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(54) CIRCUIT BREAKER, CIRCUIT BREAKER OVERTRAVEL ADJUSTMENT METHOD AND POWER SYSTEM

(57) The present invention provides a circuit breaker, a circuit breaker overtravel adjustment method and a power system. The circuit breaker comprises an arc extinguishing structure, a moving contact, and a static contact. The circuit breaker further comprises: a driving assembly is connected to the moving contact, and the moving contact is driven to make contact with or separate from the static contact. The driving assembly has an accommodating cavity. A contact pressure spring is provided within the accommodating cavity and abuts between the moving contact and the driving assembly, and is used to apply a force to the moving contact toward the static contact when the circuit breaker is in a closed state. A detection assembly comprises a pressure detector and a distance sensor. The pressure detector is disposed between the contact pressure spring and the driving assembly, and measures the pressure value of the contact pressure spring when the moving contact and the static contact tightly abut. The distance sensor is used to detect the measure distance between the moving contact and the distance sensor so as to determine the overtravel between the moving contact and the static contact according to the pressure value and the detection distance. The circuit breaker has higher reliability.

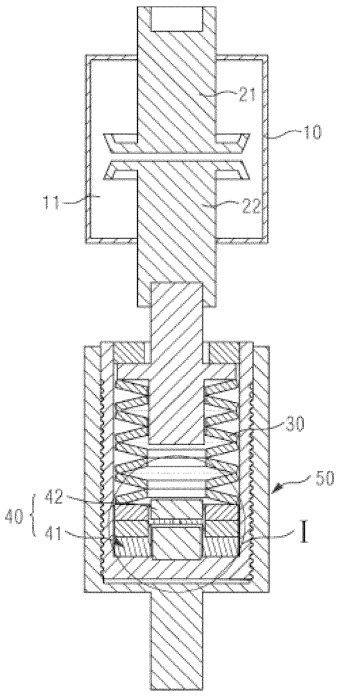

Fig. 1

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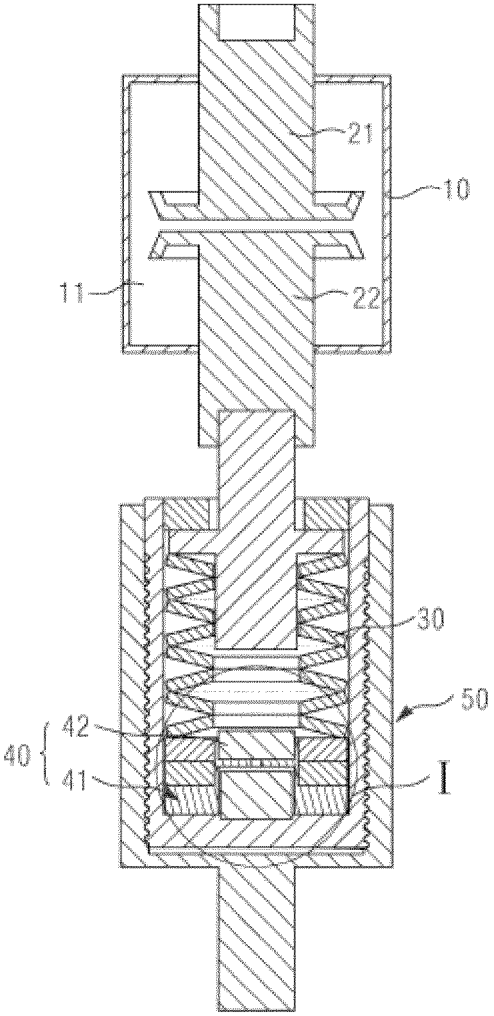

Fig. 1

Description

Technical Field

[0001] The present invention relates to the field of mechanical equipment, and in particular to a circuit breaker, a circuit breaker overtravel adjustment method and a power system.

Background Art

[0002] Circuit breakers (for example, vacuum circuit breakers) are important switching equipment of a power system. During the running of the power system, circuit breakers can connect or cut off load currents of electrical equipment. When exceptions occur to the power system, circuit breakers can reliably cut off a short-circuit current.

[0003] To guarantee that circuit breakers are able to stably and reliably connect or cut off a current and guarantee the mechanical life of circuit breakers, a contact pressure spring is connected to the moving contact of circuit breakers. When circuit breakers are in a closed state, the contact pressure spring accumulates energy to drive the moving contact to move away from the static contact quickly to open circuit breakers again, and the opening reliability is improved.

[0004] To guarantee a low contact resistance between the moving contact and the static contact in a closed state of circuit breakers, the contact pressure spring has a certain overtravel. Overtravel refers to the length to which the contact pressure spring continues to be compressed after the moving contact and the static contact are in contact with each other in the closing process. The overtravel can increase the contact pressure between the moving contact and the static contact to guarantee the reliable connection and cut-off of a current and the mechanical life of circuit breakers.

[0005] In the prior art, to determine whether the overtravel between the moving contact and the static contact satisfies the requirement, a pressure detector is adopted to measure the pressure of the contact pressure spring. Since a linear relationship exists between the pressure and the overtravel, the overtravel can be calculated according to the pressure. However, the precision in this testing method will decrease for the reasons such as wear-out after circuit breakers are used for a period of time. As a result, the measured overtravel is incorrect, and the safety and reliability of the running of circuit breakers are influenced.

Summary of the Invention

[0006] To at least partially solve the abovementioned problem, the present invention provides a circuit breaker, a circuit breaker overtravel adjustment method and a power system.

