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(54) CONTROL SYSTEM FOR A SWITCH AND A SUBSTATION COMPRISING SUCH A CONTROL SYSTEM

(57) The invention relates to a control system (1) for at least a first switch. The control system (1) comprises a a control arm (10) mounted for displacement between a first and a second position in first direction (19), the control arm (10) comprising a first end (11) configured to be connected to a drive system and a second end (12) opposite the first end (11) and a first connecting arm (20) mounted for displacement along a second direction (29) that traverses the first direction (19), the first connecting arm (20) comprising a first end (21) for connection to the first switch and a second end (22) opposite to the first end. The control system further comprises at least a first sliding element (30) comprising a first track (31) and mounted for displacement in one of the first and the second directions (19, 29). The second end (12, 22) of the one of the control arm (10) or the first connecting arm (20) which is displaceable in the same direction as the first sliding element (30), is configured to engage with the first track (31) and is constrained for movement in same direction as the first sliding element (30). The second end (22, 12) of the other of the control arm (10) and the first connecting arm (20) is arranged to move integrally with the first sliding element (30).

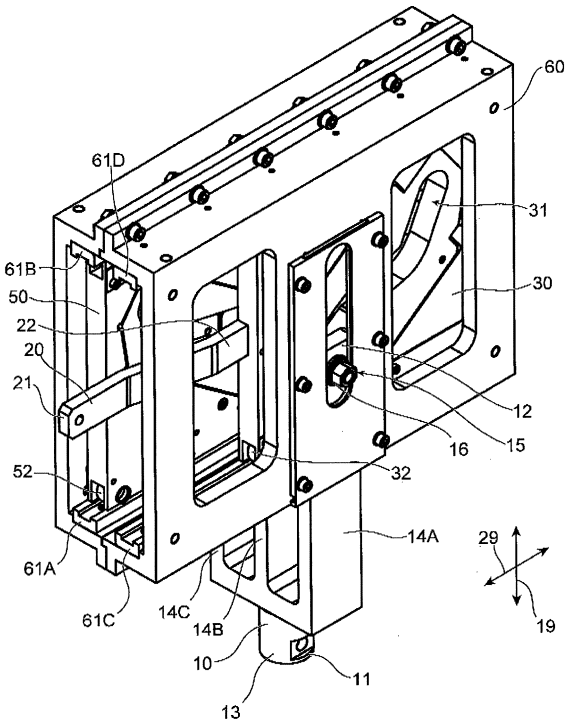

FIG. 1

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Description

TECHNICAL DOMAIN

[0001] The invention relates on the high voltage circuit breakers and the control systems used for opening and closing such circuit breakers.

PREVIOUS ART

[0002] Usually, in a high voltage substation, opening and closing of a circuit breaker is achieved by use of a control system in conjunction with a drive motor.

[0003] Such a control system commonly comprises:

- a control arm mounted for displacement between a first and a second position in a first direction, the control arm comprising a first end configured to be connected to a drive system, such as a spring mechanism, and a second end opposite the first end,
- at least one connecting arm mounted for displacement in a second direction that traverses the first direction, the at least one connecting arm comprising a first end configured to be connected to the circuit breaker and a second end opposite to the first end,
- connecting rods configured to connect the second end of the control arm with the first end of the at least one connecting arm in such a way to transfer the movement of the control arm to the at least one connecting arm.

[0004] Such a configuration does not provide a reliable connection between the drive system and the circuit breaker. Since the ratio in displacement between the control arm and the at least one connecting arm is constant, it is not possible to vary this in order to optimize the opening and the closing of the circuit breaker. Furthermore, with such a configuration, there is always a rebound effect on closing of the circuit breaker which disturbs the closing operation thereof.

[0005] To solve these such issues, the document WO 2014/198290 proposes to use a rotational cam and a casing for connecting the drive system to the circuit breaker. With such configuration, it is possible to adapt the shape of the rotational cam to provide a variable ratio of displacement between the control arm and the connecting arm during opening and closing operation of the circuit breaker. However, with such rotational cam, it is difficult to obtain a high closing speed of the circuit and the rebound effect still arises.

PRESENTATION OF THE INVENTION

[0006] The present invention aims to resolve these aforementioned drawbacks. It is an object of the invention to provide a control system that allows a variable ratio of displacement between the control arm and the at least one connecting arm during the closing and the opening operation of the circuit breaker, and in particular, a control system that allows the circuit breaker to be closed at an appropriate speed so as to suppress any rebound effect.

