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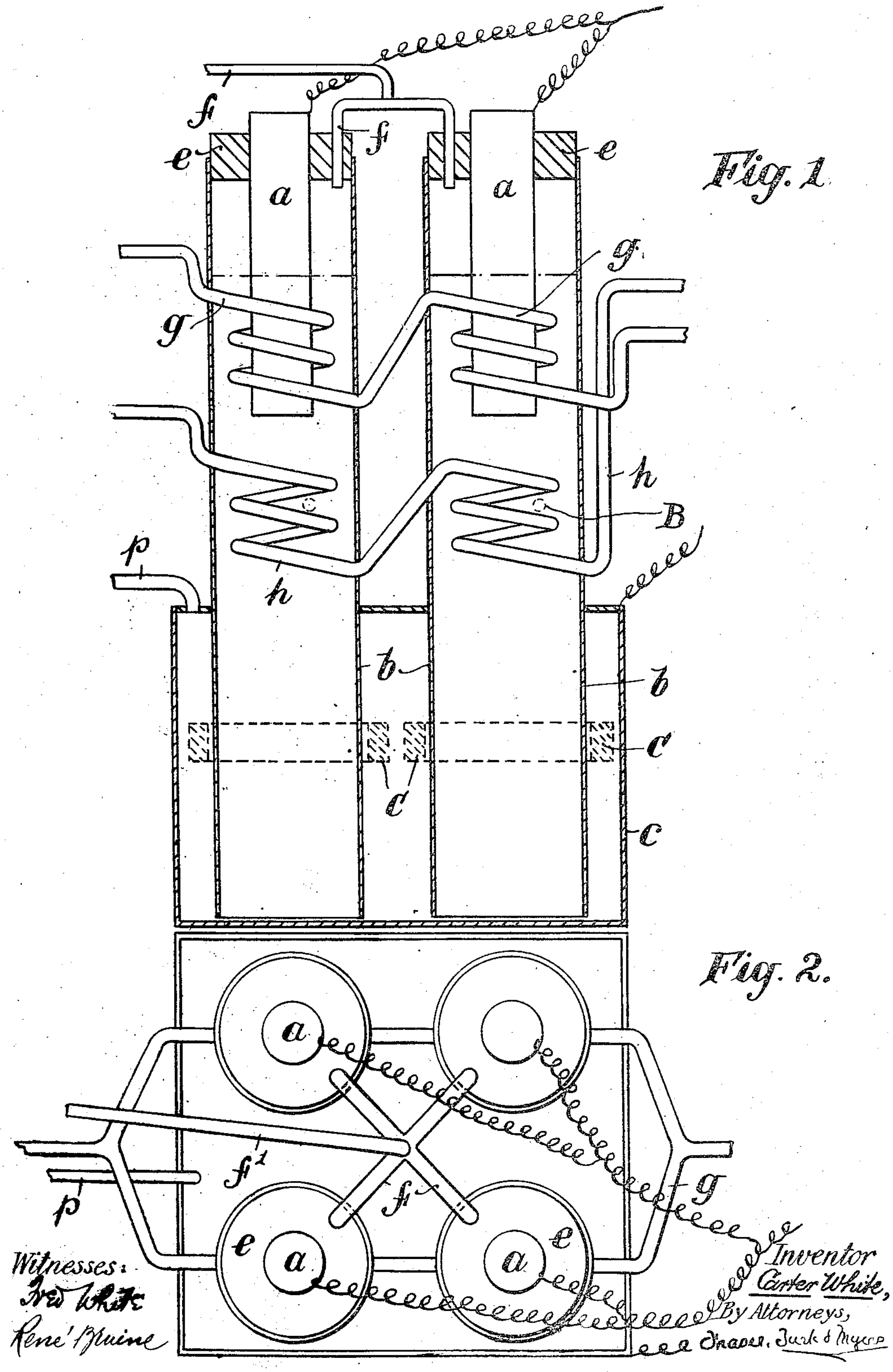
ELECTROLYTIC PROCESS AND APPARATUS.

APPLICATION FILED OCT. 7, 1913

**1,096,085.**

Patented May 12, 1914.

