

Feb. 7, 1928.

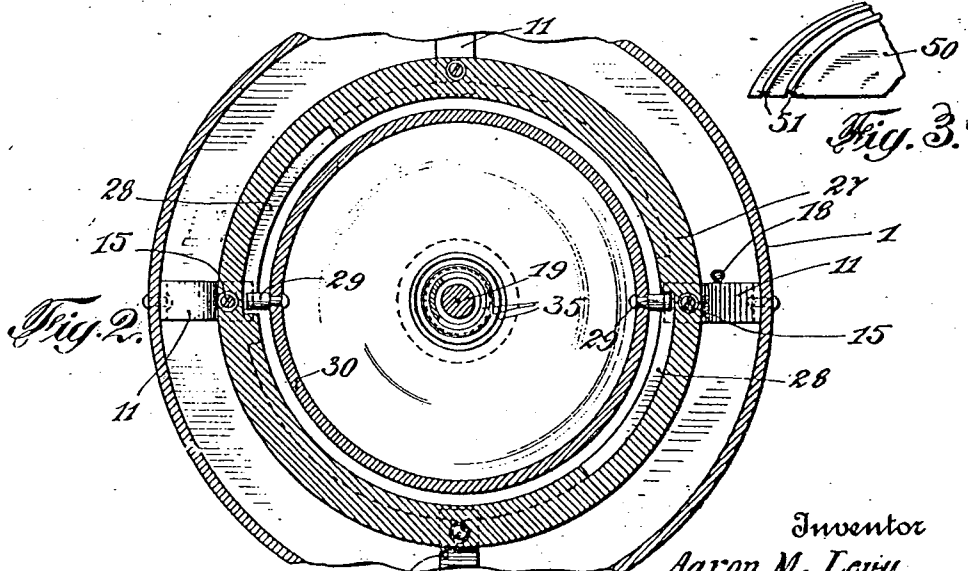
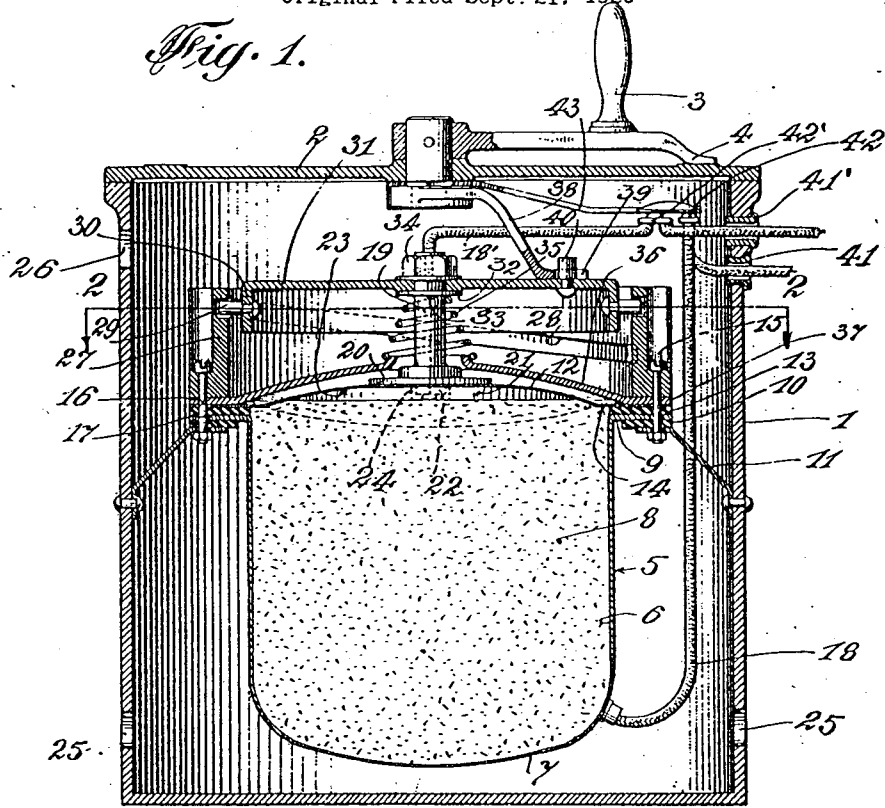
1,658,788

A. M. LEVY

ELECTRICAL RESISTANCE APPARATUS

Original Filed Sept. 21, 1920

Fig. 1.



