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R. L. GLOVER

2,552,091

DRY CELL

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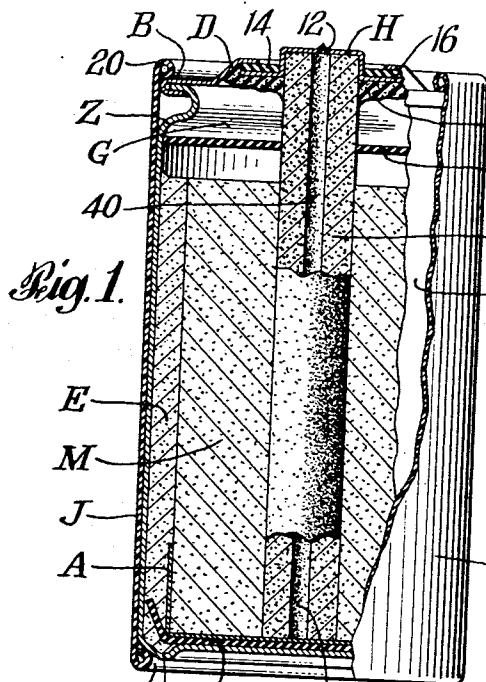


Fig. 1.

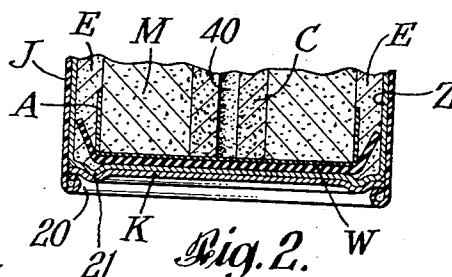


Fig. 2.

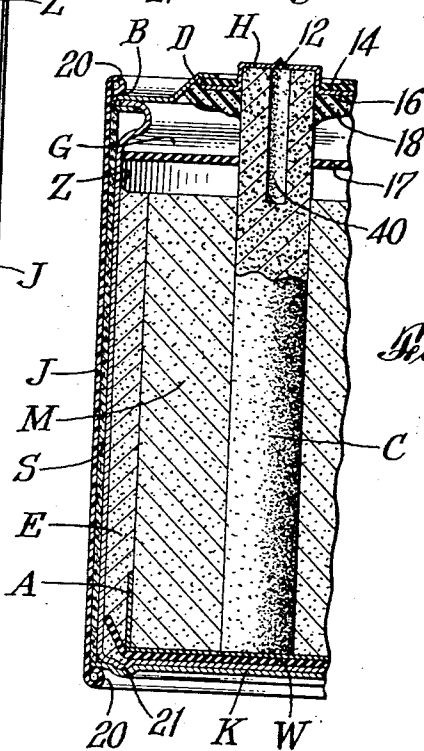


Fig. 3.

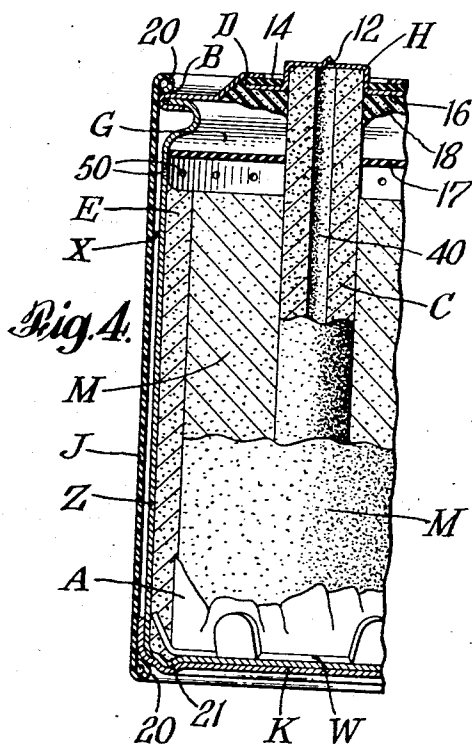


Fig. 4.

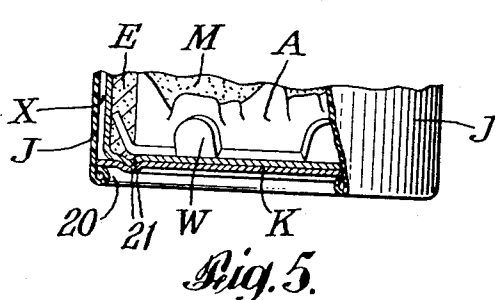


Fig. 5.

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2,552,091

DRY CELL

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mesne assignments, to Union Carbide and Car-
bon Corporation, a corporation of New York

Application December 22, 1945, Serial No. 636,835

29 Claims. (Cl. 136-133)

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This invention relates to dry cells and has for an object to provide such a cell having enhanced resistance to leakage. Another object is to provide a dry cell having a number of factors tending to substantially delay any leakage tendency.

In dry cells for flashlights and other containers, leakage of electrolyte outside of zinc forms a growing crystalline mass in drying that clings to many types of surfaces and may cause bulging of the cell jacket until the cell sticks in the enclosure. One prior suggestion for overcoming this difficulty has been the so-called metal jacket which adds weight in order to get the necessary strength.