[0007] According to a first aspect of embodiments of the present disclosure, a circuit breaker is provided. The circuit breaker comprises an arc extinguishing structure, a moving contact and a static contact. The arc extinguishing structure has an arc extinguishing chamber, at least a part of the static contact stretches into the arc extinguishing chamber, and a part of the moving contact stretches into the arc extinguishing chamber. The circuit breaker further comprises a driving assembly, the driving assembly being connected with the moving contact and driving the moving contact to contact or separate from the static contact, and the driving assembly having an accommodating cavity; a contact pressure spring, the contact pressure spring being provided in the accommodating cavity, abutting between the moving contact and the driving assembly and being used to apply an acting force toward the static contact to the moving contact in a closed state of the circuit breaker; a detection assembly, the detection assembly comprising a pressure detector and a distance sensor, the pressure detector being provided between the contact pressure spring and the driving assembly to detect the pressure of the contact pressure spring when the moving contact and the static contact abut tightly against each other, and the distance sensor being used to detect the detection distance between the moving contact and the distance sensor so that the overtravel between the moving contact and the static contact can be determined according to the pressure and the detection distance.

[0008] Alternatively, when the circuit breaker is in an open state, the distance between the moving contact and the static contact can be adjusted.

[0009] Alternatively, the driving assembly comprises an insulating pull rod and a bushing, the bushing is provided in the insulating pull rod and can be driven by the insulating pull rod to move relative to the static contact, the length the bushing protrudes out of the insulating pull rod can be adjusted to adjust the distance between the moving contact and the static contact in an open state, the accommodating cavity is provided in the bushing, and the contact pressure spring and the detection assembly are provided in the accommodating cavity of the bushing.

[0010] Alternatively, the insulating pull rod and the bushing are thread-connected.

[0011] Alternatively, the moving contact comprises a contact body and a moving rod, the moving rod is detachably connected with the contact body, at least a part of the moving rod stretches into the accommodating cavity and abuts against the contact pressure spring, and the distance sensor is used to measure the distance between one end of the moving rod in the accommodating cavity and the distance sensor.

[0012] Alternatively, the moving rod comprises a rod body and a retaining flange, the retaining flange is provided outside the rod body, the extension direction of the retaining flange is perpendicular to the lengthwise direction of the rod body, a cover plate for retaining the retaining flange is provided in the bushing, a first end of the contact pressure spring abuts against the retaining flange, and a second end of the contact pressure spring

abuts against the pressure detector.

[0013] Alternatively, the pressure detector comprises an upper cover, a pressure-sensitive element and a base, the base is provided on the driving assembly, the pressure-sensitive element is fixedly provided on the base, the upper cover covers the pressure-sensitive element, and the contact pressure spring abuts against the upper cover.

[0014] Alternatively, the circuit breaker further comprises a data transmission unit, and the data transmission unit is respectively electrically connected with the pressure detector and the distance sensor to receive and transmit a pressure acquired by the pressure detector and the detection data of the distance sensor.

[0015] According to a further aspect of the present application, a circuit breaker overtravel adjustment method is provided, the method is used for the abovementioned circuit breaker, and the method comprises: receiving a pressure, detected by the pressure detector, of the contact pressure spring and a detection distance detected by the distance sensor; if at least one of the conditions that the pressure is less than a preset nominal pressure and the detection distance is greater than a preset nominal distance is satisfied, generating a driving assembly adjustment message to indicate an adjustment of the length by which the bushing in the driving assembly protrudes out of the insulating pull rod.

[0016] According to yet a further aspect of the present application, a power system is provided, and the power system comprises the abovementioned circuit breaker.

[0017] The arc extinguishing structure in the present embodiment can be used for installing and protecting the moving contact and the static contact. The closing and opening of the circuit breaker are realized through the contact of the moving contact with the static contact and the separation of the moving contact from the static contact. The driving assembly is used to drive the moving contact to move. The contact pressure spring is provided in the accommodating cavity of the driving assembly, the contact pressure spring is used to provide an abutting force for the moving contact in a closed state, and in addition, the contact pressure spring accumulates some energy in a closing process of the circuit breaker to provide high initial energy for the moving contact at the time of the opening of the circuit breaker so that the moving contact can be separated from the static contact at high speed in an initial condition to break an electrical arc and/or a melted solder connection between the moving contact and the static contact. In order to accurately detect the overtravel of the contact pressure spring and ensure that the abutting force corresponding to the overtravel between the moving contact and the static contact satisfies the requirement, a detection assembly is provided in the accommodating cavity. The detection assembly comprises the pressure detector and the distance sensor. The pressure detector detects the pressure (the pressure is roughly equal to the abutting force the contact pressure spring provides for the moving contact, the rough equality means that the difference between the pressure and the abutting force is less than the allowable error, and the allowable error can be determined according to the specific structure of the circuit breaker, the gravity of the moving contact and other factors, which are not restricted in the present embodiment) of the contact pressure spring, and the distance sensor detects the detection distance between the moving contact and the distance sensor. In this way, the real overtravel and the abutting force between the moving contact and the static contact can be determined according to the detected pressure and detection distance. Thus, the detection accuracy is improved and the problem of an insufficient abutting force caused by fatigue relaxation of the contact pressure spring, or the wear-out or ablation of the moving contact or the static contact can be avoided.

Brief Description of the Drawings

[0018] The drawings below are intended to illustrate and explain the embodiments of the disclosure, but are not used to restrict the scope of the embodiments of the disclosure. In the drawings,

Fig. 1 is a cutaway view of a circuit breaker provided by the present application,

Fig. 2 is a partial enlarged view of position I in Fig. 1, and

Fig. 3 is a 3D cutaway view of a circuit breaker provided by the present application.

