Dec. 22, 1970 R. SCHOBERLE 3,549,511
APPARATUS FOR THE DECOMPOSITION OF AN ALKALI METAL MERCURY AMALGAM
Filed July 24, 1968 4 Sheets-Sheet 1

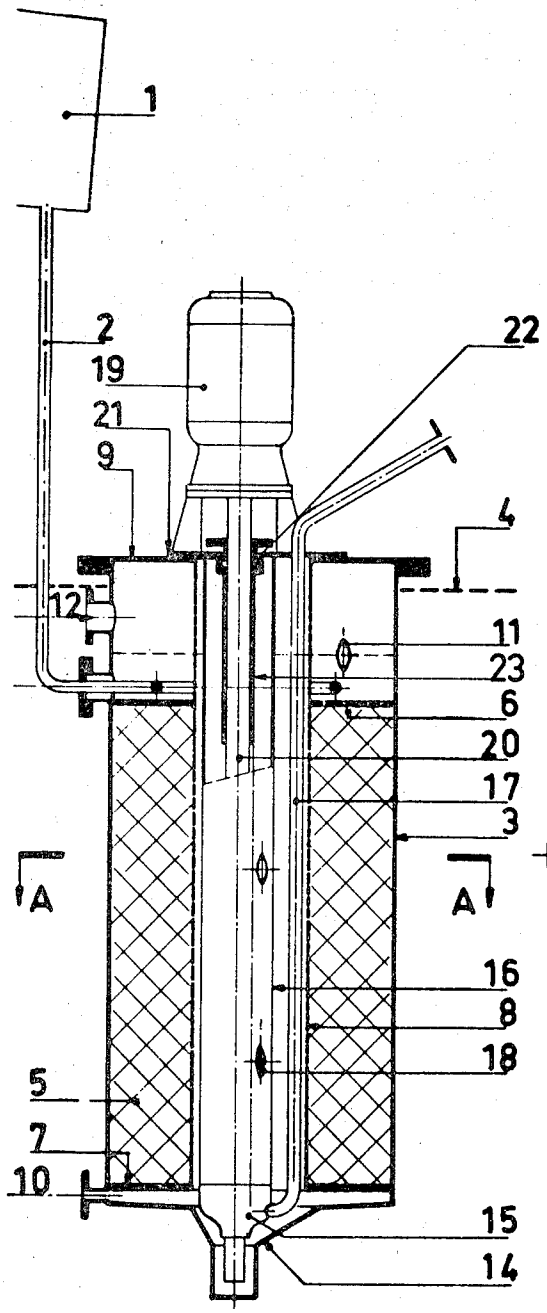

Fig. 1

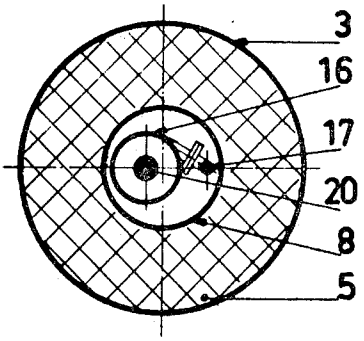

Fig. 2

Dec. 22, 1970 R. SCHOBERLE 3,549,511
APPARATUS FOR THE DECOMPOSITION OF AN ALKALI METAL MERCURY AMALGAM
Filed July 24, 1968 4 Sheets-Sheet 2

