

Sept. 23, 1941.

G. T. McDONALD

2,256,833

CONTROL DEVICE

Filed April 18, 1938

Fig. 1

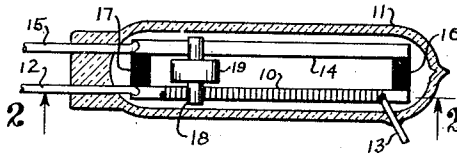


Fig. 3

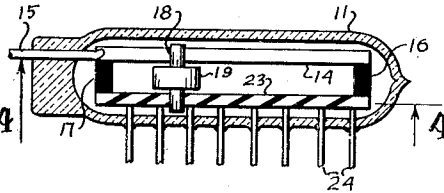


Fig. 2

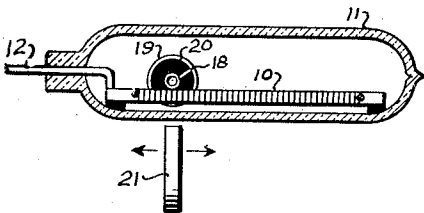


Fig. 4

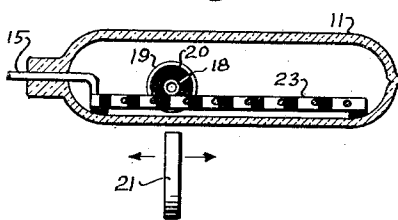


Fig. 5

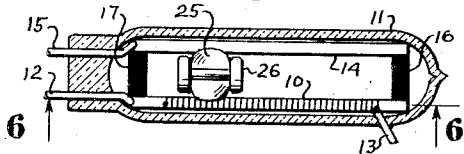


Fig. 7

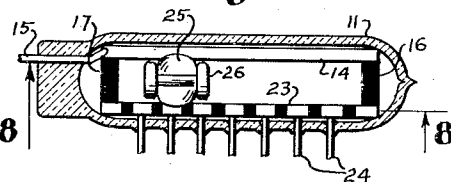


Fig. 6

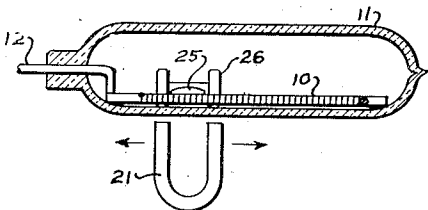
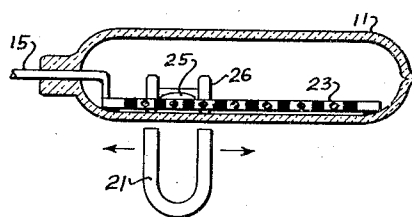


Fig. 8



INVENTOR
George J. McDonald
BY
George H. Fisher
ATTORNEY

UNITED STATES PATENT OFFICE

2,256,833

CONTROL DEVICE

George T. McDonald, Minneapolis, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

Application April 18, 1938, Serial No. 202,609

6 Claims. (Cl. 201—62)

This invention relates to electrical resistance and switching apparatus adapted to vary the resistance in an electrical circuit or direct an electric current into different paths.

Electrical apparatus of this type usually has an electrical resistance element or a series of contacts over which a movable contact mechanically frictionally slides. In such devices there is considerable electrical resistance between the movable contact and the resistance element or stationary contacts 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 contacts and resistance element tend to corrode with age. There is also a tendency for the contacts and resistance to burn and pit because of a poor contact and thus further increase the 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 movable contact and the resistance or the stationary contacts which additionally increases the contact resistance.

It may be desirable to locate such a control device in place where the surrounding atmosphere contains combustible gas, vapor or dust. An open contact resistance or switching mechanism is dangerous because some arcing is likely to occur as the contact is moved.

An object of this invention is to provide an improved variable resistance or contact mechanism which can be successfully operated automatically with a minimum of power.

Another object is to provide a variable resistance or a contact mechanism which has a low contact resistance that does not change with age.

Another object is to provide a variable resistance or contact mechanism in which the movable contact moves over the resistance or contacts in response to variations in a magnetic field.

Another object is to provide an electrical contact mechanism having the contacts hermetically sealed.

Another object is to provide an electrical contact mechanism having the contacts hermetically sealed and in which a magnetic field varied by means outside the sealed space actuates the contacting device within the sealed space.

Another object is to provide a variable resistance or contact mechanism in which all electrical contacts are made and broken within an hermetically sealed chamber to eliminate the possibility of igniting combustibles in the vicinity of the device.

Other objects will be evident from the appended claims, specification and from the drawing, in which:

Figure 1 is a horizontal section of one form of the invention.

Figure 2 is a vertical section taken on line 2—2 of Figure 1.

Figure 3 is a horizontal section of another form of the invention.