Brief description of reference numerals in the drawings:

[0019] 10: arc extinguishing structure; 11: arc extinguishing chamber; 21: static contact; 22: moving contact; 221: contact body; 222: moving rod; 2221: retaining flange; 30: contact pressure spring; 40: detection assembly; 41: pressure detector; 411: upper cover; 412: pressure-sensitive element; 413: base; 42: distance sensor; 43: data transmission unit; 50: driving assembly; 51: upper end face; 52: insulating pull rod; 53: bushing; 531: cover plate.

Detailed Description of Embodiments

[0020] To more clearly understand the technical characteristics, objective, and effects of the embodiments of the disclosure, the embodiments of the disclosure are described by reference to the drawings.

[0021] To help you to understand and more clearly describe the effects of the circuit breaker of the present application, the opening and closing processes of the circuit breaker are briefly described. As shown in Fig. 1 to 3, the circuit breaker comprises a moving contact 22, a static contact 21, an arc extinguishing structure 10 and a driving assembly 50. The arc extinguishing structure 10 is used for insulation and sealing. The driving assembly 50 is used to drive the moving contact 22 to move

relative to the static contact 21 to realize the opening or closing of the circuit breaker.

[0022] The closing process of the circuit breaker means that the driving assembly 50 drives the moving contact 22 to move in a direction near to the static contact 21 so that the moving contact 22 contacts the static contact 21 and conducts electricity. The opening process of the circuit breaker means that the driving assembly 50 drives the moving contact 22 to move in a direction away from the static contact 21 so that the moving contact 22 is separated from the static contact 21 and stops conducting electricity.

[0023] To guarantee a reliable contact between the moving contact 22 and the static contact 21 in a closed state of the circuit breaker so that the contact resistance between the two contacts is low, the contact pressure spring used to apply an acting force to the moving contact 22 has a certain overtravel. Overtravel refers to the length to which the contact pressure spring 30 continues to be compressed after the moving contact 22 and the static contact 21 are in contact with each other. For example, when the driving assembly 50 moves to a first position, the moving contact 22 contacts the static contact 21. At this time, the driving assembly 50 continues to move a distance, namely, the overtravel, to reach a second position. In this process, the contact pressure spring continues to be compressed to increase the abutting force between the moving contact 22 and the static contact 21, and thus, the contact resistance between them is low.

[0024] In a practical working process, a linear relationship exists between the overtravel and the abutting force between the moving contact 22 and the static contact 21. However, as the number of openings and closings of the circuit breaker increases, wear-out and ablation will occur to the moving contact 22 and the static contact 21, and fatigue relaxation may also occur to the contact pressure spring 30. As a result, the overtravel and the abutting force between the moving contact 22 and the static contact 21 are unable to be accurately measured, and then the reliability of the circuit breaker is reduced.

[0025] In order to realize the reliable detection of the overtravel and the abutting force between the moving contact 22 and the static contact 21, a circuit breaker is provided in the present embodiment, and the circuit breaker comprises an arc extinguishing structure 10, a moving contact 22 and a static contact 21, the arc extinguishing structure 10 has an arc extinguishing chamber 11, at least a part of the static contact 21 stretches into the arc extinguishing chamber 11, a part of the moving contact 22 stretches into the arc extinguishing chamber 11, and the circuit breaker further comprises a driving assembly 50, a contact pressure spring 30 and a detection assembly 40. The driving assembly 50 is connected with the moving contact 22 and drives the moving contact 22 to contact or separate from the static contact 21, and the driving assembly 50 has an accommodating cavity. The contact pressure spring 30 is provided in the accommodating cavity, abuts between the moving contact 22 and the driving assembly 50 and is used to apply an acting force toward the static contact 21 to the moving contact 22 in a closed state of the circuit breaker. The detection assembly 40 comprises a pressure detector 41 and a distance sensor 42, the pressure detector 41 is provided between the contact pressure spring 30 and the driving assembly 50 to detect the pressure of the contact pressure spring 30 when the moving contact 22 and the static contact 21 abut tightly against each other, and the distance sensor 42 is used to detect the detection distance between the moving contact 22 and the distance sensor 42 so that the overtravel between the moving contact 22 and the static contact 21 can be determined according to the pressure and the detection distance.

[0026] In this case, the arc extinguishing structure 10 can protect the moving contact 22 and the static contact 21. The arc extinguishing structure 10 may be a cylinder of a column or a cylinder whose cross-section is a rectangle or other shape, and the cylinder comprises a side wall, a top wall and a bottom wall, which form the arc extinguishing chamber 11. Of course, the arc extinguishing structure 10 may be other proper structures in other embodiments and the specific structure is not restricted here.

[0027] At least a part of the static contact 21 stretches into the arc extinguishing chamber 11 (the static contact 21 may be fully fixed in the arc extinguishing chamber 11 or one part stretches into the arc extinguishing chamber 11 and the other part is located outside the arc extinguishing chamber 11), a part of the moving contact 22 stretches into the arc extinguishing chamber 11, the moving contact 22 can move relative to the static contact 21, and the opening or closing of the circuit breaker is realized through the contact or separation between the moving contact and the static contact.

[0028] The driving assembly 50 is used to drive the moving contact 22 to move. The contact pressure spring 30 is provided in the accommodating cavity of the driving assembly 50, the contact pressure spring 30 is used to provide an abutting force for the moving contact 22 in a closed state, and in addition, the contact pressure spring 30 accumulates some energy in a closing process of the circuit breaker to provide high initial energy for the moving contact 22 at the time of the opening of the circuit breaker so that the moving contact 22 can be separated from the static contact 21 at high speed in an initial condition to break an electrical arc and/or a melted solder connection between the moving contact 22 and the static contact 21.

