

[54] **GAS-BLAST SWITCH**
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[57] **ABSTRACT**

A gas-blast switch comprising a switching pin and an electrode having a burning-off surface, the switching pin and electrode being electrically conductively connected with one another when the switch is in a closed condition. Drive means serve for carrying out relative separation movement of the switching pin and electrode away from one another during switching-out or disconnection of the gas-blast switch in order to extend or draw in the lengthwise direction the arc prevailing between the switching pin and the electrode during such separation movement, the arc being flushed by a flowing stream of extinguishing gas. The burning-off surface of the electrode is arranged in a widened discharge channel of a Laval nozzle directly after the narrowest location or throat of such nozzle, the switching pin during the switching-out operation being retracted in the flow direction of the extinguishing gas into the discharge channel of the Laval nozzle.

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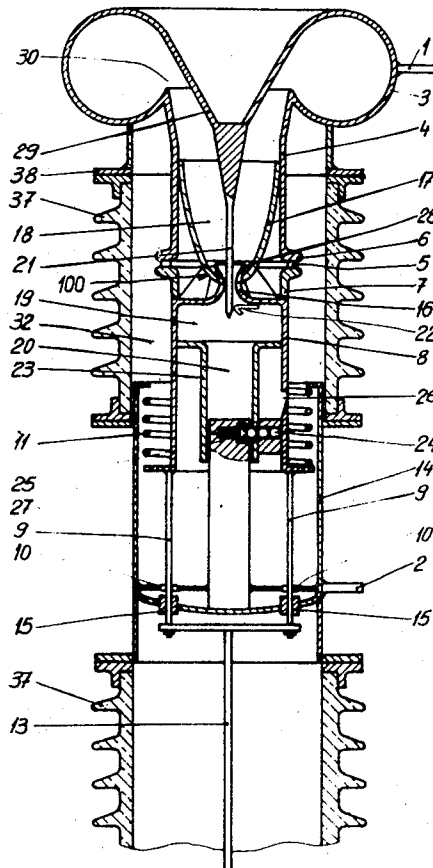
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5 Claims, 3 Drawing Figures



