

ISOLATION VACUUM CIRCUIT BREAKER WITH ZERO-CROSSING OPENING AND CLOSING AND CONTROL SYSTEM THEREOF

TECHNICAL FIELD

[0001] The present disclosure relates to the technical field of isolation vacuum circuit breakers, and in particular to an isolation vacuum circuit breaker with zero-crossing opening and closing and control system thereof.

BACKGROUND

[0002] In the field of high-voltage switching equipment, for circuit breakers used to switch on and off long unloaded circuits, unloaded transformers, capacitor banks, reactor banks, etc., the phase of system voltage and current at the instant of opening and closing of these circuit breakers is random. Therefore, the switching operation transient phenomena of overvoltage and inrush current often occur during the opening and closing operations of the circuit breakers. These transient processes can harm the insulation and lifespan of power equipment and affect the quality of electric energy, and even impact the safe and stable operation of the system. In prior art, the zero-crossing switching technology exists, which aims to actively eliminate the transient effects generated during the opening and closing process by closing the circuit at the nearest alternating-current voltage zero-crossing position and disconnecting at the nearest current zero-crossing position. Since circuit breakers typically employ a three-phase synchronized opening and closing structure, it is currently difficult for circuit breakers to achieve the individual closing or opening of each phase at the nearest alternating-current voltage or current zero-crossing position.

SUMMARY

[0003] In view of the shortcomings of the prior art, the object of the present disclosure is to provide an isolation vacuum circuit breaker with zero-crossing opening and closing and control system thereof, so as to realize three-phase different period phase-controlled opening and closing.

[0004] In order to achieve the above object, the solution provided by the present disclosure is an isolation vacuum circuit breaker with zero-crossing opening and closing, comprising a bracket, a transmission cross beam, a three-phase solid-sealed polar pole, a functional conversion group, two permanent magnet operating mechanisms and an isolating switch operating device, wherein two ends of the transmission cross beam are respectively hinged to the bracket; ; the three-phase

solid-sealed polar poles are respectively installed on the transmission cross beam, wherein the functional conversion group includes a flange, a bearing, an AB-phase output shaft and a C-phase output shaft, wherein the isolating switch operating device is in transmission connection with the bearing, and the isolating switch operating device drives the bearing to rotate; the C-phase output shaft is sleeved on the AB-phase output shaft, the flange and the bearing are respectively sleeved on the C-phase output shaft, and the flange is rigidly connected to the transmission cross beam; each phase of the solid-sealed polar column is preset with a vacuum arc extinguishing chamber and an operating rod for controlling opening or closing of the vacuum arc extinguishing chamber, wherein the operating rod of the two-phase solid-sealed polar column is in transmission connection with the AB-phase output shaft, the operating rod of another phase of the solid-sealed polar column is in transmission connection with the C-phase output shaft; and the two permanent magnet operating mechanisms are used for respectively driving the AB-phase output shaft and the C-phase output shaft to move transversely, and the AB-phase output shaft and the C-phase output shaft which move transversely drive the operating rod of the three-phase solid-sealed polar pole to move longitudinally to control opening or closing of the vacuum arc extinguishing chamber.

[0005] Further, each permanent magnet operating mechanism includes a permanent magnet mechanism controller and a driving crank arm, wherein each permanent magnet mechanism controller is in transmission connection with the AB-phase output shaft or the C-phase output shaft by means of the driving crank arm.

[0006] Further, it also includes a three-phase reversing head, wherein the three-phase reversing head is rotatably connected to the transmission cross beam respectively, the three-phase reversing head is respectively matched with the operating rod of the three-phase solid-sealed polar pole, and the operating rod of each phase of the solid-sealed polar column is in transmission connection with the AB-phase output shaft or the C-phase output shaft by means of the reversing head.

[0007] Further, the flange and the bearing are fixedly connected by means of screws.

[0008] Further, a control system of an isolation vacuum circuit breaker with zero-crossing opening and closing, comprising a circuit breaker control module, A-phase control module, an auxiliary switch, an energy storage capacitor bank, a three-phase voltage transformer and a three-phase current transformer, wherein the three-phase voltage transformer and the three-phase current transformer are

electrically connected to the phase control module, respectively, and the three-phase voltage transformer and the three-phase current transformer are arranged at a main loop port of the circuit breaker; the phase control module, the auxiliary switch, the energy storage capacitor bank and the two permanent magnet mechanism controllers are electrically connected to the circuit breaker control module, respectively; the phase control module is used for receiving the voltage waveform and the zero-crossing point domain value provided by the three-phase voltage transformer, for receiving the current waveform and the zero-crossing point domain value provided by the three-phase current transformer, and for sending an opening instruction or a closing instruction to the circuit breaker control module; and the circuit breaker control module is used for receiving contact state information of the auxiliary switch, for receiving energy storage state information of the energy storage capacitor bank, and for sending an opening signal or a closing signal to the permanent magnet mechanism controller to control the opening or closing of the circuit breaker by means of the permanent magnet mechanism controller.