[0029] In order to accurately detect the overtravel of the contact pressure spring 30 and ensure that the abutting force corresponding to the overtravel between the moving contact 22 and the static contact 21 satisfies the requirement, a detection assembly 40 is provided in the accommodating cavity, the detection assembly 40 comprises the pressure detector 41 and the distance sensor 42, the pressure detector 41 detects the pressure (the pressure is roughly equal to the abutting force the contact pressure spring 30 provides for the moving contact 22,

the rough equality means that the difference between the pressure and the abutting force is less than the allowable error, and the allowable error can be determined according to the specific structure of the circuit breaker, the gravity of the moving contact 22 and other factors, which are not restricted in the present embodiment) of the contact pressure spring 30, and the distance sensor 42 detects the detection distance between the moving contact 22 and the distance sensor 42. In this way, the real overtravel and the abutting force between the moving contact 22 and the static contact 21 can be determined according to the detected pressure and detection distance. Thus, the detection accuracy is improved and the problem of an insufficient abutting force caused by fatigue relaxation of the contact pressure spring 30, or the wear-out or ablation of the moving contact 22 or the static contact 21 can be avoided.

[0030] The structure and the working process of the circuit breaker are described below in combination with the drawings.

[0031] In the present embodiment, as shown in Fig. 1 to Fig. 3, the cylinder or the casing in other shapes of the arc extinguishing structure 10 is an insulating casing. The static contact 21 is fixed relative to the arc extinguishing structure 10. The moving contact 22 can move relative to the arc extinguishing structure 10 to contact or separate from the static contact 21.

[0032] To conveniently adjust the overtravel of the circuit breaker to guarantee the abutting force between the moving contact 22 and the static contact 21 in the case of fatigue relaxation occurring to the contact pressure spring 30 or wear-out or ablation occurring to the moving contact 22 or the static contact 21 and thus guarantee a low contact resistance between the moving contact 22 and the static contact 21 in a closed state, the distance between the moving contact 22 and the static contact 21 can be adjusted in an open state of the circuit breaker in the present embodiment.

[0033] For example, when the circuit breaker is in an open state, the driving assembly 50 may be located in a first position. At this time, the distance between the moving contact 22 and the static contact 21 can be adjusted by adjusting the position of the moving contact 22. If the distance between the moving contact 22 and the static contact 21 before the adjustment is a first distance, then the distance between them after the adjustment is a second distance, and the second distance is less than the first distance. Thus, when the circuit breaker is closed again, the overtravel of the contact pressure spring 30 increases in the process of the movement of the driving assembly 50 from the first position to the second position because the distance between the moving contact 22 and the static contact 21 decreases. In this way, an overtravel decrease caused by wear-out or ablation of the moving contact 22 or the static contact 21 can be compensated, and the problem of an increase of the contact resistance caused by a decrease of the abutting force between the moving contact 22 and the static contact 21 caused by an overtravel decrease can also be solved. In addition, this way can also solve the problem of an insufficient abutting force caused by fatigue relaxation of the contact pressure spring 30 to guarantee the reliability and safety of the working of the circuit breaker.

[0034] In a feasible way, in order to realize the adjustment of the distance between the moving contact 22 and the static contact 21 in an open state, the driving assembly 50 comprises an insulating pull rod 52 and a bushing 53. In this case, the insulating pull rod 52 is connected with the power source in the circuit breaker so that it is driven by the power source to move and then drive the bushing 53, the contact pressure spring 30 and the moving contact 22 to move. The insulating pull rod may comprise a pull rod segment and a pull rod frame, the pull rod frame may be integrated with the pull rod segment, and the pull rod segment is connected with the power source. The pull rod frame is provided on an end portion of the pull rod segment and is used to accommodate the bushing 53.

[0035] The bushing 53 is provided in the insulating pull rod 52 and can be driven by the insulating pull rod 52 to move relative to the static contact 21. The bushing 53 has the previously-mentioned accommodating cavity, and the contact pressure spring 30 and the detection assembly 40 are provided in the accommodating cavity so that they are borne by the bushing 53.

[0036] The length by which the bushing 53 protrudes out of the insulating pull rod 52 can be adjusted to adjust the distance between the moving contact 22 and the static contact 21 in an open state. In this case, the length by which the bushing 53 protrudes out of the insulating pull rod 52 may be the distance between the upper end face 51 of the bushing 53 and the upper end face of the pull rod frame. Since a part of the moving contact 22 stretches into the bushing 53, the distance between the moving contact 22 and the static contact 21 can be changed by adjusting the length by which the bushing 53 protrudes out of the insulating pull rod 52. Such an adjustment way is simple, reliable and safe. In addition, since the structures of the bushing 53 and the insulating pull rod 52 are simple, the reliability is further improved and the probability of a failure is reduced.

[0037] Alternatively, the insulating pull rod 52 and the bushing 53 are thread-connected. Such a connection way guarantees that not only the length by which the bushing 53 protrudes out of the insulating pull rod 52 can be adjusted, but also the pitch of thread can be set according to the required adjustment precision to satisfy the adjustment precision requirement.

[0038] To better cooperate with the contact pressure spring 30, the moving contact 22 in the present embodiment comprises a contact body 221 and a moving rod 222. As shown in Fig. 1 to Fig. 3, the contact body 221 is mainly used to contact the static contact 21 to conduct electricity.

[0039] The moving rod 222 is detachably connected with the contact body 221, and at least a part of the mov-

ing rod 222 stretches into the accommodating cavity to abut against the contact pressure spring 30 to realize the cooperation between the moving contact 22 and the contact pressure spring 30.

[0040] In a feasible way, one end of the moving rod 222 in the accommodating cavity abuts against the contact pressure spring 30. Thus, at the time of the closing of the circuit breaker, the bushing 53 is driven by the insulating pull rod 52 to move, then the contact pressure spring 30 is compressed and the contact pressure spring 30 pushes the moving contact 22 to move to close the circuit breaker.

