

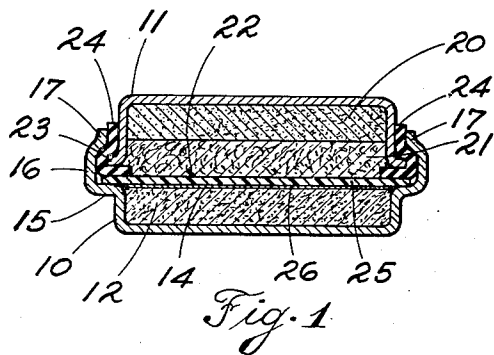
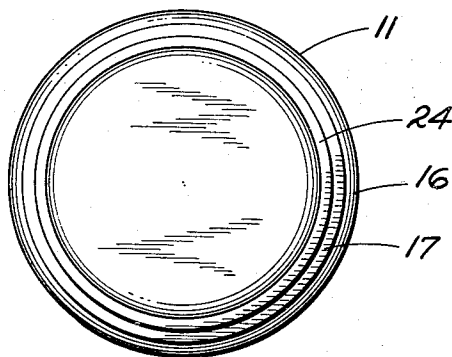
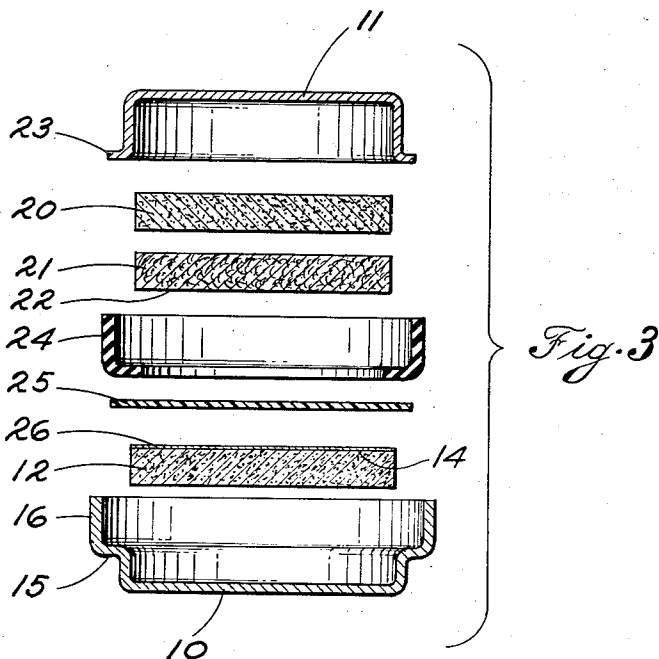
Nov. 4, 1958

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2,859,266

ALKALINE DRY CELL

Filed May 31, 1955



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2,859,266

ALKALINE DRY CELL

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Application May 31, 1955, Serial No. 511,845

18 Claims. (Cl. 136—111)

This invention relates to primary electric cells and more particularly to dry cells of the alkaline type and to methods of making such cells.

In cells of this type bibulous separators are disposed between the anodes and the cathode-depolarizers. The separators, the anodes and the depolarizers are all permeated by electrolyte and in order to prevent any possibility of short-circuiting the cell by particles of the depolarizing material, as well as to reduce or substantially eliminate the migration of soluble constituents of the depolarizer into the separators, porous barriers, such as polyvinyl alcohol or porous polyvinyl chloride in sheet form, or micro-porous ceramic discs, are commonly interposed between the depolarizers and the separators. While it has been proposed to seal the edges of the porous barriers to the containers for the active materials of the cells, this type of construction has not been used to any great extent for the reason that bubbles of air or other gas frequently are trapped between the barriers and the depolarizers and when the edges are sealed, there is no way for the gas to escape. The bubbles separate the barriers from the depolarizers and render ineffective that portion of the depolarizer surface adjacent the bubbles. The trapped gas thus increases the resistance and reduces the efficiency of the cells and in some cases makes the cells entirely inoperative.

Accordingly, it has been the practice to leave the edges of the barriers free to permit gas to escape from between the depolarizer and the barrier. The freedom of the edges of the barriers, however, does not always prevent formation and entrapment of bubbles between the barriers and the depolarizers and the consequent separation of the barriers from the depolarizers. Also the free edges provide paths around the barriers through which the dissolved constituents of the depolarizers can migrate and through which the mercury produced in the operation of the cells having mercuric oxide depolarizers can pass to make a direct connection with the anodes or the containers for the anodes of the cells, thereby short-circuiting the cells.