[0009] The beneficial effects of the present disclosure are: the C-phase output shaft is sleeved on the AB-phase output shaft, and the two permanent magnet operating mechanisms are used for respectively driving the AB-phase output shaft and the C-phase output shaft, realizing three-phase different period phase-controlled opening and closing, enabling the three-phase main contacts to close the circuit at the nearest alternating-current voltage zero-crossing position and disconnect at the nearest alternating-current current zero-crossing position respectively, thereby actively eliminating the transient effect hazards generated during the opening and closing process and achieving the optimal phase control effect of the circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Fig. 1 is a front view of a circuit breaker.

[0011] Fig. 2 is a schematic diagram of a permanent magnet operating mechanism.

[0012] Fig. 3 is a schematic diagram of a AB-phase output shaft and a C-phase output shaft.

[0013] Fig. 4 is a schematic diagram of a control system.

[0014] Wherein, 1-bracket, 2-transmission cross beam, 3-solid-sealed polar column, 31-operating rod, 32-reversing head, 4-functional conversion group, 41-AB-phase output shaft, 42-C-phase output shaft, 43-flange, 44-bearing, 5-permanent magnet operating mechanism, 51-permanent magnet mechanism controller, 52-driving crank

arm, and 6-isolating switch operating device.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0015] In order to facilitate understanding of the present disclosure, the present disclosure will be described more fully below with reference to the accompanying drawings. Preferred embodiments of the present disclosure are shown in the accompanying drawings. However, the present disclosure may be embodied in many different forms and is not limited to the embodiments described herein. The purpose of providing these embodiments is to make the disclosure of the present disclosure more thorough and comprehensive.

[0016] Referring to Fig. 1 to 3, an isolation vacuum circuit breaker with zero-crossing opening and closing, comprising a bracket 1, a transmission cross beam 2, a three-phase solid-sealed polar pole 3, a functional conversion group 4, an isolating switch operating device 6, a three-phase reversing head 32 and two permanent magnet operating mechanisms 5, wherein the two permanent magnet operating mechanisms 5 and the isolating switch operating device 6 are arranged on one side of the bracket 1. The three-phase solid-sealed polar pole 3 is installed on the transmission cross beam 2, and two ends of the transmission cross beam 2 are hinged to two sides of the bracket 1 by means of two coaxial rotating pairs respectively, so that the three-phase solid-sealed polar pole 3 rotates along with the rotation of the transmission cross beam 2.

[0017] In this embodiment, the functional conversion group 4 includes a flange 43, a bearing 44, an AB-phase output shaft 41 and a C-phase output shaft 42 with a sleeve structure, wherein the C-phase output shaft 42 is sleeved on the AB-phase output shaft 41. The two permanent magnet operating mechanisms 5 are used for respectively driving the AB-phase output shaft 41 and the C-phase output shaft 42 to move transversely, wherein each permanent magnet operating mechanism 5 includes a permanent magnet mechanism controller 51 and a driving crank arm 52, and each permanent magnet mechanism controller 51 is in transmission connection with the AB-phase output shaft 41 or the C-phase output shaft 42 by means of the driving crank arm 52. The permanent magnet mechanism controller 51 drives the crank arm 52 to swing, and then the swing driving crank arm 52 drives the AB-phase output shaft 41 or the C-phase output shaft 42 to move forward or backward transversely.

[0018] In this embodiment, each phase of the solid-sealed polar column 3 is preset with a vacuum arc extinguishing chamber and an operating rod 31 for controlling