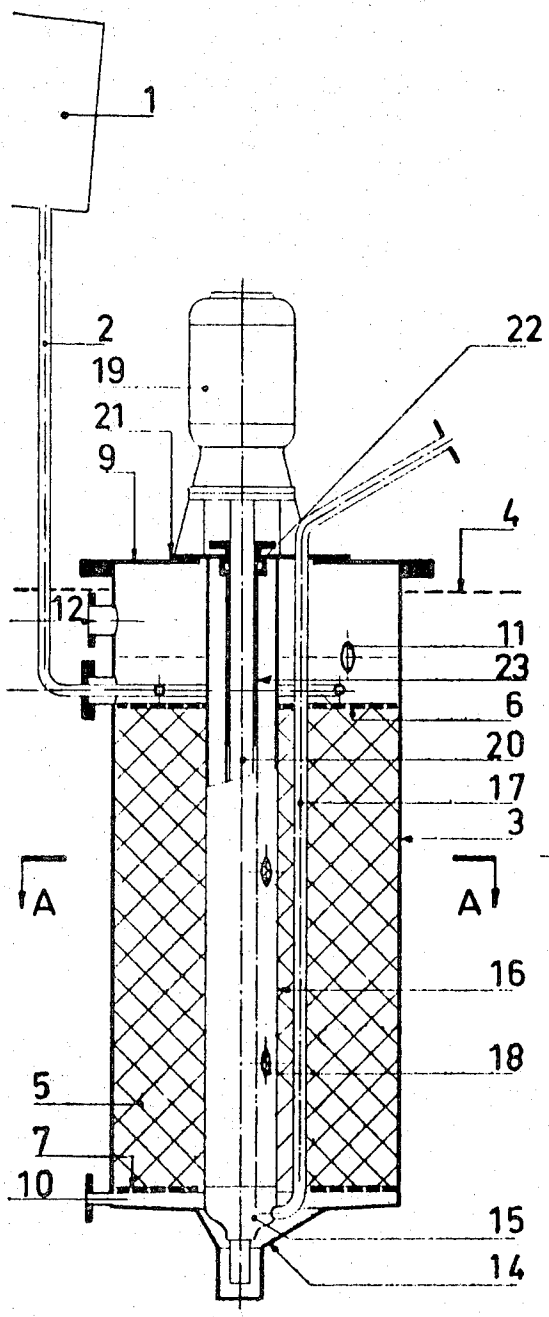

Fig.3

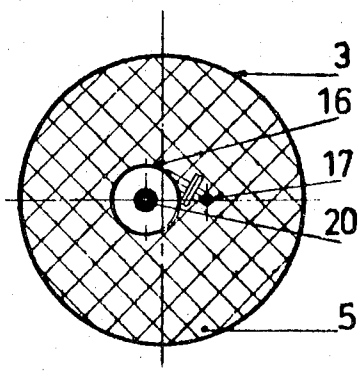

Fig.4

Dec. 22, 1970 R. SCHOBERLE 3,549,511
APPARATUS FOR THE DECOMPOSITION OF AN ALKALI METAL MERCURY AMALGAM
Filed July 24, 1968 4 Sheets-Sheet 3

