

Description

This invention relates to a seal that is adapted to close the open end of an electrochemical cell casing. In particular, the present invention relates to a seal for cylindrical alkaline cells which can develop high internal pressures, such as cells which have zinc anodes containing little or no mercury.

Some cylindrical alkaline cells are sealed by placing a seal (such as that shown and described in US patent 4,670,362) onto a bead formed just below the upper open end of the cell casing and crimping the upper end of the casing inwardly and over the outer periphery of the seal to compress it against the bead.

Radially crimping a seal into place is an alternative to the beaded crimping method described above and generally creates a much tighter seal. In this crimping method a portion of the cell casing wall at the open end is expanded. A seal member fits closely within the expanded opening. The seal member includes a metal disc which fits within a circular outer wall of a plastic grommet. The expanded portion of the casing is reduced back to its original size whereby a radial force causes the metal disc to bite into the grommet wall. US patent No. 3,069,489 discloses a radially crimped seal like the one just described. That patent states that the plastic grommet must be made from a material which has good cold-flow characteristics so that over time the amount of plastic material flowing out of the seal area due to the compressive force is minimized. The patent states that the seal described maintained its integrity over several months. Today, however, alkaline cells must remain tightly sealed for up to five years. Thus, a problem with a radially crimped seal is that even with materials having good low flow characteristics there is still some flow which takes place over long time periods and the seal becomes less effective.

Most alkaline cell seals also have a vent designed to open at a predetermined pressure. If the vent were to fail to open there is also a pressure, higher than the vent pressure, which can dislodge the seal from the cell casing. This is called the decrimping pressure. Most cells are designed so that the decrimping pressure is sufficiently greater than the venting pressure to ensure that the vent will open first. In cells having low mercury content much higher internal pressures are encountered than in present commercial cells. Thus, a cell design for low mercury content cells must not only have a vent capable of managing high internal pressures, but must also have a crimp design which can maintain even higher pressures.

WO-A-8911164 (EP 413701, GB 2218564) discloses an alkaline cell top with a circular plastics grommet which has an axial aperture and an upwardly extending wall at its periphery, and a metal support seated within the wall of the grommet.

It is an object of the present invention to provide a reliable seal for a radially crimped cell which can main-

tain high internal pressures even after temperature fluctuations.

According to the present invention there is provided an insulating seal for the open end of an electrochemical casing comprising: a circular plastic grommet having an upper surface, a lower surface, an upwardly extending circumferential wall at its periphery, and an axial aperture, wherein said grommet has a diameter such that it closely fits within the open end of the cell casing; and a metal support member with a central disc portion, spring means located in the periphery of the member, and an axial aperture; characterised by strengthening means disposed in said disc portion, said strengthening means comprising a depressed region in the central disc portion said strengthening means being adapted to retard upward movement of the center of the support when said spring means is put under inwardly directed, radially applied, compressive forces, and wherein said metal support is seated within and coaxial with the circumferential wall of said grommet.

Also according to the invention there is provided An electrochemical cell comprising a cylindrical casing having an open end, an anode, a cathode, a separator between said anode and cathode, and a sealing member under radial compression disposed in the open end of the casing; said sealing member comprising a circular plastic grommet having a circumferential wall and a circular metal support member seated within the circumferential wall of the grommet; said support member comprising a central disc portion, an outer radially extending, continuous, annular flange, and spring means between said flange and the periphery of said disc portion; wherein a lower portion of the circumferential wall of the grommet is compressed between said flange and said casing; characterised in that said support member further comprises a depressed region in central disc portion to retard upward movement of the center of the support when said spring means is put under inwardly directed, radially applied, compressive forces and said flange bites into the lower portion of circumferential wall and said spring means is under partial compression within its elastic limit whereby said spring means is adapted to expand or compress in response to temperature fluctuations so that compression of the lower portion of the grommet wall is maintained.

In a preferred embodiment, the seal is preassembled to provide an integrated part which can be handled as a single element during cell assembly. An integrated seal has many advantages not already mentioned. For example, no additional manufacturing steps are required after the member is crimped in place. Thus, there is no possibility of disrupting the seal once it is formed. Another advantage is that a better seal between the current collector and the boss is obtained. The seal between the current collector and the boss can be made without the possibility of any electrolyte being trapped therebetween, as can occur when a nail-type collector is inserted through a plastic grommet that is sealed in place. any

electrolyte trapped in this manner would enhance the wicking of electrolyte from within the cell and would result in leakage.

These, and other features and objects of the invention are more fully described hereafter in association with the accompanying drawings, in which:

Fig. 1 is a side view of a cell casing;
 Fig. 2 is a cross sectional view through an integrated seal made in accordance with the present invention;
 Fig. 3 is a top view of a metal support member made in accordance with the present invention;
 FIG. 3A is a cross sectional view through the metal support member shown in FIG. 2 taken along line A-A;
 FIG. 3B is an enlarged portion of the cross sectional view shown in FIG. 3A;
 FIG. 4 is a top view of a plastic grommet;
 FIG. 4A is a cross sectional view through the plastic grommet shown in FIG. 4 taken along line A-A;
 FIG. 4B is an enlarged view of the cross section contained within the circled portion shown in FIG. 4A;
 FIG. 4C is a cross section through the central portion of an embodiment of a plastic grommet having the vent membrane adjacent to the boss;
 FIG. 5 is a cross-sectional view through a rivet-type current collector;
 FIG. 6 is a cross sectional view through the central region of an integrated seal having a nail-type current collector;
 FIG. 7 is a top view of a terminal end member;
 FIG. 7A is a cross sectional view through the terminal end member shown in FIG. 7 taken along line A-A;
 FIG. 8 is a cross sectional view through an electrochemical cell made in accordance with the present invention, and
 FIG. 9 is a cross sectional view through a seal pre-assembly showing an alternate embodiment.

Referring now to Figure 1, cylindrical cell casing 10 is provided with cylindrical wall 12 having a closed end 14 and an expanded (or stepped) portion 18 at its upper, open end 16. For a "AA" size cell the diameter of expanded portion 18 is about 0.51 mm (0.02 inch) greater than the diameter of the main casing body. For cell sizes larger than "AA", such as "C" or "D", the expanded portion is about 0.76 mm (0.03 inch) greater. For larger cell sizes such as "C" and "D" it is preferred that the wall thickness of casing 10 be about 0.3 mm (0.012 inch), whereas for smaller cell sizes such as "AA" and "AAA" it is preferred that the wall thickness be about 0.25 mm (0.01 inch). Casing 10 can be made from suitable materials such as cold rolled steel, stainless steel, and nickel plated cold rolled steel. The height of expanded portion 18 is sufficient so that upper end 22 can be folded in and over the periphery of the seal member.

The embodiment of the present invention shown in

FIGS. 2-8 is designed to be used for larger cell sizes such as "C" or "D". Smaller cell sizes, such as "AA" and smaller, require slight modifications as discussed below in reference to FIG. 9. Referring now to Figure 2, integrated seal assembly 24 comprises a plastic grommet 30 and a metal support 40 held firmly together by a rivet-type current collector 50 and a negative terminal end cap 60 that is in electrical contact with collector 50; either directly, or, as shown, indirectly through physical contact with metal support 40. End cap 60 is held in the assembly by the upper outer wall 39 of grommet 30 which is turned inwardly and over the periphery of end cap 60.

Referring now to Figures 3 and 3A, metal support 40 comprises a central disc portion 41 with a circular depressed portion 42 formed centrally therein and a centrally located aperture 43. Depressed portion 42 acts to strengthen the metal support 40, and particularly prevents the central disc portion 41 from deflecting outwardly during radial crimping.

