

A. PIETZSCH & E. STEINBUCH.  
 PROCESS FOR CONTINUOUS ELECTROLYSIS OF AQUEOUS SOLUTIONS.  
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FIG. 1.

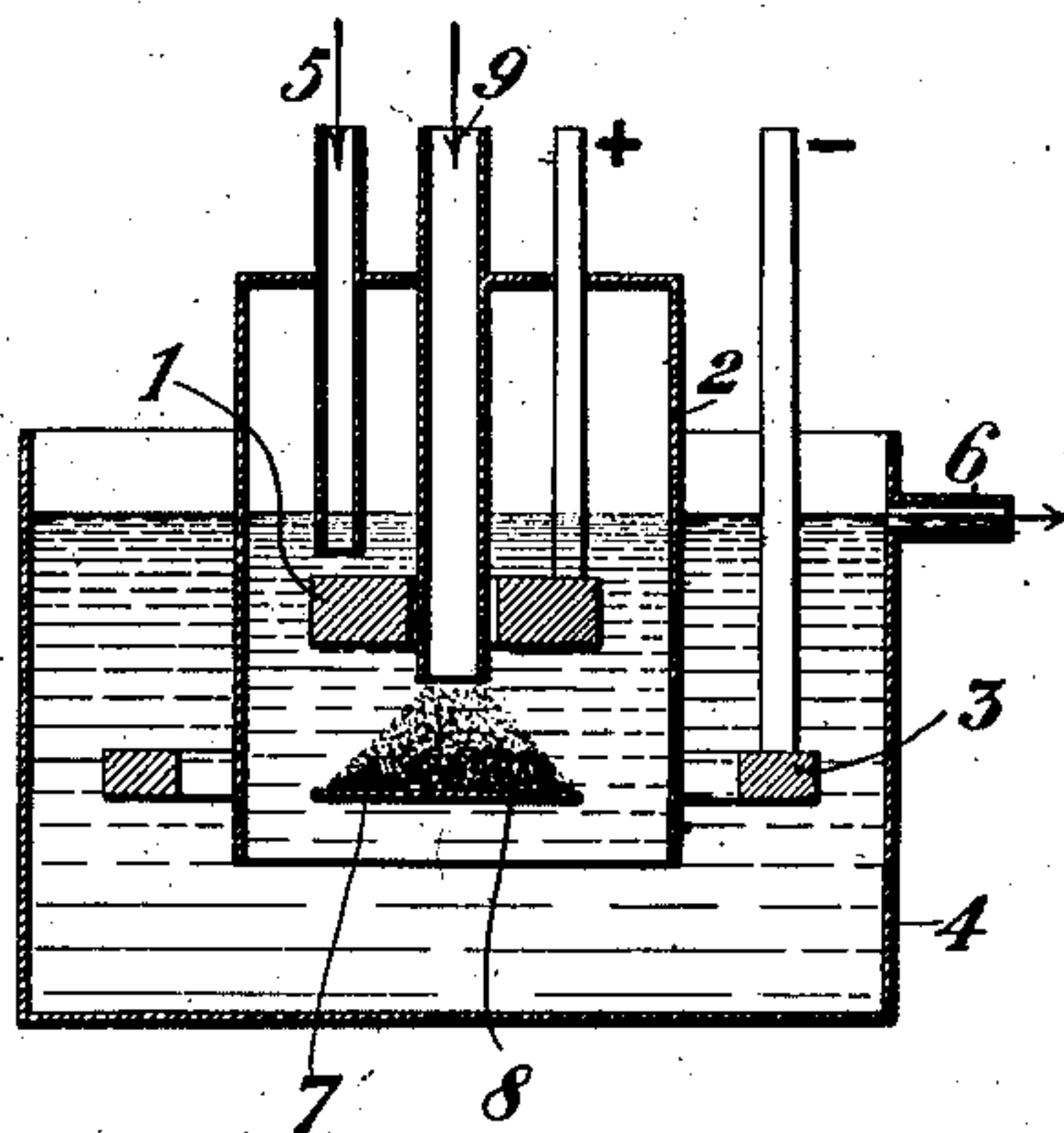
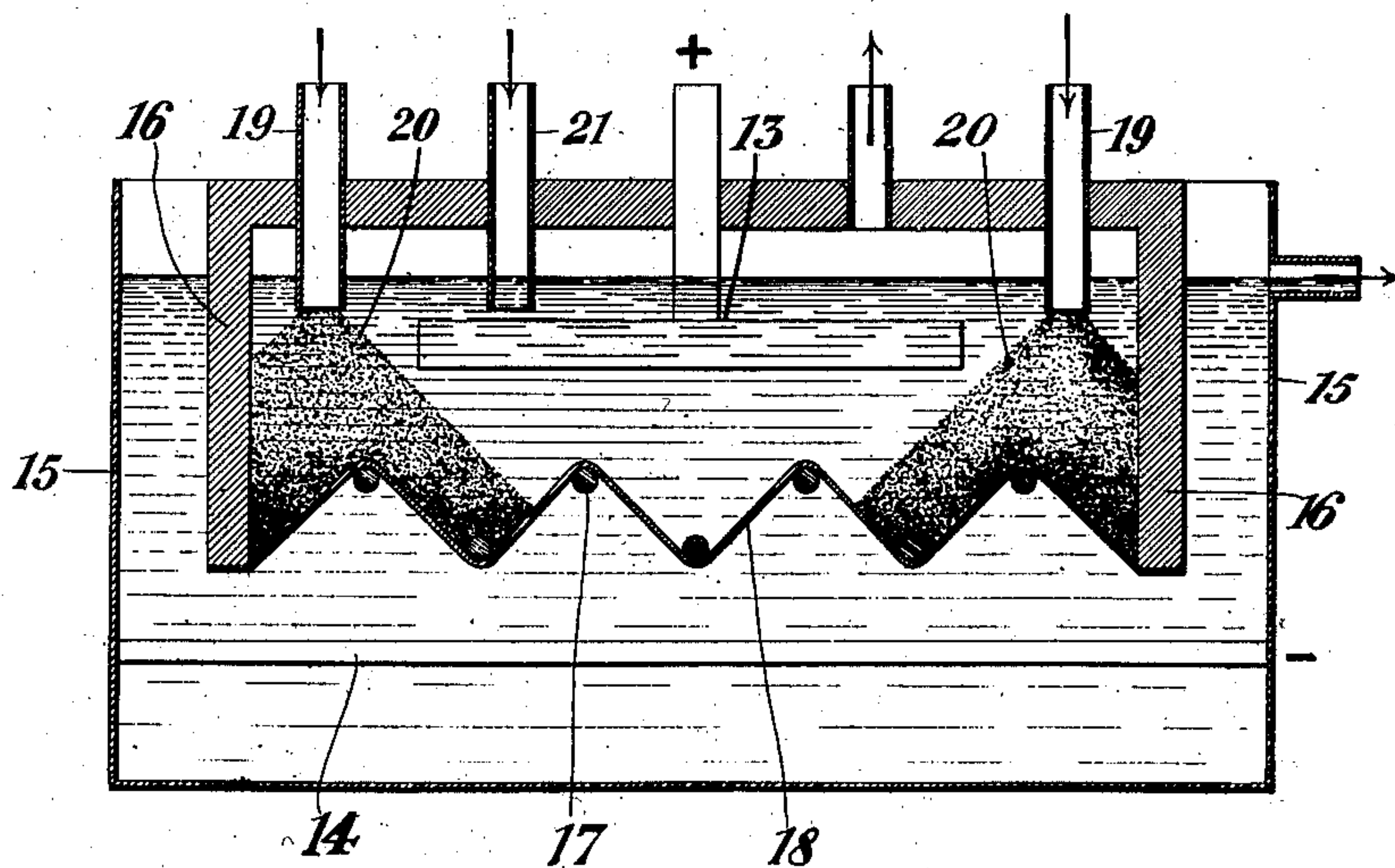


FIG. 2.



