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RESPACING OF ELECTRODES IN ELECTROLYTIC CELLS FOR THE
PRODUCTION OF THE HALATES, PERHALATES OR
HYPOHALITES OF ALKALI METALS

Filed Oct. 29, 1965

Sheet 1 of 4

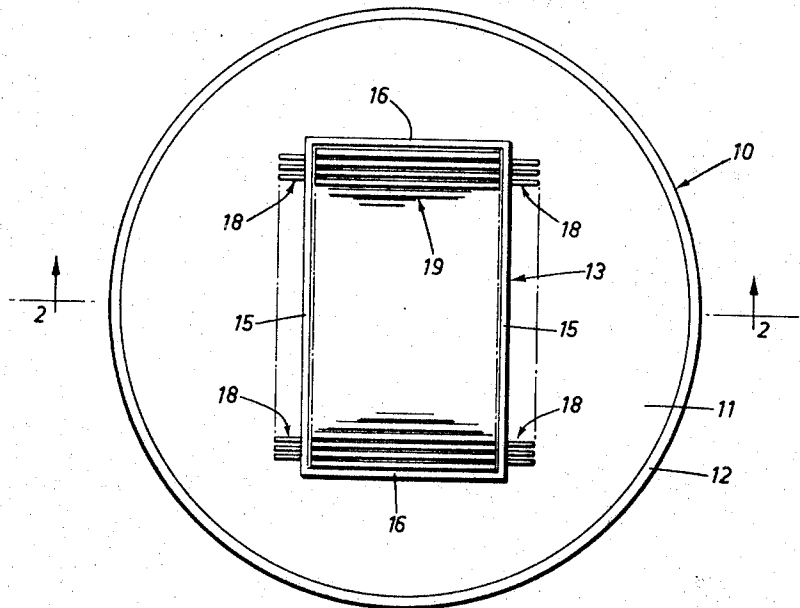


FIG. 1

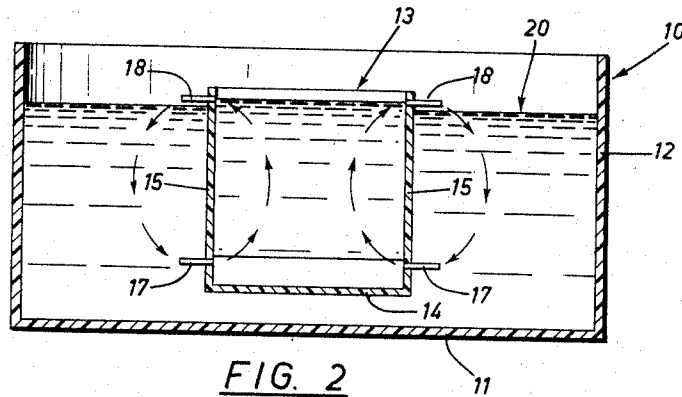


FIG. 2

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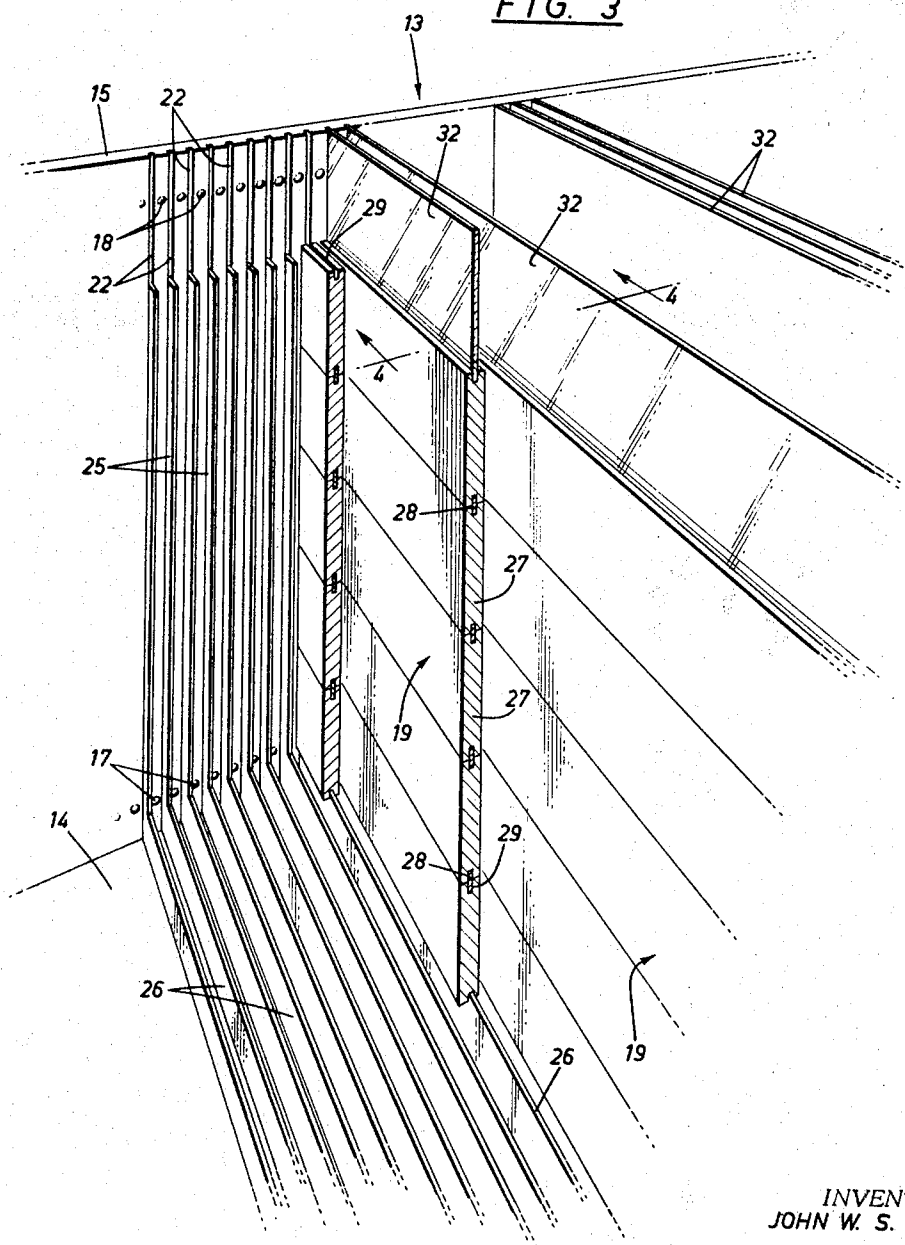
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Sheet 2 of 4

