Oct. 30, 1951 C. R. FISHER ET AL 2,572,918

GAS DEPOLARIZED CELL

Filed Nov. 13, 1946 2 SHEETS—SHEET 1

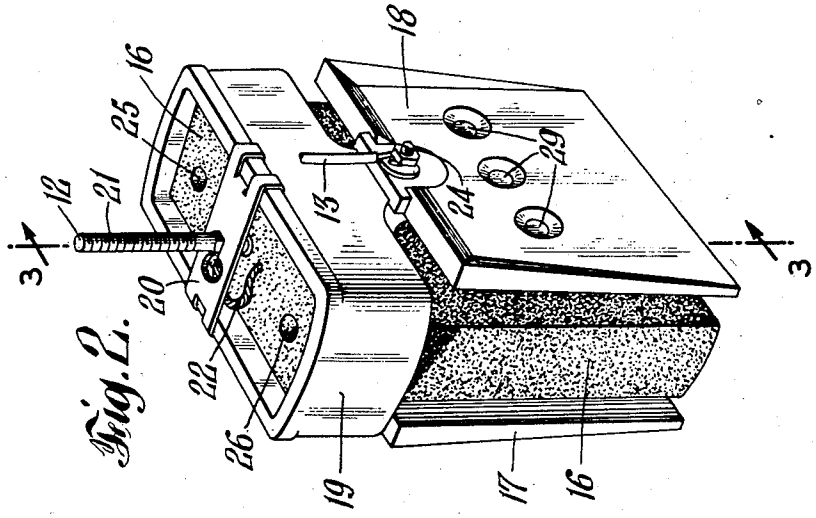


Fig. 2.

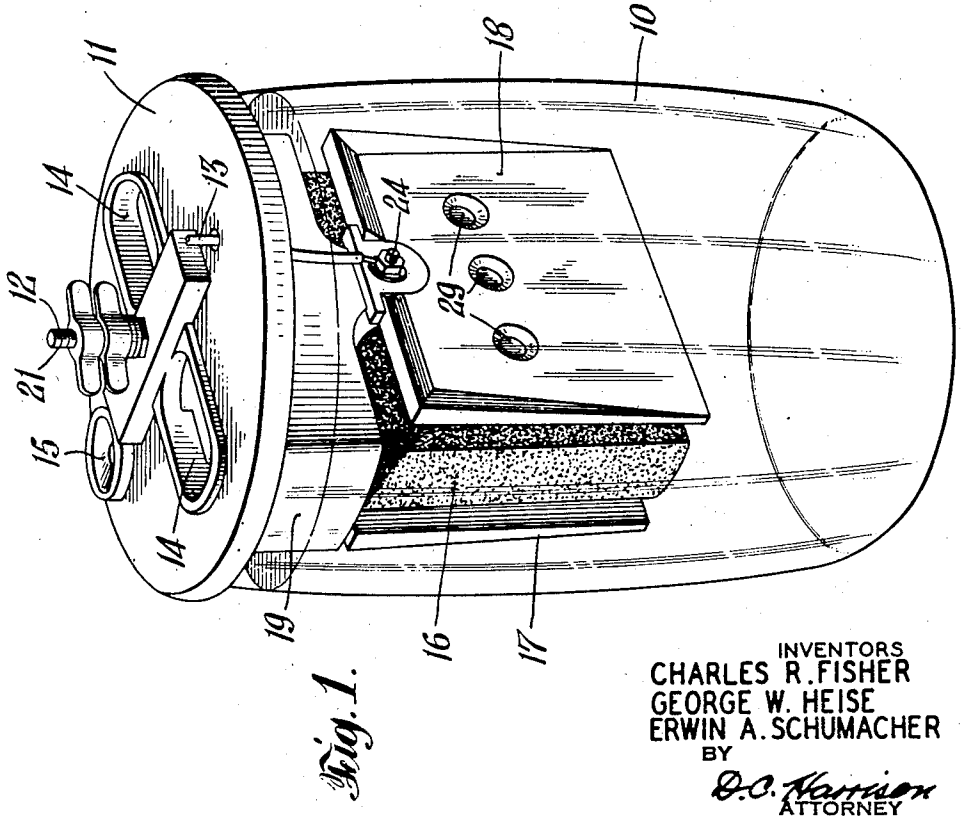


Fig. 1.

