Aug. 20, 1946. C. E. POLLARD, JR 2,406,036

SEALED CONTACT DEVICE

Filed May 22, 1943 2 Sheets-Sheet 1

FIG. 1

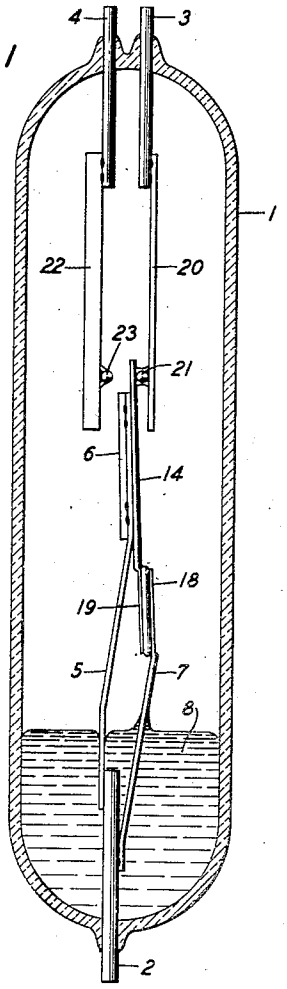


FIG. 2

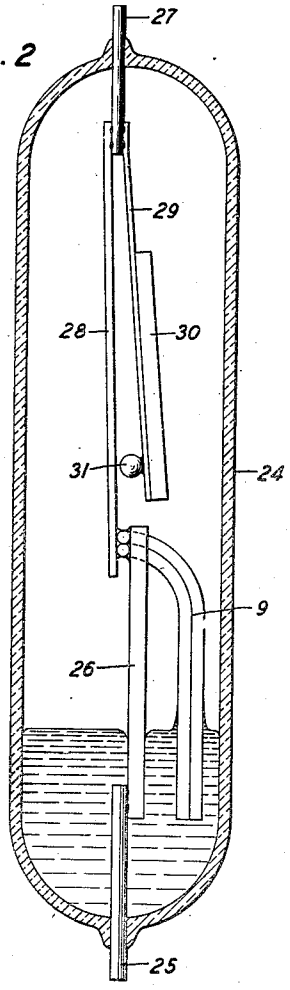


FIG. 3

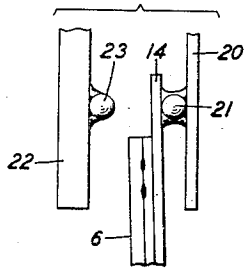


FIG. 4

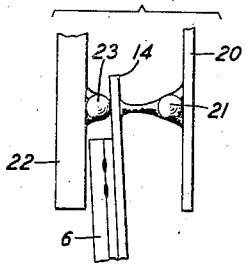
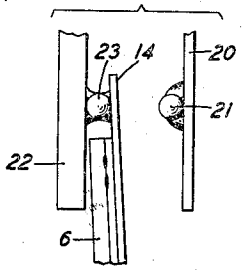


FIG. 5



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FIG. 6

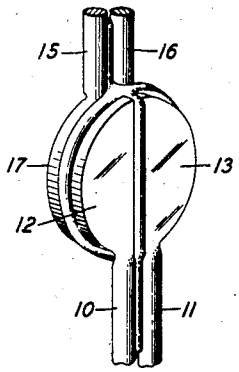


FIG. 7

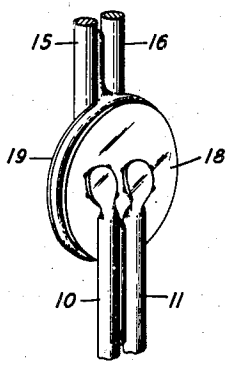


FIG. 8

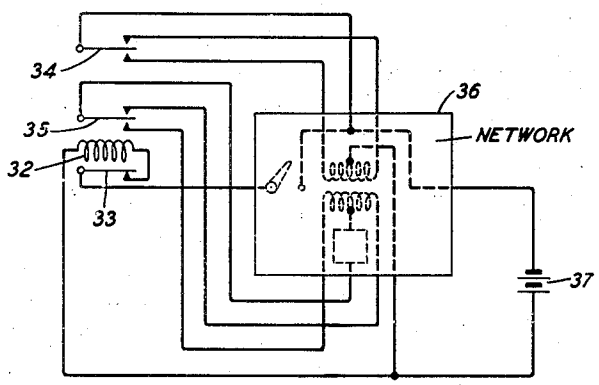
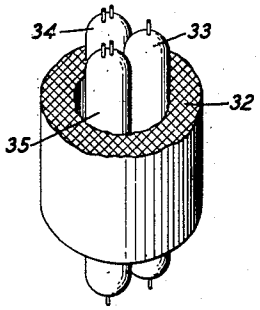


FIG. 9



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UNITED STATES PATENT OFFICE

2,406,036

SEALED CONTACT DEVICE

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Application May 22, 1943, Serial No. 487,999

7 Claims. (Cl. 200—112)

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This invention relates to electrical switching devices, and particularly to sealed contact units which in cooperation with actuating coils are used as relays.

