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V. GROSSE

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ELECTRIC SWITCH

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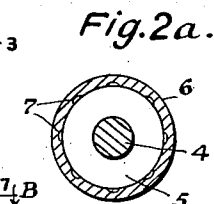
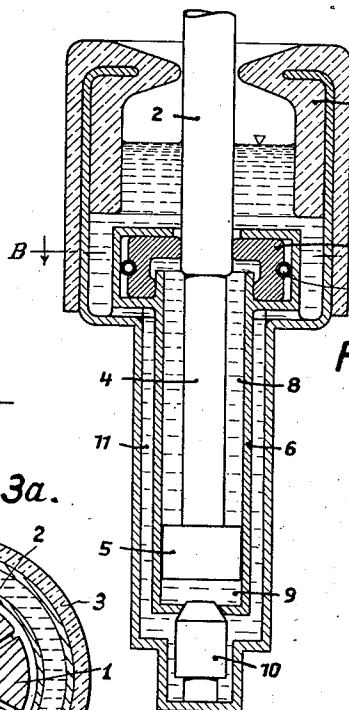
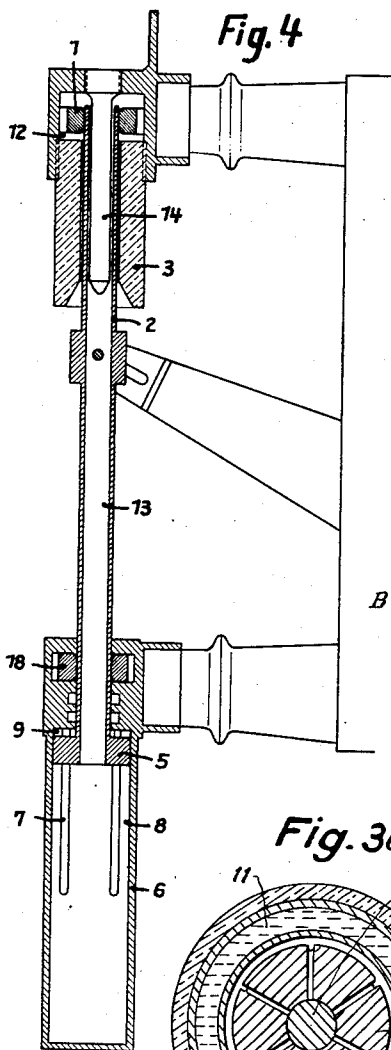
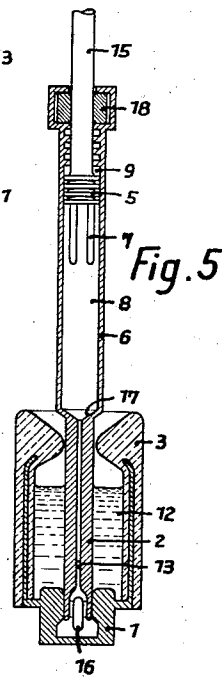
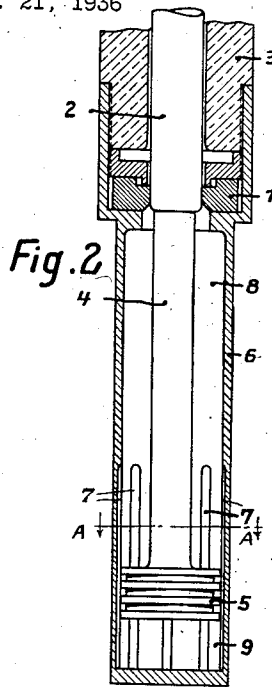
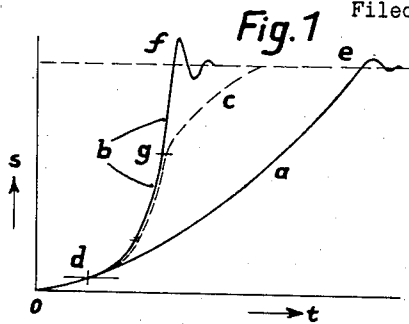
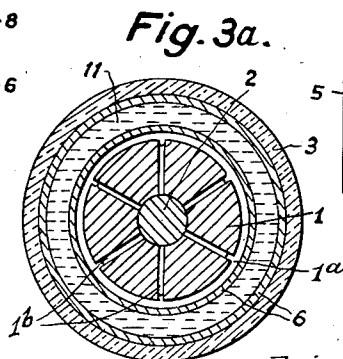
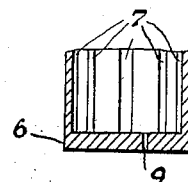


