Dec. 2, 1930. G. A. BURNHAM 1,783,279

CIRCUIT INTERRUPTER

Filed Oct. 30, 1926 2 Sheets-Sheet 1

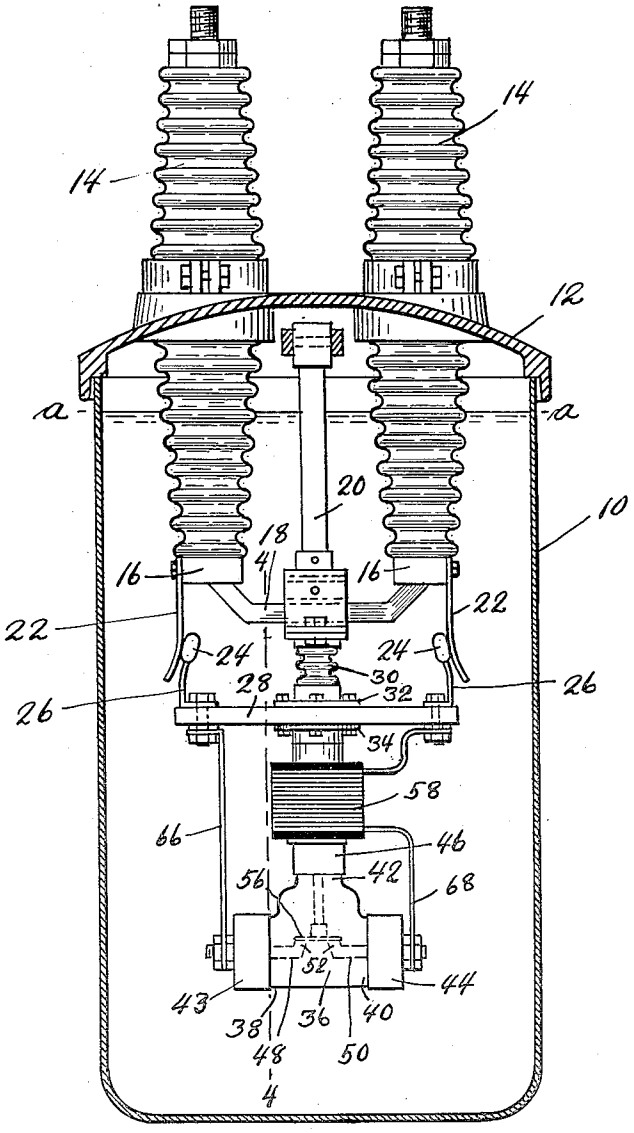


Fig. 1.

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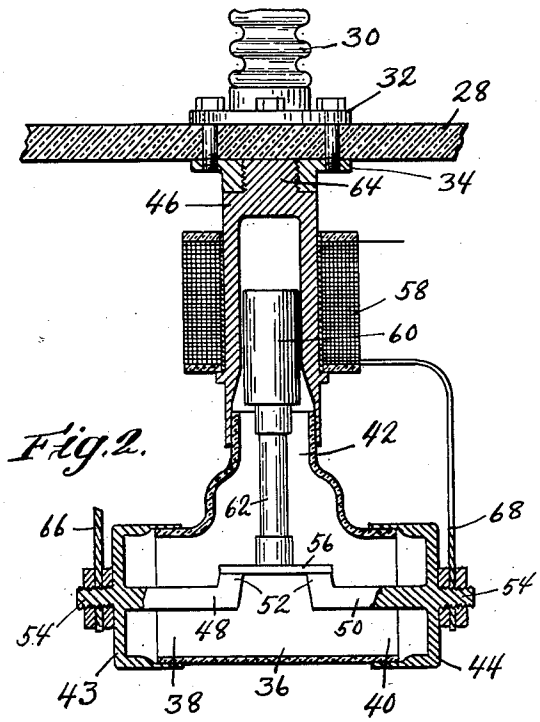


Fig. 2.

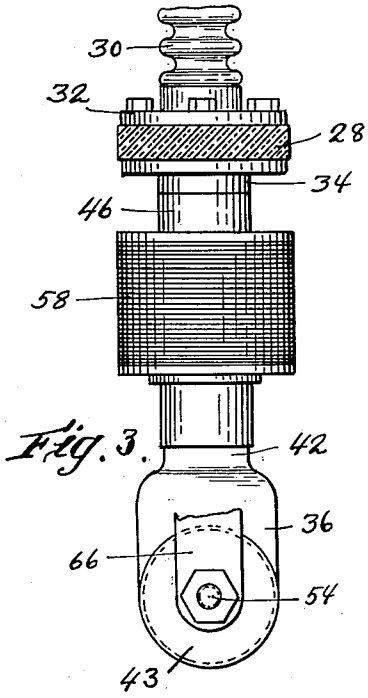


Fig. 3.

