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CIRCUIT INTERRUPTER

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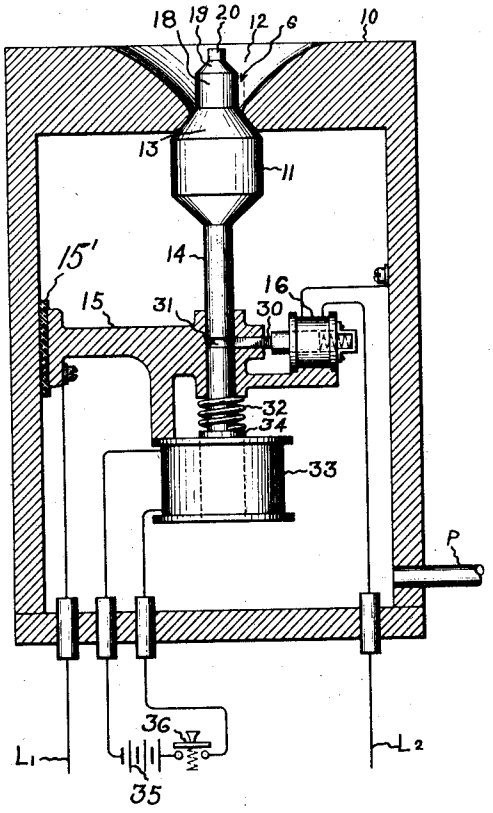

Inventor:
Josef Biermanns,
by Charles O'Mullan
His Attorney.

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UNITED STATES PATENT OFFICE

JOSEF BIERMANNS, OF KARLSHORST, GERMANY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

CIRCUIT INTERRUPTER

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My invention relates to circuit interrupters and provides an improved form of switch having specially designed arcing contacts for alternating current circuit interrupting service.

Heretofore it has been considered that the interrupting capacity of a switch generally increases with the speed at which the contacts are separated. However, I propose to make an exception to this rule with switches used in alternating current service, and particularly with switches using compressed gas as an arc extinguishing medium. In the compressed gas switches, I preferably make one contact of annular shape with a cooperating specially formed pin contact arranged to be retracted into a container, out of which the compressed gas rushes through the annular stationary contact, although my invention is not necessarily limited thereto.

For a better understanding of my invention let it be assumed that the switch contacts in an alternating current circuit are separated immediately after the current passes through zero and that the arc continues at least until the next passage of the current through zero. In this case with the contacts moving apart at high speeds, the arc is drawn out and becomes of relatively large size and thus produces such a high pressure and such a large quantity of heat that the arc cannot readily be extinguished.

This disadvantage is overcome in accordance with my present invention by an improved arrangement of the arcing contacts so as to divide the circuit breaking operation into three stages. In the first stage the contacts are separated as quickly as possible to a distance apart which cannot be jumped by the operating voltage. At 100 kilovolts, the distance of 5 mm is sufficient to serve this purpose, when a gas extinguishing medium as air or carbon dioxide for example at high pressure, as 10 atmospheres, is employed. In the second stage of the circuit interrupting operation, the arc gap distance between the separated contacts remains substantially constant or the contacts may move only very slowly away from each other. The duration of this particular stage must be the equivalent of at least the period of time between two passages of the current through zero, that is at least one half cycle of the alternating current, which with 50 cycle current is one-hundredth of a second.

The third stage of the circuit breaking operation consists in moving the contacts to their final off position, this movement again being made at high speed.

In carrying out the invention in one form the sequence of the three stages of circuit breaking operation may be obtained by suitably designing the contact operating mechanisms so as to effect the separation thereof quickly, slowly and quickly in succession. If desired, a suitable cam mechanism readily may be used for this purpose with the contact operating cam suitably formed to initially separate the contacts the required arcing distance at high speeds, and then maintain a uniform arc gap between the contacts for a certain period before final separation thereof to the off position.