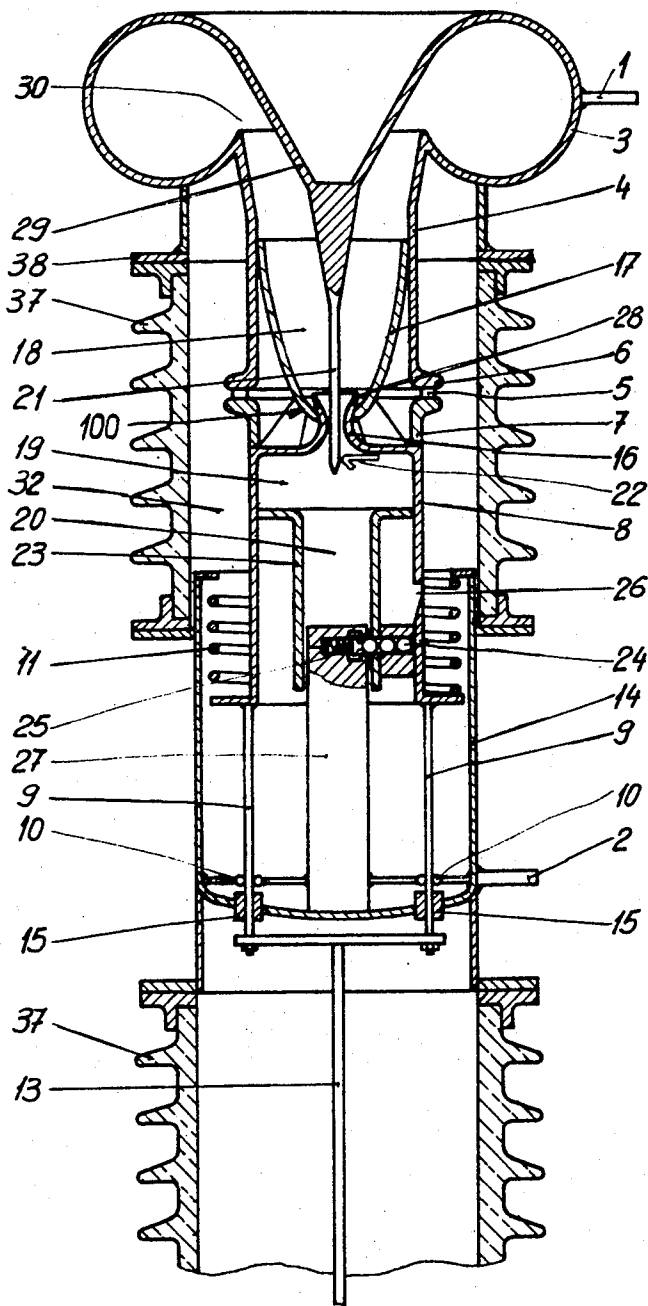


Fig. 1

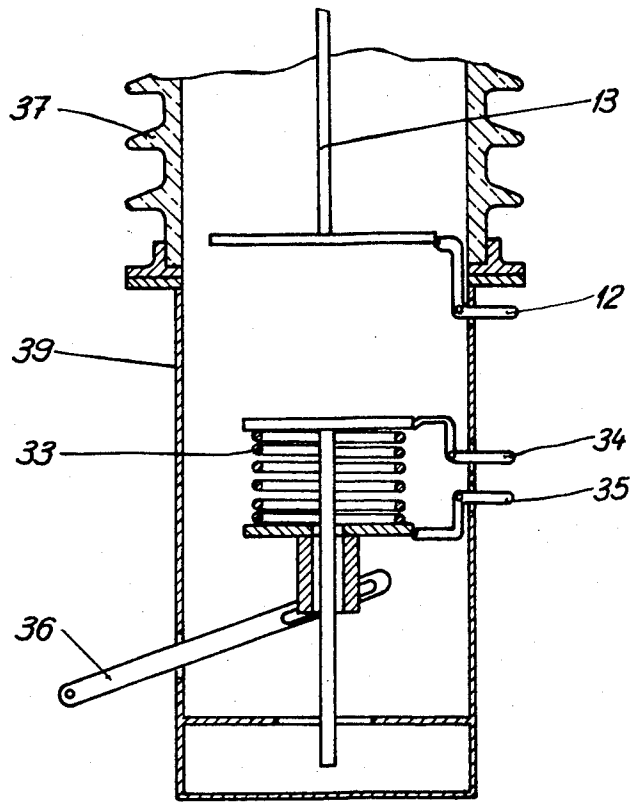


Fig. 2

GAS-BLAST SWITCH

BACKGROUND OF THE INVENTION

The present invention relates to a new and improved gas-blast switch of the type embodying a switching pin and an electrode having a burning-off surface, wherein, when the switch is closed the switching pin and the electrode are electrically conductively connected with one another, whereas during the switching-off or disconnection operation the switching pin and electrode are spaced from one another owing to a relative movement carried out, through the action of a drive, between such switching pin and electrode in order to draw or extend the arc along its length and which arc is present during the separation or spacing of such components, the arc being flushed by a flowing stream of extinguishing or quenching gas.

Gas-blast switch constructions are known to the art wherein the arc to be extinguished is drawn into a blast or discharge nozzle. This blast nozzle is arranged between the electrodes taking-up the base points of the arc throughout the arc extinguishing or quenching path. The extinguishing gas is compressed at one side of the blast nozzle and upon freeing the nozzle opening it flows to the other side of such blast nozzle at which prevails a lower pressure. As a result the arc conducted through the blast nozzle is flushed or blown with the extinguishing or quenching gas.

Other state-of-the-art constructions of gas-blast switches resort to the technique of radially flushing the arc. Here the extinguishing or quenching gas is delivered in a radial direction with respect to the arc, the discharge flow occurring axially. With these arc extinguishing arrangements the flow of the extinguishing gas in the blast nozzle or in the mouth of the axial discharge channels is impaired by the thermal expansion and the disassociation of the extinguishing gas. It should be appreciated that at the arc channel leading through the blast nozzle and at the mouth of the axial discharge channels there occurs an infeed or supply of energy during the duration of burning of the arc, so that the arc and its surroundings reach very high temperatures. In fact temperatures in the order of magnitude of 10,000°C have been measured. The thermal energy is radiated to the regions surrounding the arc, so that at the narrowest cross-section or throat of the blast nozzle or the axial discharge channels the extinguishing gas and the walls are markedly heated-up. Owing to thermal expansion of the extinguishing gas a pressure increase occurs in front of the blast nozzle and in front of the axial discharge channels.

The expansion of the plasma is also quite intensive for certain extinguishing gases because, apart from the thermal expansion of the extinguishing gas at the plasma region there also occurs disassociation, again bringing about a volume increase. For instance, when using sulphur hexafluoride as the extinguishing gas, which consists of 7 atoms per molecule, owing to the thermal disassociation which occurs at about 2,500°C, the volume increases 7-fold.

SUMMARY OF THE INVENTION

Accordingly, from what has been discussed above it should be apparent that this field of technology is still in need of gas-blast switches which are not associated with the aforementioned drawbacks and limitations of

the prior art constructions. Therefore it is a primary aim of this invention to effectively and reliably fulfill the existing need in the art through the provision of a new and improved gas-blast switch which is not associated with the aforementioned drawbacks and limitations of the prior art constructions.