[0041] Or in another feasible way, the moving rod 222 comprises a rod body and a retaining flange 2221, the retaining flange 2221 is provided outside the rod body, the extension direction (left-to-right direction shown in Fig. 1) of the retaining flange 2221 is perpendicular to the lengthwise direction (up-to-down direction shown in Fig. 1) of the rod body, and a first end of the contact pressure spring 30 abuts against the retaining flange 2221 to push the moving contact 22 to move. In this way, a part of the contact pressure spring 30 can be put on the rod body. Thus, the rod body is utilized to guide the extension and retraction of the contact pressure spring 30, and in addition, the rod body can be utilized to provide some support for the contact pressure spring 30 and avoid the contact pressure spring from being twisted when the contact pressure spring is pressed.

[0042] The retaining flange 2221 may be in the shape of a ring or in any other proper shape, and the specific shape is not restricted here.

[0043] To limit the moving rod 222 and prevent the moving rod 222 from being separated from the bushing 53, a cover plate 531 for retaining the retaining flange 2221 is provided in the bushing 53. The reliability of cooperation is guaranteed after the cover plate 531 retains the retaining flange 2221.

[0044] Alternatively, as shown in Fig. 1 and Fig. 2, the pressure detector 41 is provided in the bushing 53. Specifically, the second end of the contact pressure spring 30 abuts against the pressure detector 41. In this way, the pressure detector 41 can reliably detect the pressure of the contact pressure spring 30.

[0045] In an example, the pressure detector 41 comprises an upper cover 411, a pressure-sensitive element 412 and a base 413, the base 413 is provided on the driving assembly 50 (for example, in the bushing 53 of the driving assembly 50), the pressure-sensitive element 412 is fixedly provided on the base 413, the upper cover 411 covers the pressure-sensitive element 412, and the contact pressure spring 30 abuts against the upper cover 411. The upper cover 411 can protect the pressure-sensitive element 412 on the one hand, and can transfer the pressure applied by the contact pressure spring 30 on the pressure-sensitive element 412 on the other hand. The pressure-sensitive element 412 is used to convert the pressure into an electrical signal to realize the accurate measurement of the pressure. The base 413 can support the pressure-sensitive element 412 and the upper cover 411.

[0046] In the present embodiment, a groove is provided in the middle of the base 413, the distance sensor 42 is provided in the groove, and the distance sensor 42 is used to measure the distance between one end of the moving rod 222 in the accommodating cavity and the distance sensor 42. The distance is a detection distance. The overtravel can be accurately determined according to the detection distance, and then whether the overtravel satisfies the requirement can be determined.

[0047] The distance sensor 42 may be any sensor, for example, laser sensor, which can realize a distance detection and convert the detected distance into an electrical signal. The type of the distance sensor is not restricted in the present embodiment.

[0048] Alternatively, the circuit breaker further comprises a data transmission unit 43, and the data transmission unit 43 is respectively electrically connected with the pressure detector 41 and the distance sensor 42 to receive and transmit a pressure acquired by the pressure detector 41 and the detection data of the distance sensor 42. The data transmission unit 43 may be a wired data transmission chip or a wireless data transmission chip (for example, WIFI chip or Bluetooth chip). As shown in Fig. 1 and Fig. 2, two through-holes are provided in the base 413 to correspond to the distance sensor 42 and the pressure-sensitive element 412, respectively, and one transmission line passes through one through-hole and connects the distance sensor 42 and the data transmission unit 43 to send the detection distance detected by the distance sensor 42 to the data transmission unit 43. Another transmission line passes through the other through-hole and connects the pressure-sensitive element 412 and the data transmission unit 43 to send the acquired pressure to the data transmission unit 43. The data transmission unit 43 can send a pressure and a detection distance to a gateway in a wired or wireless way, and the pressure and the detection distance are transmitted to an external monitor through the gateway.

[0049] The monitor can display the pressure and the detection distance in real time, or determine whether it is necessary to adjust the distance between the moving contact 22 and the static contact 21 in an open state according to the pressure and the detection distance to guarantee the abutting force between the moving contact 22 and the static contact 21 in a closed state.

[0050] The overtravel adjustment process of the circuit breaker is described as follows:

Before fatigue relaxation occurs to the contact pressure spring 30 and wear-out or ablation occurs to the moving contact 22 and the static contact 21, the power source drives the insulating pull rod 52 to move from the first position to the second position, the insulating pull rod 52 drives the bushing 53 and the moving contact 22 to move to allow the moving contact 22 to contact the static contact 21, and the overtravel to which the contact pressure spring 30 is compressed is a first overtravel in a closing

process. At this time, the pressure of the contact pressure spring 30 detected by the pressure detector 41 is denoted as pressure P1, and the abutting force between the moving contact 22 and the static contact 21 may be considered approximately equal to P1. The detection distance detected by the distance sensor 42 between the distance sensor and the lower end face of the rod body of the moving contact 22 (namely, the end face of one end of the rod body in the bushing 53) is denoted as distance H1.

[0051] After the circuit breaker is used for a period of time, in one case, if fatigue relaxation occurs to the contact pressure spring 30, the abutting force which can be provided by the same compressed overtravel decreases. At this time, the power source drives the insulating pull rod 52 to move from the first position to the second position, the insulating pull rod 52 drives the bushing 53 and the moving contact 22 to move to allow the moving contact 22 to contact the static contact 21, and the overtravel to which the contact pressure spring 30 is compressed is a first overtravel in a closing process. The detection distance detected by the distance sensor 42 between the distance sensor and the lower end face of the rod body of the moving contact 22 (namely, the end face of one end of the rod body in the bushing 53) is still distance HI. Since fatigue relaxation occurs to the contact pressure spring 30, the elasticity produced by the same compressed distance decreases so that the pressure (denoted as pressure P2) detected by the pressure detector 41 also decreases, that is to say, pressure P2 is less than pressure P1, and then, the abutting force between the moving contact 22 and the static contact 21 is less than pressure P1. In this way, the contact resistance between the moving contact 22 and the static contact 21 is likely to increase. To avoid this case, the bushing 53 can be rotated to increase the length by which the bushing 53 protrudes out of the insulating pull rod after the opening of the circuit breaker. In this way, the insulating pull rod 52 still moves from the first position to the second position, but the compressed overtravel of the contact pressure spring 30 is greater than the first overtravel. Then, the elasticity produced by the contact pressure spring 30 increases, and the abutting force between the moving contact 22 and the static contact 21 increases to reduce the contact resistance.

