

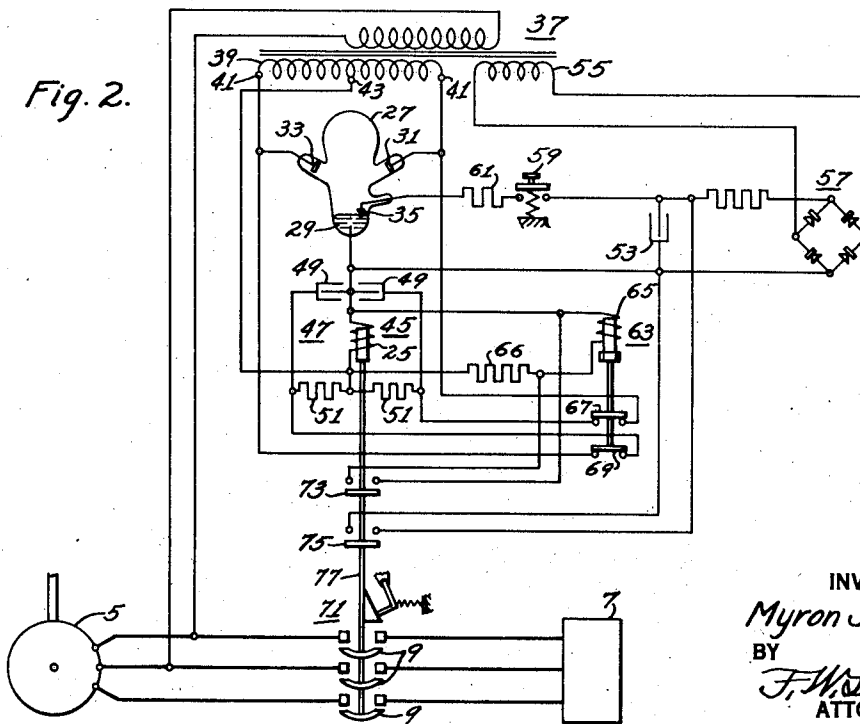
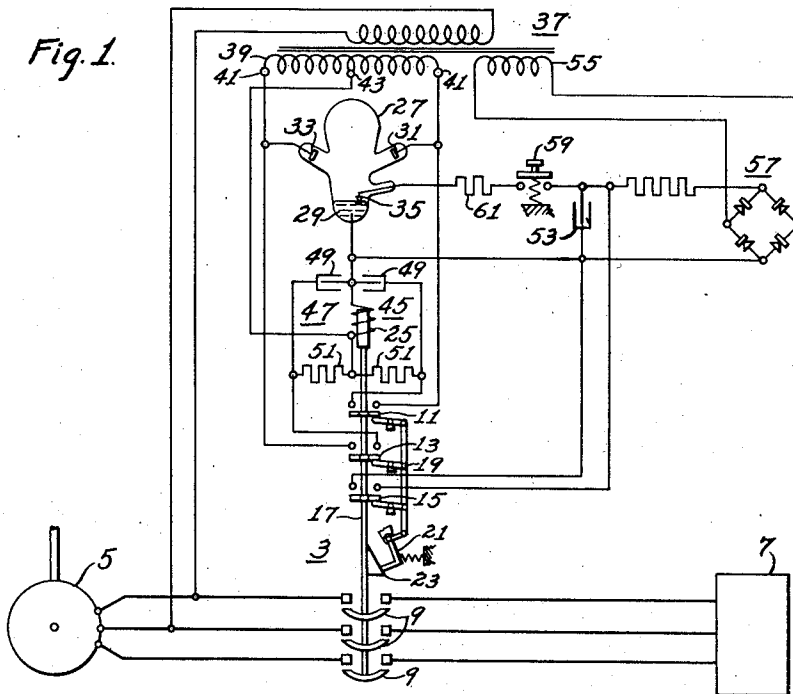
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VAPOR ELECTRIC DEVICE

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VAPOR ELECTRIC DEVICE

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My invention relates to electric discharge apparatus and has particular relation to control apparatus for circuit breakers.

A circuit breaker is customarily provided with a closing coil which is supplied with current when the breaker is to be operated. Since the circuit breaker contacts and the other associated mechanisms including the core are relatively heavy, the closing coil is of the direct current type and draws a heavy current when operating the breaker.

