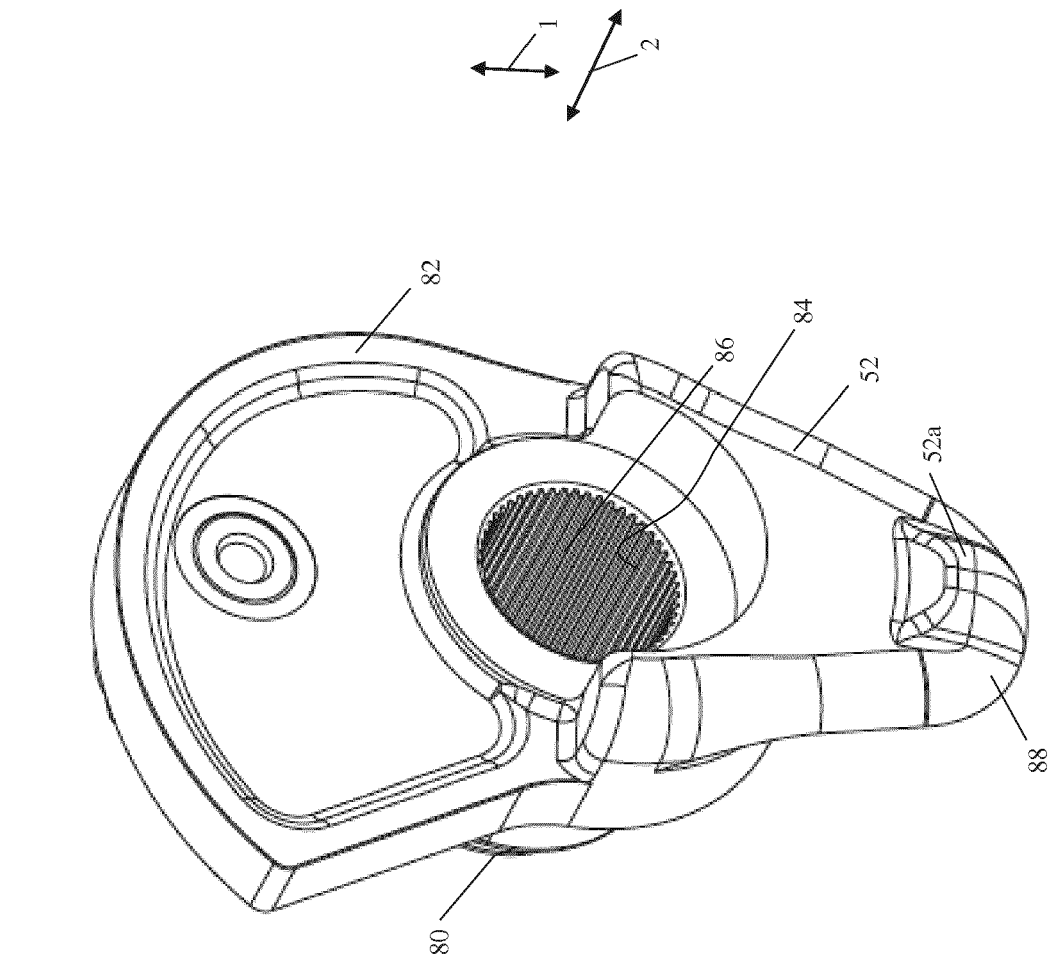

FIG. 2

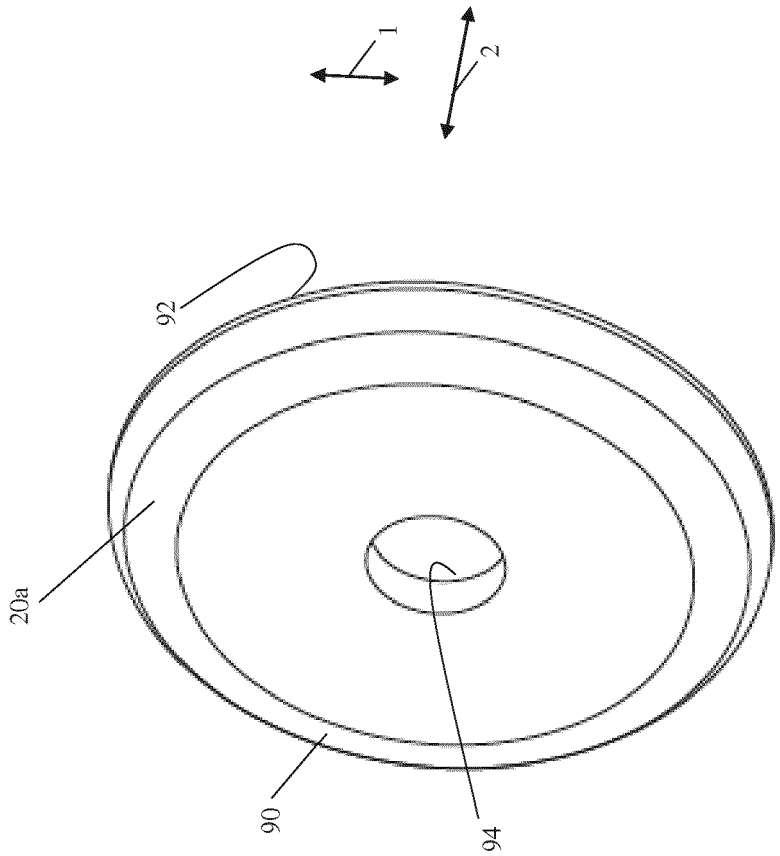

FIG. 3

FIG. 5

