Sept. 28, 1937. D. G. LITTLE ET AL 2,094,363

HIGH VOLTAGE DIRECT CURRENT CONTACTOR

Filed Dec. 17, 1936

Fig. 1.

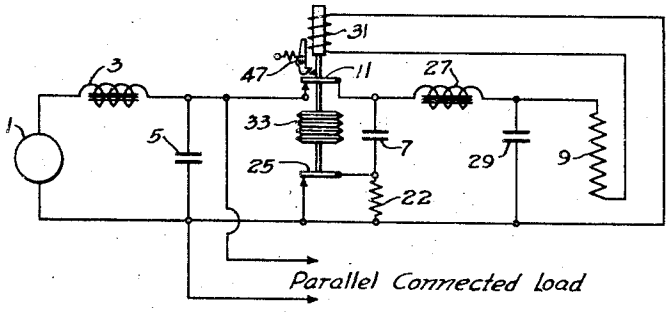


Fig. 2.

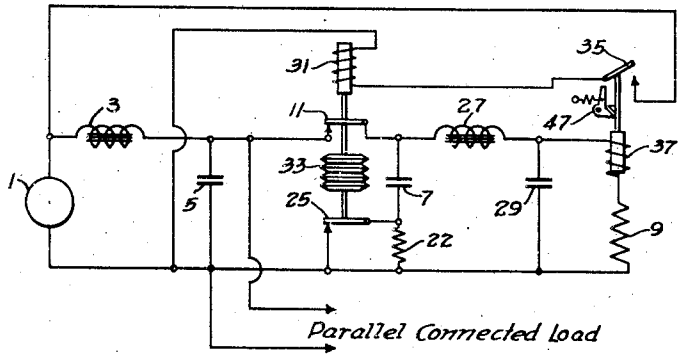


Fig. 3.

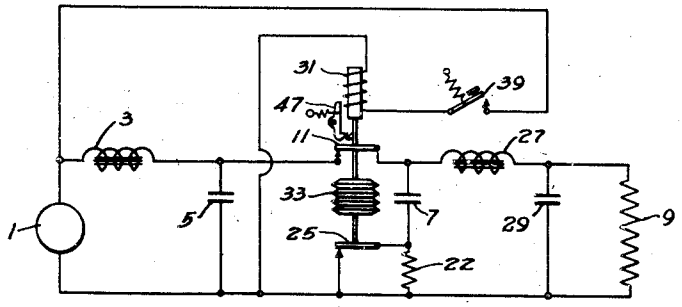
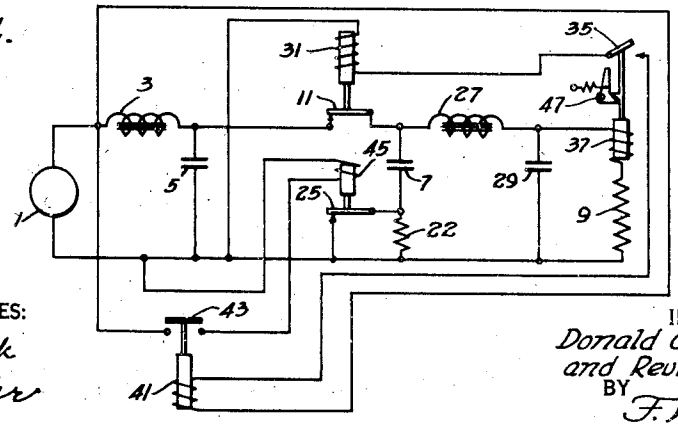


Fig. 4.



WITNESSES:
Michael Stark
E. Broeler

INVENTORS.
Donald G. Little
and Reuben Lee.
BY
F. W. Lyle.
ATTORNEY

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HIGH VOLTAGE DIRECT CURRENT CONTACTOR

Donald G. Little, Longmeadow, and Reuben Lee, Springfield, Mass., assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application December 17, 1936, Serial No. 116,338

12 Claims. (Cl. 175—294)

Our invention relates to high voltage direct current circuits, more particularly to a method and means for opening such circuits without the accompaniment of destructive arcing across the switch contacts. The invention constitutes an improvement upon the invention disclosed in an earlier filed copending application in the name of Reuben Lee, Serial No. 31,745, filed July 16, 1935.

It is an object of our invention to provide means whereby the high voltage direct current circuit may be opened without arcing across the opening contacts.

It is a further object of our invention to provide means whereby a plurality of apparatus, fed from a high voltage direct current source, may be individually cut in or out of the supply circuit without necessitating opening of the supply source to the other apparatus.