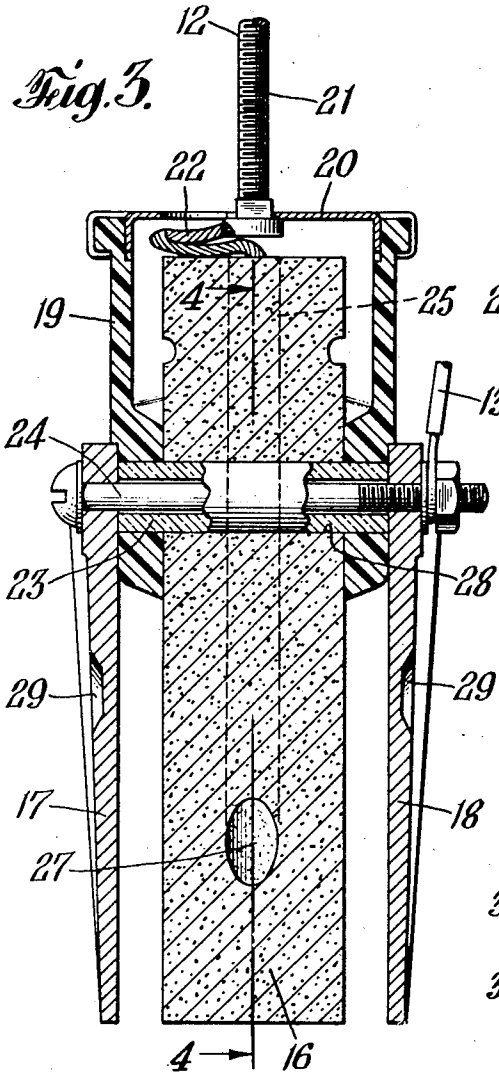
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Fig. 3.



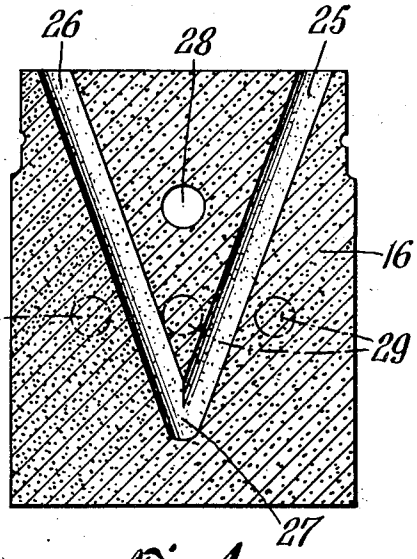


Fig. 4.

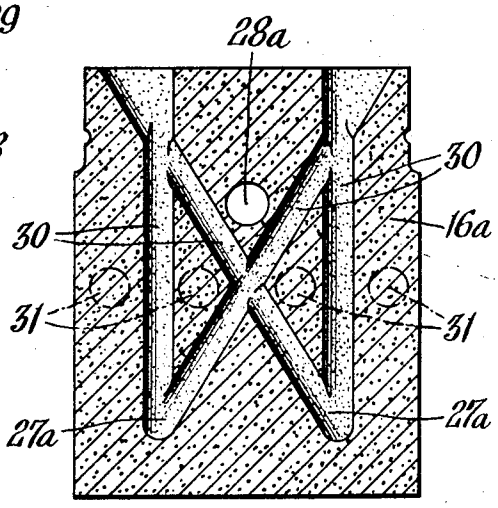


Fig. 5.