FIG. 3



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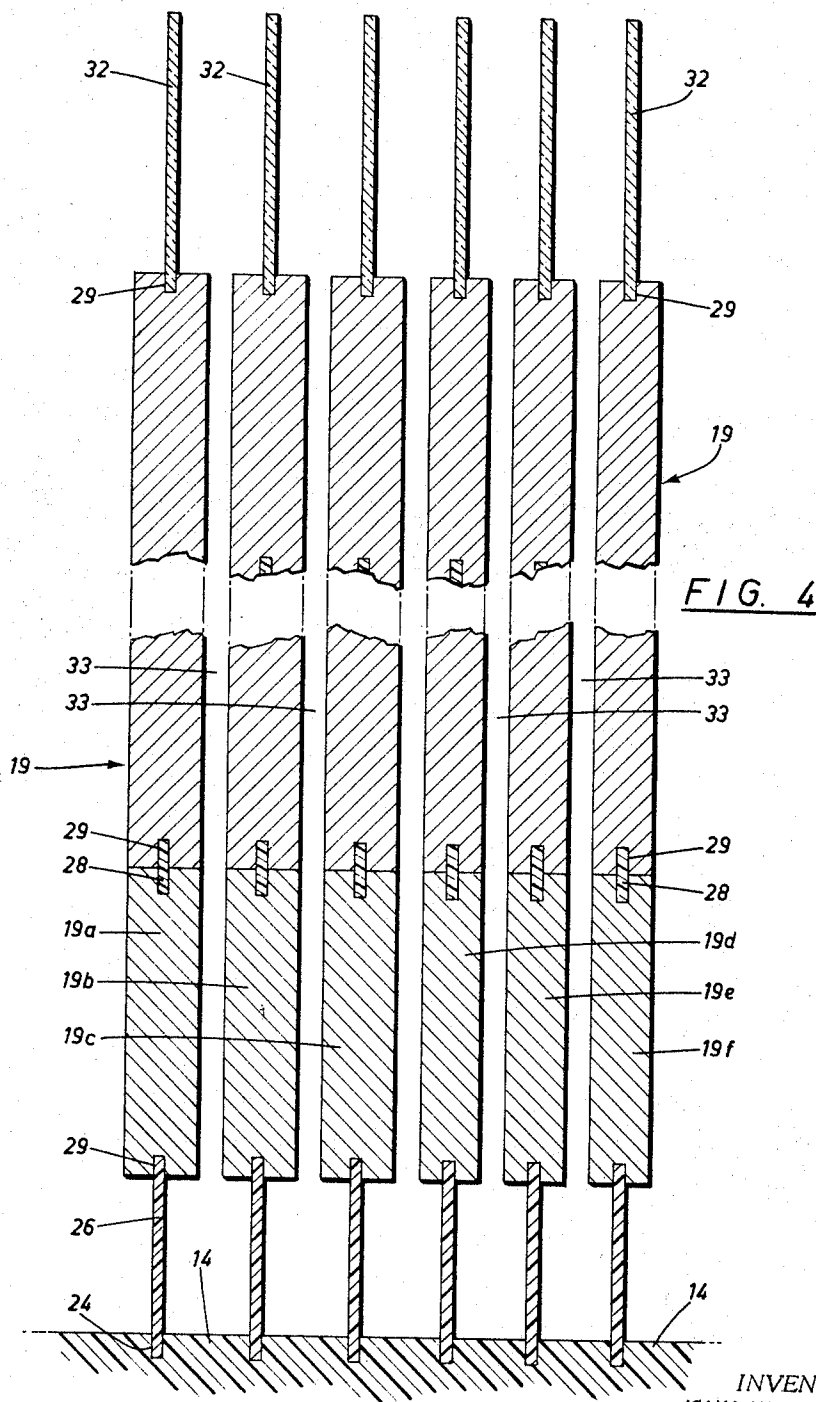
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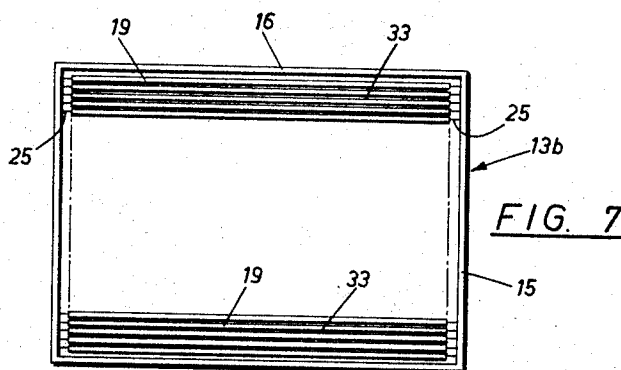
