April 5, 1927. 1,623,326

J. WHALEN

ELECTRIC SWITCH

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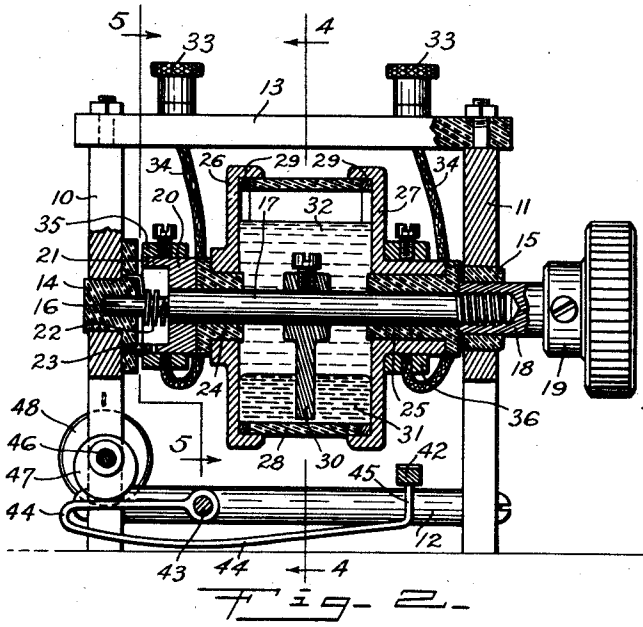


Fig. 2.

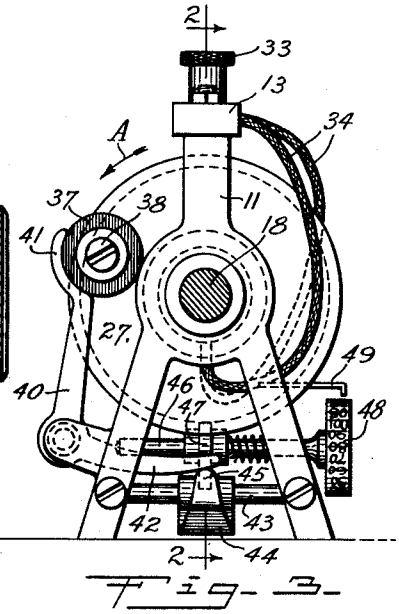


Fig. 3.

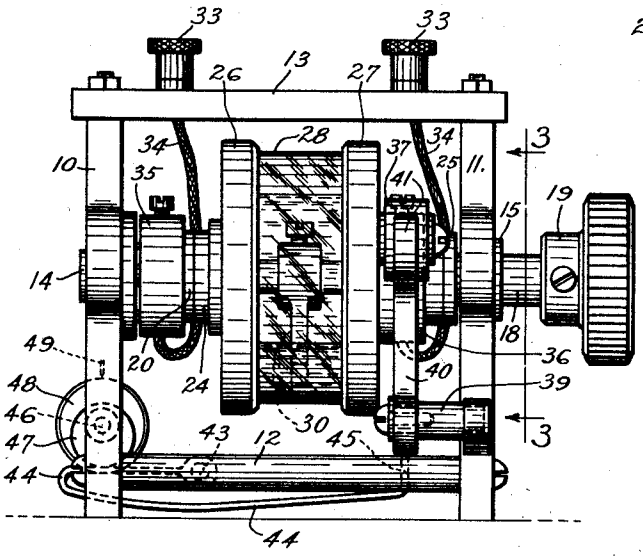


Fig. 1.

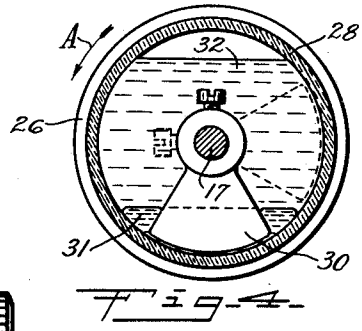


Fig. 4.

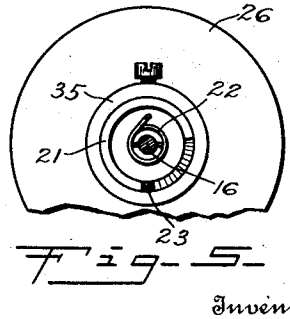


Fig. 5.

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UNITED STATES PATENT OFFICE.

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ELECTRIC SWITCH.