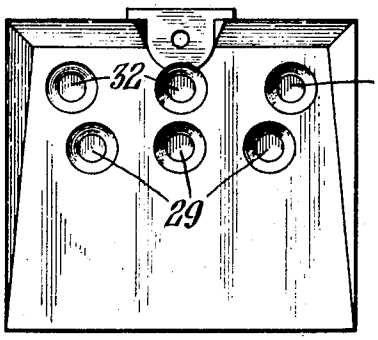


Fig. 6.

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GAS DEPOLARIZED CELL

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Application November 13, 1946, Serial No. 709,654

25 Claims. (Cl. 136—136)

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This invention relates to gas depolarized primary cells and especially air depolarized cells having porous carbon cathodes and has for an object to increase the permissible current density for a given electrode surface. Another object is to provide such a cell that is easy to renew, incorporating an assembly of unitary construction, designed to be discarded after a single service cycle. A further object is to provide more certain indicating means to show when the cell needs renewing.

It has previously been shown that the heavy drain operating characteristics of porous, gas permeable, and electrolyte impervious carbon cathode of the air-depolarized cell can be improved by suitable ventilating openings. In this invention better ventilation passages are provided, permitting the cathode to be smaller in size for a given current carrying capacity and a given voltage. Specifically the carbon of this invention is provided with downwardly extending gas passages of suitable diameter leading from its top surface well into the lower portion of the electrode and connected at their base so that the circulation of gas through these passages is facilitated. The exact reasons for the efficacy of this construction are not entirely understood. However, it is believed that with an air depolarized cell some of the oxygen content of the air is absorbed by the porous carbon, leaving the nitrogen rich air lighter in weight than the surrounding atmosphere which has not lost its oxygen content with the result the air after losing its oxygen is caused to rise in either one or the other of the sides of the V passage thus causing circulation. It is thought that physical circulation of gas is a necessity in the present invention to effectively supply the depolarizing gas. This has been confirmed in an air depolarized cell by closing the passages with just enough mercury at the vertex of the V to prevent air circulation without significant reduction in size of ventilating holes, with the result that the V ventilated cell through which air could not circulate, was found to operate much less satisfactorily.

It has also been proposed to have small areas of the zinc anode made of thinner walled material than the main body for the purpose of indicating when these walls have been corroded and therefore the cell is in need of renewal. With gas-depolarized cells such indicator panels have heretofore lacked reliability and accuracy. To enhance their reliability the number of these indicating panels has been increased and their position has been changed from the lower portion

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of the zinc to the upper portion, into an area where the current density is more nearly uniformly distributed. This area has been found to be between about 15% to 50% of the area of the anode measured down from its top.

According to the present invention the current density of the air depolarized primary cell for a given voltage and electrode area has been raised and the carbon electrode made smaller in size for a given rating, by having the vent passages connected to enhance circulation of air through the electrode. At the same time indicating panels in the anodes are made more reliable thus better adapting the cell for use in railroad signal work where reliability is a prime factor.

Referring to the drawings:

Fig. 1 is a perspective showing one embodiment of this invention suspended in the conventional size jar of batteries for railroad signal operation;

Fig. 2 is a perspective showing the replaceable anode and cathode unit;

Fig. 3 is a section on the line 3—3 of Fig. 2;

Fig. 4 is a longitudinal section through the carbon of Fig. 3 on the line 4—4 but with the sleeve 23 and bolt 24 removed;

Fig. 5 is a view corresponding to Fig. 4 but showing a modified construction;

Fig. 6 is a modified construction of a zinc plate having six instead of three indicating panels, adapted for use with the carbon of the type shown in Fig. 4.