Fig. 3



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UNITED STATES PATENT OFFICE

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ELECTRIC SWITCH

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8 Claims. (Cl. 200—149)

Electric switches are known in which the arc is extinguished by flowing pressure means, the pressure of which is produced by the heat of the arc in a chamber closed in a substantially piston-like manner by the switching member. Such switches are more particularly constructed as liquid, for instance, oil or water switches (especially blow-out chamber switches), and as gas switches, in which the gas, which is under atmospheric or higher initial pressure, is heated by the arc. Switches are also known in which the arc burns in the proximity of gas delivering insulating walls and in which the gases are developed from these walls by the heat of the arc.

The pressure required for extinguishing the arc increases with the current to be switched off, and as a rule becomes high in the case of a strong short circuit. This pressure causes the switch member which closes the blowout chamber in a substantially piston-like manner to be accelerated in the direction of the movement for the switching off. The acceleration itself is desirable, since it results in a quicker lengthening of the arc and thus, in a quicker blow-out, especially in the case of large currents. However, when the switched-off position is reached, large forces of inertia arise in the switch, and in order to cope with them, constructions, which are especially stable, are required.

These forces of inertia depend upon the current to be switched off. Therefore it is not possible readily to annihilate them by a braking action at the end of the switching movement, since the brakes adapted to brake the largest possible forces of inertia would delay the disconnection in the case of small currents.

Attempts have been made to absorb these forces by buffers. Such buffers, which are capable of absorbing the whole of the energy along a short path, are heavy and expensive. Moreover, they tend to oscillate, and the oscillations could lead to back ignitions by a backward impact of the switching member.

All these disadvantages are avoided by the present invention, according to which the forces which accelerate the movable switching member during the switching-off are opposed by forces, which increase with the pressure of the extinguishing means produced by the arc. For this purpose the extinguishing pressure, which acts on the switching rod closing the blow-out chamber in a piston-like manner, acts on a counter piston connected with the switching member, the forces of which counter piston act in opposition to the force exerted on the switching member.

Various forms of construction for carrying the invention into effect are illustrated, by way of example, in the accompanying drawing.

Figure 1 shows the course of the switch movement as a function of time.

Figure 2 illustrates a sectional elevation of a construction according to the invention in which the switch has gas developing walls, and Figure 2a is a transverse section along the line A—A in Figure 2, whilst Figure 2b shows the detail of a modification of this form of construction.

Figure 3 illustrates a liquid switch in sectional elevation, and Figure 3a is a section along the line B—B in Figure 3.

Figure 4 is a sectional elevation of a further construction of gas switch with gas developing walls.

Figure 5 is a sectional elevation of another form of liquid switch.

Figure 1 is a diagram showing the course of the movement in the case of a switch of the kind referred to. The ordinates show the path of the switching member during the disconnection and the abscissae represent the time. The curve *a* illustrates the course of the movement of a known switch when small currents are switched off, that is to say, the course of the movement which is effected only by the drive. *d* represents the contact position when the contacts are separated and *e* the switching-off position.

The curve *b* shows the course of the same switch when a large short circuit current is switched off. After the separation of the contacts there is a strong acceleration of the switching member, in consequence of which the latter strikes with considerable force against the abutment at *f*.

When use is made of the counter piston brake according to the invention, the course may be modified, as shown by the curve *c*. In the first part of the switching operation, from *o* to *g*, there is a communication between the two sides of the piston. Therefore the pressure increases on both sides thereof. This connection is interrupted at *g*. While the pressure on the counter side of the piston drops with the further movement, the pressure on the a.c. side is further increased. Whilst the arc had an accelerating effect on the switching member up to *g*, a more or less powerful braking action now takes place according to the dimensions of the piston surfaces, which braking action together with the friction, reduces the speed at the end of the switching operation approximately to the speed which is reached for the switching off, when no

current passes through the switch, which speed is represented by the curve *c* from *g* to *e*. This course gives a quick lengthening of the arc and, in spite thereof, a soft impact when the switching member reaches the end position.

