Jan. 27, 1931. K. ROTH 1,790,248

ELECTRODE FOR ELECTROLYTIC CELLS

Filed Jan. 21, 1926 2 Sheets-Sheet 1

Fig. 1.

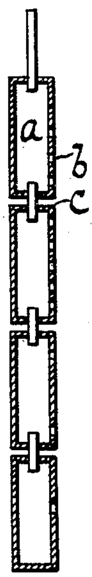


Fig. 2.

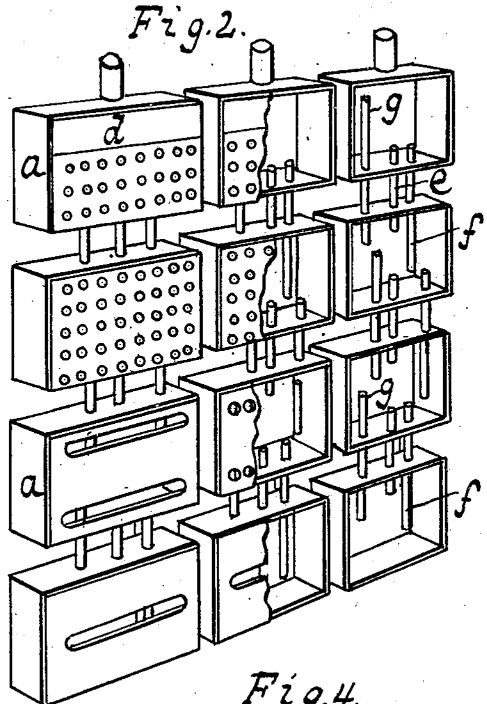


Fig. 3.

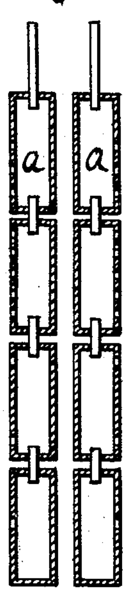
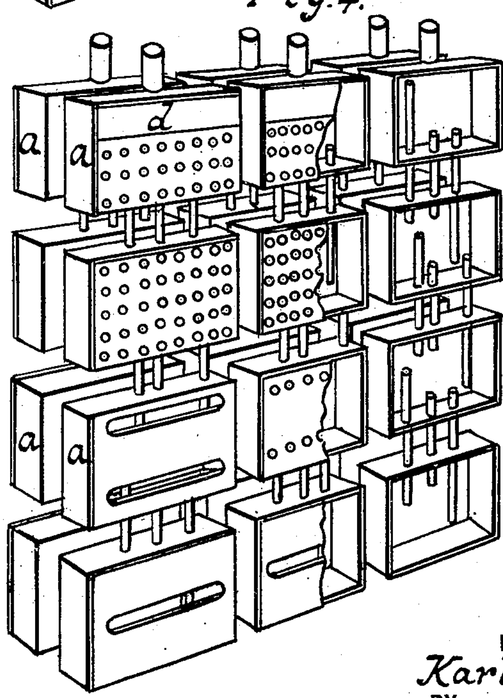


Fig. 4.



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ELECTRODE FOR ELECTROLYTIC CELLS

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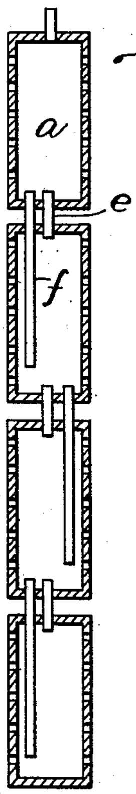
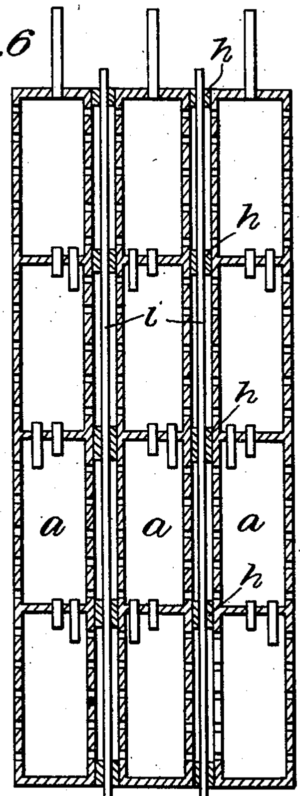