As shown in Fig. 1 this invention is shown embodied in an air depolarized cell comprising the conventional glass jar or container 10, of cells used in railroad signal work, provided with a top 11 of appropriate insulating material having a central terminal 12 for the cathode and a second terminal 13 leading from the anodes. An elongated central opening 14 permits access of air to the ventilating passages in the carbon cathode. Another opening 15 enables an oil layer to be placed on top of the electrolyte to prevent creepage of solution and to reduce the rate of evaporation or carbon dioxide absorption. The dotted line indicated in Fig. 1 illustrates a conventional height of the liquid electrolyte after the cell has been renewed. The carbon cathode 16 is of the customary porous type which is permeable to gas but impervious to the electrolyte as is customary in this art and as described for example in the prior patent to Heise et al. 2,207,734, dated July 16, 1940. Spaced from opposite sides of the cathode are zinc anodes 17 and 18. The three electrodes are supported from

a collar 19 of suitable insulating material such as a polystyrene resin or the like sealed to the carbon. Other functions of this collar 19 are to prevent electrolyte accidentally splashing on the top of the cathode 16 or getting into the vent passages, and, further, to keep oil from making contact with, and injuring the carbon. Spanning the top of this collar 19 is a bridge 20 shown in Fig. 2 for the purpose of supporting the entire replaceable unit from a terminal bolt 21 connected by the flexible conductor 22 with the carbon.

As shown in Fig. 3 a ceramic sleeve 23 surrounds a bolt 24 insulating the same from the carbon, this bolt serving to clamp the zinc plates 17 and 18 together and also serving to electrically connect them. The sleeve 23 is coated with paraffin wax or similar substance to render the sleeve impermeable to gas. The carbon electrode in Fig. 3 is supported by the bolt 24 and the sleeve 23 although it will be understood it might be supported by the sealing material between the carbon and the collar 19. The spacing projections on the collar 19 which receive the bolt 24 are generally parallel to and between the carbon and each zinc electrode as shown in Figs. 1 to 3. The metal bridge 20 is shown as having bifurcated ends extending around opposite edges of the collar 19 as well as a downturned portion engaging inner faces of the collar on each side.

As shown in Fig. 4 the gas permeable porous carbon 16 is provided with downwardly extending air circulating passages or channels 25 and 26 leading from the top surface of the carbon well into the lower portion of the electrode adjacent its lower end. For the purpose of facilitating circulation of air through these passages they are connected at their lower ends as shown by the numeral 27 at the vertex of the V in Fig. 4. The perforation 28 is the one through which the bolt 24 and sleeve 23 pass. The dotted circles shown in Fig. 4 illustrate the location of the indicating panels 29 in the zinc electrode 17 and 18 with respect to the air circulating passages. In other words these indicating panels are located in the upper portion of the zinc and laterally displaced from the axes of the circulating passages so that they are not located opposite such an air passage. Preferably these indicating panels are located in the upper portion of the zinc in which current density has been found to be more nearly uniform thereby enhancing the reliability of the indicating panels for their indicating purpoes.

In Fig. 5 is shown a modified construction of porous cathode 16*a* having the usual perforation 28*a* for supporting the carbon and in this case being provided with porous, downwardly extending connected ventilating passages 30 of the general shape illustrated. The indicating panels 31 in the zincs are in this case four in number and located between the air circulating passages as shown in Fig. 5.

In Fig. 6 the zinc anodes are provided not only with three indicating panels 29 shown in Figs. 1 to 3 inclusive but are also provided with a second or upper row of such panels 32 arranged as illustrated so that here again the panels do not lie opposite the V shaped ventilating passages of Fig. 4.

When exhausted the entire unit shown in Fig. 2 is replaced or thrown away and another unit substituted for use with a new or fresh electrolyte solution. The collar is of such type of insulating material that it is not attacked by the caustic solution or by the oil layer over the electrolyte.