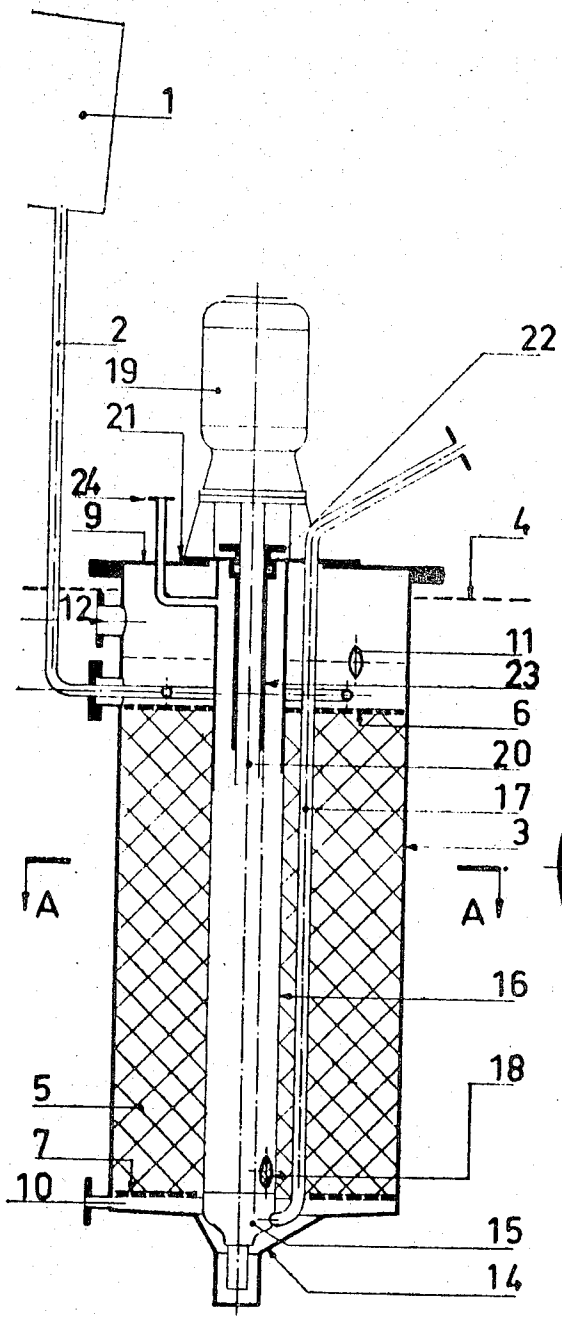

Fig.5

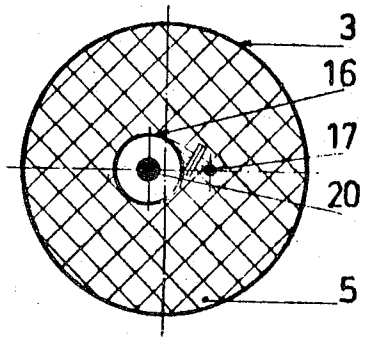

Fig.6

Dec. 22, 1970 R. SCHOBERLE 3,549,511
APPARATUS FOR THE DECOMPOSITION OF AN ALKALI METAL MERCURY AMALGAM
Filed July 24, 1968 4 Sheets-Sheet 4

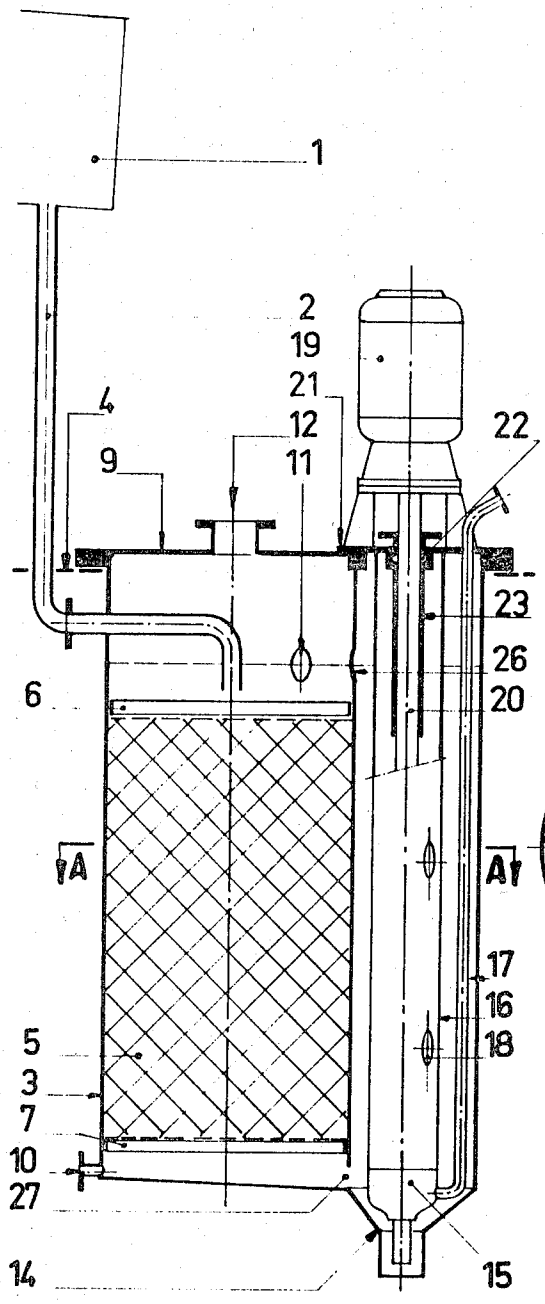

Fig. 7

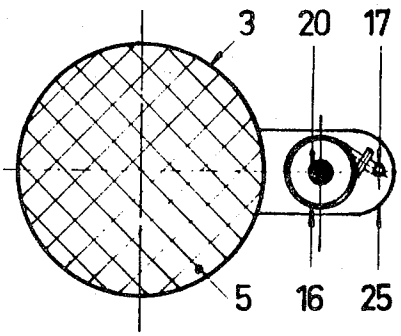

Fig. 8

United States Patent Office 3,549,511
Patented Dec. 22, 1970

3,549,511

APPARATUS FOR THE DECOMPOSITION OF AN ALKALI METAL MERCURY AMALGAM

Robert Schoberle, Roermond, Netherlands, assignor to Solvay & Cie, Brussels, Belgium, a corporation of Belgium