In contrast to that attempted solution, the present invention attains comparable results without placing so much reliance upon the combined weight and strength as does the iron jacket. A number of factors contribute to this result in the present invention. One such factor is increased gas space in the cell without reducing its effective rating. Two additional gas spaces are provided that are not found in the customary commercial cell. One of these is an exudant chamber outside of the zinc and another is a long hole in the carbon to provide better venting without lowering the resistance to liquid egress from the cell. Another factor has been a lighter weight resinous plastic jacket which is electrolyte-proof, non-fibrous, and stiff enough not to bulge under any crystalline growth of electrolyte material. Such jacket is stiff and resistant in the sense that it maintains a high degree of mechanical rigidity through its ability to resist penetration by the electrolyte, or any other effect by the electrolyte operating to decrease significantly its stiffness.

This application is a continuation-in-part of my prior application Serial No. 439,458 filed April 18, 1942 for "Dry Cells and Process for Manufacturing the Same" now Patent No. 2,396,693, dated March 19, 1946.

Referring to the drawing:

Fig. 1 is an elevational view of a construction in section showing one embodiment of this invention;

Fig. 2 is a partial detail showing the device of Fig. 1 with a reinforced bottom;

Fig. 3 is a sectional view illustrating another embodiment of this invention having a short hole in the carbon and provided with absorbent material between the jacket and zinc electrode;

Fig. 4 is a sectional view illustrating the exudant chamber without any filling, the cell being provided with another type reinforced bottom;

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Fig. 5 is a sectional detail showing a further type bottom reinforcing, spacing the jacket from the zinc.

This cell includes many customary features such as a zinc electrode Z surrounding electrolyte material E and a depolarizing mix M around a central carbon electrode C as illustrated in Fig. 1. Means are provided for closing the ends of the cell including a metal cover D at the top and a bottom formed by the zinc electrode Z being extended across the bottom end. The usual insulating washer W may be provided, also the metal cap H over a carbon electrode. A blanket A of anti-tarnish paper or other thin, tough, sulphide-free paper is capable of reducing the likelihood of short circuit from particles of mix breaking off. The usual gas chamber G is formed at the upper end of the cell within which is the usual top washer 17 constituting a means for supporting the carbon electrode. A vent hole 12 is aligned with the hole or passage 40 in the carbon electrode. The periphery of the metal cap H is provided with a flange 16 carrying an insulating washer 14 to prevent any short circuit between the metal cover D and the metal cap H. If desired sealing material 18 is provided around this washer to protect the cell against prematurely drying out. These foregoing features are believed conventional elements of dry cell construction.

In the embodiment illustrated in Fig. 1 the jacket J both here and in each of the other embodiments has its ends 20 spun over the contact the ends of the cell and prevent looseness of the cell in the jacket. Each of the embodiments illustrated may have a long or short passage 40 in the carbon electrode. Where the embodiment shown in Fig. 1 has no reinforcement for the zinc bottom, the construction shown in Fig. 2 does have such a reinforcement. Although not believed necessary in any of the embodiments illustrated, nevertheless some conventional type sealing material may be placed in the location B to insure greater moisture proofness in any exudant chamber and reduce the tendency for electrolyte material therein to dry out. The construction of Fig. 2 is the same as that of Fig. 1 except for the bottom reinforcement. It will be noted the plate K as well as the bottom of the zinc have strengthening ribs 21 which nest into one another as shown.

The metal cap K at the bottom in Figs. 2 to 5 inclusive is contiguous the zinc at the bottom of the cell to mechanically reinforce the same against bulging due to internal pressure. This

cap is soldered to the zinc or spot welded in the center portion and also around or in portions adjacent the periphery so that both bottom sheets will necessarily have to move together in event of any flexure. This bottom when of the shape as in Fig. 4 fits tightly over the end of the zinc. The metal reinforcing cap K is preferably of a metal less active than zinc such as terneplate, tinplate, cadmium plated steel and the like so that such cap is not attacked significantly so long as the zinc is present.

The embodiment illustrated in Fig. 3 is like that in Fig. 2 except for the addition of a layer of absorbent material S such as the cellulose wadding or preferably absorbent paper. Absorbent paper is preferred material. It assists in immobilizing any electrolyte expressed through a perforation in the zinc can by its absorbent effect. Creepage through the jacket is impossible due to its non-fibrous electrolyte-proof nature. The absorbent material may be waterproofed for a distance of $\frac{1}{8}$ " to $\frac{1}{4}$ " from the top and bottom of the cell.