The object of the invention is to provide means to damp the vibration of a moving armature and its support in such a manner that undesirable distortional vibration is suppressed without interference with the regular operation thereof.

In accordance with this invention the contact making and breaking device consists generally of an armature carrying a contact movable between a front and a back contact. The contact carried by the armature is in the form of a wick which is always supplied with liquid mercury drawn by capillary action from a reservoir of mercury. The contacts are, therefore, continuously replaceable.

An important feature of the device is a slip-joint in the wick. This gives a mechanical break and prevents interference with the stiffness of the armature. At the same time, since the joint is easily bridged by the capillary action of the mercury, it provides a continuous path for flow of mercury from the reservoir to the contact.

This joint is located near a point of minimum motion for normal operation but of considerable motion caused by certain undesired distortion. For a simple cantilever beam at small deflection, the motion of the tip appears to be in the line of a circle about a point one-third of the beam length from the support. The cantilever armature of the present invention, however, is not uniform and this apparent center is nearer the support. Therefore, the location of the slip-joint for minimum motion would be somewhat nearer the support than one-third of the beam length.

At high frequencies the armature tends to set up a harmonic mode as follows. On release, the armature tip strikes the back contact and the middle of the armature bows out beyond its static released position. This bow-out and the recovery therefrom are the action of a cantilever beam with tip support. But after recovery to the static released position the tip support is lost, and the kinetic energy of the recovery lifts the whole armature, now as a simple cantilever, off the back contact. This produces a bounce, or undesired break in the back contact circuit. At certain driving frequencies this harmonic mode becomes quite pronounced.

To avoid this bounce, the slip-joint in the wick is expanded into two discs, with their surfaces parallel to each other but perpendicular to the motion of the armature The harmonic vibration mentioned above changes the spacing between the discs, and this by a pumping action on the mercury filling the space gives hydraulic damping of the harmonic vibration. The discs are located at a compromise position to give high damping of the harmonic vibration and low damping of the fundamental operation.

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Other features will appear hereinafter.

The drawings consist of two sheets having nine figures as follows:

Fig. 1 is a section of a switch embodying the present invention;

Fig. 2 is a section of another type of switch useful in explaining the theory of operation;

Figs. 3, 4 and 5 are fragmentary and detailed views showing three stages in the operation of the contacts of the switch of Fig. 1;

Fig. 6 is a fragmentary view in perspective of the hydraulic brake shown in Fig. 1;

Fig. 7 is a similar view of an alternative construction of the same;

Fig. 8 is a schematic circuit diagram showing how the switches of Figs. 1 and 2 might be employed; and

Fig. 9 is a perspective view showing how one switch according to Fig. 2 and two switches according to Fig. 1 might be arranged under the influence of a single coil as in the circuit of Fig. 7.

The switch of Fig. 1 is built up on a body 1 or envelope of glass into the lower end of which is sealed a terminal 2 in the form of a tube for tubulation purposes. This terminal may be a nickel iron alloy having almost exactly the same temperature coefficient of expansion as the glass body 1 and which is well adapted to making an air-tight seal with the said body. Similar terminals 3 and 4 of solid material are sealed in the upper end of the body 1.

The lower terminal has a spring 5 welded thereto which supports an armature 6 of magnetic material. There is also a wick 7 consisting of a pair of wires of a copper nickel alloy attached to the terminal 2 which serve to draw mercury from the reservoir 8 upwardly. The construction of this wick may be partly visualized from the wick 9 of Fig. 2 and from the detailed drawing of Figs. 6 and 7. In Fig. 6 it will be seen that the wick consists of two wires 10 and 11 which terminate in flattened portions 12 and 13 respectively.

Another wick 14 attached to the upper end of the armature 6 consists of two wires 15 and 16 which extend downwardly and similarly terminate in flattened portions of which the portion 17

is partly shown. These flattened portions are spaced only a small distance apart and like the wire portions of the wick provide a path for the upward movement of the mercury from the reservoir 8.

Fig. 7 shows an alternative construction in which the hydraulic brake consists of two thin wafers 18 and 19 to which the wires 10 and 11 and the wires 15 and 16 respectively are welded. These wafers are like the wires of the wick made of material which is easily wetted with mercury so that the stream of mercury will be continuously maintained from the reservoir below between the wires 10 and 11, between the wafers 18 and 19, between the wires 15 and 16 and about the contacts with which the upper end of the wick 14 comes in contact.

Attached to the terminal 3 is a contact member 20 having little or no magnetic properties, and attached to the lower end thereof is a copper nickel contact piece 21 which has the same attraction for mercury as the wick so that it remains continuously wet with mercury through its normal contact with the upper end of the wick 14.

Attached to the terminal 4 is a magnetic pole-piece 22 having a copper nickel contact 23 similar to the contact 21.