Another and more specific object of the present invention relates to an alternating current-gas-blast switch having a novel construction of arc extinguishing system wherein during the interruption of current flow there is not present any pressure build-up at the flow path of the extinguishing gas, there is possible rapid removal of the ionized gas out of the extinguishing path, a pronounced cooling of the region about the base of the arc, slight thermal radiation to the walls neighboring the extinguishing zone, and removal of practically the entire energy of the arc by the flowing extinguishing gas.

Now, in order to implement these and still further objects of the invention, which will become more readily apparent as the description proceeds, the gas-blast switch of the present invention contemplates that the burning-off surface of the electrode is arranged following the widening discharge channel of a Laval nozzle directly after the narrowest location of such nozzle, whereby the switching pin during the switching-out operation is retracted in the flow direction of the extinguishing gas in the discharge channel of the Laval nozzle.

The wall of the discharge channel of the Laval nozzle is advantageously formed of an insulating material.

The use of a Laval nozzle allows the extinguishing gas to flow at supersonic velocities at a portion of the discharge channel of the nozzle. The extinguishing gas attains the velocity of sound at the constricted or throat portion disposed between the inflow channel and the discharge channel, from which location it then can flow further at supersonic velocity with sufficiently small counter-pressure at the discharge channel. Extinguishing or quenching of the arc partially occurs at the extinguishing gas flowing at supersonic velocity. Hence, there occurs during a pressure surge in front of the switching pin the transition to a velocity below that of the speed of sound i.e., a subsonic velocity. Consequently, at the flow which is at supersonic velocity and before the null crossover or throughpassage of the current the hot ionized gases are quickly removed out of the switching path. At the region surrounding the tip of the switching pin, at the location with the greatest field strength, there prevails a subsonic flow, in other words increased gas density. The base points of the arc are thus extremely well cooled. At the throat or constricted portion of the Laval nozzle there only flows cold extinguishing gas. The further flow of such extinguishing gas is not hindered by thermal expansion and disassociation. The cold extinguishing gas does not admix with the already heated gases along the switching path since no turbulence is present in the supersonic flow. Almost the entire energy of the arc is thus removed by the flowing extinguishing or quenching gas.

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 longitudinal sectional view of a gas-blast switch constructed in accordance with the teachings of the present invention in closed condition;

FIG. 2 is a fragmentary sectional view illustrating details of the drive component; and

FIG. 3 illustrates the gas-blast switch of this development in an open condition.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Describing now the drawings, FIG. 1 of the drawings illustrates the gas-blast switch of this invention in its closed condition, FIG. 2 illustrates the drive of the switch depicted in FIG. 1, and FIG. 3 illustrates the gas-blast switch of FIG. 1 in its open condition. Current is supplied by means of the terminals 1 and 2 to the switch construction. The operating current flows through the agency of the flexed or bent ring-shaped pipe 3, the pipe or conduit 4, the contacts 5 and 6, the contact support 7, the pre-compression cylinder 8, the rods 9 and the roller contacts 10.

In the arrangement of FIG. 1 the switch-out or disconnection spring 11 is loaded or stressed and fixedly retained by the locking pawl 12 or equivalent structure as same has been depicted in FIG. 2. Release of the switch construction takes place by opening the pawl 12, either manually or by means of an electromagnet for instance. The switch-out or disconnection spring 11 now moves the insulating rod 13, the rods 9 leading out of the switch casing or tank 14 through the agency of the packing sleeves 15, the precompression cylinder 8 together with the electrode 16 forming the narrowed or constricted portion of the Laval nozzle, generally indicated at reference character 100, the contact support 7, the contacts 5, as well as the wall 17 formed of insulating material and which forms the discharge or outflow channel 18 of the Laval nozzle. The extinguishing or quenching gas present in the compartments or spaces 19 and 20 is thus compressed, but can hardly discharge or escape in that the constricted portion of the Laval nozzle 100 at the electrode 16 is still closed for the most part by the switching or tripping pin 21. At first, the contacts 5 and 6 are separated. The current then initially flows between the contact spring or blade 22 and the switching pin 21, later between the switching pin 21 and the electrode 16.

Compression is completed when the space 19 has been compressed down to practically null volume. The compressed insulating gas is located within the smaller cylinder 23 at the space or compartment 20 where the pressure is now two-fold to 12-fold that of the starting pressure. Upon termination of the precompression the pre-compression cylinder 8 has been displaced downwards within the switching tank 14 to such an extent that the arresting or latching ball 24 is pressed by means of spring 25 into a recess 26 of the pre-compression cylinder 8. As a result, the arresting or blocking action between the piston 25 and the smaller cylinder 23 is released and there is established a blocking or arresting action between the pre-compression cylinder 8 and the smaller cylinder 23. At this point in time the tip

of the switching pin 21 departs from the narrowest location or throat of the Laval nozzle 100 at the electrode 16 and thus frees the gas current.