[0052] After the circuit breaker is used for a period of time, in another case, wear-out or ablation likely occurs to the moving contact 22 or the static contact 21. As a result, the distance between the moving contact 22 and the static contact 21 increases in an open state (that is to say, the insulating pull rod 52 is in the first position). In a closing process, after the insulating pull rod 52 moves from the first position to the second position to drive the moving contact 22 to contact the static contact 21, the compressed overtravel of the contact pressure spring 30 is denoted as a second overtravel, and the second overtravel is less than the first overtravel. In this way, the detection distance (denoted as distance H2) detected by the distance sensor 42 is less than distance H1. Since the compressed overtravel of the contact pressure spring 30 decreases, the acting force applied by the contact pressure spring 30 on the moving contact 22 decreases, resulting in an increase of the contact resistance between the moving contact 22 and the static contact 21. To reduce the contact resistance, the distance the bushing 53 protrudes out of the insulating pull rod 52 can be adjusted to increase the compressed overtravel of the contact pressure spring 30 in an open state.

[0053] Of course, not only fatigue relaxation occurs to the contact pressure spring 30, but also wear-out or ablation occurs to the moving contact 22 or the static contact 21 in practice. In this case, an accurate measurement of the overtravel can be realized through the cooperation of the pressure detector 41 and the distance sensor 42. Thus, a basis and a reference can be provided for a subsequent adjustment to allow the circuit breaker to adapt to the loss of the contact pressure spring 30, the moving contact 22 and the static contact 21, efficiently guaranteeing the safety of the running of the circuit breaker. In addition, an overtravel adjustment is very simple and convenient.

[0054] According to a further aspect, a circuit breaker overtravel adjustment method is provided. The method is used for the abovementioned circuit breaker and the method comprises: receiving a pressure, detected by the pressure detector 41, of the contact pressure spring 30 and a detection distance detected by the distance sensor 42; if at least one of the conditions that the pressure is less than a preset nominal pressure and the detection distance is greater than a preset nominal distance is satisfied, generating a driving assembly 50 adjustment message to indicate an adjustment of the length by which the bushing 53 in the driving assembly 50 protrudes out of the insulating pull rod 52.

[0055] In this case, the method may be executed by a monitor deployed outside the circuit breaker or a data processing chip (for example, PLC, embedded processor, IMU or CPU) deployed inside the circuit breaker and having a data processing capability. The executor of the method is not restricted here.

[0056] In the present embodiment, the method executed by an external monitor, for example, is described, and the monitor can acquire the pressure and the detection distance from the data transmission unit 43 of the circuit breaker through a gateway.

[0057] If the pressure currently detected is less than a nominal pressure (the nominal pressure can be measured and determined before the circuit breaker leaves the factory or can be measured and calibrated when the circuit breaker is used for the first time. When the nominal pressure is determined is not restricted), fatigue relaxation or an insufficient overtravel likely occurs to the contact pressure spring, and a driving assembly 50 adjustment message may be generated to indicate an adjustment of the length by which the bushing 53 in the driving assembly 50 protrudes out of the insulating pull rod 52. For example, the driving assembly 50 adjustment mes-

sage may be a prompt message displayed on the monitor to inform a worker of adjusting the length by which the bushing 53 protrudes out of the insulating pull rod 52. In this way, the worker can adjust the bushing 53 in time after seeing the message.

[0058] Further, the message may further contain a length after an adjustment, calculated according to information such as pressure, parameters of the contact pressure spring 30, for example, elasticity coefficient, and detection distance to help the worker to quickly adjust the length to the correct one.

[0059] Or, if the detection distance is greater than a preset nominal distance (which can be measured and determined before the circuit breaker leaves the factory or can be measured and calibrated when the circuit breaker is used for the first time. When the nominal pressure is determined is not restricted), the overtravel is insufficient and a driving assembly 50 adjustment message may be generated to indicate an adjustment of the length by which the bushing 53 in the driving assembly 50 protrudes out of the insulating pull rod 52. The process of generating the message is similar to that in the previous case and therefore will not be described again.

[0060] According to yet a further aspect of the present application, a power system is provided, and the power system comprises the abovementioned circuit breaker. In a power system in which the circuit breaker is used, since the pressure detector 41 and the distance sensor 42 in the circuit breaker can collaborate to acquire the pressure and the detection distance, a decrease of the pressure or overtravel of the contact pressure spring 30 can be detected in time when ablation or wear-out occurs to the moving contact or the static contact or fatigue relaxation occurs to the contact pressure spring 30, avoiding the problem of incorrect monitoring results caused by low adaptability of a single detection method to the two changes, improving the accuracy of the monitoring results and then improving the reliability.

[0061] In addition, since the insulating pull rod 52 has a pull rod frame, the bushing 53 is connected in the pull rod frame and the length by which the bushing 53 protrudes relative to the pull rod frame can be adjusted; the length by which the bushing protrudes can conveniently and quickly be adjusted to increase the pressure or overtravel when the pressure or the overtravel decreases. Thus, the adjustment is more convenient, quicker and safer. In addition, the abutting force (namely, contact pressure) between the moving contact 22 and the static contact 21 is guaranteed, and then the reliability of the working of the circuit breaker is guaranteed.

