Sept. 4, 1928. 1,683,408

L. A. M. PHELAN ET AL

ELECTRICAL SWITCHING DEVICE

Original Filed June 17, 1922

Fig. 1.

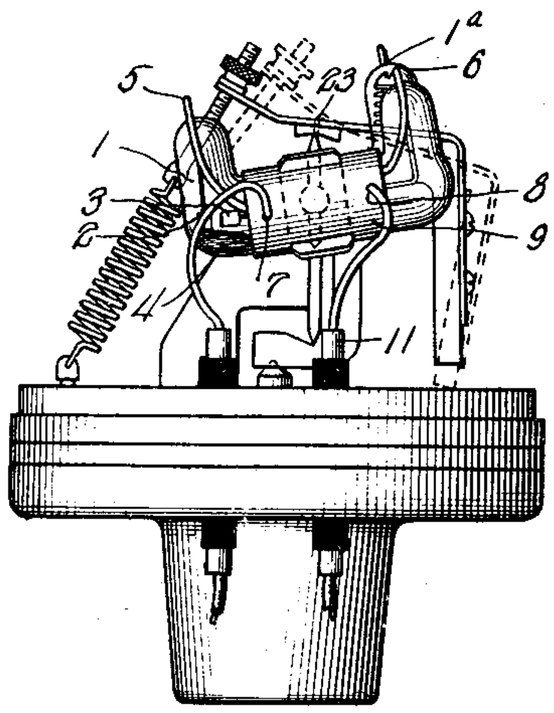


Fig. 2.

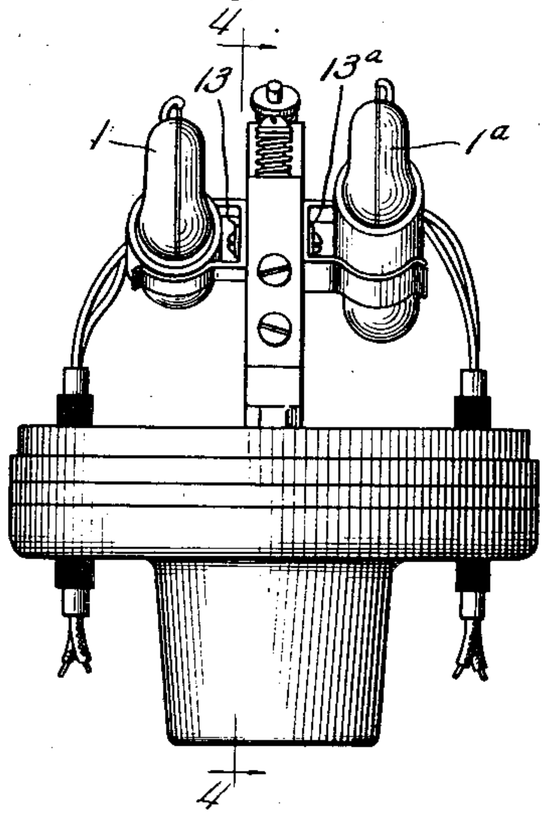


Fig. 3.

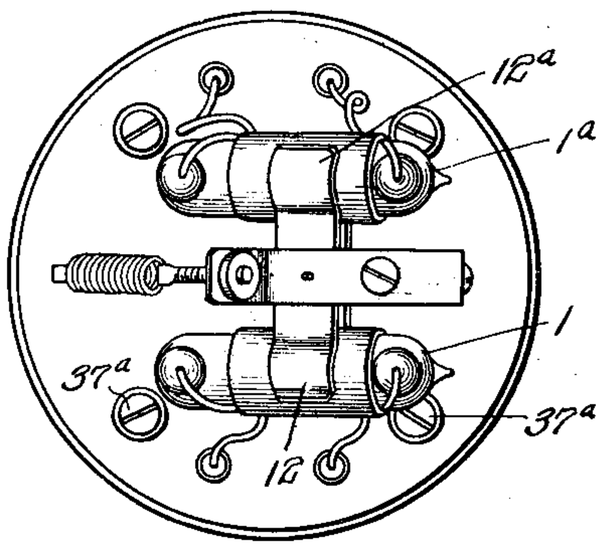


Fig. 4.