In a preferred embodiment, an outwardly extending, annular, "U"-shaped channel 45 is attached at the outer edge of the central disc portion 41. Channel 45 functions as a spring which becomes partially compressed when the radial crimp is formed. Thus, when the assembled cell is subjected to thermal fluctuations, channel 45 can expand or compress further thereby maintaining an outwardly directed sealing pressure at all times. "U"-shaped channel 45 is formed by inner wall 46 and outer wall 47.

Radial flange 48 extends outwardly from the upper portion of outer wall 47. In a crimped cell, the seal is created by a portion of grommet 30 being squeezed between radial flange 48 and portion 18 of casing 10. It is preferred that flange 48 has a diameter which is less than the inner diameter of the crimped cell so that it is not possible for the support to cut through an interposed portion of grommet 30.

"U"-shaped channel has a true radius "b" as shown in FIG. 3B. If the "U"-shaped channel was narrower and deeper than the one shown it would permanently deform more readily. It is also preferred that the angle "a" formed between leg 46 and central disc portion 41 is between about 100° and 115°. Such angle permits skirt 44 and channel inner wall 46 to move inwardly when inwardly directed radial compressive forces are applied, and helps to prevent the central disc portion 41 from flexing upwardly during crimping. The inward movement of skirt 44 is assisted by keeping the depth of channel 45 at about one half the height of metal support member 40. However, other shapes of the channel and other angles between the skirt and disc portion which will provide similar sealing characteristics are within the scope of the present invention.

In a preferred embodiment metal support 40 is made of nickel plated, cold-rolled steel having a thickness of about 0.51 mm (0.02 inch). Other suitable materials include cold rolled steel, hot rolled steel, stainless steel, steel alloys, and beryllium copper. It is also preferred that metal support 40 be provided with a means, such as ap-

ertures 49, for releasing the vented gas which escapes when the cell vents (discussed further below).

Referring now to FIGS. 4 and 4A the details of grommet 30 will be explained. Figure 4A shows a cross section through circular plastic grommet 30 taken along the line A-A in FIG. 4. Grommet 30 comprises a central disc portion 31 and an axially extending boss portion 32 at the center of disc portion 31. Boss portion 32 has an axial aperture 25 therethrough. A chamfer 26 can be provided for easier insertion of a current collector through aperture 25. A "U"-shaped annular channel 33 is connected to disc portion 31. Channel 33 is comprised of an inner wall 34, an outer wall 35, and a bottom wall 36 whereby the upper edge of inner wall 34 is connected to the periphery of central disc portion 31. The particular shape of channel 33 depends on the shape of channel 45 in metal support member 40 since channel 45 fits within channel 33 in the assembled seal (see FIG. 2).

An outwardly directed shoulder 28 is connected to the upper edge of outer wall 35 of channel 33. An upwardly extending circumferential wall 37 is connected to the outermost portion of shoulder 28. Circumferential wall 37 is comprised of an upper portion 39 and a lower portion 38. The outer diameter of shoulder 28 is approximately equal to, or slightly less than, the inner diameter of step 20 in casing 10. Thus, the engagement of shoulder 28 on step 20 of casing 10 supports the assembly both before and after radial crimping. The inner diameter of lower wall portion 38 is approximately equal to, or slightly greater than, the outer diameter of metal support

40. Since grommet 30 does not need to have a thickness which provides mechanical strength as in prior art cell tops the various portions of grommet 30 which have a surface exposed to the interior of the cell can be made thin so that an appreciable amount of hydrogen permeation through the grommet portions can take place. In accordance with the present invention, the portions of grommet 30 which are available for hydrogen permeation from within the cell are central disc portion 31 and the walls 34, 35 and bottom 36 of channel 33. It is therefore desirable to have these portions of the grommet thin enough so that hydrogen permeation is enhanced. Thus, the actual surface area available for permeation is greater than the apparent surface area of the grommet. In one embodiment the thickness of portions 34, 35, and 36 is about 0.51 mm (0.02 inch). In another embodiment annular disc is about 0.38 mm (0.015 inch) thick while the other portions are 0.51 mm (0.02 inch) thick. This latter embodiment allows for even greater hydrogen permeation through annular disc 31 than the former embodiment where disc 31 is 0.51 mm (0.02 inch) thick. The lower limit for thickness in all areas is about 0.25 mm (0.01 inch) since below this it is difficult to mold the part and it is difficult to control the venting pressure. The upper limit is defined by the desired hydrogen permeability, but a practical upper limit which still has reasonable hydrogen permeability is about 0.76 mm (0.03 inch).

The thickness of lower wall portion 38 is greater than one half the difference between the diameter of support member 40 and the inner diameter of casing 10. Thus, when seal 24 is radially crimped into place radial flange 48 bites into wall portion 38. It is preferred that the strain on the plastic in this area is within the elastic limit of the plastic at the time the crimp is formed. It is preferred that flange 48 does not compress wall portion 38 by more than 50%, and more preferably not more than 25%, of its original thickness. The degree to which wall 38 is compressed depends on the type of plastic used, the thickness of wall 38, and the difference between the diameter of metal support 40 and the inner diameter of casing 10. However, once the plastic material is chosen it is within the skill of the artisan to optimize the other two values so that the plastic remains within its elastic limit. Materials which have a compressibility such that they remain within their elastic limit while at the same time being hard enough to place spring means 45 under compression include nylon, nylon alloys, polysulfone, filled polypropylene, and alloys of these.

As used herein the term "nylon" encompasses a variety of different materials in the nylon family. Varieties of nylon are generally characterized by the length of the carbon chains in the diamine and the diacid which are used to prepare the polymer. Nylon 6-6 is prepared by the reaction of hexamethylenediamine (six carbon atoms) with hexanedioic acid (six carbon atoms). Nylon 6-12 is prepared from the same diamine as is nylon 6-6, but reacted instead with dodecanedioic acid having 12 carbon atoms. Nylon 12-12 is prepared from a dodecamethylenediamine and a dodecanedioic acid each of which has 12 carbon atoms. Nylon is known to absorb moisture and it is preferred that the plastic grommets are fully moisturized after forming. This is generally done by boiling. Nylon can be alloyed with a variety of polymers, non-limiting examples of which are other nylons, polyethylene, polypropylene, ABS, and polysulfone.

While all of the above mentioned materials are useful from a strength viewpoint, it has been discovered that certain of these materials have a high hydrogen permeability. Nylon 6-6 has the poorest hydrogen permeability, being about $1 \text{ cm}^3 \text{ H}_2 (\text{@STP}) \cdot \text{cm} / \text{S} \cdot \text{cm}^2 \cdot \text{cm Hg}$. It is preferred that materials having at least three times this permeability be used in low mercury content cells. Plastics with at least three times the hydrogen permeability of nylon 6-6 include nylon 6-6/ABS alloys, nylon 6-12, alloys comprising nylon 6-12, nylon 12-12, alloys comprising nylon 12-12, mineral filled polypropylene and alloys thereof, and polysulfone and alloys thereof. The following Table lists some of the preferred materials and their hydrogen permeability. Unless otherwise specified the nylon containing materials are fully moisturized. The units of permeability are $\text{cm}^3 \text{ H}_2 (\text{@STP}) \cdot \text{cm} / \text{S} \cdot \text{cm}^2 \cdot \text{cm Hg}$.