A suitable arrangement with which the said course of movement can be obtained is illustrated in Figure 2, which shows a switch with gas delivering walls. 1 is the fixed and 2 is the movable rod-like contact. 3 is the insulating switch tube of gas delivering material, 4 is the so-called "filling rod", which is secured to the switching member 2 and follows the latter into the switch tube 3 during the switching-off movement. At its free end the filling rod 4 is provided with a counterpiston 5, which slides in a fluid-tight manner in the container 6 in which the filling rod is disposed. This sealing may be carried out as a labyrinth-packing, as a piston-ring packing, as a stuffing-box, or simply by an accurate fitting of the piston. The wall of the container 6 is provided with grooves 7, which connect the cylinder space 8, which is subjected to the arc pressure, with the counter space 9. When a large current is switched off the gas pressure in the two spaces 8 and 9 first increases approximately uniformly. The additional accelerating force acting on the switching member is equal to the product of the cross-section q_1 of the switching member 2 and the arc pressure p_1 . After the piston has passed beyond the grooves 7 the spaces 8 and 9 are separated from one another. Whilst the pressure p_1 in the space 8, more especially if the arc has not yet been extinguished, is further increased, the pressure p_2 in the space 9 decreases. The additional force acting on the switching member is:

$$q_2 p_2 - (q_2 - q_1) p_1$$

wherein q_2 is the cross-section of the piston 5. If the same is made sufficiently large, it is always possible for the above expression to become negative, that is to say, the force acting on the switching member has a retarding action.

The space 9 may be closed, as shown in Figure 2, or it may be open to atmosphere through a hole 9a, as shown in Figure 2b, so that a constant pressure is produced in the space 9.

In the drawing the switch is shown in the switching-on position. During the switching-off movement the switching member is acted upon, in addition to the driving force, by two forces, after the piston has passed beyond the grooves 7 between the spaces 9 and 8. These forces are determined by the pressures on the two sides of the piston and upon the effective piston-surfaces. The pressure in the blow-out chamber acts on the one side of the piston 5, and the counterpressures on the other side of the piston 5 may greatly vary as regards their values and course.

If the counter-pressure chamber 9 is closed, a reduced pressure is produced in this chamber during the switching-off movement of the piston 5, which reduced pressure produces a braking effect which increases with the length of the switching movement.

If the counter-pressure chamber 9 is open to the atmosphere, the pressure on the back of the piston 5 is constant. In this way it is attained that, irrespective of any possible leakage in the guiding of the piston, the counter-force is dependent exclusively upon the pressure in the switching chamber or on the pressure in the cylinder space 8 which is in communication with the switching chamber 3.

In Figure 3, 1 is the fixed contact consisting of a number of segments held together by a yielding member 1a, gaps 1b being left between the segments (see Figure 3a). 2 is the movable rod contact. 3 is the wall of insulating material of a switch chamber which is filled up to a certain level with water, oil or another suitable liquid. 4 is the "filling rod" provided at its free end with a piston 5 which slides in a fluid-tight manner in the container 6. The space 8 of the container 6 is in communication with the switch chamber through the gaps 1b between the segments and is, therefore, also filled with liquid. The space 9 of the container 6 behind the piston 5 is closed up by an excess pressure valve 10, which opens when the pressure in the space 9 exceeds a certain predetermined value. The space behind the excess pressure valve 10 is also in communication with the switch chamber through the surrounding water column 11 and is therefore also filled with liquid.

The switching-off operation takes place in the same way as described with reference to Figure 2, the arc causing gases and vapours to be developed from the liquid, which gases and vapours produce a pressure in the chamber 3. This pressure acts on the piston 5 through the liquid, the transmission of pressure being possible owing to the gaps between the segments of the contact 1. However, when switching-on, the liquid, which is present in the space 9, must be pressed out by the piston 5 through the excess pressure valve 10.

In Figure 4, 1 is again the fixed contact, 2 the movable contact which is in the form of a tube having a bore 13 and provided at its lower end with a piston 5. 3 is the switch chamber the wall of which is capable of evolving gases. 6, 7, 8, 9 refer to the same parts as those already described in connection with Figures 2 and 3. The pressure chamber 8 is in communication with the contact space 12 through the bore 13. 14 is a fixed rod of insulating material, which, when the switch is closed, projects into the bore, and which, during the switching-off movement reduces the cross-section of the switch chamber 3. 15 is a guide for the movable electrode 2, which serves at the same time as a lead in of the current.

The operation of this form of construction will be readily understood from the description given in connection with Figure 2. Of course, the construction illustrated in Figure 4 may be modified so as to be capable of being used in connection with other switches in which the arc is extinguished by flowing pressure means, for instance, in blow-out chambers, compressed gas switches, liquid switches, etc.