Figure 4 is a vertical section taken substantially on line 4—4 of Figure 3.

Figure 5 is a horizontal section of a third form of the invention.

Figure 6 is a vertical section taken on line 6—6 of Figure 5.

Figure 7 is a horizontal section of a fourth form of the invention.

Figure 8 is a vertical section taken substantially on line 8—8 of Figure 7.

Throughout the various modifications of the invention here described, like reference characters are used to indicate corresponding parts.

In the device shown in Figures 1 and 2, an electrical resistance 10 in the form of a potentiometer is horizontally disposed within a sealed glass envelope 11. The left-hand end of the resistance 10 is provided with a lead wire 12 extending outside the glass envelope 11 and sealed therein. The right-hand end of resistance 10 is similarly provided with a lead wire 13. Parallel to resistance 10 but horizontally spaced therefrom within envelope 11 is a conducting bar 14 which is also provided with a lead wire 15 extending outside the envelope 11. Insulating

blocks 16 and 17 serve as spacers and supports for resistance 10 and bar 14.

In order to vary the effective value of resistance 10 an electrically conducting roller 18 is provided to bridge resistance 10 and bar 14. Between resistance 10 and bar 14, roller 18 is provided with an annular iron or steel armature 19. Armature 19 is suitably spaced from roller 18 as by insulation 20. The roller could be constructed in any way that would provide an electrical connection between resistance 10 and bar 14 together with an armature coaxially disposed with relation to the roller.

The envelope 11 serves the purpose of keeping dust and dirt off the working parts, of preventing corrosion of the contact surfaces, assuring uniform operation, and of preventing arcing at the contact from igniting any combustibles in the vicinity of the device.

A permanent magnet 21 outside the glass envelope may be moved lengthwise thereof by any suitable means, not shown, such as a temperature responsive element. Since the armature 19 will be included in the field of magnet 21 it will move the roller 18 along the resistance and bar on changes in position of the magnet with respect to the envelope. Since there are no sliding contacts, very little effort will be required to change the effective value of the resistance. Good contact is assured because the contact surfaces will not corrode or become dirty.

The device shown in Figures 3 and 4 is similar to that shown in Figures 1 and 2 except that a segmented contact member 23 is substituted for the resistance element. Contact member 23 consists of alternate segments of non-magnetic metal and insulation arranged diagonally of the length of the member. By providing member 23 with a flat upper surface and the diagonal contact segments, the roller 18 will never be in open circuit position. If open circuit positions of the roller are desired, the segments could be straight rather than diagonal. The segments are provided with separate lead wires 24 extending through the glass envelope.

The operation of this modification of the invention is similar to that of the preceding modification, except that the roller completes an electrical circuit between bar 14 and the various segments of contact member 23 rather than between the bar and the windings of an electrical resistance. An external resistance may have taps leading to the terminals 24 or the device may be used for any purpose where it is desired to selectively control a plurality of electric circuits.

It should be particularly pointed out in connection with these first two modifications that the construction including a rotating armature materially increases the sensitivity of the device. Bearing in mind that there is necessarily some mechanical resistance to moving roller 18 along the two parallel conductors in either the first or second modification, it will be understood that magnet 21 must be displaced from a point immediately beneath armature 19 before the horizontal component of force along the length of the conductors will be sufficient to move armature 19 and roller 18. Here, however, a slight movement of magnet 21 in one direction will result in a greater magnetic pull being exerted on that portion of the armature which will move toward the magnet when movement of the armature is accomplished but which is slightly elevated until there is a movement. The increased pull on this portion of the armature exerts a torque on the

roller 18 which instigates movement before it would otherwise occur.

The device shown in Figures 5 and 6 is similar to the device of Figures 1 and 2 except that a globule of mercury 25 is substituted for the roller 18 as the movable contact member. As in the previous modifications the bar 14 and the resistance 10 is horizontal when in operative position. Here, however, the bottom of the glass envelope 11 must also be horizontal so that the globule of mercury 25 will not tend to move of its own weight. In order to move the globule of mercury 25, a spool-shaped armature 26 is placed over the mercury with its two enlarged ends confining the mercury lengthwise of the envelope 11. Because of the high surface tension of mercury, movements of the armature 26 will cause the globule 25 to move correspondingly. The density of mercury is so great that it will tend to float the steel or iron armature reducing friction between the armature 26 and envelope 11 to a minimum. It has been found desirable to coat the armature 26 with vitreous enamel to serve as electrical insulation, preventing electrical contact of either bar 14 or resistance 10 by the armature, and to give the armature a very smooth surface. Magnet 21 serves to move the armature and mercury in this case as it did to move the roller in the previous cases.