opening or closing of the vacuum arc extinguishing chamber. The three-phase reversing head 32 is rotatably connected to the transmission cross beam 2 respectively, and the three-phase reversing head 32 is respectively matched with the operating rod 31 of the three-phase solid-sealed polar pole 3, wherein the operating rod 31 of each phase of the solid-sealed polar column 3 is in transmission connection with the AB-phase output shaft 41 or the C-phase output shaft 42 by means of the reversing head 32; that is, the operating rod 31 of the A-phase solid-sealed polar column 3 and the B-phase solid-sealed polar column 3 is in transmission connection with the AB-phase output shaft 41 by means of the A-phase reversing head 32 and the B-phase reversing head 32, and the operating rod 31 of the C-phase solid-sealed polar column 3 is in transmission connection with the C-phase output shaft 42 by means of the C-phase reversing head 32. Through the action of the reversing head 32, the forward transverse acting force of the AB-phase output shaft 41 or the C-phase output shaft 42 is converted into a downward longitudinal acting force on the operating rod 31, so that the operating rod 31 controls the vacuum arc extinguishing chamber to be opened; similarly, the backward transverse acting force of the AB-phase output shaft 41 or the C-phase output shaft 42 is converted into an upward longitudinal acting force on the operating rod 31, so that the operating rod 31 controls the vacuum arc extinguishing chamber to be closed. Through the above structure, the AB-phase output shaft 41 and the C-phase output shaft 42 which move transversely drive the operating rod 31 of the three-phase solid-sealed polar pole 3 to longitudinally move so as to control the opening or closing function of the vacuum arc extinguishing chamber.

[0019] In this embodiment, the adopted permanent magnet mechanism controller 51 is a conventional technique in the art, the permanent magnet mechanism controller 51 is provided with an excitation coil and a movable iron core, wherein the movable iron core is connected with the driving crank arm 52, the iron core is driven to move by means of the excitation coil, and the driving crank arm 52 is driven to swing by means of the movable iron core.

[0020] In this embodiment, the phase-controlled opening and closing of three-phases in different periods is realized through the above structure, wherein the permanent magnet operating mechanism 5 drives the AB-phase output shaft 41 to move transversely, and the operating rod 31 of the A-phase solid-sealed polar column and the B-phase solid-sealed polar column are driven by the transversely-moving AB-phase output shaft 41 to longitudinally move so as to control opening or closing

of the vacuum arc extinguishing chamber of the A-phase solid-sealed polar column and the B-phase solid-sealed polar column; and another permanent magnet operating mechanism 5 drives the C-phase output shaft 42 to move transversely, and the operating rod 31 of the C-phase solid-sealed polar column are driven by the transversely-moving C-phase output shaft 42 to longitudinally move so as to control opening or closing of the vacuum arc extinguishing chamber of the C-phase solid-sealed polar column. By adopting the three-phase different period phase-controlled opening and closing, the three-phase main contact can close the circuit at the nearest voltage zero-crossing position respectively, so that the circuit is disconnected at the nearest current zero-crossing position, the transient effect hazard generated in the opening and closing process is actively eliminated, and the optimal phase control effect of the opening and closing circuit is obtained.

[0021] In this embodiment, the flange 43 and the bearing 44 of the functional conversion group 4 are respectively sleeved on the C-phase output shaft 42. The flange 43 is rigidly connected to the transmission cross beam 2, and the flange 43 and the bearing 44 are fixedly connected through screws. The isolating switch operating device 6 is in transmission connection with the bearing 44, and the isolating switch operating device 6 drives the bearing 44 to rotate, wherein the rotation of the bearing 44 drives the transmission cross beam 2 to rotate, and the three-phase solid-sealed polar pole 3 rotates along with the rotation of the transmission cross beam 2 to realize closing or opening of the isolation switch. The isolating switch operating device 6 in this embodiment is a conventional technology in the art, and therefore will not be described in detail here.

[0022] In this embodiment, dual-function compounding of common rotation isolation of the three-phase solid-sealed polar pole 3 and phase-controlled zero-crossing opening and closing of three-phase different periods is achieved through the above structure, integrated composite of the phase-controlled circuit breaker and the rotary isolation function is achieved, and the unique technical advantages are achieved.

[0023] In this embodiment, the transmission cross beam 2, AB-phase output shaft 41, C-phase output shaft 42, operating rod 31, flange 43 and bearing 44 and other components of the mechanical transmission chain system are all made of precision metal and are rigidly matched. Under power drive and within the set stroke, corresponding to the phase control angle position and time accuracy requirements, the

rigidity variable of the overall transmission system geometry is less than 1 mm.

[0024] Referring to Fig. 4, in this embodiment, a control system of an isolation vacuum circuit breaker with zero-crossing opening and closing, comprising a circuit breaker control module, A-phase control module, an auxiliary switch, an energy storage capacitor bank, a three-phase voltage transformer and a three-phase current transformer. The three-phase voltage transformer and the three-phase current transformer are electrically connected to the phase control module, respectively, and the three-phase voltage transformer and the three-phase current transformer are arranged at a main loop port of the circuit breaker. The phase control module, the auxiliary switch, the energy storage capacitor bank and the two permanent magnet mechanism controllers 51 are electrically connected to the circuit breaker control module, respectively.