Surrounding the zinc electrode Z in Fig. 4 for example is an exudant chamber X for any electrolyte material which may exude through the zinc after its corrosion. The outer wall of this exudant chamber is constituted by a jacket J of insulating material which is non-fibrous and stiff enough when in contact with electrolyte material to prevent crystalline growth of such material from causing the jacket to bulge. The exudant chamber in Fig. 3 is shown as being filled to a large extent with an absorbent material S such as highly absorbent paper or cellulose wadding whereas in Figs. 4 and 5 no such absorbent material is used. When absorbent paper is used its top and bottom edge are preferably impregnated with a waterproofing material for an eighth to a quarter of an inch. The ends 20 of the jacket J are spun over as illustrated in the drawing for the purpose of making contact with the ends of the cell enough to prevent egress of electrolyte material. One difference between the present construction and that shown in Patent No. 2,396,693, resides in elimination of the necessity for sealing material closing the ends of the exudant chamber X. It has been found that such sealing material is not essential. The present invention permits reducing the load on such sealing material so that it may be curtailed or frequently even eliminated. This is because the jacket J possesses initially, and maintains even against the effect of contacting electrolyte, ample mechanical strength to hold an effective contact seal at both the upper and lower ends of the cell. However to provide greater moisture proofness in the exudant chamber such sealing material as is described in said parent application may be used though not believed necessary here. Or if desired, a sealing material may be placed outside of the metal ends around the inner portion of the head in the location designated by the letter B. The zinc at the bottom of the cell in Figs. 2 to 5 inclusive is reinforced by a bottom cap K to prevent bulging, the zinc and the cap K having nesting engagement in strengthening ribs 21 illustrated.

As shown in Fig. 4 one or more holes 50 may be placed in the zinc electrode so that gas pressure inside the cell may be equalized within the cell and the exudant chamber thus removing any tendency for tensile stress to exist in the zinc due to internal pressure. Similar holes may be

used in each of the other embodiments illustrated if desired.

The total volume of gas space is about 15% of the total volume of the cell and the relative volumes of the three gas chambers are about as follows: the exudant chamber X about $\frac{1}{3}$ or roughly 33% of the gas chamber G; the full length bore 40 in the carbon electrode C is about 6% of the gas chamber G whereas the short bore in Fig. 3 is only about 2% of the volume of the gas chamber G.

The construction of Fig. 4 has no filler within the exudant chamber so that as electrolyte material tends to crystallize pressure between the stiff jacket and the zinc may tend to spread such electrolyte material and thus reduce any tendency for the jacket to bulge. The reinforcing cap K has side portions which extend in between the jacket and zinc for spacing them apart at the bottom. The crimped joint between the metal cover D and the zinc electrode extends radially outward from the outer surface of the main body portion of the zinc to effectively space the jacket and zinc at the top of the cell.

Fig. 5 is like Fig. 4 except that the reinforcing bottom K does not have the axially extending side portions but merely is of large enough diameter to space the jacket from the zinc. The interesting strengthening ribs 21 tend to axially position the bottom cap with respect to the zinc and jacket.

The exudant chamber X has a two-fold function, one such function is to provide additional gas space into which gas and exudant electrolyte material may move radially to reduce pressure generated within the zinc electrode. Another function for the exudant chamber when combined with a stiff jacket having an electrolyte-proof inner surface is to provide space into which any exudant electrolyte material may spread so that its crystalline growth on drying need not cause bulging of the jacket J.

The jacket or sleeve J is preferably thermoplastic material such as a vinyl chloride polymer, vinyl chloride-acetate copolymer, cellulose acetate butyrate, ethyl cellulose or a thermo setting plastic such as a phenolic condensation product. In practice the jacket J is made of cellulose acetate butyrate purchased under the trade name of Tenite II, a product of Tennessee Eastman Corporation having formula 205E with plasticity H. For the flashlight type dry cell the jacket including its spun over ends is $2\frac{3}{8}$ " long uncurled and $2\frac{1}{4}$ " long over curled ends, having an inside diameter of 1.25" with its wall .020" thick. Its physical properties at 77° F. and 50% relative humidity are as follows:

Modulus of elasticity $(1.33 \text{ to } 1.67) \times 10^5$
Specific gravity, 1.18 to 1.22
Tensile strength, 4300 to 6000 lbs., p. s. i.
Flexure strength, 6300 to 9700 lbs., p. s. i.
Rockwell hardness, R95 to R114

This material is adapted to absorb not more than 2% moisture on immersion in water for 24 hours so that the material retains its stiffness whether in contact with the moist electrolyte material or not. The material being non-fibrous is not subject to penetration between the fibers as is a material such as paper. It is not particularly adapted to impede the creepage of electrolyte along its surface but does prevent it from creeping and wicking through the body of the material. The jacket is made in the form of a seamless tube and is adapted to receive printing and the

usual markings. The pressure generated within the cell does not cause either the jacket J or the zinc Z to bulge since they are of cylindrical shape and rather any such tendency is believed due to the growth of crystalline mass of electrolyte material, which is resisted by the jacket.

In the parent patent the jacket was anchored to the cell principally by the sealing material at each end of the exudant space whereas in the present application the jacket makes a contact seal with the ends of the cell. Any pin hole or fracture in the film on the inside of the jacket in the parent case was in danger of causing the fibrous material to absorb a large quantity of moisture from the electrolyte material whereas in the present case the jacket is non-fibrous and therefore removes the possibility of the behavior just described.