As shown in Fig. 1, there is an air gap between the armature 6 and the pole-piece 22 so that when this device is energized by a surrounding coil the armature 6 will move toward the left and the wick 14 will move away from the contact 21 and into connection with the contact 23. This provides an ordinary transfer operation.

However, as illustrated in Figs. 3, 4 and 5 this may be made into a make-before-break transfer device. Given proper spacing between the opposite contacts 21 and 23 and proper speed of movement of the wick 14 the mercury from the contact 21 will be drawn out into a thread, as shown in Fig. 4, which will not break until contact is made between the wick 14 and the contact 23. It has been found that with proper design where the armature 6 is vibrated at a given rate the contact between the wick 14 and the contacts 21 and 23 may be closed in each case more than fifty per cent of the time.

It will be noted that the wick consisting of the portions 7 and 14 is provided with a slip-joint, shown in some detail in Fig. 6. This is placed at a point in the length of the wick where it will become effective as a hydraulic brake for certain movements of the armature assembly. For ordinary movement of the armature this plays no part, but for unwanted movement such as certain flexures of the armature caused by the impact of the wick 14 against the contacts 21 and 23, the faces of the flattened portions tend to move toward and away from each other whereupon the mercury held between these faces acts as a restraining means and damps the vibrations which would otherwise occur and thus prevents contact chatter.

The switch of Fig. 2 is a single circuit normally closed contact device built on a glass body or envelope 24 having a terminal 25 sealed in the bottom end thereof. To this terminal there is welded a pole-piece 26 which acts as a support for the wick 9, which draws mercury from the reservoir to the contact position. A terminal 27 sealed in the opposite end of the body 24 forms a support for the spring 28 which normally makes contact with the end of the wick 9 and provides a closed path from terminal 25 to

terminal 27. There is also a spring 29 welded to the terminal 27 which supports an armature 30 and this has a bumper 31 secured thereto. When the device is energized by current passing through a surrounding coil the air gap between the pole-piece 26 and the armature 30 is shortened and through the movement of the armature 30 the bumper 31 is made to strike the spring 28 whereby a quick break of the connection between the spring 28 and the wick 9 is produced.

This device may be used as an interrupter and may be employed to break the circuit of its energizing coil. One application of these devices is illustrated in Figs. 8 and 9. A single coil 32 is used as a means to energize one switch 33 according to Fig. 2 and two switches 34 and 35 according to Fig. 1. When a switch in the network 36 is closed, current from the battery 37 will flow in series through the switch 33 and the coil 32 and produce a vibrating action which is controlled by the properties of the spring 28. The consequent interrupted energization of the coil 32 will cause the simultaneous energization of the switches 34 and 35. One of these switches 34 may cause the alternate application of the battery to the two sides of a midtap primary transformer winding and the other may cause the simultaneous alternate application of a load circuit to the corresponding two sides of a midtap secondary transformer winding for the familiar purpose of current transformation and control in portable radio sets.

What is claimed is:

1. An electrical switching device comprising an armature, a set of wetted mercury contacts operated thereby, and a wetted mercury brake for controlling the movement of said armature.

2. An electrical switching device comprising an armature, a set of wetted mercury contacts operated thereby, a wick for maintaining said contacts wetted with mercury, and a mercury wetted hydraulic brake for controlling the movement of said armature.

3. An electrical switching device comprising an armature, a set of wetted mercury contacts operated thereby, a reservoir of mercury, a wick to conduct mercury from said reservoir to said contacts, and a slip-joint in said wick for damping the vibration of said armature.

4. An electrical switching device comprising an armature, a set of wetted mercury contacts operated thereby, a reservoir of mercury, a wick to conduct mercury from said reservoir to said contacts, and a slip-joint in said wick whereby one portion of said wick moves with said armature and another portion of said wick remains stationary, said slip-joint functioning to maintain a thread of mercury intact between said reservoir and said contacts during the relative movement of said portions of said wick, said slip-joint being constructed and arranged to produce maximum movement between the faces thereof responsive to undesirable movements of said armature.

5. An electrical switching device comprising a reed, an armature mounted thereon, a set of wetted mercury contacts operated thereby, a reservoir of mercury, a wick to conduct mercury from said reservoir to said contacts, said wick comprising one portion attached to said armature and terminating in a flat surface and another portion held stationary in said reservoir of mercury and terminating in a like-shaped flat portion, said flat portions being placed substantially parallel to each other and at a distance from each other to

allow capillary maintenance of mercury therebetween.

6. An electrical switching device comprising an armature, a set of contacts operated thereby, means for maintaining a replaceable contact surface on said contacts comprising a reservoir of mercury and a wick between said contacts and said reservoir, said wick having a slip-joint intermediate its ends whereby the said armature is relieved of mechanical restraint from said wick.

7. An electrical switching device comprising an

armature, a set of wetted mercury contacts operated thereby, a reservoir of mercury, a wick to conduct mercury from said reservoir to said contacts and a slip-joint in said wick for performing the dual purpose of relieving said armature of mechanical restraint due to said wick under normal operation and for providing means for damping unstandard vibration of said armature.

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