

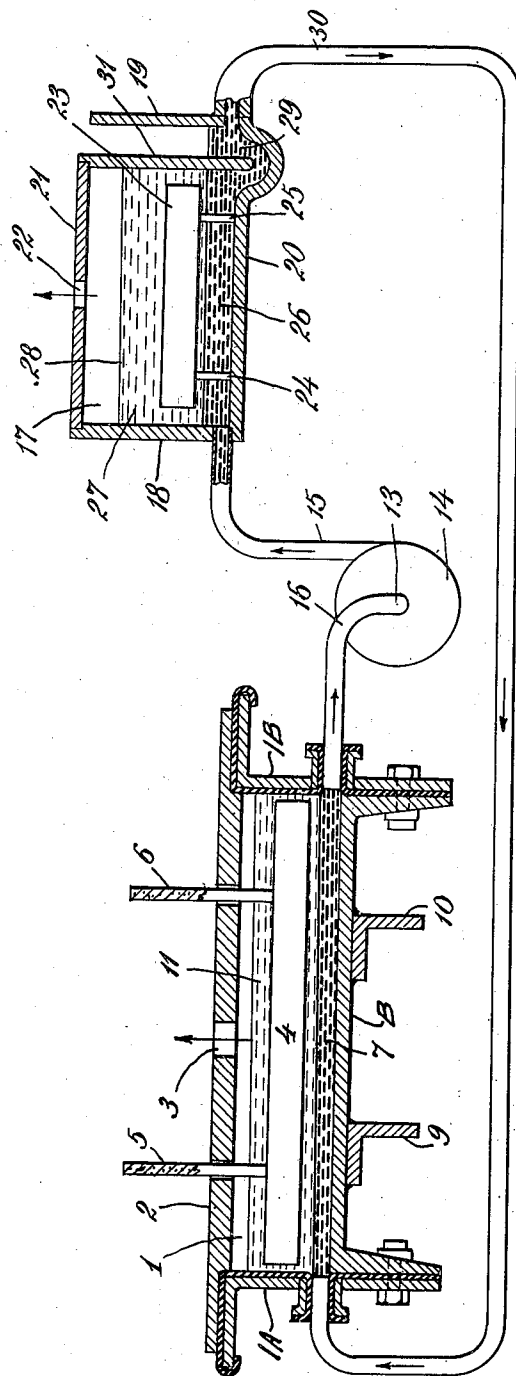
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OPERATION OF MERCURY CELLS

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OPERATION OF MERCURY CELLS

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2 Claims. (Cl. 204—125)

This invention relates to mercury cells and aims to provide improvements in cell structure and methods of operation thereof to the end that interruption of mercury flow in the cell shall cause no damage to the cell or involve operating hazards.

Mercury cells are employed commonly for the electrolysis of aqueous solutions of alkali metal halides, such for example as sodium chloride. Such cells are provided with an anode or brine compartment in which a pool of alkali metal halide solution is subjected to electrolysis brought about by contact with an anode at which the anion of the halide is discharged as halogen gas and an underlying layer of mercury which acts as cathode in the compartment and picks up the alkali metal to form an amalgam therewith. The amalgam thus formed is pumped or otherwise transferred into a neighboring cathode or caustic compartment, where it comes into contact with an overlying aqueous body. The amalgam acts as anode in the caustic compartment and gives up the alkali metal for reaction with water to form hydrogen gas which is discharged at a cathode and alkali metal hydroxide which goes into solution in the aqueous body. The depleted amalgam is returned to the brine compartment and thus a mercury circulation between the two compartments is set up.

Electrical contact between the mercury layer in the brine compartment and a direct current power source, which supplies energy to the cell to bring about the reactions described above, is furnished by a metallic contact member disposed in the bottom of the compartment underneath the mercury cell. Thus the brine compartment may have a bottom formed of an iron plate or it may be made of insulating material through which one or more iron bolts or studs project for contact with the mercury.

During electrolysis the solution in the brine compartment dissolves a relatively large proportion of the halogen gas. Thus a sodium chloride solution undergoing decomposition becomes chlorinated, and this chlorinated solution is corrosive, as are solutions of the other alkali metal halides when these become halogenated. Consequently it is desirable to protect the metal contact members from contact with the solution in the brine compartment. When the cell is operating with proper mercury circulation, protection for the contact members is afforded by the overlying layer of mercury but in heretofore customary practice, the cells are constructed so that the mercury tends to drain out of the brine compartment into,

