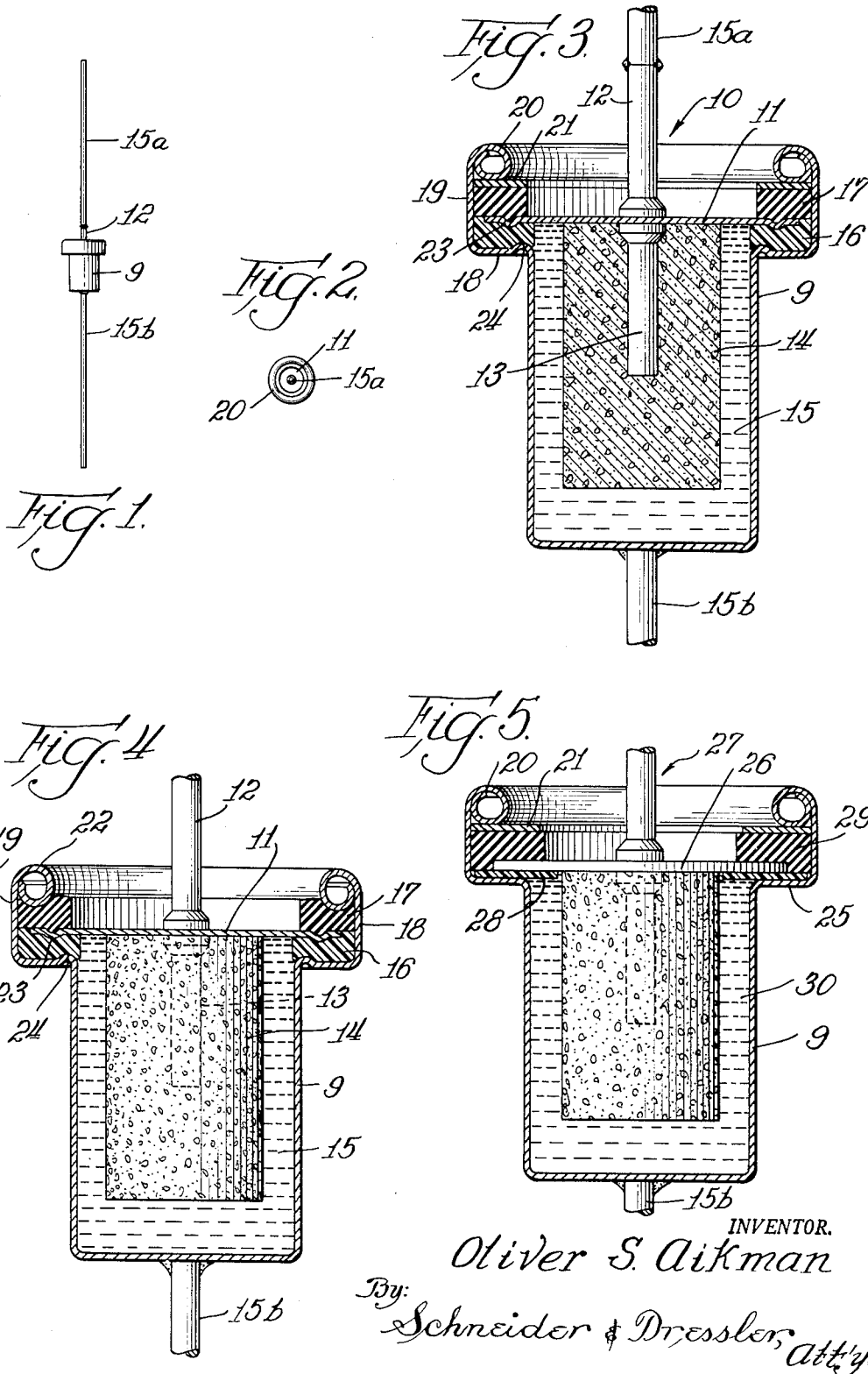


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ELECTRICAL APPARATUS
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ELECTRICAL APPARATUS

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This invention relates to an electrical apparatus and particularly to a seal construction for electrolytic condensers. The invention hereinafter described may be applied to other devices where a hermetic seal together with electrical insulation is required.

The invention is particularly applicable to devices containing sulphuric acid or similar chemicals having strong creeping tendencies. In addition to the natural tendency of a sulphuric acid solution to surface creepage, there is the additional factor that in an electrical device, such as an electrolytic condenser, some heat is generated within the device. This heat results in the acid electrolyte becoming chemically more active and in an increase in pressure within the sealed container, thus increasing the tendency to creep.