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My invention relates to electric switches of the class in which one or more poles of the switch consist of conductive fluid or metal such as mercury. It is the object of my invention to provide a switch especially designed and adapted for use with electric motors as a safety device or automatic cut-out for stopping the current supply to the motor when the latter is overloaded to such an extent and for such time as to cause heating thereof to a predetermined temperature, whereby the motor may be protected from overheating, independently of the current values of the electrical supply thereto. A further object of my invention is to provide a switch capable of opening or breaking a circuit in which a heavy current is flowing, without causing arcing at the switch-poles, and in which the moving parts of the switch mechanism are so constructed and arranged as to be operable with a very small expenditure of energy. A further object is to provide a switch employing as one of the separable poles a body of fluid metal or amalgam of such composition as to have no appreciable solvent action upon the solid metal poles or other parts with which the fluid is in contact. A further object of my invention is to provide a switch wherein the separation of poles takes place beneath the surface of a body of non-conductive liquid which serves to inhibit arcing, and in which said liquid is transparent and is retained within a transparent container, whereby the action may be observed if desired. A further object is to provide a switch of the character above set forth, in which the parts are biased to circuit-opening position and are held in circuit-closing position by a trigger device, the latter being sufficiently sensitive to readily enable its operation by direct mechanical connection with a thermostatic element.

In the accompanying drawings Fig. 1 is a side view of a switch embodying my invention, Fig. 2 is a longitudinal vertical section of the same, Fig. 3 is an end view thereof, Fig. 4 is a vertical section on the line 4—4 of Fig. 2, and Fig. 5 is a detail section on the line 5—5 of Fig. 2.

In carrying out my invention according to the illustrated embodiment thereof, I provide a fixed frame comprising the metal end-members 10 and 11 of which the lower parts or legs are connected by longitudinal rods 12, and the upper ends are connected to each other by a bar 13 of insulating material. In the end-members 10 and 11 are secured the insulating bushings 14 and 15. The bushing 14 is bored to form a bearing for the reduced end 16 of a shaft 17. The opposite end of the shaft is threaded, and upon said threaded portion is screwed the sleeve-nut 18 to which is secured the hand-wheel 19, the latter being of insulating material. The sleeve-nut 18 extends through the bushing 15, being rotatable therein so that said bushing forms a bearing for the shaft 17, of which the member 18 may be regarded as an extension. Adjoining the reduced end 16 of the shaft, a collar 20 is secured thereon by sweating the parts together, said collar having an annular flange 21 extending toward the bushing 14 and inclosing a cylindrical space about the shaft-end 16. In said space is disposed the spring 22 of which one end is connected with the shaft and the other to the bushing 14, the spring being under a tension tending to rotate the shaft in the direction of the arrows A in Figs. 3 and 4. A pin 23 on the bushing 14 extends into a notch in the end of the flange 21, the circumferential extent of said notch being such that rotation of the shaft is limited to about one-fourth of a revolution. On the shaft 17, between the collar 20 and the inner end of the sleeve-nut 18, is disposed a cylinder or drum which is constructed as follows: A pair of sleeves 24 and 25, of insulating material, each having an integral flange at one end, are disposed upon the shaft so that the flanged ends adjoin respectively said collar 20 and sleeve-nut 18. Upon said sleeves 24 and 25 are mounted the metal end-pieces 26 and 27 of the drum or cylinder, and between said end-pieces is disposed the tube 28 which is preferably of glass, the ends of said tube fitting inside the peripheral flanges of the end-pieces and seating against gaskets 29 which insure fluid-tight joints between the tube and the end-pieces. The sleeves 24 and 25 fit tightly upon the shaft 17, to form fluid-tight joints therewith, but are slidable longitudinally of the shaft to the extent necessary for transmitting the clamping pressure from the sleeve-nut 18 to the collar 20, whereby to press together the drum-members 26, 27

and 28. Within the drum, between the sleeves 24 and 25, a sector-shaped contact-piece 30 is secured to the shaft, as shown.