[0062] It should be understood that although the specification is described according to the embodiments, it does not mean that each embodiment contains only one independent technical solution. The described method in the specification is used only for the purpose of clarity. Those skilled in the art should consider the specification as a whole body, and the technical solutions in the embodiments can be combined properly to form other embodiments those skilled in the art can understand.

[0063] The abovementioned embodiments are only specific embodiments of the disclosure but are not used to restrict the scope of the embodiments of the disclosure. Any equivalent change, modification or combination made by those skilled in the art without departing from the idea or principle of the embodiments of the disclosure should fall within the scope of protection of the embodiments of the disclosure.

Claims

1. A circuit breaker, **characterized in that** the circuit breaker comprises an arc extinguishing structure (10), a moving contact (22) and a static contact (21), the arc extinguishing structure (10) has an arc extinguishing chamber (11), at least a part of the static contact (21) stretches into the arc extinguishing chamber (11), and a part of the moving contact (22) stretches into the arc extinguishing chamber (11), and the circuit breaker further comprises:

   a driving assembly (50), the driving assembly (50) being connected with the moving contact (22) and driving the moving contact (22) to contact or separate from the static contact (21), and the driving assembly (50) having an accommodating cavity;
   a contact pressure spring (30), the contact pressure spring (30) being provided in the accommodating cavity, abutting between the moving contact (22) and the driving assembly (50) and being used to apply an acting force toward the static contact (21) to the moving contact (22) in a closed state of the circuit breaker;
   a detection assembly (40), the detection assembly (40) comprising a pressure detector (41) and a distance sensor (42), the pressure detector (41) being provided between the contact pressure spring (30) and the driving assembly (50) to detect the pressure of the contact pressure spring (30) when the moving contact (22) and the static contact (21) abut tightly against each other, and the distance sensor (42) being used to detect the detection distance between the moving contact (22) and the distance sensor (42) so that the overtravel between the moving contact (22) and the static contact (21) can be determined according to the pressure and the detection distance.

2. The circuit breaker as claimed in claim 1, **characterized in that** when the circuit breaker is in an open state, the distance between the moving contact (22) and the static contact (21) can be adjusted.

3. The circuit breaker as claimed in claim 2, **charac-**

terized in that the driving assembly (50) comprises an insulating pull rod (52) and a bushing (53), the bushing (53) is provided in the insulating pull rod (52) and can be driven by the insulating pull rod (52) to move relative to the static contact (21), the length by which the bushing (53) protrudes out of the insulating pull rod (52) can be adjusted to adjust the distance between the moving contact (22) and the static contact (21) in an open state, the accommodating cavity is provided in the bushing (53), and the contact pressure spring (30) and the detection assembly (40) are provided in the accommodating cavity of the bushing (53).

4. The circuit breaker as claimed in claim 3, **characterized in that** the insulating pull rod (52) and the bushing (53) are thread-connected.

5. The circuit breaker as claimed in claim 3, **characterized in that** the moving contact (22) comprises a contact body (221) and a moving rod (222), the moving rod (222) is detachably connected with the contact body (221), at least a part of the moving rod (222) stretches into the accommodating cavity and abuts against the contact pressure spring (30), and the distance sensor (42) is used to measure the distance between one end of the moving rod (222) in the accommodating cavity and the distance sensor (42).

6. The circuit breaker as claimed in claim 5, **characterized in that** the moving rod (222) comprises a rod body and a retaining flange (2221), the retaining flange (2221) is provided outside the rod body, the extension direction of the retaining flange (2221) is perpendicular to the lengthwise direction of the rod body, a cover plate (531) for retaining the retaining flange (2221) is provided in the bushing (53), a first end of the contact pressure spring (30) abuts against the retaining flange (2221), and a second end of the contact pressure spring (30) abuts against the pressure detector (41).

7. The circuit breaker as claimed in any of claims 1 to 6, **characterized in that** the pressure detector (41) comprises an upper cover (411), a pressure-sensitive element (412) and a base (413), the base (413) is provided on the driving assembly (50), the pressure-sensitive element (412) is fixedly provided on the base (413), the upper cover (411) covers the pressure-sensitive element (412), and the contact pressure spring (30) abuts against the upper cover (411).

8. The circuit breaker as claimed in any of claims 1 to 6, **characterized in that** the circuit breaker further comprises a data transmission unit (43), and the data transmission unit (43) is respectively electrically connected with the pressure detector (41) and the distance sensor (42) to receive and transmit a pressure acquired by the pressure detector (41) and the detection data of the distance sensor (42).

9. A circuit breaker overtravel adjustment method, **characterized in that** the method is used for the circuit breaker as claimed in any of claims 1 to 8, and the method comprises: receiving a pressure, detected by the pressure detector (41), of the contact pressure spring (30) and a detection distance detected by the distance sensor (42); if at least one of the conditions that the pressure is less than a preset nominal pressure and the detection distance is greater than a preset nominal distance is satisfied, generating a driving assembly (50) adjustment message to indicate an adjustment of the length by which the bushing (53) in the driving assembly (50) protrudes out of the insulating pull rod (52) .

10. A power system, **characterized in that** the power system comprises the circuit breaker as claimed in any of claims 1 to 8.

