July 21, 1925. 1,546,433

G. A. BURNHAM

ELECTRIC SWITCH

Filed June 22, 1920. 2 Sheets-Sheet 1

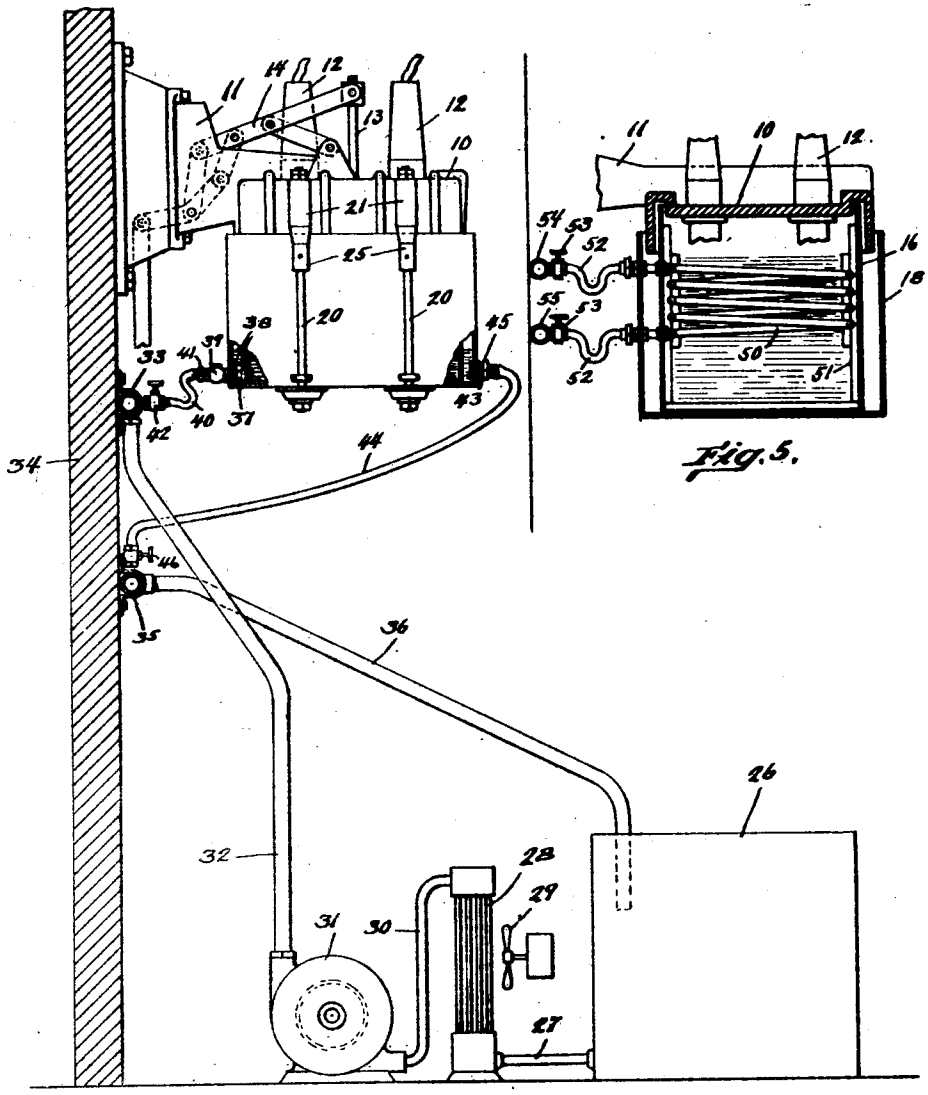


Fig. 1.

Fig. 5.

