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2,432,973

APPARATUS FOR FEEDING GRANULAR SALT INTO A FUSED SALT ELECTROLYSIS CELL

Filed Jan. 24, 1944

3 Sheets-Sheet 1

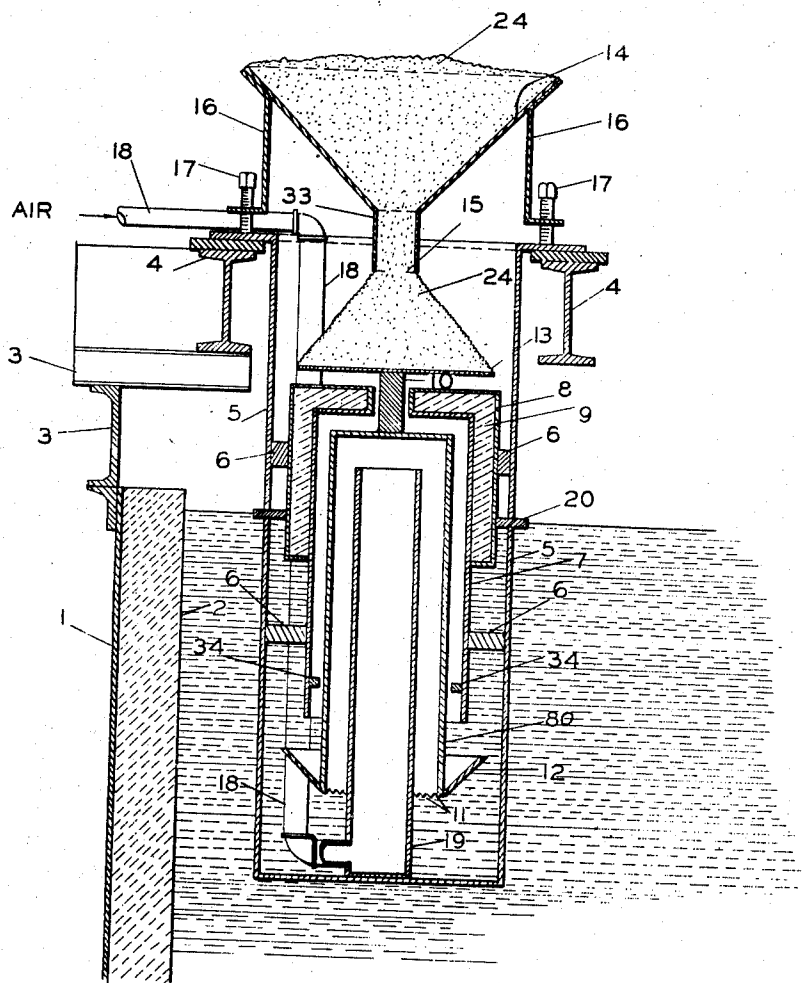


FIG. 1

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3 Sheets-Sheet 2

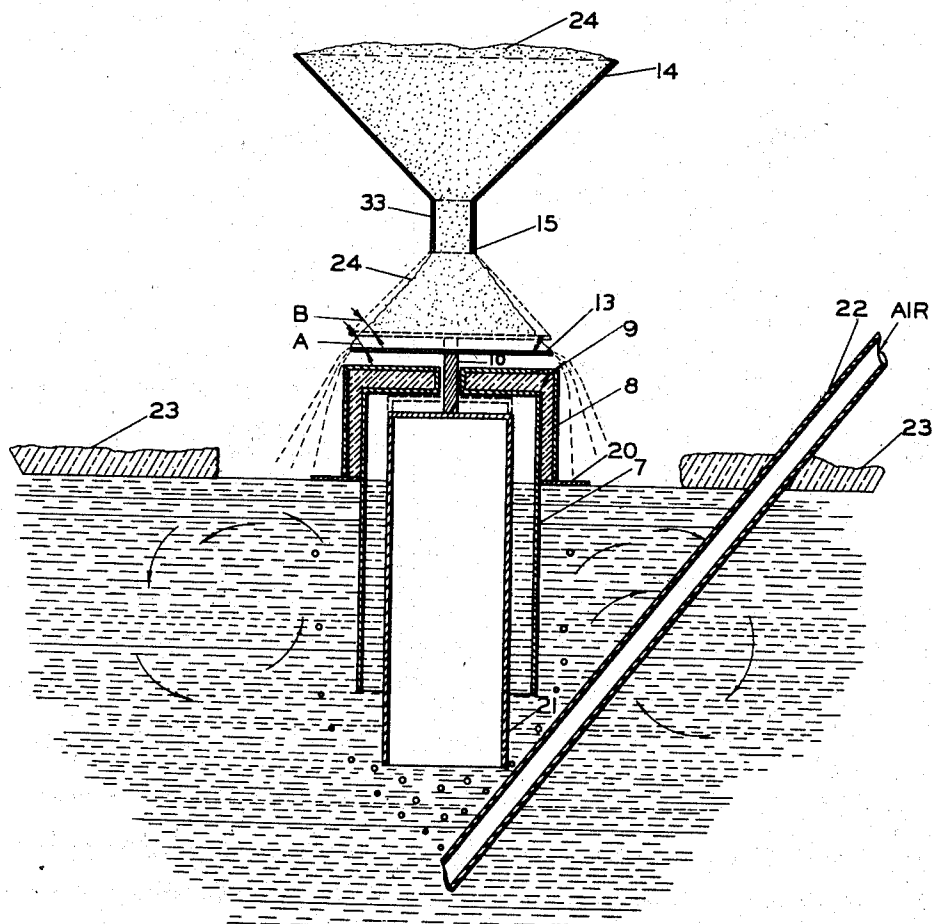


FIG. 2

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3 Sheets-Sheet 3

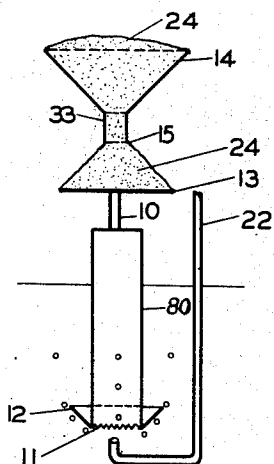


FIG. 3

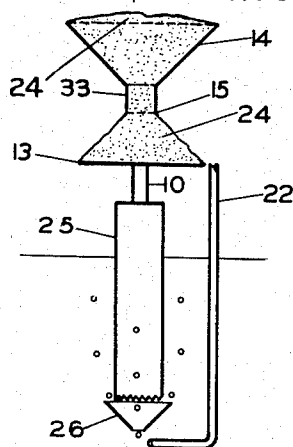


FIG. 4

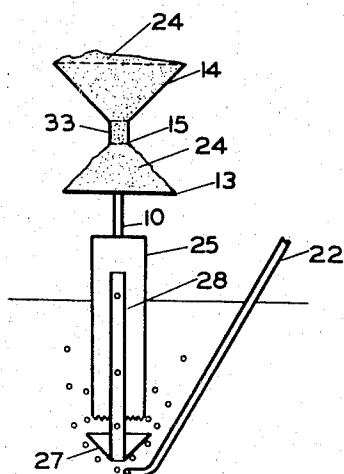


FIG. 5

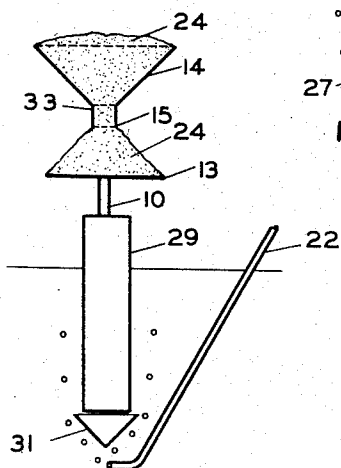


FIG. 6

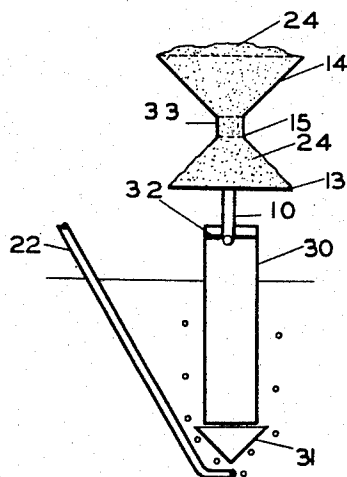


FIG. 7

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UNITED STATES PATENT OFFICE

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APPARATUS FOR FEEDING GRANULAR SALT
INTO A FUSED SALT ELECTROLYSIS CELLGeorge E. Smedberg, Niagara Falls, N. Y., as-
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Application January 24, 1944, Serial No. 519,415

5 Claims. (Cl. 204-246)

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This invention relates to level control in fused salt electrolytic cells and more particularly, to a means for feeding granular salt into such cells so as to automatically maintain a desired level of electrolyte therein.