Inventor
Aaron M. Levy
By his Attorney
Morris Hirsch.

UNITED STATES PATENT OFFICE.

AARON MICAH LEVY, OF NEW YORK, N. Y., ASSIGNOR OF ONE-FOURTH TO JULIUS HOCHMAN AND ONE-FOURTH TO MAURICE SAMBURG.

ELECTRICAL RESISTANCE APPARATUS.

Application filed September 21, 1920, Serial No. 411,778. Renewed February 20, 1925.

My present invention relates to electrical resistance apparatus and more particularly to apparatus of the compression type.

It is an object of the invention to provide apparatus of the above type simple and relatively inexpensive in construction, the ohmage of which while readily adjustable within fine limits, shall, nevertheless, not be subject to undesired fluctuation or variation, even when left in circuit continuously for a substantial period of time.

Certain preferred features of the invention reside in the construction of a resistance unit embodying a container preferably cylindrical in shape, substantially filled with comminuted resistance material, the walls of the container being preferably of thin heat-resisting material, the container being completely closed to prevent escape of even the smallest particles of the resistance material, part of said container being readily displaceable to vary the compression and, therefore the resistance of the included medium, the interior of the container wall contacted by the resistance medium being preferably devoid of projections of protuberances.

Although the best results as regards constancy of resistance or conductivity of the unit for any particular setting are obtained when all of the preferred features are employed, it will be understood that satisfactory operation may be brought about for certain purposes when one or more of these features are not utilized.

Referring now to the drawings,

Fig. 1 is a view in longitudinal section showing a preferred application of my invention;

Fig. 2 is a fragmentary transverse sectional view taken along the line 2—2 of Fig. 1, and;

Fig. 3 shows a fragment of a modified form of diaphragm.

Referring now to the drawings, I have shown by way of example a rheostat comprising a common form of enclosing casing 1 having a cover 2 and an operating handle 3 with a pointer 4 to indicate the setting of the rheostat upon the usual form of scale (not shown) on the cover.

Within the casing 1, I provide a resistance unit comprising a container 5 of a substan-

tially non-oxidizable or non-corrodible metal, sufficiently heat-resisting to withstand the temperature occurring in use of the apparatus for instance, brass. The container has preferably a thin cylindrical wall 6 and a thin end or bottom wall 7 integral therewith in the neighborhood of $\frac{1}{2}$ inch in thickness. By preference the bottom wall is in the form of a segment of a sphere convex externally and concave internally, although different forms of curved surface may be employed.

Enclosed within the container 5 to completely fill the same is a compression resistance medium 8. This medium comprises preferably a mixture of comminuted graphite and mica subdivided into small flakes, although any appropriate resilient mineral fiber may be used in this mixture in place of the mica. Other types of permanently resilient compressible resistance medium such as shredded carbonized cloth may also be used. My invention does not reside in the particular resistance medium per se. Any substance or mixture of substances preferably in comminuted form, the conductivity of which will increase with the pressure applied thereto is satisfactory, provided it is either inherently resilient, or is associated with resilient means to effect increase of resistance when pressure is released.

The container 5 has a flange or rim 9 formed integral therewith at its upper edge, the said flange furnishing a rest for the container within the casing 1. By preference an insulating heat-resisting gasket 10 is interposed between support brackets 11 secured to the inside of the casing, upon which brackets the gasket rests; the container in turn resting upon said gasket. The container extends downwardly from the support brackets and the entire surface thereof is freely exposed within the casing 1, for a purpose which will appear below.

Preferably a diaphragm 12, completely closes or seals the container against egress of even the smallest particle of the comminuted resistance material contained therein. The diaphragm by preference is formed of asbestos or equivalent mineral fiber compressed into a thin felt and held preferably between layers of asbestos cloth, although wire mesh may be employed for this purpose. If de-

sired, a suitable metal diaphragm 50 (see Fig. 3) may be used instead of the asbestos diaphragm, this diaphragm having preferably pressed out circumferential grooves. The diaphragm is electrically insulated from the container preferably by a second insulating gasket 13 of heat-resisting material interposed between the flange 9 of the container and the rim 14 of the diaphragm. When the asbestos diaphragm is used, the gasket 13 may be omitted.