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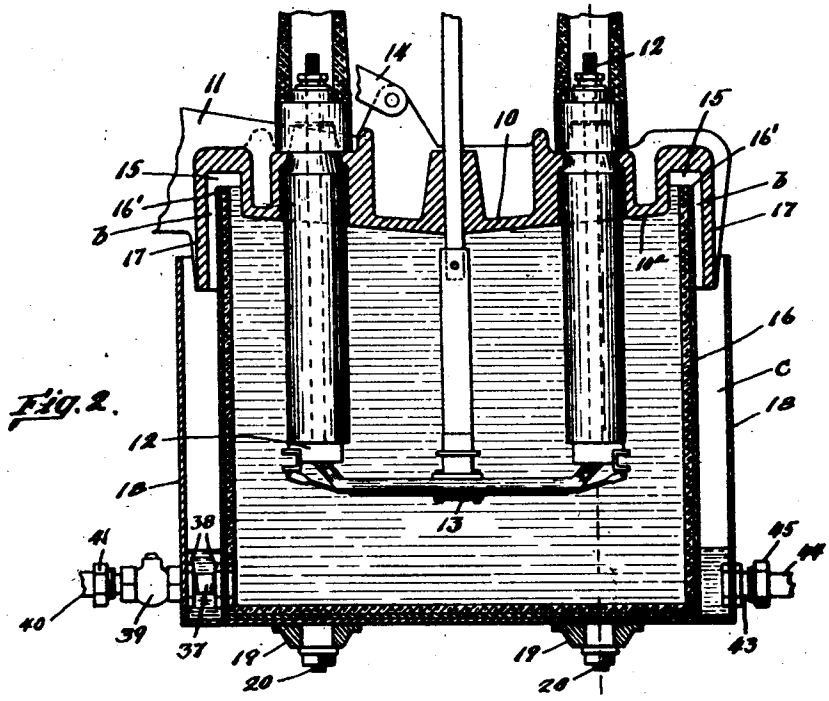


Fig. 2.

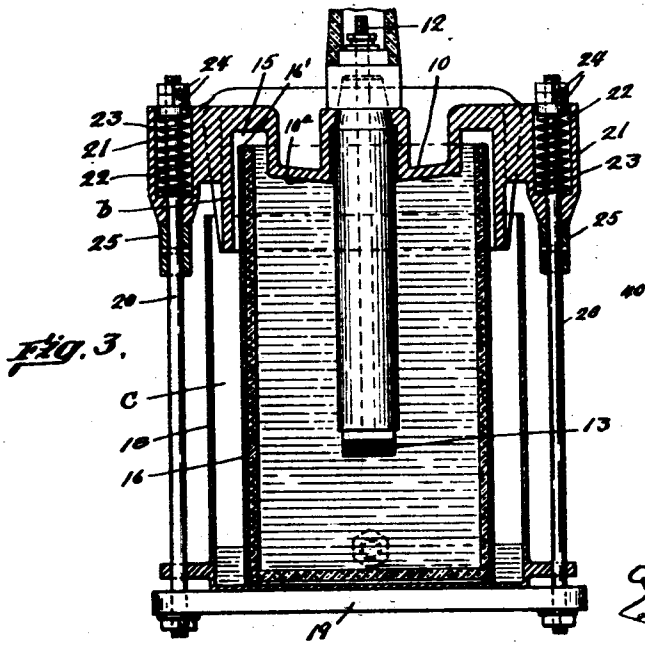


Fig. 3.

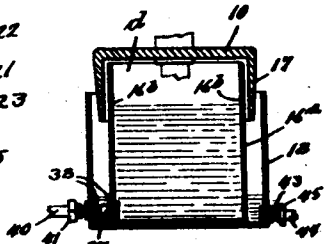


Fig. 4.

Inventor,
George A. Burnham
by
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Patented July 21, 1925. 1,546,433

UNITED STATES PATENT OFFICE.

GEORGE A. BURNHAM, OF SAUGUS, MASSACHUSETTS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO CONDIT ELECTRICAL MANUFACTURING COMPANY, A CORPORATION OF MASSACHUSETTS.

ELECTRIC SWITCH.

Application filed June 22, 1920. Serial No. 390,850.