In addition to the problem of creepage of electrolyte, there is the added problem of maintaining the hermetic character of the seal over a wide range of temperatures, such as would be encountered in various parts of the world. Thus equipment, particularly that used by the military or by aircraft, must generally be capable of withstanding extremes of temperature ranging from about minus 60 degrees centigrade up to about 85 degrees centigrade, and even higher. Sometimes the device in which a condenser is a component may undergo a sharp temperature change within a matter of minutes or hours. It is therefore of the utmost importance that the various characteristics of the seal be maintained over such a temperature range irrespective of how fast the temperature may vary.

The seal construction, to be hereinafter described, has been found to be particularly effective, not only under adverse conditions involving electrolytes, but also under conditions where the size of the condenser, or other device to which the seal is applied, is small in comparison to its energy or power handling ability. Thus the electrolytic condenser with which the invention is particularly described is of the type having extremely small physical dimensions for its electrical capacity. Such a condenser has a comparatively small amount of electrolyte therein and it is therefore of the utmost importance that this small amount be conserved in order to maintain the device at high operating efficiency. Additionally, because of the small physical dimensions of the electrolytic condenser, all creepage of the electrolyte is to be prevented, because of the possibility of a flashover along the surface of the insulation, thus causing the ultimate breakdown of the device.

For a full description of the invention, reference will now be made to the drawings, showing a preferred illustrative embodiment of the invention, it being understood that some departure from the precise details disclosed herein is permissible without departing from the spirit of the invention. Referring to the drawings:

Figure 1 shows a side elevation of an electrolytic condenser provided with the seal construction forming the subject matter of this invention;

Figure 2 is a top view of the device shown in Figure 1;

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Figure 3 is a side sectional view showing the construction of the electrolytic condenser of Figure 1;

Figure 4 is a similar view to Figure 3 but showing a modified form of construction;

Figure 5 is a similar view to Figure 3 but showing a further modified construction.

Referring first to Figures 1 to 3, inclusive, there is shown an electrolytic condenser having housing or can 9. This housing is of metal and preferably of a metal which is ductile and draws easily. Thus in the specific example illustrated here, a condenser has at least one pole of tantalum and is characterized by large capacitance for the physical dimensions involved. For this condenser, housing or can 9 may be of silver, or tantalum, or silver with an interior coating of tantalum. Silver is particularly desirable since, as a cathode material, it has no tendency to form a film, nor does it react chemically with the electrolyte, or with suitable gasket materials. Furthermore, silver has excellent heat and electrical conductivity and is ductile so that it may be readily drawn and crimped. In the event that housing or can 9 requires tantalum, the tantalum may be deposited electrolytically on the inside of a silver can and additional sintered tantalum material may be attached to the inside of the can to increase the capacitance thereof.

An electrode assembly 10 is carried by the housing. This assembly comprises disc 11 of tantalum, pin 12 on the outside of disc 11 and support pin 13 on the inside of disc 11. Pins 12 and 13 are preferably of tantalum and are bonded to disc 11 by spot welding or in any other suitable manner.

Carried by support pin 13 is a mass of porous tantalum metal 14 which is applied to the disc and to support pin 13 by a sintering operation. This mass of porous tantalum has formed thereon an oxide film of extreme thinness and having a high dielectric constant. In the event that a nonpolarized condenser is to be provided, the same porous tantalum metal may also be applied to the interior of housing 9. Housing 9 also contains electrolyte 15. In the case of a tantalum condenser, and particularly one that must withstand the extremes of temperature previously referred to, the electrolyte may be a 40% solution of sulphuric acid. Other concentrations and other electrolytes may be used.

It is preferred to provide leads for the condenser so that it may be easily wired or soldered into a circuit without danger to the condenser proper. Accordingly, leads 15a and 15b may be soldered, welded or otherwise permanently attached to pin 12 and housing 9 as shown. These leads are preferably of copper and sufficiently long for the desired purpose.

In the form of the invention shown in Figure 3, there is provided inner sealing ring 16 below the annular rim of disc 11 and outer sealing ring 17 above the annular rim of disc 11. It is preferred to have one of the two sealing rings recessed to accommodate the thickness of the material forming disc 11. It is, of course, possible to provide recesses in both sealing rings. However, it is simpler to provide the recess in one of the sealing rings and in the form shown in Figure 3, the recess is in the top surface of inner sealing ring 16.

