United States Patent [19]

Thaler

[11] **3,891,893**

[45] **June 24, 1975**

[54] **HIGH-VOLTAGE POWER SWITCH**

[75] Inventor: **Richard Thaler,** Uterentfelden, Switzerland

[73] Assignee: **Sprecher & Schuh AG,** Aarau, Switzerland

[22] Filed: **May 24, 1974**

[21] Appl. No.: **473,323**

[30] **Foreign Application Priority Data**

May 28, 1973 Switzerland 7625/73

[52] **U.S. Cl.** ..... **317/11 A;** 317/11 C; 317/58; 200/145 R; 200/148 A; 200/150 B

[51] **Int. Cl.** **H02h 7/22**

[58] **Field of Search** .... 317/11 R, 11 A, 11 E, 11 C, 317/58, 59; 200/145 R, 148 A, 150 B, 148 B, 150 G, 150 E, 82 B, 144 R

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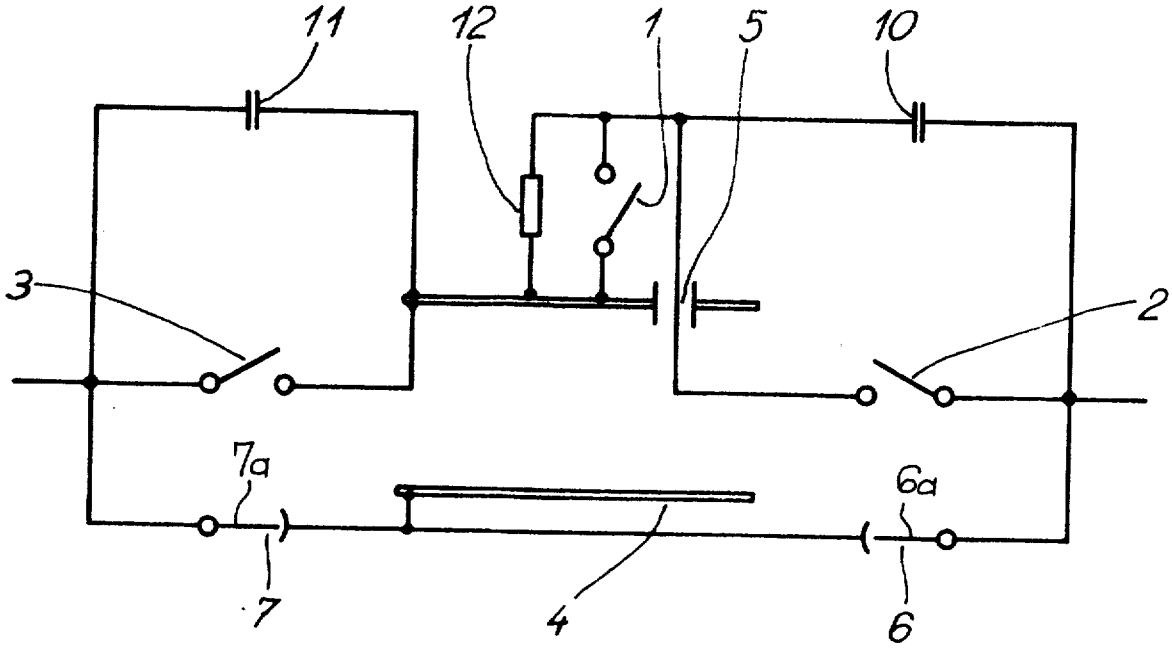
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Primary Examiner—J. D. Miller
Assistant Examiner—Patrick R. Salce
Attorney, Agent, or Firm—Waters, Schwartz & Nissen

[57] **ABSTRACT**

A high-voltage power switch embodying at least two power switch locations having each terminal or pole connected in series and composed of at least one oil-poor switch and at least one gas-blast switch with self-flushing or extinguishing action. The arc extinguishing compartment of the oil-poor switch is sealed with a pressure stroke transducer and the part of the pressure stroke transducer which carries out the stroke movement is operatively connected with a pump device of the gas-blast switch in order to be able to use the pressure energy dependent upon current and present in the arc extinguishing compartment of the oil-poor switch during the cut-off operation for the actuation of the gas-blast switch.