To all whom it may concern:

Be it known that I, GEORGE A. BURNHAM, a citizen of the United States, residing at Saugus, in the county of Essex and State of Massachusetts, have invented an Improvement in Electric Switches, of which the following is a specification.

This invention relates to an electric switch adapted to carry and interrupt current of high value.

The current-carrying capacity of an electric switch is strictly limited by its physical dimensions and there is a limit beyond which it is not commercially practicable to extend its physical dimensions because of the small increase in carrying capacity resulting therefrom.

In my Patent No. 1,337,995, dated April 27, 1920, and my co-pending applications Serial No. 300,557, filed May 29, 1919, issued as Patent No. 1,483,839, dated February 12, 1924, and Serial No. 286,353, filed March 31, 1919, I have disclosed an electric switch having means by which it is artificially cooled, by which the current carrying capacity and the current interrupting capacity of a switch of given physical dimensions is largely increased.

The dynamic energy developed within the switch upon circuit interruption is relatively great and unless means are provided whereby to absorb such energy the switch components may become damaged.

In my Patent No. 1,413,156, dated April 18, 1922, and co-pending applications Serial No. 374,276, filed April 16, 1920, issued as Patent No. 1,498,507, dated June 17, 1924, Serial No. 391,466, filed May 14, 1920, Serial No. 386,347, filed June 3, 1920, issued as Patent No. 1,483,840, dated February 12, 1924, Serial No. 388,324, filed June 11, 1920, issued as Patent No. 1,512,083, dated October 21, 1924, I have set forth a switch having energy absorbing means comprising a relatively yielding switch frame and oil receptacle by which the rupturing capacity of the switch is increased without a corresponding increase in its physical dimensions.

In my co-pending application Serial No. 388,324, filed June 11, 1920, I have set forth a switch having means by which the switch is completely filled with oil whereby explosions within the switch upon certain conditions of circuit interruption will be obviated and the current rupturing capacity may be still further increased.

For some purposes, it may be desirable to provide a switch having a relatively great carrying capacity, and an interrupting capacity but slightly greater than its carrying capacity, yet it is more often desirable to provide a switch having a relatively moderate carrying and relatively high interrupting capacity.

However, when switching equipment is to be provided for the control and interruption of circuits carrying very high values of current, with which this invention is particularly concerned, when the current normally to be carried and interrupted is very high and where the current rise upon overloads, or upon severe short circuit conditions, may be relatively enormous, it is imperative that the switch, in addition to a large current carrying capacity have a relatively great current interrupting capacity.

An object of this invention, therefore, is the provision of a switch having both a relatively great current-carrying capacity and relatively great current interrupting capacity with relatively moderate physical dimensions; and I accomplish this object by the novel combination in an electric switch of means to absorb energy resulting from circuit interruption and means artificially to cool the switch.

In one of my above-named co-pending applications, namely, Serial No. 388,324, filed June 11, 1920, I have set forth an electric switch adapted to be completely filled with oil having means to replenish oil in the oil receptacle as oil is expelled therefrom during circuit interruption or is vaporized while the switch is in service, thereby to maintain the oil receptacle properly filled with oil. Said means specifically comprises a float governed valve controlled by the level of oil within the switch adapted to admit oil therein when the oil level recedes from a predetermined length and close when the oil level approaches the predetermined height.

A further object of this invention is the provision of another means by which the

oil level in the switch will be maintained at the proper height; and this object is attained by so arranging the oil receptacle that oil will overflow therefrom into the spill receptacle when the proper level is reached therein, and continually replacing the oil in the spill receptacle back into the oil receptacle.

Certain features of this invention are disclosed in my co-pending applications Serial No. 300,557, filed May 29, 1919, and Serial No. 454,427, filed March 17, 1921.

Fig. 1 is a diagrammatic representation of a switching equipment embodying my invention.

Fig. 2 is a longitudinal sectional elevation of the switch of Fig. 1.