To control the supply of power to the closing coil an auxiliary relay in accordance with the teachings of the prior art of which I am aware is provided. The relay is actuated by the operation of a control contact. The latter may be manually operable but is, more often, operated automatically in response to a fault on another network or to a prior opening of the circuit breaker. In many cases it is desirable that the circuit breaker be closed as quickly as possible after the control contact is closed. The time required for the actuation of the auxiliary relay introduces a delay in the operation of the circuit breaker which may consume as high as 12% of the total time required to close the breaker.

It is accordingly an object of my invention to provide an arrangement for operating a circuit breaker immediately after the control contact has been closed.

Another object of my invention is to eliminate the delay in the closing of a circuit breaker which is incident to the auxiliary coil.

A general object of my invention is to provide an arrangement of simple and inexpensive structure for supplying direct current to the closing coil of a circuit breaker used to control an alternating current circuit.

An ancillary object of my invention is to provide an electric discharge device of the immersed ignition electrode type particularly adapted for use in the operation of a circuit breaker.

An incidental object of my invention is to provide a circuit breaker system in which in response to a closing operation only a single operation of the circuit breaker shall be possible.

More concisely stated, it is an object of my invention to provide a simple and tractable high-speed circuit breaker control system.

According to my invention, I provide an electric discharge valve having a cathode of the pool type, a plurality of anodes and an ignition electrode which dips into the cathode. The closing coil is supplied through the valve from an alternating current source and the valve rectifies the

current from the source and at the same time performs the function of the auxiliary coil. The ignition electrode is so disposed within the valve that when it is supplied with an impulse of current, it is capable of igniting a discharge between any one of the anodes and the cathode. Once a discharge between any anode and the cathode is initiated, it is maintained by the reactive action of the closing coil. As the potential impressed on each of the anodes in its turn predominates the discharge is transferred from one anode to the other. The valve continues to supply current until the circuit breaker is operated. When this occurs, capacitors charged by the current flow through the valve are connected to the anodes in such manner as to extinguish the discharge. Since the ignition of a valve in response to an exciting impulse is an instantaneous phenomenon the operating time of the auxiliary coil in the prior art apparatus is eliminated in my invention.

To supply the ignition current to the valve, a capacitor is charged before the operation is commenced. The capacitor is discharged through the ignition electrode when the control contact is closed. When the circuit breaker operates, it closes a contact, short circuiting the capacitor and preventing further operation of the breaker through the valve, regardless of whether or not it is closed or open.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawing in which:

Figure 1 is a diagrammatic view showing an embodiment of my invention, and

Figure 2 is a diagrammatic view showing a modification of my invention.

The apparatus shown in Figure 1 comprises a circuit breaker 3 which interconnects an alternating current source 5 of any general type with a load 7. The circuit breaker 3 is provided with the usual main movable contacts 9 and a set of auxiliary movable contacts 11, 13 and 15. The auxiliary contacts 11, 13 and 15 are slidable on the operating bar 17 and are actuable by pivotal levers 19 coupled to the latch 21 whereby the circuit breaker is held in the closed position. When the latch 21 slips into engagement with its cooperative locking cam 23 on the circuit

breaker rod, the levers 19 actuate the auxiliary movable contacts 11, 13 and 15 to engage corresponding fixed contacts.

The circuit breaker 3 is provided with a closing coil 25 which is supplied with current through an electric discharge valve 27 when the circuit breaker is to be closed. The valve 27 comprises a mercury pool cathode 29, a plurality of anodes 31 and 33 and an ignition electrode 35 which dips into the cathode. The electrode 35 is so disposed that current flow through it may produce a discharge between any anode 31 or 33 and the cathode 29. The valve may have the same structure and may be formed of the same parts as an ordinary ignitron.

The valve 27 and the closing coil 25 are supplied with current from the source 5 through a transformer 37 provided with a secondary section 39 having a plurality of terminal taps 41 and an intermediate tap 43. The anodes 31 and 33 are connected to the terminal taps 41 and the cathode 29 is connected to the intermediate tap 43 through the closing coil 25. Across the closing coil a plurality of networks 45 and 47, each consisting of a capacitor 49 and a resistor 51 in series, are connected.

Ignition current is supplied from a capacitor 53 which is charged from the source 5 through another secondary section 55 of the transformer 37 and a rectifier 57. When the operation of a breaker is to be initiated, control contact 59 is closed and the ignition capacitor 53 is discharged through the ignition electrode 35 and the cathode 29. At the instant when the capacitor 53 is discharged, one or the other of the anodes 31 or 33 of the valve 27 is electrically positive relative to the cathode and a discharge is initiated between the positive anode and the cathode. A resistor 61 is provided in the ignition capacitor circuit to assure that the discharge of the capacitor continues for a sufficient time interval to establish the discharge in the valve.