5 Claims, 6 Drawing Figures



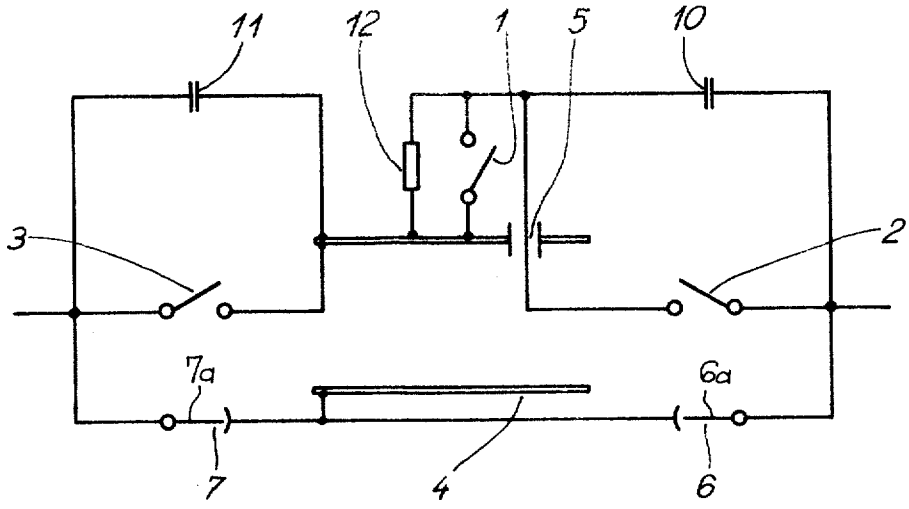


Fig. 1

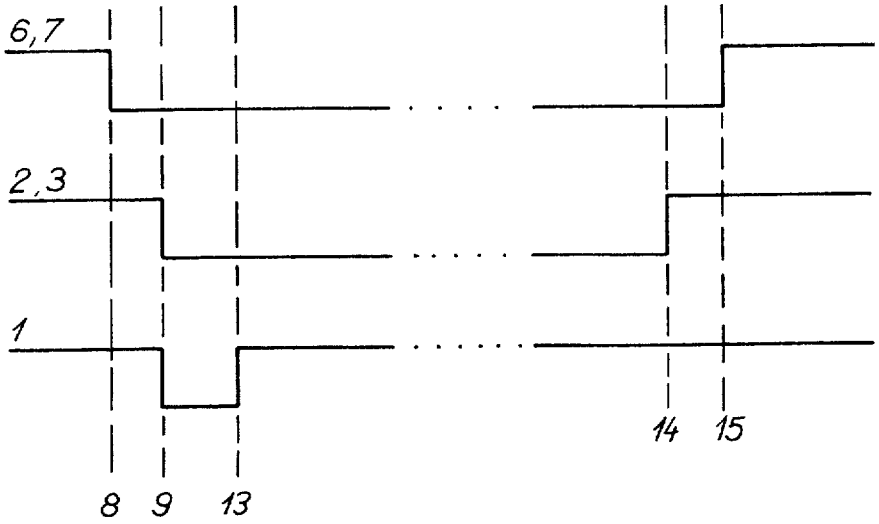


Fig. 2

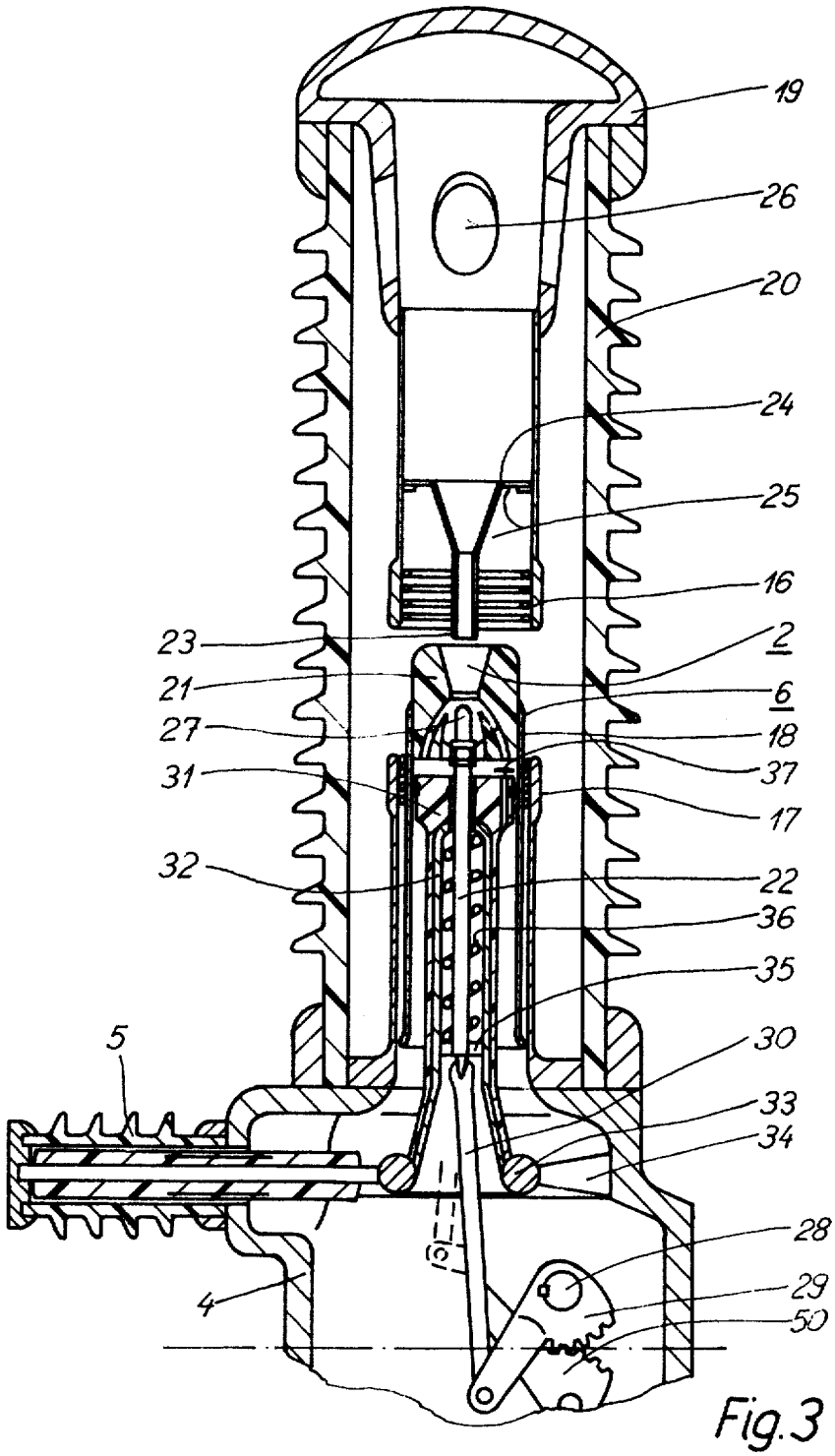

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Fig.3

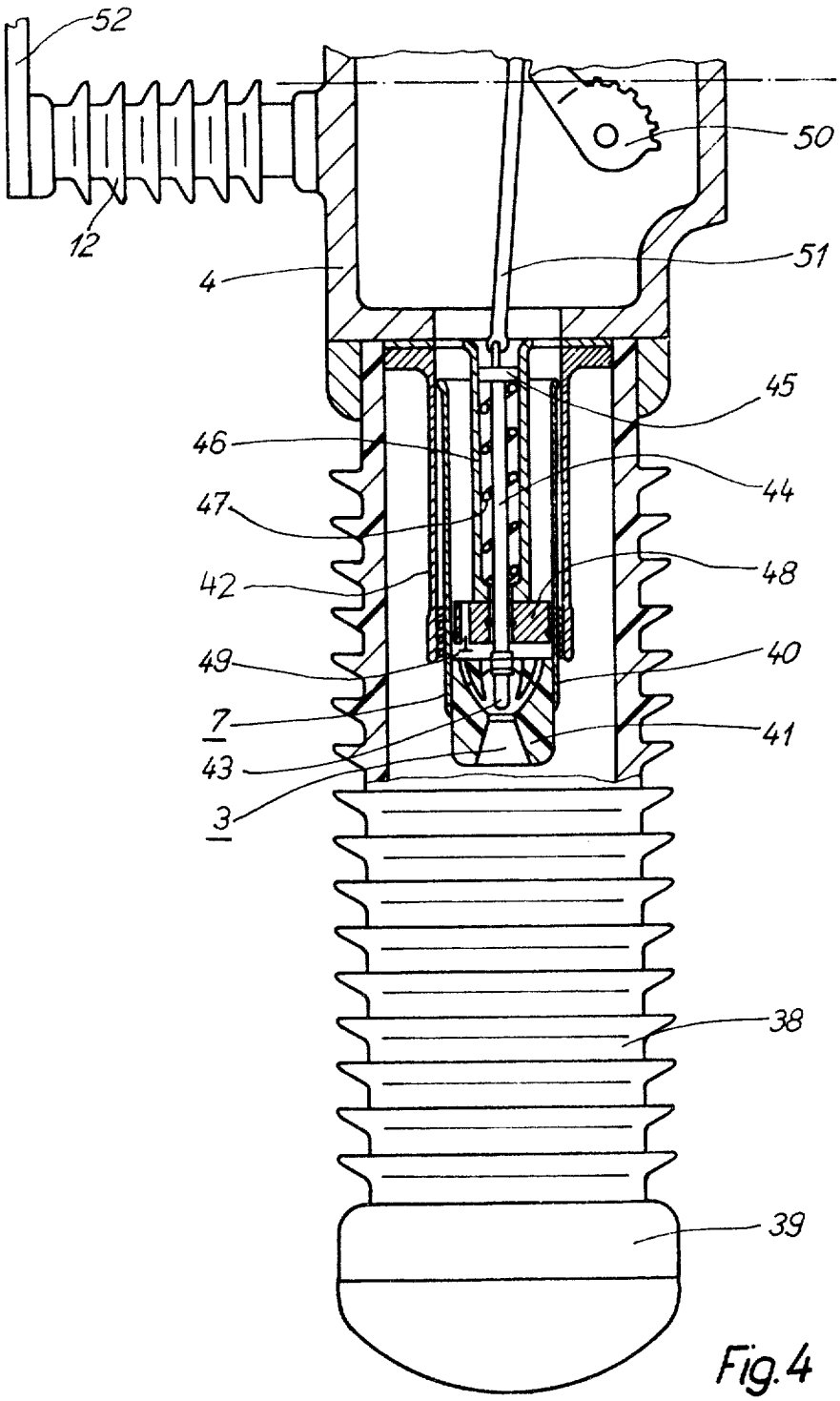


Fig. 4

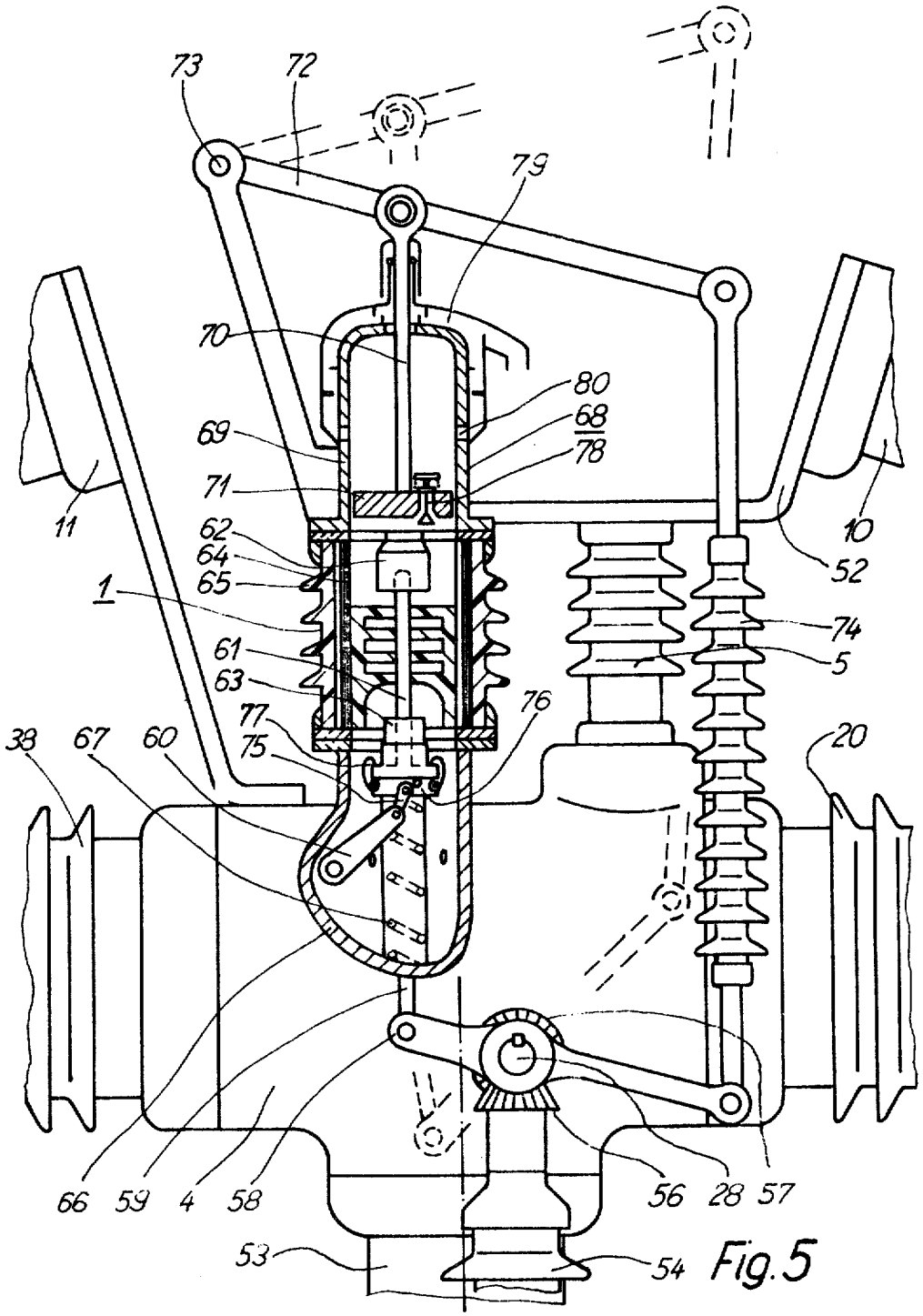

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Fig. 5

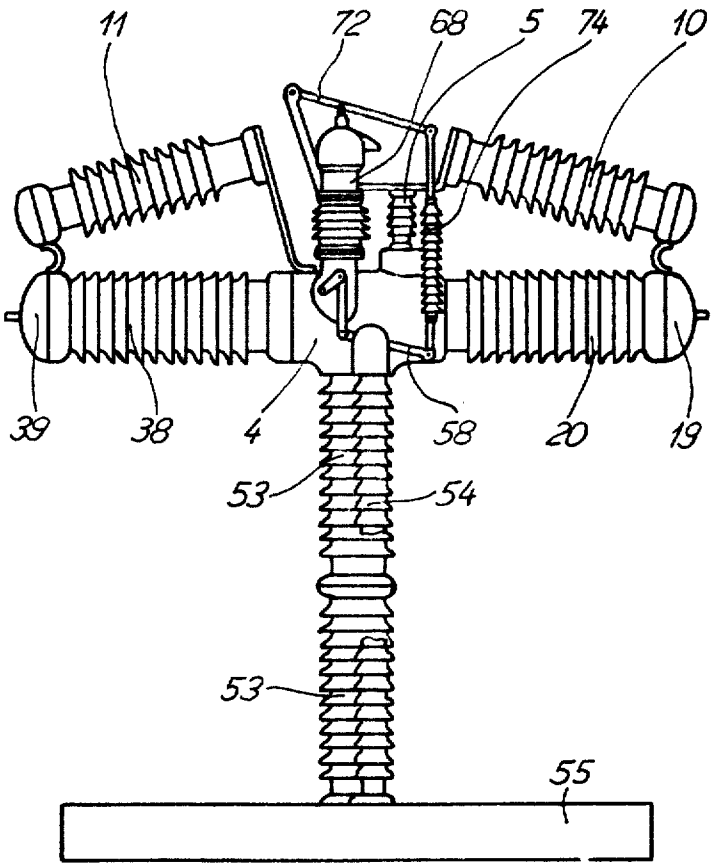


Fig. 6

HIGH-VOLTAGE POWER SWITCH

BACKGROUND OF THE INVENTION

The present invention relates to a new and improved construction of high-voltage power switch or switch arrangement of the type incorporating at least two power switching locations having each terminal or pole connected in series and composed of at least one oil-poor switch and at least one gas blast switch with automatic flushing or blowing, the oil-poor switch possessing a more rapid natural restrengthening action and restrengthens at a prescribed lower voltage value than the gas-blast switch, and further including a switch drive for actuating the power switching locations, and means for the potential