In Figures 7 and 8 a segmented contact member as employed in Figures 3 and 4 is substituted for the resistance element of Figures 5 and 6. It is not necessary, here, to provide diagonal segments as in Figures 3 and 4 in order to avoid open contact positions of the movable contact because mercury 25 makes contact along an appreciable length of contact member 23. As described in connection with the previous modifications, movements of magnet 21 lengthwise of envelope 11 serves to move the mercury to bridge bar 14 and contact member 23 at various points along their length.

While the several modifications have been described as employing a glass envelope 11, it will be seen that any suitable non-magnetic material may be used. If a metal envelope were used it would be possible to eliminate conducting bar 14 by using the envelope as a conductor in place of the bar. In that case lead wires to the resistance or segmented contact member would necessarily be insulated from the envelope.

It will be seen from the foregoing specification that a variable resistance or contact mechanism has been provided that may be operated with a minimum of power, one that has low contact resistance which will remain constant over a long period of time, and one that will not present a fire hazard in certain installations.

While several modifications of the invention have been described, other modifications will be apparent to those skilled in the art. The invention should be limited only by the appended claims.

I claim as my invention:

1. In a current controlling device, the combination of, an elongated horizontally located tubular container of non-magnetic material, a pair of elongated contact members hermetically sealed therein and located lengthwise in parallel relation in the container, contacting means bridging the elongated contact members and adapted to be moved along the same, at least one of said contact members being of the type used to vary the electrical resistance of a circuit in accordance with the point at which said member

is contacted, an armature in the container and located between the elongated contact members and close to the surface of the container for moving the contacting means along the contact members, and a magnet outside of the container and adjacent said armature, said magnet being movable longitudinally thereof for magnetically moving the armature and hence the contacting means along the elongated contact members.

2. In a current controlling device, the combination of, an elongated horizontally located container of non-magnetic material, a pair of elongated contact members hermetically sealed therein and located lengthwise in parallel relation in the container, rollable means supported by the two elongated contact members and adapted to be moved along the same for bridging them electrically at various proportions of their lengths, at least one of said contact members being of the type used to vary the electrical resistance of a circuit in accordance with the point at which said member is contacted, an armature in the container and located between the elongated contact members for moving the rollable means along the contact members, and a magnet outside of the container movable longitudinally thereof for magnetically moving the armature and hence the rollable means along the elongated contact members.

3. In a current controlling device, the combination of, an elongated horizontally located container of non-magnetic material, a pair of elongated contact members hermetically sealed therein and located lengthwise in parallel relation in the container, a globule of mercury bridging the elongated contact members and adapted to be moved along the same, at least one of said contact members being of the type used to vary the electrical resistance of a circuit in accordance with the point at which said member is contacted, an armature in the container located between the elongated contact members to constrain the globule of mercury lengthwise of the container for positioning the globule at various points along the lengths of the contact members, and a magnet outside of the container movable longitudinally thereof for magnetically moving the armature and hence the globule of mercury along the elongated contact members.

4. In a current controlling device, the combination of, an elongated horizontally located tubular container of non-magnetic material, a pair of elongated contact members hermetically sealed therein and located lengthwise in parallel

relation in the container, contacting means bridging the elongated contact members and adapted to be moved along the same, at least one of said contact members being of the type used to vary the electrical resistance of a circuit in accordance with the point at which said member is contacted, an armature in the container and located between the elongated contact members and close to the surface of the container for moving the contacting means along the contact members, said armature being guided in its longitudinal movement by said elongated contact members, and a magnet outside of the container and adjacent said armature, said magnet being movable longitudinally thereof for magnetically moving the armature and hence the contacting means along the elongated contact members.

5. In a current controlling device, the combination of, an elongated horizontally located tubular container of non-magnetic material, a pair of elongated contact members hermetically sealed therein and located lengthwise in parallel relation in the container, contacting means bridging the elongated contact members and adapted to be moved along the same, at least one of said contact members being an electrical resistance, an armature in the container and located between the elongated contact members and close to the surface of the container for moving the contacting means along the contact members, and a magnet outside of the container and adjacent said armature, said magnet being movable longitudinally thereof for magnetically moving the armature and hence the contacting means along the elongated contact members.

6. In a current controlling device, the combination of, an elongated horizontally located tubular container of non-magnetic material, a pair of elongated contact members hermetically sealed therein and located lengthwise in parallel relation in the container, contacting means bridging the elongated contact members and adapted to be moved along the same, at least one of said contact members being of the segmented contact type, an armature in the container and located between the elongated contact members and close to the surface of the container for moving the contacting means along the contact members, and a magnet outside of the container and adjacent said armature, said magnet being movable longitudinally thereof for magnetically moving the armature and hence the contacting means along the elongated contact members.

GEORGE T. McDONALD.