A further object of our invention is to provide means for disconnecting a load from a high voltage direct current supply source upon the occurrence of an overload without producing destructive effects upon such other load circuits as may be connected to the same high voltage direct current supply source.

Additional objects of our invention will be pointed out in the following description of the same, taken in conjunction with the accompanying drawing wherein the four figures constitute each a circuit diagram embodying the features of our invention.

The features of our invention constitute improvements upon the circuit of Fig. 1 of the aforementioned application Serial No. 31,745, wherein there is disclosed a source of high voltage direct current energy 1, which might constitute either a direct current generator, or a source of alternating current in combination with means for rectifying it, the output of this high voltage direct current source being fed through a filter comprising a series connected inductance 3 and a parallel arrangement of condensers 5 and 7, across which may be connected the load 9 to which the filtered high voltage direct current energy is fed. Between the two condensers 5 and 7 and in series with the load 9 is located a switch 11 which may either constitute relay contacts or a manually or automatically controlled switch. In accordance with the intended operation of this circuit, the load 9 may be disconnected from its high voltage direct current supply source by the mere opening of the circuit at the switch or contacts 11, and this may be accomplished without the occurrence of sparking across the contacts.

According to the theory upon which this circuit operates, at the instant of opening the contacts 11, there is zero voltage across them by reason of the fact that the voltage across the load 9 due to the voltage which has accumulated across the condenser 7 will be substantially equal to, but opposite in phase to, the voltage of the direct current source, and they being in series opposition at the instant the switch begins to open, there exists no voltage gradient across the contacts.

A transient condition begins to exist, however, due to the discharge of the condenser 7 across the load thus decreasing the series opposing voltage and permitting a voltage to develop across the opening contacts, but the rate of decrease is small compared to the speed of opening of the contacts 11, so that at no instant does the voltage which builds up across the opening contacts exceed the instantaneous breakdown voltage during the opening period.

During closing of the switch or contacts 11, and to prevent a sudden heavy charging current through the condenser 7 at the instant of the closing of the switch, a resistance 22 of small value is inserted in series with this condenser.

The improvements which we have made upon the above described circuit have for their purpose to permit sudden overloads to cause opening of the contacts 11 before the condensers 5 and 7 have an opportunity to discharge into the load, that excess energy which the load is in the process of demanding from the circuit under such conditions; and also to eliminate a bare possibility of arcing across the contacts 11, due to the presence of the resistance 22 which has been placed in the circuit for the purpose of preventing heavy charging currents through condenser 7 at the instant of closing of the switch.

Accordingly, in order to satisfy the objects of our invention, we shunt the resistance 22 by a switch or pair of contacts 25 and cause the same to operate in accordance with the operation of the switch 11, but lagging the operation of the switch by a brief time interval, both on the make and the break operation.

Another feature of the invention resides in more strongly fortifying the switch 11 against arcing when the operation of the same is initiated by reason of an overload condition. This is accomplished by placing between the filter condenser 7 and the load, and in the load circuit, an impedance 27; and in shunt with the load we locate a condenser 29. This combination will serve to prevent a sudden overload from permitting the filter condensers 5 and 7 from discharg-

ing into the load circuit, and this is explained by the fact that the instantaneous excess energy, which is demanded by the load upon the occurrence of an overload, will be supplied by the condenser 29 shunting the load, whereas the inductance 27 will serve as an obstacle to the instantaneous flow of energy from the filter circuit. Thus the proper condition of stability exists for permitting the load disconnecting contacts to open without the occurrence of a sparking potential across the opening contacts.

With the inductance 27 and load shunting condenser 29 in the circuit, the overload relay coil for actuating the resistance shunting contacts 25 will preferably be located in that portion of the load circuit supplied by the shunting condenser upon the occurrence of an overload condition, thus making it certain that the overload relay coil will operate with maximum speed.

The various circuits disclosed in the Figs. 1 to 4 illustrate different means and methods for operating the switch 11 to open and close the circuit to the load 9, and at the same time, obtain the proper sequential operation of the switch or relay contacts 25 shunting the resistor 22.

In Figs. 1 to 3, the load circuit opening switch 11 and the resistance shunting contacts 25 are both operated from the same winding 31, the delayed operation of the resistance shunting switch or contacts 25 being brought about by introducing a time delay element such as a bellows 33 or a dashpot in the relay or switch assembly, so that it interposes a delay in the operation of the resistance shunting switch, without interposing any similar delay or otherwise interfering in the fast operation of the load disconnecting switch 11. Any other devices known in the art which will interpose a similar delay may be utilized for the purpose.

In the circuit of Fig. 1, the operating coil for actuating the switch 11 and the shunting contacts is connected in series with the load whereby it will carry the entire load current and thus produce maximum effect in response to overload conditions occurring in the circuit.