control and damping with the aid of capacitors, inductances and resistors, wherein when using capacitors and resistors the capacitors are connected in parallel with the gas-blast switches and the resistors with the oil-poor switches, and when using inductances and resistors the resistors are connected parallel with the gas-blast switches and the inductances with the oil-poor switches.

A high-voltage power switch of the above-described type has become known to the art from Swiss U.S. Pat. No. 408,160. The means for the potential control and damping bring about that the voltage distribution of the transient voltage which recurs across the switch after current interruption or cut-off, experiences a displacement as a function of time at the individual switching locations. The rapid ascending starting portion of the recurring voltage appears practically completely across the oil-poor switch. Oil-poor switches, after extinguishing the cut-off arc, possess a rapid electrical strengthening of the switching path, they are suitable for taking-up the steep ascending starting voltage of the recurring voltage. Oil-poor power switches are, however, not economically advantageous for very high operating voltages per cut-off location.

The steepness or slope of the recurring voltage flattens after a few microseconds following extinguishing of the cut-off arc, the peak values of the recurring voltage however further increase. This increasing less steep voltage gradually appears across the gas-blast switch. Gas-blast switches are economically advantageous for high operating voltages per cut-off location, however possess only a relatively slow electrical restrengthening of the switching path after extinguishing of the cut-off arc. The series circuit of an oil-poor switch and a gas-blast switch which has been described in the above-mentioned Swiss U.S. Pat. No. 408,160 affords an economically advantageous combination for a high-voltage power switch. A drawback of this arrangement resides in the fact that for actuating the switch relatively high drive energy is required, particularly then when the gas-blast switch possesses automatic blowing or extinguishing action.

Oil-poor power switches are known in the art which, for the purpose of utilizing the pressure energy of the switching gas upon the interruption of a switching arc, are equipped with differential pistons. In the prior art switches the differential piston actuates an extinguishing pump which is provided for conveying the extinguishing medium to the cut-off or interruption path. A drawback of the known oil-poor switches resides in the fact that their cut-off locations are only suitable for a relatively low operating voltage per cut-off location, with the result that the use of a high-voltage switch with a number of series connected interruption or cut-off locations is associated with economical drawbacks.

SUMMARY OF THE INVENTION

Hence, it is a primary object of the present invention to provide a new and improved construction of high-voltage power switch with at least two power switching locations having each terminal or pole connected in series and consisting of at least one oil-poor switch and at least one gas-blast switch with self-extinguishing action and which only requires a relatively small drive energy.