[0007] In a first aspect, the invention resides in a control system for at least a first switch, the control system comprising:

a control arm mounted for displacement between a first and a second position in first direction, the control arm comprising a first end configured to be connected to a drive system and a second end opposite the first end,

- a first connecting arm mounted for displacement along a second direction that traverses the first direction, the first connecting arm comprising a first end for connection to the first switch and a second end opposite to the first end,

the control system further comprising:

a t least a first sliding element comprising a first track and mounted for displacement along one of the first and the second directions,

wherein the second end of one of the control arm or the first connecting arm which is displaceable in the same direction as the first sliding element, is configured to engage with the first track and is constrained for movement in same direction as the sliding element; and

wherein the second end of the other of the control arm and the first connecting arm is arranged to move integrally with the first sliding element.

[0008] With such control system, the kinetics of the closing/opening of the switch is controlled by the angular orientation of the track. Hence, it is design the track so to optimize the terminal velocity of the closing of the switch in such a way so as to suppress the rebound effect.

[0009] Furthermore, such a control system is particularly interesting for a T-configuration in which the control arm in mounted for displacement along a first direction and at least the first switch comprises a mobile contact displaceable along the second direction which is perpendicular to the first direction.

[0010] The control system may control both a first switch and a second switch and may further comprise:

- a second connecting arm configured for displacement in a second direction, the second connecting arm comprising a first end configured to connect to the second switch and a second end opposite the first connecting end,
- a second sliding element comprising a second track and mounted for displacement in the same direction as the first sliding element.
- wherein the second end of one of the control arm or the second connecting arm which is displaceable in the same direction as the first sand second sliding elements, is configured to engage with the second

track and is constrained for movement in same direction as the first and second sliding elements; and

wherein the second end of the other of the control arm and the second connecting arm is arranged to move integrally with the second sliding element.

[0011] With such a configuration, it is possible to control the opening of two different switches with adapted opening and closing kinetics for each.

[0012] In another embodiment, where the control system is arranged for the control of two switches, the first end of the first connecting arm may also be connected to the second switch.

[0013] The control system may further comprise a transmission mechanism for connecting the first end of the connecting arm with the first and the second switch. The transmission mechanism may comprise at least first and second moving parts configured to move in opposite directions when the first connecting arm is moved along the second direction.

[0014] The first end of the connecting arm may comprise a toothed bar portion,
wherein the transmission mechanism comprises for each of the first and second switch:

- a toothed gear configured to engage with the toothed bar portion,
- a toothed bar configured to engage with the toothed gear and to be connected to the respective switch.

[0015] With such configuration, it is not necessary to provide two connecting arms for the opening and the closing of the first and second switches. This is particularly beneficial when the drive system and the switches are distant from one another.

[0016] In an alternative embodiment, for controlling first and second switches, the first sliding element comprises a second track. In this embodiment, the control system further comprises:

- a second connecting arm mounted for displacement in the opposite direction to that of the first connecting arm, the second connecting arm comprising a first end configured for connection to the second switch and a second end opposite the first end,

wherein the second connecting arm is constrained for movement in the same direction as the first connecting arm and wherein the second end thereof is configured to engage in the second track.

[0017] With such configuration, it is possible to open and close the first and second switch with the exact same kinetics.

[0018] The invention also relates to a high voltage substation comprising:

- a control system as described above, and
- a switch connected to the first end of the first connecting arm.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Embodiments of the present invention will now be described in more detail with reference to the accompanying drawings in which:

- Figure 1 shows a perspective view of a control system of the present invention, the control system being configured for the opening of a first and a second circuit breaker,
- Figure 2 shows a perspective view of the control system of the present invention in which a housing thereof has been removed to show first and second sliding elements,
- Figure 3 shows a partial perspective view of a control system according to a second embodiment of the present invention comprising a single sliding element, with only a partial view of a connecting arm being shown,
- Figure 4 shows a partial front view of a control system according to the second embodiment of the invention showing a first end of a connecting arm configured for connection to the first and second circuit breakers.

[0020] In the different drawings, the same numerical references are used to denote the same or similar components to facilitate understanding of the invention.

DESCRIPTION OF PARTICULAR EMBODIMENTS

[0021] Figure 1 shows a control system 1 of the invention configured for connection of a first and a second circuit breaker (not shown) to a drive system (not shown).

[0022] The control system 1 of the invention comprises:

- a housing 60,
- a control arm 10 configured for movement in a first direction 19 between a first and second position, the control arm 10 comprising a first end 11 connected to the drive system and a second end 12 opposite the first end 11,
- a first connecting arm 20 configured for movement in a second direction 29 traversing the first direction 19, the first connecting arm 20 comprising a first end 21 connected to the first circuit breaker and a second end 22 opposite the first end 21,
- a second connecting arm 40 configured for movement in the second direction 29, the second connecting arm 40 comprising a first end 41 connected to the second circuit breaker and a second end 42 opposite the first end 41,
- a first sliding element 30 comprising a first track 31 and being configured to move in the first direction 19,
- a second sliding element 50 comprising a second

track 51, the second sliding element 50 configured to move in the first direction 19.

