

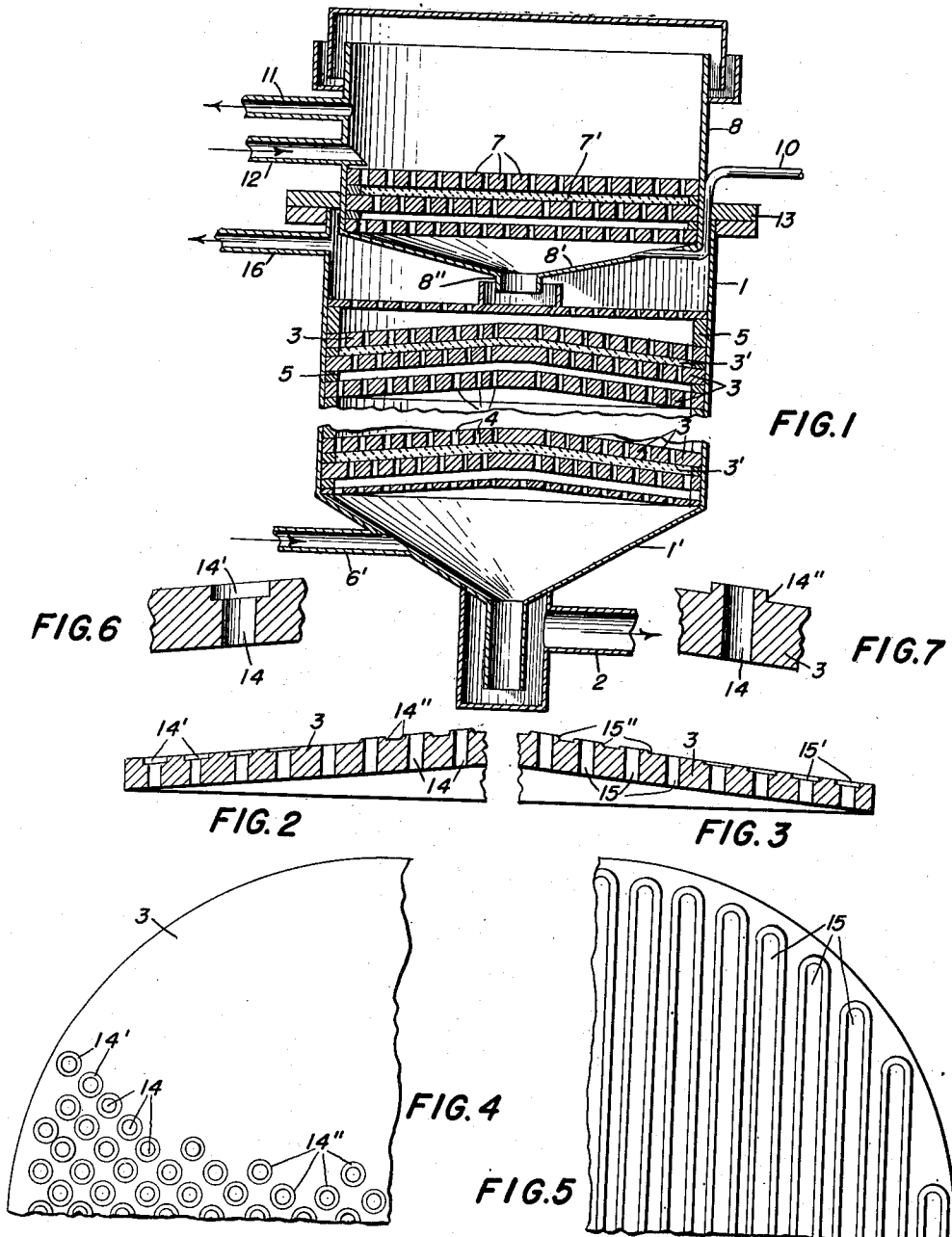
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ALKALI METAL AMALGAM DECOMPOSER

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ALKALI METAL AMALGAM DECOMPOSER

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This invention is concerned with the decomposition of alkali metal amalgam in the presence of water, in order to produce alkaline hydroxides, as caustic soda or caustic potash.

It is well known that the process of amalgam decomposition is to be considered as an electrochemical one, in which caustic solution acts as the electrolyte, the alkaline amalgam forms the anode and a second electrode of suitable material forms the cathode of the galvanic element.

Several devices have been heretofore adopted in order to achieve a decomposition as highly efficient as possible. For instance, the lines along which the three different phases (cathode, anode and electrolyte) contact one another have been increased by using grid shaped cathodes, and the temperature has also been increased either by preheating the amalgam or by direct heating of the decomposer. One has tried to make the amalgam and the caustic solution flow countercurrently so that the decomposition of the more concentrated amalgam might occur in the presence of the more concentrated caustic solution; but practically this device found but a scarce application because of the mixing up caused by the stirring of mercury and the developing of hydrogen.