In the operation of fused salt electrolytic cells it is desirable to maintain a constant level of electrolyte within the cell. For this purpose, reliance on hand feeding or manual control of feeding devices has not been entirely satisfactory. The various automatic feeding devices which are available have not proved satisfactory for use in feeding electrolytic salt cells because of the peculiar conditions existing.

An object of the present invention is to provide an improved method and apparatus for feeding granular salt to electrolytic fused salt cells. A further object is to automatically control the feed of granular salt to the aforesaid cells in such manner as to maintain substantially constant level of electrolyte in the cells. Another object is to provide means for preventing the freezing of electrolyte around moving parts of the feeding device. Still another object is to provide a means and method whereby granular salt is rapidly dissolved into the electrolyte as feed without the formation of an undesirable crust of frozen electrolyte at the point of feed. Still other objects will be apparent from the following description of my invention.

In its broader aspects my invention comprises a reservoir or conduit for granular salt having an orifice located above the surface of the electrolyte and a horizontal pan located below the orifice and arranged to have limited vertical movement. Granular salt flows from the orifice onto the pan, forming a conical pile of salt thereon. The vertical movement of the pan is made responsive to changes in level in the electrolyte so that when the level of electrolyte is raised to a predetermined height, the pan is moved upwardly to such point that the greatest angle between the surface of the pan and a line drawn from an edge of the pan to the nearest edge of the orifice is less than the angle of repose of the granular salt. In a preferred modification of the invention, the movement of the pan is governed by and responsive to the movement of a float in the electrolyte. However, if desired, other known means for causing the movement of the pan to respond to changes in electrolyte level may be utilized.

The appended drawings show various preferred forms of the invention. Figure 1 is a vertical sectional view of one form of the invention. Figure 2 is a diagrammatic vertical sectional view

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illustrating one form of the invention and the principle of operation. Figures 3, 4, 5, 6 and 7 are diagrammatic drawings illustrating various forms of the invention.

Figure 1 shows one form of my automatic feeding device situated in an electrolytic fused salt cell, a portion only of the cell being shown. The wall of the cell is constructed of a steel casing 1 provided with a refractory lining 2. The automatic feeding device is supported in the cell by means of conventional supporting members 3 and 4. The lower part of the feeding device is supported by an open cage 5 which depends from supporting members 4. Within cage 5 and attached thereto, by brackets 6, is a stationary inverted bell 7, the upper portion of which is provided with a jacket 8 which is filled with an insulating material 9, e. g., glass wool or asbestos fiber. An annular baffle 20 is fastened to jacket 8 of bell 7 at or below the desired electrolyte level and extends outside of cage 5. Bell 7 is also provided at the top with a hole for pan shaft 10. Within bell 7 is located float bell 80 which is closed at the top and open at the bottom and is capable of limited vertical movement. Bell 7 thus provides a cylindrical partition around the upper part of float bell 80 and extends below the surface of the electrolyte in the cell. Four or more guide lugs 34 assist in maintaining bell 80 in a vertical position. The bottom of float bell 80 is provided with a serrated edge 11 and an outwardly flaring frusto-conical skirt or baffle 12. The upper diameter of skirt 12 is made at least equal to and preferably larger than the diameter of the inverted bell 7. The closed top of the float bell 80 is rigidly connected by means of shaft 10 to the center of a horizontal circular pan 13. Directly above pan 13 is situated a reservoir or hopper 14 provided with a vertical cylindrical conduit 33 terminating in circular orifice 15, coaxial with pan 13. Hopper 14 and conduit 33 are shown in section. Hopper 14 is supported on supports 4 by means of brackets 16 and adjusting screws 17 so that the height of the orifice 15 above the pan can be adjusted. The drawing shows the hopper 14 filled with granular salt 24, which flows through orifice 15 and forms a conical pile on pan 13. An air inlet pipe 18 passes downwardly into the electrolyte to one side of the float bell assembly and terminates in an upwardly open stand pipe 19 which opens into the upper portion of float bell 80.

