(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 742 292 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
**13.05.2026 Bulletin 2026/20**

(21) Application number: **24212060.8**

(22) Date of filing: **11.11.2024**

(51) International Patent Classification (IPC):
***H01H 3/42*** *(2006.01)* ***H01H 33/666*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
**H01H 33/666; H01H 3/42;** H01H 2033/6667

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
**BA**
Designated Validation States:
**GE KH MA MD TN**

(71) Applicant: **ABB SCHWEIZ AG**
**5400 Baden (CH)**

(72) Inventors:
- **GENTSCH, Dietmar**
  **40882 Ratingen (DE)**
- **REUBER, Christian**
  **47877 Willich (DE)**
- **BELLUT, Markus**
  **40235 Düsseldorf (DE)**

(74) Representative: **Maiwald GmbH**
**Engineering**
**Elisenhof**
**Elisenstrasse 3**
**80335 München (DE)**

# (54) CIRCUIT BREAKER

(57) The present invention relates to a circuit breaker, comprising:
- a vacuum interrupter (10);
- a lever system (50);
- a drive shaft (70); and
- a coupler (80);

wherein the vacuum interrupter comprises a fixed contact and a moveable contact;
wherein a first end of the lever system is connected to the moveable contact;
wherein a first part of the coupler is connected to the drive shaft, and wherein the first part of the coupler is at an on-axis location of the drive shaft;
wherein a second part of the coupler is connected to a second end of the lever system, and wherein the second part of the coupler is at an off-axis location of the drive shaft;
wherein a first rotation of the drive shaft in a first direction is configured to provide a first rotation to the second part of the coupler around the axis of the drive shaft in the first direction; and
wherein the first rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the lever system to move the moveable contact towards, and come into contact with, the fixed contact.

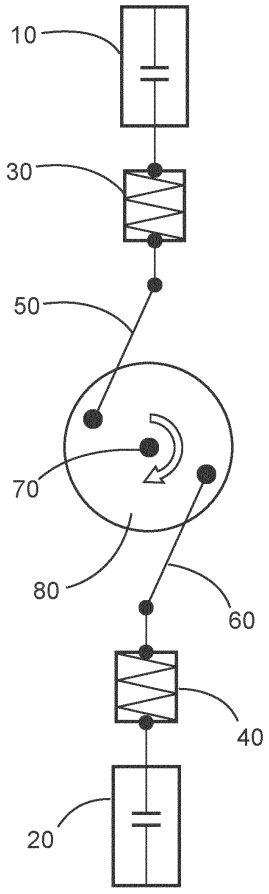


Fig. 1

EP 4 742 292 A1

## Description

### FIELD OF THE INVENTION

**[0001]** The present invention relates to circuit breakers, for a switchgear, such as a low voltage or medium voltage or high voltage circuit switchgear.

### BACKGROUND OF THE INVENTION

**[0002]** To operate a vacuum interrupter, a linear motion is necessary to open and close the contacts of the vacuum interrupter.

**[0003]** For medium voltage circuit breakers it is state-of-the-art to use one vacuum interrupter, or indeed two vacuum interrupters in series, to interrupter short-circuit currents in circuits above 40 KV.

**[0004]** If two vacuum interrupters are operated in series, homogeneous voltage distribution across both vacuum interrupters in the open position and during operation is required.

**[0005]** A preferred situation would be to have a drive mechanism that can be used to drive a single vacuum interrupter if necessary, and also that could be used to drive two vacuum interrupters in series.

**[0006]** Such a drive mechanism does not exist.

**[0007]** There is a need to address this situation.

### SUMMARY OF THE INVENTION

**[0008]** Therefore, it would be advantageous to provide an improved drive mechanism for a circuit breaker of a switchgear that can operate a single vacuum interrupter and two vacuum interrupters in series.

**[0009]** The object of the present invention is solved with the subject matter of the independent claims, wherein further embodiments are incorporated in the dependent claims.

**[0010]** In a first aspect, there is provided a circuit breaker, comprising:

- a vacuum interrupter;
- a lever system;
- a drive shaft; and
- a coupler.

**[0011]** The vacuum interrupter comprises a fixed contact and a moveable contact. A first end of the lever system is connected to the moveable contact. A first part of the coupler is connected to the drive shaft, and the first part of the coupler is at an on-axis location of the drive shaft. A second part of the coupler is connected to a second end of the lever system, and wherein the second part of the coupler is at an off-axis location of the drive shaft. A first rotation of the drive shaft in a first direction is configured to provide a first rotation to the second part of the coupler around the axis of the drive shaft in the first direction. The first rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the lever system to move the moveable contact towards, and come into contact with, the fixed contact.

**[0012]** In this way, a new circuit breaker design is provided where an eccentric kinematic chain is used to convert rotary motion into linear motion to move the moveable contact of a vacuum interrupter.

**[0013]** Thus, by connected the lever system at different distances from the drive shaft, different speeds of operation of the moveable contact can be provided, and where different degrees of length of moveable contact movement can be provided through different amounts of rotation of the drive shaft. In this manner, the same drive system can be utilized for different vacuum interrupters.