A definite improvement of the decomposition process was achieved with the invention first of the vertical decomposer (U. S. A. Patent No. 2,083,648 granted to Herbert Gorke) and then of multi-stage decomposition (Netherlands Patent No. 140,391, granted to Vittorio De Nora). By the former of these inventions the amalgam is made to flow downwardly through a tower packed with a cathodic mass of nonamalgamatable material broken down in relatively small pieces, so arranged in the tower in the path of the amalgam stream as to finely subdivide it, while a stream of water is passed upwardly through the said cathodic mass. Practically this mass is composed of small pieces of graphite presenting either regular or irregular shapes, like rings, cubes or spheres. According to the latter invention, one rendered practically possible to apply the principle by which the decomposition of the depleted amalgam is achieved in the presence of dilute caustic solution, whereas the still concentrated amalgam is made to react with an already concentrated caustic solution, so as to furtherly increase the strength of this last. The advantage afforded by this method is the possibility to obtain highly concentrated caustic directly from the amalgam produced in the electrolysis cell, though the alkali metal concentration in such amalgam must be kept down to a rather low value, as specified for the best operating conditions within the cell.

I have now found that it is possible to obtain highly concentrated caustic solutions, directly and without any difficulty, by using a cathode mass formed by a series of plates or trays superimposed to and spaced from one another, such plates being provided with passages through which the amalgam and the caustic solution are both passed. By this device two objects are accomplished.

The first object is to obtain a thorough stratification of the caustic solution, so that the highest concentration may be present at the product caustic outlet and the lowest concentration near the make water inlet, inasmuch as the hydrogen developed by reaction and bubbling upwardly through the openings in the plates is prevented from mixing the caustic layers of different density.

The second object accomplished by this device is to increase the cathodic surface and the anodic surface as well,

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inasmuch as, by passing through the openings, the amalgam stream is fractured down into many small drops.

In the drawing, which diagrammatically illustrates my invention:

Fig. 1 is a sectional elevational view of a vertical decomposer embodying my invention.

Fig. 2 is a sectional elevational view in a scale different from the preceding figure, and according to a particular form of construction, of one element of the cathodic mass which is the object of my present invention.

Fig. 3 is a similar view showing a modified form of element.

Fig. 4 is a fragmentary top view of the same plate as shown in Fig. 2.

Fig. 5 is a similar view of a modified form of plate.

Fig. 6 is a detail of Fig. 2 in an enlarged scale.

Fig. 7 is a similar view of Fig. 3.

The decomposer body consists of a shell 1, whose section is preferably though not necessarily cylindrical. It is provided with the mercury outlet 2 at its bottom and incorporates a pile of cathodic plates 3, in which are worked out the openings 4.

The spacers 5 that are arranged between the plates along the rim of these last serve to separate the plates. Furthermore, they must carry out a gasketing function against the shell wall, in order to prevent the caustic and the amalgam stream from being bypassed through any gap between the pile of cathodic plates and the shell.

Another important feature of the invention is the amalgam rinse compartment, by which the efficiency of the decomposer and the product purity are enhanced. This compartment consists of a pile of plates 7, the material of which is unreactive with water and alkali amalgam, though they may be quite similar in shape to the cathodic plates already described. Plates 7 are mounted in a shell 8' above the decomposition compartment and separated therefrom by means of a mercury closure 8". The free space between plates 7 may be filled up with dumped pieces 7' of nonconductive material.

The wash water or steam entering the rinse compartment at its bottom through pipe 10 is forced through the openings of plates 7 and countercurrently to the amalgam fed from inlet 12 above the plates. After washing, the amalgam drops in the decomposition chamber through the mercury closure 8" whereas wash water or steam are discharged upwards through the outlet 11.

It is advisable that the holes in each plate be not on a same vertical line with the holes in the nearby plates, in order to secure a widespread contact of the amalgam both with the cathodic material and the caustic solution. When holes are replaced by slots, which may offer some constructional advantages, the slots should be staggered or turned with respect to the slots in the nearby plates.

The trays of cathodic material may also be made with a set of bars or strips of any shape placed on a same plane and spaced at a convenient distance apart from each other.

In order to enhance the subdivision of the amalgam and enlarge the active surface of contact it is profitable to place between the trays some filling material 3' electrically conductive but nonamalgamatable, which in particular may consist of rings or any other shaped pieces of graphite.

Beside flowing through the decomposer by gravity, as previously described, the amalgam can also be passed upwardly. In this last case it is particularly advisable that the openings in the plates, as well as the spacings between the plates, be as small as possible.

