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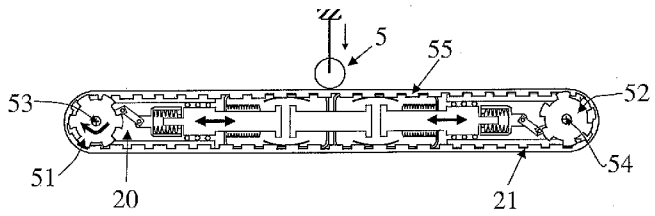


Fig. 4

(57) Abstract: High voltage switching device comprising an outer casing, and at least two vacuum interrupters electrically connected in series to each other and having each a fixed contact and an associated movable contact. An actuating mechanism actuates the movable contacts between a first closed position in which they are connected to the corresponding fixed contacts, and a second open position in which they are separated therefrom. The actuating mechanism comprises a single drive unit supplying the energy required to move the movable contacts, and transmission means transmitting the energy required to the movable contacts; the transmission means comprise at least one transmission belt or chain drive which is actuated by the drive unit and operatively links the movement of the movable contacts.

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HIGH-VOLTAGE SWITCHING DEVICE

The present disclosure relates to a high-voltage switching device, i.e. for applications with rated voltage above 1 kV.

As well known in the art, electric grids for transmitting and/or distributing power to various loads and users are equipped with various switching devices; such switching devices, typically current interrupters or circuit breakers, have the main task of properly protecting the grid in which they are used as well as various loads and equipment connected therewith from damages which may be caused for example by electrical faults, e.g. short circuits.

To this end, a typical circuit breaker comprises an interruption chamber with current interruption mechanisms constituted by at least one fixed contact and a corresponding moving contact; when a fault occurs, the circuit breaker or interrupter is opened by suitable actuating mechanisms which cause the movable contact to electrically separate from the fixed contact, thus interrupting the flow of current.

During opening, the mutual separation of the contacts is accompanied by the generation of an electric arc between the two contacts which should be extinguished as quickly as possible.

To face this issue, different solutions have been implemented over the years. One of the most practised solutions foresees the use of compressed gaseous substances inside the interrupting chamber, such as nitrogen, noble gases, air, sulphur hexafluoride (SF_6) and mixtures thereof. But with these substances it is indispensable to use devices for monitoring the pressure of the gas used and for replenishing it in order to maintain the dielectric performance of the switching device; further, it is necessary to adopt safety systems in order to avoid and/or indicate any loss outside the device. This obviously affects the constructive complexity of the circuit breaker and its overall reliability.

In addition, some such gases represent a major concern about environmental

issues, in particular as regard to SF_6 and its negative impact on the greenhouse effect.

Manufactures have also developed a different current interruption technology where the contacts are positioned and separate from each other inside a vacuum interruption chamber; in practice the vacuum interruption chamber surrounds a sealed space inside which a vacuum atmosphere is created and where the contacts separate.

This type of interruption technology does not have the above mentioned environmental issues.

On the other hand, in order to increase the overall dielectric withstand of a switching device there have been proposed various solutions using two or more vacuum chambers or vacuum circuit breakers within the same switching device; however, these solutions introduce other issues to be faced, such as complexity of the mechanisms used to actuate the various contacts as well as of coordination of their movement, overall size of the device which may become rather voluminous and cumbersome, repeatability of manoeuvres, robustness and reliability of the actuating mechanism, cost of its realization, ease of assembly, installation and maintenance, et cetera.

The present disclosure is aimed at facing at least some of the above mentioned issues and provides in particular a high voltage switching device comprising:

- an outer casing;
- at least a first vacuum current interrupter having a first fixed contact and an associated first movable contact, and a second vacuum current interrupter having a second fixed contact and an associated second movable contact, said first and second vacuum interrupters being positioned inside said outer casing and electrically connected in series to each other;
- an actuating mechanism for actuating both said first and second movable contacts between a first closed position in which said first movable contact and

said second movable contact are electrically coupled with said first fixed contact and said second fixed contact, respectively, and a second open position in which said first movable contact and said second movable contact are electrically separated from said first fixed contact and said second fixed contact, respectively, wherein said actuating mechanism comprises a single drive unit for supplying the energy required to move said first and second movable contacts, and transmission means for transmitting said energy to said first and second movable contacts, said transmission means comprising at least one flexible transmission element selected from the group consisting of a transmission belt or chain drive which is actuated by said drive unit and operatively links the movement of said first and second movable contacts.

Further characteristics and advantages will become apparent from the description of some preferred but not exclusive exemplary embodiments of a high-voltage switching device according to the present disclosure, illustrated only by way of non-limitative examples with the accompanying drawings, wherein:

Figures 1 and 2 are side views partially showing a possible embodiment of a high- voltage switching device according to the present disclosure with the contacts in a first closed position and in a second open position, respectively;

Figures 3 and 4 are a side view and a top view, respectively, schematically illustrating some components used according to a possible embodiment of a high voltage switching device according to the present disclosure;

Figures 5 and 6 are a side view and a top view, respectively, schematically illustrating some components used according to another possible embodiment of a high voltage switching device according to the present disclosure;

Figures 7 and 8 are a side view and a top view, respectively, schematically illustrating some components used according to yet a further possible embodiment of a high voltage switching device according to the present

disclosure;

Figures 9 and 10 schematically represent two further possible embodiment of a high voltage switching device according to the present disclosure;

Figures 11-14 are schematic representations of possible eccentric mechanisms which can be used in a high voltage switching device according to the present disclosure;

Figure 15 is a schematic view representing a possible end-stroke mechanism which can be used in a high voltage switching device according to the present disclosure.

It should be noted that in the detailed description that follows, identical or similar components, either from a structural and/or functional point of view, have the same reference numerals, regardless of whether they are shown in different embodiments of the present disclosure; it should also be noted that in order to clearly and concisely describe the present disclosure, the drawings may not necessarily be to scale and certain features of the disclosure may be shown in somewhat schematic form.

With reference to the figures, the high voltage switching device according to the present disclosure, indicated by the overall reference 100, comprises an outer casing 1, such as for example a metal-clad casing, i.e. it is electrically conducting and can be connected to ground potential, or alternatively it can be a live tank or an insulating casing.