Inner sealing ring 16 rests upon outwardly extending shoulder 18 formed in housing 9. Inner sealing ring 16 is directly in contact with the electrolyte so that this inner sealing ring must be made of material which is stable over a wide range of temperatures and which can withstand the electrolyte namely, is inert thereto. An example of a preferred material is the synthetic plastic polytetrafluoroethylene, sold under the tradename Teflon. Another suitable material is the synthetic plastic polytrifluorochloroethylene, sold under the tradename Kel-F. Other materials such as polymerized tetrachloroethylene

and the like may be used, as may also mica and the like. These materials are relatively inelastic and have a cold flow characteristic. Accordingly, substantial resilience for the seal as a whole is provided by outer sealing ring 17 when made of a resilient material, for example a synthetic rubber, such as the rubbery copolymer of butadiene and acrylonitrile (Buna N) or the rubbery copolymer of butadiene and styrene (Buna S), particularly butyl rubber.

The outer boundaries of the two sealing rings rest against wall portion 19 of housing 9, this portion 19 extending axially of and away from shoulder 18. In section, the metal of housing 9, flange 18 and wall 19 has a generally Z-shaped appearance. Wall portion 19 of the housing metal extends beyond the two sealing rings and is crimped or turned over and inwardly to form a hollow, generally toroidal-shaped flange 20. As is clearly indicated in Figure 3, the metal forming the flange is curled inwardly, this curling operation being performed in any suitable manner, as by a suitably shaped die, for example.

Between outer sealing ring 17 and inwardly curled flange 20 there is disposed annulus 21 of metal such as silver or tantalum. Annular member 21 functions to distribute the compression force exerted by flange 20 over sealing ring 17.

In order to insure a long, useful life for the seal, it is preferred to provide annular ribs 23 and 24 in disc 11 and housing 9, respectively. As clearly indicated in the drawing, rib 24 in the housing is at the intersection of the side wall of the housing proper and shoulder 18. This rib is concave from outside of the housing so as to extend into the bottom portion of inner sealing ring 16. This location of rib 24 is particularly desirable since in any event the metal would have to be curved to form a rounded corner to prevent cracking of the metal. Thus rib 24 functions as a dam to hold back cold flow of the bottom part of the material forming inner sealing ring 16. Rib 23 functions to permit some contraction and expansion of disc 11 under varying temperature conditions.

Rib 23 is formed so that it extends into the material of inner sealing ring 16 and this rib is preferably laterally offset from rib 24. Thus the recess in the top part of inner sealing ring 16 to accommodate the edge of disc 11, together with ribs 23 and 24, substantially prevent cold flow of inner sealing ring 16 to a point where flow is a negligible factor in the life of the seal. The two sealing rings have about the same thickness and are much thicker than disc 11. In the assembled device as shown in Figure 3, flange 20 is turned over in such a manner that the two sealing rings are under compression.

In the event that the temperature range over which the seal is to operate is different than stated before, then the material of which outer sealing ring 17 is made may also be different so that it will maintain its resilient character over the operating temperature range of the seal.

It is also understood that in case a different electrolyte is used, then the material of which inner seal 16 is formed may be different. However, the construction described has been found to be effective for the particular conditions set forth. In practice, many devices where seals are necessary do not require such rigorous protection so that variation in the nature of materials and construction is possible.

Referring now to Figure 4, the construction is generally similar to the construction shown in Figure 3 with the exception that annular metal member 21 has been omitted and that the inwardly curled flange indicated in Figure 4 by 22 does not double back within itself as far as flange 20 does in Figure 3. Thus as shown in Figure 3, the edge of the metal is forced to curl inwardly for a substantial angle after a double layer of metal has been formed. In Figure 4, however,

the edge of the metal does not extend as far, the angular extent of double thickness of metal being comparatively small.

It is of course possible to have flange 20 of Figure 3 and flange 22 of Figure 4 substantially similar and obtain the desired compression force by controlling the gauge of metal and the dimension or curvature of the flange.

Referring now to Figure 5, this form differs from the forms shown in Figures 3 and 4 in the elimination of rib 24 formed in the housing. Thus, housing 9 has flange or shoulder 25 extending outwardly therefrom, the metal being curved at the corner in accordance with usual practice. Disc 26 and pin 27 form part of the electrode assembly. Within housing 9, there is electrolyte 30 which may be of any suitable material in case the condenser is not of the tantalum variety. Instead of a condenser, the device may be a transformer with oil as insulation.