Fig. 3 is a transverse sectional elevation of the switch of Fig. 1.

Fig. 4 is a transverse sectional elevation of a modified form of switch arranged to carry out my invention.

Fig. 5 is a transverse sectional elevation of an oil switch having modified cooling means.

As shown in Figs. 1, 2 and 3 my invention is applied to the switch set forth in my co-pending application Serial No. 309,853, filed July 10, 1919, which application has eventuated in Patent No. 1,413,156, dated April 18, 1922. The switch comprises the switch frame 10 which forms a cover for the oil receptacle and which has an arm 11 extended therefrom by which the switch is secured to a support. Stationary switch members 12 and movable switch members 13 are carried by said frame and depend therebelow into the oil receptacle; and switch operating mechanism 14 also is carried by said frame.

Said switch frame is formed on its under side with a peripheral groove or recess 15 therein adapted to receive the top portion 16′ of the oil receptacle which is adapted to extend into said groove above the lower portion 10^a of the switch frame and be peripherally spaced from the switch frame to provide a vent space a therebetween; and the oil receptacle is adapted to contain oil to such a height that the oil stands in said vent space whereby the switch will be entirely filled with oil to its covers, and all appreciable chambers or pockets are obviated in which an explosive mixture of air and oil vapor might otherwise collect.

The switch frame is formed with the peripheral depending flange or apron 17 which surrounds the top portion of the side walls of the oil receptacle 16 and depends downwardly a substantial distance over the outer face of the side walls of the oil receptacle. Said apron is peripherally spaced from the side walls of the oil receptacle whereby to provide a vent passage b between it and the oil receptacle through which gas and oil vapor will be discharged from the switch and cooled before their final exit from the switch.

Preferably the top of the oil receptacle is adapted to be below the bottom of the groove 15 in the switch frame by a distance substantially equal to the width of the passage b whereby to permit the substantially free or unrestricted venting of the switch.

Said oil receptacle is contained within an outer or spill receptacle 18, the side walls of which latter receptacle are peripherally spaced from the side walls of the oil receptacle whereby to provide a chamber c adapted to collect oil or condensed oil vapor expelled from the switch and also to receive the heated oil caused to flow from the inner oil receptacle in the performance of my invention.

Said spill receptacle extends above the bottom of the apron 17 whereby to collect substantially all of the vapor and oil discharged from the switch.

Said two receptacles may be secured together by any suitable means as by spot-welding the bottoms together.

Said receptacles are supported upon the grids 19. Rods 20 are secured to said grids and extend upwardly along the side walls of the spill receptacle and are slidably arranged in recesses in lugs 21 of the switch frame. The upper portion of said recesses are enlarged to form the spring recesses 22. Compression springs 23 are disposed over the end of said rods 20 and nuts 24 threaded on said rods serve to retain the receptacle in position to the switch frame. This arrangment permits of the yielding or downward movement of the oil receptacle relative to the switch frame or the switch members therein contained upon development of pressure in the switch due to circuit interruption. The receptacle may be removed from position about the switch members by removing the nuts of said rods 20. Sleeves 25 are fixed to said rods 20 to engage the lower end of said lugs 21 whereby to restrict the extent of upward movement of said oil receptacle and govern the height of the vent passage between the top of the oil receptacle and the switch frame.

Due to the resistance of the current carrying components of the switch and the resistance of the brush contacts, said components become heated by the relatively high values of current adapted to be carried thereby. Also, due to the alternating flux surrounding the current carrying components, and the magnetic material of the oil receptacle made commercially necessary by reason of strength and cheapness, heat is generated in the walls of the oil receptacle due to eddy current and hysteresis losses therein. The heating of the switch reduces the current carrying and current rupturing capacities of the switch.