Filed July 24, 1968, Ser. No. 747,304
Claims priority, application Belgium, July 26, 1967, 701,848
Int. Cl. B01k 3/00; C22d 1/04
U.S. Cl. 204—249 10 Claims

ABSTRACT OF THE DISCLOSURE

The apparatus comprises a common chamber which contains the piling used as a catalyst for the decomposition of the amalgam formed in a mobile mercury electrolytic cell and the pump which drives the recovered mercury back toward the cell for reuse. A single tank also contained in the chamber provides for the storage of mercury collected during the decomposition which may be used as a drawing reserve for the centrifugal pump as as well as storage in the event the cell is stopped.

BACKGROUND OF THE INVENTION

The present invention relates to vertical piles used for the decomposition of the amalgam of alkali metal formed in a mobile mercury cathode electrolytic cell. It concerns, more particularly, an apparatus and system for the decomposition of the amalgam which flows or drips across a fixed bed of catalyst particles in contact with a decomposition liquid which is circulating countercurrent to the amalgam and for recycling the mercury thus obtained toward the mercury cell.

Certain devices have been proposed previously in which the operations of decomposition of the amalgam and the elevation of the recovered mercury for recycling purposes are combined. However, such known systems are not suitable for a modern electrolytic installation due to the low decomposition capacity of the piles, the reduced height of delivery of the mercury and the restricted flow thereof.

Vertical piles in current use have a height in excess of two meters. The decomposition capacity of modern piles has been improved by enlarging the mercury/catalyst contact surface in the presence of the decomposition liquid; in order to accomplish this, the mercury is finely divided in a distributor or divider at the entrance of the pile, and the catalyst is in the form of a piling of small particles. The deliver or driving device of the mercury must be capable of guaranteeing a flow on the order of 120 liters per minute at a manometric height often in excess of 3 meters, corresponding to the geometric height of the pile and to the loss of pressure in the delivery pipe, the length of which is substantially that of the cell, namely about 12 to 15 meters, and the section or profile of which is reduced as much as possible so as to limit the amount of mercury immobilized.

Such performances are economically unrealizable with archaic devices, such as paddle wheels and Archimedean screws, as well as by driving mercury by means of a rising fluid. Only centrifugal pumps are capable of overcoming such a difference of level and are able to guarantee the required flow of mercury for a reasonable investment and in an acceptable size so that they are not an encumbrance and do not occupy an undue amount of space.

Up to the present, centrifugal pumps have been mounted outside the pile, in a large tank set up at the level of the base of the pile, in order to collect the mercury of the cell in the event of a stoppage of the installation.

Generally, the pump has been located under the floor of the electrolysis room, and dismantling a pump having such difficult access is laborious and dangerous. In order to avoid noxious mercury vapor, the temperature of the mercury at the outlet of the pile is around 120° C., and to avoid the formation of crusts by carbonation of small droplets of lixivium, i.e., aqueous caustic leached from the amalgam, carried by the mercury coming out of the pile, it has been necessary to circulate water in the tank of the centrifugal pump. Furthermore, the flow of the circulating water has had to be relatively rapid to avoid its boiling. Further, the water inevitably carried mercury so that it has been necessary to have it circulate in a shuttle with refrigerant.

Finally, and most important, in installation of the above type, a large quantity of mercury is immobilized as a total or dead loss at the base of the pile and in the pipe or conduit connecting it to the tank of the pump in order to prevent the passage of lixivium towards it.

SUMMARY OF THE INVENTION

The principal object of the present invention is the provision of an improved apparatus or installation for carrying out the decomposition of an alkali metal amalgam which is formed in a mobile mercury cathode electrolytic cell and for recycling the recovered mercury toward said cell. Another object of the present invention is the provision of an apparatus wherein the inconveniences and difficulties of previous systems are substantially eliminated.

These objects and others are accomplished by the present invention, according to which, the piling which catalyzes the decomposition of the finely divided amalgam and the centrifugal pump which drives the mercury resulting from this decomposition towards the electrolytic cell are arranged in a common chamber. This common chamber simultaneously acts as the decomposition pile, the pump tank and the tank for the storage of mercury required in the event of a stoppage of the electrolytic cell.