The assembly imposes no strain on the soft and fragile carbon and the zinc anodes are supported independently of the carbon. The bolt 21 is removable and can be locked in place when the assembly is fastened to the cover. When removed from the retaining slot in the yoke or bridge piece 20 the bolt can be laid flat thus reducing the overall size of the assembly and facilitating packaging and shipping. The flexible conductor 22 establishes electrical contact between the bolt 21 and the carbon without imposing any strain on the carbon. The collar 19 and the cover 11 may be made structurally integral by being molded in one piece instead of two, thus doing away with the need of the bridge 20 and supporting bolt 21. As shown in Fig. 3 the zinc anodes are clamped against extensions on the collar 19 through which bolt 24 and sleeve 23 pass. The bolt 24 is preferably made of amalgamated iron while sleeve 23 may be of glass or porcelain. Should the sleeve be of porous insulating material it is coated with paraffin wax or other material to render it impermeable to gas. Instead of the construction illustrated, the bolts for clamping the zinc to the collar 19 may be molded into the plastic collar thus eliminating the necessity for the hole 28 in the carbon but creating the need for an electrical connection between the two zinc anodes.

The diameter of the ventilating holes is determined to a large extent by the service requirements, increasing as current drain is raised. In a cell designed for railway signal service as in the present case, the service drain requirements are high, including such demands as one ampere continuous discharge for evaluation tests and up to 2.5 to 3.0 amperes on intermittent load under actual service conditions. We have found that, for such service and a carbon of the general shape and size shown in Figs. 1 and 2, the diameter of the ventilating hole should be greater than ¼ inch and preferably about ⅜ inch. The upper limit is fixed by several considerations; it is our present opinion that the wall thickness, i. e., shortest distance from ventilating hole to active surface, should not be less than ⅜ inch and preferably ½ inch or more to guard against penetration of electrolyte through seams, cracks, or fortuitous channels into the ventilating wells; further, the larger the hole diameter, the lower become mechanical strength and electrical conductivity of the carbon electrode as a whole. It has been found that with air circulating passages of the type shown in Fig. 4 that the current density may be increased by about 50 to 75% compared with the current density obtainable if the carbon electrode were not ventilated. In other words, if the carbon were not ventilated, it would have to be 50 to 75% greater than it is in the present case. This reduction in size of the carbon electrode is important when consideration is given to the use of this type cell in the conventional standard size battery jar used for railroad signal operation.

To attain the desired 50–75% increase in size of electrode, increase in horizontal length cannot be considered because of the lack of space in the conventional 500 ampere hour battery jar. Increase in vertical dimension is undesirable, because of the greater distance air must travel and the resulting difficulty in obtaining uniform current density and, further, because of the well-known corrosion difficulties, due to concentration cell effects, when zinc anodes extend downward into the region of exhausted electrolyte which accumulates at the bottom of the cell. Increase

in electrode thickness also involves considerations of space available in a cylindrical jar and does not give corresponding increase in active electrode areas. All these expedients are costly, because of the extra carbon required and all of them reduce the space available for electrolyte by an amount equivalent to 40 to 50 ampere hours, or 8–10% of the nominal rating of the battery.

The double V type ventilating passages shown in Fig. 5 show an increase in permissible current density to 75 to 100% compared with the unventilated carbon electrode of equal size. The beneficial effect of ventilation of the type illustrated is particularly marked at low temperatures, and therefore lowers the temperature at which a unit can safely be used at a given load. It is emphasized that V-ventilation offers an extremely simple means of obtaining increased current density and improved uniformity of current distribution approaching in effectiveness complete ventilation, but without the manufacturing difficulty and expense of the latter.