for example, the caustic compartment when the mercury flow is interrupted by stopping of the pump, or otherwise. The contact members thus tend to become exposed to the halogenated solution in the brine compartment, unless a dam is disposed to retain a layer of mercury above the contact members. Moreover, when the mercury pump in such a cell stops (or if for any other reason mercury circulation ceases) while current continues to be supplied to the cell, the alkali metal content of any mercury retained in the brine compartment builds up very rapidly and thereafter deposition of alkali metal at the mercury layer (cathode) substantially ceases, and hydrogen is deposited instead. This hydrogen is not retained by the mercury, but on the contrary is released in the brine compartment where it may form an explosive mixture with the halogen being discharged at the anode. If the amount of mercury retained in the brine compartment is under such circumstances relatively small, the potentially explosive gas mixture is formed in a short time if the operator, who usually has to care for a large number of cells, does not detect the interruption of the mercury circulation.

As the result of my investigations, I have developed a method and apparatus whereby the aforementioned explosion hazard is eliminated automatically and in which there is no possibility of corrosion of metal contact members in the brine compartment through contact with chlorinated solutions or the like and which, moreover, permits economies in the amount of mercury required to be maintained in a cell circuit. These advantages preferably are realized, in accordance with my invention, by disposing the anode or brine compartment of a mercury cell at a lower level than the cathode or caustic compartment which is connected to the brine compartment by a drain. The amount of mercury present in the brine compartment and other portions of the cell which may drain thereto is so maintained that, in the event of the interruption of mercury circulation, a pool of mercury will accumulate in the brine compartment up to the level of the anode. In such a structure the mercury, upon interruption of circulation, drains into the brine compartment and makes contact with the anode, thus automatically short-circuiting the cell. When this occurs, there is discharged in the brine compartment an amount of hydrogen which is the chemical equivalent of the sodium contained in the mercury amalgam. This discharge of hydrogen, however, is relatively small in amount and takes place in a relatively short time

as compared with that which might occur in a conventional type of cell in which electrolysis continues after pump failure until the trouble is discovered by the operator and the power supply is shut off by him. Consequently my invention reduces explosion hazards. Moreover, in a mercury cell constructed in accordance with my invention, it is not necessary to provide a dam to retain mercury in the brine compartment to cover the metallic parts in the bottom of the compartment. The elimination of the dam permits a reduction in the amount of mercury required to be maintained in the cell circuit, with consequent economies.

In short, my invention contemplates the improvement in the operation of a mercury cell (in which mercury is circulated between a layer thereof underlying an anode in a compartment in which the mercury picks up alkali metal and a chamber in which the alkali metal is released) which comprises during the circulation maintaining a column of mercury above the layer and outside of the compartment, said column exceeding in volume the space in the compartment between the layer therein during circulation and the level of the bottom of the anode therein, and permitting the mercury of said column to drain into the compartment and cause the space to be filled upon interruption of the circulation. This method for automatically short-circuiting the brine compartment of the cell preferably is conducted in a mercury cell in which during the circulation the column of mercury is maintained above the layer in a conduit or conduits or in a relatively elevated caustic compartment during the circulation by a pump or the like, but is free to flow by gravity into the brine compartment when circulation ceases.

These and other features of my invention will be apparent in the light of the following detailed description, taken in conjunction with the accompanying single figure which is a schematic elevation of a mercury cell constructed in accordance with my invention.

As shown in the figure, the mercury cell comprises a brine compartment 1 having sides lined with insulating material and sealed by a cover 2 of insulating material in which is provided an outlet 3 for chlorine gas. Conveniently, the brine compartment has sides 1A, 1B bolted to a bottom B formed of an inverted iron channel, as shown in the drawing and described in greater detail and claimed in the copending application Serial No. 302,501, filed November 2, 1939, by Chester N. Richardson. An anode 4 of conductive material such as carbon, or the like, is suspended in the brine compartment by a pair of integrally formed rods 5, 6, which pass through the cover and are connected to a conventional direct current power source (not shown).

A layer of mercury 7 is retained on the bottom B of the brine compartment and is connected to the power source through a plurality of contact members in the form of iron lugs 9, 10, bolted or welded to the bottom. Overlying the mercury layer is a pool 11 of concentrated aqueous sodium chloride solution which covers the anode and rises to a liquid level 12 near the top of the cell. The bottom of the cell slopes slightly from left to right.

In normal operation of the cell, chlorine is deposited at the anode, escapes therefrom and is removed continuously through the chlorine outlet. Sodium ions migrate to the mercury layer,

which acts as a cathode in the brine compartment and give up their charge so that a sodium amalgam is formed. This amalgam is pumped substantially continuously out of the bottom of the brine compartment through a downwardly projecting conduit 13, made of insulating material such as rubber and connected to the bottom of the compartment. The amalgam flows into a conventional mercury pump 14, which should be constructed of insulating material with which mercury does not amalgamate, so that the pump is not attacked and the amalgam does not become grounded. The pump forces the amalgam upwardly through an outlet conduit 15, also of insulating material (which with the conduit 13 and the pump form a mercury seal 16) and into the bottom of a caustic compartment 17 that is disposed at a higher level than the brine compartment.