I have carried out an experimental work in order to determine which is the best size for the openings in the plates. I have thus ascertained that, in order to obtain best results, the over-all area corresponding to the openings should be less than half the area of the remaining surface, but more than one sixth of this last.

Experimental work has been carried out also in order to determine the best spacing between nearby plates. In fact, if this spacing is too large, the amalgam will remain for an unnecessarily long time in contact only with caustic solution, without bringing about any decomposition. On the other hand, if the spacing between two nearby plates is too small, the amalgam will fill up the major part of it before dropping therefrom, thus pre-

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venting an extensive contact of caustic solution with both amalgam and cathodic material. I have found that the said spacing will most advantageously range from $\frac{1}{16}$ to $\frac{1}{2}$ inch. On the other hand, the best spacing depends also on the minimal size that is given to the openings, inasmuch as spacing should be more than one half of the opening minimal size and less than twofold. As to the opening size, this should be neither less than $\frac{1}{16}$ in., nor more than $\frac{1}{2}$ in.

Beside being perfectly flat and horizontal, the upper and lower surfaces of each plate may also be given a slight slope, so as to favor the passage of the amalgam through the lowest openings and of the hydrogen through the highest ones, thus preventing the two flows from disturbing each other.

The openings in each plate 14 or 15 may advantageously be slightly countersunk as 14' and 15' (Fig. 6) below the level of the upper surface, in order to provide a wider contact area for the chemical reaction to take place. On the other hand, some of the holes may be made to protrude as 14'' and 15'' (Fig. 7) above the surface of the amalgam, in order to favor the escaping of hydrogen through these holes.

When decomposition is carried out in more than one stage, each stage may be composed of a set of conductive but non-amalgamatable parts assembled according to the above described invention.

In a preferred embodiment of the invention the slope may be obtained by giving the trays the conical shape with either the concavity or the convexity facing upwardly.

What I claim is:

1. An apparatus for the decomposition of alkali metal amalgam comprising a shell, means at the upper portion of the shell for introducing alkali metal amalgam into the upper portion of the shell, a plurality of superposed trays of non-amalgamatable cathodic material superimposed in vertically spaced relation in said shell, each of said trays having a plurality of openings therein, non-amalgamatable filling material interposed between the trays, means at the lower portion of the shell beneath said trays for introducing an aqueous medium and discharging mercury, and means at the upper part of said shell for discharging alkali metal hydroxide solution formed in the shell, the surfaces of the trays being slightly sloped and the openings in the lowermost portion of the trays being countersunk below the upper surface of the trays and the openings in the uppermost portion of the trays being surrounded by flanges jutting above the upper surface of the tray.

2. An apparatus for the decomposition of alkali metal

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amalgam comprising a shell, means at the upper portion of the shell for introducing alkali metal amalgam into the upper portion of the shell, a plurality of superposed trays of non-amalgamatable cathodic material superimposed in vertically spaced relation in said shell, each of said trays having a plurality of openings therein, non-amalgamatable filling material interposed between the trays, means at the lower portion of the shell beneath said trays for introducing an aqueous medium and discharging mercury, and means at the upper part of said shell for discharging alkali metal hydroxide solution formed in the shell, the surfaces of the trays being slightly sloped and the openings in the lowermost portion of the trays being countersunk below the upper surface of the trays, and the openings in the uppermost portion of the trays being surrounded by flanges jutting above the upper surface of the tray, the said opening being in the form of slots and slots in each tray being positioned at an angle relatively to the slots of adjacent trays.

3. An apparatus for the decomposition of alkali metal amalgam comprising a shell, means at the upper portion of the shell for introducing alkali metal amalgam into the upper portion of the shell, a series of vertically spaced superposed trays of non-amalgamatable cathodic material in said shell, between the upper and lower portions thereof, providing a series of vertically arranged spaces between the uppermost and lowermost trays, each of said trays having a plurality of openings therein, non-amalgamatable filling material interposed in the spaces between the trays, means at the lower portion of the shell beneath said trays for introducing an aqueous medium and discharging mercury, and means at the upper part of said shell for discharging alkali metal hydroxide solution formed in the shell, the openings in one tray being staggered with respect to the openings in adjacent trays and the ratio of the spacing distance between the trays to the minimum size of the openings ranging from 1:2 to 2:1.

References Cited in the file of this patent

UNITED STATES PATENTS

789,721	Decker	May 16, 1905
2,083,648	Gorke	June 15, 1937
2,423,351	Taylor	July 1, 1947
2,551,248	Deprez et al.	May 1, 1951
2,598,228	Cox	May 27, 1952

FOREIGN PATENTS

24,837	Great Britain	Dec. 27, 1895
310,872	Italy	Sept. 11, 1933