3 SHEETS—SHEET 1.



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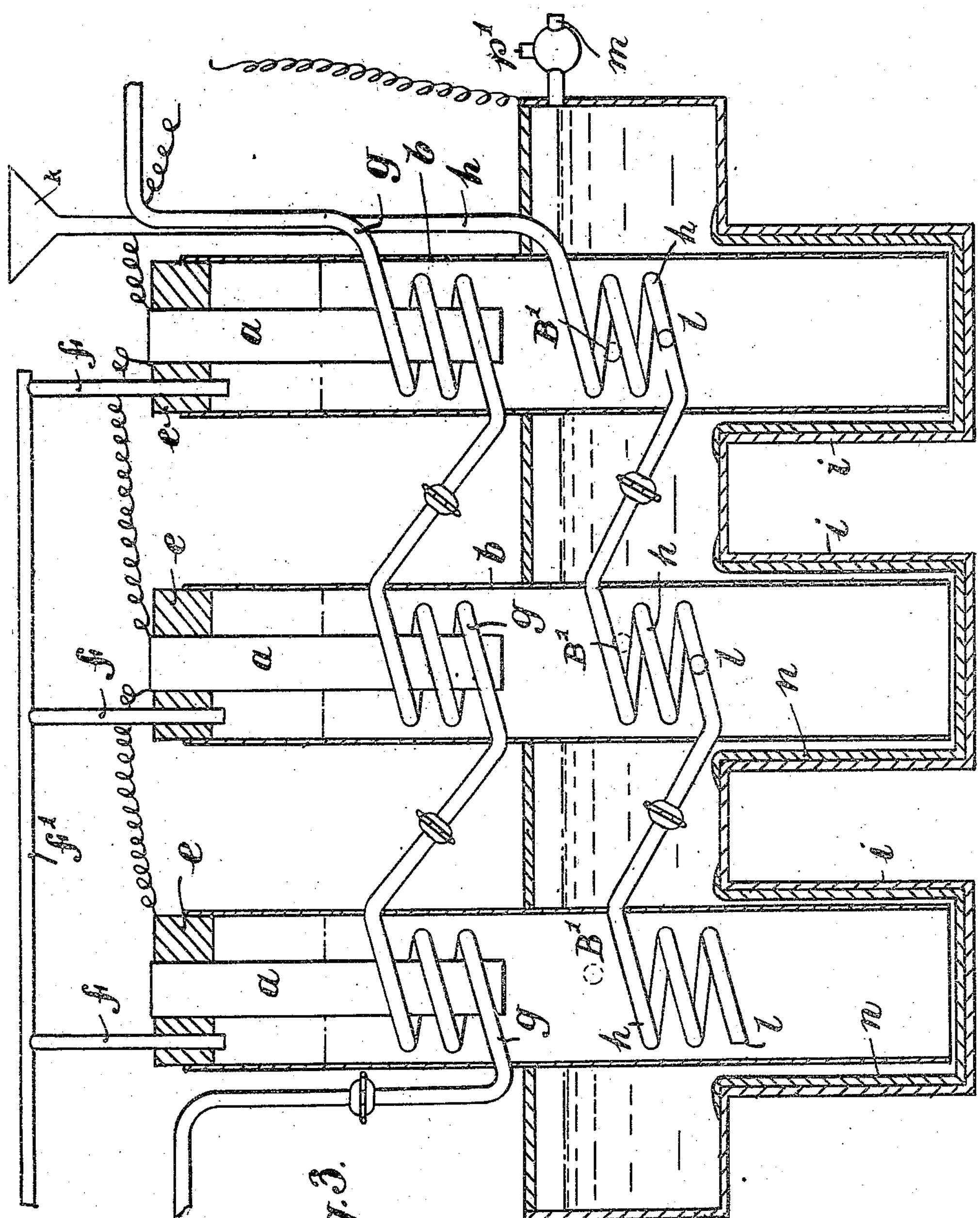

Fig. 3.

Witnesses:

Fred White

René Bruine

Inventor:

Carter White,

By Attorneys,

Fraser, Turk & Myers

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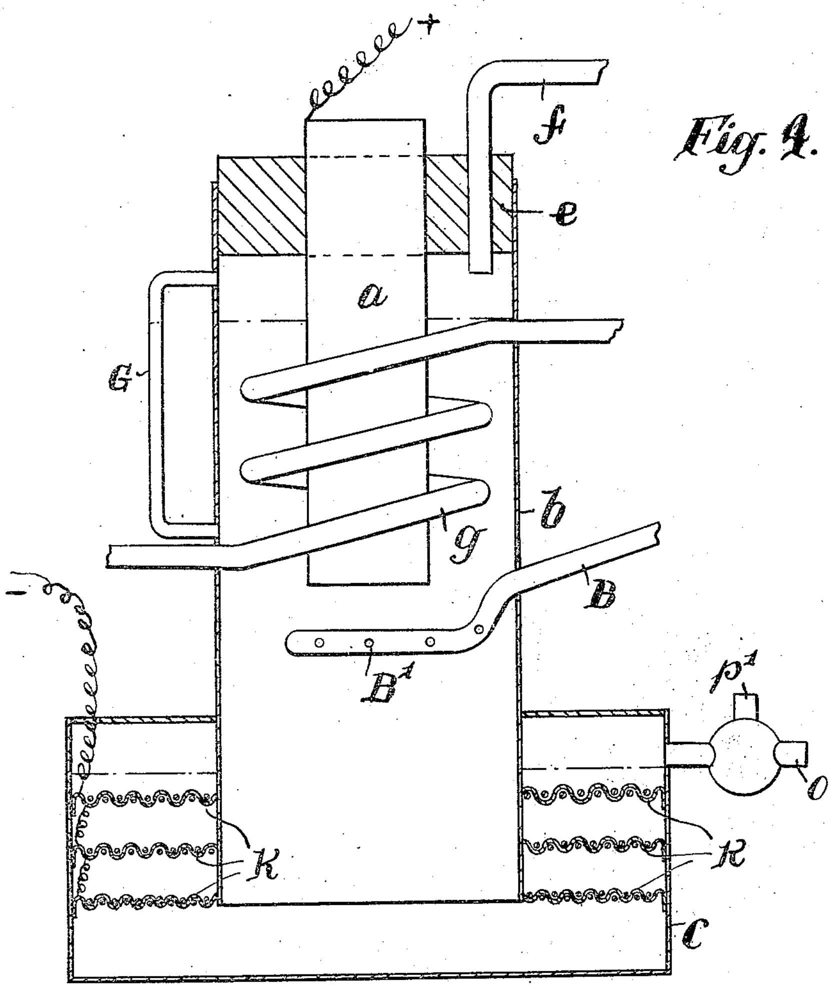
Fig. 4.




Witnesses:
Fred. White,
René Bruine

Inventor:
Carter White,
By Attorneys,
Fraser, Turk & Myers

# UNITED STATES PATENT OFFICE.

CARTER WHITE, OF LONDON, ENGLAND.

## ELECTROLYTIC PROCESS AND APPARATUS.

1,096,085. Specification of Letters Patent. Patented May 12, 1914.

Application filed October 7, 1913. Serial No. 793,884.

*To all whom it may concern:*

Be it known that I, CARTER WHITE, of 18 Old Swan Lane, in the city of London, England, chemist, have invented certain new and useful Improvements in or Relating to Electrolytic Processes and Apparatus, of which the following is a specification.

This invention relates to the electrolysis in simple cells (*i. e.* without diaphragms) of solutions that evolve a gaseous anion liable to redissolve in or be taken up by the electrolyte, and the object of the invention is more effectively to remove such gaseous anion and restrain the same from being taken up again by the electrolyte, while enabling the electrolysis to be conducted economically and with a good output.

The invention is particularly intended for application to the electrolysis of solutions of sodium or potassium chlorid in simple cells, where, as is known, the chlorin liberated at the anode tends to dissolve in the bath and form hypochlorite, chlorate, or other complex chlorin compounds. This dissolving of chlorid in the electrolyte can be obviated or substantially reduced by means of the present invention.

The invention is not restricted to the electrolysis of sodium or potassium chlorid solutions, but may be employed in any other cases where it is desirable to remove from an electrolyte a gaseous anion liberated in the electrolysis, in order to prevent the same from dissolving in or reacting with the electrolyte.

As another example the invention may be employed for the electrolysis of sodium or potassium nitrate solutions.

I will describe the invention as applied for the electrolysis of a solution of chlorid of sodium or potassium.

According to the invention I apply local heat and exhaust to a portion of the electrolyte (*i. e.* the anolyte) contained near the anode in an anode chamber communicating below the anode with the electrolyte in the cell outside, without interposition of a diaphragm. The locally heated portion of the electrolyte is drawn up around the anode above the level of the electrolyte in the cell, by the exhaust which is applied for drawing away the gaseous anion. A pump, exhauster, or any other suitable means may be employed for drawing away the chlorin and may serve to draw the electrolyte up around the anode in the anode chamber as before mentioned to permit the heat to be applied to this portion above the level of the liquid in the cell. By the combined effect of the local heating of the portion of the electrolyte near the anode and of the exhausting action exerted above the same, the chlorin can be quickly and effectively removed as liberated. With a view to assisting further in the attainment of this object I may cool the liquid below or in the neighborhood of the heated portion, so as to confine the heat more closely to the electrolyte in the neighborhood of the anode. If desired the brine or other solution to be electrolyzed may itself be used for cooling the electrolyte in the chambers below the heated portions.