Material	Permeability
nylon 6-6/ABS (50/50)	6.1
nylon 6-12	4.4
nylon 6-12 (dry)	5.5
nylon 12-12	3.2
20% talc filled polypropylene	14.5
nylon 6-12/12-12 (50/50)	4.4

Even when plastics having high hydrogen permeability are used to mold grommet 30 it is still necessary to include a vent means whereby excessive pressures can be relieved more quickly. Referring now to FIGS. 4, 4A and 4B there is shown an annular vent 70. The Figures show that the reduced thickness of vent section 70, as compared to adjacent portions of annular disc 31, is obtained by including an annular groove in both the top and bottom surfaces of central disc 31 wherein the grooves are coincident. Each groove has a depth of less than one half the thickness of central disc 31 whereby a thin membrane remains between the grooves. It has been discovered that a vent membrane formed in this manner is more reliable than a membrane of the same thickness but formed by a groove in only one side. Such design is also preferred because venting occurs at a lower internal pressure than if the notch was taken out of either the bottom or the top of annular disc 31.

FIGS. 4A and 4B show a preferred location of annular vent 70 in the outer periphery of central disc 31. When vent 70 ruptures, annular disc 31 disconnects from inner wall 34 of channel 33 and disc 31 can flex upwardly and inwardly while being hinged to boss portion 32. FIG. 4C shows an alternate embodiment wherein vent 71 is directly adjacent to boss 32. In this embodiment the presence of boss 32 on one side of the vent membrane creates a shear force on the membrane when internal pressure is applied which causes the membrane to rupture at a lower internal pressure than when the membrane is located in the periphery of disc portion 31. A potential problem of locating annular vent 71 as shown is that when the vent ruptures there is an outer portion of central disc 31 which stays attached to inner channel wall 34 and which can flex upwardly and outwardly. Such an embodiment could cause the flexed portion of disc 31 to block off openings 49 provided in metal support 40 for passage of vented gas. Therefore, apertures 49 may have to be relocated to prevent this from happening.

It is preferred that the thickness of grommet 30 in the area of shoulder 28 is greater than other portions of the grommet so that extra material is provided to minimize fractures where shear forces are exerted on shoulder 28 during radial crimping. Thus, it is desirable to have the thickness of shoulder 28 be about 0.76 mm (0.03 inch).

It is within the scope of the present invention, however, that shoulder 28 is the same thickness as the walls

of channel 33. This latter embodiment retains all of the sealing and venting characteristics as the embodiment having a thicker shoulder portion 28. Upper outer wall 39 is preferred to be about half the thickness of lower outer wall 38 so that it can more easily be heat-formed inwardly over the periphery of negative end cap 60 thereby holding negative end cap in place until the radial crimp is formed (discussed further below).

FIG. 4A shows a downwardly dependent skirt portion 27 connected to lower channel wall 36. Skirt portion 27 is not required for sealing the cell but rather is used to contain the upper edge of the cell separator (see FIG. 8). The separator is usually formed as a cylinder whereby the upper end of the cylinder fits within the inner circumference of skirt 27. Other designs of such skirt portions are possible and could be incorporated into the seal described herein.

Metal support 40 and grommet 30 are firmly held together by rivet 50 (Fig. 2). Figure 5 shows a sideview of an embodiment of a rivet for use in the present invention. Rivet 50 comprises an upper shank 52, a flange 53, and an indentation 54 in the end of upper shank 52. The diameter of upper shank 52 is about the same as, or slightly larger than the inner diameter of axial aperture 25 in boss 32 such that a tight fit results. The upper shank 52 is inserted through axial aperture 25 in boss 32 from the underside of grommet 30 until flange 53 contacts the underside of boss 32. The upper end of shank 52 extends above the top of boss 32. Metal support 40 fits inside grommet 30 such that the upper end of shank 52 projects through aperture 43 of support member 40. The assembly is completed by forming rivet head (55 in Fig. 2) using indentation 54 in upper shank 52. FIG. 2 shows the completed assembly. It is preferred that rivet head 55 does not project above the upper surface of central disc 41 in metal support 40.

Since rivet 50 is the electrical feedthrough between the negative terminal and the anode inside the cell a current collector is also connected to rivet 50. An embodiment of a current collector is shown in Figure 5. Lower shank 51 extends downwardly from flange 53. The length of shank 51 is such that, in an assembled cell, it projects into a centrally located anode of a cell such as a primary alkaline cell.

Once grommet 30 and metal support 40 are riveted together a leakproof seal is created between flange 53 and boss 32 whereby electrolyte leakage past this seal is precluded. While this compression seal is fully adequate, it may be desirable to also include a sealant material in this area. Thus, before rivet 50 is inserted through grommet 30 a bead of sealant material is applied on flange 53. Thus, when the rivet is inserted and the rivet head is made a layer of sealant material is interposed between flange 53 and boss 31 as well as sealant filling chamfer 26 of plastic grommet 30. Non-limiting examples of suitable sealants include polyamides and bitumen.

Since rivet 50 is in physical contact with the anode

and the electrolyte it must be made from a material which is chemically compatible with the electrolyte and anode. Brass is a preferred material when the anode is zinc and the electrolyte is a KOH electrolyte. Other suitable materials include nickel-silver, silicon-bronze, and copper.

An alternative current collector to the rivet-type just described is a conventional nail-type current collector. FIG. 6 shows a cross section through the middle portion of a seal wherein a nail-type collector 55 is used to hold metal support 40 and plastic grommet 30 together. In this embodiment the apertures in boss 32 and metal support 40, through which current collector 55 passes, are sized to give a tight interference fit with the nail shank creating a seal thereby. Additionally, an amount of sealant can be applied at the upper end of boss 32 before the nail is inserted. Thus, when the nail is inserted the sealant is drawn down between the nail and the boss whereby any leakage paths are effectively blocked off.

Referring now to FIG. 7 and 7A there is shown a metal circular terminal end member 60 which is the external negative electrical contact of the cell. Terminal member 60 has a outer diameter which is less than the outer diameter of metal support member 40. Thus, when seal 24 is crimped in place and the diameter of metal support member 40 is reduced there is substantially no radial force exerted on terminal member 60.

Terminal member 60 is comprised of a central platform region 61 and an annular "U"-shaped channel 63 attached thereto. Platform region 61 may have an annular groove 62. Annular groove 62 has a diameter such that it nests inside central depression 42 of metal support 40 as shown in FIG. 2. This arrangement serves to locate terminal member 60 onto metal support 40 during assembly before upper wall 39 of plastic grommet is heat formed inwardly to hold terminal member 60 in place. Annular channel 63 is comprised of an inner wall 67, an outer wall 64, and a bottom wall 65. Inner wall 67 is connected to the periphery of platform region 61. Bottom wall 65 has a plurality of apertures 66 therein to complete the passageway for vented gases. Apertures 66 could also be located in inner wall 67.

The height of channel inner wall 67 is such that when platform region 61 is resting on central disc portion 41 of metal support 40 the lower surface of bottom wall 65 does not contact flange 48 of metal support 40. This arrangement is seen in FIG. 2. The purpose of this separation is to prevent any upward forces from being exerted on terminal member 60 by radial flange 48 when the seal is radially crimped. The outer edge of radial flange 48 is bent slightly inwardly and upwardly when the radial crimp is made. For the seal depicted in FIG. 2 the distance of separation is about 0.01 inch. It is preferred that the separation distance is kept at a minimum so that radial flange 48 just touches channel bottom wall 65 when the radial crimp is formed as shown in FIG. 8.

End terminal 60 makes mechanical and electrical contact to metal support 40 as shown in FIG. 2. The outer portion of platform 61 is in contact with the outer portion

of central disc portion 41 of metal support 40. Contact in this area can be further guaranteed by either welding the parts together or by interposing a conductive grease, conductive epoxy, or like material between the surfaces.

5 An embodiment having a slightly different conductive path is obtained by placing an amount of conductive epoxy or like material in central depression 42 of metal support 40 whereby the head of current collector 50 is covered and the epoxy makes contact to the center portion of terminal member 60. Thus, a variety of arrangements are possible for electrically connecting end terminal 60 to metal support 40 and all are within the scope of the present invention.