Now in order to implement this object and others which will become more readily apparent as the description proceeds, the high-voltage power switch or switch arrangement of this development is manifested by the features that the arc extinguishing compartment of the oil-poor switch is sealed with a pressure-stroke transducer and the part of the pressure-stroke transducer which carries out the stroke movement is operatively connected with the pump device of the gas-blast switch in order to be able to use, during the cut-off operation, the current-dependent pressure energy which prevails in the arc extinguishing compartment of the oil-poor switch, for the actuation of the gas-blast switch.

The pressure-stroke transducer can consist of a cylinder which connects with the arc extinguishing compartment of the oil-poor switch and a piston which is relatively movable within such cylinder.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above, will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

FIG. 1 is a schematic circuit diagram of a high-voltage power switch designed according to the present invention,

FIG. 2 is a graph showing curves depicting the time course of the contact opening and closing of the switching elements shown in FIG. 1;

FIG. 3 is a longitudinal sectional view of one gas-blast switch;

FIG. 4 is a longitudinal sectional view of the other gas-blast switch;

FIG. 5 is a longitudinal sectional view of the oil-poor switch with a part of the high-voltage power switch; and

FIG. 6 is a total view of the high-voltage power switch.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Describing now the drawings, in FIG. 1 there is illustrated a schematic circuit diagram of a high-voltage power switch arrangement according to the invention. The three power switching locations 1, 2, 3 which are connected in series consist of an oil-poor switch 1 and both of the gas-blast switches 2 and 3 with automatic flushing or blowing action. The mechanism housing 4 is provided with a throughpassage 5. The closed power switching locations 1, 2, 3 are bridged by means of both of the parallel separators or disconnectors 6 and 7. The infeed of current occurs primarily via the parallel connected separators 6, 7 when the power switch is closed. Upon interruption of the current initially both of the

separators 6 and 7 are opened. The time-course of the opening and closing of the contacts 6*a*, 7*a* has been shown in FIG. 2. The separation or opening of the contacts 6*a*, 7*a* of the separators 6, 7 occurs at the point in time 8. During continuation of the cut-off movement all of the power switching locations 1, 2, 3 are opened at the same point in time 9. At all three switches 1, 2, 3 there appears an arc which is extinguished at the null crossover of the current. After the moment of extinguishing of the arcs there appears at the terminals of the high-voltage power switch the recurring voltage. Distribution of the recurring voltage across the individual power switching locations 1, 2, 3 is controlled as a function of time by the capacitors 10, 11 and the resistor 12. The recurring voltage which possesses a relatively large starting slope, with the selected RC-control, after extinguishing of the arcs appears practically completely across the oil-poor switch 1 during the first few microseconds. The oil-poor switch 1 possesses a more rapid natural strength than the gas-blast switches 2, 3 and therefore the oil-poor switch 1 can take-up the starting portion of the recurring voltage. The subsequent considerably less steep portion of the recurring voltage then appears for the most part across the gas-blast switches 2, 3. The oil-poor switch 1 therefore strengthens at a predetermined lower voltage value than the gas-blast switches 2, 3.

It is possible to also further expand upon the control by means of an inductance connected in parallel with the oil-poor switch 1. With this control capacitors are connected in parallel with the gas-blast switches 2, 3, and a resistor and an inductance are connected in parallel with the oil-poor switch 1.

After the gas-blast switches 2, 3 have taken-up practically the entire recurring voltage the oil-poor switch 1 is again closed at the point in time 13, remaining in this state until the next cut-off operation. The oil-poor switch 1 does not participate in the closing movements of the high-voltage power switch. During closing movement of the high-voltage power switch both of the power switching locations 2 and 3 are closed at the point in time 14, and thereafter the separators or disconnectors 6 and 7 are closed at the point in time 15.

FIG. 3 illustrates the gas-blast switch 2 and the separator or disconnector 6 together with the through passage 5 and the mechanism housing 4. The separator 6 consists of both fixed contacts 16, 17 and a contact tube 18 which connects such fixed contacts in the closed position. The fixed contact 16 is fixedly electrically conductively connected with a closure cap 19 of the hollow insulator 20, and the fixed contact 17 is electrically conductively fixedly connected with the mechanism housing 4. The contact tube 18 is secured to a blast nozzle 21 consisting of insulating material and actuated in conjunction therewith by means of a contact rod 22.

The fixed contact 23 of the power switching location is secured to the closure cap 19 and constructed to be hollow throughout. A support or holder 24 is provided with openings or through-passages 25 in order to positively provide for the hot switching gases emanating from the blast nozzle 21 free flowpaths into the closure cap 19. The switching gases can cool at the closure gap 19 and flow via the openings 16 into the gas compartment of the switch.