[0023] The control arm 10 is constrained for translation in the first direction 19, having its second end engaged in the first and second tracks 31 and 51. The second ends 22, 42 of the first and second connecting arms 20, 40 are arranged to move integrally with the first and the second sliding elements 30, 50 respectively.

[0024] The control arm 10 is fork-shaped, with a central rod 13 comprising the first end 11 of the control arm 10 and three parallel legs 14A, 14B, 14C extending from the central rod 13 and comprising the second end of the control arm 10. The central rod 13 and the three legs 14A, 14B, 14C extend in the first direction 19.

[0025] The three legs 14A, 14B, 14C of the control arm 10 are aligned in a first transverse direction perpendicular to the first direction 19, and each leg includes a hole 15 at the second end 12 of the control arm 10. The holes 15 in the three legs 14A, 14B, 14C are aligned along a second transverse direction perpendicular to the first transverse direction and are configured to accommodate an axle 16.

[0026] The axle 16 includes first and second rollers 17A engaged in the first and the second tracks 31 and 51 respectively. The first and second rollers 17A are arranged between the first and the second legs 14A, 14B and the second and the third legs 14B, 14C of the three legs of the control arm 10.

[0027] The first and second sliding elements 30, 50 have a planar parallelepiped rectangle form, the planar faces being parallel to a plane comprising the first and the second directions 19 and 29. The first and second sliding elements 30, 50 further include rollers 32 on two sides thereof that are parallel to the second direction 29. The first and second sliding elements 30, 50 also comprise first and second openings that form the first and the second tracks 31, 51 of the first and second sliding elements 30, 50 respectively.

[0028] The first and second tracks 31, 51 extend along the planar faces of the first and second sliding elements 30, 50 and comprise three successive sections, each oriented at a different angle 31A, 31B, 31C between the first and second directions 19 and 29. More precisely, in an open configuration illustrated in Figure 1, the orientation angles of the three sections 31A, 31B, 31C are selected according to the desired kinematics of the opening and closing of the first and second circuit breaker.

[0029] As shown in Figure 1 and 2, when the control arm 10 is moved from an open to a closed position, the design of the first and second tracks 31, 51 facilitates the following kinematics of the first and second connecting arms 20, 40:

- the first section 31A of the track 31 is oriented at an angle of approximately at 45°, and the first and second connecting arms 30, 50 move at a first average velocity for a first period of time,
- the second section 31B of the track 31 is oriented at an angle of less than 45°, the first and second connecting arms 30, 50 are configured move at a second average velocity for a second period of time,
- the third section 31C of the track 31 is oriented at an angle greater than 45° and the first and second connecting arms 30, 50 are configured move at a higher speed for third period of time,

[0030] According to one embodiment of the present invention shown in Figures 1 and 2, the first and second tracks may be provided on a removeable part of the first and second sliding elements 30, 50 so as to facilitate adjustment of the opening and closing kinematics of the first and second circuit breakers by replacement of the removeable parts of the first and second sliding elements with tracks that are configured according to a new kinematic.

[0031] The first and second sliding elements 30, 50 are arranged inside a housing 60 comprising a hollow chamber with two pairs of rails 61A, 61B and 61C, 61D respectively that extend along the second direction 29. Each pair of rails 61A, 61B and 61C, 61D, form first and second guides for movement of the first and the second sliding elements 30, 50 parallel to each other.

[0032] The rollers 32, 52 of each of the first and second sliding elements 30, 50 engage with the rails 61A, 61B and 61C, 61D of the first and second guides respectively. This engagement constrains movement of the first and second sliding elements 30, 50 in the second direction 20.

[0033] The first and second connecting arms 20, 40 are arranged to move integrally with the first and second sliding elements 30, 50 respectively. In this way, the movement of first and second connecting arms 20, 40 is also constrained in the second direction 29.

[0034] When the control arm 10 moves in the first direction 19 from an open position to a closed position as illustrated on figures 1 and 2:

- the axle 16 and the first and second rollers 17A slide within the first and second tracks 31, 51,
- the first and second sliding elements 30, 50, move in the second direction 29, with the speed of the displacement being controlled by the angular orientation of the three sections of the first and second tracks 31, 51; and
- the first and second connecting arms 20, 40 move together with the first and second sliding elements 30, 50 in the second direction 29, thus closing the first and second circuit breakers.

[0035] Figures 3 and 4 illustrate a control system according to a second embodiment of the invention. This second embodiment differs from the above described first embodiment in that it comprises a single sliding element 30 only.

[0036] As shown in Figure 3, the control system 1 according to the second embodiment comprises:

a control arm 10 arranged for movement in a first direction 19 between first and second positions, the control arm 10 comprising a first end 11 connected to a drive system 70 and a second end 12 opposite the first end 11,

- a first connecting arm 20 arranged for movement in a second direction 29 perpendicular to the first direction 19, the first connecting arm 20 comprising a first end 21 connected to first and second switches and a second end 22 opposite the first end 21,
- a first sliding element 30 comprising a first track 31, the first sliding element arranged for movement in the first direction 19.