**[0014]** In an example, the circuit breaker further comprises an operating stud. The first end of the lever system is connected to the moveable contact via the operating stud. At the end of the first rotation of the second part of the coupler around the axis of the drive shaft in the first direction the operating stud has been activated by a first amount such that a force of a first magnitude is applied by the operating stud to the moveable contact whilst the moveable contact is in contact with the fixed contact.

**[0015]** In an example, activation of the operating stud by the first amount comprises a compression of the operating stud to a first degree.

**[0016]** In an example, a second rotation of the drive shaft in the first direction is configured to provide a second rotation to the second part of the coupler around the axis of the drive shaft in the first direction. The second rotation of the drive shaft is an additional rotation to the first rotation of the drive shaft. The second rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the lever system to maintain the moveable contact in contact with the fixed contact.

**[0017]** In an example, at the end of the second rotation of the second part of the coupler around the axis of the drive shaft in the first direction the operating stud has been activated by a second amount such that a force of a second magnitude is applied by the operating stud to the moveable contact whilst the moveable contact is in contact with the fixed contact. The second magnitude is less than the first magnitude.

**[0018]** In this way, the moveable contact is held securely in position in contact with the fixed contact in that an initial increase in force is required in order to move the moveable contact away from the fixed contact.

**[0019]** In an example, activation of the operating stud by the second amount comprises a compression of the operating stud to a second degree, and the compression of the operating stud to the second degree is less than the compression of the operating stud to the first degree.

**[0020]** In an example, the drive shaft is configured such that after the second rotation of the drive shaft in the first direction the drive shaft cannot rotate further in the first direction.

**[0021]** In an example, a counter rotation of the drive shaft in a second direction opposite to the first direction is configured to provide a counter rotation to the second part of the coupler around the axis of the drive shaft in the second direction. The counter rotation of the second part of the coupler around the axis of the drive shaft in the second direction is configured to activate the lever system to move the moveable contact away from the fixed contact.

**[0022]** In a second aspect, there is provided a circuit breaker, comprising:

- a first vacuum interrupter;
- a second vacuum interrupter;
- a first lever system;
- a second lever system;
- a drive shaft; and
- a coupler.

**[0023]** The first vacuum interrupter comprises a fixed contact and a moveable contact. The second vacuum interrupter comprises a fixed contact and a moveable contact. A first end of the first lever system is connected to the moveable contact of the first vacuum interrupter. A first end of the second lever system is connected to the moveable contact of the second vacuum interrupter. A first part of the coupler is connected to the drive shaft, and the first part of the coupler is at an on-axis location of the drive shaft. A second part of the coupler is connected to a second end of the first lever system, and the second part of the coupler is at an off-axis location of the drive shaft. A third part of the coupler is connected to a second end of the second lever system, and the third part of the coupler is at an off-axis location of the drive shaft. A first rotation of the drive shaft in a first direction is configured to provide a first rotation to the second part of the coupler around the axis of the drive shaft in the first direction and provide a first rotation to the third part of the coupler around the axis of the drive shaft in the first direction. The first rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the first lever system to move the moveable contact of the first vacuum interrupter towards and come into contact with the fixed contact of the first vacuum interrupter, and the first rotation of the third part of the coupler around the axis of the drive shaft in the first direction is configured to activate the second lever system to move the moveable contact of the second vacuum interrupter towards and come into contact with the fixed contact of the second vacuum interrupter.

**[0024]** In this way, a new circuit breaker design is provided where an eccentric kinematic chain is used to convert rotary motion into linear motion to move moveable contacts of two vacuum interrupters synchronously.

**[0025]** It is to be noted that the vacuum interrupters could be identical or could be different, and where the second part of the coupler and the third part of the coupler could be the same axial distance from the drive shaft axis, providing for the same stroke distance, or could be at different axial distances to provide for different stroke lengths, that could be appropriate if two vacuum of different sizes were being utilized that required different magnitudes of movements of the moveable contacts.

**[0026]** In an example, the circuit breaker further comprises a first operating stud and a second operating stud. The first end of the first lever system is connected to the moveable contact of the first vacuum interrupter via the first operating stud. At the end of the first rotation of the second part of the coupler around the axis of the drive shaft in the first direction the first operating stud has been activated by a first amount such that a force of a first magnitude is applied by the first operating stud to the moveable contact of the first vacuum interrupter whilst the moveable contact of the first vacuum interrupter is in contact with the fixed contact of the first vacuum interrupter. The first end of the second lever system is connected to the moveable contact of the second vacuum interrupter via the second operating stud. At the end of the first rotation of the third part of the coupler around the axis of the drive shaft in the first direction the second operating stud has been activated by a second amount such that a force of a second magnitude is applied by the second operating stud to the moveable contact of the second vacuum interrupter whilst the moveable contact of the second vacuum interrupter is in contact with the fixed contact of the second vacuum interrupter.

**[0027]** In an example, activation of the first operating stud by the first amount comprises a compression of the first operating stud to a first degree, and activation of the second operating stud by the second amount comprises a compression of the second operating stud to a second degree.

**[0028]** It is to be noted that the first operating stud and the second operating stud could be identical, but they could be different.

**[0029]** It is also to be noted that the first amount could be the same as the second amount, but the first magnitude could be the different to the second magnitude.

**[0030]** It is also to be noted that the first magnitude could be the same as the second magnitude, but the first magnitude could be the different to the second magnitude.

