C. A. KRAUS.

VAPOR ARC CIRCUIT BREAKER.

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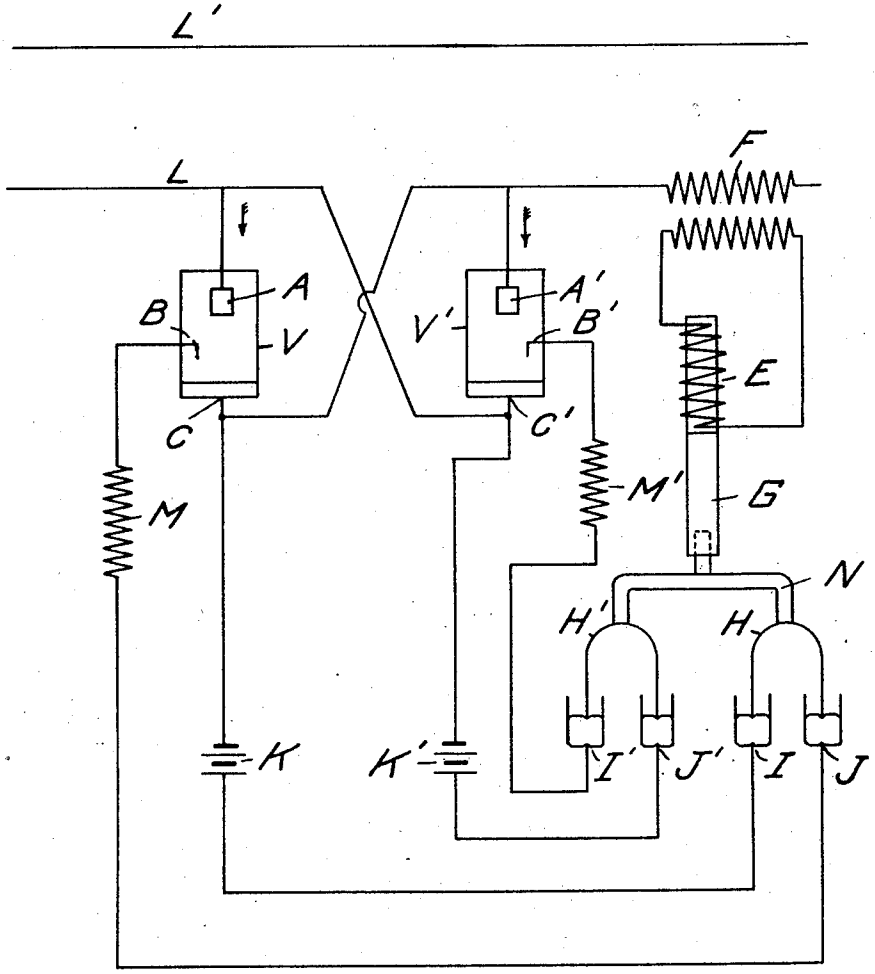
1,046,086. Patented Dec. 3, 1912.



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VAPOR-ARC CIRCUIT-BREAKER.

1,046,086. Specification of Letters Patent. Patented Dec. 3, 1912.

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To all whom it may concern:

Be it known that I, CHARLES A. KRAUS, a citizen of the United States, and resident of Newton Highlands, in the county of Middlesex and State of Massachusetts, have invented new and useful Improvements in Vapor-Arc Circuit-Breakers, of which the following is a specification.

My invention relates to devices for interrupting currents in alternating current transmission systems, and has for its object the elimination of dangerous and destructive arcs to which circuit breakers now and heretofore employed are liable.

The system for circuit breaking which I have invented is characterized by the interruption of current-maintaining conditions at or near that stage in the alternating circuit when current is zero. At the present time circuit breakers for high potential alternating currents operate by separating a pair of copper blocks immersed in oil. Repeated operation of such a circuit breaker results in rapid deterioration of the oil, necessitating frequent renewal, and this, in service lines which are in practically continuous operation, is disadvantageous and may be dangerous as well as expensive both as to time and materials. But a more serious defect inherent in the construction and operation of such circuit breakers lies in the fact that the break may come at a time when the current has considerable magnitude; under these conditions electrical oscillations are liable to be set up especially where underground covered cables constitute the lines.

I am aware that attempts have been made to employ a mercury arc for circuit breaking, as by severing a column of mercury by tipping a suitably shaped apparatus or by lifting an electrode out of a body of mercury. Such a contrivance involves either the rapid movement of a considerable body of mercury or of a necessarily heavy movable electrode, either of which can be accomplished only with difficulty and usually with danger to the mercury containing vessel.