For the purpose of explaining the operation of the apparatus, we may assume that the discharge is first initiated between the right-hand anode 31 and the cathode 29. In such a case, current flows in a circuit extending from the right-hand terminal 41 of the secondary section 39 through the right-hand anode 31, the cathode 29, the closing coil 25, to the intermediate tap 43. At the end of the half-period during which the right-hand terminal 41 of the secondary section 39 is positive and the left-hand terminal negative, the potential impressed by the secondary section 39 on the right-hand branch 31—29 of the valve 27 passes through zero. However, current flow is maintained in the branch by the reactive action of the closing coil 25. The current flow persists under the action of the closing coil until the anode-cathode potential in the left-hand branch 33—29 of the valve 27 becomes sufficiently positive to take over the discharge. The above described process is now repeated for the left-hand branch until the potential of the right-hand branch 31—29 again becomes sufficiently positive so that the discharge is again transferred.

While the closing coil 25 is being supplied with current through the valve 27, the potential drop across the coil is impressed in the capacitor-resistor networks 45 and 47. The capacitors 49 are charged, the plates connected directly to the closing coil being positive and the other plates being negative.

After the closing coil has carried current for

a predetermined interval of time, the breaker 3 is operated and latched in the closed position. The movement of the latch in closing actuates the auxiliary contacts 11, 13 and 15. The upper contacts 11 and 13 connect the negative plates of the capacitors 49 in the networks 45 and 47 to the anodes 31 and 33, respectively, of the valve 27 and thus impress a substantial negative anode-cathode potential across the branches of the valve. The latter potential counteracts the potential supplied by the secondary section 39 and renders the valves non-conductive.

The lower auxiliary contact 15 short-circuits the ignition capacitor 53 and thus prevents further ignition of the valve 27 if the breaker 3 remains closed. If the breaker should reopen for any reason, it does not reclose if the control contact 59 remains closed. This situation arises from the fact that the ignition capacitor 53 is discharged by the short-circuiting auxiliary contact 15 and is prevented from recharging after the breaker 3 opens by the closed circuit through the control contact 59, resistor 61, ignition electrode 35 and cathode 29. Thus pumping is prevented.

The apparatus shown in Fig. 2 is largely similar to that shown in Fig. 1. However, in this case the lever arrangement between the circuit breaker latch 23 and the auxiliary contacts 11, 13 and 15 in the Fig. 1 system is not used. In place of this arrangement a slow acting relay 63 is provided. When the coil 65 of the relay is supplied with current it picks up quickly. However, when the current flow through the coil is interrupted the relay drops out slowly.

The slow acting relay 63 is provided with a pair of contacts 67 and 69 which normally maintain the capacitors 49 charged from the closing coil 25 connected to the anodes 31 and 33, respectively. However, since the capacitors 49 are initially uncharged, this connection does not interfere with the operation of the valve 27. The coil 65 of the relay 63 is connected in parallel with the closing coil 25 through a resistor 66 and when the valve 27 is rendered conductive, the slow-acting relay is operated at the same time as the circuit breaker 71.

The breaker 71 is provided with a pair of auxiliary contacts 73 and 75 which are secured to the operating rod 77 and which close when the circuit breaker closes. The upper contact short-circuits the coil 65 of the slow-acting relay 63. The short-circuiting of the closing coil 25 at the same time is prevented by the resistor 66 connected between the closing coil 25 and the coil 65 of the relay 63. The slow relay 63 does not immediately operate when its coil is short-circuited. The delay in the operation is sufficient to enable the circuit breaker 71 to be latched in the closed position. When the slow-acting relay does operate, the capacitors 49 are connected to the anodes 31 and 33 of the valve 27 and the latter is rendered non-conductive.

While my invention is shown herein as practiced with a discharge valve of the ignitron type and operates most propitiously with a valve of this type, other valves may be used. For example, a hot cathode, arc-like, or high-vacuum valve, having a cathode, a control electrode and a plurality of anodes yields satisfactory results where the power required for the closing coil is not too great.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are pos-

sible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. For use with a source of alternating current having an intermediate tap and a plurality of terminal taps an electric discharge valve having a cathode of the pool type, a plurality of anodes and an ignition electrode which dips into said cathode at such a point that it may ignite an arc between any anode and said cathode, connections between said terminal taps and said anodes and between said intermediate tap and said cathode, said connections having reactive means interposed therein, and means for supplying ignition current to said ignition electrode, said supply means comprising charge-storing means, means for charging said charge-storing means, means for discharging said charge-storing means through said ignition electrode and means responsive to said valve when it is rendered conductive for thereafter preventing the recharging of said charge storing means.