The installation of the present invention for the decomposition of the amalgam of alkali metal formed in a mobile mercury cathode electrolytic cell and for the delivery of the mercury resulting from this composition toward the electrolytic cell comprises a chamber enclosing a fixed bed of catalyst on which the finely divided amalgam streams or drips in contact with decomposition liquid in countercurrent circulation and also encloses a mercury centrifugal pump. A baffle is mounted in the chamber between the pump and the fixed bed of catalyst to prevent contact between the catalyst and at least the mobile components of the pump. The common chamber which encloses the catalyst bed and the pump is sealed by means of a cover and is provided with means for storing the mercury which results from the decomposition reaction. In this way, the common chamber acts as a decomposition pile, a storage tank for the mercury resulting from the decomposition, a mercury drawing reserve for the centrifugal pump and a means for storage of mercury in the event of a stoppage of the electrolytic cell. The present installation is also provided with means for introducing the amalgam into the chamber and onto the fixed bed of catalyst in finely divided form and means for introducing the decomposition liquid into the chamber and into countercurrent contact with the amalgam.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a device of the present invention in axial section and FIG. 2 represents the same device in horizontal section following lines A—A of FIG. 1. FIGS. 3, 5, and 7 also show in axial section different embodiments of the devices of the present invention, and FIGS.

4, 6 and 8 are horizontal sections along lines A—A of FIGS. 3, 5 and 7 respectively. In all of the drawings, the common reference numbers refer to the same or similar parts.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The various aspects of the apparatus of the present invention including its operation are best described with reference to the drawings. In FIGS. 1 and 2, the electrolytic cell **1** is in communication by means of a conduit or pipe **2** with a cylindrical chamber **3** which is accessible from the floor **4** of the electrolysis room. The chamber **3** houses a fixed bed of catalyst 5, generally a piling of graphite particles. Two perforated discs **6** and **7** are held between the lateral wall of chamber **3** and a perforated cylinder or baffle **8** which connects the two discs **6** and **7** and extends toward the top to a cover **9**. A conduit or pipe **10** is provided at the base of chamber **3** for the introduction of the decomposition liquid or solution, and an exit tube **11** for the decomposition solution is provided above the catalyst bed. A pipe **12** is also provided above the bed of catalyst particles for the escape of gases, especially hydrogen formed during the course of the decomposition. At the bottom of the chamber **3** inclined walls lead toward a collector **14** which is situated approximately coaxial with the axis of the cylinder **8**. A centrifugal pump **15** is situated in the cylinder **8** which is free from piling. The centrifugal pump **15** is introduced through the top of the chamber **3** with its casing **16** and its discharge pipe **17**. The casing **16** is provided with openings **18** for the circulation of the decomposition liquid or solution. The pump **15** is moved or driven by the motor **19** by means of a long shaft **20** which rotates in the decomposition liquid or solution. The motor assembly, shaft, pump, casing, and delivery pipe is supported by a plate **21** which seals the opening provided in the cover **9** for the passage of the pump **15**. A packing **22** assures the tightness of the shaft to the plates. A plunger or tube **23** which forms a part of the plate **21** surrounds an upper part of the shaft **20** in order to prevent a massive loss of gas in the event of leakage at the packing **22**.

The operation of the apparatus is carried out in the following manner. The amalgam coming out of the electrolytic cell **1** flows through the conduit or pipe **2** into the chamber **3** where the amalgam is distributed in a finely divided state as it passes through the perforated discs **6** and **7** onto the piling of catalyst particles **5** which aids its decomposition. The decomposition liquid which is usually water or dilute caustic alkali solution, although other suitable solutions such as polysulfides may be used, is introduced into the base of chamber **3** through conduit **10** and flows through the piling so as to contact the amalgam in a countercurrent stream, and the decomposition solution leaves the chamber through the pipe **11**. The perforated cylinder **8** and the openings **18** in the casing **16** permit the circulation of the decomposition liquid in the casing **16** so that the shaft **20** rotates in the decomposition liquid. Hydrogen formed during the course of the decomposition escapes through the pipe **12**.

The mercury, substantially free of alkali metal after it has flowed or dripped through the piling **5** in contact with the decomposition liquid, flows on the inclined bottom of the chamber **3** to the collector **14** which is situated approximately in the axis of the cylinder **8**. The mercury collector **14** provides a drawing reserve for the centrifugal pump **15**.