[0025] The zero-crossing phase control process of the control system is as follows:

the three-phase voltage transformer and the three-phase current transformer provide an alternating-current voltage waveform, an alternating-current current waveform and a zero-crossing point domain value to the phase control module in real time, and then the phase control module responds to the input dynamic current alternating-current voltage waveform and its domain value, forms a simulated electronic loop, accurately judges the zero-crossing phase, and instantly sends out an opening/closing instruction at the zero-crossing phase. The circuit breaker control module receives the opening/closing instruction, detects an energy storage capacitor bank state and an auxiliary switch contact state, and if the instruction is a closing instruction, the energy storage capacitor bank has stored energy (the capacitor voltage value is greater than a set value), meanwhile, the auxiliary switch normally open contact is opened (the circuit breaker is opened), and the circuit breaker control module sends a closing signal to the permanent magnet mechanism controller 51. Conversely, if the instruction is an opening instruction, and the energy storage capacitor bank has stored energy (the capacitor voltage value is greater than a set value), meanwhile, the auxiliary switch normally open contact is closed (the circuit breaker is closed), and the circuit breaker control module sends an opening signal to the permanent magnet mechanism controller 51.

[0026] In this embodiment, based on the pulse current effect accessed by the energy storage capacitor bank matched with the power control side, the zero-crossing phase control process effectively and reliably meets the characteristic of transient

superposition electromagnetic driving when the permanent magnet operating mechanism 5 drives the circuit breaker vacuum arc extinguishing chamber to be just opened or closed, so as to meet the characteristic requirements of opening and closing of the circuit breaker on time, stroke and speed.

[0027] Specifically, the phase control module is provided with a voltage input end Ua, a voltage input end Ub and a voltage input end Uc, and a current input end IA, a current input end IA1, a current input end IB, a current input end IB1, a current input end IC and a current input end IC1, wherein Ua, Ub and Uc are respectively connected to secondary voltages of the three-phase voltage transformer, IA, IA1, IB, IB1, IC and IC1 are respectively connected to secondary currents of the three-phase current transformer, and the three-phase voltage transformer and the three-phase current transformer are electrically connected with the phase control module.

[0028] The phase control module is further provided with an A-phase closing signal output end, an A-phase opening signal output end, a C-phase closing signal output end and a C-phase opening signal output end, and the four output ends of the phase control module are electrically connected to the circuit breaker control module respectively. The A-phase closing signal output end, the A-phase opening signal output end, the C-phase closing signal output end and the C-phase opening signal output end are respectively used for sending an A-phase closing instruction, an A-phase opening instruction, a C-phase closing instruction and a C-phase opening instruction.

[0029] In order to facilitate the description of the specific zero-crossing phase control process of the embodiment, the two permanent magnet operating mechanisms 5 are divided into an AB-phase permanent magnet operating mechanism 5 and a C-phase permanent magnet operating mechanism 5, wherein the AB-phase permanent magnet operating mechanism 5 is used for driving the AB-phase output shaft, and the C-phase permanent magnet operating mechanism 5 is used for driving the C-phase output shaft to move transversely. The specific zero-crossing phase control process comprises the steps that the phase control module instantly sends out an opening instruction or a closing instruction in the zero-crossing phase of the A-phase, and when the circuit breaker control module receives the A-phase closing instruction or the A-phase opening instruction, the circuit breaker control module sends the A-phase closing signal or the A-phase opening signal to the permanent magnet mechanism controller 51 of the AB-phase permanent magnet operating mechanism 5 according to

the above zero-crossing phase control process. The phase control module instantly sends out an opening instruction or a closing instruction in the zero-crossing phase of the C-phase, and when the circuit breaker control module receives the C-phase closing instruction or the C-phase opening instruction, the circuit breaker control module sends the C-phase closing signal or the C-phase opening signal to the permanent magnet mechanism controller 51 of the C-phase permanent magnet operating mechanism 5 according to the above zero-crossing phase control process.

[0030] In this embodiment, the auxiliary switch and the energy storage capacitor bank are common parts in the art. Therefore, the working principle is not repeated in the specification.

[0031] In this embodiment, the phase control module and the circuit breaker control module can adopt a common controller such as a single-chip microcomputer. The control of the above-mentioned three-phase voltage transformer, the three-phase current transformer, the phase control module, the auxiliary switch, the energy storage capacitor bank and the two permanent magnet mechanism controllers 51 belongs to a computer program and can be loaded on a computer or other programmable data processing equipment by computer program instructions, so that a series of operation steps are executed on a computer or other programmable equipment to generate computer-implemented processing, and therefore, the instructions executed on the computer or other programmable equipment provide steps for realizing the functions specified in one or more flows of the flow chart and/or one or more blocks of the block diagram, and for a person skilled in the art, the method is a conventional technical means.