**[0031]** In an example, a second rotation of the drive shaft in the first direction is configured to provide a second rotation to the second part of the coupler around the axis of the drive shaft in the first direction and provide a second rotation to the third part of the coupler around the axis of the drive shaft in the first direction. The second rotation of the drive shaft is an additional rotation to the first rotation of the drive shaft. The second rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the first lever system to maintain the moveable contact of the first vacuum interrupter in contact with the fixed contact of the first vacuum interrupter. The second rotation of the third part of the coupler around the axis of the drive shaft in the

first direction is configured to activate the second lever system to maintain the moveable contact of the second vacuum interrupter in contact with the fixed contact of the second vacuum interrupter.

**[0032]** In an example, at the end of the second rotation of the second part of the coupler around the axis of the drive shaft in the first direction the first operating stud has been activated by a third amount such that a force of a third magnitude is applied by the first operating stud to the moveable contact of the first vacuum interrupter whilst the moveable contact of the first vacuum interrupter is in contact with the fixed contact of the first vacuum interrupter. The third magnitude is less than the first magnitude. At the end of the second rotation of the third part of the coupler around the axis of the drive shaft in the first direction the second operating stud has been activated by a fourth amount such that a force of a fourth magnitude is applied by the second operating stud to the moveable contact of the second vacuum interrupter whilst the moveable contact of the second vacuum interrupter is in contact with the fixed contact of the second vacuum interrupter. The fourth magnitude is less than the second magnitude.

**[0033]** In this way, the moveable contacts are held securely in position in contact with the fixed contacts in that initial increases in force are required in order to move the moveable contacts away from the fixed contacts.

**[0034]** It is also to be noted that the third amount could be the same as the fourth amount, but the third magnitude could be the different to the fourth magnitude.

**[0035]** It is also to be noted that the third magnitude could be the same as the fourth magnitude, but the third magnitude could be the different to the fourth magnitude.

**[0036]** In an example, activation of the first operating stud by the third amount comprises a compression of the first operating stud to a third degree. The compression of the first operating stud to the third degree is less than the compression of the first operating stud to the first degree. Activation of the second operating stud by the fourth amount comprises a compression of the second operating stud to a fourth degree. The compression of the second operating stud to the fourth degree is less than the compression of the second operating stud to the second degree.

**[0037]** In an example, the drive shaft is configured such that after the second rotation of the drive shaft in the first direction the drive shaft cannot rotate further in the first direction.

**[0038]** In an example, a counter rotation of the drive shaft in a second direction opposite to the first direction is configured to provide a counter rotation to the second part of the coupler around the axis of the drive shaft in the second direction and provide a counter rotation to the third part of the coupler around the axis of the drive shaft in the second direction. The counter rotation of the second part of the coupler around the axis of the drive shaft in the second direction is configured to activate the first lever system to move the moveable contact of the first vacuum interrupter away from the fixed contact of the first vacuum interrupter. The counter rotation of the third part of the coupler around the axis of the drive shaft in the second direction is configured to activate the second lever system to move the moveable contact of the second vacuum interrupter away from the fixed contact of the second vacuum interrupter.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0039]** Exemplary embodiments will be described in the following with reference to the following drawing:

Fig. 1 shows an example of a circuit breaker according to an embodiment of the invention in an open configuration; and

Fig. 2 shows an example of a circuit breaker according to an embodiment of the invention in a closed configuration.

## DETAILED DESCRIPTION OF EMBODIMENTS

**[0040]** Figs. 1-2 relate to the new development for circuit breaker and the mechanism for closing one or two vacuum interrupters.

**[0041]** An exemplar circuit breaker comprises:

- a vacuum interrupter 10;
- a lever system 50;
- a drive shaft 70; and
- a coupler 80.

**[0042]** The vacuum interrupter comprises a fixed contact and a moveable contact. A first end of the lever system is connected to the moveable contact. A first part of the coupler is connected to the drive shaft, and the first part of the coupler is at an on-axis location of the drive shaft. A second part of the coupler is connected to a second end of the lever system, and wherein the second part of the coupler is at an off-axis location of the drive shaft. A first rotation of the drive shaft in a first direction is configured to provide a first rotation to the second part of the coupler around the axis of the drive shaft in the first direction. The first rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the lever system to move the moveable contact towards, and come into contact with, the fixed contact.

**[0043]** In this way, a new circuit breaker design is provided where an eccentric kinematic chain is used to convert rotary motion into linear motion to move the moveable contact of a vacuum interrupter.

**[0044]** Thus, by connected the lever system at different distances from the drive shaft, different speeds of operation of the moveable contact can be provided, and where different degrees of length of moveable contact movement can be provided through different amounts of rota-

tion of the drive shaft. In this manner, the same drive system can be utilized for different vacuum interrupters.

**[0045]** It is to be noted that the coupler 80 could be a disc with its plane perpendicular to the axis of the drive shaft or an arm perpendicular to the axis of the drive shaft.

**[0046]** In an example, the circuit breaker further comprises an operating stud 30. The first end of the lever system is connected to the moveable contact via the operating stud. At the end of the first rotation of the second part of the coupler around the axis of the drive shaft in the first direction the operating stud has been activated by a first amount such that a force of a first magnitude is applied by the operating stud to the moveable contact whilst the moveable contact is in contact with the fixed contact.