[0037] The second end 21 of the first connecting arm 20 is configured to engage in the first track 31 and is constrained for movement in the second direction only. The second end 12 of the control arm 10 is arranged for integral movement with the sliding element 30.

[0038] The control arm 10 comprise a central rod 13 with a two-legged fork provided at either end 11, 12 thereof. The legs of each fork at each end of the control arm 10 extend parallel to each other along a plane comprising the first and second directions 19, 29. Each leg of the forks comprises a through hole that is aligned with the hole in the other leg at the same end 11, 12, of the control arm 10 in the plane defined by the fork.

[0039] The first end 11 of the control arm 10 is connected by the means of an axle passing through the holes, to a rotating arm 71 of a drive system 70. The first end 11 of the control arm 10 is connected to the drive system 70 by the axle 16 and the rotating arm 71. The second end 12 of the control arm 10 is connected, by the means of an axle passing through the holes in the legs of the fork, to the first sliding element 30.

[0040] Since the first sliding element 30 is arranged for movement in the first direction 19 only, with the connection of the control arm 10 to the sliding element 30 and to the rotating arm 71, rotation of the rotating arm 71 leads to a displacement of the control arm 10 in the first direction 19. Hence, movement of the control arm 10 is integral with movement of the first sliding element 30 in the first direction 19.

[0041] Similarly to the previously described first embodiment of the present invention, the first sliding element 30 of the second embodiment has a planar parallelepiped rectangle form, the planar faces being parallel to a plane comprising the first and second directions. The first sliding element 30 includes rollers 32 on two sides thereof that are parallel to the first direction 19. The first sliding element 30 further includes a first opening that forms the first track 31 of the first sliding element 30.

[0042] The control system 1 also comprises two parallel rails 61A, 61B extending in the first direction 19, the rails 61A, 61B forming a guide for the first sliding element 30.

[0043] The rollers 32 of the first sliding element 30 engage with the rails 61A, 61B so that the first sliding element 30, is constrained for movement in the first direction 19 only.

[0044] As illustrated in Figure 4, the first connecting arm 20 has a longitudinal form and comprises a toothed bar portion 25 at the first end 21 and a two-legged fork at the second end 22 thereof.

[0045] The legs of the fork of the second end 22 extend parallel to each other along a plane comprising the second direction 29, perpendicular to the first direction 19. Each fork leg comprises a through hole 23 aligned with the through hole 23 of the other leg of said two-legged fork along a line comprising the plane defined by the two-legged fork. These holes 23 accommodate an axle 24.

[0046] The axle 24 includes a roller, not shown, that engages with the first track 31 of the first sliding element 30, the roller being arranged between the legs of the fork of the first connecting arm 20.

[0047] The first connecting arm 20 is constrained for movement in the second direction 29 by the means of two guiding sleeves 65A, 65B, a first one of which is provided between the first sliding element 30 and the toothed bar portion 25, a second one of which is provided along a portion of the first end 21 of the first connecting arm 20 which is above the toothed bar portion 25.

[0048] The control system according to the second embodiment further comprises:

- irst and second toothed gears 67A, 67B configured to engage with the toothed bar portion 25,
- first and second toothed bars 66A, 66B configured to engage with the first and second toothed gears 67A, 67B respectively and connected with the first and second circuit breakers respectively.

[0049] With such a configuration, the first end 21 of the first connecting arm 20 is connected to the first and second circuit breakers by the means of the first and second toothed gears 67A, 67B and the first and second toothed bars 66A, 66B. Hence, when the control arm 10 is displaced from the opening position, as illustrated in Figures 3 and 4, to the closed position by rotation of the rotating arm 71:

- the control arm 10 is displaced along the first direction 19,
- the first sliding element 30 is displaced along the first direction 19 with the control arm because of the constraint in movement,
- the first connecting arm 20 is displaced by the engagement of the axle 24 in the first track 31 as it is constrained for movement along the second direction 29, with the velocity of the displacement being controlled by the angular orientation or gradient of the first track 31,
- the translation of the first connecting arm 20 causes rotation of the first and second toothed gears 67A, 67B, which in turn results in translation of the first and second toothed bars 66A, 66B and the closing

of the first and second circuit breaker.