The diaphragm is firmly secured at its rim with respect to the container, by means of bolts 15 which extend transversely through the rim 14 of the diaphragm, the gasket 13, the flange 9 of the container, the gasket 10 and the brackets 11. The openings 16 and 17 in the metallic diaphragm and in the container flange through which the bolts extend are preferably substantially larger than the diameter of the bolts and spaced therefrom to prevent a short-circuiting between the diaphragm and the container.

The container 5 constitutes one of the electrical terminals of the resistance unit, an electrical conductor 18 being connected thereto preferably at the bottom thereof and extending to the exterior through an outlet 41 in casing 1. The other electrical terminal preferably comprises a post 19 to which is connected a conductor 18' extending through an outlet 41' in the casing 1. The post 19 extends upwardly or outwardly from the diaphragm and is preferably clamped centrally thereto by means of a pair of clamping washers 20 and 21 at opposite sides thereof, a nut 22 threaded upon the lower end of the post serving to clamp the diaphragm 12 between the washers 20 and 21. By preference the lower washer 21 is extended outwardly beyond the upper washer and beveled as at 23 so that the surface thereof in contact with the resistance medium shall be substantially continuous with the adjoining surface of the diaphragm as shown. The nut is preferably countersunk within the lower washer as shown at 24, the parts being so arranged that the nut and the threaded end of the post terminate substantially flush with the washer in order to provide a substantially smooth and continuous surface without sharp projections or extensions in contact with the resistance medium.

Means is provided for adjusting the pressure upon the resistance medium 8 in the container to effect any electrical resistance within the range of the apparatus. This means may comprise a cylindrical cam wall 27 rising from the upper end of the container and having a pair of cams in the form of helical grooves 28 in which fit pins 29 secured to and extending outwardly from a flange 30 upon a plate 31 concentric with and of slightly smaller diameter than the

cam wall. The plate 31 rests upon a washer 32 which in turn rests upon a shoulder 33 on post 19, a nut 34 securing the plate against upward movement with respect to post 19. The plate 33 is free to revolve around post 19 as an axis, and governs the vertical displacement of said post. A coil spring 35 preferably encircles the post and presses at its upper end against the plate 31 and rests at its lower end upon a retainer plate 36.

Preferably the periphery 37 of retainer plate 36 together with the periphery 14 of the closure diaphragm 12 are clamped between the cam wall 27 and the flange 9 of the cylindrical side wall 6 by means of the bolts 15 which extend through cam wall 27, retainer plate 36, diaphragm 12, gasket 13, container flange 9, gasket 10 and bracket 11.

The handle 3 upon the cover of the rheostat casing is connected with the container 5 in such manner that rotation thereof will cause corresponding increase or decrease of the compression of the resisting medium. For this purpose the handle has secured thereto by any desired means an arm 38 provided at its extreme end with a fork 39 straddling a pin 40 upon the plate 31.

It will be understood that as the handle 3 is turned the arm 38 will turn and through the fork 39 and pin 40 it will cause a rotation of the disk 31. For a clockwise rotation of the handle 3 in the specific embodiment shown, the pins 29 will travel downwardly along the cam grooves 28 and the plate 31 will thereby be forced downwardly and with it the post 19. This causes a depression of the diaphragmatic cover 12 against the opposition of spring 35 and a corresponding compression of the resisting medium against the end or bottom wall 7, with the consequent decrease in resistance, until the diaphragm reaches the limiting depressed position shown in dotted lines.

When the handle 3 is turned in the opposite or counter-clockwise direction the plate 31 is caused to rise by reason of the upward component of the travel of pins 29 within the cam grooves 28 and the diaphragmatic cover 12 rises therewith, the expansion of the compressed resisting medium and the expansion of spring 35 also tending to press the diaphragm upwardly. The compression upon the resisting medium is thus decreased and the electrical resistance increased. The limiting position corresponding to maximum ohmage appears in full lines on the drawings.