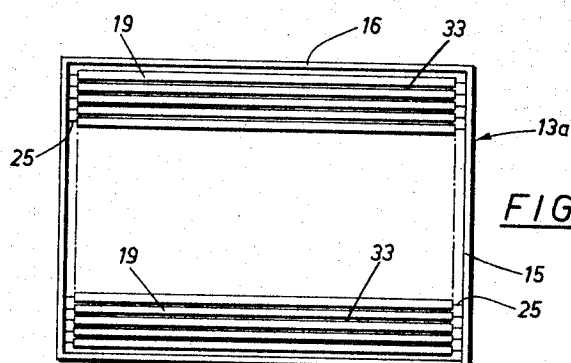
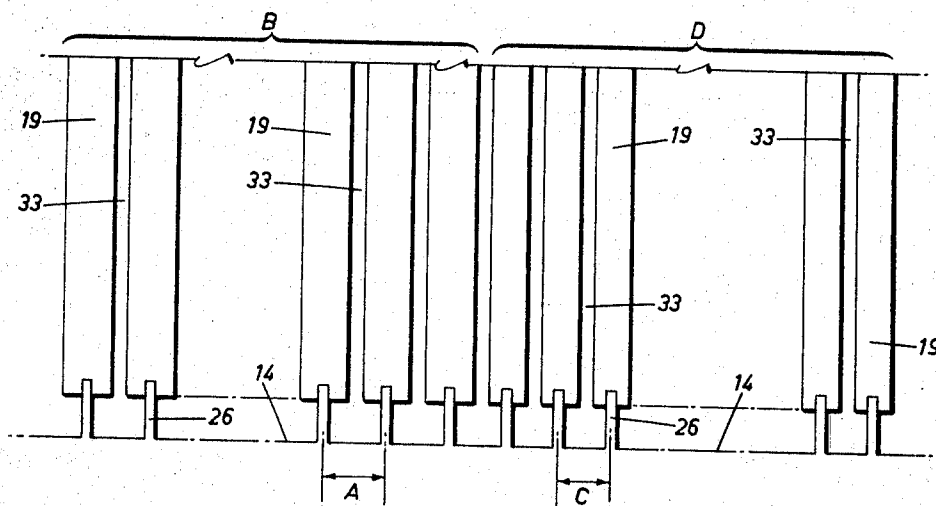
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Sheet 4 of 4



