July 12, 1960 A. L. FENTRESS 2,944,955

PURIFICATION DEVICE FOR ALKALI METAL CELLS

Filed March 27, 1959

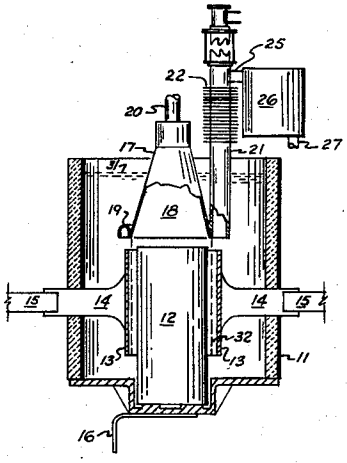


FIG. 1

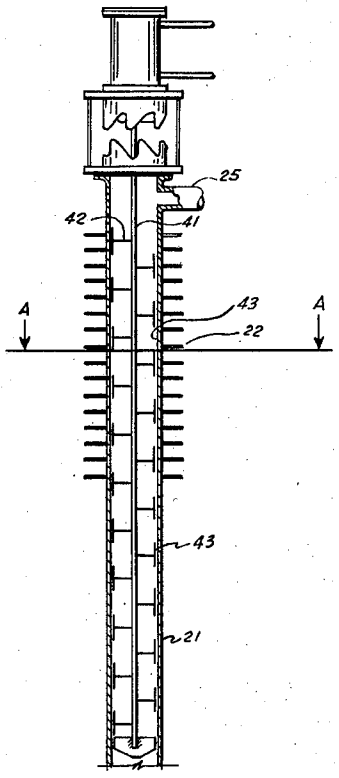


FIG. 2

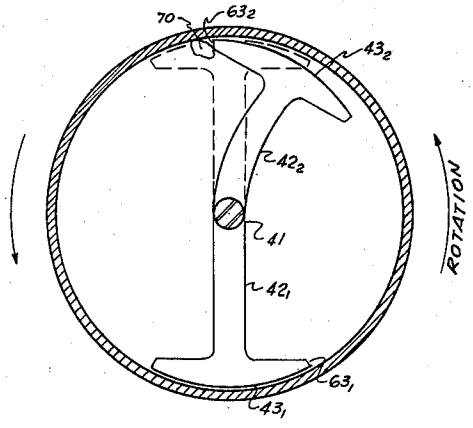


FIG. 3

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PURIFICATION DEVICE FOR ALKALI METAL CELLS

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This invention relates to a fused salt electrolysis cell, particularly to an improved device for removing undesired metal deposits from take-off conduits leading to the exterior of such cells.

Generally, cells for the production of alkali metals are of a type basically similar in design to the Downs cell, U.S. Patent 1,501,756. This cell is characterized by a bottom-mounted carbon anode surrounded by a cylindrical steel cathode. Within the annular portion formed between the anode and cathode is usually inserted a foraminous metal diaphragm. During electrolysis the chlorine is evolved from the anode and is removed from the upper portion of the cell through a gas dome situated above the anode. The alkali metal, or sodium, which is separated from the salt, is displaced to the upper portion of the cell and is manifolded within an annular collecting chamber and removed through a vertical take-off line or riser pipe communicating with the cell exterior.

Because of the high temperature required to melt alkali metal salts, particularly sodium chloride, it is customary to add a second salt thereto to lower its melting point. Generally, a fused mixture of calcium chloride and sodium chloride is employed for the manufacture of sodium. This inevitably results in the problem of removing the calcium metal from the sodium metal. The preponderance of the calcium metal is normally removed by passing the sodium metal upward through the cool riser pipe prior to discharge. The sodium metal solution gradually cools during its upward ascent thereby producing precipitation of the low solubility calcium metal. Most of the calcium metal precipitated falls or is returned to the bottom of the electrolytic cell where it dissolves. Inevitably, however, some calcium metal tends to deposit on the inner wall of the riser pipe. If such deposits were not removed, they would eventually cause the complete pluggage of the riser pipe. It is therefore essential that these deposits be removed. Customarily therefore, "tickler devices" are used to dislodge the calcium deposits. Automatically driven tickler devices are described, for example, in U.S. Patents 2,770,364, 2,770,592, and 2,861,938. These devices usually comprise a cleaner assembly operatively connected to a drive mechanism. The cleaner assembly usually consists of a plurality of cleaner blades or scrapers mounted so as to act upon the inner walls of the riser pipe, over its entire length, and to dislodge forming, or already formed, calcium deposits. Generally, the blades or scrapers are affixed to a shaft whose axis corresponds to the center of the riser pipe and extends through the pipe from above and is capable of rotation and limited vertical movement. Various drive mechanisms have been proposed for these devices.

