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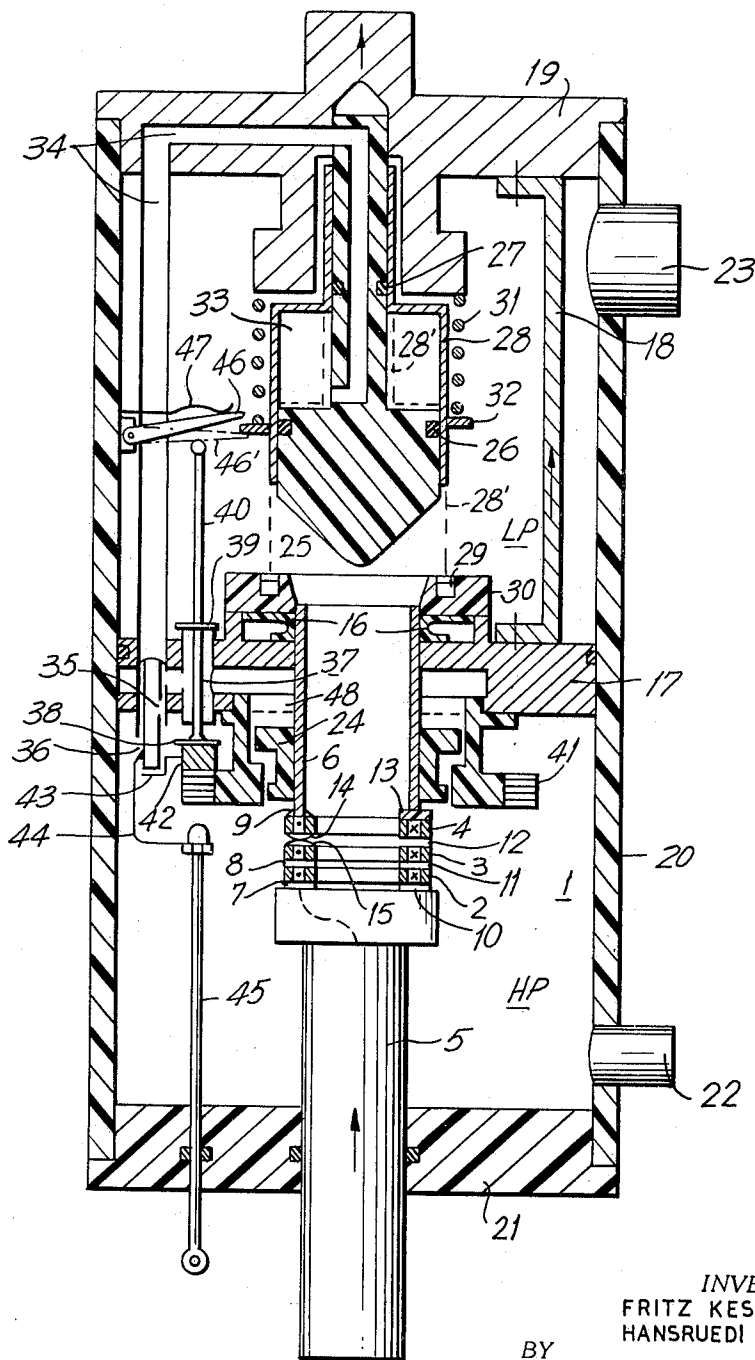
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SYNCHRONOUS CIRCUIT BREAKER WITH AUTOMATIC RECLOSING
RESPONSIVE TO UNSUCCESSFUL INTERRUPTION

