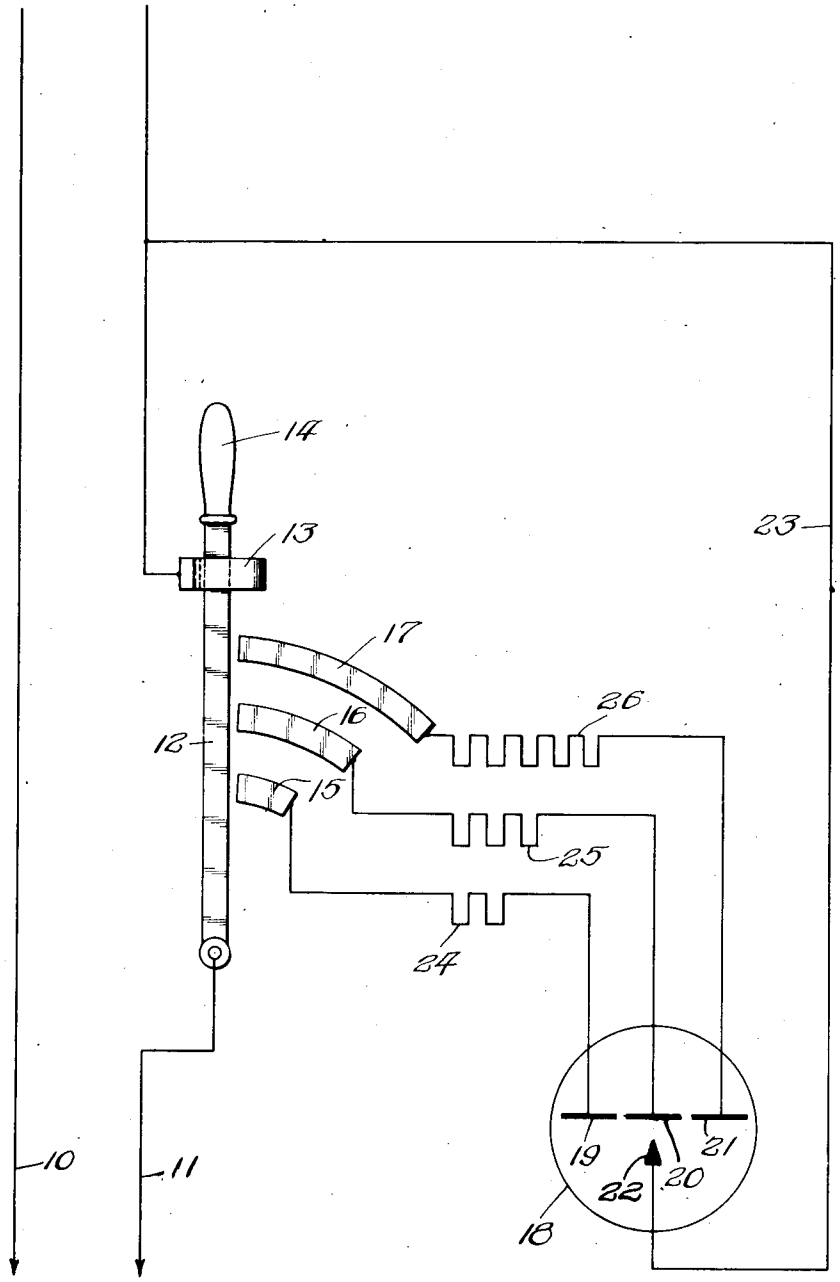
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CIRCUIT BREAKER

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Inventor:
Hugh E. Young,
By Dyrenforth, Lee, Chritton & Wiles,
Attys.

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CIRCUIT BREAKER

Hugh E. Young, Chicago, Ill.

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13 Claims. (Cl. 175—294)

This invention relates to circuit breakers, and more particularly to direct current circuit breakers wherein little or no arcing occurs upon the separation of the contacts.