The caustic compartment has walls 18, 19 and a bottom 20 (which slopes slightly from left to right) of steel or other material that amalgamates but slowly, if at all, with mercury and is sealed by a non-conductive cover 21 provided with an outlet 22 for hydrogen gas. The latter is discharged at a cathode 23 of graphite or the like supported on the bottom of the caustic compartment by a plurality of conductive rods 24, 25, short-circuiting the cathode to the amalgam anode (as described in detail and claimed in my co-pending application, Serial No. 291,000, filed August 19, 1939).

The amalgam introduced into the caustic compartment through the seal (which communicates with the compartment adjacent its bottom) forms a layer 26 in the bottom of the compartment overlain by a conductive aqueous pool 27, say of sodium hydroxide solution, having an upper level 28 above the top of the cathode.

As the amalgam flows through the layer in the caustic compartment it gives up its sodium content for reaction with the water of the overlying pool, to form hydrogen (which is withdrawn at the top of the compartment through the hydrogen outlet) and sodium hydroxide in solution (which may be withdrawn in the conventional manner). The resulting depleted amalgam is permitted to flow by gravity back into the brine compartment, passing first under a wall 31 through a shallow mercury outlet seal 29 disposed adjacent the bottom of the caustic compartment opposite the point at which the amalgam is introduced, and thence through a conduit 30 to a point at the bottom of the brine compartment remote from that at which the amalgam is removed therefrom. As indicated hereinbefore, the bottom of the caustic compartment slopes slightly from left to right toward the seal 29.

The purpose of the mercury seal disposed at the outlet for mercury at the caustic compartment is to prevent aqueous sodium hydroxide from entering the brine compartment in the event of failure of the pump. As shown in the drawing, the seal is relatively shallow, and provides a mercury column only slightly in excess of that needed to oppose the head of sodium hydroxide solution in the caustic compartment. Mercury is approximately nine or ten times as heavy as this solution, so the effective height of the mercury column in the seal need be only slightly in excess of one-ninth of the height of the liquid in the caustic compartment.

As indicated hereinbefore, mercury is continuously circulated through the apparatus during

normal operations, so that relatively shallow layers of mercury are maintained in both compartments, and the bottom of the anode is separated from the mercury in the brine compartment by a considerable distance. When the pump stops, however, the mercury in the system above the normal level of mercury in the brine compartment tends to drain back into this compartment either through the pump and its associated conduits or through the return conduit 30. The volume of mercury which thus drains into the brine compartment bears a relation to the horizontal cross sectional area of the brine compartment that the level of the mercury layer rises and comes into contact with the bottom of the anode, thus short-circuiting the cell with beneficial results hereinbefore described. Substantially all of the mercury is thus drained out of the caustic compartment but the solutions in the respective compartments are kept separate.

The sloping of the bottom of the compartments in the direction of mercury flow permits a decrease in the amount of mercury required to maintain adequate mercury flow through the cell and aids in short-circuiting the anode and the amalgam when the pump stops, such short-circuiting being accomplished almost immediately and with a minimum amount of mercury in the system.

I claim:

1. In the operation of a mercury cell involving circulation of mercury in a circuit from a layer thereof underlying an anode in a brine compartment to and from a decomposition chamber into which alkali metal carried as amalgam by the

mercury from the brine compartment is released, the improvement which comprises during the circulation maintaining in the circuit wholly above the layer and outside the compartment a column of mercury exceeding in volume the space in the compartment between the level of the layer therein during circulation and the level of the bottom of the anode therein, and upon interruption of the circulation automatically flowing the mercury of said column by gravity into the brine compartment until the level of the layer therein rises into contact with the anode.

2. In the operation of a mercury cell involving circulation of mercury in a circuit from a layer thereof underlying an anode in a brine compartment to and from a decomposition chamber into which alkali metal carried as amalgam by the mercury from the brine compartment is released, the improvement which comprises during the circulation maintaining in the circuit wholly above the layer and outside the brine compartment a column of mercury that upon interruption of circulation is free to flow by gravity into the compartment, the volume of the column exceeding the space in the brine compartment between the bottom of the anode and the level of the top of the layer during the circulation, and upon interruption of the circulation flowing the mercury of the column by gravity into the compartment and raising the top of the layer into contact with the anode while current is supplied thereto.

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