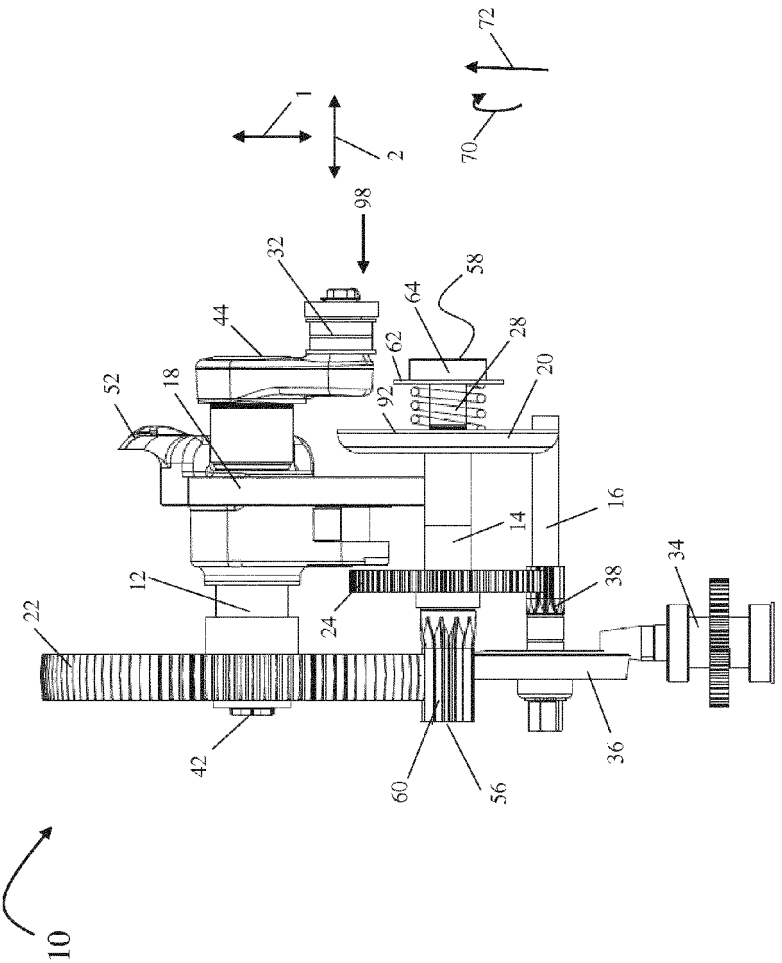
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FIG. 4