I provide means artifically to cool the oil

within the oil receptacle whereby to increase the current carrying and current rupturing capacities of the switch without a corresponding increase in the physical dimensions of the switch. While many methods are available by which the switch may be artifically cooled, some of which are set forth in my above-named co-pending applications, I prefer to circulate the hot oil taken from the oil receptacle of the switch through a refrigerating system by which it is cooled and returned in cold form to the oil receptacle where it will abstract heat from the heated components of the switch and become in itself heated.

Such a refrigerating system may include the tank 26 adapted to receive the hot oil from the switch and in which the oil may be partially cooled. A conductor 27 extends from the tank to a radiator 28, in which the oil is finally cooled; and the cooling may be assisted by the fan 29 arranged to force cold air through the radiator. A conductor 30 extends from the top of the radiator to the oil pump 31 which may be driven by any suitable means not shown. Cold oil is taken from the radiator by the pump and forced into a conductor 32 in communication with the main 33 which may be secured to a wall or other fixed support 34 and extended about the station to a number of switches adapted similarly to be cooled. The hot oil is adapted to flow from the switch into the hot oil main 35 disposed below the cold oil main 33 and similarly supported and extended about the station and returned to the tank 26 through the conductor 36. Communication for cold oil is established to the interior of the oil receptacle 16 through the nipple 37 which extends through aligned apertures in the side walls of the spill receptacle 18 and the oil receptacle 16 near the bottom thereof and is secured to the walls of both receptacles against leakage by suitable means as by the lock nuts 38. Said nipple extends beyond the side wall of said spill receptacle 18 and a check valve 39 is secured thereto which is arranged to permit the flow of oil into the receptacle but prevent a back flow of oil from the receptacle as may otherwise occur upon the development of pressure within the switch due to circuit interruption.

Inasmuch as the oil receptacles are adapted to yield relative to the switch frame and the stationarily supported oil mains under certain conditions of circuit interruption, a flexible oil conductor 40 is provided which is connected to said check valve 39 by the coupling 41 which admits of the detachment of said flexible conductor from the switch. Said flexible conductor is connected to the valve 42 forming a part of the cold oil main 33 and which is adapted to control the flow of cold oil into the receptacle.

Oil is adapted continually to flow into the inner receptacle 16 and fill it to the top and the hot oil is adapted to flow over the top and down the side walls thereof into the outer or spill receptacle 18 from which it is conducted to the hot oil main 35. A nipple 43 is secured in the side wall of the outer receptacle 18 near the bottom thereof and the flexible conductor 44 is connected thereto through the coupling 45 and to the hot oil main 35 to which it is connected through the control valve 46. The hot oil thereby is returned to the tank 26 again to be circulated through the components of the cooling system.

By this arrangement the oil within the switch is maintained in condition of maximum effectiveness and the oil receptacle may yield under pressure conditions within the switch whereby to absorb the dynamic energy developed therein.

While I prefer to utilize a switch adapted to be completely filled with oil, I may employ, when desirable, a switch having an expansion space above the oil. Such a switch is shown in Fig. 4.

The inner oil receptacle 16^a is provided with apertures 16^b in its side walls at such a distance downward from the top to maintain a suitable gas expansion chamber d beneath the switch frame 10. Said apertures 16^b are preferably above the lower end of the apron 17. Oil will flow through said apertures b into the spill receptacle 18 instead of over the top of the oil receptacle as above set forth.

In lieu of circulating the insulating oil itself through the refrigerating system I may artificially cool the oil in the oil receptacle itself by the circulation of a refrigerating medium through cooling coils immersed in the oil receptacle of the switch.

In Fig. 5 I have shown an oil switch comprising the switch frame 10 and the inner oil receptacle 16 as shown in my co-pending application Serial No. 286,353, filed March 31, 1919. Coils of pipe 50 are supported therein on the insulating frame work 51 adjacent but preferably spaced from the side walls of the oil receptacle and preferably also below the oil level therein. The ends of said coils extend through the side walls of the oil and spill receptacles and are sealed therein to prevent leakage of oil and are connected through the flexible conductors 52 and the interposed control valves 53 to the main 54 for the cold cooling medium and to the main 55 for the hot cooling medium.