As it will be described in more details hereinafter, inside the casing 1 there are positioned current interruption devices or units, and in particular at least a first vacuum current interrupter or unit 10, and a second vacuum current interrupter or unit 11.

Further, in the exemplary embodiment of figures 1-2 the casing 1 is connected for instance to two bushings 2 each housing a respective conductor, e.g. a bar or rod 3; the bars 3 are connected each to a corresponding terminal 4, with each

terminal 4 connected operatively to the corresponding vacuum interrupter 10 or 11, respectively. In practice, the bars 3, terminals 4 and related connections between them and with the vacuum interrupters 10, 11 allow to realize input/output electrical connections of the switching device 100 for example with an external power line, with the current flowing through the interrupters 10, 11 according to solutions well known or readily available to those skilled in the art and therefore not described herein in details.

In the embodiments illustrated, the first vacuum interrupter 10 comprises a first fixed contact 31 and an associated first movable contact 41 which are positioned inside a first vacuum chamber 13, and the second vacuum current interrupter 11 comprises a second fixed contact 32 and an associated second movable contact 42 which are positioned inside a second vacuum chamber 14; the first and second vacuum interrupters 10, 11 are positioned inside the outer casing 1 and are electrically connected in series to each other.

The switching device 100 comprises an actuating mechanism adapted to actuate both the first movable contact 41 and the second movable contact 42 between: a first position in which the first movable contact 41 and the second movable contact 42 are electrically coupled (inside the respective vacuum chamber 13, 14) with the first fixed contact 31 and the second fixed contact 32, respectively (see for example figure 1 where the switching device 100 is in closed position); and a second position in which the first movable contact 41 and the second movable contact 42 are electrically separated (inside the respective vacuum chamber 13, 14) from the first fixed contact 31 and the second fixed contact 32, respectively. Such separated position is schematically shown in figure 2 where the switching device 100 is opened and the flow of current through it is interrupted.

The actuating mechanism of the switching device 100 comprises a single drive unit 40 for supplying the energy required to move both the first and second

movable contacts 41, 42, and transmission means, globally indicated by the reference number 50, for transmitting the mentioned required energy to the first and second movable contacts 41, 42. In particular, the transmission means 50 comprise at least one flexible transmission element 55 selected from the group consisting of a transmission belt or chain drive which is actuated by the drive unit 40 and operatively links to each other the movement of the first and second movable contacts 41, 42.

One or more tensioning devices, schematically indicated in the figures by the reference number 5, are provided and operatively associated to the transmission belt or chain drive 55 for properly tensioning it, at the time of initial installation, as well as during its working life.

In the exemplary embodiments illustrated in figures 1-6, the first and second vacuum interrupters 10, 11 are for example positioned back-to-back, namely the two vacuum interrupters 13 and 14 are arranged such that the two fixed contacts 31 and 32 are next to one another.

In this embodiment, the movable contacts 41, 42 when actuated by the actuating mechanism, move along a reference axis 101, one towards the other when switching from the second position illustrated in figure 2 to the first position of figure 1, and one away from the other when switching from the first position (starting position illustrated in figure 1) to the second position illustrated in figure 2.

In the exemplary embodiment of figures 7-8, the vacuum interrupters 10, 11 are positioned inside the outer casing 1 in the so-called candle-stick arrangement, namely, there is an alternation of a fixed contact and a correspondingly associated movable contact along the reference axis 101; in practice, according to this layout, when actuated, the movable contacts 41, 42 move along the axis 101 all in the same direction either when separating (e.g. towards the left side)

from the corresponding fixed contacts 31, 32 or when coupling with them (e.g. towards the right side).

Preferably, the actuating mechanism of the switching device 100 according to the present disclosure is arranged to self-lock the first and second movable contacts 41, 42 at least in the first closed position, more preferably in both the first closed position and the second open position.

With the above definition of self-lock (or self-hold), it is hereby meant that the actuating mechanism, through its various components, as they will be described in the following, is capable of assuming an overall position suitable to keep the movable contacts in the first closed position or the second open position alone and without the need of a constraining force exerted by the drive unit 40, nor of any additional latching mechanism or similar position-locking devices.

In particular, as illustrated for example in figures 3-6, the transmission means comprise at least a first wheel 51 and a second wheel 52 which are spaced apart from each other and mounted to rotate, under the action of the drive unit 40, about two respective fixed axes 53, 54, and the transmission belt or chain drive 55 is looped around the first and second wheels 51, 52.

Further, in the various embodiments illustrated in figures 3-10, the transmission means 50 comprise a first mechanism 20 converting the rotational movement of the transmission belt or chain drive 55 into a linear movement of the first movable contact 41 along the axis 101; in the embodiments illustrated the transmission means further comprise a second such mechanism 21 which is operatively connected, e.g. mechanically, to the second movable contact 42 and to the transmission belt 55 or chain drive 55 so as to cause the linear movement of the second movable contact 42

Preferably these two mechanisms 20, 21 have the same mechanical construction.

Figure 11 schematically represents a crank-slider mechanism 20 or 21.

More preferably, the two mechanisms, 20, 21 are eccentric mechanisms; with the definition of eccentric mechanism it is hereby meant a mechanism formed by one or more components at least one of which components, e.g. a disk, wheel cam, or like elements, is mounted rotating around an axis which is offset with respect to the center of the component itself.

In particular, in the switching device according to the present disclosure, the first and second mechanisms 20, 21 are each of the cam-follower type, as illustrated in figures 12-14. In particular, each mechanism 20 or 21 comprises a cam element 22 which is for instance mounted rotating about an axis 15 and constitutes the eccentric element, and a follower 23 which can be a flat follower (figure 13) or a roller (figure 14). Each mechanism is mechanically connected to the associated movable contact (as well as to other components of the actuating mechanism) according to solutions readily available to those skilled in the art and therefore not described in details herein. For example, one or more links or rods can be used, with or without associated springs.

According to the exemplary embodiment illustrated in figures 3-4, the drive unit 40 is mounted to rotate a drive output axis 43, for example a shaft or equivalent rotating element connected to the drive unit 40 itself; the first wheel 51 is mounted rotating about the same drive output axis 43, namely the first axis 53 of the first wheel 51 and the rotating axis 43 of the drive unit 40 coincide.