In all such devices, however, there is a common tendency for the devices to function for a period and then to fail. After the tickler fails, or ceases to function, a new cleaner assembly must be inserted into the operating cell. The duration of time within which a tickler will continue to properly function before it must be removed from the cell is referred to as "tickler life." Tickler life

for present commercial ticklers is of extremely short duration. When an automatic tickler fails to function it is essential that the tickler be fairly promptly placed back in operation to prevent a complete pluggage of the riser pipe. To remove the pluggage it must be chipped away by hand and a new cleaner assembly placed in the operating cell. Since a single cell installation contains a large number of cells it is apparent that this is a quite costly operation. Extension of "tickler life" means large savings in money and operating labor. Obviously then, extension of "tickler life" is a very desirable goal.

Accordingly, it is an object of the present invention to provide a new and improved automatic tickler or cleaning assembly capable of operation for extended periods without functional failures. It is also an object of the present invention to provide a new and improved tickler which will greatly decrease operating cost. A further object is to provide apparatus for the most effective cleaning of the riser pipe walls than has heretofore been possible. A more specific object of a highly preferred embodiment is to provide mechanism capable of exerting a variable cleaning action automatically correlated with the degree of adhesion of fouling deposits.

The details of the apparatus and of preferred embodiments will be more readily understood from the following description and by reference to the accompanying Figures 1–3, wherein:

Figure 1 is a generalized elevation illustrating the relation of the assembly of the present invention to the fused salt electrolysis cell for which it is intended,

Figure 2 is an elevation, in partial cross section and on a larger scale, of the cell riser pipe having the apparatus of the invention and operating means incorporated therein, and

Figure 3 is cross section AA showing the cleaner blades in greater detail. This figure also illustrates the preferred embodiment of the invention, as hereinafter defined.

These figures will be better understood from the following description.

The apparatus comprises generally the combination, with a cell riser pipe, of an automatic tickler assembly which includes a cleaner device extending into the said vertical riser pipe, and having motor means operatively connected therewith for imparting vertical reciprocation and rotational motion of the said device within the riser pipe. The present invention provides an improved cleaner consisting of an elongated member or central shaft, of length approximately equal that of the riser pipe, with a plurality of arms mounted on the said member which project at substantially right angles therefrom and are spaced along the said member. Upon the extremities of the arms are affixed arcuate cleaner blades. The leading edges, or the edges in the direction of movement, are beveled. Each of the blades are adjacent and arced to correspond to the curvature of the inner wall of the riser pipe. The summation of the vertical dimensions of the said blades is substantially equal to the vertical dimension of the riser pipe such that upon rotation of the cleaner device the entire inner surface area of the riser pipe is swept clean.

A more highly refined embodiment, described more mully hereinafter, provides arms which are slightly flexible at operating temperature. Thus when the blades, when moved in either a vertical or horizontal direction, come into contact with a nonreadily severable formation the position of the leading or cutting edge relative to the formation acted upon is not permitted to yield or ride over the formation. Instead the position of the cutting edge is preserved and force is brought to bear upon the formation. In all embodiments a "slicing action" is brought to bear upon the formation because of the simul-

taneous rotation and vertical motion of the elongated member.

The features and advantages will be better understood from the following detailed description of the invention and of its preferred embodiment.

