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A REVIEW ON PRE INSERTION RESISTOR SWITCH MECHANISM

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ABSTRACT

In this paper an effort is made to review the inventions that have been done for the different delay mechanisms for the Pre insertion resistor switch and placement with the circuit breaker. Circuit breaker is used in high voltage switch gear to break the current. Different researchers have designed the mechanism of Pre insertion resistor switch to give delay between circuit breaker or primary switch and closing resistor switch or auxiliary switch during the closing operation of circuit breaker. Researchers designed and placed the closing resistor switch in parallel or in series with the circuit breaker.

KEYWORDS: Circuit breaker, Pre Insertion resistor switch, closing time, Pre insertion time, High voltage switchgear.

INTRODUCTION

The circuit breakers being the most important component of high voltage switchgear, is used to switch on and off various power system equipment like transformers, transmission lines, capacitor banks, reactors and many more. During switching operations, the equipment as well as the breakers are exposed to severe electrical stresses like over voltage or inrush currents. The no load energization of transmission lines will impose switching surges, whereas the no load energization of transformers will result in to high magnetic inrush currents. This in turn, may damage the load as well as the circuit breakers which are intended to perform the said duty. Circuit breakers having pre-insertion resistors (PIR) have been employed to mitigate the said over voltage and current stresses. The PIR is placed in the circuit for few milliseconds prior to energization of the power system equipment. In this way, the resistor of PIR comes in the circuit for few milliseconds prior to real load energization. The resistor provides damping of the aforesaid current and voltage surges, thereby provides the mitigation effect.

This type of circuit breaker has a primary and an auxiliary switch called closing resistor. This closing resistor switch used either in series with the primary switch or in parallel combination. Both switches operated with a common drive with some delay in closing time. The auxiliary switch has a spring to hold it in open position. Primary switch is directly connected with a drive mechanism. When the breaker operates the primary switch close first prior to the auxiliary switch. In order to close the auxiliary switch after the primary switch some delay mechanism used between both primary and auxiliary switch.

CIRCUIT BREAKER

It's an electromechanical device used for breaking, interrupting the circuit. In other words it can switch from being ideal conductor to ideal insulator in shortest possible time. Circuit breaker is used for the safety in switch yard to protect other equipment's in the electrical circuit. It can be operated by command as well also by manually. For automatic operated circuit breaker operating mechanism is used, which has potential energy to operate the circuit breaker in high speed. In operating mechanism the potential energy can be stored by pneumatic, metal spring or some hydraulic system.

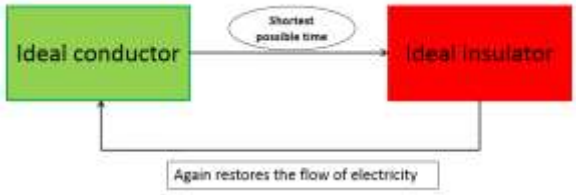


Fig. 1 Circuit Breaker definition

Electrical Circuit for breaker with closing resistor in series.

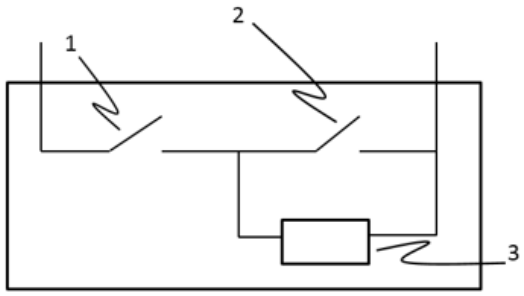


Fig. 2 closing resistor placement in series with circuit breaker.

In the Fig. 2 single line diagram shown, in which 1 is primary switch (Interrupter), 2 is auxiliary switch (closing resistor) and 3 is resistance in the circuit.

Electrical Circuit for breaker with closing resistor in parallel.

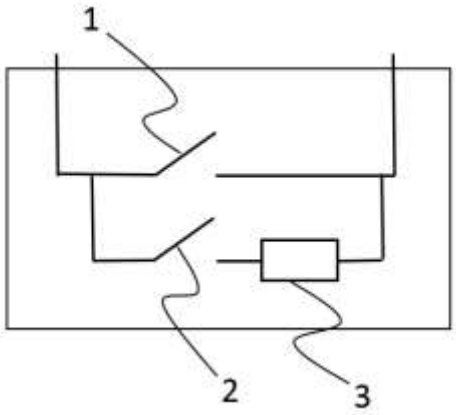


Fig. 3 closing resistor placement in parallel with circuit breaker.