According to the exemplary embodiment illustrated in figures 5-6, the drive unit 40 is mounted to rotate a drive output axis 43 which is substantially parallel to - and placed between and at the same distance from - the two respective axes 53, 54 of rotation of the first and second wheels 51, 52; in this embodiment, the transmission means 50 further comprise a third wheel 56 mounted rotating about the drive output axis 43 and the transmission belt or chain drive 55 is looped around the first, second and third wheels 51, 52, 56.

In this way, the two lateral wheels 51 and 52 are mounted symmetrically with respect to the drive unit 40 and the associated third wheel 56; accordingly, the two movable contacts 41, 42 can be moved substantially synchronously to each other.

The transmission belt or chain drive 55 and the wheels 51, 52 (and when present third wheel 56) around which the belt or chain drive 55 is looped around can be mounted inside the outer casing 1 or outside it; in the latter case, the initial installation and adjustment, as well as maintenance interventions, are simplified to a certain extent.

Preferably, the flexible transmission element 55 is a timing belt 55, namely a synchronous drive belt or toothed drive belt and the first wheel 51, the second wheel 52 and when present the third wheel 56, are pulleys, e.g. toothed pulleys. For example, the transmission timing belt 55 can be that commercially available under the name of POLY CHAIN® GT CARBON™; in any case, any belt suitable for the application can be used, such as those made of fiber reinforced materials, e.g. Kevlar reinforced or glass fiber reinforced ones, as well as other suitable materials. In case the belt is located outside the casing 1 of a dead tank breaker, steel reinforced belts can also be used.

Alternatively, the flexible transmission element 55 can be a chain drive of any suitable type available on the market and in this case the first wheel 51, the second wheel 52 and when present the third wheel 56, are gearwheels. Also in this case, if the chain drive 55 is located outside the casing 1 of a dead tank breaker, steel reinforced chains can be used.

Preferably, the drive unit 40 is mounted to rotate the drive output axis 43 of about 180° when moving the first and second movable contacts 41, 42 from the closed position to the open position, and also again of 180° when moving the first and second movable contacts 41, 42 from the open position to the closed position; more preferably, the drive unit 40 is mounted to rotate its drive output

axis 43 in one direction only, namely it moves the component schematically represented by the axis 43 always and only clockwise or counterclockwise.

For example, the two schematic mechanisms illustrated in figures 11 and 12 show the sequence of opening-closing operations with unidirectional rotation in the same direction for both operations.

Further, according to this embodiment, each cam element 22 of the cam-follower type eccentric mechanisms 20, 21 preferably comprises a first cam profile 24 (e.g. upper half outer profile of the cam element 22) shaped to adjust the travel path of the associated first/second moving contacts 41, 42 when moving from the closed position to the open position, and a respective second cam profile 25 (lower half outer profile of each cam element 22) shaped to adjust the travel path of the associated first and second moving contacts 41, 42 when moving from the open position to the closed position.

The drive unit 40 can comprise an electric rotating motor or a spring operated motor.

For example the drive unit 40 can be constituted by any suitable motor already available on the market; for example the motor can be selected from the MotorDrive series models MD1.n, such as the model MD1.3, or the type BLK82, or the ESH9 commercialized by the ABB® Group.

Alternatively, the drive unit 40 can comprise a flat torsion spring as a drive, schematically illustrated in figure 15; in this case, an end-stroke mechanism 70 is used just to stop and release the rotation of the clock spring drive 40 when the movable contacts 41, 42 reach the corresponding end-stroke closed or open position.

In practice, when for example the switching device 100 has to close, the drive unit 40 (e.g. in the form of an electric rotating motor) rotates clockwise of 180° (or counterclockwise) and transmit the movement thorough the transmission means 50 (and in particular, the eccentric mechanisms 20, 21 and the belt or

chain drive 55 with the associated wheels 51, 52) to the movable contacts 41, 42. In this way, the movable contacts 41, 42 slide along the reference axis 101 (and perpendicularly with respect to the rotation axis of the motor 40) one towards the other until they arrive to touch each the respective fixed contact 31, 32 (position of figure 1). In this status, the mutual position of the various components of the actuating mechanism is such that the contacts can be kept in the reached position without the need of having a biasing force exerted by the motor 40 or without the need of any latch. When it is necessary to open the switching device, the motor 40 rotates of 180° again in the same direction, e.g. clockwise; likewise, the movement is transmitted through the transmission means 50 (and in particular, the eccentric mechanisms 20, 21 and the belt 55 with the associated wheels 51, 52) to the movable contacts 41, 42. In this way, the movable contacts 41, 42 slide along the reference axis 101 (and perpendicularly with respect to the rotation axis of the motor 40) one away from the other until they arrive at the end of their stroke (position of figure 2).

It has been found that the switching device 100 according to the present disclosure offers some improvements over prior art solutions; indeed, thanks to the configuration and mutual position of its various elements.

Such results are achieved thanks to a solution which in principle makes the switching device 100 according to the present disclosure easy to be used in connection with different types of electric substations.

Hence, the present disclosure also encompasses an electric power distribution and/or transmission substation characterized in that it comprises a high voltage switching device 100 of the type previously described and as defined in the appended claims. Clearly more than one switching device 100 can be used in a single substation.

The switching device 100 thus conceived is susceptible of modifications and variations, all of which are within the scope of the inventive concept as defined

in particular by the appended claims; any possible combination of the previously disclosed embodiments/alternatives can be implemented and has to be considered within the inventive concept of the present disclosure; all the details may furthermore be replaced with technically equivalent elements. For example, any of the previously described components may be differently shaped, or used in a different number or parts or elements, or the components previously described can be differently connected with respect to each other. For instance, the bushings 2 can be omitted, and the switching device 100 can assume the form of a typical high-voltage circuit breaker; it is possible to use only one vacuum chamber, i.e. the two vacuum chambers 13, 14 can be "merged" into a single one defining a unique internal space under vacuum inside which the two couple of contacts 41-31 and 42-32 couple/separate; or it would be possible to use a separating wall positioned transversally with respect to the axis 101 and which divides the internal space under vacuum of the chamber into two separated half spaces each devoted to coupling/separation of a respective couple of contacts 31-41, 32-42. It is possible to have a drive unit 40 rotating of 180° in one direction (e.g. clockwise) when for example separating the contacts, and of 180° in the opposite direction (e.g. counterclockwise) when coupling the contacts; in this case, the parts of the transmission belt or chain drive 55 never touching the associated wheels 51, 52 (and when present 56), can be replaced by rigid rods, thus increasing stiffness.