The general disposition of the apparatus of the present invention and a sodium cell is illustrated by Figure 1 as above mentioned. Referring to Figure 1, the principal components of a cell include a cell body **11** comprising an external steel shell lined with refractory brick or lining. A centrally mounted carbon anode **12** is surrounded by a cylindrical cathode **13**, having lugs **14** projecting through the cell walls and providing for connection to bus bars **15** supplying the electric current. Similarly the current is fed to the anode **12** by an anode bus bar **16**. A dome and collector assembly **17** is mounted centrally above the anode-cathode electrodes and includes a chlorine dome **18** in the form of an inverted generally conical member and a sodium collecting conduit **19**. The chlorine dome terminates in a chlorine discharge line **20** to transfer the gaseous chlorine to subsequent operations. The sodium collecting conduit **18** meets and is connected to the rise pipe **21**. The riser pipe, here shown only in external view, is an elongated steel tube provided with fins **22** on at least a portion of the external portion. Surmounting the riser pipe is the guiding and actuating assembly discussed and described in detail hereafter. The fins **22** on the exterior portion of the riser pipe improve the dissiptation of heat from the interior of the pipe and its contents. Sodium discharge from the cell is discharged through a connecting line **25** from the riser pipe and feeds a receiving box **26** which is a container for temporary hold up of the sodium, the sodium being then passed through a discharge spout **27** to a transfer vessel or container.

In operation, the cell contains, up to a level approximately intermediate the full vertical elevation of the chlorine dome **18**, fused electrolyte chlorides or a "bath" **31**. This molten bath includes not only sodium chloride but appreciable quantities of calcium chloride. The sodium and chlorine as released in the annular space between the anode **12** and cathode **13** and rise on opposite sides of a diaphragm **32**. The sodium collects in the channel **19** and flows to the entrance of the riser pipe **21**. It then rises in the riser pipe **21** and is discharged through line **25** to the receiver **26** and thence through the nozzle to a transfer container, not shown. The heat loss from the riser pipe through the fins **22** results in precipitation of calcium at and on the interior wall of the riser pipe **21**.

The details of construction and operation of the improved tickler will be more readily understood by reference to Figure 2. This is an elevation on larger scale than Figure 1 and is also a partial section showing the relation of an automatic tickler, particularly the cleaner device, with the riser pipe **21**. The driving mechanism can be one of several kinds. It can be a pneumatic piston-cylinder combustion or an electrically driven device for example. A preferred pneumatic actuated device is fully described in U.S. Patent 2,770,364. The cleaner device includes a central shaft or elongated member **41** upon which is mounted a plurality of arms **42** projecting outwardly at substantially right angles therefrom. The arms **42** preferably project outwardly from the shaft **41** so as to be in one vertical plane, each arm **42** being alternatively placed on opposite sides of the shaft **41** and 180° apart, and support cutter blades **43** as hereinafter defined. It will be understood however that other arrangements of the arms are possible, subject to the condition that the width of the arcuate blades **43**, spacing, etc. are such as to define contiguous cutting paths upon the riser pipe walls in conformity with the frequency of reciprocation and rotation of the assembly. Affixed to the extremities of these arms **42** are arcuate cleaner blades **43**. The blades **43** have beveled edges **63** at least in the direction of movement, and beveled so that the sharper edge is inclined toward the adjacent riser pipe wall. The blades **43** are arced to correspond to the curvature of the inner wall of the riser pipe **21** and the lengths of the arms **42** are such as to place each of the blades **43** adjacent the inner walls of the riser pipe **21**. Generally a clearance of about 0.125 inch is allowed between the cutter blades **43** and the riser pipe inner wall. The arcuate blades **43** are usually made from rectangular members having a length:width ratio of from about 1:1 to about 3:1. The thickness of the blades **43** is usually from about 0.125 inch to about 0.75 inch. The cutting edges **63** of the blades **43** are preferably beveled to define an angle of from about 30° to about 45°, the angle being that angle formed between a line extended perpendicularly from the shaft **41** to the apex of a cutting edge **63** and the face of that edge **63**. Generally, also, it is essential that the blades **43** be spaced apart at such intervals that rotation of the shaft **41** causes the blades **43** to define contiguous paths along the inner surface of the riser pipe **21**; the summation of such paths being generally equal in vertical dimension to the vertical dimensions of the inner surface of the riser pipe **21**.