If the zinc face be divided into six equal-depth horizontal segments the preferred area for location of the indicating panels will be in the second and third segments from the top and at least ½ inch in from the sides to avoid edge effects. It is the function of the indicating panels to show when the rated capacity has been obtained, perforation of the zinc showing that the cell should be renewed to avoid signal failure. As many as 7 panels may be provided in each zinc. Even more reliable indication is obtained by subdividing each individual panel with transverse or vertically reinforcing ribs or both. In the present cell of Figs. 1 to 4, each zinc is provided with three indicating panels each ⅛ inch thick, this thickness being slightly greater (by about 5%) than the theoretical value assuming uniform current density for the entire zinc surface. The area of the indicating panel should be less than 10% and preferably less than 5% of the total area of the zinc electrode. When the panel is $\frac{1}{32}$ inch in diameter and three such panels are used for each zinc then each panel has an area slightly less than .1 square inch and the total of the three panels is .3 square inch which is then 1.5% of the active zinc area. The bevelled portion around the indicating panel is for the purpose of increasing the visibility when the cell is viewed at an angle. This invention enables the advantage of the hollow, built-up type of carbon electrode in uniform current density to be more nearly approached in the cheaper solid block type carbon electrode. By the term "built-up" type of carbon electrode is meant one which cannot be molded in a single block but has to be built up from more than one piece with the aid of adhesive or other securing means. The term "solid block" type carbon electrode implies one which is capable of being molded or formed into a single block and does not need to be built up from several preformed parts. The solid block type is cheaper because no labor and materials are needed in building up such a cathode from preformed parts.

We claim:

1. A replaceable electrode unit for a gas depolarized cell comprising a gas permeable carbon electrode impervious to wetting by electrolyte uniformly spaced from a zinc electrode on each of two opposite sides of the carbon, a collar of insulating material surrounding the carbon and supporting all electrodes therefrom, said collar having spacing projections extending substantially parallel to and between the carbon and each zinc electrode, and clamping means securing each zinc electrode to its spacing projection of said collar, said clamping means also supporting said carbon electrode between said spacing projections.

2. In a replaceable unit having an anode and cathode for a gas depolarized cell, the combination therewith of the improvement for increasing the current density of the cell, said improvement comprising an electrolyte-impervious gas permeable carbon electrode of the solid block type provided with means for supporting said electrode with its top surface exposed to the depolarizing gas above the surface of electrolyte, a plurality of pairs of V shaped channels extending from the top surface for at least a major portion of the length of the electrode with their axes in the same general plane, whereby depolarizing gas may circulate through said channels during operation of the cell.

3. An electrode unit for a gas depolarized cell comprising a pair of anodes between which is mounted a gas permeable carbon electrode impervious to electrolyte uniformly spaced from said anodes, the carbon electrode being provided with downwardly extending ventilating passages connected within the carbon so that circulation of depolarizing gas is possible through such passages as some of the content of the depolarizing gas is consumed during operation of the cell, each anode being provided with a plurality of indicating panels of less depth than its thickness around the panels, each of said panels being located in the portion of the anodes where current density is substantially uniform, there being one such panel between said passages and one laterally outside each passage.

4. A replaceable unit for a gas depolarized cell comprising a gas permeable carbon electrode impervious to electrolyte uniformly spaced between zinc electrodes, the carbon being provided with V shaped passage through which depolarizing gas is adapted to circulate during operation of the cell, the vertex of said V extending below the longitudinal center of the carbon, at least three indicating panels in each zinc, each located in the portion of the zinc where current density is substantially uniform, the central one of such panels being located above the vertex of the V passage and between the two sides thereof, at least one other panel in each zinc being at about the same level as the first mentioned panel but on the opposite side of one part of the V passage from the first.

5. An electrode unit for a gas depolarized cell comprising a gas permeable carbon block impervious to electrolyte uniformly spaced between zinc plates, a collar of insulating material surrounding the carbon near the top thereof sealed to the carbon block and provided with projections spacing the zinc plates from the carbon block, a sleeve of insulating material passing through the carbon and projections, a clamping bolt through said sleeve, the sleeve having been treated with a material to render the sleeve gas impervious.

6. A unit according to claim 5 in which the coating material is paraffin wax located on the outside of said sleeve and the sleeve is of ceramic material.

7. A replaceable unit for a gas depolarized primary cell comprising a cathode and anode secured thereto, the cathode being of the solid block type of porous, gas permeable but electrolyte impermeable carbon provided with a substantially V-shaped gas circulating channel ex-

tending from an upper surface of the electrode downwardly into a lower portion of the cathode where said channel has its vertex, and a collar of insulating material supporting and spacing said electrodes adjacent an upper portion thereof, said collar extending around said cathode and sealed against the admission of electrolyte between said collar and cathode, whereby any oil film on electrolyte need not contact the carbon cathode.