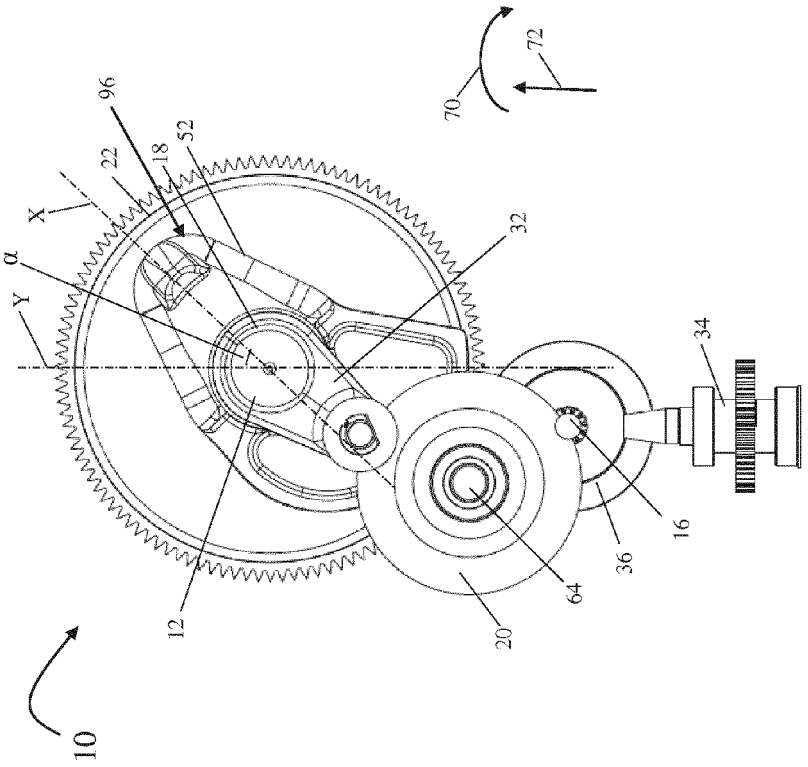
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FIG. 7