In Figure 5, 1 is again the fixed, 2 the movable contact provided with a bore 13, and 3 is the switch chamber, the interior 12 of which is filled with liquid. The piston 5 is fixed, and the container 6 surrounding it is movable, the movable electrode 2 being attached thereto. The driving means, for instance a lever, which is not shown, is connected with the container 6. The pressure space 8 is in communication with the interior 12 of the switch chamber through the bore 13. 7 are again the grooves in the container wall, which as explained in connection with the forms of construction shown in Figures 2 and 4 connect the pressure space 8 with the space 9 lying behind the piston during the first part of the switching-off movement. 10 is the current lead-in, 15 a guiding rod of conducting material, which leads the current from 13 to the movable contact 2 over the container wall 6. 16 is a pin provided

at the end of the movable contact 2 and which burns out.

During the switching off, the pressure in the chamber 8 is the same as in the interior 12 of the switch chamber, since liquid and gas developed by the switching operation flows into the said chamber 8 through the bore 13 and compresses the air contained therein. The operation will be clearly understood from that above given in connection with Figure 2. The extremity of the movable contact, viz., the pin 16, lies within an intensive flow of the extinguishing means, so that the extinguishing action is substantially facilitated. The pin 16 from which the arc starts is completely surrounded by the current of the extinguishing means. The braking action at the end of the switching operation is due to the pressure in the space 8 acting on the surface 17 in a direction opposite to the switching movement.

Also in the case of small currents an additional blow-out effect is obtained by the air being pressed out of the space 8 and blown on to the foot of the arc at the tip of the movable contact.

What I claim is:

1. In an electric switch containing pressure means for extinguishing the arc, the pressure of which means is produced by the heat of the arc, a blow-out chamber and a movable switching member adapted to close the said blow-out chamber in an essentially piston-like manner and in which the pressure of the said means exerts on the said movable switching member a force which accelerates the switching-off movement, a piston connected to the switching member, a cylinder for the said piston, the means connecting the piston to the switching member being made hollow to connect the part of the said cylinder facing away from the blow-out chamber with the blow-out chamber, whereby the forces which accelerate the movable switching member during the switching-off operation are opposed by forces which increase with the pressure of the pressure means.

2. In an electric switch containing pressure means for extinguishing the arc, the pressure of which means is produced by the heat of the arc, a blow-out chamber and a movable switching member adapted to close the said blow-out chamber in an essentially piston-like manner and in which the pressure of the said means exerts on the said movable switching member a force which accelerates the switching-off movement, the movable switching member having a hollow cylindrical part and a bore connecting the said hollow cylindrical part with the switching chamber and a fixed piston-like guide in the hollow cylindrical part of the movable switching member, whereby the forces which accelerate the movable switching member during the switching-off operation

are opposed by forces which increase with the pressure of the pressure means.

3. An electric switch containing pressure means for extinguishing the arc, the pressure of which means is produced by the heat of the arc, a blow-out chamber and a movable switching member adapted to close the said blow-out chamber in an essentially piston-like manner and in which the pressure of the said means exerts on the said movable switching member a force which accelerates the switching-off movement, a piston connected to the movable switching member, a cylinder for the said piston, which is in communication with the blow-out chamber on the side of the piston facing the latter chamber, and means of communication in the cylinder wall between the one side and the other side of the piston capable of being operative during a portion or during the whole of the switching movement, so that the resistance of flow is made dependent on the length of the movement, whereby the forces which accelerate the movable switching member during the switching-off operation will be opposed by forces which increase with the pressure of the pressure means.

4. An electric switch as claimed in claim 3 in which the communication between the one side and the other side of the piston in the wall of the cylinder is so adapted, that the flow resistance will be small during the first part of the switching-off movement, and attain a higher value at the end of the movement.

5. In an electric switch containing pressure means for extinguishing the arc, the pressure of which means is produced by the heat of the arc, a blow-out chamber, a movable switching member adapted to close the said blow-out chamber in an essentially piston-like manner, the pressure of the said means exerting on the said movable switching member a force which accelerates the switching-off movement, and a piston which is acted upon at least during a portion of the switching movement by the pressure in the blow-out chamber and which is connected to the switching member so as to oppose the accelerating force acting thereon.

6. An electric switch as claimed in claim 5, having an insulating continuation in the movable switching member between the piston and the movable contact of the said switching member.

7. An electric switch as claimed in claim 5, in which the piston side facing away from the blow-out chamber lies in a space of constant pressure, more particularly atmospheric pressure.

8. An electric switch as claimed in claim 5, in which the cylinder space is closed on the side of the piston facing away from the blow-out chamber.

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