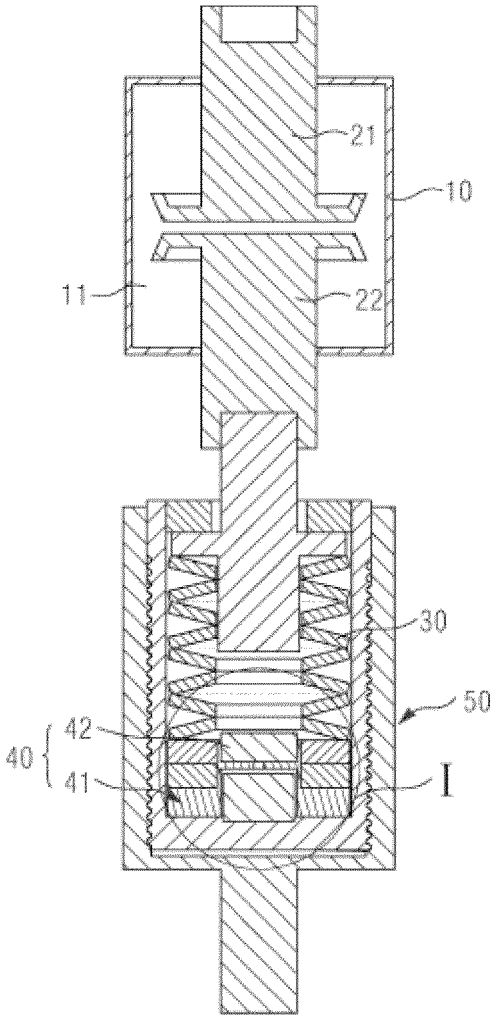

Fig. 1

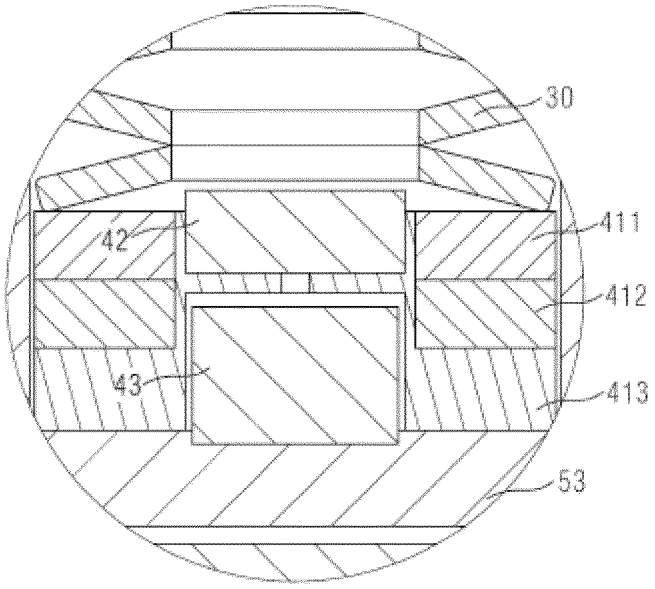

Fig. 2

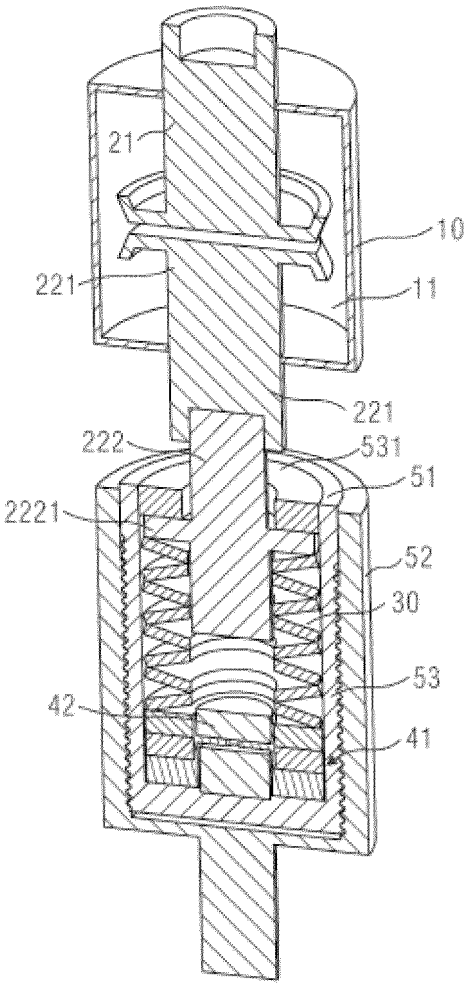

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/120803

A. CLASSIFICATION OF SUBJECT MATTER

H01H 71/00(2006.01)i; G01R 31/327(2006.01)i

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; G01R

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)

CNTXT, ENTXT, ENTXTC, DWPI, CNKI: 断路器, 压力, 位置, 位移, 距离, 传感器, breaker, pressure, distance, sensor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 203572932 U (CHUANKAI ELECTRIC CO., LTD.) 30 April 2014 (2014-04-30) description, paragraphs 22-29, and figures 1-2	1-10
Y	CN 201332066 Y (CHANGZHOU MECAN ELECTRIC TECHNOLOGY DEVELOPMENT CO., LTD.) 21 October 2009 (2009-10-21) description, pages 1-2, and figure 1	1-10
A	CN 108054051 A (HENAN PINGGAO GENERAL ELECTRIC CO., LTD. et al.) 18 May 2018 (2018-05-18) entire document	1-10
A	US 4064383 A (GENERAL ELECTRIC COMPANY) 20 December 1977 (1977-12-20) entire document	1-10

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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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
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 June 2022	**10 June 2022**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/120803

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 203572932 U	30 April 2014	None	
CN 201332066 Y	21 October 2009	None	
CN 108054051 A	18 May 2018	CN 108054051 B	20 March 2020
US 4064383 A	20 December 1977	CA 1073016 A	04 March 1980

Form PCT/ISA/210 (patent family annex) (January 2015)