Within the drum or hollow cylinder, formed as above described, is placed a quantity of fluid metal 31 sufficient to fill the lower portion of the space to a level about midway between the lower side of the hub of the contact-piece 30 and the inner side of the tube 28. About the fluid metal 31 is placed a quantity of non-conductive liquid 32, sufficient to fill the remainder of the drum-space to a level approximately as shown, the un-filled air-space at the top being of such volume as to allow for the thermal expansion of the contained liquids without causing more than a nominal increase of pressure within the cylinder. The fluid metal 31 is preferably an amalgam formed by dissolving in mercury a quantity of ordinary soft solder (consisting of equal parts by weight of lead and tin) as much as the mercury will dissolve without loss of active fluidity at ordinary temperatures. The use of such an amalgam instead of pure mercury is preferred for the reason that it is desirable to employ for the end-pieces of the drum, the shaft 17, and contact-piece 30, metal of high electrical conductivity, such as copper, which is soluble or amalgamable to a considerable extent by pure mercury, but which I have discovered to be not soluble or amalgamable to an appreciable degree in the described mercury-solder amalgam; so that by the use of the fluid amalgam the parts named may be of copper without suffering depreciation under continued use in contact with the fluid conductor. The amalgam is also less expensive than pure mercury. The liquid 32 is preferably glycerine, of which the insulating properties are sufficient to effectively suppress arcing, and which, being transparent, enables observation of the immersed parts when desired.

On the insulating frame-bar 13 are mounted a pair of binding-posts 33 to which are connected the terminals of the circuit to be controlled by the switch. From said binding-posts 33 the flexible conductors 34 are extended to collars 35 and 36, said collars being secured respectively to the collar 20 and to the hub of the end-piece 27 of the drum. The drum and shaft are revoluble as a unit, the shaft-end 16 turning within the bushing 14, and the shaft-extension or sleeve-nut 18 turning within the bushing 15. When the drum and shaft are positioned as shown in Figs. 1, 2 and 4, so that the contact-sector 30 dips into the fluid metal 31, the electric circuit is closed through the binding-posts 33 conductors 34, collars 35 and 36, drum end-piece 27, amalgam 31, contact-sector 30, shaft 17, and collar 20. When the shaft and drum are rotated so that the contact-sector 30 extends laterally in a position such as indicated by dotted lines in Fig. 4, the circuit is opened between the amalgam and said contact-sector.

In the illustrated structure, rotation of the drum and shaft to the circuit-opening position is effected by the spring 22, of which the tension serves to bias the switch to said circuit-opening position. For retaining the switch in circuit-closing position the following means are provided: On the end-piece 27 is revolubly mounted a roller 37 of insulating material, a pin or stud 38 being attached to the member 27 for carrying said roller. On the adjacent frame-member 11 is pivotally mounted a trigger or lever comprising an arm 40 which extends upwardly from the pivot-pin 39 and has a curved terminal portion 41 of which the inner face forms a seat for the roller 37, and an arm 42 which extends in horizontally to a point beneath the axis of the drum-shaft 17. The lever is so proportioned that when the roller is engaged with the curved seat-portion 41 the pressure upon the lever, due to the attention of the spring 22 tending to rotate the drum as described, will be exerted almost directly toward the lever-fulcrum or axis of the pivot-pin 39, and there will be no tendency for the roller-pressure to move the lever, although a very slight movement of the lever outwardly will enable the roller-pressure thereon to cause a further displacement or tilting of the lever about its fulcrum, whereby the roller may swing past the seat, and the drum thus be released and permitted to rotate to the circuit-opening position. Extending transversely between the frame-rods 12 is a rocking-shaft 43 of which the ends are pivoted in said rods, and to the central portion of said shaft is attached one end of a thermostat-bar 44. Said bar extends from the shaft longitudinally of the frame between the legs of the end-member 10, and is then turned downwardly in a U-bend of which the lower portion passes back beneath the shaft, extending beyond the same to a point below the arm 42 of the trigger-lever, and a terminal portion 45 being turned upwardly to engage said arm 42. In the legs of the frame end-member 10 is journaled a small shaft 46 having upon the central portion thereof a cam or eccentric 47 which engages the upper side of the bar 44. One end of the shaft 46 extends through the frame-leg and carries a small graduated disk 48, a fixed finger or pointer 49 being extended out from the leg and terminating near the periphery of the disk as a reference point for reading the graduations thereon. The cam or eccentric may be rotated by means of the shaft 46 to move the bar 44 pivotally about the axis of the

shaft 43 and thus bring the upturned end 45 into adjusted relations to the horizontal arm 42 of the trigger-lever.