10 For cosmetic purposes end terminal member 60 is preferably made from a metal having a shiny surface such as nickel plated cold rolled steel wherein the formed member is plated with nickel either before or after forming.

Once the end terminal member 60 is located in place on metal support 40, the integrated seal 24 can be completed by heat forming upper edge 39 of grommet 30 inwardly and over outer wall 64, as shown in FIG. 2. The heat forming step can be carried out using conventional tooling for heat forming plastics.

25 Reference will now be made to FIG. 8 which shows a cross section of an electrochemical cell having a seal radially crimped in place in accordance with the present invention. Electrochemical cell 80 comprises a cylindrical casing 10 with an anode 82, a cathode, 84, and a separator 85 between said anode and cathode contained therein. Radially crimped into the upper end of the cell casing is an integrated seal such as is shown in FIG. 2.

Cell casing 10 has an indentation 86 formed in the upper end thereof. Indentation 86 is an artifact of step 20 (FIG. 1) after being radially crimped inwardly and serves as a support whereby downward movement of the seal is precluded. Cell casing 10 further comprises an upwardly extending wall portion 88 connected to indentation 86 which portion is the sealing area of cell 80. Adjacent to the inner surface of wall portion 88 is a portion of lower outer wall 38 of grommet 30 compressed between wall portion 88 and radial flange 48 of metal support 40. In accordance with the present invention, spring means 45 (FIG. 3A) is under partial compression within its elastic limit.

Comparison of the metal support members shown in FIGS. 2 and 8 reveals that the diameter of support 40 has been reduced and the outer edge of radial flange 48 has moved slightly upwardly toward terminal member 60 in the crimped cell. The inner portion of flange 48 is turned downwardly which causes the lowest portion of channel 45 to be pushed downwardly. Skirt 44 and inner channel wall 46 have been pushed inwardly and, at the same time, walls 46 and 47 are compressed towards each other. The interaction of the downward movement of channel 45 and the inward movement of skirt 44 and wall 46 prevents any doming of the central portion of sup-

port 40 which would otherwise occur. The tendency for these movements to relax exerts an outwardly directed compressive force by flange 48 against grommet wall 38.

Uppermost portion 90 of cell casing 10 is turned inwardly and over the inwardly formed upper wall 39 of grommet 30. It is important that the angle formed between wall portion 88 and upper portion 90 is less than 90° and preferably less than 60°. Such an angle imparts very high strength in holding the seal in place whereby very high internal pressures are required to decrimp the cell. Further, the foldover of upper casing portion 90 holds terminal end member 60 downwardly against metal support member 40 ensuring good electrical contact therebetween.

As shown in FIG. 8, the upper surface of terminal member 60 is recessed from rim 92 of casing 10. Since terminal member 60 is the negative electrical contact of cell 80 such an arrangement precludes a user from electrically connecting a cell in a backwards position to another cell. It is desirable to prevent this from happening since the reversed cell could be vented by the other cell or cells forcing current through the backwards cell. Generally, having the upper surface of terminal member 60 recessed from rim 92 by 0.05-0.10 mm (0.002-0.004 inch) is sufficient to accomplish the desired result.

Cells made in accordance with the present invention have decrimp pressures in the range of 11032000 Pa (1600 psi). The vent pressure is in the range of 4137000 Pa (600 psi) whereas a conventional circular vent for similarly sized cells vents at about 2758000 Pa (400 psi). Thus, the present invention is better suited to manage the higher internal pressures associated with alkaline cells having little or no mercury in their anodes.

Extensive leak testing of radially crimped alkaline cells with 0% mercury in the anode and having a seal member in accordance with the present invention has demonstrated that the seal does not leak. Test cells have been subjected to a variety of environmental tests. Thermal shock tests have been carried out on undischarged cells with no leaks being detected. In contrast, 63% of cells made having a conventional beaded crimp and having 1.5% mercury in the anode showed signs of leakage. Thus, even greater leakage is expected with a beaded cell if the anode contains no mercury.

Undischarged cells made in accordance with the present invention and having 0% mercury were also subjected to a temperature and humidity test with temperature cycling. At the end of the four prolonged storage periods the cells were inspected periodically for leakage. None of the cells showed any signs of leakage. In contrast 37% of conventional cells made having a beaded crimp and 1.5% mercury in the anode showed signs of leakage.

Similar tests were performed using discharged cells which are known to generate higher internal pressures on storage than undischarged cells. Cells made in accordance with the present invention and without mercury were discharged until their original capacity was reduced

by 25%. The cells were subjected to the thermal cycling test with no signs of leakage compared to discharged conventional cells with 1.5% mercury where 90% of the cells tested leaked.

The seal member described herein is readily adapted to fit all cylindrical cell sizes. However, because of the slim diameter of "AA" size and smaller size cells, there are some minor alterations which are preferred in order to maintain the same sealing characteristics.

Referring now to FIG. 9, there is shown a cross sectional view through seal preassembly 100, suitable for use in a "AA" size cell. Preassembly 100 is comprised of plastic grommet 110, metal support 120, and current collector 130 which holds grommet 110 and metal support 120 together. Preassembly 100 differs from the integrated assembly shown in FIG. 2 in the shape of metal support 120 and grommet 110. Although FIG. 9 does not show an end terminal member, the terminal member 60 shown in FIG. 2 would be suitable, downsized to the diameter for a "AA" size cell.

Metal support 120 comprises step 122 connected between downwardly dependent skirt 124 and inner wall 126 of annular "U"-shaped channel 125. Step 122 provides a connection between skirt 124 and channel 125 without having to change the angle between skirt 124 and central disc portion 127. As discussed above it is preferred that this angle is between 100 and 115°. If step 122 was not present this angle would have to be increased to greater than 120° to connect to inner channel wall 126 whereby the spring characteristic of the metal support member would be changed. Step 122 has a secondary function which is to support outer disc portion 128 of grommet 140 as internal cell pressure increases. It has been discovered that venting occurs at a given pressure more reliably than if outer disc portion 128 were not supported. For this reason the metal support shown in FIG. 3A for larger cells could also have a step included. However, a disadvantage to the inclusion of step 122 is that it makes metal support 120 more difficult to form.

FIG. 9 also shows a V-shaped channel 142 as opposed to a squared "U"-shaped channel 33 (shown in FIG. 4A) in the plastic grommet. V-shaped channel 142 has a greater surface area than a "U"-shaped channel and therefore allows greater hydrogen diffusion. The choice between these or other shapes for the channel in the plastic grommet is a matter of preference for one skilled in the art. If hydrogen diffusion is important the V-shaped channel would be preferred but in other situations the "U"-shaped channel might be preferred.

The above description is for illustration and explanation purposes. Variations can be made by one with ordinary skill in the art and still remain within the scope of the claimed invention.

Claims

1. An insulating seal for the open end of an electro-

port 40 which would otherwise occur. The tendency for these movements to relax exerts an outwardly directed compressive force by flange 48 against grommet wall 38.

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Extensive leak testing of radially crimped alkaline cells with 0% mercury in the anode and having a seal member in accordance with the present invention has demonstrated that the seal does not leak. Test cells have been subjected to a variety of environmental tests. Thermal shock tests have been carried out on undischarged cells with no leaks being detected. In contrast, 63% of cells made having a conventional beaded crimp and having 1.5% mercury in the anode showed signs of leakage. Thus, even greater leakage is expected with a beaded cell if the anode contains no mercury.

