

Dec. 10, 1935.

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2,023,748

ELECTRICAL RESISTANCE APPARATUS

Filed May 16, 1934

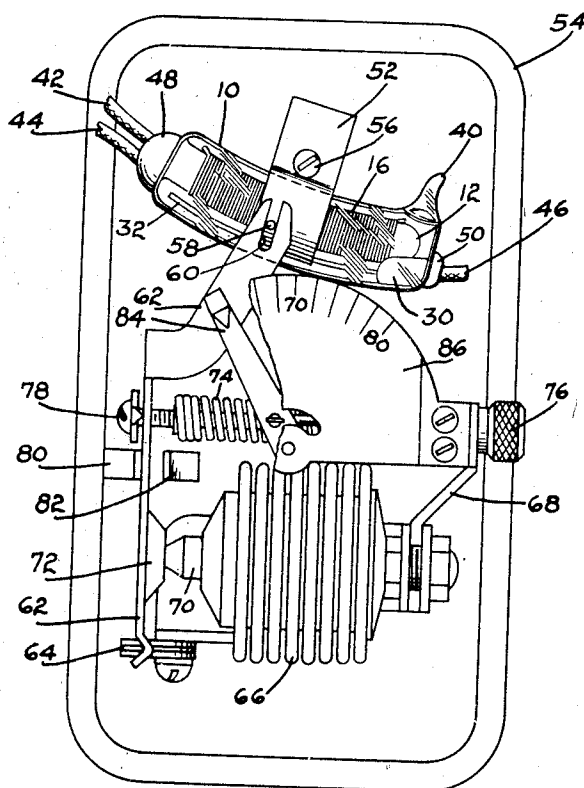
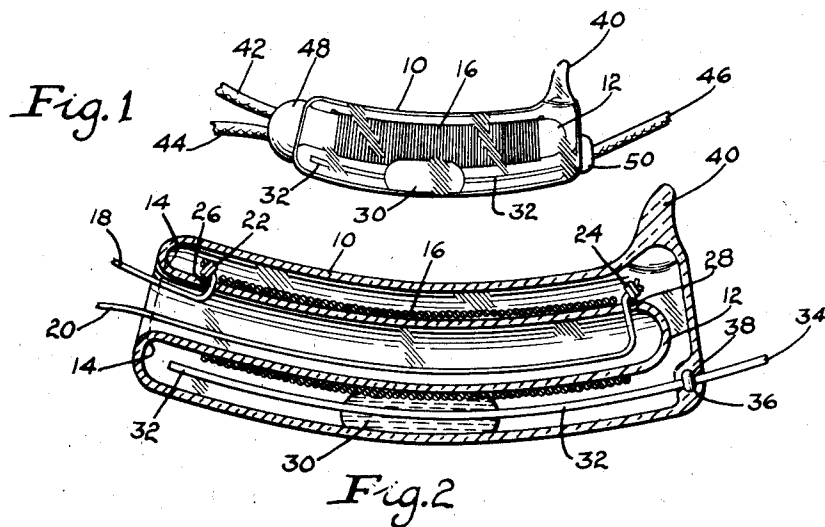


Fig. 3

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UNITED STATES PATENT OFFICE

2,023,748

ELECTRICAL RESISTANCE APPARATUS

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Application May 16, 1934, Serial No. 725,971

3 Claims. (Cl. 201—55)

This invention relates in general to electrical resistance apparatus adapted to vary the resistance in an electrical circuit. Common forms of such apparatus are potentiometers and rheostats.

Electrical apparatus of this type usually have an electrical resistance element over which a movable contact mechanically frictionally slides to vary the resistance between one or both ends of the resistance element and the movable contact.

In such devices, there is considerable electrical resistance between the movable contact and the resistance element which is known as "contact resistance". This contact resistance is different for different positions of the movable contact. It also changes from time to time for the same position because dust and other foreign particles get under the contact and also because the contact and resistance element tend to corrode with age. There is also a tendency for the movable contact and resistance element to burn and pit because of a poor contact and thus further increase the contact resistance. This contact resistance is very detrimental to the life and accuracy of such apparatus.