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2 Sheets-Sheet 1

FIG. 1



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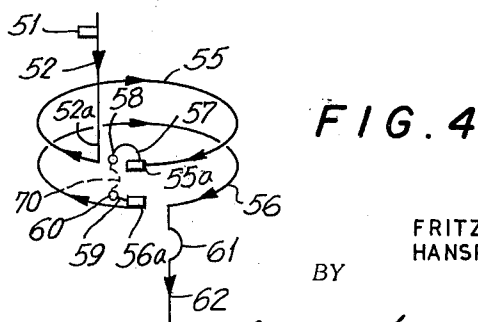
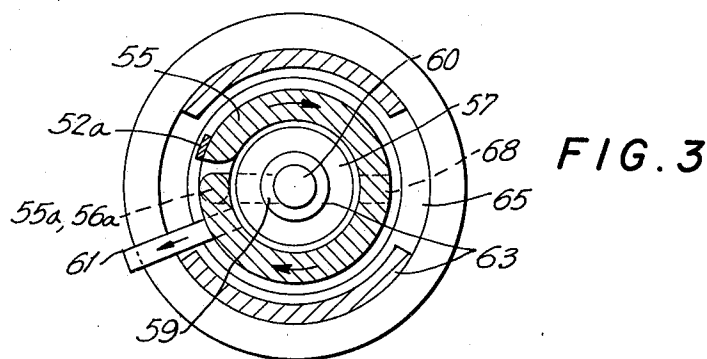
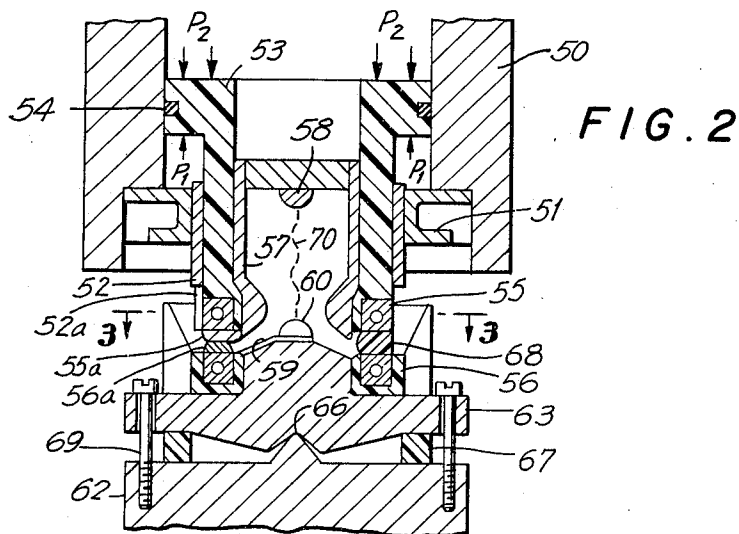


FIG. 4

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SYNCHRONOUS CIRCUIT BREAKER WITH AUTOMATIC RECLOSING RESPONSIVE TO UNSUCCESSFUL INTERRUPTION

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6 Claims

ABSTRACT OF THE DISCLOSURE

A high pressure gas blast circuit breaker having a movable solenoid contact which opens slightly prior to zero current through the closed contacts and recloses if current continues to flow (through an arc) after an interruption operation.

This invention relates to high voltage gas blast interrupter structures, and more particularly to a solenoid contact arrangement which opens just prior to current zero and closes the contacts if the interruption is unsuccessful. This invention is an improvement of the device shown in copending application Ser. No. 585,511, filed Oct. 10, 1966, entitled "Synchronous Circuit Breaker," in the name of Fritz Kesselring, and assigned to the assignee of the present invention.

The above noted application shows a novel valve arrangement for a high voltage gas blast interrupter structure. The present invention is a modification of the contact structure and operating valves whereby the interrupter operates in a synchronous circuit breaker mode, thereby to increase the efficiency, life and rating of the structure.

Accordingly, a primary object of this invention is to provide a high voltage gas blast interrupter provided with electrodynamic means and acts as a synchronous interrupter.

Another object of this invention is to improve the efficiency of the operation of a gas blast interrupter.

A further object of this invention is to provide a gas blast interrupter which is electrodynamically closed upon a failure to interrupt just prior to a preselected zero current through the contacts.

These and other objects of this invention will become apparent from the following description when taken in connection with the drawings, in which:

FIGURE 1 is a longitudinal cross-sectional view of an interrupter constructed in accordance with the invention.

FIGURE 2 is a cross-sectional view of a second embodiment of the invention.

FIGURE 3 is a cross-sectional view of FIGURE 2 taken across section line 3—3 in FIGURE 2.