Undischarged cells made in accordance with the present invention and having 0% mercury were also subjected to a temperature and humidity test with temperature cycling. At the end of the four prolonged storage periods the cells were inspected periodically for leakage. None of the cells showed any signs of leakage. In contrast 37% of conventional cells made having a beaded crimp and 1.5% mercury in the anode showed signs of leakage.

Similar tests were performed using discharged cells which are known to generate higher internal pressures on storage than undischarged cells. Cells made in accordance with the present invention and without mercury were discharged until their original capacity was reduced

by 25%. The cells were subjected to the thermal cycling test with no signs of leakage compared to discharged conventional cells with 1.5% mercury where 90% of the cells tested leaked.

The seal member described herein is readily adapted to fit all cylindrical cell sizes. However, because of the slim diameter of "AA" size and smaller size cells, there are some minor alterations which are preferred in order to maintain the same sealing characteristics.

Referring now to FIG 9, there is shown a cross sectional view through seal preassembly 100, suitable for use in a "AA" size cell. Preassembly 100 is comprised of plastic grommet 110, metal support 120, and current collector 130 which holds grommet 110 and metal support 120 together. Preassembly 100 differs from the integrated assembly shown in FIG. 2 in the shape of metal support 120 and grommet 110. Although FIG. 9 does not show an end terminal member, the terminal member 60 shown in FIG. 2 would be suitable, downsized to the diameter for a "AA" size cell.

Metal support 120 comprises step 122 connected between downwardly dependent skirt 124 and inner wall 126 of annular "U"-shaped channel 125. Step 122 provides a connection between skirt 124 and channel 125 without having to change the angle between skirt 124 and central disc portion 127. As discussed above it is preferred that this angle is between 100 and 115°. If step 122 was not present this angle would have to be increased to greater than 120° to connect to inner channel wall 126 whereby the spring characteristic of the metal support member would be changed. Step 122 has a secondary function which is to support outer disc portion 128 of grommet 140 as internal cell pressure increases. It has been discovered that venting occurs at a given pressure more reliably than if outer disc portion 128 were not supported. For this reason the metal support shown in FIG. 3A for larger cells could also have a step included. However, a disadvantage to the inclusion of step 122 is that it makes metal support 120 more difficult to form.

FIG. 9 also shows a V-shaped channel 142 as opposed to a squared "U"-shaped channel 33 (shown in FIG. 4A) in the plastic grommet. V-shaped channel 142 has a greater surface area than a "U"-shaped channel and therefore allows greater hydrogen diffusion. The choice between these or other shapes for the channel in the plastic grommet is a matter of preference for one skilled in the art. If hydrogen diffusion is important the V-shaped channel would be preferred but in other situations the "U"-shaped channel might be preferred.

The above description is for illustration and explanation purposes. Variations can be made by one with ordinary skill in the art and still remain within the scope of the claimed invention.

Claims

1. An insulating seal for the open end of an electro-





chemical casing (10) comprising:

a circular plastic grommet (30) having an upper surface, a lower surface, an upwardly extending circumferential wall (37) at its periphery, and an axial aperture (25), wherein said grommet has a diameter such that it closely fits within the open end of the cell casing (10);
and a metal support member (40) with a central disc portion (41), spring means (45,46,47) located in the periphery of the member, and an axial aperture (25); characterised by strengthening means disposed in said disc portion (41), said strengthening means comprising a depressed region (42) in the central disc portion (41), said strengthening means being adapted to retard upward movement of the center of the support (40) when said spring means (45, 46, 47) is put under inwardly directed, radially applied, compressive forces, and wherein said metal support (40) is seated within and coaxial with the circumferential wall (37) of said grommet (30).

2. The seal of Claim 1 further comprising a current collector (50) extending through the apertures in the metal support and the grommet, said current collector being in mechanical and electrical contact with said support and being in a sealing relationship with the aperture in the grommet.
3. The seal of Claim 2 wherein said current collector comprises a rivet portion and said rivet holds said grommet and metal support together, said rivet comprising a shaft (52), a flange (53) disposed near one end of the shaft, and a rivet head (54) at the other end of the shaft, wherein said flange engages with the lower surface of the boss and the rivet head is formed against the upper surface of the metal support whereby the support and boss are compressed axially together such that a leak tight seal is made between the flange and the boss.
4. The seal of Claim 2 or 3 further comprising a circular conductive end terminal (60) on the side of said support opposite said grommet, said end terminal having a diameter less than the diameter of the metal support member and with said end terminal being in contact with the current collector and/or the central disc portion of the support; and said end terminal being held against the support by a turned down edge of the upwardly extending circumferential wall of said grommet, whereby an integrated seal assembly is provided which assembly is adapted to be inserted into the open end of an electrochemical cell casing as a single unit.
5. The seal of any preceding Claim wherein said sup-

port member further comprises a downwardly and outwardly dependent skirt portion (44) attached to the outer edge of the central disc portion and said spring means is attached to the lower end of the skirt whereby said skirt portion moves inwardly and said spring means moves downwardly under inwardly directed radial compressive forces applied to the outer edge of the support member, wherein said spring means has a tendency to move upwardly and said skirt has a tendency to move outwardly upon the release of said compressive forces.

6. The seal of Claim 5 wherein said spring means comprises an annular U-shaped channel (45) having an inner wall and an outer wall wherein said channel is attached by its inner wall to the lower end of the skirt whereby said inner and outer channel walls move closer together under inwardly directed radial compressive forces.
7. The seal of Claim 6 wherein the height of the channel is about one half the height of the support member.
8. The seal of Claim 5 or 6 wherein said support member further comprises a radial flange (47) attached to the spring means wherein the outer edge of the flange is the sealing portion of the support member.
9. The seal of any preceding Claim wherein said strengthening means in the central disc portion comprises a circular depression (42) having a diameter of not more than half the diameter of the disc portion.
10. The seal of any preceding Claim wherein said grommet comprises a centrally located boss (32) extending above and below said disc portion wherein said axial aperture passes through the boss and further comprising coincident annular vent grooves (70, 71) in said upper and lower surfaces of the disc portion encircling the boss whereby a vent membrane is located between the grooves.
11. A seal of Claim 10 wherein said annular vent is located in the outer periphery of the disc portion.
12. The seal of Claim 10 or 11 wherein said grommet is made of a plastic having a hydrogen permeability of at least $3\text{cm}^3 \text{H}_2(\text{@STP})\cdot\text{cm}/\text{S}\cdot\text{cm}^2\cdot\text{cm Hg}$.
13. The seal of any preceding Claim wherein said grommet is made of a plastic selected from the group consisting of nylon 6-6, nylon 6-12, nylon 12-12, polysulfone, mineral filled polypropylene, and alloys of these.
14. A seal as claimed in any of Claims 1 to 12 made from a plastic selected from the group consisting of Nylon 12-12, plastic alloys comprising Nylon 12-12, alloys



of nylon 6-6 and ABS, and mixtures of these.