Having the carbon electrode pores partially impregnated with a water repellant material similar to the oil described in the patent to Chaney 1,836,903 increases the resistance or impermeability of the carbon to water when the pores are of Chaney's capillary size. The passage or hole 40 may extend the full length of the carbon as illustrated in Figs. 1, 2 and 4 or such passage may extend only through at least a major portion of the space G above the depolarizer mix and electrolyte material. The carbon should be free of any transverse openings connecting with the hole 40 which are larger than the pores as otherwise resistance to water passing into the passage 40 might be objectionably lower. The function of the passage 40 in the carbon electrode is primarily to lower the resistance of the carbon to the escape of gas since the path for gas transversely through the pores is shorter than would be the case if the passage 40 were not present. For reducing gas pressure in the passage 40 gas is vented through opening 12. A second function for the passage 40 is to serve as an additional gas chamber since the larger the total gas space within the cell the longer will be the delay necessary for any pressure generated within the cell to rise objectionably high under the most adverse conditions. From the standpoint of its venting function the presence of depolarizing mix getting into the passage 40 during insertion of the carbon into the mix is not objectionable but from the standpoint of the passage 40 being a gas chamber whose volume added to the volume of the gas chamber G and the volume of the exudant chamber X, increases the total volume available for holding gas, it may be desirable to keep out the depolarizing mix by use of a small washer over the end of the carbon on being moved into the depolarizing mix. A five-fold reduction in resistance to gas venting is achieved. Accordingly an original stock having only $\frac{1}{5}$ the water or gas permeability of the solid stock may be used when an electrode having a passage 40 is adopted. The time to incidence of electrolyte leakage from the vent hole 12 is longer by three-fold or more when the hollow electrode illustrated is used instead of the solid electrode of the same stock. The full length passage 40 in the electrode also functions as a trap for electrolyte material which may become filled under pressure. The electrolyte may evaporate as rapidly as it comes to the surface of the passage or hole 40 in the carbon electrode, leaving a porous layer of crystals. If the electrolyte reaches the inner surface of the electrode faster than evaporation takes place it may spread over such inner surface without being forced out from the vent hole. It

takes several times longer for leakage to occur from the vent hole 12 when a hollow electrode is used than when the electrode is solid. This time element may be prolonged to effect the overall safety factor of the cell against leakage. With the described invention the total available pressure relieving gas spaces is increased almost 30% with no decrease in the amount of active cell ingredients. The possibility of making a carbon more dense offers greater resistance to the escape of liquid without increasing the resistance to gas being vented.

Where the parent patent sought to prevent bulging of the jacket by sealing material around the top and bottom of the exudant chamber, the present invention does not contemplate the need for the same degree of moisture proofness since the jacket J is stiff enough to resist outward bulging under any local growth of electrolyte material and possesses strength to hold an effective pressure seal contact at both ends of the cell. Where the construction of the parent Patent 2,396,693 tended to impede the spreading of electrolyte by strands of spacing material, the present invention regards the spreading of electrolyte within the exudant chamber to be less objectionable when the non-bulging jacket may make some spreading necessary. The ends of the jackets are both preferably spun over after the same is in place on the cell. While not shown in Fig. 1 it will be understood that greater resistance to leakage is obtained when an absorbent paper wrap is placed between the jacket and the zinc. Such paper has not been illustrated because it need not be of as great thickness as is illustrated in Fig. 3. However, the variant of the construction shown in Fig. 1 with this paper present is preferred to that illustrated. There is then an exudant chamber present though of reduced thickness. As stated before when such thinner absorbent paper is used its ends are impregnated with a electrolyte and water proofing material for an eighth to a quarter of an inch from each edge. Such construction is equivalent to the use of a thinner absorbent sheet than that which is shown in Fig. 3.

Among the advantages of this invention may be mentioned the provision of total volume of gas chambers being larger due to the bore in the carbon electrode and to the exudant chamber outside the zinc, without reducing the effective quantity of active elements and materials. The greater the total volume of gas spaces, the longer will be deferred the generation of any objectionably large pressures within the cell under extreme conditions. The non-fibrous stiff sleeve is strong enough when wet to resist bulging due to the growth of electrolyte material. The absorbent material in Fig. 3 possesses the advantages pointed out previously. The vent 12 aligned with the bore in the carbon electrode is sufficient to vent any pressure in all three gas chambers, especially after the zinc has been corroded or when the zinc is provided with hole 50. The reinforced bottom plate K is plated with an appropriate material which does not react with the zinc and electrolyte present. The hollow carbon electrode is more permeable to gas venting due to the short path for the gas to travel, and accomplishes this without reducing the resistance to passage of liquid through the pores of the carbon.

By having the cell capable of venting gas pressure, the jacket need be only stiff enough not to bulge under growth of electrolyte material in crystallizing and drying, or stiff enough to spread

the electrolyte material and enable any such growth to occupy a greater area. It is not certain but possible that such growth of the electrolyte in crystallizing may occur inwardly instead of outwardly. Also, when gas is vented from the exudant chamber between the zinc and jacket, then more space in this chamber may be occupied by exudant electrolyte material than would be the case if compressed gas impeded the spread of any such electrolyte material. In other words, with this invention the plastic jacket may be made lighter than has heretofore been possible and the exudant chamber more effective as an expansion spaced for electrolyte material.