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1

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RESPACING OF ELECTRODES IN ELECTROLYTIC CELLS FOR THE PRODUCTION OF THE HALATES, PERHALATES OR HYPOHALITES OF ALKALI METALS

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5 Claims

ABSTRACT OF THE DISCLOSURE

Electrolysis is carried out in an electrolytic cell containing electrodes held in spaced apart relationship with respect to each other by a first set of spacers. After the electrodes are partially consumed they are shifted to another part of the cell or to another cell where the spacers are positioned closer together than the first set of spacers, and electrolysis is carried out using the partially consumed electrodes.

This invention relates to processes for the electrolytic production of the halates, perhalates or hypohalites of alkali metals. More particularly, this invention relates to processes for improving the economy of production of such compounds.

When an alkali metal halide is electrolysed in an electrolytic cell employing consumable electrodes, such as graphite, for example, the electrodes wear away, and eventually they must be replaced.

In a multipolar sodium chlorate cell, for example, there is a definite economic relationship between the cost of the installed graphite electrodes, the total cost of the power supplied, and the total production of chlorate. This relationship is a direct result of the fact that as the graphite electrodes are consumed, the gaps between adjacent electrodes increase, and the power per unit weight of chlorate produced increases. The economic relationship may be expressed as follows:

Cost per pound of chlorate=

$$\frac{\text{Installed graphite cost} + \text{total power cost}}{\text{total production}}$$

In the past it has been common practice to operate an electrolytic cell for the production of any of the foregoing compounds until the gaps between adjacent electrodes became so large as to materially increase the power cost, and then to discard the electrodes.

In accordance with this invention, instead of discarding the electrodes after use, they are respaced in the same or another electrolytic cell and used again.

In brief, in accordance with this invention, there is provided a process for producing at least one compound selected from the class consisting of the halates, perhalates and hypohalites of an alkali metal wherein, as in the prior art, an alkali metal halide electrolyte is electrolysed in the electrolysis zone defined between two spaced apart electrodes, at least one of which is consumed during the process, until this one electrode is partially consumed. Thereafter, this partially consumed electrode is positioned with respect to another electrode, which may be the same as the other electrode of the first named two electrodes, such that the spacing (centre to centre) therebetween is less than the spacing that existed between the aforementioned two electrodes. An alkali metal electrolyte then is electrolysed in the electrolysis zone defined between the aforementioned one and another electrodes.

This invention will become more apparent from the

2

following detailed description, taken in conjunction with the appended drawings, in which:

FIGURE 1 is a plan view illustrating electrolytic apparatus for carrying out this invention,

FIGURE 2 is a section taken along line 2—2 in FIGURE 1,

FIGURE 3 is a perspective view of a part of the inside of the electrolytic cell shown in FIGURE 1,

FIGURE 4 illustrates one method of carrying out this invention using only one electrolytic cell and is a section taken along line 4—4 in FIGURE 3,

FIGURE 5 is a view similar to FIGURE 4 illustrating another method for carrying out this invention using only one electrolytic cell, and

FIGURES 6 and 7 are plan views of two electrolytic cells illustrating still another method for carrying out this invention but using two electrolytic cells.

While, for the sake of simplicity, this invention will be described hereinafter in connection with the electrolysis of a brine solution to produce sodium chlorate, it should be understood that the invention is applicable to the electrolytic production generally of a compound selected from the class consisting of the halates, perhalates and hypohalites of an alkali metal.

In addition, it should be appreciated that while this invention will be hereinafter described in connection with bipolar electrolytic cells wherein at least two of the electrodes are monopolar and at least one is bipolar, the electrodes being connected in series electrically, the invention also may be practised with monopolar electrolytic cells wherein there are at least two electrodes and all electrodes are of the monopolar type, all positive electrodes being connected in parallel, and all negative electrodes also being connected in parallel.