In operation a constant stream of air or other suitable gas is fed through pipe 18. The air passes upwardly into float bell 80, forcing out

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any liquid therein so that this bell is kept full of air at all times. Excess air escapes around the mouth of bell 80, flowing across the serrated edge 11, and upwardly over the outside surface of baffle 12. Part of the air thus passing upwardly around inverted bell 7 strikes baffle 20 and is thrown outwardly before it rises to the surface of the electrolyte and escapes. This causes a circular motion of the electrolyte near the surface which aids in dissolving salt fed in at the point, as will be explained more fully hereinafter. Hopper 14 is kept continuously filled with granular salt. When the cell level is below a predetermined point, the salt flowing from hopper 14 through orifice 15 forms a conical pile of salt on plate 13 and then flows over the edge of plate 13 into the electrolyte surrounding the inverted bell 7. As the electrolyte rises in the cell, float bell 80 rises, thereby raising plate 13. When plate 13 has risen to the point where a line drawn from its edge to the nearest edge of orifice 15 forms an angle with the surface of the plate which is equal to or less than the angle of repose of the granular salt, the flow of salt through orifice 15 stops. When the electrolyte level is lowered by consumption of electrolyte, float bell 80 correspondingly lowers plate 13 until the angle mentioned above becomes greater than the angle of repose of the salt, whereupon the salt again flows through orifice 15 and spills over the edge of plate 13 into the cell bath.

The principle of operation may be further explained by reference to Figure 2 is a more or less diagrammatic illustration of a simplified form of the apparatus. Figure 2 shows the stationary inverted bell 7, provided with jacket 8, insulating material 9 and annular baffle 20, as in Figure 1. Within bell 7 is located float bell 21 connected by shaft 10 to the circular, horizontal pan 13. Hopper 14 is provided with cylindrical conduit 33, having orifice 15 located directly above and concentric with pan 13, as in Figure 1. Granular salt 24 fills hopper 14 and loads pan 13. Air is supplied to float bell 21 by means of inlet pipe 22 which is directed at an angle and terminates directly below the center of float bell 21.

In operation, the air entering pipe 22 enters float bell 21, maintaining the bell filled with air, and the excess air bubbles up around the outside of bell 7 and into contact with the annular baffle 20. This upward movement of the air bubbles causes a corresponding upward movement of the electrolyte around the outside of bell 7. Annular baffle 20 deflects the upward movement of the electrolyte and air outwardly in a radial direction. This causes radial circulation of the electrolyte as shown by the arrows in the drawing. This upward movement of the electrolyte prevents salt from freezing at the surface of the electrolyte in the near vicinity of the feed mechanism, and in particular, maintains an area free from frozen salt crust, into which the salt fed from the edge of pan 13 may fall. Surrounding this crust-free area, a crust of frozen salt 23 builds up and is maintained on the cell bath. This is of advantage in preventing undue loss of heat from the electrolyte.

The above-described circulation of the electrolyte causes a rapid surface flow of electrolyte outwardly in radial directions in the area surrounding baffle 20. Salt falling from the edge of pan 13 falls into this area, and the rapid stream of electrolyte swiftly carries the salt granules underneath the surface of the bath where they

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rapidly dissolve. Without such means for rapidly dissolving the solid salt, it would soon form a crust of frozen salt at the point of entrance.

The annular baffle 20 in Figures 1 and 2 also serves to protect the upper part of the feeding device from splashing of the electrolyte. Without means for deflecting the circulating bath and upwardly flowing air bubbles outwardly, the rising bath tends to splash molten salt which freezes on solid surfaces. The rapid outward radial flow of electrolyte caused by baffle 20 effectively prevents such splashing.