The jacket illustrated herein as being provided with spun-over ends is claimed in the co-pending application of A. P. Drummond, Serial No. 667,768, filed May 7, 1946, for "Dry Cell," to obtain a good fit for the jacket without any looseness longitudinally between the cell and jacket.

I claim:

1. A dry cell combination of an electrolyte material, a depolarizing mix, a central electrode within the mix and electrolyte material, an outer electrode outside the electrolyte material and mix, means closing the ends of the cell, a principal means for venting gas pressure within the cell through a cell wall, of a carbonaceous electrode containing a water repellent material, having capillary pores but being free of any transverse openings larger than its pores, and having a longitudinal bore, said carbonaceous electrode constituting a principal gas venting device which is more resistant to the passage of electrolyte material than to the passage of gas from the cell, whereby gas may be vented generally radially through at least a portion of said carbonaceous electrode wall without substantially reducing the resistance of the cell wall to the passage of liquid within the cell out through said cell wall, and a resinous plastic jacket outside the outer electrode and of electrolyte-proof material which is non-bulging when in contact with electrolyte material or its crystalline growth, said jacket having portions bent over each end of the cell.

2. A flashlight-type dry cell having a central electrode, depolarizing mix around said electrode, electrolyte material surrounding the mix, an outer electrode outside the electrolyte material, means closing each end of the cell and the improvement comprising in combination, a carbonaceous electrode containing a water repellent material, having capillary pores but being free of any transverse openings larger than its pores, having a longitudinal bore, said electrode constituting a principal gas venting device which is more resistant to the passage of electrolyte material than to the passage of gas, whereby gas may be vented generally radially through at least that portion of said carbonaceous electrode which is above the electrolyte and depolarizing materials, and a jacket outside the outer electrode of cellulose acetate butyrate having a specific gravity between 1.18 and 1.22, a tensile strength of 4300 to 6000 pounds per square inch, a modulus of elasticity of around $(1.33 \text{ to } 1.67) \times 10^5$, a Rockwell hardness of R95 to R114, a flexural strength of 6300 to 9700 pounds per square inch, adapted to absorb not more than 2% moisture on immersion in water for 24 hours, and which is not adapted to bulge under growth of electrolyte material in crystallizing and drying when not substantially thicker than .020 inch.

3. A dry cell having a central electrode, depolarizing mix around said electrode, electrolyte

material outside the mix, an outer electrode surrounding the electrolyte material, means for closing each end of the cell, a gas chamber between said end closing means but beyond said electrolyte material and depolarizing mix, and the improvement for enhancing the leakproof character of the cell by an increase in gas space in which expansion may occur which comprises a second gas chamber having longitudinal walls extending adjacent the first and separated from the first mentioned gas chamber by one of said electrodes which is gas permeable, a gas vent from one of said chambers, and said gas permeable electrode being constructed to oppose the passage of electrolyte material therethrough.

4. A dry cell having a central carbon electrode, an electrolyte material, a depolarizing mix between the central carbon electrode and the electrolyte material, a zinc electrode surrounding electrolyte material, means for closing the ends of the cell, a gas chamber between the zinc and carbon electrodes within the end closing means and beyond the electrolyte material and depolarizing mix, the improvement in venting such cell which comprises the carbon electrode being partially impregnated with a water repellent material, having a porosity adapted for gas venting radially therethrough, having an axial bore of a length and size capable of greatly reducing the resistance of the carbon to the passage of gas radially into the bore, and being substantially free of transverse gas passages through the walls of the carbon which are substantially larger in size than the pores of the carbon, and a vented metal cap extending over the bore in an end portion of the carbon electrode whereby gas venting into the bore and out of said cap is facilitated.

5. A dry cell having a central porous carbon electrode, an electrolyte material, a depolarizing mix between the central carbon electrode and the electrolyte material, a zinc electrode around the electrolyte material, means for closing the ends of the cell, a gas chamber at one end portion of the cell between the zinc and carbon electrodes, between the end closing means and beyond the electrolyte material and depolarizing mix, an exudant chamber outside the zinc provided with an outer wall substantially uniformly spaced from the zinc and having an inner surface of electrolyte-proof material, means for closing the ends of said exudant chamber, said carbon electrode having a hollow axis of substantial length and size to constitute an expansion chamber whose volume added to the volume of the exudant chamber and said gas chamber is effective to delay substantially a pressure increase tending to rupture the cell, the carbon electrode having walls free of any transverse passages larger than its pores and being at least partially impregnated with a water resistant material.

6. A dry cell having a zinc electrode around an electrolyte material, a central carbon electrode, a depolarizing mix between the carbon electrode and the electrolyte material, means for closing the ends of said cell, a gas chamber at one end of the cell within the adjacent end closing means but beyond the electrolyte material and depolarizing mix, the improvement in venting the gas chamber through the pores of the carbon electrodes which comprises the carbon electrode being provided with a substantially axial bore of a size and length to lower the resistance of the electrode to about 20% of the resistance an electrode offers to the passage of gases therethrough when of the same porosity but without such bore,

the electrode except for such bore being free of holes between the bore and the outside which are substantially larger than its pores.