When such devices are operated manually or where a large amount of power is available for operating them, a heavy contact pressure may be used and, as a result, the contact resistance does not seriously affect their accuracy or usefulness. However, when they are operated automatically by thermostats and other such devices which produce a very small amount of power, they are not satisfactory. If a heavy contact pressure is used to overcome the detrimental contact resistance then they do not readily respond to the automatic means and are therefore unsatisfactory. If a light contact pressure is used to make them readily respond to the automatic means the contact resistance becomes quite large and seriously interferes with the accuracy and usefulness of the device. This light contact pressure makes it easy for dust and other foreign particles to get under the contact and cause burning and pitting of both the contact and element which additionally increases the contact resistance.

One of the objects of this invention is to provide an improved variable electrical resistance apparatus which can be successfully operated automatically with a minimum of power.

Another object of this invention is to provide a potentiometer or rheostat type of device which has a low contact resistance that does not change with use or age.

Another object of this invention is to produce a potentiometer or rheostat type of device which

has the movable mechanical contact replaced with a body of conducting fluid.

Another object of this invention is to provide a potentiometer or rheostat type of device which is not affected by dust and other foreign matter in the air and which will not corrode or oxidize.

Another object of this invention is to provide a potentiometer or rheostat type of device which has the resistance element and movable contact hermetically sealed.

Another object of this invention is to provide a potentiometer or rheostat of the fluid contact type wherein the liquid can be made to assume any desired position with respect to the resistance element with a minimum of effort.

Other objects and advantages reside in certain novel features of the construction, arrangement, and combination of the parts which will be hereinafter more fully described and particularly pointed out in the appended claims, reference being had to the accompanying drawing forming a part of this specification, and in which:

Fig. 1 is a side elevation of a form of fluid contact type of device having circuit-connections adapting it for use as a potentiometer or rheostat.

Fig. 2 is an enlarged vertical section of the device shown in Fig. 1, but having the flexible leads and insulating compound omitted.

Fig. 3 shows a thermostatic actuating mechanism operating the device shown in Fig. 1.

In the drawing there has been disclosed a preferred form of the invention for the purpose of explanation and description. In the specific form shown, the container or envelope 10 is made of soft glass but may be made of various other materials well-known in the mercury switch art. The envelope 10 has an elongated member projecting therein. This projection is here shown as a tube 12 which is preferably of soft glass and integral with the envelope. The envelope 10 and the tube 12 are made up separately and may then be fused together at 14 but it is not essential that they be fused together for other means of supporting the tube 12 inside the envelope 10 may be employed.

An elongated resistance element 16 is supported on the inwardly projecting member such as the tube 12. The resistance element 16 is shown in the drawing as a coil of wire wound on the outer face of the tube 12 and therefore within the envelope 10. This wire may be commercial "Chromel C" resistance wire which is an alloy resistance wire composed of iron, chromium and nickel. However, any resistance material which will not deteriorate in the presence

of mercury will be satisfactory. The resistance element 16 has "Dumet" leading-in wires 18 and 20 attached to its ends at 22 and 24. The "Dumet" leading-in wires 18 and 20 are sealed through the glass tube 12 at 26 and 28 in accordance with the well-known practice in the mercury switch art. "Dumet" is known in the art to be copper clad invar electro-welded together. It is not necessary that the resistance element 16 be wound on the tube 12 since it is only necessary that it be properly supported within the envelope 10 preferably parallel with the lower wall thereof. When the device is used as a rheostat it is obviously not necessary to have both leading-in wires 18 and 20. In such case either one may be omitted or not connected in any circuit. But, when used as a potentiometer both leading-in wires are essential.