Furthermore, while the instant invention will be described hereinafter in connection with electrolytic cells employing graphite electrodes, it is to be understood that other electrodes of a type that are consumed during the operation of the cell may be substituted for the graphite electrodes.

Referring now to FIGURES 1 and 2 there is shown electrolytic apparatus which includes a cell tank 10 that is generally circular in plan and which has a bottom wall 11 and upstanding side walls 12. Positioned in cell tank 10 is an electrolytic cell 13 that is generally rectangular in plan and which includes a housing having a bottom wall 14, upstanding side walls 15 and upstanding end walls 16, the top of electrolytic cell 13 being open, as shown. Fixed to and extending through both side walls 15 are inlet and outlet tubes 17 and 18 respectively. Means (not shown) are provided for supporting the housing with its bottom wall 14 spaced above bottom wall 11 of cell tank 12. Positioned in the housing of electrolytic cell 13 and constituting a part of electrolytic cell 13 are a plurality of spaced apart, parallel, graphite electrodes 19 that are spaced inwardly from side walls 15 and above bottom wall 14 by means of suitable spacers, which will be described hereinafter in greater detail in connection with FIGURE 3.

The direction of electrolyte flow from cell tank 10 through electrolytic cell 13 and back into cell tank 10 is shown by the arrows in FIGURE 2. The electrolyte 20, which, for the production of sodium chlorate, is a brine solution, flows from cell tank 10 into tubes 17 and thence through tubes 17 into electrolytic cell 13. Electrolysis of the electrolyte takes place in the various electrolysis zones defined between adjacent electrodes 19, and the electrolyte then is discharged from electrolytic cell 13 through tubes 18 back to cell tank 10.

Turning now to FIGURE 3, it will be seen that a plurality of spaced apart, parallel grooves 22 are pro-

vided in walls 15 and open into the chamber defined by the housing of electrolytic cell 13. These grooves or channels 22 are perpendicular to bottom wall 14, and extensions thereof are provided at 23 in weirs 21. In addition, as shown in FIGURE 4, grooves or channels 24 also are provided in bottom wall 14 and open into the chamber defined by the housing of electrolytic cell 13. Grooves 24 are parallel to each other and are aligned with grooves 22 in side walls 15.

Disposed in grooves 22 are removable spacers 25 in the form of elongated strips of a suitable material, such as polyvinyl chloride, which, incidentally, also may be used for fabricating cell tank 10 and the housing and tubes of electrolytic cell 13. Of course, other suitable materials that are electrical insulators and that are able to resist chemical attack by the electrolyte can be used. It will be seen that spacers 25 are in tongue and groove relationship with grooves 22 and project inwardly into the chamber defined by the housing of electrolytic cell 13, spacers 25 being at right angles to side walls 15.

Disposed in tongue and groove relationship in grooves 24 and upstanding from bottom wall 14 at right angles thereto are spacers 26, which may be made of the same material as spacers 25, and which also are in the form of elongated strips. Spacers 26 extend across bottom wall 14 and into grooves 22, while spacers 25 sit on spacers 26. Of course, spacers 26 are disposed parallel to each other.

Each electrode 19 consists of a group of graphite "planks" 27 that are seated one on top of the other. The various "planks" 27 of any given electrode are held together by means of elongated strips 28 of any suitable material, such as glass or polyvinyl chloride, which are disposed in grooves 29 provided in the top and bottom edges of "planks" 27 and extending the length thereof. The end edges of "planks" 27 are similarly grooved, and spacers 25 extend into these grooves. As shown in FIGURES 3 and 4, spacers 26 extend into the grooves 29 in the bottom edges of bottom "planks" 27 of electrodes 19. It thus will be seen that spacers 25 and 26 co-operate with electrodes 19 to hold these electrodes in spaced apart relationship with respect to each other. Electrodes 19 have flat, planar surfaces which are disposed parallel to each other.

Seated in each groove 29 in the top edges of top "planks" 27 are partitions 32 of glass or other suitable electrically insulating material that also seat in grooves 22. Partitions 26 and 32 prevent electrolyte in one unit cell from passing over one of the electrodes of this unit cell into the next adjacent unit cell.

Inlet and outlet tubes 17 and 18 are shown in FIGURE 3 but, for the sake of simplicity, have not been shown in FIGURE 4. There is one inlet and one outlet tube in each side wall 15 of each unit cell (four tubes per unit cell). As is known in the art, a unit cell consists of two adjacent electrodes and the interelectrode space or electrolysis zone therebetween.