In the Fig. 3 single line diagram shown, in which 1 is primary switch (Interrupter), 2 is auxiliary switch (closing resistor) and 3 is resistance in the circuit.

CLOSING RESISTOR SWITCH

A switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. The mechanism of a switch may be operated directly by a human operator to control a circuit (for example, a light switch or a keyboard button), may be operated by a moving object such as a door-operated switch, or may be operated by some sensing element for pressure, temperature or flow. A relay is a switch that is operated by electricity. Switches are made to handle a wide range of voltages and currents; very large switches may be used to isolate high-voltage circuits in electrical substations. In high voltage circuit breaker closing resistor switch is used to overcome the problem of transient current and also to restrict the damage of equipment which are placed in line. Very high resistance is placed in the circuit to restrict flow of transient current.

PRE INSERTION TIME

Interval of time during a closing operation between the instant of contact touch of the resistor elements in any one pole and the instant of contact touch in the breaking unit of that pole [6].

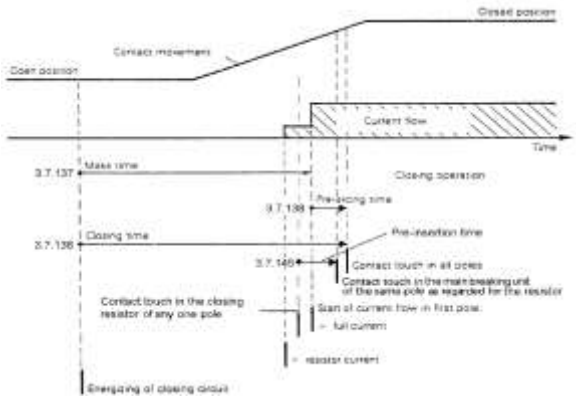
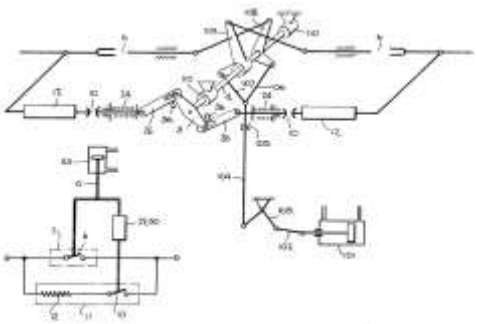


Fig. 4 Circuit breaker with switching resistor

LITERATURE REVIEW

Dieter Noack, US3763340 [5]

The resistor and auxiliary switch connected in series with each other and both connected in parallel with primary switch. Force coupling is provided between auxiliary switch and breaker drive which depend upon the position of the drive. Due to the parallel placement of the auxiliary switch with primary switch contact touch in auxiliary switch happened for the short period of time. The force coupling between auxiliary switch and drive has a rod and connecting rod having a slot.



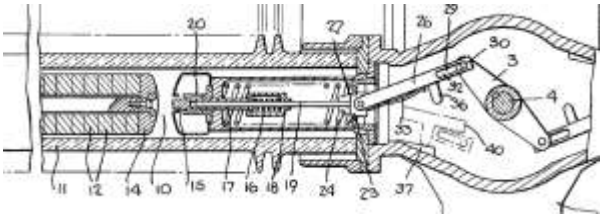


Fig. 5 Operating parts of closing resistor switch [5]

A spring plate 23 is attached at the end of the composite contact pin 15 facing away from the stationary contact 14. A pressure spring 24 bears against plate 23 and biases the contact pin 15 in the direction of switch opening. For switch closure, the contact pin 15 is actuated with a rod 26 that is pivoted at the spring plate 23 at location 27. The rod 26 is part of the force-coupled connection means and has elongated opening or slot 29. A crank 3 with crank pin 30 also constitutes part of the force-coupled connection. The crank pin 30 of the crank 3 engages the slot 29 and, in this way, a lost-motion connection is provided which can be blocked in dependence upon position. Blocking action is provided by stop cam 32 pivotally mounted on pin 27.

Willie B. Freeman, Klaus Froelich, US5245145 [2]

This mechanism includes a crank arm 110 pivotally mounted on the fixed pivot 111 secured to the housing portion 60. The crank is shown in a solid line position, corresponding to the full open position for the resistor contacts, and in a dotted line, contact-open position. Crank has its outer end pivotally connected to the drive link 113. The other end of drive link is pivotally mounted in turn to the contact tube 51 at its right hand end. The left hand surface of crank arm is oriented so as to intersect a roller 120 carried on the operating shaft 31. Consequently, when shaft moves to the right in order to close the interrupter, roller will roll along the bottom surface of crank thus rotating the crank arm in a clockwise direction.