In the circuit of Fig. 2, the operating coil 31 is connected in a separate circuit across the source 1 of direct-current voltage through a switch or relay contacts 35, the operation of which is controlled by a winding 37 connected in the load circuit in series with the load 9. The operating coil circuit is normally opened and is closed only in response to excitation of the coil 37 in the load circuit, which is designed to respond during conditions of overload, when it will close the switch 35 to excite the operating coil 31 and open the load circuit switch 11 and the shunting contacts 25 in the proper sequence.

The circuit of Fig. 3 is somewhat similar to that of Fig. 2, except that it is designed for manual operation only, and does not embody operation of the switches in response to overload conditions. In accordance with the disclosure in this figure, a manually operated spring biased circuit closing device 39 is embodied in the operating coil circuit, the closing of which switch will complete the circuit through the operating winding 31 and cause the proper operation of the switches in question.

In the embodiment of our invention disclosed in the circuit of Fig. 4, the proper sequential operation of the load circuit switch 11 and the shunting switch 25 is obtained, not through any particular construction of the switch operating mechanism, but through a series of inter-connected circuits. An overload winding 37 is connected in the load circuit in series with the load 9, and this is designed to operate a circuit closing device 35 to close a circuit through the winding 31 associated with the load circuit switch 11 and another winding 41 associated with a circuit closing element 43 which is located in a separate circuit to a winding 45 asscciated with the shunting switch 25. The energy necessary for energizing the various windings is derived from the direct-current source 1. It is clear that upon the development of an overload condition, the operation of the resistance shunting switch 25 will occur after the operation of the main load switch 11, which is the sequence desired.

Since the load disconnecting contacts will open without sparking or arcing across the contacts, any other loads, connected in multiple with the load 9 experiencing an overload condition, will not be affected thereby, and the same would be true were that same load 9 disconnected from the circuit through manual operation of the same or equivalent contacts. Parallel connected load circuits are shown in Figs. 1 and 2, and it is understood, are applicable in the circuits of Figs. 3 and 4.

In each of the above described circuits of Figs. 1, 2 and 4, the relay, which operates directly in response to the overload condition, is provided with a manually releasable latching device 47 which, upon energization of the relay, holds it in energized position. Upon releasing of the latching mechanism, proper sequential closing of the switches or contacts 11 and 25 is assured, the switch 11 being first to close in every instance. In the circuit of Fig. 3, the latch is associated with the coil 31.

The circuits of the type described find their principal application in the field of radio, where a plurality of transmitters are fed from a common source of high voltage direct current energy of the order of 15,000 volts. It is quite often desirable to be able to switch one or the other of these transmitters in or out of the circuit at such high or higher voltages, without interrupting or cutting in on the operation of the other transmitters.

While we have disclosed our invention in great detail, various modifications may be apparent to those skilled in the art, and it is our desire that our invention be not limited to the specific details disclosed, but that it shall be only limited by the prior art and the appended claims.

We claim as our invention:

1. In combination, a source of direct current power, a load circuit connected thereto, a circuit opening device for opening the circuit so as to effectively disconnect the load from the power source, means connected to the load for maintaining a voltage across the load during the interim of opening said circuit, to prevent arcing across said circuit opening means, said arc preventing means including a condenser in series with a resistor across said circuit on the load side of said circuit opening device, and means for rendering said resistor ineffective during operation of said circuit opening device when opening said circuit, and rendering said resistor effective at recurrent closure thereof.

2. In combination, a source of direct current power, a load circuit connected thereto, circuit opening means for opening the circuit so as to effectively disconnect the load from said power source, means connected to the load for maintaining a voltage across the load during the interim of opening said circuit to prevent arcing across

said circuit opening means, said arc preventing means including a condenser in series with a resistor across said circuit on the load side of said circuit opening means, and means comprising a relay operated in response to a predetermined change in load current for rendering said resistor ineffective during operation of said circuit opening means when opening said circuit.

3. In combination, a source of direct current power, a load circuit connected thereto, a circuit opening device for opening the circuit so as to effectively disconnect the load from the power source, means connected to the load for maintaining a voltage across the load during the interim of opening said circuit, to prevent arcing across said circuit opening device, said arc preventing means including a condenser in series with a resistor across said circuit on the load side of said circuit opening device, actuating means for said device including a relay winding in said load circuit having asscciated contacts connected across said resistor, for rendering said resistor ineffective during operation of said circuit opening device when opening said circuit.