Referring now to FIGURE 4, it will be seen that the spacing between any two adjacent ones of the three electrodes designated 19a, 19b and 19c is the same. It is to be understood, that where herein the term "spacing" is used, this refers to the centre to centre spacing of the electrodes, i.e., the spacing of partitions 26 on a centre to centre basis. It also will be noted that the spacing between any two adjacent ones of the three electrodes designated 19d, 19e and 19f is the same. However, the spacing between any two adjacent ones of electrodes 19a, 19b and 19c is greater than the spacing between any two adjacent electrodes of electrodes 19d, 19e and 19f, but, in all cases the interelectrode gaps 33, i.e., the distance between adjacent surfaces of adjacent electrodes, is the same.

The only difference between the apparatus shown in FIGURE 4 and that shown in FIGURE 5 is that spacers 25 and 26 are formed integral with side walls 15 and bottom wall 14 respectively rather than being removably

positioned in grooves in these walls. Again, as in the case of FIGURE 4, the spacing A between any two adjacent electrodes of the group of electrodes within the group marked B is the same. The spacing C between any two adjacent electrodes of the group of electrodes marked D also is the same, but C is less than A. In all cases, however, the interelectrode gaps 33 are the same.

The electrodes 19 shown in FIGURES 4 and 5 all are within the housing of electrolytic cell 13 and constitute a part of electrolytic cell 13. The electrodes 19 are shown as they would be before use of the cell to produce sodium chlorate by electrolysis of brine is commenced.

As is known in the art, the end electrodes of the electrodes of the electrolytic cell are connected to the positive and negative terminals of a rectifier (not shown) and, in practising this invention, electrolyte 20 (brine) is electrolysed in the electrolysis zones between the facing surfaces of adjacent electrodes, the electrolyte from the various unit cells being discharged through tubes 18 back into cell tank 10 where a chemical reaction producing sodium chlorate takes place. The electrolyte recirculates and passes into the various electrolysis zones through tubes 17, and the electrolysis process is repeated. During this process the graphite electrodes are consumed. In accordance with this invention, after the graphite electrodes 19a, 19b and 19c have been partially consumed, they are removed from the electrolytic cell, along with electrodes 19d, 19e and 19f, and the partially consumed electrodes 19a, 19b and 19c are substituted for or replace electrodes 19d, 19e and 19f. These latter electrodes may be discarded or may be substituted for other electrodes. New electrodes of the same size and type as electrodes 19a, 19b and 19c are provided to replace electrodes 19a, 19b and 19c. Electrolysis of electrolyte 20 then may be continued.

As a more specific example, electrodes 19a, 19b and 19c initially may be 1 inch in thickness, while electrodes 19d, 19e and 19f initially may be $\frac{3}{4}$ inch in thickness. The interelectrode gaps may be $\frac{3}{16}$ inch. After electrodes 19a, 19b and 19c have been consumed to the point that they are $\frac{3}{4}$ inch in thickness, they are used to replace electrodes 19d, 19e and 19f. Electrodes 19d, 19e and 19f need not be discarded at this point but could be used to replace other electrodes that are thinner than electrodes 19d, 19e and 19f, in the same way as electrodes 19a to 19c are used to replace electrodes 19d to 19f. Generally, however, electrodes should be discarded after they have been consumed to the point where they are only about $\frac{1}{4}$ inch in thickness, so that there is a limit to the number of times that any given electrode can be respaced.

It should be noted that it is not essential that all interelectrode gaps 33 be the same, but this is desirable.

Those skilled in the art will appreciate that by respacing the electrodes as outlined hereinbefore, considerable economy effected insofar as power cost is concerned, because the cost of power increases as the interelectrode gap increases, so that if a 1-inch electrode were used in an electrolytic cell without respacing the electrode and until the electrode had been consumed to the extent that it was only about $\frac{1}{4}$ inch in thickness, the interelectrode gap between this electrode and its adjacent electrodes would have increased very measurably, as would have power cost.