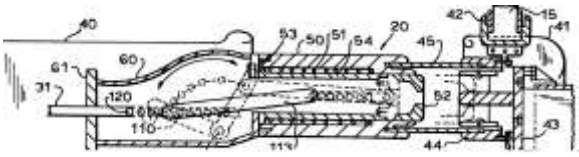


Fig.6 Section view of novel resistor module assembly [2]

The rotation of the crank arm then drives link to the right so that the movable contact tube 51 similarly moves to the right and moves the movable contact 52 in to sliding engagement with the stationery contact 44. By appropriately adjusting the angle of crank arm to the axis of shaft 31, the mechanical advantage between the motion of roller and motion of contact can be controlled. Good results have been obtained when this "angle of attack" is about 20 degrees as shown in the solid line positon of crank, and about 110 degrees in the dotted line position. When the tube moves to the right it compresses spring 54. Consequently, when the interrupter is to be open the operating rod moves to the left so that compression spring now drives the tube to the left as the retreating roller permits counter clockwise rotation of the crank arm. These novel simple mechanism can, by appropriate adjustment of the lengths of the various links and the total motion of operating rod between the interrupter open and close position, be tailored to produce the motion desirable opening and closing travel curves for the movable contact.

Yoshiharu Hidaka, US4499350 [3]

Fig.7 shows only one unit of the circuit breaker. This main contacts circuit breaker portion 51 is connected in parallel with a closing resister switch 54. This closing resistor switch includes resistance switching contacts 53 and fixed contact 71 provided with a wipe spring 70, and movable contact 74 than can be advanced or retracted by a drive mechanism 73 which includes second lever 72. The operation of the mechanism can be explained by the figure 7. When the closing command is applied to the drive portion, the drive force is transmitted through the insulating rod 82 to the first lever 65 and the respective main contact circuit breaker portions of the circuit breaker units commence a closing operation. At the same time, this drive force is transmitted through the link rod 81 to the second lever 72, causing the respective resistance switching contacts 53 of the circuit-breaker units to commence closing operation. Now the construction and arrangement of the various electrodes is such that the closing time of the resistance switching contacts is shorter than the closure time of the main contacts circuit breaker portions. So although they start their closing operation at the same time, the resistance switching contacts are closed first. The effect of this is to insert the closing resistors first of all in series into the power transmission system, then after they have carried the current for a certain time, the main contacts circuit-breaker portions close, short-circuiting operation.

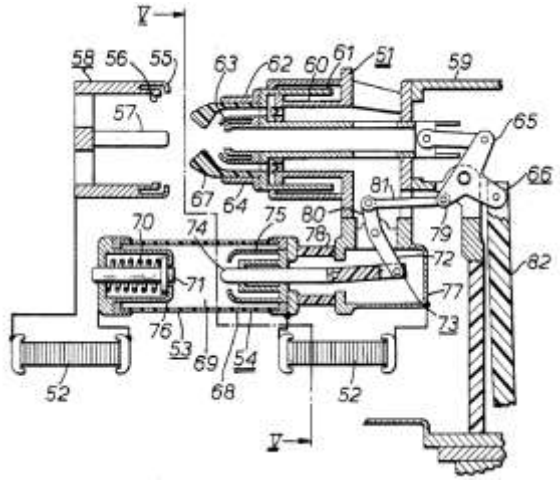


Fig. 7 Section view of circuit breaker with closing resister [3]

Tuneo Kishi, Hiroshi Itoh, Masaoki Tamura, Seizo Nakano, Masao Hosokawa, US4009458 [4]

The operating mechanism for the interrupter and closing resistor switch can be explain by fig. 8. In the mechanism first operating linkage 20 comprises a triangle lever 22 which is pivoted to the central bracket 14 with a pivot pin 21 as its first vertex, a link 25 whose one end is pivoted with a pin 24 to the upper end of the operating rod 19 and whose other end is pivoted with a pin 23 to a second vertex of the lever 22, and another link 29 whose one end is pivoted to a third vertex of the lever 22 with a pin 26 and whose other end is pivoted with a pin 28 to a puffer shaft 27 formed integrally with and extended from the puffer cylinder.