FIGURE 4 is a schematic diagram of the circuit of the embodiment of FIGURES 2 and 3.

Referring first to FIGURE 1, a solenoid contact 1 consists of fixed windings 2 and 3 and of the movable winding 4. Winding 2 is fixed to the lower terminal 5 and winding 4 is fastened to a metal cylinder 6 which is movable in the axial direction. Metallic connections 7, 8 and 9 are provided between the terminal 5, solenoid windings 2 and 3, and solenoid winding 4 and the metal cylinder 6, respectively, at one lateral side thereof. The major portion of the periphery of the solenoid contact

elements 2 to 6 are insulated from each other by insulation disks 10, 11, 12 and 13. The main contacts of the interrupter are formed by contacts 14 and 15 secured to elements 3 and 4. Current passes from terminal 5, through windings 2 and 3, contacts 15 and 14, winding 4, cylinder 6, flows through slide contacts 16 to a conductive plate 17, and then to conductive strap 18 to the upper terminal 19 of the interrupter. The current path is indicated by arrows; with current flow in the solenoid contact windings 2, 3 and 4 indicated by the conventional arrow and dot. The housing of the interrupter is formed by an insulating cylinder 20 having a bottom insulation plate 21. The lower part of the housing beneath plate 17 forms a high pressure container HP, while the upper portion is a low pressure container LP. Compressed gas conduit 22 is connected to the lower chamber, and discharge conduit 23 is connected to the low pressure portion.

The metal cylinder 6 is secured to a differential piston 24, the bottom side of which is continuously under high pressure, while the pressure on the top of the differential piston 24 is controlled in a manner which will be explained later.

Within the upper terminal 19 there is arranged an insulating body 25 which has, at its lower end, a gasket 26 and at its upper end a gasket 27. A stepped hollow cylinder 28, which moves with respect to gaskets 26 and 27, is movable toward a gasket 29 which is recessed in insulation plate 30 which surrounds metal cylinder 6 and is fixed on plate 17. Cylinder 28 is biased downward by compression spring 31 which seats on flange 32 of cylinder 28. Cylinder 28 and gasket 29 form a valve which lies behind the point of interruption in relation to the direction of flow of the high pressure gas. The space 33 within the hollow cylinder 28 is connected, via a conduit 34, and two valves 35 and 37, to the high pressure container HP.

Valve 35 is controlled by the schematically illustrated cylindrical slide 36. The valve 37 is a double-acting valve having the valve plates 38 and 39 which are connected to each other by rod 40.

An annular magnetic circuit 41 surrounds the main current circuit which is to be interrupted and cooperates with a movable release armature 42. The armature 42 is mechanically connected to the valve plates 38 and 39 and the rod 40 of valve 37. Armature 42 carries an angle piece 43 which is disposed below the slide 36. The slide 36 is furthermore connected, via a rigid strap 44, to an actuating rod 45.

In the closed position of the interrupter, shown in FIGURE 1, the hollow cylinder 28 will be in the lower position 28' indicated in dashed line. Furthermore, the valve 37 and the armature 42 are held in the position shown by a rotatable lever 46 which is biased downward by a leaf spring 47 to the position 46'. If circuit interruption is now to be effected, the actuating rod 45 is pushed upward. The cylindrical slide 36 of the valve 35 will move upward so that the valve 35 is opened. The interior 33 of the hollow cylinder 28 then comes under high pressure via the lower opening of the valve 37, and the hollow cylinder 28 is moved upward from the gasket 29. Shortly before the cylinder 28 reaches its uppermost position, the lever 46 is rotated counterclockwise against the action of the pressure spring 47 so that the armature 42 and valve 37 are released. The armature 42 drops out (moves upward) upon passage of the current through zero as a result of the pressure exerted on the upper valve plate 39 of valve 37, which moves to its upper position and is held therein by the pressure on the lower valve plate 38. The valve 37, as a result of the pressure exerted on the upper valve plate 39, then moves to its upper position and is held therein by the pressure on the lower