**[0047]** The operating stud 30 could comprise a spring mechanism that is able to be compressed and provide an associated restoring force, or could be a piston for example, or anything else that provides a restoring force as it is compressed.

**[0048]** In an example, activation of the operating stud by the first amount comprises a compression of the operating stud to a first degree.

**[0049]** In an example, a second rotation of the drive shaft in the first direction is configured to provide a second rotation to the second part of the coupler around the axis of the drive shaft in the first direction. The second rotation of the drive shaft is an additional rotation to the first rotation of the drive shaft. The second rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the lever system to maintain the moveable contact in contact with the fixed contact

**[0050]** In an example, at the end of the second rotation of the second part of the coupler around the axis of the drive shaft in the first direction the operating stud has been activated by a second amount such that a force of a second magnitude is applied by the operating stud to the moveable contact whilst the moveable contact is in contact with the fixed contact. The second magnitude is less than the first magnitude.

**[0051]** In this way, the moveable contact is held securely in position in contact with the fixed contact in that an initial increase in force is required in order to move the moveable contact away from the fixed contact.

**[0052]** In an example, activation of the operating stud by the second amount comprises a compression of the operating stud to a second degree, and the compression of the operating stud to the second degree is less than the compression of the operating stud to the first degree.

**[0053]** In an example, the drive shaft is configured such that after the second rotation of the drive shaft in the first direction the drive shaft cannot rotate further in the first direction.

**[0054]** In an example, a counter rotation of the drive shaft in a second direction opposite to the first direction is configured to provide a counter rotation to the second part of the coupler around the axis of the drive shaft in the second direction. The counter rotation of the second part of the coupler around the axis of the drive shaft in the second direction is configured to activate the lever system to move the moveable contact away from the fixed contact.

**[0055]** An exemplar circuit breaker comprises:

- a first vacuum interrupter 10;
- a second vacuum interrupter 20;
- a first lever system 50;
- a second lever system 60;
- a drive shaft 70; and
- a coupler 80.

**[0056]** The first vacuum interrupter comprises a fixed contact and a moveable contact. The second vacuum interrupter comprises a fixed contact and a moveable contact. A first end of the first lever system is connected to the moveable contact of the first vacuum interrupter. A first end of the second lever system is connected to the moveable contact of the second vacuum interrupter. A first part of the coupler is connected to the drive shaft, and the first part of the coupler is at an on-axis location of the drive shaft. A second part of the coupler is connected to a second end of the first lever system, and the second part of the coupler is at an off-axis location of the drive shaft. A third part of the coupler is connected to a second end of the second lever system, and the third part of the coupler is at an off-axis location of the drive shaft. A first rotation of the drive shaft in a first direction is configured to provide a first rotation to the second part of the coupler around the axis of the drive shaft in the first direction and provide a first rotation to the third part of the coupler around the axis of the drive shaft in the first direction. The first rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the first lever system to move the moveable contact of the first vacuum interrupter towards and come into contact with the fixed contact of the first vacuum interrupter, and the first rotation of the third part of the coupler around the axis of the drive shaft in the first direction is configured to activate the second lever system to move the moveable contact of the second vacuum interrupter towards and come into contact with the fixed contact of the second vacuum interrupter.

**[0057]** In this way, a new circuit breaker design is provided where an eccentric kinematic chain is used to convert rotary motion into linear motion to move moveable contacts of two vacuum interrupters synchronously.

**[0058]** It is to be noted that the vacuum interrupters could be identical or could be different, and where the second part of the coupler and the third part of the coupler could be the same axial distance from the drive shaft axis, providing for the same stroke distance, or could be at different axial distances to provide for different stroke lengths, that could be appropriate if two vacuum of different sizes were being utilized that required different magnitudes of movements of the moveable contacts.

**[0059]** It is to be noted that the coupler 80 could be a disc with its plane perpendicular to the axis of the drive shaft or two arms perpendicular to the axis of the drive shaft.

**[0060]** It is also to be noted that the two vacuum interrupters 10, 20 need not be oriented opposite to each other at opposite sides of the drive shaft, but could be oriented at 90 degrees to each other. Then rather than the two lever systems 50, 60 being connected to the coupler 80 at 180 degree positions with respect to the drive shaft 70, they would also be mounted at 90 degrees to each other with respect the drive shaft 70.

**[0061]** It is also to be noted that if two vacuum interrupters of different sizes were utilized, then a mounting point of the lever of the smaller vacuum interrupter (with a smaller required operational movement of the moveable contact being required) could be brought inwards towards the drive shaft and there would still be synchrony of movement of the moveable contacts of the two vacuum interrupters, but different movement distances of the moveable contacts provided.