The device 100 can comprise more than two current interrupters, as for example illustrated schematically in figures 7-8 where there are illustrated three interruption units each comprising a fixed contact and an associated movable contact; in this case, for each additional movable contact illustrated, the transmission means 50 can comprise an additional mechanism, e.g. eccentric of the type above described, operatively connected to a corresponding additional wheel and with the transmission belt or chain drive looped around it as well.

Further, one or more of the wheels illustrated can take the shape of a disk, or even it is possible that it is constituted by a portion of a rotating shaft which connected to the drive unit (i.e. the shaft constitutes the drive output axis) and whose outer profile is properly designed to couple with the belt 55.

In addition, the switching device 100 and related components above described can be used according to different constructive arrangements; for example, figures 9 and 10 illustrate schematically two possible embodiments of a three-phase switching device 100. For example figure 10 illustrates an embodiment where a unique transmission belt 55 is used for all the movable contacts of all phases and is looped around all wheels present. Figure 9 instead illustrates an embodiment where there is one transmission belt 55 for each phase and the belts of the various phases are operatively interconnected to each other and to the drive unit 40 by means of a second transmission belt 550. In these embodiments, there could be a unique outer casing 1 or there could be an outer casing 1 for each phase.

Also the materials used, so long as they are compatible with the specific use and purpose, as well as the dimensions, may be any according to the requirements and the state of the art.

CLAIMS

1. A high-voltage switching device (100) comprising:

- an outer casing (1);

- at least a first vacuum current interrupter (10) having a first fixed contact (31) and an associated first movable contact (41), and a second vacuum current interrupter (11) having a second fixed contact (32) and an associated second movable contact (42), said first and second vacuum interrupters being positioned inside said outer casing (1) and electrically connected in series to each other;

- an actuating mechanism for actuating both said first and second movable contacts (41, 42) between a first closed position in which said first movable contact (41) and said second movable contact (42) are electrically coupled with said first fixed contact (31) and said second fixed contact (32), respectively, and a second open position in which said first movable contact (41) and said second movable contact (42) are electrically separated from said first fixed contact (31) and said second fixed contact (32), respectively, wherein said actuating mechanism comprises a single drive unit (40) for supplying the energy required to move said first and second movable contacts (41, 42), and transmission means (50) for transmitting said energy to said first and second movable contacts (41, 42), said transmission means (50) comprising at least one flexible transmission element (55) selected from the group consisting of a transmission belt or chain drive which is actuated by said drive unit (40) and operatively links the movement of said first and second movable contacts.

2. A high-voltage switching device (100) according to claim 1, wherein said actuating mechanism is arranged to self-lock said first and second

movable contacts (41, 42) in said first closed position and in said second open position.

3. A high-voltage switching device (100) according to one or more of claims 1-2 wherein said transmission means comprise at least a first wheel (51) and a second wheel (52) which are spaced apart from each and other and mounted to rotate about two respective fixed axes (53, 54) and wherein said at least one transmission belt or chain drive (55) is looped around said first and second wheels (51, 52).

4. A high-voltage switching device (100) according to one or more of the previous claims wherein said transmission means further comprise a first mechanism (20) operatively connected to said first movable contact (41) and to said transmission belt or chain drive (55) and a second mechanism (21) operatively connected to said second movable contact (42) and to said transmission belt (55), and wherein said first and second mechanisms (20, 21) are substantially identical to each other.

5. A high-voltage switching device (100) according to claim 4 wherein said first and second mechanisms (20, 21) comprise each an eccentric.

6. A high-voltage switching device (100) according to one or more of the previous claims wherein said drive unit (40) is mounted to rotate a drive output axis (43) and said first wheel (51) is mounted rotating about the same drive output axis (43).

7. A high-voltage switching device (100) according to one or more of the claims 1-5 wherein said drive unit (40) is mounted to rotate a drive output axis (43) which is substantially parallel to and placed between and at the same distance from the two respective axes (53, 54) of rotation of said first and second wheels (51, 52), and wherein said transmission means (50) comprise a third wheel (56) mounted rotating about said drive output

axis (43) with said transmission belt or chain drive (55) looped around said first, second and third wheels (51, 52, 56).

8. A high-voltage switching device (100) according to one or more of the previous claims wherein said drive unit (40) is mounted to rotate said drive output axis (43) by about 180° either when moving said first and second movable contacts (41, 42) from the closed position to the open position or when moving said first and second movable contacts (41, 42) from the open position to the closed position.

9. A high-voltage switching device (100) according to one or more of the previous claims wherein said drive unit (40) is rotating said drive output axis (43) in one direction only.

10. A high-voltage switching device (100) according to one or more of the previous claims wherein said first and second mechanisms (20, 21) are of the cam-follower type.

11. A high-voltage switching device (100) according to claim 10, wherein each cam element (23) of said cam-follower type mechanisms (20, 21) comprises a respective first cam profile (24) shaped to adjust the travel path of the associated first and second moving contacts (41, 42) when moving from the closed position to the open position, and a respective second cam profile (25) shaped to adjust the travel path of the associated first and second moving contacts when moving from the open position to the closed position.

12. A high-voltage switching device (100) according to one or more of the previous claims wherein said transmission belt or chain drive (55) and the wheels (51, 52, 56) around which the belt is looped around are mounted outside said outer casing (1).

13. A high-voltage switching device (100) according to one or more of the previous claims wherein it comprises one or more tensioning devices (5) for tensioning said transmission belt or chain drive (55).

14. A high-voltage switching device (100) according to one or more of the previous claims wherein said transmission belt (55) is a timing belt and said first wheel (51), second wheel (52) and when present third wheel (56) are pulleys.

15. A high-voltage switching device (100) according to one or more of the claims 1-13 wherein said first wheel (51), second wheel (52) and when present third wheel (56) are gearwheels with said chain drive (55) looped around them.

16. A high-voltage switching device (100) according to one or more of the previous claims wherein said drive unit comprises an electric rotating motor.

17. A high-voltage switching device (100) according to one or more of the previous claims wherein said drive unit comprises a flat torsion spring, and wherein it further comprises an end-stroke mechanism (70) for stopping the rotation of said flat torsion spring when said first and second movable contacts have reached the corresponding end-stroke closed or open position.

