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R. J. McNITT

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ELECTROLYSIS OF FUSED SALTS

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Fig. 1,

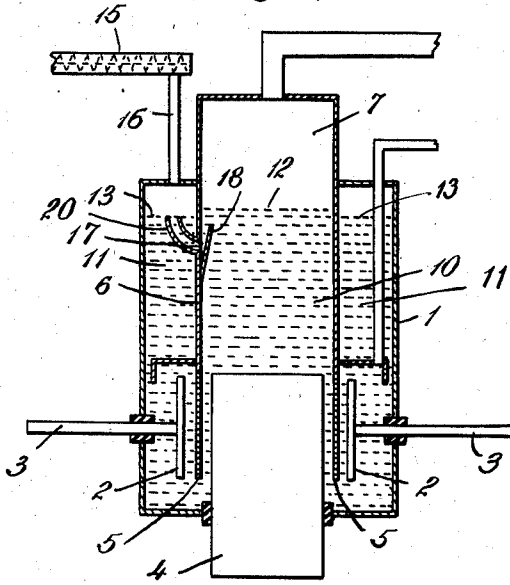


Fig. 2,

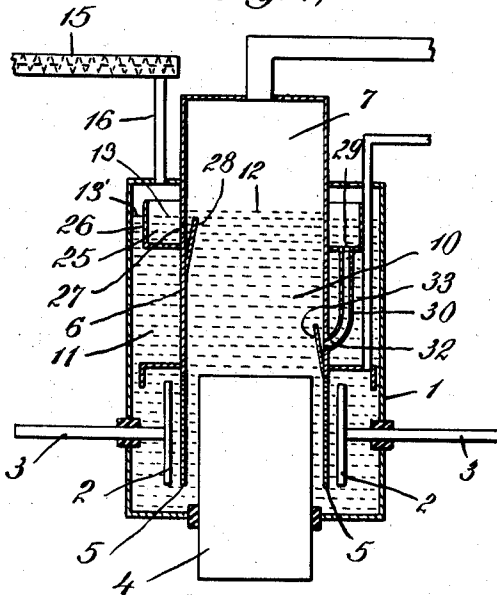
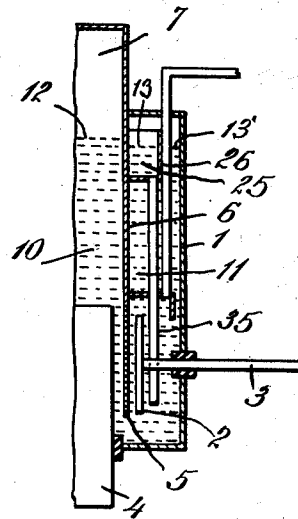


Fig. 3.



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ELECTROLYSIS OF FUSED SALTS

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8 Claims. (Cl. 204—68)

This invention relates to the electrolysis of fused baths and has for its object the provision of an improved method and apparatus for replenishing the electrolyte with the constituents decomposed by the electric current.

The invention is particularly applicable to electrolytic cells in which replenishing materials are introduced into a feed compartment which is separate from the anode and cathode compartments of the cell.

Difficulty has been encountered in cells of this kind if the replenishing material is in a finely divided solid state. Especially where a mechanical feeder is employed such material forms a floating crust under the feeder spout and accumulates as a cone until the flow from the spout becomes entirely blocked.

Another difficulty has been encountered where a mixed bath is employed in the cell, that is where a fluxing agent is incorporated in the bath to lower its freezing point and permit the operation of the cell at a lower temperature than the freezing point of the constituent which is decomposed. Here it is found that upon feeding the replenishing material, the proportion of this material in the bath in the feed compartment becomes excessive tending to raise its freezing point with the formation of a congealed mass therein.

My invention overcomes these difficulties. In accordance with the method of the invention, one or more streams of molten electrolyte from the interior of the anode compartment flow through one or more openings provided in the wall of the anode compartment, and mixing with the electrolyte in the feed compartment prevents the accumulation therein of an excessive proportion of the replenishing materials and also facilitates the feeding of these materials into the bath.

Where hand-feeding is used, I have gotten excellent results by merely boring a few small holes through the wall separating the anode compartment from the feed compartment, but where mechanical feeding is employed I prefer to conduct the stream of electrolyte to the place where the replenishing material is fed into the bath and to discharge the stream into the electrolyte of the feed compartment in such a manner that the particles of replenishing materials which are fed into the bath will be swept away and melted as fast as they fall into the bath.

The apparatus of the invention comprises one, or more than one, opening in the wall of the anode compartment permitting the flow of the molten bath from the anode compartment to the feed compartment and preferably adjacent the

place where the salt is added to the bath. The opening is constructed and arranged to permit the passage of the molten bath without any of the gas which passes upward through the anode compartment.