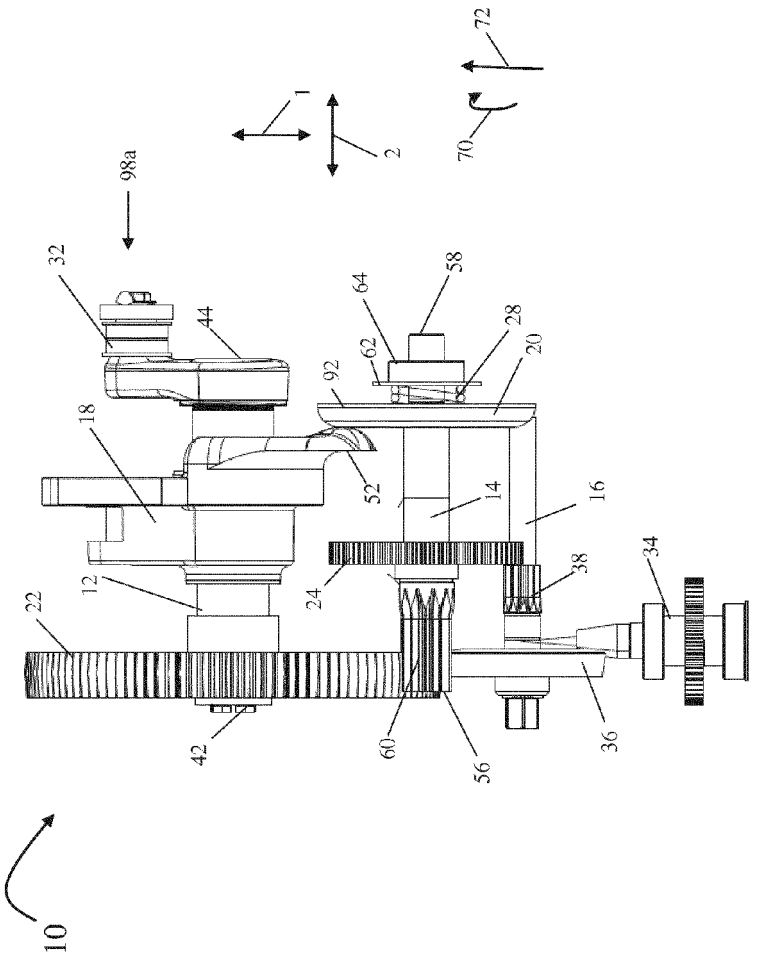
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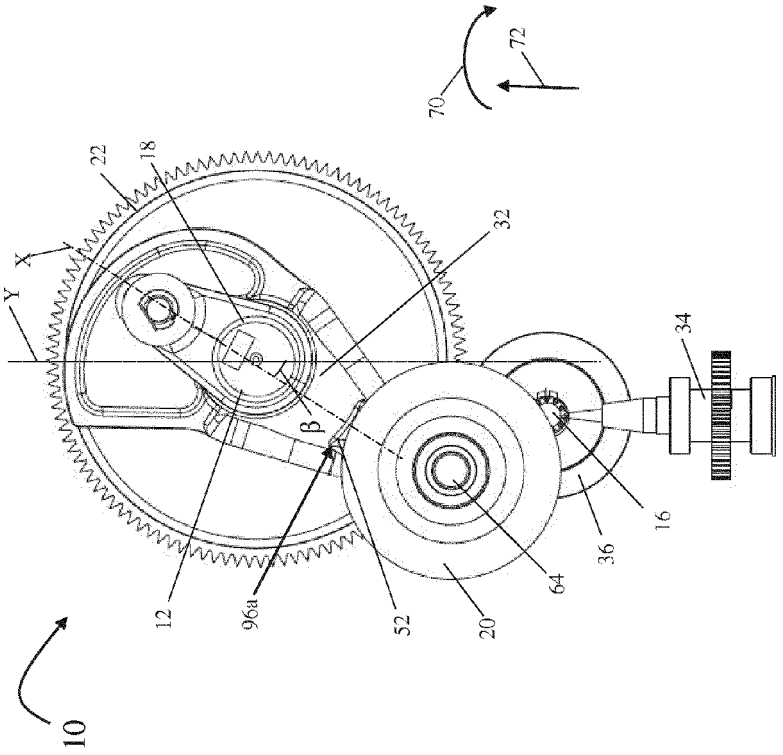
FIG. 6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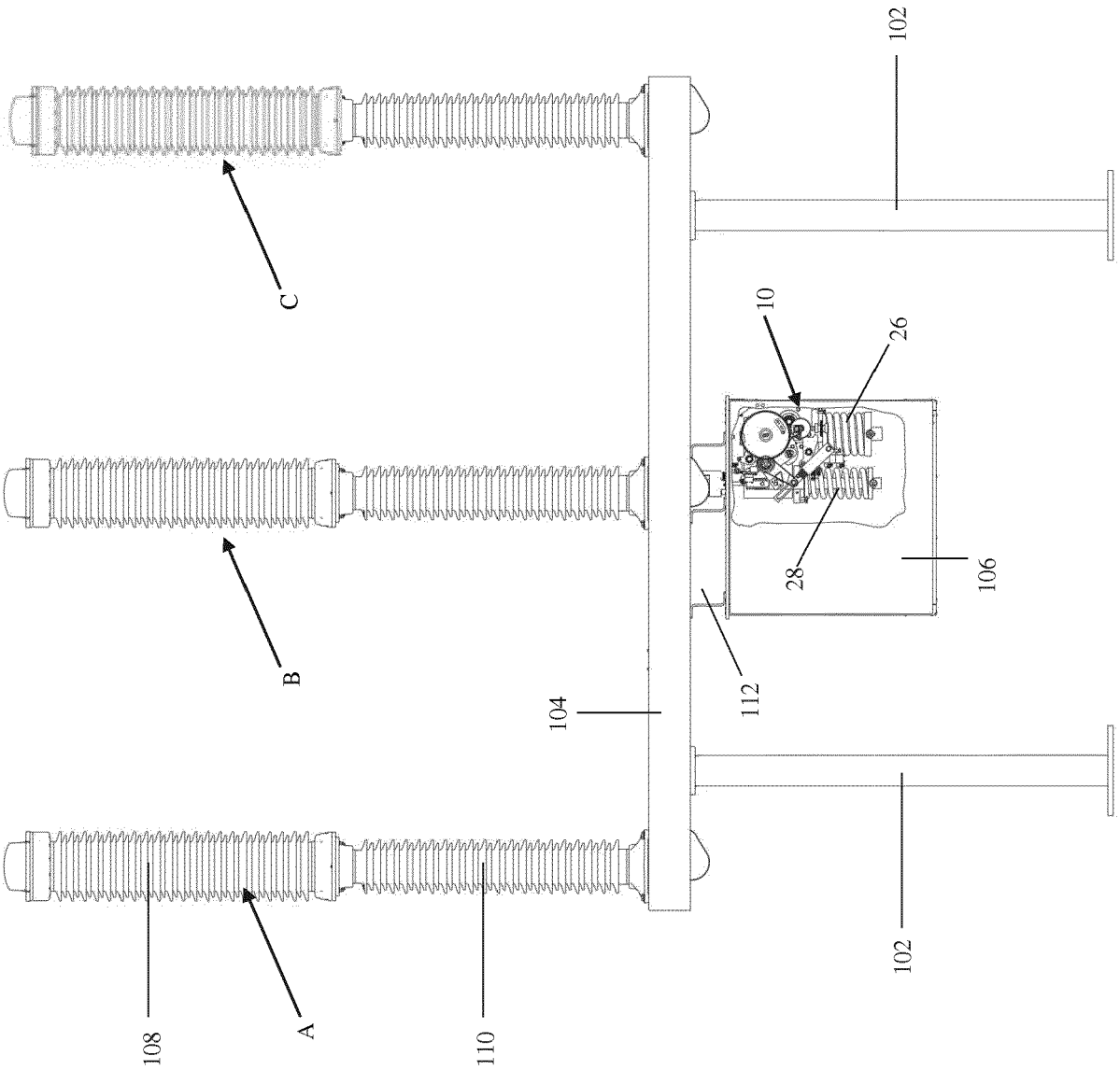
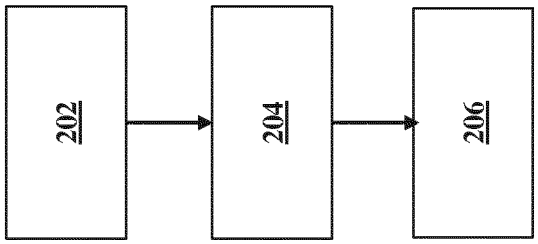


FIG. 8

FIG. 9



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EUROPEAN SEARCH REPORT

Application Number
EP 19 19 8964

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	US 5 901 838 A (NAKATANI ICHIZO [JP] ET AL) 11 May 1999 (1999-05-11) * column 6, line 24 - column 8, line 48 * * figures 1-4 * -----	1-7, 10-12,15 8,9,13, 14	INV. H01H3/30
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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	11 March 2020	Glaman, C

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11-03-2020

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