Witness:  
*J. B. Winstanley*  
*H. J. McKeever*

Inventors:  
*Albert Pietzsch and*  
*Ewald Steinbuch*  
*By T. H. Kinsey, Attorney*

# UNITED STATES PATENT OFFICE.

ALBERT PIETZSCH, OF TRIBERG, GERMANY, AND EWALD STEINBUCH, OF MONTHEY, SWITZERLAND, ASSIGNORS TO SOCIETY OF CHEMICAL INDUSTRY IN BASLE, OF BASEL, SWITZERLAND.

## PROCESS FOR CONTINUOUS ELECTROLYSIS OF AQUEOUS SOLUTIONS.

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*To all whom it may concern:*

Be it known that we, ALBERT PIETZSCH, electrical engineer, a subject of the King of Saxony, and resident of Triberg, Grand Duchy of Baden, Germany, and EWALD STEINBUCH, electrical engineer, a citizen of the Swiss Republic, and resident of Monthey, Canton of Valais, Switzerland, have invented new and useful Improvements in Processes for Continuous Electrolysis of Aqueous Solutions, of which the following is a full, clear, and exact specification.

In a large number of electrolytic processes working losses occur because the products formed at the electrodes also take part in the conduction of the current, so that undesired migrations of ions occur between the electrode compartments, involving the aforesaid losses. It has been attempted to prevent the passage of undesired ions from one electrode compartment to the other by causing the electrolyte to flow in a direction opposed to the migration of the ions, thus forcing the ions back again and intermixing them with the ions of the fresh electrolyte which take up the transport of the current in the desired manner.

Exact investigation of the bell electrolytic processes has shown that the objectionable migration of the OH-ions is the more surely frustrated, the more Cl-ions are caused to flow with the electrolyte in the direction opposite to the OH-ions migrating from the cathode to the anode, that is to say, the more concentrated the circulating solution is in potassium chlorid or sodium chlorid. Now the solution fed to the electrolytic cell can never be kept saturated because should the temperature fall, blocking of the pipes by crystallization must ensue; moreover, account must be taken of the fact that, in obedience to the laws governing the migration of ions, it is theoretically impossible to maintain the anode solution, even when the feeding arrangements are perfect, of the same concentration as the inflowing solution. Thus if— $a$  is the amount of salt in grams per liter in the electrolyte fed to the cell,  $b$  the amount of salt in the anode compartment in grams per liter,  $c$  the amount of salt in the cathode compartment in grams per liter,  $1_A$  the ionic velocity of the anion,  $1_K$

the ionic velocity of the cathion, the following law is true:—

$$\frac{a-b}{b-c} = \frac{1_K}{1_A}, \quad 55$$

whence—

$$b = \frac{a + c \cdot \frac{1_K}{1_A}}{1 + \frac{1_K}{1_A}} \quad 60$$

From this equation the values for the conditions of the bell process may be calculated to be as follows:—

1. For potassium chlorid solution:—Solution fed to the cell  $a=280$  grams of KCl per liter. Alkali produced=120 grams per liter (equivalent to 160 grams KCl per liter), from which

$$c=280-160=120 \text{ grams per liter.}$$

$$\frac{1_K}{1_A} = \frac{0.497}{0.503} = 0.99, \quad 75$$

wherefore—amount of salt in the anode compartment,  $b=200$  grams per liter, whereas a saturated solution of potassium chlorid contains 300 grams per liter. 80

2. For sodium chlorid solution:—Solution fed to the cell  $a=300$  grams of NaCl per liter. Alkali produced=110 grams per liter (equivalent to 160 grams of NaCl per liter), whence 85

$$c=300-160=140 \text{ grams per liter.}$$

$$\frac{1_K}{1_A} = \frac{0.396}{0.604} = 0.655, \quad 90$$

wherefore—amount of salt in the anode compartment,  $b=224$  grams per liter, whereas a saturated solution of sodium chlorid contains 315 grams per liter.