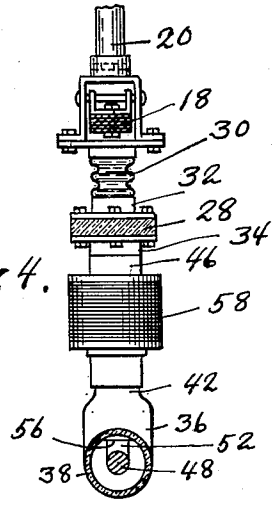


Fig. 4.

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1,783,279

UNITED STATES PATENT OFFICE

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CIRCUIT INTERRUPTER

Application filed October 30, 1926. Serial No. 145,321.

This invention relates to circuit interrupters of the type wherein the current is interrupted in a high vacuum so that the arc is of short length and duration.

The vacuum switch forming a part of this invention comprises an evacuated insulating casing containing separable contact members with means to effect the separation of the contact members whereby to interrupt the circuit through the switch. In certain of its aspects the switch may normally be closed and the contact members are adapted to be separated to interrupt the circuit and thereafter to make contact again.

Some of the objects of this invention are (1) to shunt the vacuum switch with a current-carrying switch so that the vacuum switch does not normally carry any material load that would tend to heat its current conducting components; (2) means to open the current-carrying switch and thereby divert the load to the vacuum switch for the purpose of interrupting the circuit; (3) a disconnecting switch to isolate the vacuum switch from the circuit after it has operated to interrupt the circuit; (4) means to operate the vacuum switch and the disconnecting switch in the order named; (5) means to delay the reclosing of the vacuum switch until after the disconnecting switch has opened; (6) a common actuating member for all three switches; (7) an oil-containing receptacle in which the vacuum switch is contained whereby to provide high insulation between its exposed current conducting components and thereby to reduce the distances required to maintain adequate insulation between the vacuum switch and objects at ground potential and also to prevent leakage of gas into the vacuum switch through the side walls thereof; (8) an oil containing casing in which all three switches are contained provided with a pair only of insulated circuit terminals for all of the switching apparatus; (9) to generally improve the construction and operation of electric circuit interrupters.

Fig. 1 is a sectional elevation through the casing of an electric switch embodying the invention.

Fig. 2 is a sectional view of the vacuum switch shown in Fig. 1.

Fig. 3 is a side elevation of the vacuum switch.

Fig. 4 is a view taken along line 4—4 of Fig. 1.

The electric switch or circuit interrupter embodying this invention comprises a casing having the oil receptacle 10 and the cover 12 therefor. The casing is adapted to be filled with oil or other electrically insulating fluid to some level *a—a*. Since a circuit-interrupting arc is not drawn beneath the surface of the oil, the casing may be made much lighter than has heretofore been safe with oil immersed switches of equivalent capacity. The interrupter is provided with insulated circuit terminals 14 which are carried by and extended above the cover 12 and also extended below said cover into the oil in said receptacle. The lower ends of said terminals terminate in stationary switch members as the contact blocks 16 of a current-carrying switch. The movable switch member of said current-carrying switch includes a brush-member 18 which is adapted to bridge said contact blocks and normally carry the current of the switch circuit. Said brush-member is secured to the lower end of an insulating switch rod 20 which is raised and lowered to close and open the switch by means of suitable operating mechanism (not shown) attached to the upper end of said rod. The circuit interrupter also includes a disconnecting switch of which the stationary switch members comprise the contact strips 22, which strips are secured to the contact blocks 16 and depend therebelow and are curved outwardly away from each other. The movable switch member of the disconnecting switch includes the contact members 24 which are carried by resilient strips 26 attached to a horizontally-disposed insulating bar 28. Said contact members 24 are adapted to ride over said stationary contact members 22 and maintain contact therewith throughout a substantial part of the movement of the movable switch member and to maintain contact when the brush-member 18 is separated from the contact blocks 16 and thence ultimately to be

moved below and free of contact with the contact members 22 in the switch-open position. Said movable contact members are insulated from each other by said bar 28 and are connected in series with the terminals of the vacuum switch hereinafter to be described. Said bar 28 is carried by the switch rod 20 below the brush-member 18 by means including the insulator 30. The lower end of said insulator is fixed in a flange member 32 and said insulating bar 28 is clamped between said flange member and a lower flange member 34, which lower flange member serves as a supporting means for the vacuum switch.