These and other novel features of the invention will be better understood after considering the following discussion taken in conjunction with the accompanying drawing, in which:

Fig. 1 is a side elevation of a cell for the electrolysis of a fused salt illustrating an embodiment of the invention;

Fig. 2 is a side elevation of a cell for the electrolysis of a fused salt illustrating a different embodiment of the invention; and

Fig. 3 is a fragmental view of the cell of Fig. 2, illustrating a modified form of the invention.

The cell illustrated more or less diagrammatically in the drawing is the type used for the electrolysis of fused salts of light metals, for example, sodium chloride. The cell comprises the usual shell 1 for holding the molten charge, an annular cathode 2, having conductor leads 3, an anode 4, and the usual perforated diaphragm 5 arranged between the cathode and the anode. Attached to and extending upward from the diaphragm is a side-wall 6 which, together with the diaphragm 5 and flanged hood 21, divide the cell into cathode, anode, and feed compartments. The upper part of the side-wall 6 above the bath has a closed top and forms the gas chamber 7. The fused or molten bath is divided into three parts, part 10 which is inside the side-wall 6 or anode compartment, a part containing the cathode, and a part 11 which comprises the feed compartment outside the side-wall 6, and above the cathode compartment.

The cell is provided with a mechanical feeding device, comprising a worm feed 15 and upright chute 16 by means of which the salt to replenish the electrolyte is deposited at the surface 13.

In the cell of Fig. 1, that part of the cell which is outside the side-wall 6 and occupied by the bath 11, is the feed compartment. As shown in Fig. 1, I provide a hole 17 in the side-wall 6 a short distance below the surface 13. A shield 18 is attached to the inside of the side-wall below the hole and extends upward at a suitable angle permitting the passage of molten salt into hole 17, but preventing the entrance of gases rising from the anode. The molten salt entering the hole flows through duct 20 and produces a current which carries away and melts the salt as fast as it is fed into the bath.

In the apparatus illustrated in Fig. 2, the replenished electrolyte flows from the feed compartment 25 into the anode compartment instead of into the cathode compartment as shown in Fig. 1. The salt is discharged from the feeder chute 16 onto the surface of the bath 13 inside of feed compartment 25. Electrolyte flows from the anode compartment into the feed compartment through hole 27, protected against the entrance of anode gases by shield 28. A current is produced in the feed compartment which carries away and melts the salt as fast as it falls from the chute.

Through openings 29 and 32, connected by duct 30, the replenished electrolyte flows from the feed compartment into the anode compartment. Entrance opening 32 should be placed well below exit opening 27 to obtain a strong rate of flow.

Fig. 3 illustrates a modification of the apparatus in which the replenished electrolyte flows from the feed compartment 25 to the lower part of the cathode compartment instead of to the upper part of the cathode compartment as shown in Fig. 1.

In the cells illustrated in the drawing, the diaphragm and active anode surface are placed very close together and due to the rising stream of electrolyte on all sides of the anode, the upper level 12 of the bath in the anode compartment is appreciably above the upper level 13 of the bath in the feed compartment. This difference in level of the bath forces the electrolyte to flow in a strong stream with considerable velocity from the anode compartment into the feed compartment.

I may dispense with the duct 20 even with apparatus such as that of Fig. 1 and pass the hot bath from the anode compartment through the bath 11 to the surface 13, or I may arrange a suitable baffle in the bath 11 to direct and control the stream of molten bath. Various forms of nozzle may be used also in connection with the duct outlet to control the flow. In some cases, it is difficult to design the cell so as to get a sufficiently strong current of electrolyte flowing from the interior of the anode compartment, and it becomes necessary to accelerate the flow by a jet of gas, as an airlift, or by a suitable impeller. It is to be understood that while I prefer to discharge the stream of molten bath from the anode compartment in the immediate vicinity of the deposited salt that this is not always necessary, although it is generally advantageous.

The invention not only facilitates the feeding of salt into the bath and prevents incrustations interrupting the continuous feed, but it has special advantages in cells using fluxing agents to lower the melting point of the bath and permit the operation of the cell at a temperature which lies below the melting point of the constituent of the electrolyte which is decomposed by the electric current.

The circulation caused by the stream of electrolyte flowing from the anode compartment to the feed compartment prevents the accumulation in excessive proportions of the salt or other substance which is used to replenish the electrolyte, with the result that the melt in the feed compartment does not reach a constituency having a melting point higher than the operating temperature of the cell and hence cannot congeal to a mushy semi-solid mass, as is the case where there is no circulation of electrolyte through the feed compartment.