2. For use with a reactive device responsive to current and a source of alternating current having an intermediate tap and a plurality of terminal taps, the combination comprising an electric discharge valve having a cathode of the pool type, a plurality of anodes and an ignition electrode which dips into said cathode at a point such that current flow through it may ignite an arc between any one of said anodes and said cathode, connections, including said reactive device, between said anodes and said terminal taps and said cathode and said intermediate tap, means for supplying a discrete current pulse to said ignition electrode to render said valve conductive and means responsive to the actuation of said reactive device to render said valve non-conductive.

3. For use with a reactive device responsive to current and a source of alternating current having an intermediate tap and a plurality of terminal taps, the combination comprising an electric discharge valve having a cathode of the pool type, a plurality of anodes and a single ignition electrode which dips into said cathode at a point such that current flow through it may ignite an arc between any one of said anodes and said cathode, connections, including said reactive device, between said anodes and said terminal taps and said cathode and said intermediate tap, means for supplying only a discrete current pulse to said ignition electrode to render said valve conductive and means responsive to the actuation of said reactive device to render said valve non-conductive and to prevent the supply of another current pulse to said ignition electrode.

4. For use with a reactive device responsive to current and a source of alternating current having an intermediate tap and a plurality of terminal taps, the combination comprising an electric discharge valve having a cathode of the pool type, a plurality of anodes and a single ignition electrode which dips into said cathode at a point such that current flow through it may ignite an arc between any one of said anodes and said cathode, connections, including said reactive device, between said anodes and said terminal taps and said cathode and said intermediate tap, means, including a capacitor, means for charging said capacitor and means for discharging said capacitor, for supplying a discrete

current pulse to said ignition electrode to render said valve conductive and means responsive to the actuation of said reactive device to render said valve non-conductive.

5. For use with a reactive device responsive to current and a source of alternating current having an intermediate tap and a plurality of terminal taps, the combination comprising an electric discharge valve having a cathode of the pool type, a plurality of anodes and a single ignition electrode which dips into said cathode at a point such that current flow through it may ignite an arc between any one of said anodes and said cathode, connections, including said reactive device, between said anodes and said terminal taps and said cathode and said intermediate tap, means including a capacitor, means for charging said capacitor and means for discharging said capacitor, for supplying a discrete current pulse to said ignition electrode to render said valve conductive and means responsive to the actuation of said reactive device to render said valve non-conductive and to prevent the further charging of said capacitor.

6. For use with a reactive device responsive to current and a source of alternating current having an intermediate tap and a plurality of terminal taps, the combination comprising an electric discharge valve having a cathode of the pool type, a plurality of anodes and a single ignition electrode which dips into said cathode at a point such that current flow through it may ignite an arc between any one of said anodes and said cathode, connections, including said reactive device, between said anodes and said terminal taps and said cathode and said intermediate tap, means for supplying a discrete current pulse to said ignition electrode to render said valve conductive and means responsive to the actuation of said reactive device to render said valve non-conductive, said responsive means including charge-storing means to be charged by the potential derived from said reactive device and means actuated after said device is actuated to connect said charge-storing means between said anodes and said cathode in such a sense that the potential of said storing means extinguishes the discharge between said anodes and cathode.

7. For use in operating a circuit breaker having a closing coil, requiring direct current from an alternating current source having a plurality of terminal taps and an intermediate tap the combination comprising a plurality of electric discharge paths each defined by an anode and cathode means, connections between said anode and said terminal taps and said cathode means and said intermediate tap, said connections including said closing coil, means for rendering any one of said paths conductive, said paths being so related that when one of said paths is rendered conductive it cooperates to maintain the others conductive, regardless of whether or not said rendering means continues to function, and means responsive to the resultant operation of said breaker by said closing coil when said paths are rendered conductive for rendering said paths non-conductive.