7. A dry cell having a depolarizing mix, a carbon electrode within said mix, electrolyte material surrounding the mix, a zinc electrode around the electrolyte material, means closing each end of the cell, a gas chamber within one end closing means but beyond the electrolyte material and depolarizing mix, and the improvement for increasing the leakproof character of the cell by increasing the volume of gas space which comprises said carbon electrode being provided with a longitudinal hole therein constituting a second gas chamber of a length to extend at least through a major part of the depth of said first mentioned gas chamber, said carbon electrode being permeable to gas transversely of said hole but free of transversely extending holes larger than its pores and connected with said longitudinal hole and said carbon electrode having been treated at least in the longitudinal portion thereof containing said hole to increase the water resistant character of its pores whereby gas may be vented by a short radial path into said longitudinal hole without increasing the danger of leakage of electrolyte material.

8. A dry cell having a depolarizing mix, a carbon electrode within said mix, electrolyte material surrounding the mix, a zinc electrode around the electrolyte material, means closing each end of the cell, a gas chamber between said end closing means but beyond the electrolyte material and depolarizing mix, and the improvement for increasing the leakproof character of the cell by increasing the volume of gas space which comprises said carbon electrode being provided with a longitudinal hole therein constituting a second gas chamber of a length to extend at least through a major part of the depth of said first mentioned gas chamber, said carbon electrode being permeable to gas transversely of said hole but free of transversely extending holes larger than its pores and connected with said longitudinal hole and said carbon electrode having been treated at least in the longitudinal portion thereof containing said hole to increase the water resistant character of its pores whereby gas may be vented by a short radial path into said longitudinal hole without increasing the danger of leakage of electrolyte material, an exudant chamber outside of said zinc electrode and closed by an outer wall having an electrolyte proof inner surface the ends of said exudant chamber being closed against free egress of any electrolyte material therein, and a vent for gas from the longitudinal hole to the outside of the cell.

9. A dry cell having a depolarizing mix, a central electrode within said mix, electrolyte material surrounding the mix, an outer electrode around the electrolyte material, means closing each end of the cell, a gas chamber between said end closing means but beyond the electrolyte material and depolarizing mix, and the improvement for increasing the leakproof character of the cell by increasing the volume of gas space which comprises said central electrode being provided with a longitudinal hole therein constituting a second gas chamber of a length to extend at least through a major part of the depth of said first mentioned gas chamber, said central electrode being permeable to gas transversely of said hole, an exudant chamber outside of said outer electrode and closed by an outer wall having an electrolyte proof inner surface, the ends of said

exudant chamber being closed against free egress of any electrolyte material therein, and a gas vent from at least one of the three mentioned chambers to the outside of said cell.

10. A dry cell having a central electrode, depolarizing mix around said electrode, electrolyte material surrounding the mix, an outer electrode outside the electrolyte material, means closing each end of the cell, and the improvement comprising in combination, a carbonaceous electrode containing a water repellent material having capillary pores but being free of any transverse openings larger than its pores, having a longitudinal bore, said electrode constituting a principal gas venting device which is more resistant to the passage of electrolyte material than to the passage of gas, whereby gas may be vented generally radially through at least that portion of the carbonaceous electrode which is above the electrolyte material and the depolarizing mix, and a jacket forming an exudant chamber outside the outer electrode with an outer wall for said chamber being non-bulging under the growth of any crystalline dried electrolyte material in said chamber, the inner surface of said wall being non-fibrous, electrolyte proof and of electrical insulating material.

11. A dry cell having a depolarizing mix, a central electrode within said mix, electrolyte material around the mix, an outer electrode surrounding the electrolyte material, means for closing the ends of the cell, a jacket of non-fibrous insulating material outside the outer electrode and cooperating with the end closing means by having its ends spun over to form beads in contact with the end closing means, said jacket being electrolyte proof and non-bulging under the growth of crystallizing electrolyte material contiguous said jacket, a metal bottom reinforcing an outer electrode bottom against bulging, and nesting strengthening ribs on both the reinforcing metal bottom and outer electrode bottom, said metal bottom being held against the outer electrode by said jacket.

12. A dry cell having a depolarizing mix, a central electrode within said mix, electrolyte material around the mix, an outer electrode surrounding the electrolyte material, means for closing the ends of the cell, a carbon electrode containing a water repellent material having capillary pores but being free of any transverse openings larger than its pores, having a longitudinal bore, said electrode constituting a principal gas venting device which is more resistant to the passage of electrolyte material than to the passage of gas, whereby gas may be vented generally radially through at least a portion of said carbon electrode, and a jacket of non-fibrous insulating material outside the outer electrode having at least one end spun over to form a bead cooperating with and contacting that end closing means, said jacket being electrolyte proof and non-bulging under the growth of crystallizing electrolyte material contiguous said jacket, a metal bottom having its periphery spacing the outer electrode from said jacket.