8. A gas depolarized primary cell comprising a transparent container, a replaceable unit comprising a porous cathode not wet by electrolyte and having connected ventilating passages extending into the cathode from the top thereof and of a size and shape to enable depolarizing gas to circulate therethrough, said cathode being of material capable of consuming some of the depolarizing gas for depolarizing purposes in the cell, a pair of anodes spaced from the cathode by an insulating plastic collar sealed to the cathode, threaded securing means for supporting said anodes from said collar, a cover of insulating material for said container and cell, said cover supporting the replaceable unit by threaded means.

9. A replaceable unit for a gas depolarized primary cell comprising a porous carbon cathode permeable to gas but impervious to electrolyte, connected ventilating passages for circulation of depolarizing gas from the top portion of said cathode, an insulating plastic collar surrounding the upper portion of said cathode and sealed thereto below the top of the carbon, anodes spaced from opposite sides of the cathode and carried by said collar, a metal strip spanning said collar for supporting said cathode and anodes therefrom, a supporting bolt extending upwardly from said strip, and a flexible terminal connection for each electrode which is independent of the support for the electrodes from said collar.

10. A replaceable unit for a gas depolarized cell comprising a gas permeable, electrolyte impervious carbon cathode having its pores distributed substantially uniformly throughout, spaced between a pair of metal anodes, the cathode having downwardly extending gas circulating passages connected in the lower half of said carbon, each anode being provided with at least one life indicating panel located in the upper half of the anode and displaced laterally from the axis of said passages, said panel being of less thickness than the anode material around it.

11. A replaceable unit for a gas depolarized primary cell comprising a porous carbon gas permeable but electrolyte impervious cathode, a pair of anode metal members spaced from the cathode on opposite sides thereof, insulating material by means of which both the cathode and anodes are adapted to be supported from a cover for the cell, the cathode having downwardly extending gas circulation passages from its upper surface connected in the lower half of said cathode, and a plurality of indicating panels of reduced thickness located in the upper portion of the anodes about 15% to 50% of the depth of the anodes down from their top, and laterally displaced from each of said gas circulation passages.

12. A replaceable unit for a gas depolarized primary cell comprising a porous carbon cathode which is gas permeable but impervious to electrolyte, a supporting collar of insulating material to which said cathode is fastened, a pair of anode plates spaced from the cathode on opposite sides thereof and secured to said collar, the cathode being provided with at least two gas circulating passages extending from the top of the electrode

well into the lower portion thereof and connected within said cathode to facilitate circulation of gas therethrough, each anode plate being provided with a plurality of life indicating panels of reduced thickness, not over 5% to 10% of the total area of a plate, located in an area of substantially uniform current density between about 15 to 50% of the way down from the top of the plate and laterally displaced from the axis of the downwardly extending passages.

13. A replaceable cathode for a gas depolarized primary cell comprising a solid block type of porous gas permeable but electrolyte impermeable carbon provided with a plurality of generally V-shaped gas circulating passages extending from a top surface of the carbon block downward for at least a major portion of the length of the cathode, into a lower portion thereof, said passages having their axes in substantially the same longitudinal plane and said plurality of V-shaped passages being connected intermediate the ends of said passages and also adjacent at least one end of said passages within the carbon block.

14. A replaceable unit for a cell having depolarizing gas supplied to the cathode, said unit comprising an electrolyte impervious gas permeable carbon cathode spaced from a metal anode, said cathode having a passage extending from its top surface into the body of the electrode and out again at said top surface whereby depolarizing gas may be circulated through said passage, and a collar of insulating material supporting both the cathode and anode, said collar being sealed to the upper side portions of the cathode and extending above the top surface of said cathode.