Thus, the mercury gathered in the collector **14** has a double function: on the one hand, it assures the correct operation of the centrifugal pump by playing the role of a plug or stopper, absorbing the inevitable fluctuations in the flow of the mercury and maintaining the minimum level required by the pump, and on the other hand, it serves as a guard or barrier against the pumping of caustic alkali solution. In standard-type installations a widely proportioned conduit or pipe is required to prevent pumping of caustic alkali solution which immobilizes a considerable quantity of mercury.

The device of the present invention, therefore, achieves a considerable economy in the amount of mercury immobilized compared to installations in current use. Moreover, the present invention eliminates the need for a large mercury storage tank with the concomitant requirement of means for rapid water circulation, recycling and refrigeration systems all required in conventional type installations wherein the centrifugal pump is mounted outside of the vertical decomposition pile. Whenever a stoppage of the cell is required or happens by accident, the mercury contained therein can be completely stored in chamber **3** without difficulty or inconvenience.

Further, the pump assembly of the present device may be dismantled very rapidly in order to make a replacement or repairs and for general maintenance purposes. In effect, it is sufficient to unbolt plate **21** supporting the assembly. This operation does not require the removal of cover **9** and can be carried out in full safety at the same level of the floor **4** of the electrolysis room.

The installation or device of the present invention may be varied in several ways. In a particular embodiment of the present invention, in order to increase or enlarge the space occupied by the piling **5**, so that the decomposition capacity of the installation is increased without increasing the total amount of space occupied by the apparatus, the cylindrical screen or baffle plate **8** which prevents contact between the shaft of the pump and the catalyst particles may be constituted by the casing of the pump itself. This aspect of the invention is illustrated in FIGS. 3, 4, 5 and 6 wherein the piling particles **5** are prevented from contacting the shaft **20** by the pump housing or casing **16**. In apparatus of this type, apertures **18** are provided, which have screens thereon, as shown in the drawing. In this embodiment of the invention, the pump casing assembly must be put in place before introduction of the piling; the latter is then emptied or removed by suction for example for the dismantling of the pump.

It is not essential for the delivery pipe **17** which recycles the mercury back to the electrolytic cell to be an integral part of the assembly of the centrifugal pump. According to another variant of the inevntion, the delivery pump **17** protrudes directly from the mercury collector **14** and is therefore outside the chamber **3** of which it is an integral part. This variant also makes it possible to increase the quantity of catalyst in the chamber **3**, and accordingly, the capacity of the decomposition pile, without changing the dimensions of chamber **3**, by the reduction in the section or profile of the perforated cylinder **8** due to the omission of the delivery pipe **17** therefrom.

Another variant of the present invention is illustrated in FIGS. 5 and 6, wherein the decomposition liquid or solution is not introduced at the base of the device through the conduit or pipe **10**, but rather from the top through the pipe **24** which communicates with the top of the pump housing **16**. In this apparatus, the casing **16** only communicates through its base, by means of one aperture **18** provided therein with the chamber **3**. Thus, the decomposition liquid introduced through the conduit **24** flows between the shaft **20** and the casing **16** and enters the decomposition vessel **3** through the screened aperture **18**, so that the shaft **20** of the centrifugal pump constantly rotates in the entering decomposition liquid. If water is used as the decomposition liquid, the shaft **20** of the pump rotates in water, whereas in the installations illustrated in the other figures, it runs in dilute caustic alkali solution. The pipe **10** of FIG. 5 is used only to drain the vessel.

In a preferred embodiment of the present device, the shaft **20** is supported only by a bearing at its upper part; the shaft **20** is thus back balanced and submitted to

bending stress. Accordingly, if it is running in caustic solution, caustic embrittlement may cause it to break. Therefore in this preferred embodiment, it is particularly desirable to have the shaft running in water as is possible with the installation illustrated in FIGS. 5 and 6. A further advantage in having the shaft **20** rotate in water instead of caustic alkali solution, as is possible when the decomposition liquid is introduced at the top of the apparatus, is to prevent any of the caustic solution which results from the decomposition reaction from being lead away with the mercury into the electrolytic cell by the pump **15** through the mercury lift pipe **17**.