**[0062]** In an example, the circuit breaker further comprises a first operating stud 30 and a second operating stud 40. The first end of the first lever system is connected to the moveable contact of the first vacuum interrupter via the first operating stud. At the end of the first rotation of the second part of the coupler around the axis of the drive shaft in the first direction the first operating stud has been activated by a first amount such that a force of a first magnitude is applied by the first operating stud to the moveable contact of the first vacuum interrupter whilst the moveable contact of the first vacuum interrupter is in contact with the fixed contact of the first vacuum interrupter. The first end of the second lever system is connected to the moveable contact of the second vacuum interrupter via the second operating stud. At the end of the first rotation of the third part of the coupler around the axis of the drive shaft in the first direction the second operating stud has been activated by a second amount such that a force of a second magnitude is applied by the second operating stud to the moveable contact of the second vacuum interrupter whilst the moveable contact of the second vacuum interrupter is in contact with the fixed contact of the second vacuum interrupter.

**[0063]** In an example, activation of the first operating stud by the first amount comprises a compression of the first operating stud to a first degree, and activation of the second operating stud by the second amount comprises a compression of the second operating stud to a second degree.

**[0064]** It is to be noted that the first operating stud and the second operating stud could be identical, but they could be different.

**[0065]** It is also to be noted that the first amount could be the same as the second amount, but the first magnitude could be the different to the second magnitude.

**[0066]** It is also to be noted that the first magnitude could be the same as the second magnitude, but the first magnitude could be the different to the second magnitude.

**[0067]** In an example, a second rotation of the drive shaft in the first direction is configured to provide a second rotation to the second part of the coupler around the axis of the drive shaft in the first direction and provide a second rotation to the third part of the coupler around the axis of the drive shaft in the first direction. The second rotation of the drive shaft is an additional rotation to the first rotation of the drive shaft. The second rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the first lever system to maintain the moveable contact of the first vacuum interrupter in contact with the fixed contact of the first vacuum interrupter. The second rotation of the third part of the coupler around the axis of the drive shaft in the first direction is configured to activate the second lever system to maintain the moveable contact of the second vacuum interrupter in contact with the fixed contact of the second vacuum interrupter.

**[0068]** In an example, at the end of the second rotation of the second part of the coupler around the axis of the drive shaft in the first direction the first operating stud has been activated by a third amount such that a force of a third magnitude is applied by the first operating stud to the moveable contact of the first vacuum interrupter whilst the moveable contact of the first vacuum interrupter is in contact with the fixed contact of the first vacuum interrupter. The third magnitude is less than the first magnitude. At the end of the second rotation of the third part of the coupler around the axis of the drive shaft in the first direction the second operating stud has been activated by a fourth amount such that a force of a fourth magnitude is applied by the second operating stud to the moveable contact of the second vacuum interrupter whilst the moveable contact of the second vacuum interrupter is in contact with the fixed contact of the second vacuum interrupter. The fourth magnitude is less than the second magnitude.

**[0069]** In this way, the moveable contacts are held securely in position in contact with the fixed contacts in that initial increases in force are required in order to move the moveable contacts away from the fixed contacts.

**[0070]** It is also to be noted that the third amount could be the same as the fourth amount, but the third magnitude could be the different to the fourth magnitude.

**[0071]** It is also to be noted that the third magnitude could be the same as the fourth magnitude, but the third magnitude could be the different to the fourth magnitude.

**[0072]** In an example, activation of the first operating stud by the third amount comprises a compression of the first operating stud to a third degree. The compression of the first operating stud to the third degree is less than the compression of the first operating stud to the first degree. Activation of the second operating stud by the fourth amount comprises a compression of the second operating stud to a fourth degree. The compression of the second operating stud to the fourth degree is less than

the compression of the second operating stud to the second degree.

**[0073]** In an example, the drive shaft is configured such that after the second rotation of the drive shaft in the first direction the drive shaft cannot rotate further in the first direction.

**[0074]** In an example, a counter rotation of the drive shaft in a second direction opposite to the first direction is configured to provide a counter rotation to the second part of the coupler around the axis of the drive shaft in the second direction and provide a counter rotation to the third part of the coupler around the axis of the drive shaft in the second direction. The counter rotation of the second part of the coupler around the axis of the drive shaft in the second direction is configured to activate the first lever system to move the moveable contact of the first vacuum interrupter away from the fixed contact of the first vacuum interrupter. The counter rotation of the third part of the coupler around the axis of the drive shaft in the second direction is configured to activate the second lever system to move the moveable contact of the second vacuum interrupter away from the fixed contact of the second vacuum interrupter.

**[0075]** A specific detailed embodiment is now described, where reference is again made to Figs- 1-2.

**[0076]** A rotary motor is used as a drive solution, where the rotary motion is converted into a linear motion to be able to operate the vacuum interrupters 10, 20. The rotary motor turns a shaft 70 that is connected to a disc 80 or a segmented part 80. Two levers 50, 60 are fixed on the disc or segmented part and each connected to one operating stud 30, 40 which is connected to the moveable contact of each vacuum interrupter.

**[0077]** Fig. 1 shows the kinematic chain where the vacuum interrupter is in OFF position. If the disc or segmented part turns clockwise, driven by the rotary motor, a linear motion of the operating studs is realized via the levers. The moveable contacts of the vacuum interrupters move in vertical direction until movable and fixed contacts are touching. The design could be made where a counterclockwise movement generates this movement.