valve plate 38. In this way, the region 48 above the differential piston 24 is evacuated, so that from this moment on a release force is built up which at first is mainly counteracted by the electrodynamic holding force due to current flow through windings 2 to 4 of the solenoid contact 1. Shortly before the next passage of current through zero, the holding force between the stationary solenoid windings 2 and 3 and the movable solenoid winding 4 reduce to such an extent that the solenoid contact opens due to the differential pressure acting on the piston 24. An arc is then drawn between the contacts 14 and 15 which normally is quenched upon passage of the current through zero, with quenching gas flowing from the high pressure space HP through the cylinder 6, past the insulating body 25, and into the low pressure space LP. The bottom of the hollow cylinder 28 and the gasket 29 which form a downstream blast valve are screened off from the action of hot gas, as described in the above noted application Ser. No. 585,511.

When valve 37 moves to its upper position, the space 33 within the hollow cylinder 28 is evacuated, and the hollow cylinder 28, after a time delay of about 20-30 ms. (which could be determined by suitable dimensioning of the pipeline 34 and of the openings of the valves 35 and 37) moves back to the position indicated in the dashed line, so that the solenoid contact 1 is again immersed in high pressure gas. Note that lever 46 is held in its upper position by rod 40 due to the pressure on the lower valve plate 38.

If the system is now to be reclosed, the actuating rod 45 is pulled down to move angle piece 43, armature 42 and valve 37 down into the position shown in the drawing. The pressure spring 47 then presses the lever 46 downward to hold valve 37 in position.

If interruption of the arc does not take place during passage of current through zero, the current continues to flow through windings 2, 3 and 4 of the solenoid contact 1. The current now increases and produces, between the windings 2 and 3, on the one hand, and 4, on the other hand, an electrodynamic force of attraction which leads to an immediate reclosing. Upon the next passage of the current through zero, the switch automatically carries out another attempt at disconnection.

FIGURES 2 and 3 show another solenoid contact system which can be used for the synchronous interrupter of FIGURE 1 where special arc electrodes are provided which, after opening of the solenoid contact, are in series with the solenoid contacts.

Referring to FIGURES 2 and 3, an upper cylindrical current lead 50 is connected to the sliding contacts 51. A current-conducting cylinder 52 is fastened to a differential piston 53 formed of insulating material. A gasket 54 is placed between differential piston 53 and current lead 50. The solenoid contact consists of a movable winding 55 which is rigidly connected to the differential piston 53 and a stationary winding 56. The movable winding 55 is connected at one end to the current-conducting cylinder 52 via its extension 52a and at its other end to a nozzle-shaped conductive cylinder 57, inserted in the differential piston 53. An arcing electrode 58 is connected to the conductive cylinder 57. Movable solenoid winding 55 carries contact stud 55a.

The stationary solenoid winding 56 carries the contact stud 56a with winding 56 connected electrically at one end to metal strip 59 having a stationary arc electrode 60 and at the other end to a flexible conductive strip 61 (see FIGURE 3) with the stationary lower terminal 62. The stationary winding 56 is fastened to and insulated from a pot-shaped powder magnet core 63 which, on its periphery, has recesses 64 and 65, as seen in FIGURE 3. The magnet core 63, and thus the solenoid winding 56, rest in the manner of a balance beam on a knife edge 66 and are supported by a rubber ring 67. The magnet core 63 is movable relative to screws 69 and the lower terminal 62 so that the rubber ring 67 is under an initial

stress. Opposite the contact studs 55a and 56a there is arranged an insulating member 68 which is fastened to the stationary solenoid winding 56.

The path of the current in the embodiment of FIGURES 2 and 3 is shown in FIGURE 4, the reference numbers of FIGURE 4 being the same as those of FIGURES 2 and 3. The current flows from the sliding contacts 51 to the cylinder 52 and, via the extension 52a, to the starting point of the solenoid winding 55. Current thereafter flows from the end of winding 55, via the contact studs 55a and 56a, to the starting point of the stationary solenoid winding 56. Current then flows from the end of winding 56 via the flexible strip 61 to the stationary current lead 62. The contact stud 55a is connected to the arc electrode 58, and the contact stud 56a is connected, via the conductive strip 59, to the arc electrode 60. Therefore, in case of an arc 70 between the electrodes 58 and 60, the current also flows over the solenoid windings 55 and 56. Thus, upon the existence of the arc 70, electrodynamic forces of attraction are maintained to cause reclosing of the switch if interruption is unsuccessful.