The vacuum switch forming a part of this invention is illustrated in Figs. 2 and 3. As shown in these figures, the switch includes a glass casing 36 having the opposed horizontal necks 38 and 40 and an upstanding neck 42 which is disposed between said lower necks. Metal caps 43 and 44 are welded to said necks 38 and 40 and a heavy copper tube 46 is welded to said upper neck 42. Conducting studs 48 and 50 are integrally formed with said caps and extend inwardly within the casing 36 and terminate in spaced contact members 52. Said caps are provided with integral and externally disposed studs 54 which are externally screw-threaded and provide means for connecting circuit terminals with said studs 48 and 50. The movable switch member comprises a bar 56 which is adapted to rest upon and bridge said contact members 52. The switch is electrically operated by means of a solenoid 58 which is received upon the tube 46. An armature or core 60 is loosely disposed within said tube and is arranged to be attracted by said solenoid whereby to move said bridging bar upwardly and away from said stationary contact members thereby to interrupt the circuit through the device and is adapted to drop by gravity and reclose the circuit through the switch when the solenoid is deenergized. Said bridging member is connected with said core 60 and is insulated therefrom by an insulating rod 62. The upper end of said tube is provided with an externally screw-threaded projection 64 which is screwed into the lower supporting flange 34 whereby to secure the switch dependently from the switch rod beneath said insulating bar 28. The terminals of the vacuum switch are adapted to be connected in series with the solenoid 58 and the contact members 24 of the disconnecting switch by means of conductors 66 and 68 as shown in Fig. 1.

Upon the opening movement of the circuit interrupter, the brush member 18 is moved away from the contact members 16. The full line current is thereby caused to pass in series through the disconnecting switch and the vacuum switch. The solenoid 58 of the vacuum switch is thereby energized and attracts its plunger 60 thereby drawing an arc between the stationary and movable switch members of the vacuum switch and ultimately interrupting the current thereat. During the operation of the vacuum switch, the separable contact members of the disconnecting switch are adapted to maintain contact with each other. Upon further opening movement of the circuit interrupter, however, and after the vacuum switch has operated to interrupt the circuit, the contact members of the disconnecting switch are adapted to separate, thereby to disconnect the vacuum switch from the line and to provide a positive oil insulation between the terminals of the circuit interrupter.

The reclosing movement of the vacuum switch is adapted to be delayed until after the disconnecting switch has opened. To this end, the tube 46 surrounded by the solenoid 58 is composed of a low resistance metal, as copper, and has a relatively thick side wall. It thereby comprises a short-circuited one-turn secondary of a transformer of which the solenoid 58 comprises the primary winding. The magnetic field produced by the current flowing in this tube at the moment the circuit is interrupted in the vacuum switch serves to maintain the plunger 60 in elevated position for a length of time sufficient to permit the complete opening of the disconnecting switch.

The transformer action also serves to prevent the momentary opening of the vacuum switch when the circuit interrupter is being closed and before the current-carrying switch has been closed, although this feature is not of great importance.

The casing of the vacuum switch is adapted to be evacuated to an exceedingly high degree, and preferably as high as practicable, so that current conduction through the evacuated space is greatly hindered, and the metal parts within the casing, and especially the contact members 52 and 56, are adapted to have the occluded gases removed therefrom whereby a heavy current at high potential can be interrupted rapidly and with but a small elongation of the circuit interrupting arc. By the provision of the high vacuum and the removal of the occluded gases and the oil insulation provided between the exposed terminals of the casing, the vacuum switch can interrupt large amounts of energy at high potentials with relatively small physical dimensions. The oil insulation provided about the vacuum switch reduces to relatively small dimensions the amount of clearance necessary between the switch and grounded objects and thus reduces the dimensions of the space in which the apparatus is enclosed. Since no circuit-interrupting arc is drawn in the oil-containing casing, the clearance between the wall of the casing and live conductors therein can be materially reduced over those dimensions considered necessary in the usual type of oil-immersed electric switch. The insulat-

ing liquid also insulates the evacuated container from the air and so prevents loss of vacuum that would occur if the container were surrounded by air, due to diffusion through the walls thereof.

I claim:

1. A circuit interrupter having current carrying members separable in an insulating fluid, circuit interrupting members separable in a vacuum, and separable disconnecting members arranged in series with said circuit interrupting members and in parallel with said current carrying members.

2. A circuit interrupter having current carrying members separable in an insulating fluid, circuit interrupting members separable in a vacuum, and separable disconnecting members arranged in series with said circuit interrupting members and in parallel with said current carrying members, said disconnecting members also being separable in insulating fluid.