Fig. 5

Fig. 6



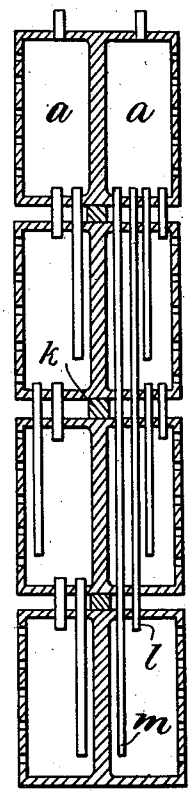


Fig. 7

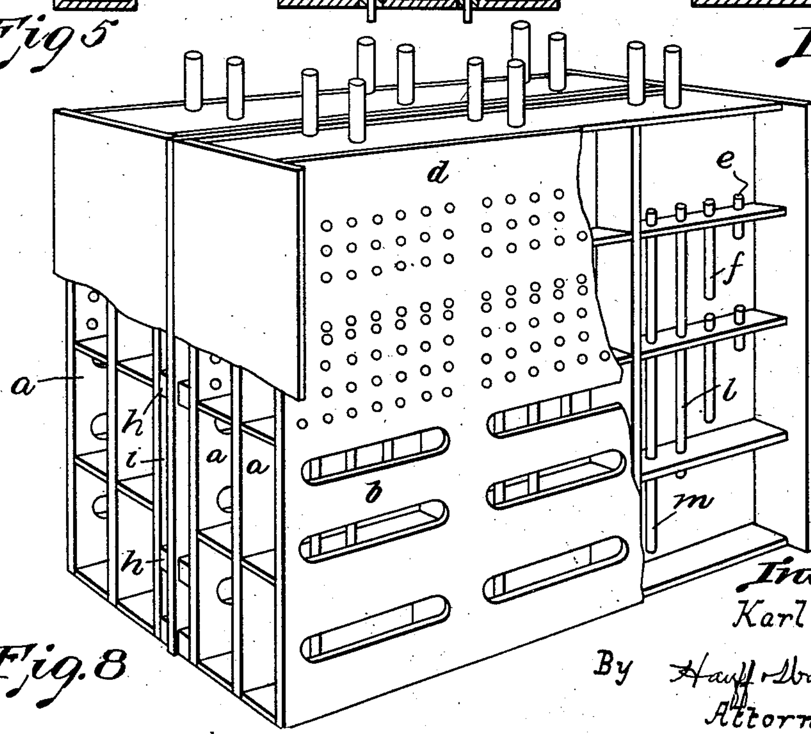


Fig. 8

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UNITED STATES PATENT OFFICE

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ELECTRODE FOR ELECTROLYTIC CELLS

Application filed January 21, 1926, Serial No. 82,761, and in Germany January 22, 1925.

The present invention relates to electrodes for the electrolytic development of gases, especially by the decomposition of water.

My improved electrodes have the advantage that the formation of foam from the electrolyte and the fine gas bubbles formed is avoided to a great extent and units of high capacity can be constructed on a comparatively small floor area.

My invention will be explained with reference to the accompanying drawings which, however, are diagrammatical and to which I do not wish to limit my invention.

Fig. 1 shows a vertical section of one form of my improved electrode. Fig. 2 shows a front perspective view thereof partly broken away. Fig. 3 shows a vertical section of a modified form of my electrode. Fig. 4 is a front perspective view of same. Figs. 5, 6 and 7 are vertical sectional views of some other modifications of my electrode.