**[0078]** Closing operation:

With further rotation of the shaft the springs of the operating studs are compressed. A stable ON position is realized by turning the shaft a few degrees beyond the vertical breakover point (dead point) so that the springs of the operating studs start to relax. This is shown in Fig. 2 that shows the kinematic chain where the vacuum interrupter is in the ON position. At this position an end-stop is provided ensuring a stable end position in the closed position. The contact spring relaxation need only be limited,
because the linear movement around the dead point is very low, and the contacts still remains in contact under the contact spring force.

**[0079]** Opening operation:
To open the vacuum interrupter from closed end stop position is achieved by turning the shaft counterclockwise. At the onset of this movement the springs of the operating studs must first be compressed until the breakover point (dead point) is exceeded after a few degrees of rotating.

**[0080]** The mechanical connection of both operating studs to the eccentric results to a synchronous operating of both vacuum interrupters. An advantage of the double lever and double vacuum design is that based on the non-linear movement while closing, both counterforces generated from contact springs are lower thanks to the given non-linear travel. Also, as detailed above synchronous closing is also provided for both vacuum interrupters, and the design can be utilized for a single vacuum interrupter of different designs, and indeed two vacuum interrupters of different designs can be synchronously operated.

Reference numerals

**[0081]**

| | |
|---|---|
| 10 | Vacuum interrupter |
| 20 | Second vacuum interrupter |
| 30 | Operating stud |
| 40 | Second operating stud |
| 50 | Lever system |
| 60 | Second lever system |
| 70 | Drive shaft |
| 80 | Coupler |

**Claims**

**1.** A circuit breaker, comprising:

- a vacuum interrupter (10);
- a lever system (50);
- a drive shaft (70); and
- a coupler (80);

wherein the vacuum interrupter comprises a fixed contact and a moveable contact;
wherein a first end of the lever system is connected to the moveable contact;
wherein a first part of the coupler is connected to the drive shaft, and wherein the first part of the coupler is at an on-axis location of the drive shaft;
wherein a second part of the coupler is connected to a second end of the lever system, and wherein the second part of the coupler is at an off-axis location of the drive shaft;
wherein a first rotation of the drive shaft in a first direction is configured to provide a first rotation to the second part of the coupler around the axis of the drive shaft in the first

direction; and
wherein the first rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the lever system to move the moveable contact towards, and come into contact with, the fixed contact.

**2.** Circuit breaker according to claim 1, further comprising an operating stud (30), wherein the first end of the lever system is connected to the moveable contact via the operating stud, and wherein at the end of the first rotation of the second part of the coupler around the axis of the drive shaft in the first direction the operating stud has been activated by a first amount such that a force of a first magnitude is applied by the operating stud to the moveable contact whilst the moveable contact is in contact with the fixed contact.

**3.** Circuit breaker according to claim 2, wherein activation of the operating stud by the first amount comprises a compression of the operating stud to a first degree.

**4.** Circuit breaker according to any of claims 1-3, wherein a second rotation of the drive shaft in the first direction is configured to provide a second rotation to the second part of the coupler around the axis of the drive shaft in the first direction, wherein the second rotation of the drive shaft is an additional rotation to the first rotation of the drive shaft, and wherein the second rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the lever system to maintain the moveable contact in contact with the fixed contact

**5.** Circuit breaker according to claim 4 when dependent upon any of claims 2-3, wherein at the end of the second rotation of the second part of the coupler around the axis of the drive shaft in the first direction the operating stud has been activated by a second amount such that a force of a second magnitude is applied by the operating stud to the moveable contact whilst the moveable contact is in contact with the fixed contact, and wherein the second magnitude is less than the first magnitude.

**6.** Circuit breaker according to claim 5, wherein activation of the operating stud by the second amount comprises a compression of the operating stud to a second degree, and wherein the compression of the operating stud to the second degree is less than the compression of the operating stud to the first degree.

**7.** Circuit breaker according to any of claims 4-6, wherein the drive shaft is configured such that after the second rotation of the drive shaft in the first direction the drive shaft cannot rotate further in the first direction.

**8.** Circuit breaker according to any of claims 1-7, wherein a counter rotation of the drive shaft in a second direction opposite to the first direction is configured to provide a counter rotation to the second part of the coupler around the axis of the drive shaft in the second direction, and
wherein the counter rotation of the second part of the coupler around the axis of the drive shaft in the second direction is configured to activate the lever system to move the moveable contact away from the fixed contact.

**9.** A circuit breaker, comprising:

- a first vacuum interrupter (10);
- a second vacuum interrupter (20);
- a first lever system (50);
- a second lever system (60);
- a drive shaft (70); and
- a coupler (80);

wherein the first vacuum interrupter comprises a fixed contact and a moveable contact;
wherein the second vacuum interrupter comprises a fixed contact and a moveable contact;
wherein a first end of the first lever system is connected to the moveable contact of the first vacuum interrupter;
wherein a first end of the second lever system is connected to the moveable contact of the second vacuum interrupter;
wherein a first part of the coupler is connected to the drive shaft, and wherein the first part of the coupler is at an on-axis location of the drive shaft;
wherein a second part of the coupler is connected to a second end of the first lever system, and wherein the second part of the coupler is at an off-axis location of the drive shaft;
wherein a third part of the coupler is connected to a second end of the second lever system, and wherein the third part of the coupler is at an off-axis location of the drive shaft;
wherein a first rotation of the drive shaft in a first direction is configured to provide a first rotation to the second part of the coupler around the axis of the drive shaft in the first direction and provide a first rotation to the third part of the coupler around the axis of the drive shaft in the first direction; and

wherein the first rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the first lever system to move the moveable contact of the first vacuum interrupter towards and come into contact with the fixed contact of the first vacuum interrupter, and the first rotation of the third part of the coupler around the axis of the drive shaft in the first direction is configured to activate the second lever system to move the moveable contact of the second vacuum interrupter towards and come into contact with the fixed contact of the second vacuum interrupter.