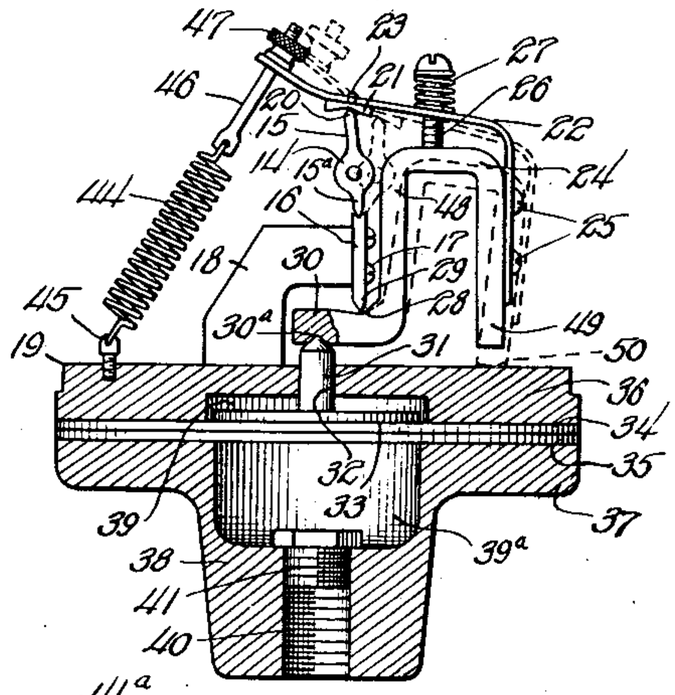
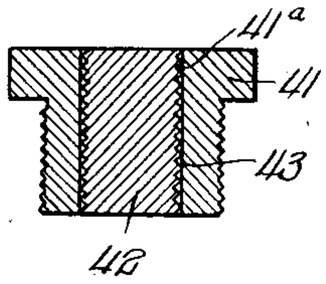


Fig. 5.



Witness:
W. A. Clark

Inventors
Louis A. M. Phelan & Clifford Hotchkiss
By Jones, Addington, Ames & Seibold
Attys.

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UNITED STATES PATENT OFFICE.

LOUIS A. M. PHELAN AND CLIFFORD HOTCHKISS, OF BELOIT, WISCONSIN.

ELECTRICAL SWITCHING DEVICE.

Original application filed June 17, 1922, Serial No. 604,162. Divided and this application filed March 5, 1925. Serial No. 13,039.

Our invention relates to electrical switching devices adapted particularly for the control of electrical circuits.

The subject matter of this invention pertains to a device making use of the general type of liquid electrical contactor tube which consists of a container in which are mounted spaced cooperating electrodes adapted to be bridged by a body of mercury, when the container is properly actuated or tilted from a position bordering on the horizontal.

Our present invention employs an electrical contactor of the above character associated with pressure actuated members, which are expanded or contracted by reason of a greater or lesser pressure effecting movement thereof, which movement constitutes the acting force for the said contactor.

The electrical contactor is designed to be mounted on a suitable supporting structure which is operatively connected with a pressure operated member that serves on expansion and contraction thereof to actuate the contactor tube or to tilt the contactor tube into and out of circuit closing position.

One object of our invention is to provide a switch of this type which can be conveniently adjusted to accommodate a wide range of pressures exerted upon a pressure responsive device and which, at the same time, will be very positive in its operation.

A further particular object of the invention is to provide a simple adjusting means for varying the necessary amount of effective pressure required to tilt the contactor back to normal position after it has once been actuated.

A further object of our invention is to provide a switch device of the type indicated, which will be simple and economical to construct and which will possess great durability, even when subjected to mechanical abuse and when used in connection with considerable quantities of electrical current at substantial voltages.

Further objects will appear upon reference to the following description and accompanying drawings, in which—

Figure 1 is a vertical elevational view of one modification of a device, embodying a form of our present invention, the cover being removed;

Fig. 2 is an elevational view taken at right angles to that shown in Fig. 1;

Fig. 3 is a top plan view of the device of Fig. 1;

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 2; and

Fig. 5 is a detail sectional view of the type of orifice used in connection with the diaphragm chamber of this device.

The specific structure of Figs. 1 through 5, in general, comprises a pair of liquid contactor tubes which are mounted on a suitable supporting and tilting mechanism which is operated by a pressure operated member in this instance a diaphragm. The contactor tubes 1 and 1ª may be of similar construction and may be both mounted in the same manner except as hereinafter pointed out and serve to make and break the two sides of an electrical circuit.

In the assembly of the device it is possible, if desired, to use two grades of contactor tubes; that is, one of a very carefully made type in which all of the arcing due to interruption of the current can take place while the other contactor tube may be of an inferior type and may be included in the circuit only for the purpose of opening and closing its side of its circuit as a safety precaution after the interruption has already taken place in the first tube. The aforesaid combination comprising two grades of contactor tubes forms no part of our present invention.