18. An electric power distribution and/or transmission substation characterized in that it comprises a high voltage switching device according to one or more of the preceding claims.

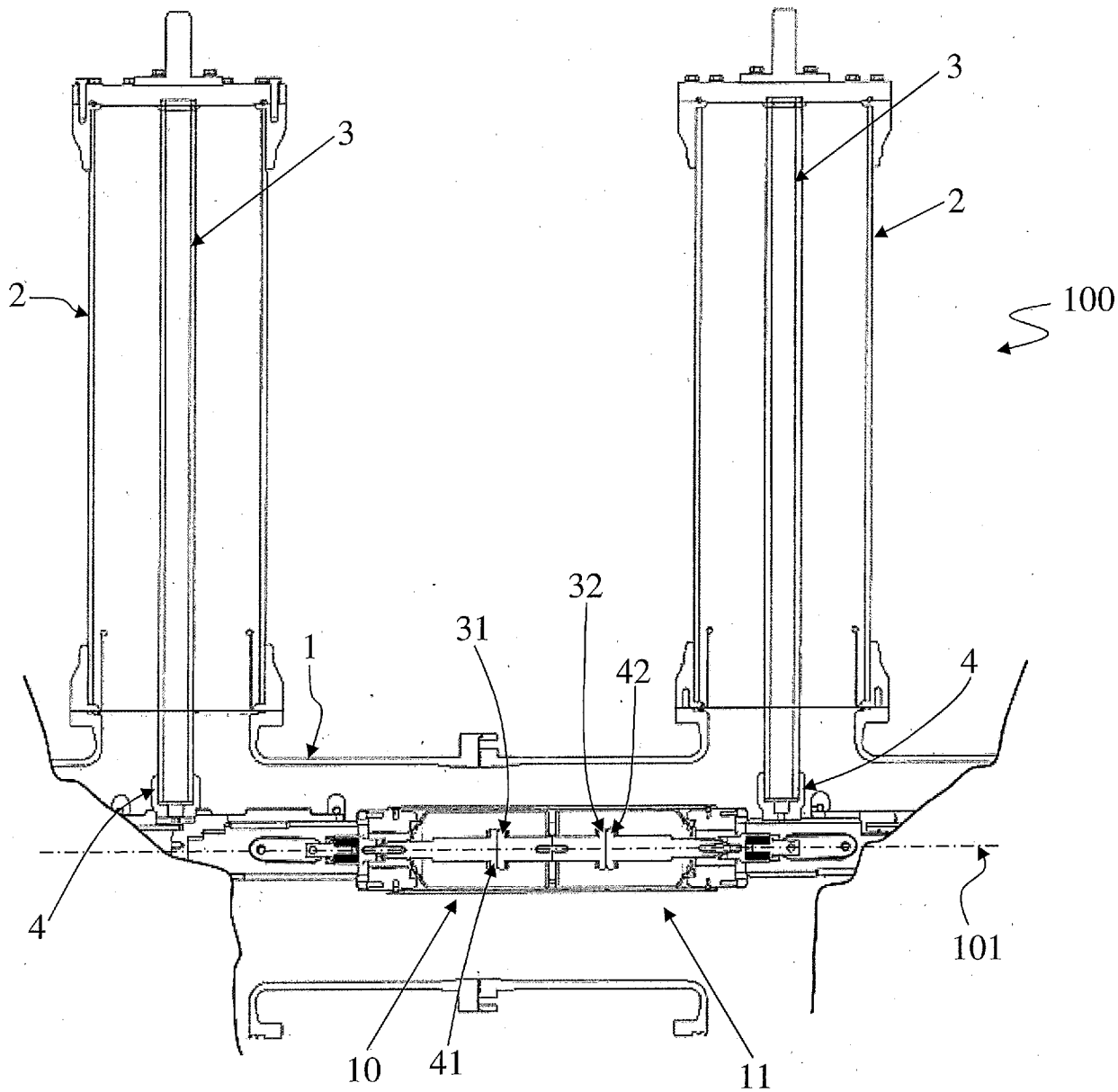


Fig. 1

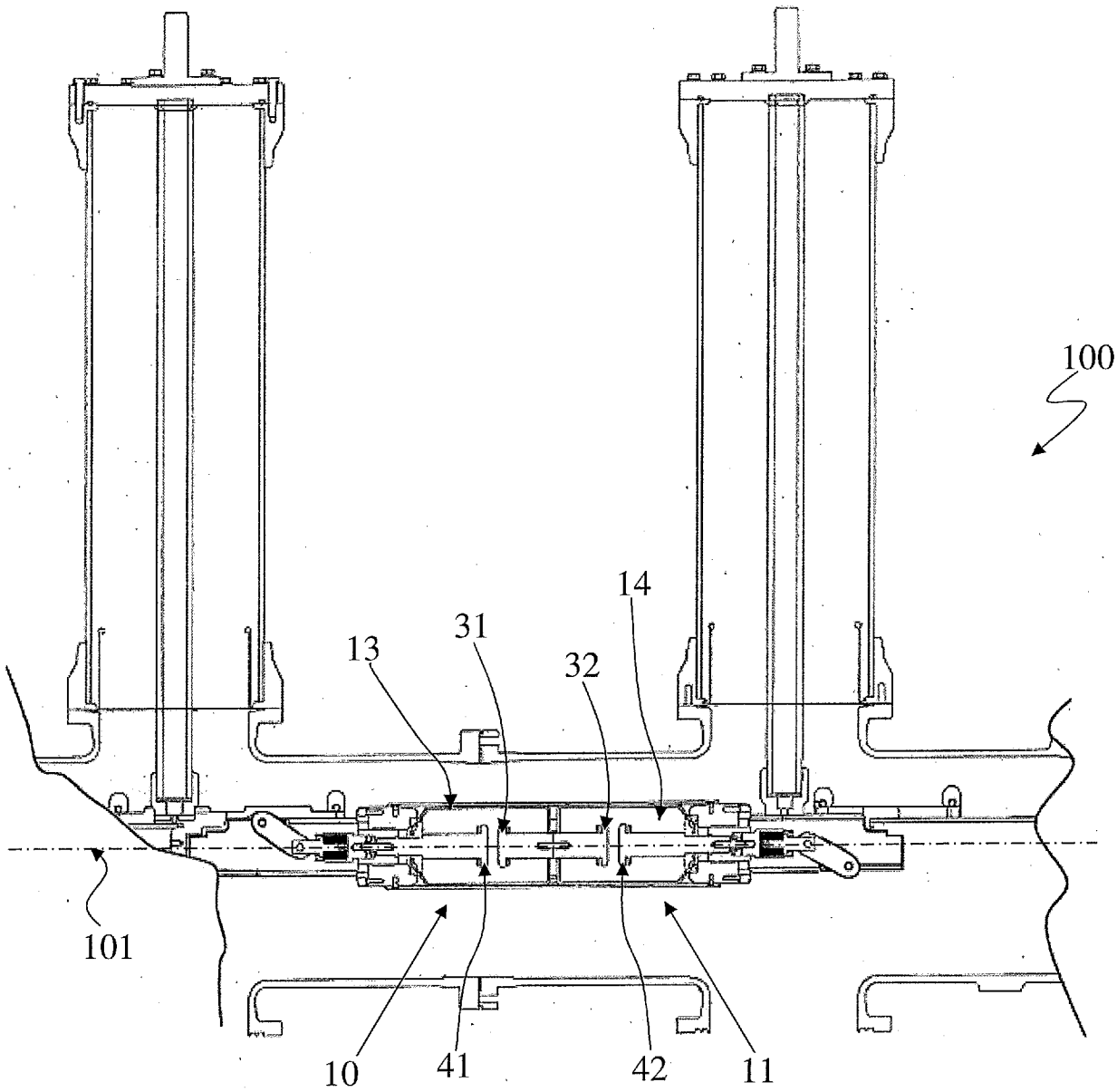


Fig. 2

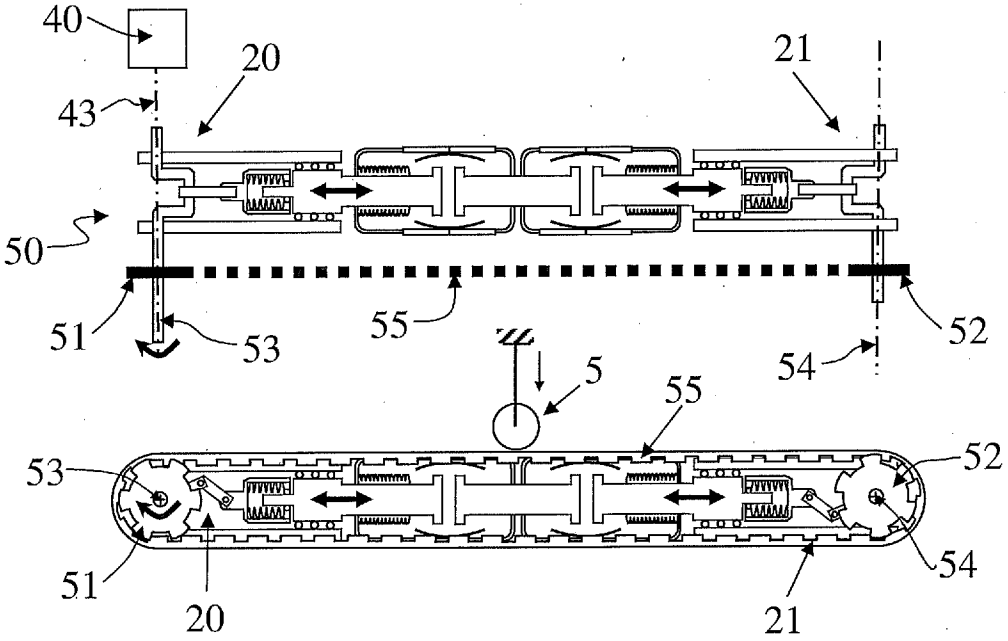


Fig. 3

Fig. 4

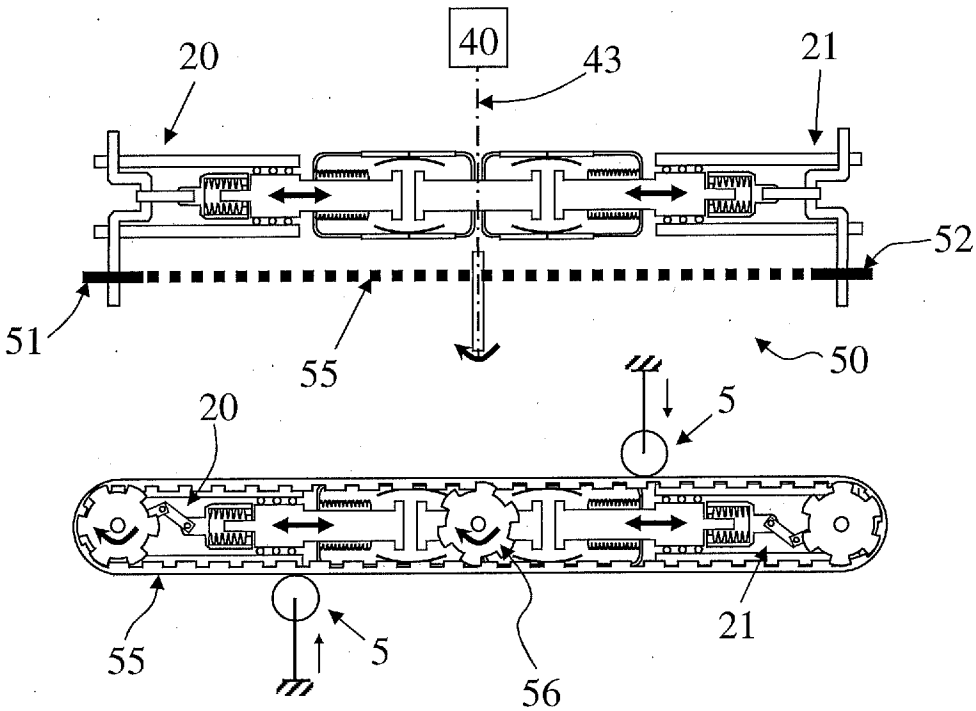


Fig. 5

Fig. 6

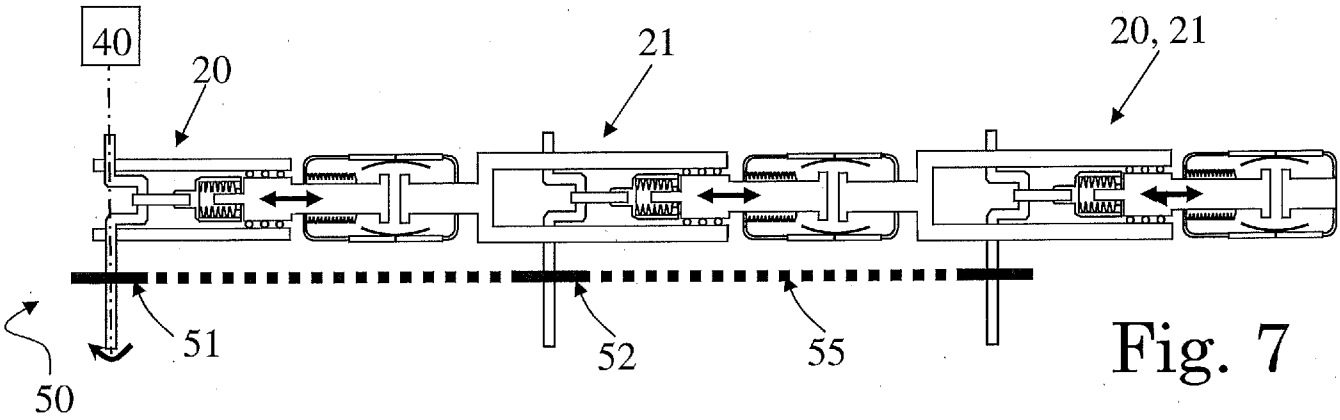


Fig. 7

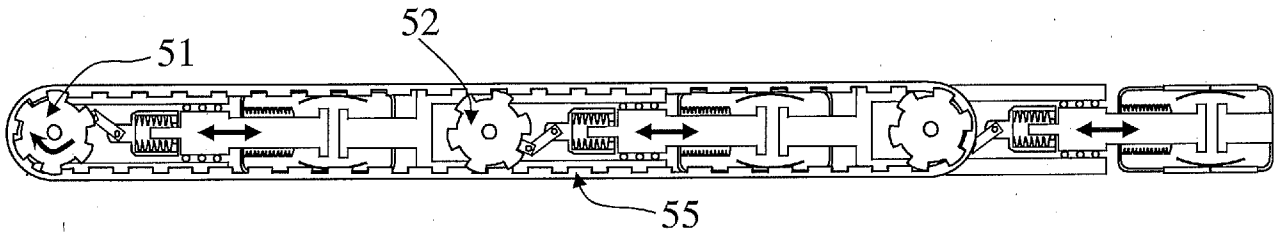


Fig. 8

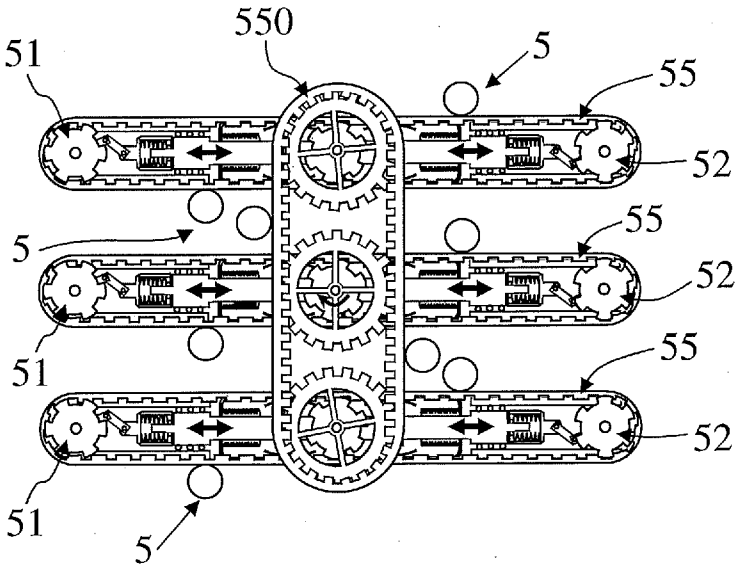