13. A dry cell having a depolarizing mix, a carbon electrode within said mix, electrolyte material surrounding the mix, a zinc electrode around the electrolyte material, means closing each end of the cell, a gas chamber between said end closing means but beyond the electrolyte material and depolarizing mix, and the improvement for increasing the leakproof character of the cell by increasing the volume of gas space which com-

prises said carbon electrode being provided with a longitudinal hole therein constituting a second gas chamber extending the full length of said carbon electrode, said carbon electrode being permeable to gas transversely of said hole but free of any transversely extending holes larger than its pores and connected with said carbon electrode, and said carbon electrode having been treated to increase the water resistant character of its pores, means closing an end of said carbon electrode within the cell to prevent depolarizing mix or electrolyte material filling said longitudinal hole.

14. A dry cell having a central electrode, depolarizing mix around the electrode, electrolyte material surrounding the mix, an outer electrode outside the electrolyte material, means for closing each end of the cell, a gas chamber between said end closing means but beyond said electrolyte material and depolarizing mix, a principal gas vent from said chamber through a carbonaceous electrode containing a water repellent material, having capillary pores but being free of any transverse openings larger than its pores, having a longitudinal bore, said electrode constituting said principal gas venting device and being more resistant to the passage of electrolyte material than to the passage of gas, whereby gas may be vented generally radially through at least a portion of said carbonaceous electrode, and the improvement for enhancing the tendency of the cell to resist leakage of electrolyte material comprising an exudant chamber outside the outer electrode, the outer wall of said exudant chamber being non-bulging due to the growth of any crystalline electrolyte material in said exudant chamber, having an inner surface which is non-fibrous and electrolyte proof, and the ends of said exudant chamber being closed against the free passage of electrolyte material, the outer wall of said exudant chamber being spaced from the outer electrode in at least one end of the cell by a metal spacer between them.

15. A dry cell having a central electrode, depolarizing mix around said electrode, electrolyte material surrounding the mix, an outer electrode outside the electrolyte, means for closing the ends of the cell, and the improvement in enhanced leakproofness which comprises in combination, a carbonaceous electrode containing a water repellent material having capillary pores but being free of any transverse openings larger than its pores, having a longitudinal bore, said electrode constituting a principal gas venting device which is more resistant to the passage of electrolyte material than to the passage of gas, whereby gas may be vented generally radially through at least that portion of said carbonaceous electrode which is above the electrolyte and depolarizing materials, a stiff jacket outside the outer electrode, and an exudant chamber between the outer electrode and jacket, said chamber being free of material which impedes the spreading of an exudant electrolyte material in said chamber.

16. A dry cell comprising inner and outer electrodes with electrolyte material and depolarizing mix therebetween, means for closing the ends of the cell, a device constituting a principal gas vent from said cell through a carbonaceous electrode containing a water repellent material, said electrode having capillary pores but being free of any transverse openings which are larger than its pores, having a longitudinal bore, and being more resistant to the passage of electrolyte material than to the passage of gas from said cell,

a jacket of non-fibrous insulating material non-bulging under growth of crystalline electrolyte material between the jacket and outer electrode and having its end spun over the end closing means forming a bead at each end of the cell, said outer electrode and jacket being spaced apart in at least a portion of their length, and absorbent material between said jacket and outer electrode extending throughout at least a major portion of the length of the cell, a crimped joint between one end closing means and the outer electrode for spacing the jacket from the outer electrode adjacent said joint.

17. A dry cell comprising a central electrode, and an outer cylindrical electrode, depolarizing mix and electrolyte material therebetween, means closing the ends of said cell, a gas vent for the cell, and a resinous plastic jacket surrounding the outer electrode and spaced therefrom in at least a portion of its length to provide an exudant chamber into which electrolyte material may move when it has penetrated through the outer electrode, said jacket being non-bulging due to any exudant electrolyte material in drying by causing such material to spread within said exudant chamber while growing, yet said jacket being substantially .02 inch in thickness whereby it is not substantially more stiff than is enough to effect said spreading, and a compact cell is provided with ample space for active cell ingredients.

18. A dry cell comprising a central electrode, and an outer cylindrical electrode, depolarizing mix and electrolyte material therebetween, means closing the ends of said cell, a gas vent for the cell, and a resinous plastic jacket surrounding the outer electrode and spaced therefrom in at least a portion of its length to provide an exudant chamber into which electrolyte material may move when it has penetrated through the outer electrode, said jacket being non-bulging due to any exudant electrolyte material in drying by causing such material to spread within said exudant chamber while growing, yet said jacket being not substantially more than .02 inch in thickness whereby it is not substantially more stiff than is enough to effect said spreading, and a compact cell is provided with ample space for active cell ingredients, said jacket being spaced from the outer electrode adjacent at least one end by a crimped joint between the outer electrode and one end closing means.

19. In a dry cell having a central electrode, an outer electrode, depolarizing mix and electrolyte material between said electrodes, and means closing the ends of the cell, the combination therewith of the improvement enhancing the leakproof character of the cell as well as its lightness in weight, compactness, and non-bulging character, said improvement comprising in combination a carbonaceous electrode containing a water repellent material having capillary pores but being free of any transverse openings larger than its pores, having a longitudinal bore, and said carbonaceous electrode constituting a principal venting device for gas in communication with the interior and exterior of the cell and offering greater resistance to egress of electrolyte material than to the passage of gas from said cell, an electrolyte-proof resinous plastic jacket surrounding the outer electrode for substantially its full length, and means closing the ends of any space between the jacket and outer electrode, whereby said jacket may be made thin and only stiff enough not to bulge under the crystalline

growth of any electrolyte material in drying and need not be thick to resist bulging due to pressure of entrapped gas.