A movable contact pin 27 of the power switching location is disposed at the end of the contact rod 22 and is arranged in the blast nozzle 21. The contact rod 22 can be actuated through the agency of a drive shaft 28 via a toothed lever portion or gear element 29 and the insulating rod 30. The unit composed of the contact tube 18, blast nozzle 21 and contact rod 22 forms an externally movable pump cylinder of the gas-blast switch possessing automatic flushing action. A pump piston 31 is force-lockingly or positively connected with the mechanism housing 4, yet electrically insulated therefrom. The pump piston 31 consists of electrically insulating material and is secured to an electrically conductive tube or pipe 32. This tube 32 is closed by means of a ring 33. Ring 33 is secured by means of support insulators 34 in the mechanism housing 4. The tube 32 is electrically insulated at the outside between the pump piston 31 and the ring 33. A sliding contact 35 is arranged within the tube 32, this sliding contact 35 providing an electrical connection between the contact rod 22 and the tube 32. The current flowing through the power switching location composed of the fixed contact 23 and the movable contact pin 27 is delivered via the through passage 5 to the next power switching location, the oil-poor power switch 1 of FIG. 1.

Within the tube 32 there is located a cut-off spring 35 which is tensioned or biased during the cut-on or switch-in movement, in order to deliver a portion of the required cut-off energy during the cut-off movement. During the switch-in movement the pump volume is filled with fresh gas via check valve 37. As the insulating gas there can be used any suitable gas, preferably sulphur hexafluoride.

FIG. 4 illustrates the gas-blast switch 3 and the separator or disconnector 7 with the resistor 12 and the mechanism housing 4 according to the arrangement of FIG. 1. The components which are not shown in sectional view in FIG. 4 and which are located beneath the hollow insulator 38 and the closure cap 39 are identical to the corresponding components of the switch depicted in and discussed above in conjunction with FIG. 3. In this arrangement the separator is also the same construction as in FIG. 3. A contact tube 40 is secured to the blast nozzle 41 formed of insulating material and slides within the fixed or stationary contact 42 which is electrically conductively connected with the mechanism housing 4. The contact rod 44 which carries the switching or contact pin 43, the blast nozzle 41 and the contact tube 40 is provided with a sliding contact 45 which establishes the electrical connection between the contact rod 44 and tube 46. This tube 46 is electrically conductively ely and forcelockingly connected with the mechanism housing 4. The cut-off spring 47 is also in this case biased or tensioned during the switch-in movement. The pump piston 48, in this arrangement, consists of metal and is provided with check valve 49. Actuation of the power switching location and the separator occurs via the toothed lever portion or gear element 50 coupled with the drive shaft 28 and rod 51.

In FIG. 4 there is also visible part of the connection 52 between the resistor 12, the oil-poor switch 1, the through-passage 5 and the capacitor 10.

FIG. 5 illustrates the mechanism housing 4 with the throughpassage 5, a respective part of both insulators 20, 38, support insulator 53, rotatable column insulator 54 and parts of both capacitors 10 and 11 as well as the connection 52. The drive shaft 28 is actuated by means of a switch drive, accommodated in the grounded chas-

sis or housing 55 illustrated in FIG. 6, through the agency of the rotary column insualtor 54 and bevel gears 56, 57. The drive shaft 28 is sealingly mounted in the mechanism housing 4 for the actuation of the gas-blast switches. Externally of the mechanism housing 4 there is secured a lever 58 to the drive shaft 28, this lever 58 actuating, via a rod 59 and lever 60, the switching pin 61 of the oil-poor switch 1.

The oil-poor power switch 1 consists of the fixed or stationary contact 62, sliding contact 63, the switching pin 61, the extinguishing compartment or chamber 64, the hollow insulator 65, the mechanism housing 66, the switch-in or cut-on spring 67 and the pressure-stroke transducer 68 which seals the arc extinguishing compartment 64.

The pressure-stroke transducer 68 comprises a cylinder 69 and a piston 71 connected with a rod 70 and movable within such cylinder 69. The rod 70 is hingedly connected with lever 72. This lever 72 is pivotally mounted about the fixed axle or point of rotation 73. Both of the levers 58 and 72 are hingedly connected with one another by the insulator 74.

During a cut-off movement the rod 59 is drawn downwards in the showing of FIG. 5 by means of the lever 58. The lever 60 which is connected with the rod 59, via a further lever which has not been particularly shown in FIG. 5, carries out a pivotal movement and via the bracket 75 downwardly draws the intermediate body member 76 which is guided in the mechanism housing 66 together with the pawls 77. The pawls 77 entrain the switching or contact pin 61 which is likewise guided in the mechanism housing 66. The prebiased switch-in spring 67 is tensioned during this movement.