By preference the apparatus is so arranged as to cause the resistance medium to be completely short-circuited for one extreme position of the handle. For this purpose the conductors 18 and 18' have contacts 42 and 42' respectively intermediate their ends and within the casing 1; said contacts

being preferably aligned as shown, and an electrical contact arm 43 rotatable with the handle connects the contacts 42, 42' to short-circuit the resistance when the pointer 4 on the handle is in position indicating zero resistance.

By preference apertures 25 and 26 are provided near the top and near the bottom of the casing 1 to effect ventilation for carrying off the heat generated during operation in the resistance unit.

I have discovered that by the use of a resistance unit of the character set forth, I achieve the desirable result of substantial constancy of conductivity for any particular setting, regardless how long the circuit in which the resistance unit is employed remains closed. My resistance unit is, therefore, of particular utility in electrical regulators and controllers where it is important to maintain a substantial constancy of resistance and my relatively inexpensive unit can, therefore, be used as a substitute for the considerably more expensive electrical resistance coil or grid resistances commonly used for such purposes.

In operation, the thin-walled container 5 quickly becomes heated as the current generates heat by its passage through the resistance medium. The ventilating current of air through passages 25 and 26 in the casing coming into contact with the entire surface of the container exposed thereto, effectively carries off the heat generated after the current has been on for a short period of time. Apparently, the temperature of the container walls remains substantially constant after the circuit has been closed a very short interval of time and, therefore, no expansion or contraction thereof takes place thereafter. It seems to follow that the pressure exerted by the walls upon the resistance medium does not vary and, therefore, that no changes in ohmage will occur. I have established experimentally that the ohmage of my unit remains substantially constant for any setting regardless how long the circuit remains closed. It is to be understood that the foregoing theory as to the reason for this uniformity is merely tentative and may be subject to modification.

Substantial constancy of ohmage for any particular setting is reliably maintained in the use of a unit as set forth embodying a container having thin walls of heat-resisting material, preferably entirely exposed to the air, the vessel being completely sealed against escape of the resistance medium contained therein, there being a total absence of protuberances or projections extending into the resistance medium. In the case of smaller installations it is also desirable, though not essential, that the walls of the container be not plane but convex or concave exteriorly, preferably the former, although in the case

of larger installations such construction is found to be of greater importance when the best results are to be obtained. It seems that ordinary plane walls, more particularly in larger installations, have a tendency to sag inwardly under heat and to thereby change the pressure upon the resisting medium. This probably accounts for varying conductivities. With convex or concave walls of the character set forth, on the other hand, the conductivity maintains a constant value for any particular setting. This is probably explained at least in part, by the fact that such convex or concave walls have no tendency to sag.

It will, of course, be understood that my unit may be used in resistance starting boxes or in other apparatus which are not kept in circuit for more than a few seconds at a time and in which any substantial rise in conductivity is not particularly undesirable. In that event although I prefer to use the form of container shown and described, and although superior results are obtained by its use, sufficiently good results can be obtained where the walls of my form of container are thick rather than thin, plane rather than curved and where the container is not completely sealed.

My resistance unit includes a completely closed container, the closure of which in the preferred embodiment is a diaphragm to permit displacement and compression of the resistance medium and to prevent escape thereof. It will be understood, however, that the broader features of my invention can be carried out by the use of a closed container in which any part of the wall thereof is flexible even though such wall portion be not resilient and in which compression is effected by displacing a portion of the container wall, utilizing the capacity of yield of the flexible portion, even though the pressure be not applied directly at such flexible portion.

It is also to be noted that although I prefer to employ a metallic container, part or all of the wall may be of heat-resisting insulating material.

It will be understood that as the resistance medium is compressed to reduce the ohmage, the pressure is directly exerted against the bottom 7, the side wall of the container is placed under tension and the gaskets 10 and 13 under compression. In some resistance devices, particularly when delicate and low ohmage control is wanted, it is desirable to place the resistance medium under considerable compression. The metallic container although thin-walled will, in such cases, withstand the substantial tensile force applied thereto, and the gaskets will be of increased effectiveness under large pressures to form a tight joint and will thus prevent loss of any of the resistance me-

dium. Where the container wall is made of insulating material of low tensile strength, it would have to be made thicker to resist breakage when allowed to extend freely below the support brack in the manner disclosed, with the disadvantages heretofore indicated.