A movable body of conducting fluid 30 herein shown as mercury is in the envelope 10 and in engagement with the resistance element 16. This fluid makes a good electrical contact with the resistance element and therefore gives a very low contact resistance. The mercury 30 is arranged to move from one end of the envelope 10 to the other end and in doing so to engage various points on or portions of the resistance element 16.

The external circuit for the mercury may be provided by the lower wall of the envelope when it is made of conducting material but, where as here shown, the envelope is of glass means must be provided to cause the mercury to complete an electrical circuit between the resistance element 16 and an external circuit connection. Therefore, in this preferred form, an electrode 32 is provided which is in engagement with the mercury 30 and which may be made of the various electrode materials used in the mercury switch art but is herein shown as being made of commercial "Chromel C" resistance wire. The electrode 32 is of sufficient cross sectional area to prevent the resistance per unit length from materially affecting the operation of the device. A "Dumet" leading-in wire 34 is welded to the electrode 32 at 36 and is also sealed through the wall of the envelope 10 at 38. This method of assembling electrodes and leading-in wires and sealing them through an envelope wall is well-known in the mercury switch art.

After the above elements are assembled, the envelope 10 may be exhausted of air and then sealed off at 40, or the envelope may be refilled with hydrogen or some other arc-suppressing gas before it is sealed off. This prevents dust and other foreign matter from interfering with the contact and also prevent corrosion and oxidation of the contact elements. The "Dumet" leading-in wires 18, 20, and 34 are equipped with insulated flexible circuit connecting wires 42, 44, and 46 respectively. The connections between the leading-in wires 18 and 20 and the flexible wires 42 and 44 are covered with an insulating cement 48 which closely adheres to the envelope 10 as disclosed in Phelan et al. Patent No. 1,826,570 granted October 6th, 1931. The connection between the leading-in wire 34 and the flexible wire 46 is also covered with a similar cement or compound 50.

The envelope 10, tube 12, and electrode 32 are all slightly curved for the purpose of providing a curved passageway or runway for the body of mercury 30 over the floor of the envelope 10 thereby causing the body of mercury 30 to

assume a definite position for each position of the envelope 10. If the envelope 10 were straight, then the mercury 30 would only have two stable positions and these would be at the ends of the envelope 10, for if the envelope 10 were tilted sufficiently to cause the mercury 30 to move at all, it would move the full length of the envelope 10. The curvature of the envelope 10 is just sufficient to cause the mercury 30 to have a stable or definite position for each position of the envelope 10. By slightly tilting the envelope 10, the body of mercury 30 will move accordingly and thus change the point at which the electrode 32 is connected to the resistance element 16. The resistance between wires 18 and 20 is fixed by the amount of resistance in the resistance element 16 and remains constant, but the resistance between either of the wires 18 or 20 and the wire 34 is determined by the position of the body of mercury 30. With the mercury 30 in the position shown in Figs. 1 and 2, the resistance between the wires 18 and 34 is about equal to the resistance between the wires 20 and 34. But with the mercury 30 in the position shown in Fig. 3, the resistance between the wires 18 and 34 is relatively large and the resistance between the wires 20 and 34 is relatively small which is a phenomenon characteristic of a potentiometer.