According to the present invention, these difficulties are overcome, and cells with improved life and increased reliability and uniformity as compared with previous types of cells are produced by cementing the barriers to the depolarizers by means of an adhesive that displaces the air from the porous surfaces of the depolarizers and is permeable to the electrolyte, so that proper contact between the depolarizer and the barrier is assured throughout the face of the depolarizer; and preferably by sealing the peripheral edges of the barriers to the containers for the active materials of the cells, thereby blocking any paths around the peripheries of the barriers. According to the preferred method, the adhesive is applied as a liquid and is caused to set up or harden by reaction with the electrolyte. Another phase of the invention involves the provision of an improved porous barrier composed of a thin fibrous material impregnated with a material that is permeable to the electrolyte.

Referring now to drawings, Figure 1 is a cross-sectional

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view through a preferred form of primary cell embodying the invention, the thickness of certain of the components of the cell being exaggerated for convenience of illustration.

Figure 2 is a top plan view of the cell of Figure 1, and Figure 3 is an exploded view showing the components making up the cell of Figure 1.

As shown in the drawings, a preferred form of cell embodying the invention may comprise a container made up of a lower or body portion 10 and an upper or cap portion 11. Both portions of the container may be composed of suitably plated steel or other suitable metal. Preferably, the cathode or body portion 10 is composed of nickel plated steel. A mass 12 of depolarizer is compressed within the body portion and consists of one of the conventional cathode-depolarizers ordinarily used in alkaline cells. A depolarizer made up of about 90 to 97 percent by weight of finely divided mercuric oxide and the balance of finely divided graphite is preferred for most purposes, but the invention is also useful in cells embodying depolarizers composed of other metallic oxides, such as cuprous oxide, cupric oxide, bismuth oxide and manganese dioxide. The upper face 14 of the depolarizer preferably lies substantially at the level of the outwardly extending shoulder 15 of the container body 10. The body 10 terminates in an axially extending flange 16 which is crimped inwardly as at 17 to secure the cap 11 thereto.

The cap 11, which is preferably composed of tin-plated steel, contains the anode 20 and the separator 21. The anode may comprise amalgamated zinc foil, a compressed mass of amalgamated zinc powder, or other suitable material. The separator 21 extends over the surface of the zinc electrode 20 and may consist of a fibrous material, such as an alkali-resistant paper, or a suitable gel, such as a carboxy-methyl-cellulose gel. The separator functions to separate the anode from the cathode and to immobilize the electrolyte; the electrolyte is preferably composed of a solution of potassium hydroxide to which zinc has been added, ordinarily in the form of zinc oxide. The lower surface 22 of the separator is disposed opposite the surface 14 of the depolarizer and lies at about the same level as the flange 23 of the cap, which is positioned in opposition to the shoulder 15. A seal or grommet 24 composed of rubber or a suitable plastic, such as polyethylene, is engaged by the flange 23 and compressed to make a leakproof seal when the cell is assembled and the flange 16 of the body crimped inwardly as at 17.

The parts just described may all be of known or conventional construction. The present invention, as noted above, is concerned particularly with the porous barrier 25 and its relationship to the previously described parts of the cell.

The porous barrier 25 overlies the depolarizer 12 and is cemented to the upper surface 14 thereof by an adhesive layer 26. The opposite face of the barrier is directly in contact with the surface 22 of separator 21. The porous barrier may be of any suitable material that will not react with the electrolyte or the depolarizer and which has the requisite degree of porosity or permeability; i. e., which will permit the passage of ions, but which will provide an effective barrier against undissolved materials and will retard, if not prevent, the migration of dissolved constituents of the depolarizer. In a preferred form of the invention, the porous barrier is composed of a thin (about 0.008"—0.010" thick) layer of a polyvinyl chloride sheet material such as "Synpor," which is a porous polyvinyl chloride marketed by Stokes Molded Products Co. or "Koporok," a similar polyvinyl chloride material made by Richardson Co., Melrose Park, Illinois. These materials are effective barriers because of the fineness of their pores, but they permit the necessary flow of ions,

Another preferred material for the barrier is polyvinyl alcohol in sheet form (also about 0.008" to 0.010" thick). "Reynolon" polyvinyl alcohol film, supplied by Reynolds Metals Company of Richmond, Virginia, is satisfactory. Polyvinyl alcohol appears to be permeable to the electrolyte; in any event it permits the required flow of ions to take place and also acts as an effective barrier. Also, barriers having the desired characteristics may be made by impregnating thin fibrous sheet materials with polyvinyl alcohol. The fibers should be resistant to the alkaline electrolyte and the fabrics should be of about the same thickness specified above for polyvinyl alcohol barriers; either woven fabrics or unwoven, felted fibers may be employed; fibers such as rayon, nylon, copolymers of polyacrylonitrile and polyvinyl chloride, glass and polyethylene have the required characteristics. Sheet materials composed of these fibers are too porous in themselves to act as effective barriers, but when impregnated with polyvinyl alcohol the porosity of the material is reduced to the desired degree and the fibers reinforce and strengthen the polyvinyl alcohol. Fibrous barriers may be produced by impregnating the fibrous material with polyvinyl alcohol in solution and permitting the polyvinyl alcohol to dry before assembly of the cells, or as explained below, by impregnating the fibrous material with polyvinyl alcohol while the assembly operation is being carried out. In either case, it is preferred to use the same polyvinyl alcohol solution for impregnating the fibrous material as is preferably employed in the adhesive layer 26.