It is well known that if an arc be maintained from a mercury cathode surface in a vacuum container, current will pass readily from a solid anode to the mercury cathode, whereas current will not flow in the reverse direction. Therefore, if such a mercury arc check valve is included in an alternating current line, a pulsating current will flow through the vacuum apparatus in one direction, this current being substantially all of the normal alternating current in that direction. But it is necessary that an arc be maintained continuously in the vacuum apparatus, otherwise no current will flow through it. By combining two check valves of this character and connecting them in the line in parallel but in opposite directions, or as it may be expressed, in parallel opposition, a normal alternating current will flow through the line, the current in one direction flowing through one check valve and that in the other direction through the other check valve, and the loss of energy in the arcs will be small, amounting only to about one-tenth of one per cent. in a 15,000 volt line. But as already stated, the alternating current will flow through the line only so long as the arcs are maintained in each of the vacuum check valve devices during the half cycle when the line current is shut off by the characteristic check valve action. Thus, in vacuum check valve apparatus it is necessary to include auxiliary arc-maintaining devices so that when the half cycle is reached, which the check valve will permit to pass, an arc will exist and therefore supply the necessary arc connection.

My invention depends for its operation on the above briefly outlined characteristic conditions.

Referring to the drawing hereto annexed which illustrates an example of my invention in diagrammatic form, L, L′ represent the line wires of a single phase alternating current transmission line. In the line wire L two electric check valves V, V′ are connected in parallel opposition, so that the current flowing in one direction in the line wire L will pass from the anode A in check valve V to the cathode C and thence to the line wire again, while current in the opposite direction will flow from the anode A′ in check valve V′ to and through cathode C′ and thence again to the line wire L. In order to maintain the arcs in these check valves, auxiliary anodes B, B′ are provided which in the instance herein indicated are included in auxiliary circuits of which the electromotive source is independent of the main line, L, L′, and may consist of batteries indicated by K, K′. Controlling resistances M, M′ are included in the auxiliary arc-maintaining circuits if desired. Each arc-maintaining circuit is maintained in closed condition by switches represented by

the mercury contact pools I, J and I′, J′ and the circuit breaking members H and H′. These circuit breaking members are connected to a yoke N of insulating material which is carried or controlled by a solenoid armature G, the latter being of such weight as to respond only to abnormal current conditions in the solenoid E which is in circuit with the secondary of the transformer F, this being coupled with a primary in the line L.

So long as normal conditions prevail in the line L, the contact members H, H′ will remain in contact with the mercury pools I, J, and I′, J′, and the auxiliary arcs will be maintained between anodes B and B′ and cathodes C, C′, respectively. Thus the check valves V and V′ will maintain their normal operation to maintain the continuity of the line circuit. In case of sudden overload or of short-circuit in the line, the auxiliary arc maintaining currents are automatically cut off by the operation of the above described apparatus and the main line current is interrupted until the auxiliary arc maintaining currents are again set in operation. If current in the main line exceeds any desired prescribed value, the plunger or solenoid armature G is raised and with it the contact members H and H′, breaking the auxiliary arc-maintaining currents. As soon as the auxiliary currents are broken the main line current ceases and will not continue to flow until the arcs are again started in the check valve devices V and V′. It is obvious that the condition of maintenance of the main line current is interrupted by the operation of the foregoing devices at or near the point when the main current is zero. During the normal passage of the current no strain is put upon the insulation of the check valves V and V′ since the potential across them is only that of the arc, namely, about 15 volts. When the auxiliary arcs are cut off, however, and the check valves cease their operation, the potential across the valves will be the entire line potential.

Aside from the advantage of cutting off the current at the zero point, the apparatus which I have devised has the advantage of operating as quickly as desired when a heavy short circuit takes place. In the present forms of circuit breakers very massive parts are necessarily employed which cannot be made to operate rapidly owing to their inertia. Since, however, in my device only small auxiliary currents of from 3 to 5 amperes are broken, the moving parts may be made very light so that when once the system begins to move its motion will be completed in a very short interval of time. If desired the current may be cut off in the space of a single cycle. The main current cannot be started again until the auxiliary arcs are set in operation. Various means are already known for starting the arcs in vapor apparatus and since these are familiar to anyone versed in this art, no arc starting devices are shown. If it is desired an oil switch may be placed in series with the mercury arcs, so that the potential strain may be removed from the valves when the current has once been broken.

I claim:

1. The combination in an alternating current transmission system, of a line, two vapor arc check valves connected in parallel opposition in the line, auxiliary arc-maintaining devices in each check valve, and means controlled by abnormal current conditions in the line to interrupt current in the auxiliary arc-maintaining devices.

2. The combination, in an alternating current transmission system, of a line, two vapor arc check valves connected in parallel opposition in the line, auxiliary arc-maintaining devices in each check valve, a source of current for said auxiliary devices independent of the line current, and means controlled by abnormal current conditions in the line to interrupt current in the auxiliary arc-maining devices.

Signed by me at Boston, Massachusetts, this 18th day of March, 1912.

CHARLES A. KRAUS.

Witnesses:
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