According to the present invention, the assembly of the centrifugal pump including the pump housing **16**, and when present the cylindrical screen or baffle plate **8** and the mercury collector **14** do not have to occupy an appreciably axial position in the chamber **3**; they may occupy any other position compatible with the desirable operation of the installation. The pump, for example, can be set up against the lateral wall of the chamber **3**; the latter may also carry on its lateral wall a vertical by extending lateral protrusion to be used for housing the pump.

FIGS. 7 and 8 illustrate an embodiment of the present invention wherein the vessel **3** is provided with a vertically extending lateral protrusion **25** which is substantially as high as the vessel to house the pump **15** and its housing **16**. In the apparatus illustrated in FIG. 7, the mercury delivery tube **17** is also located in the projection **25**, however as previously indicated, this location is purely optional. The protrusion **25** communicates with the rest of the vessel **3** through two apertures; an aperture **26** for gas at the top and an aperture **27** for mercury at the bottom. Decomposition liquid which enters the protrusion **25** through the top aperture **26** flows back to the vessel **3** through the bottom aperture **27** thus flowing downwardly in the protrusion **25** where the pump shaft **20** is rotating in the decomposition liquid.

What I claim and desire to secure by Letters Patent is:

1. Apparatus for the decomposition of an amalgam of alkali metal formed in a mobile mercury cathode electrolysis cell and for the delivery of the mercury resulting from the decomposition to said cell, wherein the decomposition takes place by contacting said amalgam with a decomposition liquid, said apparatus comprising means defining a chamber, enclosed in said chamber a fixed bed of catalyst on which finely divided amalgam drips in contact with said decomposition liquid circulating counter-current to said amalgam, a centrifugal pump enclosed in said chamber for discharging mercury from said chamber, means connected to said pump for discharging mercury out of said chamber for delivery to said cell, a means for introducing said amalgam into said chamber and onto said fixed bed of catalyst, means for introducing said decomposition liquid into said chamber and into countercurrent contact with said amalgam, storage means for mercury resulting from said decomposition, said storage means also providing a drawing reserve for said centrifugal pump and being in communication with said bed of catalyst and said pump, means to remove gases from said chamber, and a baffle mounted in said chamber between said pump and said fixed bed of catalyst to prevent contact between said bed of catalyst and at least mobile components of said pump.

2. Apparatus according to claim **1** in which a cover covers said chamber and is provided with an opening for the passage of said centrifugal pump and further comprising a motor mounted above said chamber for driving said pump, a support supporting said motor which seals the opening in said cover, a shaft extending from said motor through the entire height of said fixed bed of catalyst for driving said pump, and a casing surrounding said shaft suspending said pump from said support.

3. Apparatus according to claim **2** which further comprises a pipe in communication with said pump positioned substantially parallel to said shaft along said casing and passing through said support to discharge mercury resulting from said decomposition.

4. Apparatus according to claim **2** in which said storage means for mercury is enclosed in the bottom of said chamber substantially coaxial with said shaft.

5. Apparatus according to claim **2** in which said casing constitutes said baffle and in which said means for the introduction of decomposition liquid is provided at the top of said chamber between said shaft and said casing and in which said casing is provided with at least one aperture at its base so that said shaft rotates in the entering decomposition liquid and said decomposition liquid flows through the aperture in the base of said casing onto said fixed bed of catalyst.

6. Apparatus according to claim **2** in which said means for introducing said decomposition liquid comprises means to introduce said decomposition liquid at the base of said chamber and in which said casing is provided with openings along its entire height for the passage of gases which form during the decomposition reaction and for passage of the decomposition liquid introduced at the base of the chamber.

7. Apparatus according to claim **6** in which said casing constitutes said baffle which prevents contact between the catalyst and the mobile components of the pump.

8. Apparatus according to claim **1** in which said baffle has openings which permit the free circulation of the decomposition liquid.

9. Apparatus according to claim **1** in which said chamber is provided along its entire height with a lateral protrusion housing said centrifugal pump, said shaft and said casing.

10. Apparatus according to claim **1** including means to continuously remove during operation reacted decomposition liquid from said chamber.

References Cited

UNITED STATES PATENTS

3,464,910	9/1969	Krebs et al.	204—220X

FOREIGN PATENTS

P 14,491	12/1956	Germany	204—248
846,603	8/1960	Great Britain	204—249

JOHN H. MACK, Primary Examiner

D. R. VALENTINE, Assistant Examiner

U.S. Cl. X.R.

204—220