I claim:

1. In the electrolysis of fused salt baths in cells having a part of the molten bath in an anode compartment and a part of the bath in a feed compartment in which the salt used to replenish the electrolyte is added to the bath in the feed compartment, the bath standing at a higher level in the anode compartment than in the feed compartment, the improved method which comprises conducting a strong stream of the molten bath from the upper part of the anode compartment to the bath of the feed compartment under the pressure caused by the higher level of the bath in the anode compartment and bringing it into contact with the added salt at the surface of the bath in the feed compartment, and so directing the said stream as to circulate that portion of the bath on which the salt was deposited causing the salt to be carried away from the place where it was deposited and melted while on the surface.

2. In the electrolysis of fused salts in cells having an anode compartment and a feed compartment, the improved method which comprises maintaining the molten bath in the anode compartment at a higher level than the molten bath in the feed compartment, circulating relatively hot molten bath in a controlled stream by means of the pressure due to the higher level of the bath in the anode compartment from the upper part of the anode compartment into the feed compartment and into contact with salt fed onto the bath to replenish the electrolyte, said stream being directed to the surface of the bath where the salt is deposited and flowing with such force that a current is created in the bath of the feed compartment which carries the deposited salt to other parts of the bath enabling it to melt on the surface as fast as it is deposited, and returning the bath replenished to the anode compartment.

3. In the electrolysis of fused salts in cells having separate anode and feed compartments, the improved method which comprises depositing salt on the surface of the bath in the feed compartment, maintaining the upper level of the bath in the anode compartment at a higher level than the level of the bath in the feed compartment, circulating relatively hot molten bath in a stream from the upper part of the anode compartment into the upper part of the feed compartment, said stream being caused by the higher level of the bath in the anode compartment, and passing a controlled stream of the molten bath from the feed compartment to the lower portion of the cell in the vicinity of the zone of electrolytic action.

4. In an electrolytic cell for the electrolysis of fused salts having an anode compartment at least partly formed by a side-wall and a feed compartment outside the side-wall, said compartments being adapted to hold a bath of molten electrolyte, the improvement which comprises a diaphragm, an anode the active surface of which is placed close to the diaphragm causing a strong upward stream of electrolyte to flow between the diaphragm and the anode, whereby the bath in the anode compartment is held at a higher level than the bath in the feed compartment, a hole in the side-wall below the level of the bath in the feed compartment, said hole being constructed and arranged to permit the molten bath to flow from the anode compartment under the force of gravity into the feed compartment but to prevent the passage of an appreciable quantity of gas along with the molten bath, said side-wall ex-

tending from the upper surface of the bath to the vicinity of the zone of electrolytic action and the depth of bath above the zone of electrolytic action being relatively deep, at least one-third the depth of the entire bath.

5. In the apparatus of claim 4, an upwardly disposed duct extending from the hole in the direction of the surface of the bath in the feed compartment, and a salt-feed means arranged to deposit salt near the upper end of said duct. 10

6. In an electrolytic cell for the electrolysis of fused salts having an anode compartment at least partly formed by a side-wall and a feed compartment outside the side-wall, said compartments being arranged to hold a molten bath of electrolyte, the improvement which comprises means for depositing salt on the molten bath inside the feed compartment, a hole in the side-wall between the feed compartment and the anode compartment below the surface of the bath in the feed compartment which connects the upper portions of the anode and feed compartments, shield means at the hole arranged to permit the molten bath of the anode compartment to flow through the hole into the feed compartment but to prevent gas from the anode passing through the hole, and duct means connecting the feed compartment and an opening in the side wall below the said hole for directing the flow of 15 20 25

molten bath from the feed compartment into the anode compartment.

7. In the apparatus of claim 6 a duct leading from the feed compartment to a second hole in the side-wall of the anode compartment, and a shield over the second hole arranged to permit the flow of electrolyte-enriched bath from the feed compartment into the anode compartment but to prevent the passage of gas from the anode compartment from entering the second hole. 5

8. In the electrolysis of fused baths in cells having a part of the molten bath in an anode compartment and a part of the bath in a feed compartment, the method which comprises maintaining the upper surface of the bath in the anode compartment above the upper surface of the bath in the feed compartment by causing an upward stream of electrolyte to flow continuously from the electrolytic zone into the upper part of the anode compartment and by suppressing the flow downward in said anode compartment, thereby forcing a stream of molten bath from the upper part of the anode compartment towards the upper part of the bath in the feed compartment by the pressure due to the head of molten bath in the upper part of the anode compartment. 10 15 20 25

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