The electrode according to my invention consists of a number of pockets *a* arranged one upon another in one or several series. The front wall (*b* in Figure 1) of the pockets fronting the counter-electrode or the diaphragm between the two electrodes is made from metal provided with suitable openings to allow the passage of gas as for example borings or slits, or it may be made from wire-mesh. If both sides of the electrode are to be used for electrolysis, either as a double-side unipolar or as bipolar electrode, both the front- and back-wall of the pocket must be made of metal and permeable for the gases. If only one side is used for electrolysis the pockets are preferably also made wholly of metal though this is not necessary.

The bulk of the gas is developed in the form of fine bubbles at the outer surface of the electrode, part of which passes through the openings of the electrode wall to the interior of the pocket. The rest of the gas bubbles is forced into the interior by suitable guiding devices, for example by horizontal partitions *h* between the electrode and the diaphragm *i* (see Figure 6) which at the same time may serve as supports for the diaphragm. The partitions may be made of any material resistant to the action of the electrolyte. The distance between the said partitions and the upper edges of the pockets may vary in accordance with the construction of the walls of the pockets.

The gases collected in each pocket are led off through the upper wall of the pocket in any suitable manner and are generally introduced into the next higher pocket. The pipes or channels leading the gases off may have any desired cross-section, and preferably their lower end extends a little into the upper part of the lower pocket, the walls of which are correspondingly left impermeable to gases in their upper part. By this construction, the fine gas bubbles rising within the pockets are forced to collect near the top of them to a kind of gas cushion. As soon as additional gas causes said gas cushion to exceed the extension of the pipes or channels into the pocket, gas is discharged in the form of big bubbles through all upper pockets. Thereby the formation of a thick emulsion of the electrolyte with the fine gas bubbles is prevented which not only would give rise to a foam, but would be liable to run back to the outside of the pocket and on account of its reduced conductivity would increase the resistance of the cell. As the quantity of gas increases from below to above, it may be advantageous to increase the number or the cross section of the gas leading pipes or channels in the upper pockets. In some cases it appears convenient not to pass the big gas bubbles successively through all of the upper pockets, but directly into the uppermost one or to the collecting pipe whether by means of pipes or outside said pockets in the spaces between the pockets or for example by prolonged pipes or channels directly running through several of these pockets as indicated in Figure 7.

When gas is discharged from the cushion in a pocket, the bubbles would drag along considerable quantities of the electrolyte contained in that pocket. The resulting vacuum would cause at once fresh electrolyte to be sucked in from other pockets, whereby a mixture of the electrolyte from several pockets in the system is caused. This circulation may be assisted by suitable pipes or channels *f* and *g* which must not necessarily connect vertically adjacent pockets. It may be desirable to connect more remote pockets by means of such pipes *f* and *g* which may be led between or behind or through adjacent pockets (see *m* in Figure 7).

By a suitable arrangement and size of the pipes or channels only small quantities of the emulsion formed of fine gas bubbles and electrolyte are allowed to pass to upper or lower pockets, and moreover a continuous circulation of the electrolyte in all pockets and thereby a uniform concentration of the electrolyte is produced.

The exchange of concentration between anolyte and catholyte may be assisted by arranging the anode pockets and cathode pockets fronting one diaphragm in a vertically staggered relation to each other.

The uppermost pockets may be built as chief gas collecting chambers (see Figures 2 and 4). For this purpose, the upper parts of their side walls must be impermeable to gas.

The hereinbefore described electrode has the advantage that it may be built as a unit for nearly any desired capacity by assembling the required number of pockets in vertical and horizontal direction without any difficulties, as would be caused with other cells by enlarging their size.

The electrodes may be constructed in many different ways. Instead of using one layer of pockets, there may be two layers with their back sides against each other (see Figures 3 and 4) so as to obtain a double-side electrode (Figures 4 and 7) which may be used as a unipolar or as a bipolar electrode. In the latter case, care must be taken that the electrode also secures a separation of the electrolytes and gases of the two adjacent compartments which may be effected by suitable tightenings *k* (Figure 7) between the pockets.