3. A circuit interrupter having main contact members, auxiliary contact members, and circuit interrupting members connected in series with said auxiliary contact members and separable in a vacuum.

4. A circuit interrupter having current carrying members, circuit interrupting members separable in a vacuum and disconnecting members in series with said interrupting members and separable in an insulating fluid.

5. A circuit interrupter having conjointly operable main current carrying members and disconnecting members, and circuit interrupting members connected in series with said disconnecting members and separable in a vacuum.

6. A circuit interrupter having a movable main current carrying member, a movable disconnecting member, a common support for said movable members, and separable circuit interrupting members connected in series with said disconnecting member and separable in a vacuum.

7. A circuit interrupter having a movable main current carrying member, a movable disconnecting member, a common support for said movable members, and separable circuit interrupting members connected in series with said disconnecting member and separable in a vacuum, said support also comprising the support for said separable circuit interrupting members.

8. A circuit interrupter comprising the combination of a current carrying switch, a disconnecting switch, a vacuum switch connected in series with said disconnecting switch, and a movable switch member common to all of the aforesaid switches.

9. A circuit interrupter comprising the combination of a current carrying switch, a disconnecting switch, a vacuum switch connected in series with said disconnecting switch, a movable support for said vacuum switch and a movable switch member connected with said current carrying and disconnecting switches.

10. A circuit interrupter having the combination of a normally-closed circuit interrupting switch, a disconnecting switch in series with said interrupting switch, and means including a retarding device to delay the closing of said interrupting switch when it is open until after said disconnecting switch is opened.

11. A circuit interrupter having the combination of a normally-closed circuit interrupting switch, a main current carrying switch normally shunting said interrupting switch and means including a retarding device to delay the opening of said interrupting switch until after said current carrying switch is closed.

12. A circuit interrupter having the combination of a normally-closed circuit interrupting switch, a switch opening solenoid in series therewith, a disconnecting switch in series with said interrupting switch and solenoid, and means associated with said solenoid to delay the closing of said circuit interrupting switch when it is open until after the opening of the disconnecting switch.

13. A circuit interrupter having the combination of a normally-closed circuit interrupting switch, a switch opening solenoid in series therewith, a disconnecting switch in series with said interrupting switch and solenoid, and means associated with said solenoid to prevent opening of the circuit interrupting switch when it is closed during the closing movement of said disconnecting switch.

14. A circuit interrupter having the combination of fixed line terminals, a bridging member adapted to connect said terminals and normally carry the current of the interrupter, a circuit interrupting switch comprising an evacuated casing having separable contact members therein, exposed terminals for said circuit interrupting switch, and means to move said terminals into and out of contact with said line terminals of the interrupter comprising means to move said evacuated container.

15. A circuit interrupter having line terminals, a movable switch rod, a circuit interrupting switch including an evacuated container carried by said rod, said container having internally-disposed circuit interrupting members and exposed circuit terminals which are adapted to be moved into and out of contact with said line terminals by the movement of said switch rod, and a bridging member carried by said switch rod arranged directly to bridge said line terminals in shunt with said circuit interrupting switch.

16. A circuit interrupter having the combination of an enclosing casing adapted to contain an insulating fluid and having interrupter-elements constituting a main current

carrying switch, a circuit interrupting switch and a disconnecting switch all contained within said casing and immersed in the insulating fluid thereof, and interrupter-operating means common to at least two of said switches.

17. A circuit interrupter having the combination of an enclosing casing adapted to contain an insulating fluid, interrupter-elements constituting a main current carrying switch, a circuit interrupting switch and a disconnecting switch all contained within said casing and immersed in the insulating fluid thereof, and interrupter-operating means common to at least two of said switches, said casing having a pair of exposed insulated line terminals common to all of said switches.

18. A circuit interrupter comprising an evacuated container composed of insulating material and having a pair of opposed and aligned necks, metal members welded to said necks and carrying stationary contact members within said container, said container also having a third neck which upstands above and between said first necks, a metal tube welded to said third neck, a movable switch member including a plunger movable within said tube, and an operating solenoid surrounding said tube.

19. A circuit interrupter including an evacuated container composed of insulating material, stationary contact members disposed therein and having terminals extended out of said container, stationary switch members, a cooperating movable switch member including a plunger for operating it, a metal tube welded to the wall of said evacuated container, said plunger being slidable within said tube and said tube having a massive side-wall, and a solenoid surrounding said tube, said tube adapted to have a current set up therein which acts upon said plunger to delay the movement thereof.

In testimony whereof, I have signed my name to this specification.

GEORGE A. BURNHAM.