15. The seal of any preceding Claim wherein said plastic grommet further comprises a U-shaped channel (33) having an inner wall and an outer wall wherein said inner wall is attached to the central disc portion, wherein the central disc portion and the channel walls have about the same cross sectional thickness whereby the surface area available for hydrogen diffusion is greater than the apparent surface area of the grommet.
16. An electrochemical cell comprising a cylindrical casing (10) having an open end, an anode (82), a cathode (84), a separator (85) between said anode and cathode, and a sealing member under radial compression disposed in the open end of the casing (10); said sealing member comprising a circular plastic grommet (30) having a circumferential wall (37) and a circular metal support member (40) seated within the circumferential wall (37) of the grommet; said support member (40) comprising a central disc portion (41), an outer radially extending, continuous annular flange (48), and spring means (45, 46, 47) between said flange (48) and the periphery of said disc portion (41); wherein a lower portion (38) of the circumferential wall (37) of the grommet (30) is compressed between said flange (48) and said casing (10); characterised in that said support member (40) further comprises a depressed region (42) in central disc portion (41) to retard upward movement of the center of the support (40) when said spring means (45, 46, 47) is put under inwardly directed, radially applied, compressive forces and said flange (48) bites into the lower portion (38) of circumferential wall (37) and said spring means (45, 46, 47) is under partial compression within its elastic limit whereby said spring means is adapted to expand or compress in response to temperature fluctuations so that compression of the lower portion (38) of the grommet wall is maintained.
17. The cell of Claim 16 further comprising a circular metal terminal member (60) resting against the upper surface of the support member; said terminal member having an upwardly extending wall (64) at its periphery; wherein the upper edge of the open end of the casing is bent inwardly over the terminal member wall with the upper portion of the grommet wall therebetween whereby the terminal member is held down against the support member by the bend in the casing and wherein the angle between the cell casing and the inwardly bent upper edge of the casing is less than 60°.
18. The cell of Claim 17 wherein the terminal member is recessed below the rim formed by the bend in the casing.

19. The cell of Claim 16, 17 or 18 wherein the grommet has an axially extending boss (32), having an axial aperture therethrough, at the center of the central disc portion; the metal support has a centrally located aperture (43); and further comprising a current collector (50) having a shank portion passing through the apertures of the grommet and the support, wherein the upper end of the shank is in mechanical and electrical contact with the metal support member and the lower portion of the shank is in mechanical and electrical contact with the anode.

20. The cell of Claim 16, in which the sealing member is an insulating seal as claimed in any of Claim 1 to 15.

Patentansprüche

1. Isolierende Dichtung für das offene Ende eines elektrochemischen Gehäuses (10), die aufweist:

eine kreisförmige Durchführungshülse (30) aus Kunststoff, die aufweist: eine obere Fläche; eine untere Fläche; eine sich nach oben zu erstreckende periphere Wand (37) an deren Umfang; und eine axiale Öffnung (25), wobei die Durchführungshülse einen derartigen Durchmesser aufweist, daß sie eng anliegend in das offene Ende des Zellengehäuses (10) paßt; und eine metallische Halterung (40) mit einem mittleren Scheibenabschnitt (41), einer Federeinrichtung (45, 46, 47), die sich im Umfang der Halterung befindet, und einer axialen Öffnung (25); dadurch gekennzeichnet, daß eine Verstärkung im Scheibenabschnitt (41) angeordnet ist, wobei die Verstärkung eine Vertiefung (42) im mittleren Scheibenabschnitt (41) aufweist, und wobei die Verstärkung so konstruiert ist, daß sie die Aufwärtsbewegung der Mitte der Halterung (40) verzögert, wenn die Federeinrichtung (45, 46, 47) nach innen zu ausgerichteten und radial angewandten Druckkräften ausgesetzt wird, wobei die metallische Halterung (40) innerhalb der und koaxial zur peripheren Wand (37) der Durchführungshülse (30) sitzt.

2. Dichtung nach Anspruch 1, die außerdem einen Stromabnehmer (50) aufweist, der sich durch die Öffnungen in der metallischen Halterung und der Durchführungshülse erstreckt, wobei der Stromabnehmer einen mechanischen und elektrischen Kontakt mit der Halterung aufweist und sich in einer abdichtenden Beziehung mit der Öffnung in der Durchführungshülse befindet.



3. Dichtung nach Anspruch 2, bei der der Stromabnehmer einen Nietabschnitt aufweist, wobei der Niet die Durchführungshülse und die metallische Halterung zusammenhält, und wobei der Niet aufweist: eine Welle (52); einen Flansch (53), der in der Nähe eines Endes der Welle angeordnet ist; und einen Nietkopf (54) am anderen Ende der Welle, wobei der Flansch mit der unteren Fläche der Nabe in Eingriff kommt, und wobei der Nietkopf gegen die obere Fläche der metallischen Halterung ausgebildet ist, wodurch die Halterung und die Nabe axial zusammengedrückt werden, so daß eine lecksichere Dichtung zwischen dem Flansch und der Nabe gebildet wird. 5
4. Dichtung nach Anspruch 2 oder 3, die außerdem eine kreisförmige, leitfähige Klemme (60) auf der Seite der Halterung aufweist, die der Durchführungshülse gegenüberliegt, wobei die Klemme einen Durchmesser aufweist, der kleiner ist als der Durchmesser der metallischen Halterung, und wobei die Klemme mit dem Stromabnehmer und/oder dem mittleren Scheibenabschnitt der Halterung in Kontakt ist, und wobei die Klemme gegen die Halterung durch einen nach unten gewölbten Rand der sich nach oben zu erstreckenden peripheren Wand der Durchführungshülse gehalten wird, wodurch eine integrierte Dichtungsbaugruppe bereitgestellt wird, und wobei die Baugruppe so konstruiert ist, daß sie in das offene Ende eines elektrochemischen Zellengehäuses als eine Baugruppe eingesetzt werden kann. 15 20 25 30
5. Dichtung nach einem der vorhergehenden Ansprüche, bei der die Halterung außerdem einen nach unten und nach außen zu herabhängenden Randabschnitt (44) aufweist, der am äußeren Rand des mittleren Scheibenabschnittes befestigt ist, und bei der die Federeinrichtung am unteren Ende des Randabschnittes befestigt ist, wodurch sich der Randabschnitt nach innen zu und die Federeinrichtung nach unten zu unter den nach innen zu gerichteten radialen Druckkräften bewegt, die auf den äußeren Rand der Halterung angewandt werden, wobei die Federeinrichtung die Neigung zeigt, sich nach oben zu bewegen, und wobei der Randabschnitt die Neigung zeigt, sich nach außen zu bewegen, wenn die Druckkräfte entlastet werden. 35 40 45
6. Dichtung nach Anspruch 5, bei der die Federeinrichtung einen ringförmigen, U-förmigen Kanal (45) aufweist, der eine Innenwand und eine Außenwand besitzt, wobei der Kanal mittels seiner Innenwand am unteren Ende des Randabschnittes befestigt ist, wodurch sich die Innenwand und die Außenwand des Kanals unter den nach innen zu gerichteten radialen Druckkräften dichter zusammen bewegen. 50 55
7. Dichtung nach Anspruch 6, bei der die Höhe des Kanals etwa die halbe Höhe der Halterung ist.
8. Dichtung nach Anspruch 5 oder 6, bei der die Halterung außerdem einen radialen Flansch (47) aufweist, der an der Federeinrichtung befestigt ist, wobei der äußere Rand des Flansches der abdichtende Abschnitt der Halterung ist.
9. Dichtung nach einem der vorhergehenden Ansprüche, bei der eine Verstärkung im mittleren Scheibenabschnitt eine kreisförmige Vertiefung (42) mit einem Durchmesser aufweist, der nicht größer ist als der halbe Durchmesser des Scheibenabschnittes.
10. Dichtung nach einem der vorhergehenden Ansprüche, bei der die Durchführungshülse eine mittig angeordnete Nabe (32) aufweist, die sich oberhalb und unterhalb des Scheibenabschnittes erstreckt, worin die axiale Öffnung durch die Nabe hindurchgeht, und die außerdem koinzidente ringförmige Entlüftungsnuten (70, 71) in der oberen und der unteren Fläche des Scheibenabschnittes aufweist, die die Nabe umgeben, wodurch eine Entlüftungsmembrane zwischen den Nuten angeordnet wird.
11. Dichtung nach Anspruch 10, bei der sich die ringförmige Entlüftung im äußeren Umfang des Scheibenabschnittes befindet.
12. Dichtung nach Anspruch 10 oder 11, bei der die Durchführungshülse aus einem Kunststoff hergestellt ist, der eine Wasserstoffdurchlässigkeit von mindestens $3 \text{ cm}^3 \text{ H}_2$ (@STP)-cm/S-cm²-cm Hg aufweist.
13. Dichtung nach einem der vorhergehenden Ansprüche, bei der die Durchführungshülse aus einem Kunststoff hergestellt ist, der aus der Gruppe ausgewählt ist, die besteht aus: Nylon 6-6; Nylon 6-12; Nylon 12-12; Polysulfon; mineralisch gefülltem Polypropylen und Legierungen dieser.
14. Dichtung nach einem der Ansprüche 1 bis 12, die aus einem Kunststoff hergestellt ist, der aus der Gruppe ausgewählt ist, die besteht aus: Nylon 12-12; Kunststofflegierungen, die Nylon 12-12 aufweisen; Legierungen von Nylon 6-6 und ABS; und Mischungen dieser.
15. Dichtung nach einem der vorhergehenden Ansprüche, bei der die Durchführungshülse aus Kunststoff weiter einen U-förmigen Kanal (33) aufweist, der eine Innenwand und eine Außenwand besitzt, wobei die Innenwand am mittleren Scheibenabschnitt befestigt ist, und wobei der mittlere Scheibenabschnitt und die Kanalwände etwa die gleiche Stärke des Querschnittes aufweisen, wodurch die Fläche,