Claims

1. A control system (1) for at least a first switch, the control system (1) comprising:

a control arm (10) mounted for displacement between a first and a second position in first direction (19), the control arm (10) comprising a first end (11) configured to be connected to a drive system and a second end (12) opposite the first end (11),

- a first connecting arm (20) mounted for displacement along a second direction (29) that traverses the first direction (19), the first connecting arm (20) comprising a first end (21) for connection to the first switch and a second end (22) opposite to the first end,

the control system further comprising:

- at least a first sliding element (30) comprising a first track (31) and mounted for displacement in one of the first and the second directions (19, 29),

wherein the second end (12, 22) of the one of the control arm (10) or the first connecting arm (20) which is displaceable in the same direction as the first sliding element (30), is configured to engage with the first track (31) and is constrained for movement in same direction as the first sliding element (30); and
wherein the second end (22, 12) of the other of the control arm (10) and the first connecting arm (20) is arranged to move integrally with the first sliding element (30).

2. The control system (1) according to claim 1, wherein the control system (1) is arranged to control the opening and closing of the first switch and a second switch, and further comprising:

- a second connecting arm (40) mounted for displacement in the second direction (29), the second connecting arm (40) comprising a first end (41) configured for connection to the second switch and a second end (42) opposite the first end (41),
- a second sliding element (50) comprising a second track (51) and mounted for displacement in the same direction as the first sliding element (30),
- wherein the second end (12, 42) of the one of the control arm (10) or the second connecting arm (40) which is displaceable in the same direction as the first sand second sliding elements (30, 50), is configured to engage with the second track (51) and is constrained for movement in same direction as the first and second sliding elements (30, 50); and

wherein the second end (42, 12) of the other of the control arm (10) or the second connecting arm (40) is arranged to move integrally with the second sliding element (50).

3. The control system (1) according to claim 1, wherein the control system (1) is arranged to control the opening and closing of the first switch and a second switch, wherein the first end (21) of the first connecting arm (20) is additionally configured for connection to the second switch.

4. The control system (1) according to claim 3, further comprises a transmission mechanism for connecting the first end (21) of the first connecting arm (20) with the first and the second switches, wherein the transmission mechanism comprises at least first and second moving parts configured to move in opposite directions when the first connecting arm (21) is moved along the second direction (29).

5. The control system (1) according to claim 4, wherein the first end of the first connecting arm (20) comprises a toothed bar portion (25),
wherein the transmission mechanism comprises for each of the first, and second switch:

- a toothed gear (67A, 67B) engaged with the toothed bar portion,
- a toothed bar (66A, 66B) engaged with the toothed gear (67A, 67B) and connected to the respective first and second switches.

6. The control system (1) according to any of claims 1 to 3, wherein the direction of movement of the first sliding element (30) is the second direction (29).

7. The control system (1) according to claim 1, wherein the control system (1) is arranged to control the opening and closing of first and second switches, the direction of movement of the first sliding element (30) being the second direction (29), wherein the first sliding element (30) comprises a second track, and further comprising:

- a second connecting arm (40) mounted for displacement in the second direction (29), the second connecting arm (40) comprising a first end (41) configured for connection to the second switch and a second end (42) opposite the first end (41),

the second connecting arm (40) being constrained for movement in the second direction (29) wherein the second end (42) is configured for engagement in the second track (51).

8. A high voltage substation comprising:

- a control system (1) according to any of claims to 7,
- at least one switch, the switch being connected to the first end (21) of the first connecting arm (20),
- a drive system, the drive system being connected to the first end (11) of the control arm (10) .