I claim:—

1. An electrical resistance unit comprising in combination, a heat-resisting container, comminuted electrical resistance material substantially filling said container, said container having a flexible closure rigidly fixed thereto at its rim to prevent escape of any part of said resistance material, said closure being displaceable to vary the compression and the electrical resistance of said enclosed material, means for displacing said closure and electrical terminals for said container.

2. An electrical resistance apparatus comprising in combination, a sealed heat-resisting container having relatively thin end walls, comminuted resistance material substantially filling said container, one of said walls of said container being of flexible metal, means for exerting pressure upon the resistance material whereby the electrical resistance imposed by the apparatus may be varied in accordance with the degree of pressure exerted upon the flexible wall.

3. The combination set forth in claim 2 in which one of the end walls of the container is of thin metal and constitutes a terminal.

4. An electrical resistance apparatus comprising in combination, a container having a curved heat-resisting side wall and a thin heat-resisting end wall, comminuted resistance material substantially filling said container, said container having a closure to prevent escape of any part of said resistance material, said closure being displaceable to vary the compression and the electrical resistance of the enclosed material, the terminals of said unit being one at said end wall and the other at said closure, said apparatus including operating means for displacing said closure, and thereby varying at will the resistance imposed by said apparatus.

5. An electrical resistance apparatus comprising in combination, a container having end walls, one of which is of relatively thin metal, a heat-resisting wall element connecting said end walls to form a sealed container, and comminuted resistance material filling said container, said parts being constructed and arranged to permit displacement of one of said end walls relative to the other to vary the compression and electrical resistance of said resistance material, said apparatus including operating means for displacing said closure, and thereby varying at will the resistance imposed by said apparatus.

6. An electrical resistance unit, comprising in combination, a container having a curved side wall, a curved end wall continuous therewith, said end wall being of a thin heat-resisting material, comminuted resistance material enclosed within said container, said container having a closure to prevent escape of any part of said resistance material, said closure being displaceable to vary the compression and the electrical resistance of the enclosed material.

7. An electrical resistance apparatus comprising in combination, a container formed of an integral piece of thin metal and comprising a cylindrical side wall and an end wall concave internally and convex externally, a resistance medium filling said container, a closure for said container, and operating means for displacing said closure, and thereby varying at will the resistance imposed by said apparatus.

8. An electrical resistance apparatus comprising in combination, a container having a cylindrical side wall, and an end wall of thin sheet metal in the form of a segment of a sphere with its convexity on the exterior, said end wall constituting an electrical terminal, resistance medium filling said container, a closure for said container, and operating means for displacing said closure, and thereby varying at will the resistance imposed by said apparatus.

9. An electrical resistance unit comprising in combination, an integral cylindrical heat-resisting container having a mineral fiber diaphragm closure, a compressible resistance medium enclosed in said container, and means operable from the exterior of the container for causing deflection of said closure, to vary the compression of said resistance medium.

10. An electrical resistance unit comprising in combination, a cylindrical heat-resisting container of thin material having a metallic end wall, an asbestos diaphragm closure, a compressible resistance medium substantially filling said container, and means operating upon said closure for deflecting the same to vary the compression of said resistance medium.

11. The combination set forth in claim 6, in which the container is formed of an integral piece of thin metal, and comprises a cylindrical side wall and an end wall concave internally and convex externally, and in which the closure is a flexible diaphragm sealing said container.

12. An electrical resistance apparatus comprising in combination, a container having a cylindrical side wall, a metallic end wall and a flexible diaphragm closure, an electrical terminal secured to said closure, and cam means cooperating with said closure to cause depression of said diaphragm in response to a rotary actuating movement.

13. An electrical resistance unit comprising in combination, a container having a side wall, a sheet metal end wall, a flexible diaphragmatic closure, an electrical terminal secured to said closure and centrally thereof and projecting outwardly therefrom, a cam wall rising from said container, cam pins rigid with said terminal and cooperating with said cam wall, and means for causing movement of said pins at will along said cam wall for depressing said diaphragmatic closure.