After contact separation in the oil-poor switch 1 switching gases are present in the arc extinguishing compartment 64 which upwardly move the piston 71 within the cylinder 69. In the piston 71 there is arranged a valve 78 which closed when high pressure prevails in the extinguishing compartment or chamber 64. However, this valve 78 remains open in the presence of relatively small pressure differentials, which occur during the closing movement of the drive shaft 28, during downard movement of the piston 71. The switching gases upwardly displace the piston 71 in the cylinder 69 to such an extent until the piston 71 frees the pressure venting or relief opening 80 which communicates via the oil separator 70 with the surroundings. The switching gases can escape out of the cylinder 69 via this opening 80. During the cut-off movement there is utilized the pressure energy of the switching gases which prevails in the oil-poor switch 1. From the showing of FIG. 2 it will be apparent that the oil-poor switch 1 only is open for a very short time-span. For this reason the pawls 77 are released by the cams or dogs housed in the mechanism housing 66 between the switching pin 61 and the intermediate body member 76 connected with the drive, whereupon the switch-in spring 67 again brings the switching pin 61 into its switching-in or cut-on position. The duration of opening of the oil-poor switch 1 is in the order of magnitude of 10 to 30 milliseconds.

FIG. 6 illustrates a total view of the high-voltage power switch or switch arrangement. In the grounded chassis 55 there is located the switch drive as previously discussed. The switch is mounted at the support insulators 53. Actuation of the switch occurs via the insulating rotary column 54. The gas-blast switch insulators 20, 38 are essentially horizontally arranged. The capacitors 10, 11 are located above the gas-blast switches. The resistor 12, as best seen by referring to FIG. 4, has not been particularly shown in FIG. 6, it is located behind the oil-poor switch 1. There can be readily recognized the arrangement of the levers 58, 72, the throughpassage 5 and the insulator 74.

A decisive advantage of the described arrangement resides in the fact that the current-dependent pressure energy prevailing in the are extinguishing compartment 64 of the oil-poor switch 1 during the cut-off operation can be employed for the actuation of the gas-blast switches 2, 3 equipped with the automatic extinguishing action. Due to these measures there is possible the use of a relatively small drive.

The connection between the pump devices of the gas-blast switches and the pressure-stroke transducer of the oil-poor power switch also can occur hydraulically.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto, but may be otherwise variously embodied and practiced within the scope of the following claims. ACCORDINGLY,

What is claimed is:

1. A high-voltage power switch arrangement comprising at least two power switching locations having each terminal connected in series, said at least two power switching locations comprising at least one oil-poor switch and at least one gas-blast switch having means providing automatic arc extinguishing, the oil-power switch possessing a more rapid natural dielectric strengthening and strenghtens at a prescribed lower voltage value than the gas-blast switch, a switch drive actuating the power switching locations, and means for the potential control and damping with the aid of capacitors, inductances and resistors, wherein when using capacitors and resistors, the capacitors are connected in parallel with the gas-blast switches and the resistors with the oil-poor switches and when using inductances and resistors the resistors are connected in parallel with the gas-blast switches and the inductances with the oil-poor switches, the improvement comprising said oil-poor switch having an arc extinguishing compartment sealed by a pressure-stroke transducer, said pressure-stroke transducer including a component which carries out the stroke movement, a pump device provided for the gas-blast switch, said component of the pressure-stroke transducer being operatively connected with said pump device of the gas-blast switch in order to be able to use, during the cut-off operation, the current-dependent pressure energy which prevails in the arc extinguishing compartment of the oil-poor switch for the actuation of the gas-blast switch.

2. The high-voltage power switch arrangement as defined in claim 1, wherein the pressure-stroke transducer comprises a cylinder which is operatively connected with the arc extinguishing compartment of the oil-poor switch and a piston member which is relatively movable within said cylinder.

3. The high-voltage power switch arrangement as defined in claim 2, wherein the cylinder is provided with a pressure vent opening which is freed by said piston member when said piston member assumes a terminal

position following pressure impingement of the arc extinguishing compartment.

4. The high-voltage power switch arrangement as defined in claim 3, wherein said piston member has a front face and a rear face, valve means arranged between the front face and rear face of the piston member, said valve means closing in the presence of high pressures in the arc extinguishing compartment and during the closing movement of the switch drive and the therewith associated return movement of the piston member into a starting position remaining open.

5. A high-voltage power switch arrangement composed of at least two power switching locations comprising at least one oil-poor switch and at least one gas-blast switch, said oil-poor switch having an arc extinguishing compartment, a pressure-stroke transducer cooperating with said arc extinguishing compartment, said pressure-stroke transducer including a component which carries out the stroke movement, a pump device provided for the gas-blast switch, said component of the pressure-stroke transducer being operatively connected with said pump device of the gas-blast switch in order to be able to use, during the cut-off operation, the current-dependent pressure energy which prevails in the arc extinguishing compartment of the oil-poor switch for the actuation of the gas-blast switch.

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