die für die Wasserstoffdiffusion verfügbar ist, größer ist als die scheinbare Fläche der Durchführungshülse.

16. Elektrochemische Zelle, die aufweist: ein zylindrisches Gehäuse (10), das ein offenes Ende besitzt; eine Anode (82); eine Katode (84); ein Trennelement (85) zwischen der Anode und der Katode; und ein Abdichtungselement, das unter radialem Druck im offenen Ende des Gehäuses (10) angeordnet wird; wobei das Abdichtungselement aufweist: eine kreisförmige Durchführungshülse (30) aus Kunststoff, die eine periphere Wand (37) besitzt; und eine kreisförmige metallische Halterung (40), die innerhalb der peripheren Wand (37) der Durchführungshülse sitzt, wobei die Halterung (40) aufweist: einen mittleren Scheibenabschnitt (41); einen äußeren sich radial erstreckenden kontinuierlichen ringförmigen Flansch (48); und eine Federeinrichtung (45, 46, 47) zwischen dem Flansch (48) und dem Umfang des Scheibenabschnittes (41), wobei ein unterer Abschnitt (38) der peripheren Wand (37) der Durchführungshülse (30) zwischen dem Flansch (48) und dem Gehäuse (10) zusammengedrückt wird; dadurch gekennzeichnet, daß die Halterung (40) außerdem eine Vertiefung (42) im mittleren Scheibenabschnitt (41) aufweist, um die Aufwärtsbewegung der Mitte der Halterung (40) zu verzögern, wenn die Federeinrichtung (45, 46, 47) nach innen zu ausgerichteten und radial angewandten Druckkräften ausgesetzt wird, und daß der Flansch (48) in den unteren Abschnitt (38) der peripheren Wand (37) eingreift und sich die Federeinrichtung (45, 46, 47) unter einem teilweisen Druck innerhalb ihrer Elastizitätsgrenze befindet, wodurch die Federeinrichtung so konstruiert ist, daß sie sich als Reaktion auf Temperaturschwankungen ausdehnt oder zusammenzieht, so daß das Zusammendrücken des unteren Abschnittes (38) der Wand der Durchführungshülse beibehalten wird.

17. Zelle nach Anspruch 16, die außerdem eine kreisförmige Metallklemme (60) aufweist, die gegen die obere Fläche der Halterung aufliegt, wobei die Klemme an ihrem Umfang eine sich nach oben zu erstreckende Wand (64) aufweist; wobei der obere Rand des offenen Endes des Gehäuses nach innen zu über die Klemmenwand gebogen ist, und wobei der obere Abschnitt der Wand der Durchführungshülse dazwischen zu finden ist, wodurch die Klemme gegen die Halterung durch die Biegung im Gehäuse nach unten gehalten wird, und wobei der Winkel zwischen dem Zellengehäuse und dem nach innen zu gebogenen oberen Rand des Gehäuses kleiner ist als 60°.

18. Zelle nach Anspruch 17, bei der die Klemme unterhalb der Kante ausgespart ist, die durch die Biegung

im Gehäuse gebildet wird.

19. Zelle nach Anspruch 16, 17 oder 18, bei der die Durchführungshülse eine sich axial erstreckende Nabe (32) in der Mitte des mittleren Scheibenabschnittes aufweist, die eine axiale Öffnung besitzt; und bei der die metallische Halterung eine mittig angeordnete Öffnung (43) besitzt; und die außerdem einen Stromabnehmer (50) aufweist, der einen Schaftabschnitt besitzt, der durch die Öffnungen der Durchführungshülse und der Halterung hindurchgeht, wobei das obere Ende des Schaftes einen mechanischen und elektrischen Kontakt mit der metallischen Halterung aufweist, und wobei der untere Abschnitt des Schaftes einen mechanischen und elektrischen Kontakt mit der Anode zeigt.

20. Zelle nach Anspruch 16, bei der das Abdichtungselement eine isolierende Dichtung ist, wie sie in den Ansprüchen 1 bis 15 beansprucht wird.

Revendications

1. Joint isolant pour l'extrémité ouverte d'un boîtier électrochimique (10) comprenant:

une rondelle d'étanchéité circulaire en plastique (30) avec une surface supérieure, une surface inférieure, une paroi circonférentielle s'étendant vers le haut (37) au niveau de sa périphérie, ainsi qu'une ouverture axiale (25), ladite rondelle d'étanchéité ayant un diamètre tel à pouvoir être ajustée fermement dans l'extrémité ouverte du boîtier de la pile (10);

et un élément de support métallique (40) avec une partie de disque centrale (41), un moyen de ressort (45, 46, 47) agencé dans la périphérie de l'élément, ainsi qu'une ouverture axiale (25); caractérisé par un moyen de renforcement agencé dans ladite partie de disque (41), ledit moyen de renforcement comprenant une région abaissée (42) dans la partie de disque centrale (41), ledit moyen de renforcement servant à retarder le mouvement ascendant du centre du support (40) lorsque ledit moyen de ressort (45, 46, 47) est exposé à des forces de compression appliquées radialement et dirigées vers l'intérieur, et ledit support métallique (40) étant agencé à l'intérieur de la paroi circonférentielle (37) de ladite rondelle d'étanchéité (30) et étant coaxial à celle-ci.