20. A dry cell according to claim 19 in which said jacket has its ends bent over the cell end closing means to constitute the means closing the ends of any space between the jacket and outer electrode.

21. A dry cell according to claim 19 in which an expansion space is provided between the jacket and outer electrode.

22. In a dry cell having a central electrode, an outer electrode, depolarizing mix and electrolyte material between said electrodes, and means closing the ends of the cell, the combination therewith of the improvement enhancing the leakproof character of the cell as well as its lightness in weight and non-bulging character, said improvement comprising in combination a carbonaceous electrode venting device for gas in communication with the interior and exterior of the cell and offering greater resistance to egress of electrolyte material than to the passage of gas from said cell, an electrolyte-proof resinous plastic jacket surrounding the outer electrode for substantially its full length, and means closing the ends of any space between the jacket and outer electrode, whereby said jacket may be made thin and only stiff enough not to bulge under the crystalline growth of any electrolyte material in drying and need not be thick to resist bulging due to pressure of entrapped gas, said venting device being constituted by the inner electrode being of carbon partially impregnated with a water repellent material, said carbon electrode having a porosity adapted for gas venting radially therethrough, having a longitudinal recess of a length and size capable of greatly reducing the resistance of the carbon to the passage of gas radially into said recess and being substantially free of transverse gas passages through the walls of said recess which are substantially larger in size than the pores of the carbon, and a vented cap extending over said longitudinal recess in an end portion of the carbon electrode, whereby gas venting into said recess and out through said cap is facilitated.

23. A dry cell according to claim 19 in which said jacket has a thickness of about .02".

24. A dry cell having a central carbon electrode, an electrolyte material, a depolarizing mix between the central carbon electrode and the electrolyte material, a zinc electrode surrounding electrolyte material, means for closing the ends of the cell, a gas chamber between the zinc and carbon electrodes within the end closing means and beyond the electrolyte material and depolarizing mix, the improvement in venting such cell which comprises the carbon electrode being impregnated with a water repellent material, having a porosity adapted for gas venting radially therethrough, having an axial bore of a length and size capable of greatly reducing the resistance of the carbon to the passage of gas radially into the bore, and being substantially free of transverse gas passages through the walls of the carbon which are substantially larger in size than the pores of the carbon, and a vented cap extending over the bore in an end portion of the carbon electrode whereby gas venting into the bore and out of said cap is facilitated.

25. In a dry cell having an inner electrode and an outer electrode, depolarizing mix and electrolyte material between said electrodes, and means closing the ends of the cell, the combination therewith of the improvement enhancing the

leakproof character of the cell, said improvement including the combination of a carbonaceous electrode containing a water repellent material having capillary pores but being free of any transverse openings larger than its pores, having a longitudinal bore, and said carbonaceous electrode constituting a principal venting device for gas in communication with the interior and exterior of the cell and offering greater resistance to the egress of electrolyte material than to the passage of gas from said cell, a jacket outside of the outer one of said electrodes for substantially its full length and spaced from the outer electrode to provide an expansion chamber for any electrolyte material that may exude through that outer electrode, and means closing the ends of said expansion chamber against egress of electrolyte material, the inner face of said jacket with which any exudant electrolyte material may come in contact having an electrolyte-proof surface.

26. A dry cell according to claim 25 in which an absorbent material is placed in said expansion chamber to facilitate the spread of any exudant electrolyte material therein.

27. A dry cell according to claim 25 in which a carbon electrode is partially impregnated with a water repellent material, has a porosity adapted for venting gas therethrough and is substantially free of any transverse gas passages through the walls of the carbon which are substantially larger in size than the pores of the carbon.

28. In a dry cell having an inner electrode and an outer electrode, depolarizing mix and electrolyte material between said electrodes, and means closing the ends of the cell, the combination therewith of the improvement enhancing the leakproof character of the cell, said improvement including the combination of a carbonaceous electrode venting device for gas in communication with the interior and exterior of the cell and offering greater resistance to the egress of electrolyte material than to the passage of gas from said cell, a jacket outside of the outer one of said electrodes for substantially its full length and spaced from the outer electrode to provide an expansion chamber for any electrolyte material that may exude through that outer electrode, and means closing the ends of said expansion chamber against egress of electrolyte material, the inner face of said jacket with which any exudant electrolyte material may come in contact having an electrolyte-proof surface, said carbon electrode being centrally arranged and provided with a longitudinal bore at least above the depolarizing mix and electrolyte material, said longitudinal bore being of a size and length capable of reducing the resistance of the carbon to the passage of gas transversely into said bore from the inside of the cell, and a vented cap extending over said bore in an end portion of the carbon electrode whereby gas venting into said bore and out through the cap is facilitated.

29. A dry cell according to claim 25 in which said jacket is stiff to resist bulging by growth of electrolyte material in drying in said expansion chamber.

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