Fig. 9

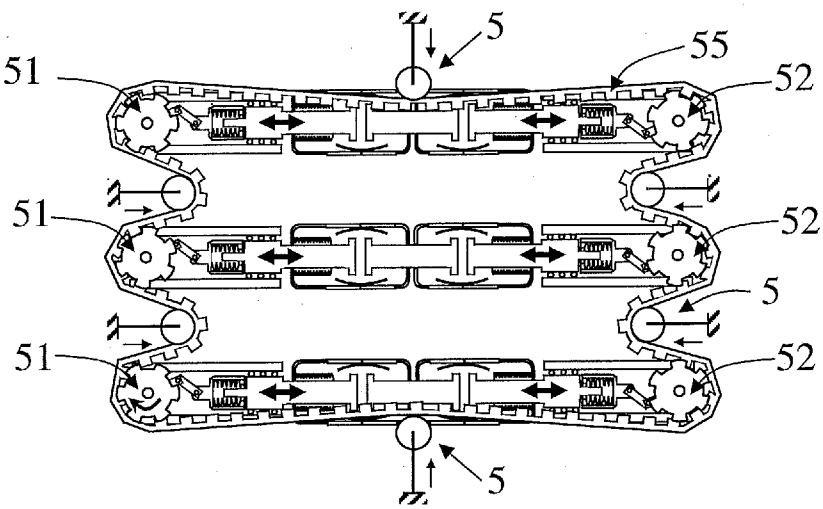


Fig. 10

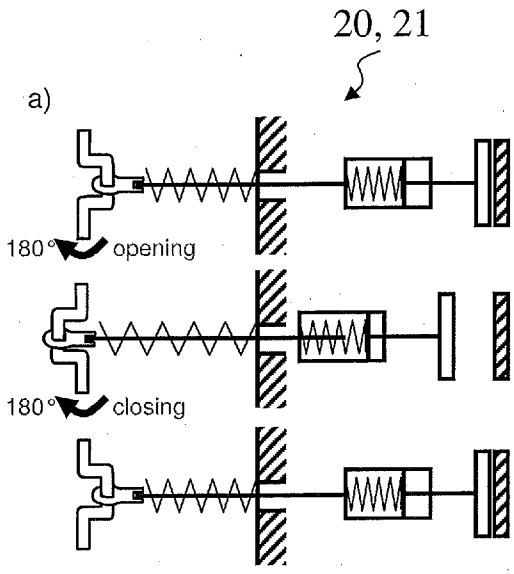


Fig. 11

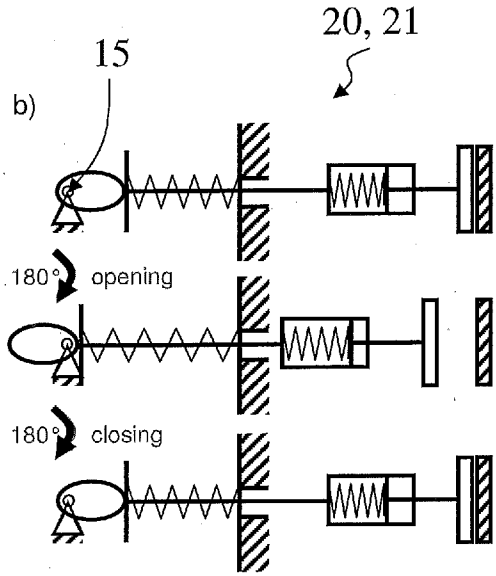


Fig. 12

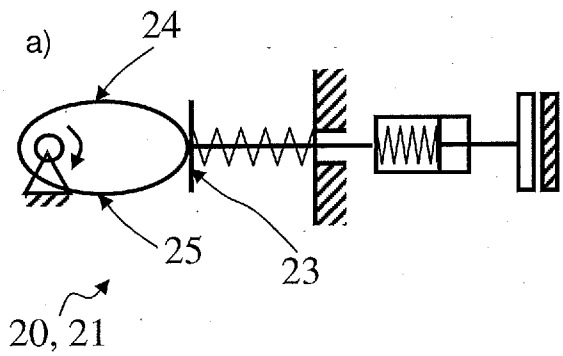


Fig. 13

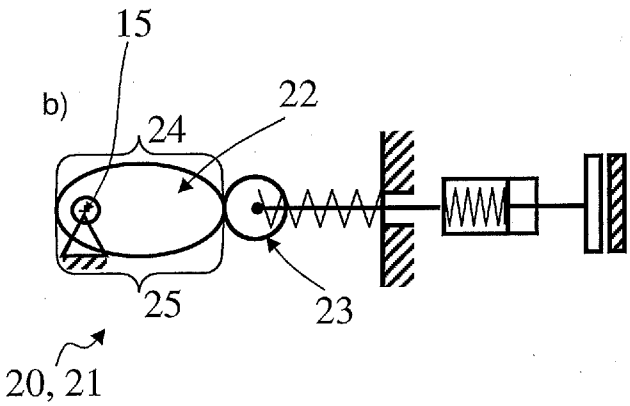


Fig. 14

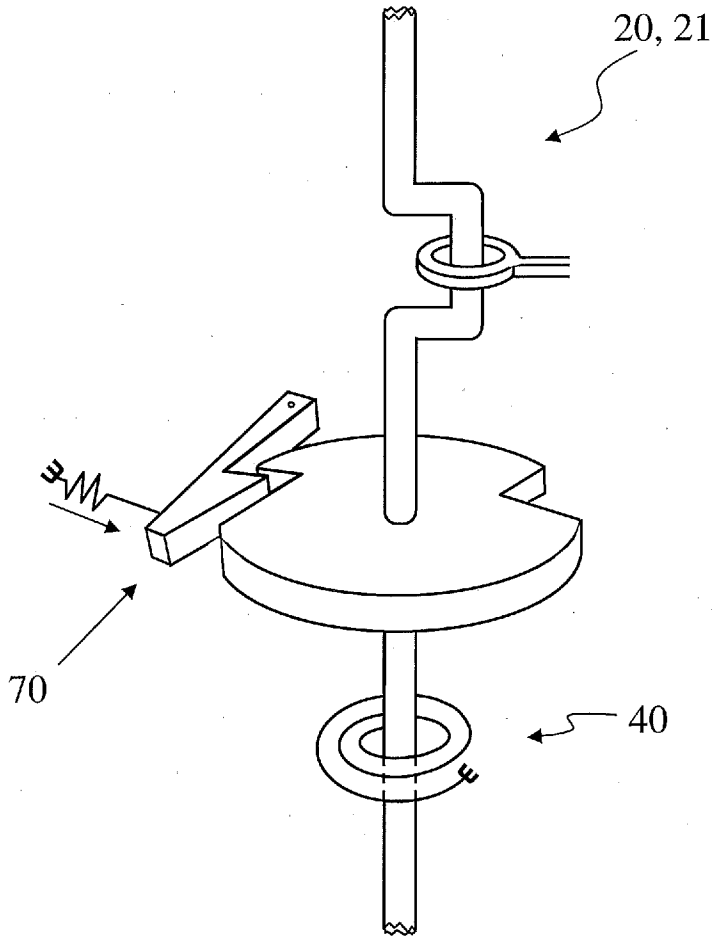


Fig. 15

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/072976

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01H33/14 H01H33/42 H01H33/664 H01H3/36
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 34 27 873 A1 (SLAMECKA ERNST) 15 May 1985 (1985-05-15) page 9, line 7 - line 9 page 11, paragraph 1 - paragraph 3 figures 1, 2	1-18
A	JP S49 30856 U (?) 16 March 1974 (1974-03-16) figures 1-3	1-18
A	DE 10 2005 027016 A1 (SIEMENS AG [DE]) 14 December 2006 (2006-12-14) paragraph [0031] - paragraph [0033] figures 1, 4	1-18

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
1 August 2013	07/08/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Fribert, Jan

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 14 40 195 A1 (SIEMENS AG) 12 December 1968 (1968-12-12) page 11, last paragraph - page 12, last line figures 1-3 -----	1-18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2012/072976

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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JP S4930856 U	16-03-1974	NONE	
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		DE 102005027016 A1	14-12-2006
		EP 1889273 A1	20-02-2008
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DE 1440195 A1	12-12-1968	NONE	