2. Joint selon la revendication 1, comprenant en outre un collecteur de courant (50) s'étendant à travers les ouvertures dans le support métallique et la rondelle d'étanchéité, ledit collecteur de courant étant en contact mécanique et électrique avec ledit sup-



- port et étant en relation d'étanchéité avec l'ouverture dans la rondelle d'étanchéité.
3. Joint selon la revendication 2, dans lequel ledit collecteur de courant comprend une partie de rivet, ledit rivet assemblant ladite rondelle d'étanchéité et ledit support métallique, ledit rivet comprenant un arbre (52), une bride (53) agencée près d'une extrémité de l'arbre, et une tête de rivet (54) au niveau de l'autre extrémité de l'arbre, ladite bride s'engageant dans la surface inférieure de la protubérance, et la tête de rivet étant formée contre la surface supérieure du support métallique, le support et la protubérance étant ainsi comprimés axialement l'un contre l'autre, un joint étanche aux fuites étant par suite formé entre la bride et la protubérance.
 4. Joint selon les revendications 2 ou 3, comprenant en outre une borne d'extrémité conductrice circulaire (60) sur un côté dudit support opposé à ladite rondelle d'étanchéité, ladite borne d'extrémité ayant un diamètre inférieur au diamètre de l'élément de support métallique, et ladite borne d'extrémité étant en contact avec le collecteur de courant et/ou la partie de disque centrale du support; et ladite borne d'extrémité étant retenue contre le support par un bord tourné vers le bas de la paroi circonférentielle s'étendant vers le haut de ladite rondelle d'étanchéité, un assemblage de joint intégré étant ainsi formé, cet assemblage pouvant être inséré dans l'extrémité ouverte d'un boîtier de pile électrochimique sous forme d'une seule unité.
 5. Joint selon l'une quelconque des revendications précédentes, dans lequel ledit élément de support comprend en outre une partie de bordure s'étendant vers le bas et vers l'extérieur (44), fixée au bord extérieur de la partie de disque centrale, ledit moyen de ressort étant fixé à l'extrémité inférieure de la bordure, ladite partie de bordure étant ainsi déplacée vers l'intérieur et ledit moyen de ressort se déplaçant vers le bas en présence d'une application de forces de compression radiales dirigées vers l'intérieur sur le bord extérieur de l'élément de support, ledit moyen de ressort ayant tendance à se déplacer vers le haut et ladite bordure ayant tendance à se déplacer vers l'extérieur lors du relâchement desdites forces de compression.
 6. Joint selon la revendication 5, dans lequel ledit moyen de ressort comprend un canal annulaire en U (45) avec une paroi interne et une paroi externe, ledit canal étant fixé par sa paroi interne à l'extrémité inférieure de la bordure, lesdites parois interne et externe du canal se rapprochant ainsi sous l'action des forces de compression radiales dirigées vers l'intérieur.
 7. Joint selon la revendication 6, dans lequel la hauteur du canal représente à peu près la moitié de la hauteur de l'élément de support.
 8. Joint selon les revendications 5 ou 6, dans lequel ledit élément de support comprend en outre une bride radiale (47) fixée au moyen de ressort, le bord extérieur de la bride constituant la partie de joint du moyen de support.
 9. Joint selon l'une quelconque des revendications précédentes, dans lequel ledit moyen de renforcement dans la partie de disque centrale comprend une dépression circulaire (42) ayant un diamètre ne dépassant pas la moitié du diamètre de la partie de disque.
 10. Joint selon l'une quelconque des revendications précédentes, dans lequel ladite rondelle d'étanchéité comprend une protubérance à agencement central (32) s'étendant au-dessus et au-dessous de ladite partie de disque, ladite ouverture axiale traversant la protubérance et comprenant en outre des rainures de ventilation annulaires coïncidentes (70, 71) dans lesdites surfaces supérieure et inférieure de la partie de disque, encerclant la protubérance, une membrane de ventilation étant ainsi agencée entre les rainures.
 11. Joint selon la revendication 10, dans lequel ledit évent annulaire est agencé dans la périphérie externe de la partie de disque.
 12. Joint selon les revendications 10 ou 11, dans lequel ladite rondelle d'étanchéité est composée de plastique ayant une perméabilité à l'hydrogène d'au moins $3 \text{ cm}^3 \text{ H}_2$ (@STP)-cm/S-cm²-cm Hg.
 13. Joint selon l'une quelconque des revendications précédentes, dans lequel ladite rondelle d'étanchéité est composée de plastique choisi dans le groupe constitué de nylon 6-6, de nylon 6-12, de nylon 12-12, de polysulfone, de polypropylène à charge minérale et d'alliages correspondants.
 14. Joint selon l'une quelconque des revendications 1 à 12, composé de plastique sélectionné dans le groupe constitué de nylon 12-12, d'alliages de plastique à base de nylon 12-12, d'alliages de nylon 6-6 et d'ABS, ainsi que de mélanges correspondants.
 15. Joint selon l'une quelconque des revendications précédentes, dans lequel ladite rondelle d'étanchéité en plastique comprend en outre un canal en U (33) avec une paroi interne et une paroi externe, ladite paroi interne étant fixée à la partie de disque centrale, la partie de disque centrale et les parois du canal ayant à peu près la même épaisseur de sec-



- tion, l'aire de surface disponible pour la diffusion d'hydrogène étant ainsi plus grande que l'aire de surface apparente de la rondelle d'étanchéité.
16. Pile électrochimique comprenant un boîtier cylindrique (10) avec une extrémité ouverte, une anode (82), une cathode (84), un séparateur (85) entre lesdites anode et cathode, et un élément de joint sous compression radiale agencé dans l'extrémité ouverte du boîtier (10); ledit élément de joint comprenant une rondelle d'étanchéité circulaire en plastique (30) avec une paroi circonférentielle (37), et un élément de support métallique circulaire (40) agencé à l'intérieur de la paroi circonférentielle (37) de la rondelle d'étanchéité; ledit élément de support (40) comprenant une partie de disque centrale (41), une bride annulaire continue externe à extension radiale (48) et un moyen de ressort (45, 46, 47) entre ladite bride (48) et la périphérie de ladite partie de disque (41); une partie inférieure (38) de la paroi circonférentielle (37) de la rondelle d'étanchéité (30) étant comprimée entre ladite bride (48) et ledit boîtier (10); caractérisé en ce que ledit élément de support (40) comprend en outre une région abaissée (42) dans la partie de disque centrale (41) pour retarder le mouvement ascendant du centre du support (40) lorsque ledit moyen de ressort (45, 46, 47) est exposé à des forces de compression appliquées radialement et dirigées vers l'intérieur, ladite bride (48) s'engageant dans la partie inférieure (38) de la paroi circonférentielle (37) et ledit moyen de ressort (45, 46, 47) étant exposé à une compression partielle dans le cadre de sa limite d'élasticité, ledit moyen de ressort pouvant ainsi se dilater ou se comprimer en réponse à des fluctuations de la température, de sorte que la compression de la partie inférieure (38) de la paroi de la rondelle d'étanchéité est maintenue.
17. Pile selon la revendication 16, comprenant en outre un élément de borne métallique circulaire (60) reposant contre la surface supérieure de l'élément de support, ledit élément de borne comportant une paroi s'étendant vers le haut (64) au niveau de sa périphérie; le bord supérieur de l'extrémité ouverte du boîtier étant plié vers l'intérieur au-dessus de la paroi de l'élément de borne, la partie supérieure de la paroi de la rondelle d'étanchéité se trouvant au milieu, l'élément de borne étant ainsi retenu contre l'élément de support par la courbure dans le boîtier et l'angle entre le boîtier de la pile et le bord supérieur plié vers l'intérieur du boîtier étant inférieur à 60°.
18. Pile selon la revendication 17, dans laquelle l'élément de borne est évidé au-dessous du bord formé par la courbure dans le boîtier.

19. Pile selon les revendications 16, 17 ou 18, dans laquelle la rondelle d'étanchéité a une protubérance à extension axiale (32) avec une ouverture axiale traversante, au centre de la partie de disque centrale; le support métallique comportant une ouverture à agencement central (43); et comprenant en outre un collecteur de courant (50) avec une partie de tige traversant les ouvertures de la rondelle d'étanchéité et du support, l'extrémité supérieure de la tige étant en contact mécanique et électrique avec l'élément de support métallique et la partie inférieure de la tige étant en contact mécanique et électrique avec l'anode.
20. Pile selon la revendication 16, dans laquelle l'élément de joint est un joint isolant selon l'une quelconque des revendications 1 à 15.