**10.** Circuit breaker according to claim 9, further comprising a first operating stud (30) and a second operating stud (40); wherein the first end of the first lever system is connected to the moveable contact of the first vacuum interrupter via the first operating stud, and wherein at the end of the first rotation of the second part of the coupler around the axis of the drive shaft in the first direction the first operating stud has been activated by a first amount such that a force of a first magnitude is applied by the first operating stud to the moveable contact of the first vacuum interrupter whilst the moveable contact of the first vacuum interrupter is in contact with the fixed contact of the first vacuum interrupter; and wherein the first end of the second lever system is connected to the moveable contact of the second vacuum interrupter via the second operating stud, and wherein at the end of the first rotation of the third part of the coupler around the axis of the drive shaft in the first direction the second operating stud has been activated by a second amount such that a force of a second magnitude is applied by the second operating stud to the moveable contact of the second vacuum interrupter whilst the moveable contact of the second vacuum interrupter is in contact with the fixed contact of the second vacuum interrupter.

**11.** Circuit breaker according to any of claims 9-10, wherein a second rotation of the drive shaft in the first direction is configured to provide a second rotation to the second part of the coupler around the axis of the drive shaft in the first direction and provide a second rotation to the third part of the coupler around the axis of the drive shaft in the first direction, wherein the second rotation of the drive shaft is an additional rotation to the first rotation of the drive shaft, and wherein the second rotation of the second part of the coupler around the axis of the drive shaft in the first direction is configured to activate the first lever system to maintain the moveable contact of the first vacuum interrupter in contact with the fixed contact of the first vacuum interrupter, and wherein the second rotation of the third part of the coupler around the axis of the drive shaft in the first direction is configured to activate the second lever system to maintain the moveable contact of the second vacuum interrupter in contact with the fixed contact of the second vacuum interrupter.

**12.** Circuit breaker according to claim 11 when dependent upon claim 10, wherein at the end of the second rotation of the second part of the coupler around the axis of the drive shaft in the first direction the first operating stud has been activated by a third amount such that a force of a third magnitude is applied by the first operating stud to the moveable contact of the first vacuum interrupter whilst the moveable contact of the first vacuum interrupter is in contact with the fixed contact of the first vacuum interrupter, and wherein the third magnitude is less than the first magnitude; and wherein at the end of the second rotation of the third part of the coupler around the axis of the drive shaft in the first direction the second operating stud has been activated by a fourth amount such that a force of a fourth magnitude is applied by the second operating stud to the moveable contact of the second vacuum interrupter whilst the moveable contact of the second vacuum interrupter is in contact with the fixed contact of the second vacuum interrupter, and wherein the fourth magnitude is less than the second magnitude.

**13.** Circuit breaker according to claim 12, wherein activation of the first operating stud by the third amount comprises a compression of the first operating stud to a third degree, and wherein the compression of the first operating stud to the third degree is less than the compression of the first operating stud to the first degree; and wherein activation of the second operating stud by the fourth amount comprises a compression of the second operating stud to a fourth degree, and wherein the compression of the second operating stud to the fourth degree is less than the compression of the second operating stud to the second degree.

**14.** Circuit breaker according to any of claims 11-13, wherein the drive shaft is configured such that after the second rotation of the drive shaft in the first direction the drive shaft cannot rotate further in the first direction.

**15.** Circuit breaker according to any of claims 9-14, wherein a counter rotation of the drive shaft in a second direction opposite to the first direction is configured to provide a counter rotation to the second part of the coupler around the axis of the drive shaft in the second direction and provide a counter rotation to the third part of the coupler around the axis of the drive shaft in the second direction, wherein the

counter rotation of the second part of the coupler around the axis of the drive shaft in the second direction is configured to activate the first lever system to move the moveable contact of the first vacuum interrupter away from the fixed contact of the first vacuum interrupter, and wherein the counter rotation of the third part of the coupler around the axis of the drive shaft in the second direction is configured to activate the second lever system to move the moveable contact of the second vacuum interrupter away from the fixed contact of the second vacuum interrupter.