The contactor tube 1, only will be described since both tubes are similar in outward appearance. The tube 1 comprises a glass container enclosing suitable electrodes 2 and 3 which are adapted to be bridged by the body of conducting liquid, such as mercury 4. The electrodes 2 and 3 are adapted to be connected to an external electrical circuit by means of leads 5 and 6, respectively, which may extend through openings or slits 7 and 8, respectively, in a rubber band 9, surrounding the contactor tube 1. The leads 5 and 6 may be attached to the rigid insulated connection wires 10 and 11, respectively, which extend to the exterior of the casing. The contactor tubes 1 and 1ª are engaged by clamping members 12 and 12ª which are fixed by means of screws 13 and 13ª, respectively, threaded into an opening 14 at

the center of a tilting holder 15. The tilting holder 15 is provided with a knife edge 15ª at its lower end which engages a supporting fulcrum 16 which is attached by screws 17 to a supporting frame 18. The supporting frame 18 may be formed integral with or may be suitably fastened to a base member 19.

At the upper end of the tilting holder 15 a knife edge 20 is formed, which engages the V shaped slotted wear piece 21 which is, in turn, fixed to a yoke spring arm 22. The knife edge 20 is provided with an extension pin 23 extending up through the wear piece 21 and through the spring arm 22. This pin serves to always maintain the tilting holder 15 in engagement with the wear piece 21.

The spring arm 22 is one member of an actuator that comprises a yoke member or arm 24, the members 22 and 24 being connected by means of screws 25. The force exerted by the spring arm 22 upon the holder 15 and its position in reference to the tilting holder 15 and the yoke member 24 may be adjusted by means of a screw 26 passing through the spring arm 22 and into the yoke 24. The head of screw 26 bears upon the spring arm 22 through the medium of a compression spring 27 surrounding the upper end of the screw 26. The screw 26 and spring 27 serve to effect an adjustment between the arm 24 and the arm 22 independently of the adjustment effected by a spring 44 to be hereinafter described.

The yoke member 24 is provided adjacent one end with a V shaped groove 28 which is engaged by a knife edge 29 located at the lower end of the supporting fulcrum 16. An extension 30 on the yoke member 24 is provided with an indentation 30ª for receiving a push rod 31 which extends up through an opening 32 in the base 19 and from the pressure responsive device. The yoke member or arm 24 floats on the pressure responsive device comprising a double diaphragm 34 and 35, and is fulcrumed on the knife edge 29. The push rod 31 is provided with a large disc 33 at its lower end which rests upon and is actuated by the double rubber diaphragm 34 and 35. The diaphragms 34 and 35 constitute a pressure responsive element and by their contraction and expansion serve to raise or lower the push rod 31 that, in turn, tilts the actuator comprising the two members or arms 22 and 24.

Hereinbefore we referred to yoke member or arm 24 as floating upon the expansible and contractible devices 34 and 35 and by this qualification we mean that the arm 24 rests thereupon in mechanical contact but that it is not attached or secured thereto, in the embodiment shown in Fig. 4. The members 34 and 35 of the expansible and contractible diaphragm are maintained in proper position and under slight tension between a flange 36 formed on the base 19 and a flange 37 formed on a lower base member 38.

The base members 19 and 38 are provided with pressure chambers 39 and 39ª, respectively. The pressure may be admitted to the chamber 39ª through an opening 40 which is provided with a special type of orifice as shown in Fig. 5, or the pressure impressed upon the expansible and contractible members 34 and 35 may be developed in any other way known in the art.

In this type of pressure operated switch it is desirable that the mechanism operate in a positive manner but still be free from all irregular jerking movements. For this reason it is desirable that the pressure within the chamber 39ª should be free from all irregular pulsations. The device shown in Fig. 5 serves to accomplish this end and consists of a bushing 41, having a smooth central bore 41ª. A plug 42 having a threaded cylindrical surface 43 is tightly fitted into the bore 41ª and the spiral groove along its exterior surface formed by the thread 43 serves as an opening or orifice to the chamber 39ª. The friction of the fluid against the long spiral walls of the groove or thread 43 is sufficient to preclude the development of jerking pressure changes within the chamber 39ª.

The coiled spring 44 is attached by a screw peg 45 to the base member 19 and by a screw rod 46 having a thumb screw 47 to the spring 22. The spring 44 in the position shown tends to oppose movement of the yoke arm 24 by the push rod 31 and the expansible and contractible diaphragms 34 and 35. The spring 44 is provided with the adjustable thumb nut 47 in order that the spring 44 may bias the action of the actuator thereby permitting adjustment of the range of pressures within which the responsive diaphragms 34 and 35 actuate the device to tilt the contactor.