It is not necessary to practice this invention by respacing electrodes within one electrolytic cell. Thus, as shown in FIGURES 6 and 7, two electrolytic cells 13a and 13b of the type hereinbefore described are provided, but the spacing between adjacent electrodes 19 in electrolytic cell 13a is greater than the spacing between adjacent electrodes 19 in electrolytic cell 13b. It may be considered that electrode assemblies employing electrodes like 19a, 19b and 19c of FIGURE 4 are used in electrolytic cell 13a, while electrode assemblies employing electrodes like 19d, 19e and 19f of FIGURE 4 are used in electrolytic cell 13b. Both electrolytic cells are operated to produce

5

6

the desired compound by electrolytic action. Both cells need not produce the same compound, however. After electrodes 19 in electrolytic cell 13a have been partially consumed, they are removed from this cell and are used to replace electrodes 19 in electrolytic cell 13b. New electrodes 19 of the same size and type as were electrodes 19 in cell 13a initially are placed in this cell, while partially consumed electrodes 19 from cell 13b may be discarded or, depending on their thickness, used in another electrolytic cell wherein the spacing between adjacent electrodes is even less than the spacing between adjacent electrodes in cell 13b. Electrolysis of an electrolyte in cells 13a and 13b then is continued.

While preferred embodiments of this invention have been disclosed herein, those skilled in the art will appreciate that changes and modifications may be made therein without departing from the spirit and scope of this invention as defined in the appended claims.

What I claim as my invention is:

1. A process for the electrolytic production of at least one compound selected from the class consisting of the halates, perhalates and hypohalites of an alkali metal which comprises; providing a first electrolytic cell comprising a housing having a bottom wall and side walls defining a chamber, a plurality of spaced apart spacers extending into said chamber from said walls, and a plurality of electrodes located in said chamber and cooperating with and held in spaced apart relationship with respect to each other by said spacers, said electrodes defining therebetween an electrolysis zone, at least one of said electrodes being of a type that is consumed during use of said electrolytic cell; providing a second electrolytic cell comprising a housing having a bottom wall and side walls defining a chamber, a plurality of spaced apart spacers extending into said chamber of said second electrolytic cell from said walls thereof and adapted to co-operate with electrodes located in said chamber of said second electrolytic cell and hold the electrodes in spaced apart relationship with respect to each other, the spacing between adjacent ones of the spacers of said second electrolytic cell being less than the spacing between adjacent ones of the spacers of said first electrolytic cell; electrolysis an alkali metal halide electrolyte in said first electrolytic cell until the consumable electrode is partially consumed; subsequently removing the partially consumed electrode from said first electrolytic cell; placing said partially consumed electrode in said chamber of said second electrolytic cell along with other electrodes, the electrodes in said chamber of said second electrolytic cell co-operating with and being held in spaced apart relationship by said spacers of said second electrolytic cell and being spaced closer together than said electrodes in said chamber of said first electrolytic cell; and electrolysis an alkali metal halide electrolyte in said second electrolytic cell.

2. A process according to claim 1 wherein each inter-electrode gap between said one electrode and each ad-

jacent electrode thereto in said first electrolytic cell prior to electrolysis of said electrolyte in said first electrolytic cell is the same as each interelectrode gap between said partially consumed electrode and each adjacent electrode thereto in said second electrolytic cell prior to electrolysis of said electrolyte in said second electrolytic cell.

3. A process for the electrolytic production of at least one compound selected from the class consisting of the halates, perhalates and hypohalites of an alkali metal which comprises; providing an electrolytic cell comprising a housing having a bottom wall and side walls defining a chamber, a plurality of spaced apart spacers extending into said chamber from said walls, and a plurality of electrodes located in said chamber and co-operating with and held in spaced apart relationship with respect to each other by said spacers, first ones of said spacers in one part of said electrolytic cell being positioned closer together than second ones of said spacers in another part of said electrolytic cell, said electrodes defining therebetween an electrolysis zone, at least one of said electrodes held by one of said second spacers being of a type that is consumed during use of said electrolytic cell; electrolysis an alkali metal halide electrolyte in said electrolytic cell until the consumable electrode is partially consumed; subsequently removing the partially consumed electrode and one of said electrodes held by one of said first spacers; replacing said last-mentioned electrode with said partially consumed electrode; replacing said partially consumed electrode with another electrode; and subsequently electrolysis an alkali metal halide electrolyte in said electrolytic cell.

4. A process according to claim 3 wherein said partially consumed electrode is replaced with an electrode of substantially the same size and type as was said consumable electrode before use of said electrolytic cell.

5. A process according to claim 3 wherein each inter-electrode gap between said one electrode and each adjacent electrode thereto held by said second spacers prior to the first electrolysis step is the same as each inter-electrode gap between said partially consumed electrode and each adjacent electrode thereto held by said first spacers prior to the second electrolysis step.

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