15. A unit according to claim 14 in which a supporting bridge spans the upper portion of said collar and is secured thereto.

16. A unit according to claim 14 in which said gas circulating passage is of general V shape and said anode is provided with an indicating panel located opposite a portion of the cathode adjacent the vertex of the V and between the sides of the V.

17. A unit according to claim 14 in which there are two anodes one on each side of the cathode and each anode is provided with at least three life indicating panels of less than 5% of the total area of the anode and located in an upper half of the anode where current density through cell operation is substantially uniform.

18. A replaceable unit for a gas depolarized primary cell comprising a cathode and anode, the cathode being of the solid block type of porous, gas permeable but electrolyte impermeable carbon provided with a generally V-shaped gas circulating channel extending from an upper surface of the cathode into a lower portion thereof, said anode being provided with at least several indicating panels, each of less thickness than the anode, laterally spaced from a position directly opposite any portion of said gas circulating channel, and located above the lower half of said anode.

19. A gas depolarized cell having a container for electrolyte, a cover for said container, a gas permeable but electrolyte impermeable porous cathode having a gas circulating passage extending downwardly from an upper portion of said cathode into a lower portion and upwardly into said upper portion, an anode on each of two opposite sides of said cathode, an insulating collar surrounding an upper portion of the cathode and having an electrolyte impermeable contact therewith, the top of said collar extending at least to

the top of the cathode and open for the admission and discharge of depolarizing gas through said passage, projections extending below the bottom of said collar between said cathode and each anode, supporting means for the collar, cathode, and anodes, fastened to said cover, electrolyte in said container having the top surface thereof intermediate the top and bottom of said collar, said cover being perforate for the admission and discharge of depolarizing gas and electrical connections leading from said electrodes through said cover.

20. A cell according to claim 19 in which said supporting means constitutes at least a portion of one of said electrical connections.

21. A replaceable unit comprising a block type carbon cathode and anode, the cathode being porous, gas permeable but electrolyte impermeable, and provided with a depolarizing gas circulating passage extending downwardly from an upper portion of the cathode into a lower portion and upwardly into said upper portion, an insulating collar surrounding an upper portion of the cathode and open for the admission and discharge of depolarizing gas through said passage, a projection extending below the bottom of said collar between said cathode and anode, means for securing the anode to said projection, and means for securing said collar, anode and cathode to a cell cover as a unit, said collar being liquid tightly sealed to the cathode around its outside.

22. A replaceable unit according to claim 21 in which said gas circulating passage has a vertical cross section of X shape with upstanding passages on each side of and connected to said X passages at both the top and bottom.

23. A unit according to claim 21 in which said anode has at least three indicating panels of about 1.5% of the area of the anode with the center of gravity of said panels located in one of the second and third sixths of the anode counting from the top, there being a panel disposed laterally each side of each upstanding passage portion.

24. An electrolyte impervious, gas permeable carbon electrode for a cell having depolarizing gas supplied thereto, a collar of electrolyte resistant insulating material sealed to the upper faces and edge portions of said electrode with liquid-tight fit and extending above the top of the electrode whereby the top of said electrode may be mounted below the electrolyte level in a cell without said top surface of the electrode coming in contact with electrolyte as long as said electrolyte is below the top of said collar, a gas circulating passage extending into said electrode from the top thereof, a supporting flange on said collar adjacent the upper end thereof, and a supporting bridge for said electrode spanning said collar and electrode and engaging the underside of said collar flange.

25. In an electrolyte impervious gas permeable carbon electrode having a gas circulating passage extending into the same from the top surface thereof whereby depolarizing gas may be circulated therethrough, the combination therewith of the improvement enabling the electrode to be of less depth for a given output, said improvement comprising an electrolyte resistant collar of insulating material sealed around the upper portion of said electrode and extending above the top of said electrode, and an insulating cover plate having gas passages therethrough in registry with said circulating passage, said electrode and collar being secured to the underside of said plate.

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