Resting directly upon shoulder or flange 25 is inner sealing ring 28 which may be of a suitably inert material, with respect to the liquid or electrolyte, and which at the same time does not have objectionable cold flow characteristics. Outer sealing ring 29 may be of a suitable resilient material, such as rubber, and has its bottom surface recessed to accommodate disc 26. The remaining parts of the sealed structure, such as annular metal member 21 and flange member 20 are similar to the correspondingly numbered parts in the construction shown in Figure 3.

In the various modifications, disc 11 or 26, forming part of the electrode assembly, is preferably formed of thin gauge metal. Thus in case the device is subject to vibration, disc 11 or 26 will have sufficient flexibility to function as a diaphragm and thus absorb or dissipate considerable vibratory energy. The actual thickness of the disc member, as far as diaphragm action is concerned, will depend upon the size or diameter of the disc and the mass rigidly coupled to the center thereof. Such vibratory action may be of substantial importance where larger sizes of apparatus are involved. In all cases, the marginal portion of the metal disc is hermetically and resiliently gripped between sealing rings. Thus housing 9 has an enlarged opening bounded by the seal structure. It is understood a housing may have a number of such seals.

As will be readily understood, some variations in details of construction and in the nature of materials may be made depending upon the conditions to be met without departing from the spirit of this invention.

I claim:

1. An electrical device of the type containing a liquid and requiring a hermetic seal, said device comprising a housing of ductile metal, said housing having a portion defining an opening, said portion extending outwardly as an offset to define an annular shoulder, the free end of said portion being curled inwardly upon itself to provide an annular toroidal flange, substantially all of said flange overlying said shoulder, compressible sealing rings of insulating material disposed between the shoulder and flange, an integral electrode assembly including a metal disc, the marginal portion of said disc being disposed between the shoulder and toroidal flange with the disc edge extending beyond the inner shoulder edge and having an insulating ring on each side of said disc portion with the disc portion overlying said shoulder and being clamped between opposing surfaces of the sealing rings, the disc and sealing rings providing a flexible, insulating, hermetically sealed construction with the inwardly directed flange portion providing a constant compressive force upon the sealing rings and a terminal on the outer surface thereof.

2. An electrical device of the type having a housing in which there is hermetically sealed a liquid and electrode assembly and where the electrode assembly must

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be electrically insulated from the housing, said construction comprising a housing of ductile metal, said housing having an enlarged opening, said housing having the metal extending outwardly as an offset to define an annular shoulder and having the free end of the housing metal curled inwardly upon itself to provide a generally toroidal-shaped flange extending about the entire perimeter of the opening, substantially all of said flange overlying said shoulder, an inner sealing ring resting upon the housing shoulder, an integral electrode assembly including a thin cover disc of metal, said assembly extending within the housing and the disc having the marginal portion thereof overlying said outwardly extending rim and resting upon the inner sealing ring, the marginal portion of said disc extending beyond the inner shoulder edge so that the disc marginal portion lies between the housing shoulder and flange, an outer sealing ring resting above the marginal portion of the disc, said two rings being of compressible material, said outer sealing ring being compressed between the flange portion and the disc portion, said two sealing rings being compressed between the flange and shoulder with the marginal portion of the metal disc being resiliently and insulatingly retained between the sealing rings, and a terminal lead attached to said disc at the outer face thereof.

3. The construction according to claim 2 wherein the inner sealing ring is of the type having cold flow characteristics and wherein annular ribs extending toward the inner sealing ring are formed in the housing flange and metal disc, said ribs being inwardly spaced from the outer portion of the inner sealing ring to function as cold flow retarding means.

4. The structure according to claim 3 wherein the annular ribs are offset from each other so that one rib is at a different distance from the center of the disc than the other rib.

5. An electrolytic condenser of the type having an electrolyte subject to creepage, said condenser having a housing of ductile metal, said housing consisting of a can-shaped portion with an outwardly offset shoulder portion and an axial extension terminating in a marginal portion, said marginal portion having the metal curled inwardly upon itself to form a generally toroidal flange substantially all of which overlies the housing shoulder portion, an integral electrode assembly including a thin metal disc, said assembly having a portion thereof within the housing and an electrolyte within said housing, an inner sealing ring of a material having substantial cold flow characteristics disposed over the shoulder portion of said housing, the housing material being shaped to provide an annular rib at the bend where the housing metal extends outwardly from the housing proper to define the outwardly offset shoulder portion with said rib being directed toward the inner sealing ring, the marginal portion of said disc overlying the housing shoulder portion and the inner sealing ring, an outer sealing ring disposed between the marginal portion of the disc and the curled flange, said curled flange portion maintaining compression upon the two sealing rings, said outer sealing ring being of a resilient material, and a terminal lead attached to the outside surface of said disc.