Figure 2 also shows, by means of dotted lines, positions of float bell 21 and corresponding positions of pan 13 in feeding and non-feeding positions. When the pan is in its lower, or feeding position, as shown by the solid lines, an angle formed by a line drawn from the edge of the pan to the nearest edge of orifice 15, i. e. angle A, is greater than the angle of repose of the granular salt and the salt flows from orifice 15. When pan 13 is raised to the upper or non-feeding position, as shown by the dotted lines, this angle, as shown by angle B, is less than the angle of repose of the granular salt, and the flow of salt stops.

The stationary inverted bell 7, having its upper part insulated by means of jacket 8 and insulating material 9, is an important part of the device illustrated by Figures 1 and 2. An important function of this element is to prevent electrolyte from freezing at the surface around the float bells 80 and 21. It also coats with baffle 20 to protect the upper portion of the float bell and pan shaft 10 against electrolyte splashing.

From the above description of preferred forms of my invention and its mode of operation, it will be apparent to the skilled engineer that various forms of the apparatus may be constructed and that the invention is not limited to particular forms which are illustrated by Figures 1 and 2. Figures 3, 4, 5, 6, and 7 are diagrammatic line drawings of various forms of my invention in vertical section. As the purpose of Figures 3 to 7 is merely to illustrate different forms of floats, baffles, and gas flow, structural details shown in Figures 1 and 2 are omitted. These figures each show hopper 14 with conduit 33 and orifice 15, and below the orifice, the disk or pan 13 connected by shaft 10 to a float bell. In Figure 3 the float bell 80 with serrated edge 11 and skirt 12 is the same as shown in Figure 1, but the air is supplied by an inlet pipe 22 terminating below the bottom of the float bell in a manner similar to that shown by Figure 2. In Figure 4 the float bell 25 lacks the annular baffle skirt 12 of Figure 3. In its place, there is an inverted, frusto-conical baffle 26 located below the bottom of the float bell with an opening in the bottom so that part of the air from the inlet pipe 22 may pass through the opening in the conical baffle and upward into float bell 25, while the remainder escapes around the outside and is deflected outwardly from the float bell. The conical baffle 26 may be stationary, or it may be connected with the float bell 25 so as to move therewith. In Figure 5 there is a stationary conical baffle 27 like that in Figure 4, but the opening therein is provided with a vertical conduit 28 which leads air from pipe 22, passing through the opening directly into the upper portion of float bell 25. Figures 6 and 7 illustrate hollow floats 29 and 30, having closed bottoms

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so that the air from inlet pipe 22 does not enter the floats but is deflected around their exteriors by conical baffles 31. In Figure 6, float 29 is a completely enclosed cylinder except that, if desired, a small vent opening (not shown) may be provided at the top to permit breathing. In Figure 7, float 30 is open at the top and is connected to the pan shaft 10 by spider 32. The conical baffles 31 may be stationary or attached to floats 29 and 30, as desired.

Various other modifications of the invention will be apparent to the skilled engineer. For example, the horizontal pan 13 may have various shapes, e. g., rectangular, although a circular pan is preferred. I may also place a vertical collar partition around one side of the pan or provide a chute or other means to divert the salt fed from the pan to one side only. The pan 13 may be any suitable size compatible with the size and construction of the fused salt cell. Also, the invention is not restricted to any particular ratio of the size of the orifice 15 to the size of the pan, so long as the pan extends outwardly on all sides beyond the edges of the orifice sufficiently to form a conical, or frusto-conical pile of salt on the pan. For example, when the orifice and pan are circular and coaxial, the radius of the pan is larger than the radius of the orifice. The minimum radius of the pan will be sufficiently great to permit building a frusto-conical pile of salt on the pan and this will vary, depending on the size of the salt granules and the angle of repose of the salt. Generally, the radius of the pan will exceed that of the orifice by a distance equal to at least 5 to 10 times the average diameter of the salt particles. In most cases, I prefer that the radius of the pan be at least $\frac{1}{8}$ inch greater than that of the orifice, e. g., in the range of $\frac{1}{4}$ to 2 inches greater.

Any structural material capable of withstanding the conditions of use may be employed to construct the device. For example, I have found steel and nickel to be satisfactory for a feeder used to feed finely divided, granular sodium chloride into a fused bath operated at temperatures above 500° C.