8. For use in operating a circuit breaker having a closing coil, requiring direct current from an alternating current source having a plurality of terminal taps and an intermediate tap the combination comprising a plurality of electric discharge paths each defined by an anode and cathode means of the pool type, connections between

said anode and said terminal taps and said cathode means and said intermediate tap, said connections including said closing coil, means including ignition electrode means dipping in said cathode means and means for supplying an impulse to said ignition electrode means for rendering any one of said paths conductive, said impulse being supplied only for a relatively small portion of the time during which said paths are to be conductive, said paths being so related to each other and to said closing coil that when one of said paths is rendered conductive it cooperates to maintain the others conductive, and means responsive to the resultant operation of said breaker by said closing coil when said paths are rendered conductive for rendering said paths non-conductive.

9. For use in operating a current responsive device requiring direct current from an alternating current source having a plurality of terminal taps and an intermediate tap the combination comprising a plurality of electric discharge paths each defined by an anode and cathode means, connections, including said device, between said anode and said terminal taps and said cathode means and said intermediate tap, means for rendering any one of said paths conductive, said means functioning only for a relatively small portion of the time during which said paths are to be conductive, said paths being so related that when one of said paths is rendered conductive, it cooperates to maintain the others conductive and means responsive to the resultant operations of said device, when said paths are rendered conductive for rendering said paths non-conductive.

10. For use in operating a current responsive device requiring direct current from an alternating current source having a plurality of terminal taps and an intermediate tap the combination comprising a plurality of electric discharge paths each defined by an anode and cathode means, connections including said device between said anode and said terminal taps and said cathode means and said intermediate tap, and means for rendering any one of said paths conductive, said means functioning only for a relatively small portion of the time during which said paths are to be conductive, said paths being so related that when one of said paths is rendered conductive, it cooperates to maintain the others conductive.

11. For use in operating a circuit breaker having a closing coil requiring direct current from an alternating current source having a plurality of terminal taps and an intermediate tap, the combination comprising an electric discharge device having a plurality of anodes, a cathode of the pool type, and an ignition electrode which dips into said cathode at a point such that the supply of current to it may ignite a discharge from any one of said anodes, connections between said anodes and said terminal taps, connections, including said closing coil, between said cathode and said intermediate tap, means for supplying current to said ignition electrode to render said paths conductive and means responsive to the actuation of said breaker by reason of the resultant current conducted through said closing coil for rendering said paths non-conductive.

12. For use in operating a circuit breaker for

an alternating current source having a closing coil, requiring direct current, from said source, said source having a plurality of terminal taps and an intermediate tap, the combination comprising an electric discharge device having a plurality of anodes, a cathode of the pool type, and an ignition electrode which dips into said cathode at a point such that the supply of current to it may ignite a discharge from any one of said anodes, connections between said anodes and said terminal taps, connections, including said closing coil, between said cathode and said intermediate tap, means for supplying current to said ignition electrode to render said paths conductive and means responsive to the actuation of said breaker by reason of the resultant current conducted through said closing coil for rendering said paths non-conductive.

13. For use in operating a circuit breaker having a closing coil requiring direct current from an alternating current source having a plurality of terminal taps and an intermediate tap, the combination comprising an electric discharge device having a plurality of anodes, a cathode of the pool type, and an ignition electrode which dips into said cathode at a point such that the supply of current to it may ignite a discharge from any one of said anodes, connections between said anodes and said terminal taps, connections, including said closing coil, between said cathode and said intermediate tap, means, including a capacitor, means for charging said capacitor and means for discharging said capacitor through said ignition electrode for supplying current to said ignition electrode to render said paths conductive and means responsive to the actuation of said breaker by means of the resultant current conducted through said closing coil for rendering said paths non-conductive and preventing the recharging of said capacitor.

14. For use in operating a circuit breaker having a closing coil requiring direct current from an alternating current source having a plurality of terminal taps and an intermediate tap, the combination comprising an electric discharge device having a plurality of anodes, a cathode of the pool type, and an ignition electrode which dips into said cathode at a point such that the supply of current to it may ignite a discharge from any one of said anodes, connections between said anodes and said terminal taps, connections, including said closing coil, between said cathode and said intermediate tap, means, including a capacitor, means for charging said capacitor and means for discharging said capacitor through said ignition electrode for supplying current to said ignition electrode to render said paths conductive and means responsive to the actuation of said breaker by means of the resultant current conducted through said closing coil for rendering said paths non-conductive and preventing the recharging of said capacitor, said responsive means including capacitive means to be charged by the potential drop across said closing coil when said discharge device is conductive and means for connecting said capacitive means to said anodes in such manner as to extinguish said paths.

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