The yoke member or arm 24 is limited in its movement by an arm 48 which will engage the heads of the screws 17 when the yoke is in normal position and also by an end 49 of the yoke which may hit against the base 19 at 50 when the yoke is tilted.

As above stated, the contactor tubes 1 and 1ª may be of two different types, one of which is constructed to withstand arcing which may occur when heavy currents are interrupted. The other tube may be so mounted upon the tilting holder 15 that it will serve only to open and close one side of the electrical circuit at such times as the circuit is opened at the first contactor tube. For this reason the contactor 1ª may be mounted at an angle to the horizontal that is slightly greater than the angle at which the contactor 1 is mounted—as indicated in Figs. 1 and 2 so that the contactor tube will

be the last to close the circuit and the first to open the circuit. By the use of this expedient it is necessary to accurately construct and adjust only one of the contactor tubes.

The operation will now be outlined. The outlet 40 may be connected to the pressure chamber, the pressure of which is to be regulated. The expansible and contractible diaphragms 34 and 35 will then expand or contract in accordance with the pressure impressed upon them. Assuming that the pressure is of the desired amount and that the electrical switch is in proper adjustment, by manipulation of the spring 44 and the independently adjustable means comprising the screw 26 and the spring 27, the contactor tubes will then be tilted to the open circuit position (indicated by the dotted lines in Fig. 1). When the pressure upon the diaphragms 34 and 35 becomes reduced they will contract, thereby permitting the push rod 31 to fall. The coiled spring 44 will now tend to tilt the yoke or arm 24 and the attached parts to the position shown in Fig. 4 and after the tilting post 15 has reached a substantial vertical position the parts will move into the position shown. The circuit will now be connected, first, at the contactor tube 1^a and then completed through the contactor tube 1. Any pressure that expands the diaphragms 34 and 35 will force the push rod 31 in an upward direction and against the force of the adjustable spring 44. When the said expansion has become sufficiently great the force of the spring 44 will be overcome and the tilting post 15 will move out of its biased position as shown in Fig. 4 and tilted into an opposite biased position as indicated by the dotted lines. During this last movement, the spring arm 22 will be under slightly less tension than when it is in the normal position.

In order to adjust the device to control the electrical circuit for a predetermined expansion or contraction of the diaphragms 34 and 35 the thumb nut 47 is turned until the spring 44 is under proper tension to just counteract the force of this pressure on the expansible and contractible diaphragms 34 and 35. In order to adjust the device to open the circuit after predetermined change in pressure has occurred, the screw 26 is turned in order to vary the pressure of the yoke spring 22 on the tilting post 15.

If it is desired that the device should operate only after a great change of pressure has occurred, the screw 26 is turned inward. If it is desired to adjust the device to operate upon a small change pressure the screw 26 is turned downward.

From the above it will be obvious that two independent adjustments are provided—namely, one by reason of the spring 44 and the other by reason of the spring 27 and the screw 26 or, in other words, one for adjusting the range of the operation of the pressure switch and the other for adjusting the necessary pressure change after which it is desired that the switch should turn to open circuit position.

In this structure, as shown, it will be noted that knife edge bearings are used throughout. This is for the purpose of avoiding the varying frictional losses which are encountered by the use of the more common types of round bearings. A further advantage of the knife edge bearings in this particular structure resides in the fact that the various elements can be much more cheaply constructed and assembled when made with this form of bearings.

While we have shown and described several embodiments of our invention, it is to be understood that many modifications may be made therein without departing from the spirit and scope of the appended claims and we desire that only such limitations shall be imposed upon our invention as are specifically pointed out in the claims and such as are required by the prior art.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent in the United States, is:

1. A pressure operated switch comprising a tilting member, a mercury tube contactor mounted on said tilting member, supporting means for one end of said tilting member, and a pressure responsive actuator having two arms supported by and bearing respectively on the other end of said tilting member and on said supporting means.

2. A pressure operated switch comprising a tilting member, a mercury tube contactor mounted on said tilting member, supporting means for one end of said tilting member, a pressure actuated yoke having two arms supported by and bearing respectively on the other end of said tilting member and on said supporting means, and spring means for controlling the actuation of said yoke.

3. A pressure operated switch comprising a tilting member, a mercury tube contactor mounted on said tilting member, supporting means furnishing a knife-edge bearing for one end of said tilting member, and a pressure actuated yoke comprising two arms having knife-edge bearings respectively at the other end of said tilting member and at said supporting means.