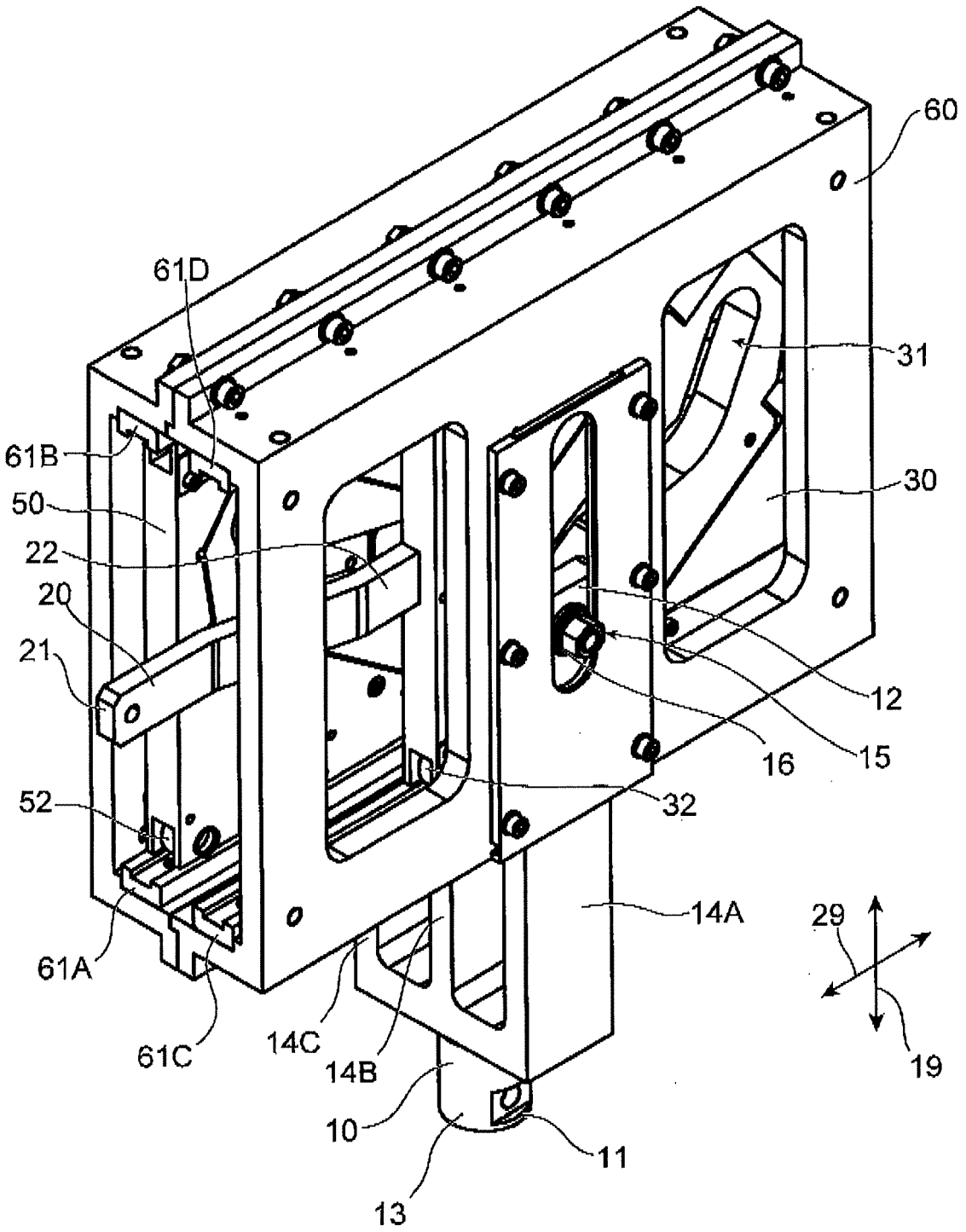
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FIG. 1

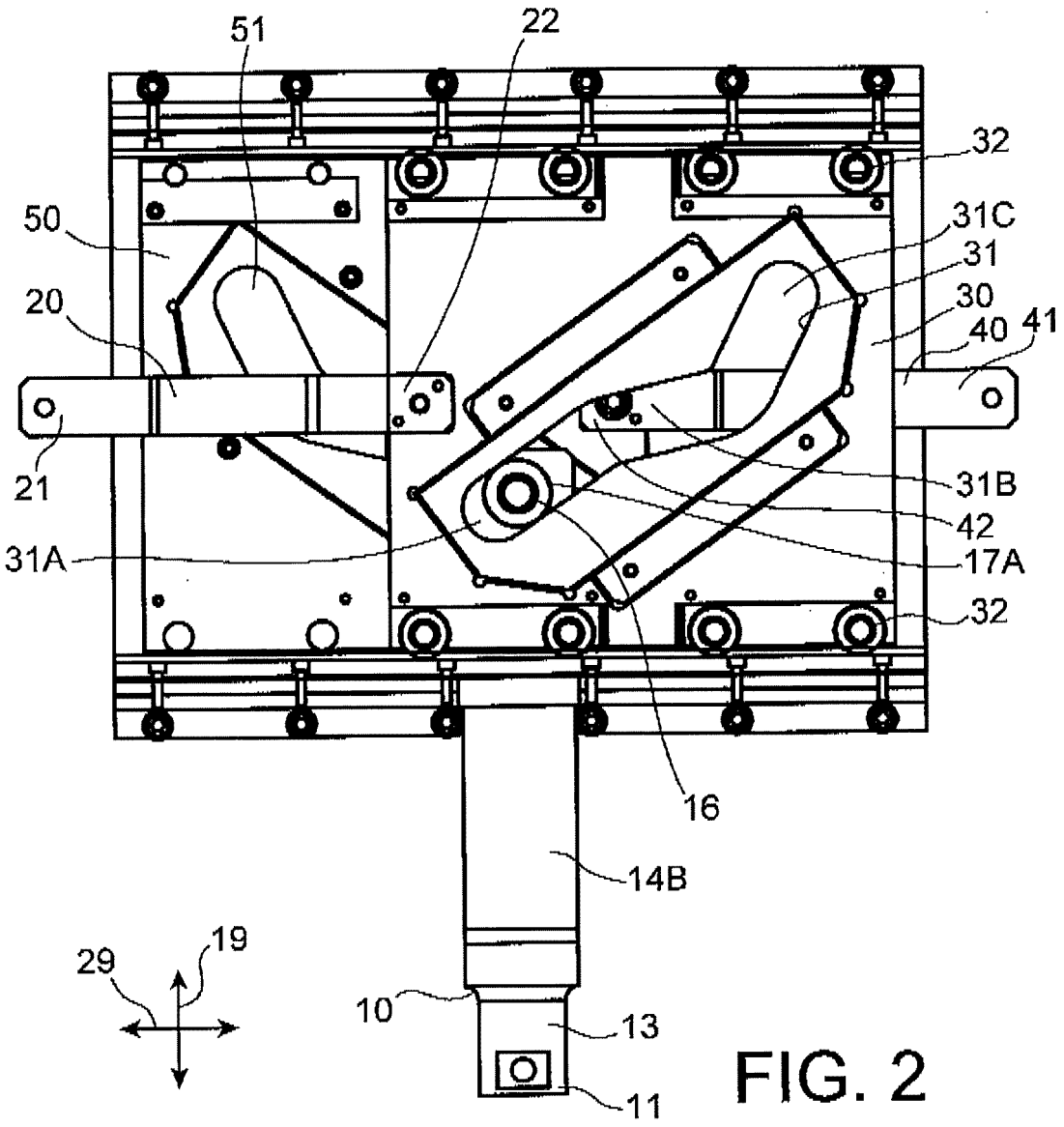
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FIG. 2