[0032] The embodiments described above are only preferred embodiments of the present disclosure and do not limit the present disclosure in any form. Any person skilled in the art can make more possible variations and modifications to the technical solutions of the present disclosure by using the technical content disclosed above without departing from the scope of the technical solutions of the present disclosure, or modified to be equivalent embodiments of the present disclosure. Therefore, any equivalent changes made based on the ideas of the present disclosure that do not deviate from the content of the technical solution of the present disclosure shall be covered by the protection scope of the present disclosure.

CLAIMS

What is claimed is:

1. An isolation vacuum circuit breaker with zero-crossing opening and closing, comprising a bracket (1), a transmission cross beam (2), a three-phase solid-sealed polar pole (3), a functional conversion group (4), two permanent magnet operating mechanisms (5) and an isolating switch operating device (6), wherein two ends of the transmission cross beam (2) are respectively hinged to two sides of the bracket (1); the three-phase solid-sealed polar poles (3) are respectively installed on the transmission cross beam (2), wherein the functional conversion group (4) includes a flange (43), a bearing (44), an AB-phase output shaft (41) and a C-phase output shaft (42), wherein the isolating switch operating device (6) is in transmission connection with the bearing (44), and the isolating switch operating device (6) drives the bearing (44) to rotate; the C-phase output shaft (42) is sleeved on the AB-phase output shaft (41), the flange (43) and the bearing (44) are respectively sleeved on the C-phase output shaft (42), and the flange (43) is rigidly connected to the transmission cross beam (2); each phase of the solid-sealed polar column (3) is preset with a vacuum arc extinguishing chamber and an operating rod (31) for controlling opening or closing of the vacuum arc extinguishing chamber, wherein the operating rod (31) of the two-phase solid-sealed polar column (3) is in transmission connection with the AB-phase output shaft (41), the operating rod (31) of another phase of the solid-sealed polar column (3) is in transmission connection with the C-phase output shaft (42); and the two permanent magnet operating mechanisms (5) are used for respectively driving the AB-phase output shaft (41) and the C-phase output shaft (42) to move transversely, and the AB-phase output shaft (41) and the C-phase output shaft (42) which move transversely drive the operating rod (31) of the three-phase solid-sealed polar pole (3) to move longitudinally to control opening or closing of the vacuum arc extinguishing chamber.

2. The isolation vacuum circuit breaker with zero-crossing opening and closing according to claim 1, wherein each permanent magnet operating mechanism (5) includes a permanent magnet mechanism controller (51) and a driving crank arm (52), wherein each permanent magnet mechanism controller (51) is in transmission connection with the AB-phase output shaft (41) or the C-phase output shaft (42) by means of the driving crank arm (52).

3. The isolation vacuum circuit breaker with zero-crossing opening and closing

according to claim 1, further comprising a three-phase reversing head (32), wherein the three-phase reversing head (32) is rotatably connected to the transmission cross beam (2) respectively, the three-phase reversing head (32) is respectively matched with the operating rod (31) of the three-phase solid-sealed polar pole (3), and the operating rod (31) of each phase of the solid-sealed polar column (3) is in transmission connection with the AB-phase output shaft (41) or the C-phase output shaft (42) by means of the reversing head (32).

4. The isolation vacuum circuit breaker with zero-crossing opening and closing according to claim 1, wherein the flange (43) and the bearing (44) are fixedly connected by means of screws.

5. A control system of an isolation vacuum circuit breaker with zero-crossing opening and closing, comprising a circuit breaker control module, A-phase control module, an auxiliary switch, an energy storage capacitor bank, a three-phase voltage transformer and a three-phase current transformer, wherein the three-phase voltage transformer and the three-phase current transformer are electrically connected to the phase control module, respectively, and the three-phase voltage transformer and the three-phase current transformer are arranged at a main loop port of the circuit breaker; the phase control module, the auxiliary switch, the energy storage capacitor bank and the two permanent magnet mechanism controllers (51) are electrically connected to the circuit breaker control module, respectively; the phase control module is used for receiving the voltage waveform and the zero-crossing point domain value provided by the three-phase voltage transformer, for receiving the current waveform and the zero-crossing point domain value provided by the three-phase current transformer, and for sending an opening instruction or a closing instruction to the circuit breaker control module; and the circuit breaker control module is used for receiving contact state information of the auxiliary switch, for receiving energy storage state information of the energy storage capacitor bank, and for sending an opening signal or a closing signal to the permanent magnet mechanism controller (51) to control the opening or closing of the circuit breaker by means of the permanent magnet mechanism controller (51).