One feature of this invention is that it sets up an arc within an arc rectifying tube; another feature of this invention is that it materially reduces the current flow before the circuit is finally opened; still another feature of this invention is that it permits a switch blade in a D. C. circuit to be opened in air without any appreciable arcing; other features and advantages of this invention will appear from the following specification and from the drawing.

Much difficulty has been experienced in opening circuits carrying heavy direct currents, or even moderate currents, since if a switch is opened in air, serious arcing occurs. This arcing burns and pits the contact points of the switch, and may prove dangerous to the machinery or operator. Many switches in use today separate their contacts in oil or some other insulating medium, but all such mediums have been found to break down after a relatively short period of use. This invention obviates these defects by dissipating the arc caused by the opening of a circuit within an arc rectifying tube.

In the particular embodiment of this invention illustrated in the drawing, the lines 10 and 11 supply D. C. current to any desired load. A knife blade switch or contact 12 is adapted to be engaged by a contact 13, and to be thrown into or out of engagement with said contact 13 by manual operation of a handle 14. The switch blade 12 has in combination therewith commutator strips or contacts 15, 16 and 17, which strips are so arranged that the knife switch separates from them in the order named as it is pulled open. The tube 18 is an arc rectifying tube of the self-starting type, i. e., one not requiring heating of the cathode before an arc can be set up therein having anodes 19, 20 and 21, and a common cathode 22. The cathode 22 is connected to the contact 13 by a lead 23. The anode 19 is connected to the commutator 15 by a lead having a small amount of resistance 24 therein; the anode 20 is connected to the commutator 16 by a lead having therein a larger resistance 25; and the anode 21 is connected to the commutator 17 through a still larger resistance 26.

The operation of this particular embodiment of the invention is as follows: With the circuit completely closed and supplying current to the load, the switch is in the position illustrated in the diagram. When it is desired to break the circuit, the switch is pulled away from the contact 13, making contact with the commutators before it completely separates from said contact 13. When the switch separates from the contact 13 no arcing occurs since a shunt circuit of low resistance around the switch is provided by the self-starting arc rectifying tube through the commutators and the switch blade. As the switch blade is opened further, it separates from the commutator 15 while still maintaining contact with the other two commutators, this separation being achieved with no arcing since the two anodes 20 and 21 assume the full current load. The current is now considerably less than before, since the two resistances 25 and 26 cause a considerable voltage drop. Further movement of the blade 12 separates it from the commutator 16, the full current now passing through the anode 21, the resistance 26, and the commutator 17. The resistance 26 now causes a still larger voltage drop, since what current now remains must pass through it alone. The switch may now be separated from the contact 17 and practically no arcing occurs, since the total current flow has been reduced to a fraction of the original, and the rectifying tube tends to dissipate the arc within itself rather than to allow it to form between the blade 12 and the commutator 17. The complete opening of the switch may, of course, be effected with one continuous motion. When it is desired to again close the circuit the switch is manually returned to the position shown in the diagram.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims, in which it is my intention to claim all novelty inherent in my invention as broadly as possible in view of the prior art.

What I regard as new, and desire to secure by Letters Patent, is:

1. In combination, circuit interrupting means comprising two relatively movable contacts adapted to complete the circuit when in engagement, electric valve means comprising a plurality of anode and cathode circuits, and means responsive to a circuit opening operation of said interrupting means for connecting said anode circuits in shunt across said contacts prior to the separation of said contacts and for opening said

anode circuits in sequence after the separation of said contacts.

2. In combination, circuit interrupting means comprising two relatively movable contacts adapted to complete the circuit when in engagement, electric valve means comprising a plurality of anodes and a cathode, and means responsive to a circuit opening operation of said interrupting means for connecting said anodes in shunt across said contacts and for disconnecting said anodes in sequence after the separation of said contacts.