The adhesive layer 26 preferably consists of polyvinyl alcohol dispersed in potassium hydroxide solution, which is applied in liquid form to the upper surface of the depolarizer before the barrier 25 is placed on top of the depolarizer. The adhesive layer is shown as applied to the depolarizer 12 in Figure 3, but it will be understood that in practice the liquid adhesive is applied after the depolarizer is positioned within the container body 10. The polyvinyl alcohol adhesive solution is preferably made by dispersing 1 pound of polyvinyl alcohol (for example "Evanol," grade 72-60, available from E. I. duPont deNemours and Co.) in 10 liters of water to which 2 pounds of 85% potassium hydroxide have been added. This gives an adhesive of approximately the following composition: 6.8% KOH, 89.2% H₂O and 4.0% polyvinyl alcohol.

The polyvinyl alcohol solution penetrates the somewhat porous surface of the depolarizer and displaces occluded gases from the surface layers of the depolarizer. When the barrier is placed on the depolarizer on which the polyvinyl alcohol solution has been disposed, the polyvinyl alcohol solution spreads over the entire upper face of the depolarizer and provides a connection between the depolarizer and the porous barrier which prevents the trapping of air or gas and the formation of bubbles.

While the adhesive layer 26 is applied in liquid form and thus is able to spread over the surface of the depolarizer and to penetrate into the pores of the depolarizer and the barrier, it is caused to set or harden by the alkaline electrolyte which permeates the cementing layer after the cell has been assembled. The same hardening or setting action takes place with the polyvinyl alcohol that is used as an impregnant for a barrier composed of fibrous material. Thus, shortly after the assembly of the cell, the barrier is securely bonded to the exposed face of the depolarizer throughout substantially its entire area. The cementing layer, however, is permeable to the electrolyte and hence does not impair the efficiency of the cell; on the contrary, it insures the maintenance of the efficiency of the cell by retaining the barrier in proper contact with the depolarizer and preventing the barrier from being displaced from the depolarizer by a bubble of air or other gas.

The barrier 25 is of greater diameter than the de-

polarizer, and the peripheral edge portion of the barrier extends over the shoulder 15 of the body 10 substantially to the inner surface of the axially extending flange 16. When the cap 11 is assembled with body 10 and the flange 16 is crimped inwardly as shown at 17, the peripheral edge portion of barrier is compressed and sealed against the shoulder 15 by the seal or grommet 24. The compression of the barrier provides an effective seal in spite of the porosity of the barrier material. Inasmuch as the edge portion of the barrier is sealed to the shoulder 15 of the body 10, all paths around the barrier between the depolarizer and the separator are effectively blocked. Thus, the barrier is able to carry out its intended function and cannot be by-passed by particles of the depolarizer or by mercury formed in the depolarizer during operation of the cell.

The preferred method of making cells embodying the invention includes the steps of pressing the depolarizer 12 into the body 10 of the container and disposing the anode 20 and the separator 21 containing electrolyte in the cap 11. A small quantity of a solution of polyvinyl alcohol made as described above is deposited on the surface 14 of the depolarizer and given a short time to spread over and penetrate into the porous surface of the depolarizer. Only one or two drops, or about 0.1 cc., of polyvinyl alcohol are required for barriers other than barriers composed of fibrous materials that have not been previously impregnated. The barrier is applied to the surface of the depolarizer in such a manner that the under surface of the barrier is wet by the polyvinyl alcohol solution throughout the area adjacent the surface 14. If the barrier is composed of thin fibrous sheet material that has not previously been impregnated with polyvinyl alcohol, a sufficient quantity of the polyvinyl alcohol solution is deposited on the surface of the depolarizer to permeate and saturate the barrier. For example, in such a case, three or four drops, or about 0.2 cc., of polyvinyl alcohol may be employed.

With either type of barrier the cell is completed by joining the cap 11 containing the anode and separator to the body 10. The separator comes firmly into contact with the barrier, and the barrier is urged firmly against the depolarizer in this operation. The cap 11 is secured to the body 10 by crimping the axially extending flange 16 inwardly as at 17, thereby compressing the sealing member 24 between the barrier and the flange 23 and compressing the barrier against the shoulder 15 to produce a leakproof assembly. As noted above, the polyvinyl alcohol is hardened or set in the completed cell by the action of the alkaline cell electrolyte. The hardening or setting takes place both in the polyvinyl alcohol that permeates the fibrous barriers as well as in the polyvinyl alcohol that cements the barriers to the depolarizers.