The second operating linkage 50 comprises a rocker lever 52 which is pivoted with a pin 51 to the central bracket 14, a connecting link 54 whose one end is connected with a pin 53 to one end of the rocker lever 52 and whose other end is pivoted with the common pin 23 to the other end of the link 25, a pushing lever 56 which is pivoted with a pin 55 to the other end of the rocker lever 52, and a biasing spring 57 loaded between the rocker lever and the pushing lever in order to bias the pushing lever in the clockwise direction. One end of the pushing lever terminates into a releasing portion while the other end forms a pushing or engaging portion.

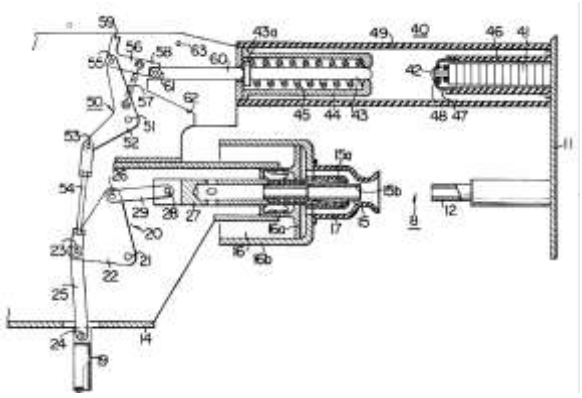


Fig. 8 Section view of circuit breaker and closing resistor switch in open state [4]

Roger Mueller, Jiri Talir,US05814782 [1]

As shown in the Fig. 9, a circuit breaker has an arcing chamber which is having cylindrical design include arcing contact. The erosion contacts of the breaker are both moved in this case, to be precise by means of a drive in connection with two mutually diametrically opposed toothed racks [7]. These toothed racks are each mechanically coupled to an actuating rod 5 and 6 made of steel. Each of the actuating rods is provided with an identically constructed coupling element 9 and 10, the structure of these coupling element describes in Fig. 10 and 11.

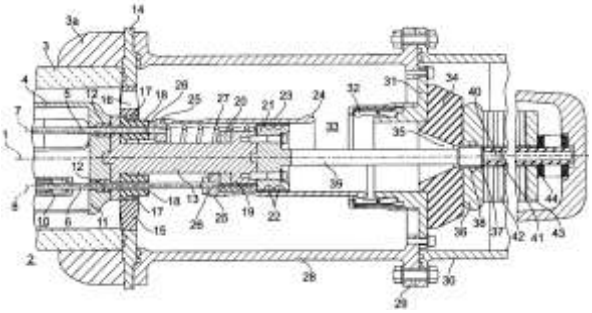


Fig. 9 closing resistor switch, upper portion is disconnected state and bottom portion is connected state [1]

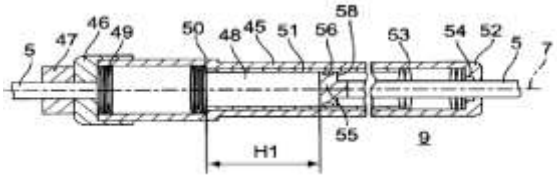


Fig. 10 First coupling element with disconnected state [1]

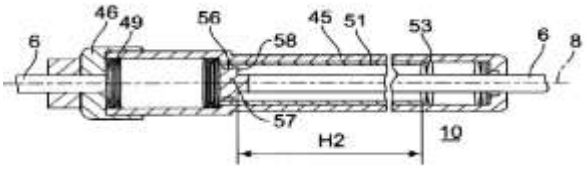


Fig. 11 Second coupling element with connected state [1]

The coupling element 9 interrupts the actuating rod 5 in such a way that the axis 7, along which the actuating rod 5 moves, is maintained for both part of actuating rod 5. However, during connection of both parts of the actuating rods, the movement of the contact cylinder 23 of the resistive contact 33 is delayed, because the axial movement transmitted from the toothed rack via the actuating rod 5 and the cover 46 to the housing 45 is transmitted to the piston 55. Thus, via the right hand continuation of the actuating rod 5 to the contact cylinder 23, only after the housing 45 has covered the travel H1.

CONCLUSION

Different researchers have introduced and analyze various mechanisms to keep delay in milliseconds between the circuit breaker contact and closing resistor switch contact.

They have designed the closing resistor switch with different time delay depends on the technical requirement for different design of circuit breakers with SF6 environment. Placement and configuration of circuit breaker with closing resistor switch is also different in each design.

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