There is now present the actual switching phase. The conductive connection now exists via an arc which prevails between the tip of the switching pin member 21 and the burning-off surface 28 of the electrode 16. The gas departs from the Laval nozzle 100, at the region of the burning-off surface 28 of the electrode 16 this gas flow is already at supersonic velocity. Now at this region, with a directed gas flow at ultrasonic speed, release of the energy of the arc in the first instance, owing to widening of the discharge channel 18, causes an acceleration of the inflowing gas and only in the second instance a backflow or backwash to the nozzle.

The accelerated gas jet arrives at the pipe or tube 4, then flows along the conducting surfaces 29 through the inflow orifice or slot 30 into the flexed ring-shaped or annular pipe 3. At this location it is circularly deflected, thus forms a turbulent or vortex ring at which the kinetic energy of the gas stream is stored until dampened by frictional forces. The pressure waves propagated back to the nozzle and the electrode 16 remain weak, as they are only caused by the partial reflections at the conducting surfaces 29 and due to frictional forces.

If the arc current approaches null, then the energy of the arc becomes smaller. The post-acceleration of the gas stream through heating thereof at the arc becomes weaker, the gas flow thus slower. The quantity of gas located at the tube or pipe 4 at this period of time has a greater velocity than the gas at the region of the arc. There is thus produced a suction action which withdraws or sucks-out the strongly ionized gas from the discharge channel 18. Hence at the time of null-crossover of the arc the discharge channel 18 contains only very little ionized gas. Since the backflow of the arc before null-crossover has receded quite markedly, at the time of null-crossover a pronounced cold gas stream at supersonic velocity departs from the Laval nozzle. With increased spacing from the electrode 16 this gas stream or jet is further accelerated. Hence, there is realized rapid removal of the ionized gas, in other words a rapid dielectric strengthening of the separation location.

Finally the switching pin 21 reaches the terminal position depicted in FIG. 3. A gas insulation path 31 is established between the pipe or tube 4 and the wall 17 of the discharge channel 18. On the one hand, there is established such a complete separation of the voltage-conducting components without there being present a creepage path contaminated by the effects of the arc. On the other hand, the return flowing gas out of the flexed ring-shaped pipe or tube 3, after dampening the turbulent or vortex flow, can admix with the outer gas volume at location 32. In this way there is countered the possibility of a brief reduction in the electrical strength of the gas in the open separation path during return flow of the heated gas out of the pipe 4 and out of the flexed ring-shaped pipe 3 to the discharge or outflow channel 18.

By means of the switching-in or connection spring 33 of FIG. 2, and after releasing the locking mechanism 34, the gas-blast switch can be again connected or switched-in and the switching-out or disconnection

spring 11 can be loaded. After the switching-in operation the locking mechanism 35 is released, where-upon the switching-in spring 33 drops and the locking mechanism 34 snaps-in. It is now possible to again disconnect the switch. The switch-in spring 33 is stressed by a non-illustrated motor drive with the aid of the lever 36 whereupon the locking mechanism 35 is again engaged.

The switch is sealed by the insulators 37, the tubular-shaped flexed tube or pipe 3 with the connection flanges 38, the switch casing or tank 14 and the grounded housing 39.

While there is shown and described a present preferred embodiment 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 gas-blast switch comprising a switching pin and an electrode having a burning-off surface, the switching pin and electrode being electrically conductively connected with one another when the switch is in a closed condition, drive means for carrying out a relative separation movement of the switching pin and electrode away from one another during the switching-out operation of the gas-blast switch in order to draw the arc prevailing between the switching pin and the electrode in the lengthwise direction during such relative separation movement, the arc being flushed by a flowing extinguishing gas stream, Laval nozzle means having a widened discharge channel following the nar-

rowest location of said nozzle means, said burning-off surface of said electrode being arranged in the widened discharge channel of the Laval nozzle means directly after said narrowest location of said nozzle means, the switching pin during the switching-out operation being retracted in the flow direction of the extinguishing gas into the discharge channel of said Laval nozzle means.

2. The gas-blast switch as defined in claim 1, wherein the wall of the discharge channel of said Laval nozzle means is formed of an insulating material.

3. The gas-blast switch as defined in claim 2, further including guide surface means arranged in the flow direction of the extinguishing gas following the discharge channel of the Laval nozzle means for laterally deflecting the flowing stream of extinguishing gas.

4. The gas-blast switch as defined in claim 3, further including means defining a gas insulation path which is present in the open condition of the gas-blast switch between the end of the discharge channel of the Laval nozzle means formed of said insulating material and the remaining components of the switch electrically conductively connected with the switching pin.

5. The gas-blast switch as defined in claim 4, further including contacts arranged substantially parallel to the electrode and the switching pin, said contacts conducting the operating current when the switch is closed and upon opening the switch are opened prior to interrupting the electrical contact between the electrode and the switching pin.

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