Those skilled in the art will appreciate that various changes in the construction of the cells and adaptations of the invention to other types of cells and batteries can be made without departing from the spirit and scope of the invention. The essential characteristics of the invention are summarized in the appended claims.

We claim:

1. A dry cell comprising an anode, a separator containing an alkaline electrolyte, a porous cathode-depolarizer, said depolarizer and said separator having opposed surfaces, a porous barrier disc composed of a material that is in the solid state interposed between the opposed surfaces of said separator and said depolarizer, and an adhesive layer of polyvinyl alcohol penetrating the porous surface of said depolarizer and cementing said barrier disc to said depolarizer.

2. A dry cell according to claim 1 wherein the porous barrier disc is composed of polyvinyl chloride.

3. A dry cell according to claim 1 wherein the porous barrier disc is composed of sheet polyvinyl alcohol.

4. A dry cell according to claim 1 wherein the porous disc is composed of a micro-porous ceramic.

5. A dry cell according to claim 1 wherein the porous barrier disc is composed of a fibrous material impregnated with polyvinyl alcohol.

6. A porous barrier disc for alkaline dry cells comprising a fibrous material impregnated with polyvinyl alcohol.

7. A dry cell comprising an anode, a separator containing an alkaline electrolyte, a cathode-depolarizer, said depolarizer and said separator having opposed surfaces, a porous barrier disc interposed between the opposed surfaces of said separator and said depolarizer, and an adhesive layer of polyvinyl alcohol cementing said disc to said depolarizer, and a container for said elements, the peripheral edge of said disc being sealed to said container.

8. An alkaline dry cell comprising a two-part container, one of said parts containing an anode and a separator containing an electrolyte, the other of said parts containing a cathode-depolarizer, one of said parts having an outwardly extending shoulder, said depolarizer and said electrolyte having opposed surfaces, a porous barrier disc interposed between the opposed surfaces of said electrolyte and said depolarizer, said disc having peripheral edge portions extending beyond said surfaces, said disc being cemented to said depolarizer by an adhesive that is permeable to the electrolyte, the edges of said disc overlying said outwardly extending shoulder on one of said parts and being clamped against said shoulder by the other of said parts.

9. A dry cell according to claim 8 wherein the adhesive is composed of polyvinyl alcohol.

10. A dry cell according to claim 9 wherein the depolarizer is porous and the surface thereof is penetrated by the polyvinyl alcohol.

11. A dry cell according to claim 10 wherein the barrier disc is composed of porous polyvinyl chloride.

12. The method of making a dry cell of the type embodying a porous barrier disc disposed between a depolarizer and a separator containing electrolyte, which includes the steps of placing an adhesive in liquid form on the depolarizer and then applying the barrier disc to the adhesive.

13. The method according to claim 12 wherein the adhesive consists essentially of a solution of polyvinyl alcohol and potassium hydroxide in water.

14. The method of making a dry cell of the type embodying a porous barrier disc disposed between a depolarizer and a separator containing electrolyte, which includes

the steps of disposing an adhesive in liquid form between the depolarizer and the barrier disc and thereafter causing the adhesive to set up and bond the barrier disc to the depolarizer by reaction with the electrolyte.

15. The method according to claim 14 wherein the adhesive is polyvinyl alcohol and the electrolyte contains a hydroxide of an alkaline metal.

16. The method according to claim 15 wherein the barrier is composed of a porous fibrous material that is permeated by the liquid polyvinyl alcohol.

17. The method of making an alkaline dry cell which comprises disposing a depolarizer in the body portion of a two part container having an outwardly extending shoulder with the exposed surface of the depolarizer at substantially the same level as said shoulder, disposing an anode and an immobilized electrolyte in the cap portion of the container, said cap portion having a flange and the exposed surface of said electrolyte being at substantially the same level as said flange, placing a layer of liquid cementitious material on said exposed surface of said depolarizer, disposing a porous barrier disc over said surface of said depolarizer in contact with said cementitious material and with the peripheral edge of said barrier disc overlying said shoulder, and thereafter securing said cap to said body and compressing said edge of said barrier disc against said shoulder by means of said flange.

18. The method of making an alkaline dry cell which comprises disposing a porous depolarizer in the body portion of a two part container having an outwardly extending shoulder with the exposed surface of the depolarizer at substantially the same level as said shoulder, disposing an anode and an immobilized alkaline electrolyte in the cap portion of the container, said cap portion having a flange and the exposed surface of said electrolyte being at substantially the same level as said flange, placing a layer of polyvinyl alcohol solution on said exposed surface of said depolarizer, disposing a porous barrier disc over said surface of said depolarizer in contact with said cementitious material and with the peripheral edge of said barrier disc overlying said shoulder, and thereafter securing said cap to said body and compressing said edge of said barrier disc against said shoulder by means of said flange.

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