Figure 3 illustrates an even more highly refined and preferred embodiment wherein the arms **42** are designed to permit flexing thereof upon the blade **43** encountering a non-readily severable calcium metal formation. Thus, Figure 3 shows section AA taken from Figure 2. The arms 42_1 and blades 43_1 are shown by solid lines in their normal position of rotation, and 42_2 and 43_2 at a moment during rotation just after the cutting edge 63_2 of the blade 43_2 has encountered an obstacle **70**. The broken lines, though the angle of deflection is highly exaggerated, show the position which the arm 42_2 and blade 43_2 would normally occupy but for the obstruction **70**, assuming that the normal position of the arm 42_1 is spaced 180° from the arm 42_3. Thus, when the cutting edge 63_2 comes into contact with the obstacle **70** and fails to sever it from the inner wall of the riser pipe **21** the forward motion of the blade 43_2 is checked. The arm 42_2 yields but does not allow the edge 63_2 to slip over the obstacle **70**. Further flexing of the arm 42_1 exerts force of the edge 63_2 upon the obstacle **70**, and tends to cause the edge 63_2 to dig deeper into the obstacle **70**. Usually the force is sufficient to dislodge the obstruction, after which time the arm 42_2 assumes its normal position.

As illustrative of the increased tickler life and improved efficiency of the apparatus in commercial installations, in a typical sodium cell "shop" a battery of the automatic ticklers herein described was placed in operation and carefully observed for an extended period of 63 days, while concurrently the remaining cells of the shop were operating with the conventional tickler. The results showed an 8.3 day average life for the tickler of the present invention and a 5.7 day average life for the conventional tickler. These results are highly significant, showing an improvement of greater than a 45 percent increase in tickler life.

Having fully described the apparatus of the invention, what is claimed is:

1. In a fused salt electrolysis cell, having a riser pipe extending above the cell for concurrently discharging sodium metal, for cooling and precipitating the calcium impurity and returning same to the cell, and having in combination with said riser pipe an automatic tickler assembly which includes a cleaner device extending into the vertical riser pipe, and motor means operatively connected therewith for imparting vertical reciprocation and rotational motion of the cleaner device within said riser pipe, the improved cleaner having an elongated member of length approximately equal that of the riser pipe, a plurality of arms mounted on said member and projecting at substantially right angles therefrom and spaced along said member, and arcuate cleaner blades having edges beveled in the direction of rotational motion and the

edges inclined toward the riser pipe wall, affixed to the extremities of said arms, said blades being adjacent to and arced to correspond generally to the curvature of the inner surface of the riser pipe, the summation of the vertical dimensions of said blades being substantially equal to the vertical dimension of the riser pipe whereby rotation of the cleaner cleans substantially the entire internal area of the riser pipe.

2. In a fused salt electrolysis cell, having a riser pipe extending above the cell for concurrently discharging sodium metal, for cooling and precipitating the calcium impurity and returning same to the cell, and having in combination with said riser pipe an automatic tickler assembly which includes a cleaner device extending into the vertical riser pipe, and motor means operatively connected therewith for imparting vertical reciprocation and rotational motion of the cleaner device within said riser pipe, the improved cleaner having an elongated member of length approximately equal that of the riser pipe, a plurality of arms mounted on said member projecting at substantially right angles therefrom and spaced along said member, and arcuate cleaner blades, having beveled edges in the direction of rotational motion and the edges inclined toward the riser pipe wall affixed to the extremities of said arms, said blades being adjacent to and arced to correspond to the curvature of the inner surface of the riser pipe, the summation of the vertical dimensions of said blades being substantially equal to the vertical dimension of the riser pipe whereby rotation of the cleaner cleans substantially the entire inner area of the riser pipe, the said shafts upon which are mounted the cutter blades are sufficiently flexible at operating temperatures, both vertically and horizontally, that when the leading edge of a cutter blade encounters a non-readily severable formation, the said shaft yields but does not permit the position of the leading edge of the cutter blade relative to its normal position adjacent the internal surface of the riser pipe wall to become lessened.

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