3. In combination, circuit interrupting means comprising two relatively movable contacts adapted to complete the circuit when in engagement, a self-starting arc rectifying tube comprising a plurality of anodes and a single cathode, and means responsive to a circuit opening operation of said interrupting means for simultaneously connecting the anode-cathode circuits in shunt across said contacts prior to the separation of said contacts and for opening said anode-cathode circuits in sequence after the separation of said contacts.

4. In combination, circuit breaking means comprising a pair of relatively movable cooperating contacts, electric valve means comprising a plurality of anode and cathode circuits, each of said anode circuits including a resistor, and means responsive to a circuit opening operation of said circuit breaking means for connecting said anode circuits in shunt across said contacts prior to the separation of said contacts and for opening said anode circuits in sequence after the separation of said contacts.

5. In combination, circuit breaking means comprising a pair of relatively movable cooperating contacts, electric valve means comprising a plurality of anode and cathode circuits, each of said anode circuits including means separate from said valve means for impeding the flow of current therethrough, and means responsive to a circuit opening operation of said circuit breaking means for connecting said anode circuits in shunt across said contacts and for opening said anode circuits in sequence after the separation of said contacts.

6. In combination, circuit breaking means comprising a pair of relatively movable cooperating contacts, electric valve means comprising a plurality of anode and cathode circuits, and means responsive to a circuit opening operation of said circuit breaking means for connecting said anode circuits in shunt across said contacts and for opening said anode circuits after the separation of said contacts.

7. In combination, circuit breaking means comprising a pair of relatively movable cooperating contacts, two-element electric valve apparatus, one of the elements thereof being disconnected from one of said contacts when said circuit breaker is in closed position, and means responsive to a circuit opening operation of said circuit breaking means for connecting said latter element to said latter contact for placing said electric valve apparatus in shunt across said contacts before separation of said contacts.

8. In combination, circuit interrupting means comprising two relatively movable cooperating contacts, one connected with one side of the line and the other connected with the other side of the line, an electric valve comprising anode and cathode elements, one of said elements being permanently connected to one side of said line, the other of said elements being normally disconnected from the other side of said line, and means responsive to an opening operation of said circuit interrupting means for first connecting said latter element to the other side of the line and then disconnecting said latter element from the line.

9. In combination, circuit interrupting means comprising a pair of cooperating contacts, electric valve apparatus comprising a plurality of conducting paths, and switching apparatus operating to connect said paths in shunt relation to said contacts prior to separation thereof and operating to disconnect said paths from said shunt relation, said switching apparatus performing the disconnecting operation progressively with respect to said different paths.

10. In combination, circuit interrupting means, an electric valve normally in open circuit relation to said circuit interrupting means, and contact means operable to connect said electric valve in shunt relation to said circuit interrupting means before said latter means is actuated to open circuit position.

11. A circuit breaker comprising, in combination, a switch, an arc rectifying tube having a plurality of anodes and a cathode therein, a resistor connected to each of said anodes, each of said resistors having a different resistance, circuit means for connecting said tube and said resistors in shunt circuit relation to said switch before opening thereof to form a plurality of parallel paths around said switch, and means for disconnecting said resistors from said shunt circuit in a predetermined order.

12. A circuit breaker comprising, in combination, a switch, a plurality of commutator strips in combination with said switch, an arc rectifying tube having a plurality of anodes and a cathode therein, a resistor connecting each anode to a commutator strip, each of said resistors having a different resistance, means for connecting said commutator strips and said tube in shunt circuit relation to said switch before opening thereof to form a plurality of parallel paths thereabout, and means for disconnecting said commutator strips from said shunt circuit in a predetermined order.

13. A circuit breaker comprising, in combination, a switch, an arc rectifying tube having a plurality of anodes and a cathode therein, a resistor connected to each of said anodes, each of said resistors having a different resistance, circuit means for connecting said tube and said resistors in shunt circuit relation to said switch before opening thereof to form a plurality of parallel paths around said switch, and means for progressively disconnecting said resistors from said shunt circuit beginning with the resistor having the minimum resistance value.

HUGH E. YOUNG.