I claim:

1. An apparatus for feeding granular salt into the electrolyte in a fused salt electrolysis cell which comprises means for releasing a down-flowing stream of said salt, said means including an orifice through which the salt flows, a substantially horizontal pan located below said orifice and adapted to receive the salt flowing therefrom, the surface of said pan extending laterally in all directions beyond said orifice, said pan being capable of vertical movement, means for raising and lowering said pan to levels above and below the level at which the greatest angle between the surface of the pan and a line drawn from an edge of the pan to the nearest edge of said orifice is equal to the angle of repose of said salt, said means for raising and lowering the pan being responsive to changes of the level of electrolyte in said cell to feed salt to said cell when the level of the electrolyte drops to a given point, said means for movement of said pan being controlled by an inverted gas-filled cylindrical bell located in said electrolyte and extending above the surface thereof and having an insulated partition enclosing at least that portion of said bell which extends above the electrolyte, and means for introducing gas into said bell.

2. In an electrolytic cell for the electrolysis of fused salts, means for releasing a falling stream

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of granular salt into said cell, said means having a circular orifice through which said stream passes, a substantially horizontal circular disk situated below and substantially coaxial with said

orifice and adapted to receive salt flowing therefrom, said disk being supported by an inverted cylindrical bell filled with gas and floating in the electrolyte in said cell, means for flowing gas into said bell and means for flowing gas into said electrolyte so as to stir the electrolyte surface in an area around said bell and below said disk to an extent sufficient to prevent freezing of the electrolyte in said area, said bell being connected to said disk to maintain it at a predetermined height above the level of said electrolyte and, responsive to changes in said level, to raise and lower said disk to levels above and below the lead at which the angle formed by the upper surface of said disk and a straight line drawn between a point on the edge of said disk and the nearest edge of said orifice is equal to the angle of repose of said salt.

3. In an electrolytic cell for electrolysis of fused salts, a device for feeding granular, solid salt into said cell and for maintaining the electrolyte therein at a predetermined level which comprises a gas-filled float floating in the electrolyte, a horizontal, circular disk rigidly attached to said float and situated above the surface of the electrolyte, a vertical, cylindrical salt conduit, the diameter of which is less than the diameter of said disk, situated above and substantially coaxially with said disk at such height that when the surface of the electrolyte is at the said predetermined level, the angle between the upper surface of said disk and a line drawn from the edge of the disk to the nearest edge of said cylindrical conduit is less than the angle of repose of said salt, said float comprising a cylindrical float bell open at the bottom, the bottom edge of said bell having a serrated edge, a frusto-conical baffle attached to said bell and extending upwardly and outwardly from said serrated edge, a cylindrical partition surrounding at least the upper portion of said float bell and extending below the surface of the electrolyte, said frusto-conical baffle being adapted to deflect gas issuing from said bell along the sides of said cylindrical partition, annular baffle means adapted to deflect outwardly the gas rising along the sides of said cylindrical partition, and means for introducing gas into said float bell.

4. The apparatus according to claim 3 in which the walls of said cylindrical partition are insulated, at least in those portions extending through and above the surface of the electrolyte.

5. In an electrolytic cell for electrolysis of fused salt a means for feeding granular, solid salt into said cell and for maintaining the electrolyte therein at a predetermined level which comprises a gas-filled float floating in the electrolyte, a horizontal, circular disk rigidly attached to said float and situated above the surface of the electrolyte, a vertical, cylindrical salt conduit, the diameter of which is less than the diameter of said disk, situated substantially coaxially with and above said disk, at such height that when the surface of the electrolyte is at the said predetermined level, the angle between the upper surface of said disk and a line drawn from the edge of the disk to the nearest edge of said cylindrical conduit is less than the angle of repose of said salt, said float comprising a cylindrical bell open at the bottom, means for introducing gas into the electrolyte below said bell, baffle means for directing part of said gas into said bell and part around the exterior thereof, an insulated hood surrounding the up-

per portion of said bell extending downward at least to the surface of the electrolyte and baffle means for deflecting outwardly the gas rising around the exterior of said bell.

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Number
13,375

Certificate of Correction

Patent No. 2,432,973.

December 16, 1947.

GEORGE E. SMEDBERG

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Column 2, line 34, for "anad" read *and*; column 3, line 33, after "Figure 2" insert *which*; column 6, line 17, claim 2, for the word "lead" read *level*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 23rd day of March, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.