14. An electrical resistance unit comprising in combination, a heat-resisting thin-walled container a diaphragmatic flexible closure therefor, an electrical terminal secured centrally to said closure and extending upwardly therefrom, a cam wall secured to said container and extending upwardly therefrom and having a pair of cam grooves, a flanged plate rotatable about said terminal and having pins extending outwardly from the flange thereof into said cam grooves, a spring coiled about said terminal and pressing at one end against said flanged disk, and a retainer for the other end of said spring, said retainer being rigid with said container.

15. An electrical resistance apparatus comprising a sealed container having a metallic bottom wall and a yielding top wall, a relatively unyielding, heat-resisting side wall constituting an electrical terminal, compression resistance medium substantially filling said container, casing enclosing said container electrically insulated and spaced therefrom and means accessible from the exterior of said casing for exerting variable pressure against said yielding top wall.

16. An electrical resistance apparatus comprising a sealed container having a relatively unyielding, heat-resisting side wall, and end walls, one of said walls being yielding, end wall terminals, a resistance medium in said container, said container being constructed to permit approach of said yielding end wall toward the other, a casing enclosing said container insulated and spaced therefrom, said casing having ventilating passages, and means accessible from the exterior of said casing for causing relative displacement of said end walls to vary the compression and electrical resistance of said resistance medium.

17. An electrical resistance apparatus comprising in combination, a container having a thin, heat-resisting side wall, a metallic end wall convex in form and a diaphragmatic closure wall, a compression resistance medium within said container, an enclosing casing, means supporting said container within said casing and insulated therefrom, an operating handle upon the exterior of said casing, and means connecting said handle to said resistance medium

to cause compression thereof responsive to actuation of said handle.

18. An electrical resistance apparatus comprising in combination, a container having a cylindrical side wall, a convex end wall continuous therewith, resistance medium within said container, longitudinally movable means for varying the compression of said resistance medium, cam means for causing movement of said means responsive to a rotary movement, an enclosing casing for said container insulated therefrom, operating means accessible from the exterior of said casing, and a connecting element between said operating means and said cam means.

19. An electrical resistance unit comprising in combination, a closed container, comminuted resistance material substantially filling the same, and an electrical terminal extending from the exterior through a wall of said container into contact with said resistance material, the portion of said terminal within said container being substantially continuous with the container wall to avoid sharp metallic edges, corners or projections within the container.

20. An electrical resistance apparatus comprising in combination, a resistance unit including a heat-conducting container having a side wall and an end wall, said container being filled with compression resistance material, a displaceable closure for said container, a support, a portion of said container adjacent said closure resting upon said support, the body of said container other than said closure extending downwardly from said support and being exposed to the surrounding air.

21. An electrical resistance apparatus comprising in combination, a resistance unit including a thin metallic container having a side wall and an end wall integral therewith, and having a supporting part at its open end, compression resistance material filling said container, a diaphragm closing the open end of said container, a casing having a support therein upon which said supporting parts rest, the body of said container extending downwardly from said support and spaced at all parts from the walls and bottom of said casing, said casing having ventilating apertures, whereby excess heat generated in said unit will be effectively eliminated.

22. An electrical resistance apparatus comprising in combination, a compression resistance unit having terminals, an enclosing casing within which said unit is mounted, electrical conductors leading from said terminals through said casing, an operating handle upon the exterior of said casing for varying the pressure upon said resistance unit, and a short-circuiting arm rotatable with said handle for establishing an electrical contact be-

tween exposed portions of said conductors to short-circuit said unit.

23. In a compression rheostat, a container having compressible resistance material housed therein, yielding metal parts in contact with said material to permit expansion thereof under heat, and means for subjecting the resistance material to compression in order to adjust the resistance thereof, at least one of the yielding metal parts in contact with the resistance material being substantially smooth and free from projections.

24. In a compression rheostat, a container having a stationary end and a displaceable

closure plate, finely divided resistance material in said container, a rigid retaining wall confining said material between said end and said closure, means to displace the closure for compressing the material in order to create paths of conductivity therethrough, said container being constructed to allow for the expansion of said material when the same becomes heated and to radiate the heat created therein.

Signed at New York city, in the county of New York, and State of New York, this 20th day of September A. D. 1920.

AARON MICHAEL LEVY.