The concentration of the salt solution flowing from the anode compartment to the cathode compartment is, therefore, owing to the alkali content of the lye produced, little more than 100 grams per liter which is essentially lower than that of a saturated solution. It follows that an improvement in the yield and concentration of alkali can be effected if arrangements are provided for saturating the electrolyte between the anode



compartment and the cathode compartment with salt. This improvement forms the subject matter of the present invention. The most simple mode is to cause the electrolyte to flow through solid salt or, at all events to flow over solid salt, the latter being supplied continuously.

In the accompanying drawing Figure 1 is a diagrammatic section through an electrolytic cell operated in accordance with the invention. Fig. 2 is a diagrammatic sectional view of a different form of our invention which it is intended to use in practice.

1 is the anode, 2 the bell, 3 the cathode, 4 the cathode container, 5 the electrolyte feed pipe, 6 the overflow, 7 a plate of non-conducting material situated beneath the anode and adapted to receive the solid salt 8 fed through the pipe 9. The solution flowing from the anode and containing a low percentage of salt becomes saturated at 8 so that as it flows to the cathode it contains an essentially increased proportion of Cl-ions which surely catch the OH-ions migrating upward from the cathode.

Having regard to the diminution of the electrolyte due to evolution of gas and evaporation this new method produces the following conditions in the distribution of salt:—

1. For potassium chlorid:—Solution fed to the salt,  $a=280$  grams of KCl per liter. KCl in the anode compartment,  $b=102$  grams per liter. Solid salt fed to the cell= $168$  grams per liter. Solution flowing from the anode to the cathode contains 270 grams of KCl per liter. Lye discharged from the cell contains 300 grams KOH and 104 grams of KCl per liter.

2. For sodium chlorid:—Solution fed to the cell 300 grams NaCl per liter. Amount of salt in the anode compartment,  $b=151$  grams of NaCl per liter. Solid salt fed to the cell= $164$  grams per liter. Solution flowing from the anode to the cathode= $315$  grams of NaCl per liter. Lye discharged contains 300 grams of NaOH and 112 grams of NaCl per liter.

The foregoing examples show that the solutions which come into question for catching the OH-ions at concentrations of the lye which are 2.5 times higher than in the ordinary bell processes are still considerably richer in Cl-ions so that even at high concentrations satisfactory yields are insured.

For the practical construction of the decomposing cell the arrangement shown in Fig. 2 may be used. 13 is the anode, 14 the cathode which is conductingly connected with the iron container 15. 16 represents two partitions of non-conducting material separating the anode compartment from the cathode compartment and between these partitions there is stretched over non-conducting rods 17 a porous fabric 18 which has a zigzag form and closes the bottom of the anode compartment. On to this fabric salt 20 is charged through the pipes 19. The salt solution flowing into the cell through pipe 21, after it has become partially impoverished at the anode, flows partly through the salt 20 and partly over this salt, and there is formed over the fabric 18 a layer of concentrated salt solution which passes through the fabric to the cathode compartment and thus prevents migration of the OH-ions formed at the cathode into the anode compartment. The gas generated at the cathode is caught by the corrugations of the fabric and led away laterally.

What we claim is:

1. The process of electrolyzing salt solutions which consists in continuously causing to continuously flow through an anode chamber past an anode into a cathode chamber past a cathode; and in causing said electrolyte to pass through a supply of the solid salt to be electrolyzed after leaving said anode and before it reaches said cathode, substantially as described.

2. The process of electrolyzing salt solutions which consists in causing an electrolyte to continuously flow through an anode chamber past an anode into a cathode chamber past a cathode; in causing said electrolyte to pass through a supply of the solid salt to be electrolyzed after leaving said anode and before it reaches said cathode; and in resupplying said solid salt, as fast as it is dissolved by said electrolyte, substantially as described.

In witness whereof we have hereunto signed our names this 5th day of November 1909, in the presence of two subscribing witnesses.

ALBERT PIETZSCH.  
EWALD STEINBUCH.

Witnesses:

GEO. GIFFORD,  
AMAND RITTER.