4. An electric switch comprising an enclosed mercury contactor switch, means for tilting said contactor switch, said means comprising a tiltable actuator embodying two substantial coextensive and simultaneously movable arms which are adjustable relatively to each other, adjustable spring means for said actuator connected to one of said

arms to predetermine the point of response of said actuator, and a knife-edge bearing for said actuator.

5. An electric switch comprising a mercury contactor tube, means for tilting said contactor tube to open and close a circuit, said means comprising a tiltable actuator embodying two simultaneously movable portions, said portions being connected together toward one end thereof and having adjusting means associated therewith away from their connection point, and a knife-edge bearing for said actuator.

6. An electric switch comprising a mercury contactor tube, means for tilting said contactor to open and close a circuit, said means comprising a tiltable actuator embodying two simultaneously movable portions which are connected together adjacent to one of their ends and which are adjustable relative to each other, independently adjustable spring means attached to one of said portions to bias said actuator and to predetermine the point of response of said actuator, and a knife-edge support for said actuator.

7. An electric switch comprising a mercury contactor tube, means for tilting said contactor tube, said means comprising a tiltable actuator embodying two simultaneously movable portions which are connected together at one end, adjustable spring means attached to one of said portions to predetermine the point of response of said actuator, and independently adjustable means associated with both of said portions, said last named means being arranged between said portions.

8. An electric switch comprising a mercury contactor tube, means for tilting said contactor tube to open and close a circuit, said means comprising a tiltable actuator embodying two portions connected to move simultaneously together, one of said portions being tiltable about a knife-edge and the other portion being adjustably attached to said first portion, and independently adjustable means to effect a predetermination of the time of response of said tiltable actuator.

9. An electric switch comprising a mercury contactor tube, means for tilting said contactor tube to and from open or closed circuit position, said means comprising a tiltable actuator embodying two substantially coextensive portions that are connected together and one of said portions being movable about a knife edge, adjusting means for predetermining the point of response of said tiltable actuator comprising a spring the tension of which may be varied, said spring being attached to one end of one of said two portions, other adjustable means for said two portions, and a contactor tube support associated with said tiltable actuator and operated thereby, said tube support being movably mounted and being adapted to be moved by said tiltable actuator.

10. An electric switch comprising a mercury contactor tube, a tiltable holder therefor, an actuator embodying two simultaneously movable portions that are connected together, adjustable spring means attached to one of said two portions to predetermine the point of response of said actuator, and independently adjustable spring means associated with both of said portions, said last named means comprising a threaded member passing through one of said portions and so associated with the other portion that movement thereof effects a relative adjustment between said two portions whereby said independent adjustment is eventuated.

11. An electric switch comprising a mercury tube contactor, means for tilting said contactor, said means comprising a tiltable actuator embodying two simultaneously movable portions which are connected together, adjustable spring means attached to one of said portions to predetermine the point of response of said tiltable actuator, and independently adjustable spring means associated with both of said portions, said last named means comprising a threaded member passing through one of said portions and so associated with the other portion that movement thereof effects a relative adjustment between said two portions whereby an indenendent adjustment is eventuated, and said threaded member having a head thereon, a spring being positioned between said head and one of said portions.

12. An electric switch comprising a mercury tube contactor to open and close a circuit, a tiltable support for the contactor, an actuator therefor comprising two simultaneously movable arms, an expansible and contractible element bearing against one of said arms, a knife-edge support for said arm about which the actuator is moved by said element, the other arm being secured to said first arm in adjustable relation thereto, and an adjustable spring means fastened to one end of one of said arms whereby resistance of the actuator to movement about said knife-edge support may be varied.

13. An electric switch comprising a mercury tube contactor, actuating means for tilting said contactor to open and close a circuit therethrough, said actuating means comprising two arms, a knife-edge support, one of said arms being movable about said knife-edge support and the other arm being secured to said first arm and adjustable relative to said first arm, and means comprising a threaded member associated with said arms for effecting said relative adjustment between said arms.

14. An electric switch comprising a mercury contactor tube for controlling an electric circuit, an actuator comprising two si-

multaneously movable and relatively adjustable portions for said contactor tube, pressure responsive means for controlling said actuator, a knife-edge support for said actuator, adjustable means connected to one of said two portions for predetermining the pressure at which said actuator will operate said contactor tube, and other adjustable means between said two portions for controlling the operation of said contactor tube when the said predetermined pressure is changed by a predetermined amount.

In witness whereof, we have hereunto subscribed our names.

LOUIS A. M. PHELAN.
CLIFFORD HOTCHKISS.