It is, however, preferable to vary the arc gap between the contacts by moving the latter uniformly and so shaping the contacts as automatically to produce the desired stages in the circuit breaking operation in timed sequence. This may be accomplished by providing parts on the arcing contacts extending a limited distance parallel to the direction of the relative movement therebetween, and in this way maintain a substantially uniform arcing gap between the contacts for the desired period. To accomplish this result the contacts may be formed in several different ways. For example with one of the contacts formed in L shape, and the other contact arranged to engage with one leg of the L and to move substantially parallel with and in spaced relation with the other leg, the desired results may be obtained. Also with spaced apart stationary contacts and a movable bridging contact therefor, a projection may be formed on the latter extending between the stationary contacts and in spaced relation therewith so as to produce the desired results. Furthermore for use in a compressed gas type of circuit interrupter, one of the contacts may be formed with an

annular opening therein and the cooperating plug contact arranged to engage with the edges of this opening and thereby serve as a gas valve. In this service, the movable plug contact is provided with a cylindrical projection extending through the annular opening in the stationary contacts clearing the same and arranged to produce the desired stages in the circuit breaking operation.

The single figure of the accompanying drawing schematically illustrates the invention embodied in the contact mechanism for a compressed gas switch.

As shown in the drawing the contacts 10 and 11 are relatively movable into and out of engagement to establish and interrupt the circuit of the supply lines L_1 and L_2. The contact 10 is composed of a suitable conducting material, as copper, and in the present instance forms part of a cylindrical container supplied with compressed gas through a pipe line P from a suitable source. A suitable tapering or nozzle-like gas discharge opening 12 is formed in the contact 10.

The contact 11 is of general cylindrical form and provided with a tapering face 13 adapted to fit into the restricted part of the opening 12 in the contact 10, and thereby serve both as a valve to confine the gas and as a circuit controlling contact. The contact 11 is mounted on the operating rod 14 which slides in a suitable guide 15 suitably insulated from the container as by the insulation-structure 15'.

The switch contact 10 is connected to the circuit line L_2 through an electromagnet 16, while the movable contact 11 is connected directly to the circuit line L_1, the connections being insulated from the gas container.

In order to maintain a uniform arc gap between the relatively movable contacts 10 and 11 during a desired portion of their movement in accordance with the present invention, the contact 11 is provided with a cylindrical extension 18 of smaller diameter than that of the restricted part of the gas outlet or opening 12 extending within the diverging part of said opening and clearing the contact 10. Thus when the contact 11 is separated from the contact 10, the cylindrical surface of the extension 18 is carried in space alignment with the inner surface of the outlet opening 12 and thereby maintains a uniform arc gap between the contact for a limited period during the operation of the switch. The length of this arc gap of course will vary with the voltage of the circuit and with the gas pressure employed, and as previously pointed out for 100 kilovolt circuits a distance of 5 mm may be greater than the striking distance of the voltage of the circuit, and hence will be sufficient. If desired an additional extension may be formed on the contact 11 by providing the tapering portion 19 and the smaller cylindrical portion 20.

Although any suitable operating mechanism may be provided for effecting the relative movement of the contacts 10 and 11, I have shown in the drawing the electromagnet 16 provided with a latch 30 which cooperates with a suitable notch 31 formed in the supporting rod 14 of the contact 11 so as to release the rod when the electromagnet 16 is energized with current above a certain value. Upon release of the latch 30, the spring 32 serves to separate the contact 11 from the contact 10. To reengage the contact the closing electromagnet 33 having the armature 34 connected to the operating rod 14 is provided, and arranged to be energized from any suitable source such as the battery 35 under the control of a switch 36.

The operation of the switch as shown is as follows:

With the contact 11 in engagement with the contact 10, the circuit of the lines L_1 and L_2 is closed. Also the gas outlet opening 12 is closed and hence a pressure is built up within the container. Upon the occurrence of abnormal overload conditions in the circuit, the electromagnet 16 is energized sufficiently to retract the latch 30 out of the notch 31, thereby releasing the contact operating rod 14. The spring 32 thereon serves to separate the contacts 10 and 11, thus permitting the compressed gas to flow in the annular space between the contacts.