4. In combination, a source of direct-current power, a load circuit therefor, a switch for opening the circuit so as to effectively disconnect the load circuit from the power source, and means connected to the load circuit to maintain voltage across the load circuit during the interim of switch opening, the difference between said load voltage and the voltage of said source during opening of said circuit being always less than a value which would cause arcing across the contacts of said switch, means for supplying overloads of substantially instantaneous duration comprising a condenser connected in circuit across the load and a choke coil in the load circuit between said condenser and said means for maintaining a voltage across said load circuit during opening of said switch.

5. In combination, a source of direct current power, a load circuit therefor, a circuit opening device for opening said circuit to effectively disconnect the load from said source, means for inhibiting the formation of an arc across the contacts of said switch during the interim of opening, said means including a condenser connected in circuit across said load circuit on the load side of said circuit opening device, and means for preventing said condenser from discharging into the load upon the occurrence of sudden changes in load.

6. In combination, a source of direct current power, a load circuit therefor, a circuit opening device responsive to current in said load circuit of a predetermined value for opening said circuit to effectively disconnect the load from said source, means for inhibiting the formation of an arc across the contacts of said switch during the interim of opening, said means including a condenser connected in circuit across said load circuit on the load side of said circuit opening device, and means for preventing said condenser from discharging into the load upon the occurrence of sudden changes in load, said means comprising a condenser in parallel to said first mentioned condenser and a choke coil in series with said load circuit and located between said condensers.

7. In combination, a source of direct current power, a load circuit therefor, a circuit opening device responsive to current in load circuit of a predetermined value for opening said circuit to effectively disconnect the load from said source, means for inhibiting the formation of an arc across the contacts of said switch during the interim of opening, said means including a condenser connected in circuit across said load circuit on the load side of said circuit opening device, and means for preventing said condenser from discharging into the load upon the occurrence of sudden changes in load.

8. In combination, a source of direct current power, a load circuit therefor, a circuit opening deviee for opening said circuit to effectively disconnect the load from said source, means for inhibiting the formation of an arc across the contacts of said switch during the interim of opening, said means including a condenser connected in circuit across said load circuit on the load side of said circuit opening device, and means for preventing said condenser from discharging into the load upon the occurrence of sudden changes in load, said means comprising a condenser in parallel to said first-mentioned condenser and a choke coil in series with said load circuit and between said condensers.

9. In combination, a source of direct current, a load circuit therefor, a circuit opening device for opening said circuit to effectively disconnect said load from said source, means for inhibiting the formation of an arc across the contacts of said switch during the interim of opening, said means including a condenser connected in circuit with a resistor across said load circuit on the load side of said circuit opening device, a pair of contacts connected in shunt to said resistor, and means for opening said circuit opening device to disconnect said load, and opening said contacts after a time interval sufficient to permit opening of said device with said resistor effectively out of said circuit.

10. In combination, a source of direct current, a load circuit therefor, a circuit opening device for opening said circuit to effectively disconnect said load from said source, means for inhibiting the formation of an arc across the contacts of said switch during the interim of opening, said means including a condenser connected in circuit with a resistor across said load circuit on the load side of said circuit opening device, a pair of contacts connected in shunt to said resistor, and means for sequentially opening said circuit opening device to disconnect said load, and opening said contacts to effectively remove said shunt from said resistance, said means comprising a relay winding in series with said load circuit, and responsive to a predetermined value of load current to actuate said circuit opening device and said contacts.

11. In combination, a source of direct current, a load circuit therefor, a circuit opening device for opening said circuit to effectively disconnect said load from said source, means for inhibiting the formation of an arc across the contacts of said switch during the interim of opening, said means including a condenser connected in circuit with a resistor across said load circuit on the load side of said circuit opening device, a pair of contacts connected in shunt to said resistor, means for sequentially opening said circuit opening device to disconnect said load, and said contacts to effectively remove said shunt from said resistor, and means for preventing variation of voltage across said condenser during sudden changes in current in said load circuit.

12. In combination, a source of direct current, a load circuit therefor, a circuit opening device for opening said circuit to effectively disconnect

said load from said source, means for inhibiting the formation of an arc across the contacts of said switch during the interim of opening, said means including a condenser connected in circuit with a resistor across said load circuit on the load side of said circuit opening device, a pair of contacts connected in shunt to said resistor, means for sequentially opening said circuit opening device to disconnect said load, and opening said contacts to effectively remove said shunt from said resistor, and means for preventing said condenser from discharging into said load circuit upon the occurrence of sudden changes in load current, said means comprising a condenser connected across said load circuit and closer to the load than said first condenser, and a choke coil in series with said load circuit and located between said two condensers.

DONALD G. LITTLE.
REUBEN LEE.