The cooling effect and consequently the current carrying and rupturing capacities of the switch in the various constructions above set forth may be regulated by the valves 42 and 46 or by the corresponding valves 53.

Removal of the oil receptacle may be performed by closing said control valves and breaking the couplings at the ends of the flexible conductors.

I claim:

1. An electric switch adapted to be completely filled with oil and overflow freely when excess oil is introduced therein, having means to maintain the switch full of oil comprising means continually to introduce oil therein to cause excess oil to flow therefrom and catch the overflowing oil and replace it in the switch.

2. An electric switch adapted to be completely filled with oil and lose oil in service and overflow freely when excess oil is introduced therein having means to maintain the switch completely filled with oil comprising means adapted continually to introduce oil therein whereby to cause the switch continually to overflow and catch the overflowing oil and replace it in the switch.

3. An electric switch arranged to be completely filled with oil and to overflow freely when excess oil is introduced therein, and means to maintain the switch completely full of oil comprising an oil circulatory system having means continually to introduce oil into the switch to cause it to overflow, means to catch the overflowing oil and means to cool the caught oil before returning it to the switch and means to return the cooled oil into the switch.

4. An electric switch having a fixed switch frame, an oil receptacle yieldingly disposed beneath said frame arranged to contain oil to a predetermined level and overflow oil over its sidewalls, a spill receptacle arranged beneath said oil receptacle to catch the overflown oil, and an oil circulatory system in communication with said oil and spill receptacles arranged to receive oil from said spill receptacle and return it to said oil receptacle.

5. An electric switch having a fixed switch frame, an oil receptacle yieldingly disposed beneath said frame arranged to contain oil to a predetermined level and overflow oil over its sidewalls, a spill receptacle arranged beneath said oil receptacle to catch the overflown oil, and an oil circulatory and cooling system in communication with said oil and spill receptacles arranged to receive hot oil from said spill receptacle and cool it and return the cold oil to said oil receptacle.

6. An electric switch having a fixed switch frame comprising a cover for the oil receptacle, an oil receptacle yieldingly disposed beneath said frame and spaced therefrom to provide a vent passage from the switch over the top of the oil receptacle, said oil receptacle adapted to contain oil to its top and overflow oil down its side-walls, a spill receptacle disposed beneath said oil receptacle to receive the overflown oil and an oil circulatory and a cooling system having oil circulating and oil cooling means, said system arranged in communication with said oil and spill receptacles adapted to receive hot oil from said spill receptacle and cool it and return the cold oil to the oil receptacle.

7. An electric switch comprising an oil receptacle, a switch frame comprising a cover for the oil receptacle, said frame having a peripheral flange depending over the side walls of the oil receptacle and spaced therefrom to provide a vent passage for the switch, said oil receptacle adapted to be filled with oil to its top and overflow oil through the vent passage, a spill receptacle containing said oil receptacle adapted to receive oil from the oil receptacle having its side walls extended above the end of the vent passage, and an oil circulatory and cooling system in communication with said oil and spill receptacles having oil circulatory and cooling means, said system arranged to receive hot oil from the spill receptacle and cool it and return the cold oil to the oil receptacle.

8. An electric switch having outer and inner receptacles, and means to effect the transfer of oil from the outer to the inner receptacle.

9. An electric switch having outer and inner receptacles, said inner receptacle arranged to vent into said outer receptacle, and means to return oil from the outer to the inner receptacle.

10. The combination of an electric switch having a yieldingly-supported component, and means to circulate a cooling medium in cooling relation with said switch including a fluid circulating and cooling system having hot-fluid and cool-fluid conduits disposed in fixed position adjacent the switch, and flexible conduits for the cooling fluid attached to and in fluid communication with said conduits and also attached to and in fluid communication with said yieldingly-supported switch component.

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

GEORGE A. BURNHAM.