6. The construction according to claim 5 wherein said disc is provided with an annular rib at the marginal portion, said rib extending toward the inner sealing ring.

7. The structure according to claim 5 wherein the inner sealing ring is recessed to accommodate the disc of the electrode assembly.

8. The structure according to claim 5 wherein the inner sealing ring is recessed to accommodate the marginal portion of the electrode assembly disc and wherein said disc has an annular rib formed therein directed toward the inner sealing ring.

9. A seal construction for an electrical device having sulphuric acid as an electrolyte and requiring an insulating, hermetic seal, said construction comprising a hous-

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ing of ductile metal, said housing being can-shaped with an outwardly offset shoulder portion at the mouth of the can, said shoulder portion terminating in an inwardly curved toroidal-shaped flange axially offset from the shoulder portion, substantially all of said flange being over the housing shoulder, an inner sealing ring of a material having a cold flow characteristic and resistant to sulphuric acid and the like, said inner ring being disposed over the housing shoulder, an integral electrode assembly including a thin metal disc having a marginal portion overlying said shoulder portion and resting upon the inner sealing ring, said disc marginal portion extending beyond the inner edge of the shoulder so that the inner sealing ring separates the disc from the housing metal, an outer sealing ring of rubber disposed between the flange and marginal portion of the disc, said two sealing rings being under compression between the flange and housing shoulder and providing a hermetic and electrical seal for the construction, and a terminal lead attached to the outside of said disc.

10. The structure according to claim 9 wherein said inner seal ring is of the group consisting of polytrifluorochloroethylene and polytetrafluoroethylene and wherein the outer sealing ring is of synthetic rubber.

11. The structure according to claim 9 wherein said inner seal ring is of a material stable over a wide range of temperatures and inert to acids such as sulphuric acid.

12. The construction according to claim 9 wherein said housing has an annular rib at the region where the housing metal begins the offset to form the shoulder, said rib being inwardly directed toward the flange and the disc has an annular rib inwardly directed toward the inner sealing ring, the rib in the disc being located somewhat closer to the outer edge of the inner sealing ring than the rib in the housing, whereby cold flow of the inner ring material is effectively controlled.

13. The construction according to claim 12 wherein the inner seal ring is of the group consisting of polytrifluorochloroethylene and polytetrafluoroethylene and wherein the outer sealing ring is of rubber.

14. The structure according to claim 13 wherein there is provided an annular metal member between the curved flange and the outer sealing ring.

15. The construction according to claim 14 wherein the inner sealing ring is recessed to accommodate the marginal portion of the disc of the electrode assembly.

16. An electrical device of the type containing a liquid and requiring a hermetic seal, said device comprising: a metal housing having a portion defining an opening, said portion including an outwardly extending annular shoulder, a sidewall extending away from the outer edge of the shoulder and a pressure bearing element extending from the sidewall and overlying said shoulder; at least two sealing rings of insulating material disposed one above the other between the shoulder and the pressure bearing element, the outer edge portions of said rings bearing against the sidewall; and an integral electrode assembly including a metal disc, the outer marginal portion of said disc being spaced from the sidewall and disposed between the opposed surfaces of the two sealing rings and clamped thereby, the two sealing rings, the disc, the pressure bearing element, and the shoulder providing a flexible, insulating, hermetically sealed construction; and a terminal on the outer surface of the disc.

17. An electrical device of the type containing a liquid and requiring a hermetic seal, said device comprising: a metal housing having a portion defining an opening, said portion including an outwardly extending annular shoulder, a sidewall extending away from the outer edge of the shoulder, and a pressure bearing element having the free end of said portion curled inwardly upon itself through an angle of more than 270 degrees, the bottom of said curled pressure bearing element overlying said shoulder; at least two sealing rings of insulating material disposed one above the other between the shoulder and

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pressure bearing element, the outer edge portions of said rings bearing against the sidewall; and an integral electrode assembly including a metal disc, the marginal portion of said disc being spaced from the sidewall and disposed between the opposed surfaces of the two sealing rings and clamped thereby, the two sealing rings, the disc, the annular shoulder, and the pressure bearing element providing a flexible, insulating, hermetically sealed construction; and a terminal on the outer surface of the disc.

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