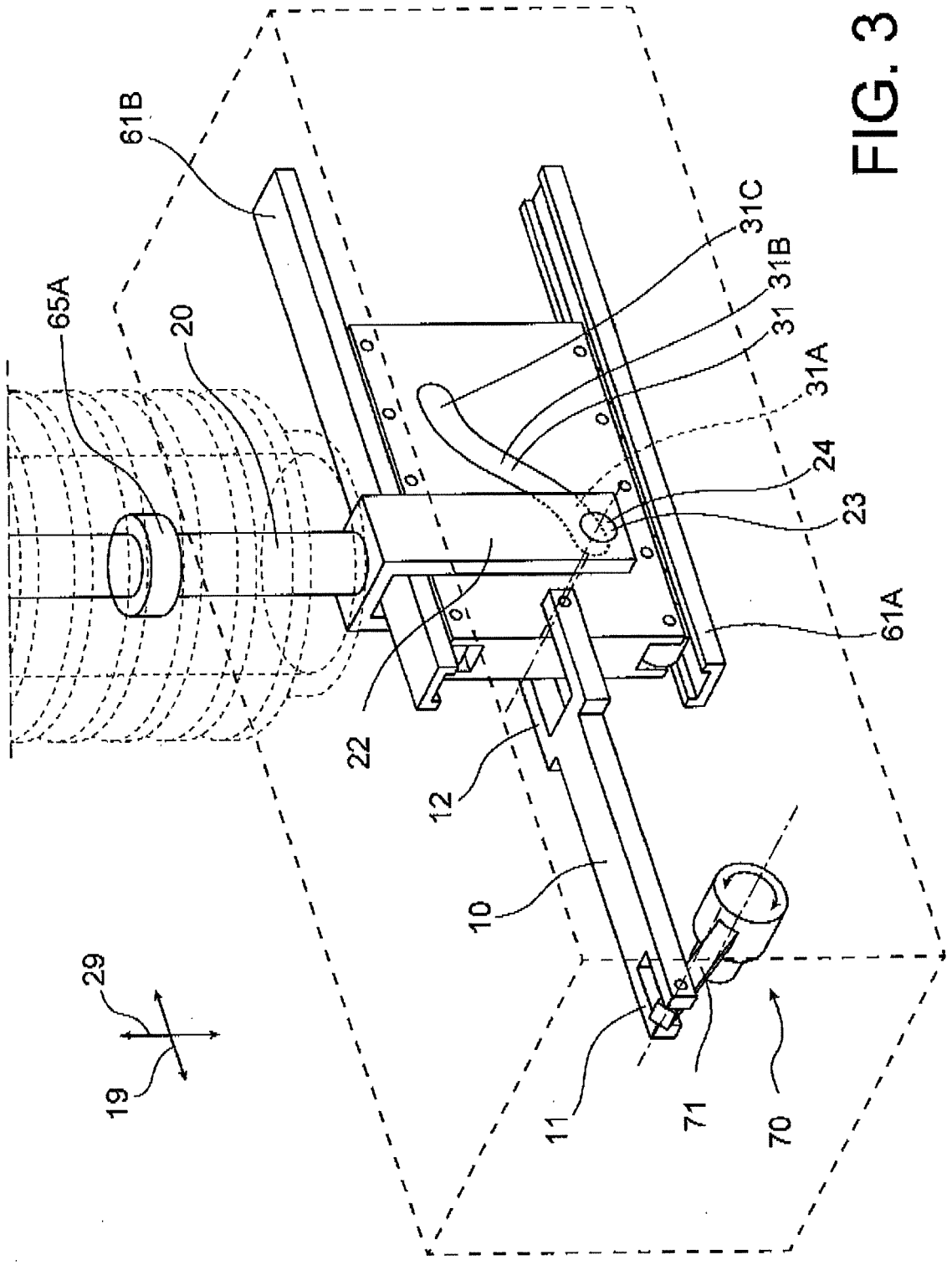

FIG. 3

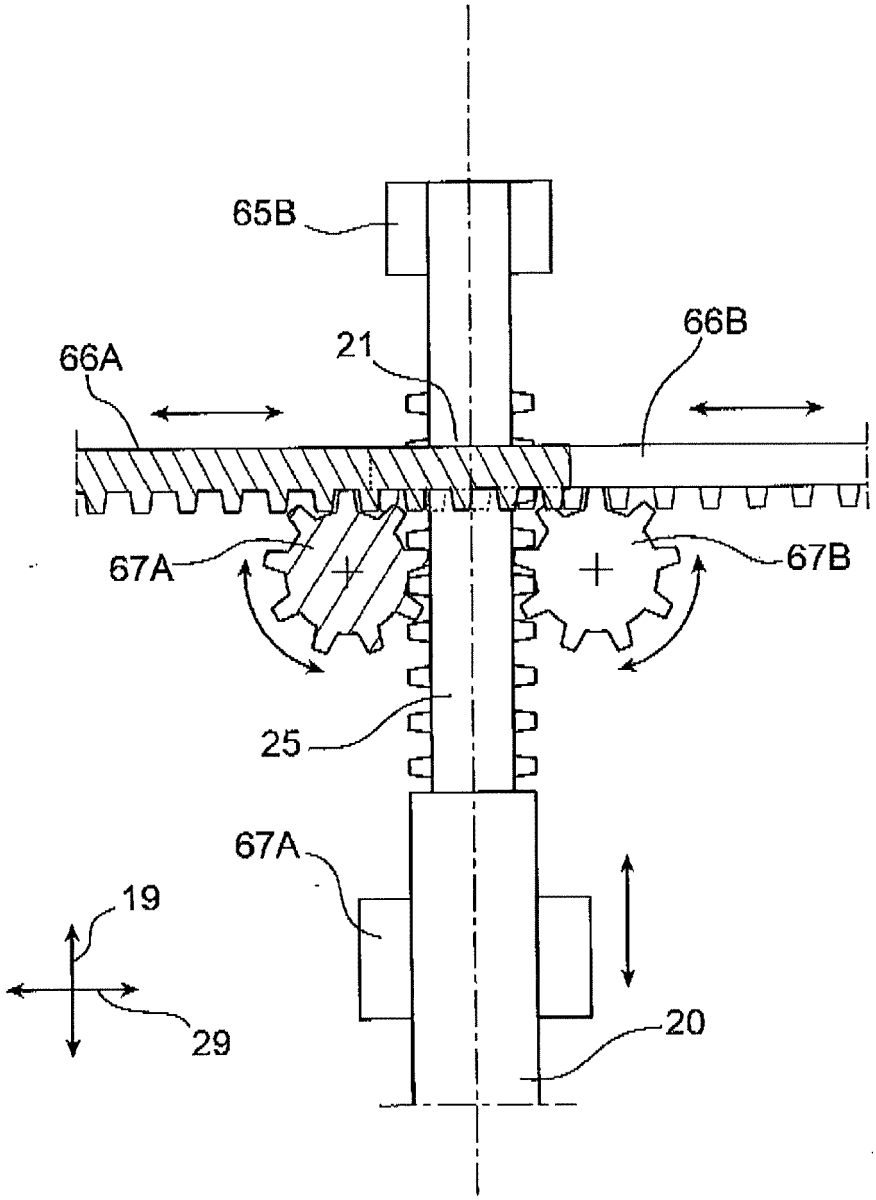

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 18 29 0025

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 3 590 186 A (BRUNNER ROCHARD G) 29 June 1971 (1971-06-29) * column 2, line 27 - column 3, line 30; figure 1 *	1-8	INV. H01H3/42 H01H33/42
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X	EP 2 752 864 A1 (LSIS CO LTD [KR]) 9 July 2014 (2014-07-09) * paragraph [0034] - paragraph [0049]; figures 2-5 *	1-8	
X	WO 2013/159819 A1 (ABB TECHNOLOGY AG [CH]; BOFFELLI CARLO [IT]; COLOMBO ANDREA [IT]; PENZ) 31 October 2013 (2013-10-31) * page 3, line 28 - page 5, line 12; figures 1-4 *	1-8	
			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	7 September 2018	Dobbs, Harvey

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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