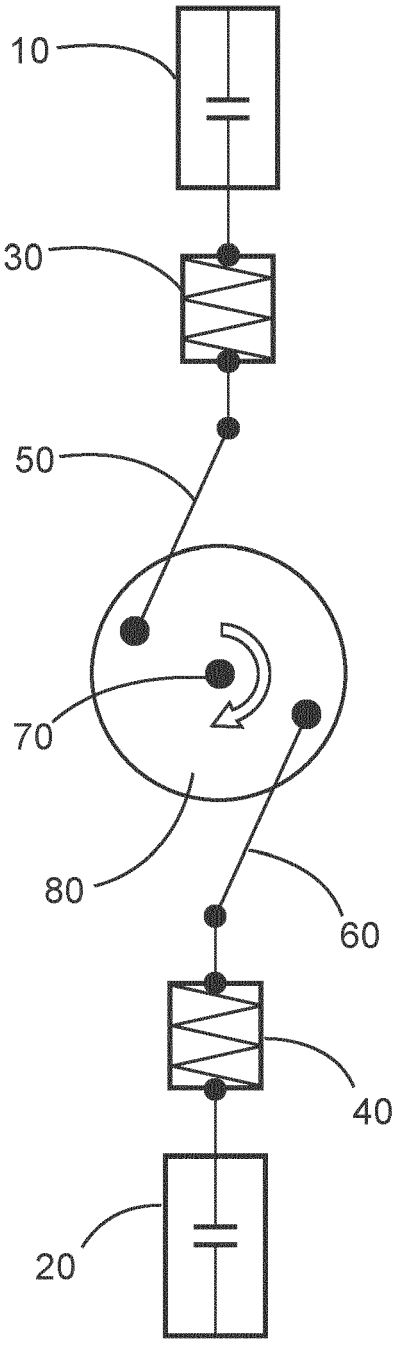


Fig. 1

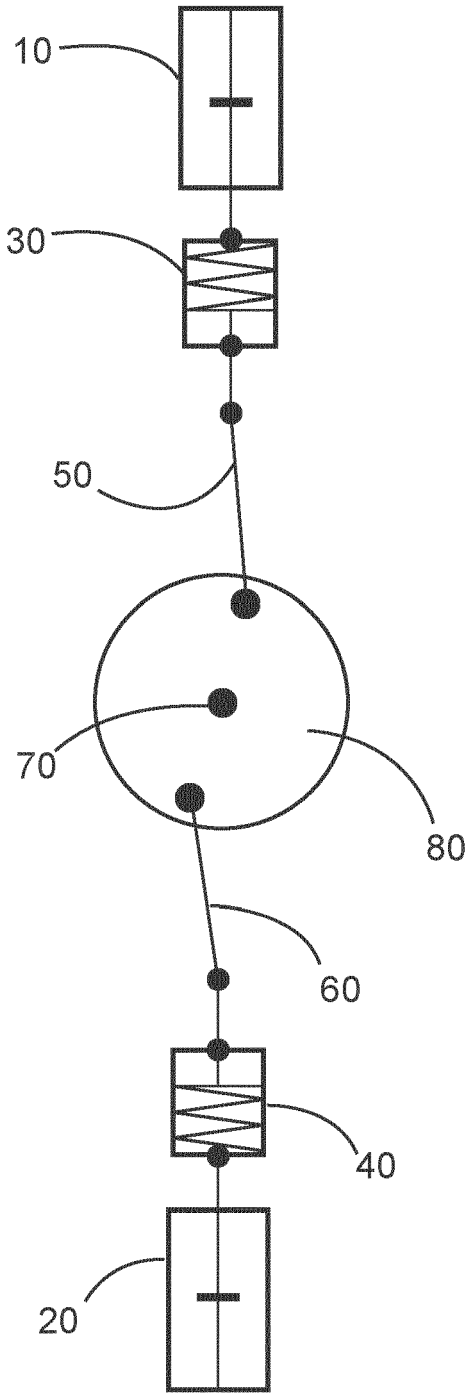


Fig. 2

Europäisches Patentamt
European Patent Office
Office européen des brevets

# EUROPEAN SEARCH REPORT

Application Number
EP 24 21 2060

## 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 | DE 199 06 156 C2 (SIEMENS AG [DE]) 13 December 2001 (2001-12-13) * abstract; figures 1-3 * * paragraphs [0001], [0005] - [0029] * | 1-15 | INV. H01H3/42 H01H33/666 |
| X | US 4 016 385 A (GOLIOTO IGOR) 5 April 1977 (1977-04-05) * abstract; figures 2,3 * * column 1, line 59 - column 4, line 50 * | 1-15 | |
| X | DE 20 2011 106188 U1 (DRIESCHER SPEZIALFAB FRITZ [DE]) 9 January 2013 (2013-01-09) * abstract; figures 1-3 * * paragraphs [0001], [0002], [0006] - [0010] * * paragraphs [0014] - [0026] * | 1-9 | |
| A | US 4 563 554 A (PERRENOUD BLAISE [CH]) 7 January 1986 (1986-01-07) * abstract; figures 1-3,5-8 * | 1-15 | |

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 | 5 March 2025 | Bauer, Rodolphe |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

# ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 21 2060

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-03-2025

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| DE 19906156 C2 | 13-12-2001 | NONE | |
| US 4016385 A | 05-04-1977 | NONE | |
| DE 202011106188 U1 | 09-01-2013 | DE 202011106188 U1 | 09-01-2013 |
| | | DK 2575153 T3 | 30-10-2017 |
| | | EP 2575153 A2 | 03-04-2013 |
| US 4563554 A | 07-01-1986 | CH 660931 A5 | 29-05-1987 |
| | | DE 3313729 A1 | 04-10-1984 |
| | | FR 2543731 A1 | 05-10-1984 |
| | | JP S59181433 A | 15-10-1984 |
| | | US 4563554 A | 07-01-1986 |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82