To insure that, when the switch is closed, the current always flows through contact studs 55a and 56a, the insulating member 68 is fastened opposite these contact studs. Since the magnet core 63 with the stationary winding 56 is movable in the manner of a balance beam, the biasing pressure will be distributed uniformly over the contact stud 56a and the insulating member 68. The pot-shaped magnet core 63 causes an increase in the magnetic induction in the movable winding 55 until full saturation is reached. Thus, a larger magnetic holding force is provided in the lower current region which is advantageous for the synchronous control.

If the contact studs 55a and 56a are to be separated, then, in the manner explained in connection with FIGURE 1, by the opening of a valve towards the low pressure side, the pressure p_2 (FIGURE 2) is reduced, while the pressure p_1 on the high pressure side remains constant. This produces a force in the disconnecting direction on the differential piston 53. The opening of the contact can, however, take place only when the electrodynamic holding force between the windings 55 and 56 becomes smaller than the disconnecting force. First of all, there is produced a small arc between the contact studs 55a and 56a, which arc is blown inward, and then continues to burn between the arc electrodes 58 and 60. If the arc 70 is quenched during the passage through zero, the disconnecting is completed. If, however, the arc is not extinguished, then the current continues to increase, and the electrodynamic force between the windings 55 and 56 increases very rapidly, which causes reclosing of the contacts. In the subsequent passage through zero, synchronous interruption is again attempted. Normal closing is obtained by increasing the pressure p_2 to such an extent that the corresponding pressure force is capable of overcoming the opposing action of the pressure p_1 .

Although this invention has been described with respect to its preferred embodiments, it should be understood that many variations and modifications will now be obvious to those skilled in the art, and it is preferred, therefore, that the scope of the invention be limited not by the specific disclosure herein, but only by the appended claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

1. A synchronous high voltage gas blast interrupter comprising first and second cooperating contacts relatively movable with respect to one another; a chamber housing said first and second contacts having a high pressure region, a low pressure region and valve means for selectively pneumatically connecting and disconnecting said high pressure region and low pressure region; said first and second contacts positioned in said high pressure region

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and disposed to receive a flow of high pressure gas therebetween when said first and second contacts are moved to a disengaged position and said valve means pneumatically connects said high pressure region and low pressure region; first and second terminal means extending from said chamber; and first and second contact elements; said first cooperating contact comprising a first flat electrical winding having said first contact element at one end thereof and having its opposite end connected to said first terminal means; said second cooperating contact comprising a second flat electrical winding having said second contact element at one end thereof and having its opposite end connected to said second terminal means; said first and second flat electrical windings being parallel and coaxial with respect to one another; said first and second contact elements being adjacent to one another; first biasing means for biasing said first contact means toward a disengaged position relative to said second contact means; second biasing means for defeating the motion of said first contact means by said first biasing means; and means for removing said second biasing means whereby said first and second contact means are disengaged by said first biasing means when the current through said first and second means falls below a given value.

2. The device of claim 1 which includes a differential piston connected to said first contact means; said differential piston having first and second opposing surfaces; said first surface exposed to the pressure of said high pressure region and comprising said first biasing means; valve means comprising said means for removing said second biasing means for selectively connecting said sec-

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ond surface of said differential piston to said high pressure region and low pressure region, respectively; said second surface comprising said second biasing means and having a larger area than said first surface.

3. The device set forth in claim 1 wherein said first and second contact elements are formed of arc-resistant material.

4. The device set forth in claim 1 which includes a magnetic circuit surrounding the circuit of said first and second contact means, and a movable armature cooperating with said magnetic circuit; said armature connected to said second valve means and operating said second valve means responsive to the energization of said magnetic circuit.

5. The device as set forth in claim 1 which includes a balance beam support connected to said second contact means.

6. The device as set forth in claim 4 which includes a balance beam support connected to said second contact means;

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