For use of the switch in preventing overheating of an electric motor, the frame of the switch may be mounted directly upon the motor-field or housing, so that the thermostatic bar 44 is in close proximity thereto. Said bar is adjusted to a position such that upon a rise of temperature thereof to a predetermined degree the end-portion 45 will be raised sufficiently to slightly lift the arm 42 of the trigger-lever, thereby tilting the vertical arm 40 outwardly to a position at which the pressure of the roller 37 upon the curved seat 41 will cause the further displacement required to permit rotation of the switch-drum to the circuit-opening position. The current supply for motors of moderate size may be controlled directly by the switch, and for motors requiring a very heavy current, or on a high-voltage circuit, the switch may be employed as a relay to control the current for operating a main-switch controlling the motor-circuit. In the described and illustrated structure the switch operates solely as a safety cut-out to prevent overload of the motor by opening the motor-circuit or a control-circuit, and the circuit is closed manually by turning the hand-wheel 19 to restore the drum to circuit-closing position, at which it is held by the engagement of the roller with the seat-portion of the trigger-lever. The thermostatic device may be calibrated so that the graduations on the disk 48 will indicate directly the temperatures at which the switch will be released, when the respective graduations are set at the pointer 49.

It will be seen that the operation of the switch mechanism proper requires a movement only of the rigid unit comprising the drum, contact-sector and shaft, the liquid 31 and 32 remaining in a substantially fixed position during the rotation of the drum. The fixity of position of the liquids result both from the gravitational tendency thereof to remain in the lowermost portion of the container, and from the inertia thereof, particularly of the heavy fluid-metal, resisting displacement of its position, so that the slight frictional contact between the liquids and the drum is insufficient to effect an appreciable movement of the liquids. Because of the small amount of energy required to actuate the rotating unit, the latter may be moved quite rapidly by the force of the biasing spring 22, although the tension of said spring is very small. In consequence thereof, the tripping of the trigger-lever to release the switch may be effected so easily that the thermostatic device may be extremely sensitive. The rapid movement of the drum to circuit-opening position causes quick separation of the polar elements, and the flow of the non-conductive liquid into the polar space suppresses all arcing between the poles. The liquid elements are pretected against changes of composition or volume which might result from exposure thereof to atmosphere, said liquids being substantially sealed within the drum by the clamping together of the drum-members.

Now, having described my invention, what I claim and desire to secure by Letters Patent is:

1. An electric switch comprising a rotatable axially horizontally cylindrical drum having a conductive peripheral portion, a contact-member inclosed by said drum and fixedly connected therewith and insulated therefrom, means for connecting terminals of an electric circuit with said contact-member and the conductive portion of the drum, a body of fluid metal disposed within the drum and tending by gravitation and inertia to remain constantly in the lowermost portion of the drum during rotation thereof, said fluid metal being an amalgam of mercury and solder, and means for rotating the drum to positions at which the contact-member is dipped into and withdrawn from the fluid metal to respectively close and open the electric circuit.

2. An electric switch comprising a rotatable axially horizontal cylindrical drum having a conductive peripheral portion a contact-member inclosed by said drum and fixedly connected therewith and insulated therefrom, means for connecting terminals of an electric circuit with said contact-member and the conductive portion of the drum, a body of fluid metal disposed within the drum and tending by gravitation and inertia to remain constantly in the lowermost portion of the drum during rotation thereof, means for rotating the drum to positions at which the contact-member is dipped into and withdrawn from the fluid metal to respectively close and open the electric circuit, means tending to move the drum to circuit-opening position, a trigger having a seat-portion movable adjacent to the drum, and a member on the drum engageable with said seat-portion of the trigger to retain the drum in circuit-closing position.

3. In an electric switch a body of fluid metal, a container in closing said fluid metal and shaped to enable said metal to remain substantially fixed in position during rotation of the container about a fixed axis, a portion of the container being of conductive material and forming a circuit-terminal constantly contacting with the fluid metal, a pole-member insulated from but fixedly secured to the container and arranged to dip into and be withdrawn from the fluid metal by rotational movement of the container about said fixed axis, means tending to rotate

the container in one direction, and a trigger device releasably connected with the drum for holding the same in a fixed position.

4. In an electric switch, a fluid-metal pole consisting of an amalgam of mercury and solder.

5. In an electric switch, a fluid-metal pole consisting of an amalgam of mercury with lead and tin.

6. In an electric switch, a pole comprising a fluid mixture of mercury and a metal not normally fluid.

7. In an electric switch, a pole comprising a conductive fluid formed by a combination of mercury with metal not normally fluid.

8. In an electric switch, a pole of fluid metal consisting of a combination of mercury amalgamated with metal of higher electric conductivity than mercury alone.

9. In an electric switch, a pole consisting of a fluid mixture of mercury and metal of greater electrical conductivity than mercury alone.

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