In Fig. 3 there is shown an automatically operating mechanism for tilting the envelope 10. In the form here shown this mechanism automatically responds to a physical condition, such as temperature. The envelope 10 is secured in a clip 52 which is pivoted to a base 54 by a stud 56. The clip 52 is equipped with a pin 58 which cooperates with a slot 60 in the upper end of an operating lever 62. The lower end of the lever 62 is formed to cooperate with a pivot 64 which is secured to the base 54. A volatile fluid temperature-sensitive bellows 66 is secured at one end to a bracket 68 which is fixed to the base 54. The other end of the bellows 66 is equipped with a pin 70 which cooperates with a socket 72 on the operating lever 62. The lever 62 is also acted upon by a tension spring 74 one end of which is attached to the base 54 through an adjustable or temperature setting stud 76 and the other end is attached to the bracket 62 by a stud 78. On the base 54 there are two stops 80 and 82 to limit the travel of the upper end of the bracket 62. The spring 74 tends to hold the lever 62 against the stop 82 but the bellows 66 which expands on a temperature rise tends to force the lever 62 against the stop 80. The tension of the spring 74 which may be varied by the adjusting stud 76 determines the temperature at which the pressure in the bellows 66 will just balance the tension of the spring 74 and cause the lever 62 to assume a position half-way between the stops 80 and 82. When the lever 62 is in this mid-position, the envelope 10 will be in the horizontal position as shown in Figs. 1 and 2. If the temperature should increase the bellows 66 will move the lever 62 towards the stop 80 which will in turn move the left end of the envelope 10 up and cause the mercury 30 to move towards the right end of the envelope 10 as shown in Fig. 3. If the temperature should decrease, the pressure in the bellows 66 will decrease and the spring 74 will move the lever 62 towards the stop 82 which will in turn move the right end of the envelope 10 up and cause the mercury 30 to move toward the left end of the envelope 10. The adjusting stud 76 which varies the tension of the spring 74 also moves the pointer 84 over the graduated

dial 88 which permits the mechanism to be set for any desired temperature.

The curvature of the envelope 10 causes the mercury 30 to assume a definite position for each position of the operating lever 62 and thus make contact with a particular part or section of the resistance element 16 to place a definite amount of resistance in the circuit. This curvature of the envelope 10 being such that when the envelope is tilted to a new position, the mercury 30 will not move beyond the position corresponding to the new position of the envelope 10.

A potentiometer or rheostat of this construction only requires a very small amount of power to change the position of the body of conducting fluid and thus change the resistance in the circuit. The electrical resistance between the fluid and the resistance element which is known as contact resistance is very low because the fluid makes a good contact with the element. Also, this contact resistance remains constant for the elements are hermetically sealed and prevent dust and other foreign matter from interfering with the contact. Since the elements are hermetically sealed they do not corrode or oxidize with use or age.

Although the device here shown and described is in the form of a potentiometer, it will be apparent that it can be used as a rheostat by only using wires 42 and 46 or wires 44 and 46. In this case one or the other of the leading-in wires 18 and 20 may be omitted.

The envelope 10 may be made of metal and the resistance element 16 insulated therefrom, in which case the electrode 32 can be dispensed with and the wire 46 attached to the envelope 10.

While but a single embodiment of the invention is herein shown and described, it is to be understood that various modifications thereof will be apparent to those skilled in the art without departing from the spirit and scope of the invention set forth in the following claims.

Having thus described my invention, what I claim as new and desire to secure by United States Letters Patent is:

1. A device of the class described comprising in combination, a sealed envelope having a projection on the inside thereof extending longitudinally from one end toward the other in parallel relation to the lower wall of the envelope, a resistance element mounted on the projection, an electrode extending along the lower wall of the envelope, electrical connections for said resistance element and said electrode and a body of conducting fluid in the envelope arranged to make contact between the electrode and various portions of the resistance element as the envelope is tilted.

2. A device of the class described comprising in combination, a hermetically sealed elongated curved envelope having a reentrant integral curved tube extending from one end of the envelope longitudinally toward the other end thereof, a resistance wire wound on the tube and having external connections one of which is sealed through the tube near the closed end thereof, an electrode entering the envelope and extending along the floor thereof, a body of conducting fluid in the envelope arranged to make contact between the electrode and various parts of the resistance wire, and means for varying the relative position of the fluid and the wire whereby the resistance between the electrode and the external connections is varied.

3. A device of the class described comprising in combination, a hermetically sealed elongated envelope having a reentrant integral tube extending from one end of the envelope longitudinally toward the other end thereof, a resistance wire wound on the tube and having external connections, an electrode entering the envelope and extending along the floor thereof, a body of conducting fluid in the envelope arranged to make contact between the electrode and various parts of the resistance wire, and means for varying the relative position of the fluid and the wire whereby the resistance between the electrode and the external connections is varied.

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