The arc formed in the gap between the contacts 10 and 11 which is combined within the annular space by the gas traversing the same at high velocity, is confined therein and at once transferred to the cylindrical portion 18 by the action of the outrushing compressed gas. The arc is thereby effectively prevented from following the movable contact. Each of the plurality of arc gaps between the spaced apart portions of contacts 10 and 11 is now equal to the radial gap G between the annular opening in contact 10 and the cylindrical portion 18 of contact 11. These gaps do not vary while the contact 11 is moved through a distance equal to the length of the cylindrical portion 18. This length of the cylindrical portion 18 is so proportioned that the uniform arc gap G is maintained for a slightly longer period than a half cycle. Thus when the alternating current approaches zero, the arc between the contacts 10 and 11 readily is extinguished. When the arc is once extinguished, it will not be reestablished due to the fact that the uniform gap G is greater than the striking distance of the circuit voltage. In case the arc is not extinguished to a surge in a highly inductive circuit or the like, at least a considerable portion of the inductive energy of the alternative current circuit is dissipated through the arc during the half cycle, and

hence when the reduced cylindrical portion 20 of the contact 11 has moved clear of the contact 10, the circuit is readily interrupted.

While I have illustrated and described the preferred embodiment of the invention in connection with a compressed gas switch, it should be understood that the invention is not necessarily limited thereto and may be employed in any other form of alternating current switches where it is desired to maintain a uniform arc gap for a limited period during the operation of the switch.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An alternating current circuit interrupter of the gas blast type comprising relatively movable arcing contacts including a nozzle-like contact and a rod contact separable to form an annular gas passage, said rod contact having a uniform portion extending within and clearing the exhaust of the other contact, the gas passage between said portion and contact forming a substantially constant arc gap of the order of approximately 5 mm. during initial separation of said contacts, and means effecting relative movement of said contacts causing further separation thereof.

2. An alternating current circuit interrupter of the gas blast type comprising relatively movable contacts including a contact having a nozzle-like opening and a rod contact coacting therewith to form an annular gas passage upon separation of said contacts, said rod contact having a reduced portion clearing the coacting contact and extending into the diverging exhaust part of said nozzle-like opening so that a substantially constant arc gap is maintained between said portion and coacting contact during initial circuit opening movement.

3. An alternating current circuit interrupter of the gas blast type including a contact having a nozzle-like exhaust opening therein, a relatively movable contact having a cylindrical portion disposed axially of said opening, said cylindrical portion extending within and clearing said exhaust opening so that upon axial movement of said movable contact during the initial separation of said contacts a constant arc gap is maintained between said cylindrical portion and stationary contact, and means effecting contact opening movement.

4. An alternating current circuit interrupter of the gas blast type comprising a stationary contact having a nozzle-like opening therein, a movable rod contact having a cylindrical portion operable into and out of said opening and in spaced relation therewith to form during the initial circuit opening movement an annular arc gap of constant length, said rod contact including an annular contact engaging surface greater in diameter than said cylindrical portion, and means effecting circuit opening movement of said rod contact.

5. A compressed gas switch comprising a stationary contact having a diverging opening therein, a relatively movable contact provided with an annular contact engaging surface coacting with the contact surface of said stationary contact at the restricted portion of said opening, said movable contact having a cylindrical portion extending through said opening into the diverging part thereof, the diameter of said portion being less than the diameter of said annular contact surface whereby a substantially uniform arc gap of constant length is maintained for a limited time subsequent to separation of said coacting contact surfaces, and means for effecting opening movement of said movable contact.

In witness whereof, I have hereunto set my hand, this second day of July, 1929.

JOSEF BIERMANNS.