The pockets of an electrode can be made all or in groups of one or a few single pieces, for example of a casting, the front walls of perforated sheet-metal or of wire-mesh or the like being put on afterwards and connected metal to metal to secure good electric conductivity. By this manner of production the metallic contact of the front walls with the source of current is easily effected.

In the case of bipolar electrodes the tightening walls between the pockets may be made of one piece with the frame. Double side unipolar electrodes (Figures 5 and 6) may be made of one layer of pockets with perforated front- and back-walls so as to allow the gases to enter into the pockets.

Or, all pockets may be surrounded by a wall common to all which means an electrode consisting of a great chamber divided into a number of pockets by horizontal and vertical walls. The horizontal walls are provided with pipes or channels, as described above, so as to form gas collecting rooms, and may also be provided with pipes for circulating the electrolyte exactly as when using separate pockets. Figure 6 shows one form of such electrodes.

An arrangement in which two double-side bipolar electrodes are separated from each other by a diaphragm *i* and in which horizontal partitions *h* for forcing the gas bubbles into the interior of the electrode pockets are provided, is shown in Figure 8.

Automatical devices may be arranged for a supply of water for that consumed during the electrolysis so as to maintain a certain quantity of electrolyte in each cell. In order to enable a cooling which when working at great outputs may become necessary, suitable hollow spaces are provided in or between some of the pockets apart from the room containing the electrolyte and filled with a cooling liquid.

I do not claim in this application a double-side unipolar electrode in accordance with my invention specifically, such being claimed in another application which has been divided out from the present one.

I claim:

1. An electrode for the electrolytic development of gases, which consists in a structure comprising a number of pockets arranged one upon another and having metal front-walls permeable to gas and connection pipes between the pockets for leading the gases upwards which pipes extend a little into the upper part of a lower pocket.

2. An electrode for the electrolytic development of gases, which consists in a structure comprising a number of pockets arranged one upon another and having metal front-walls permeable to gas and connection pipes between the pockets for leading the gases upwards which pipes extend a little into the upper part of a lower pocket, and separate pipes for circulating the electrolyte.

3. An electrode for the electrolytic development of gases, which consists in a structure comprising a number of pockets arranged one upon another and having metal front-walls permeable to gas and connection pipes between the pockets for leading the gases upwards, which pipes extend a little into the upper part of a lower pocket, and separate pipes for circulating the electrolyte, the upper edge of the front-wall of each pocket being provided with a guiding device forcing gas bubbles into the interior of the pocket.

4. An electrode for the electrolytic development of gases, which consists in a structure comprising a number of pockets arranged one upon another and having metal front-walls permeable to gas and connection pipes between the pockets for leading the

gases upwards, which pipes extend a little into the upper part of a lower pocket, and separate pipes for circulating the electrolyte, the upper part of the front-wall of the highest pocket of a vertical series being impermeable to gas.

5. An electrode for the electrolytic development of gases, which consists in a structure comprising a frame divided by partitions into a number of pockets, said pockets being provided with metal front-walls permeable to gas and connection pipes between the pockets for leading the gases upwards which pipes extend a little into the upper part of a lower pocket, and separate pipes for circulating the electrolyte.

6. An electrode for the electrolytic development of gases, which consists in a structure comprising a number of pockets arranged one upon another and in two layers with their back walls against each other, the pockets having metal front-walls permeable to gas and connection pipes between the pockets for leading the gases upwards which pipes extend a little into the upper part of a lower pocket, and separate pipes for circulating the electrolyte.

7. A bipolar electrode for the electrolytic development of gases, which consists in a structure comprising a number of pockets arranged one upon another and in two layers with their back walls against each other and which are separated by an impermeable wall, the pockets having metal front-walls permeable to gas and connection pipes between the pockets for leading the gases upwards which pipes extend a little into the upper part of a lower pocket, and separate pipes for circulating the electrolyte.

In testimony whereof I have hereunto set my hand.

KARL ROTH.