In carrying the invention into effect I may arrange in the cell one or more anode tubes depending into the electrolyte and connected at top to a pump or other means for drawing off or exhausting the chlorin evolved and provided or each provided with a heating coil, electric resistance, or other means adapted to heat the liquid at or near the anode, and I may also with advantage provide each tube with a cooling coil jacket, or other cooling means arranged to cool the liquid below the anode so as further to prevent the possibility of the heated portion of the liquid mixing with the body of the electrolyte. A cathode or cathodes may be suitably disposed in the cell, or the walls of the cell may themselves form the cathode.

The process may if desired be worked continuously and this will in fact be usually the case. For example the caustic soda solution formed in the electrolysis of sodium chlorid solution may be run off from the vessel and may be replaced by fresh chlorid solution run in to keep the electrolyte up to strength. The fresh chlorid solution may be run in through coils or cooling jackets before referred to, or direct into the anode tubes below the heated portion.

A single anode tube may be used according to the invention but in practice a number of them will usually be employed in one cell.

I will proceed to describe some examples of apparatus constructed according to the invention, reference being had to the accompanying diagrammatic drawings, in which,

Figure 1 is a diagrammatic section and Fig. 2 a diagrammatic plan illustrating one form of apparatus, Fig. 3 a diagrammatic section illustrating another form and Fig. 4 a similar section illustrating a third form of apparatus according to the invention.

In the form shown in Figs. 1 and 2, *a a* represent anodes of carbon or other suitable material disposed in the upper portion of tubes *b* of glass, glazed earthenware, or other unattackable material, which extend into the cell *c* containing the solution to be electrolyzed, say brine, the portion of the tube in which the anode is situated being above the level of the liquid in the cell *c*, which in the example shown is of iron or other suitable metal and serves as the cathode. The tubes *b b* are closed at top by wooden or other plugs *e* and are connected by pipes *f′* to a pump or exhauster of any convenient kind for drawing away the chlorin. It will be seen that when the exhauster is in action, the liquid will be drawn up into the tubes around he anode above the liquid level in the cell, as indicated in Fig. 1.

*g g* are heating coils disposed around the anodes in the tubes and supplied with steam or other heating medium.

*h h* represent cooling coils disposed below the anode and supplied with a flow of cold water or other cooling fluid.

The top of the cell between the anode tubes is shown as closed and provided with a pipe *p* for leading away the hydrogen liberated by the electrolysis. If desired a slight suction may be applied to facilitate the removal of the hydrogen.

In operation, when the cell is charged with brine or other liquid to be electrolyzed and the current is supplied to the cell, chlorin will be expelled from the portions of the liquid around the anode by the action of the heat (which may be such as to keep the liquor close to the anode near the boiling point) and will be drawn away by the exhauster, and it will be seen that although the liquid in the tubes communicates freely with that in the cell the hot liquid cannot mix to any substantial extent with the cooler liquid below, so that the chlorin is prevented or restrained from dissolving in the electrolyte and forming hypochlorate, chlorate, or other undesired compounds. Thus an hydroxid solution may be obtained which is free or freer than hitherto from hypochlorites or other impurities.

For continuous working, the brine or liquid to be electrolyzed will be admitted in a regulated stream to the anode tubes at a convenient point, for example through openings B shown in dotted lines, and the inflowing current may then serve to cool the liquid below the anodes, without using cooling coils. Or the liquid to be electrolyzed may be admitted through the cooling coils which may then discharge into the anode tubes.

In the form of apparatus for continuous working illustrated in Fig. 3, a number of anode tubes *b* such as above described are arranged so as to depend each into a well *i* in the bottom of the cell, and are provided with heating coils *g* around the anodes and with cooling coils *h* and chlorin pipes *f f′* as before. The electrolyte is supplied continuously to the cell to keep the bath up to strength, and here itself serves for cooling the liquid below the anodes. For this purpose it is supplied in a suitably regulated stream to the funnel *k* whence it flows through the cooling coils *h* in the tubes *b* and issues at *l l* into the anode tubes or it may be into the cell. Or if desired the liquid to be electrolyzed may be admitted direct into the anode tubes through openings such as shown in dotted lines at B′ without or with the employment of cooling coils supplied with a separate cooling liquid. The caustic soda solution formed runs off from the cell by the overflow outlet *m* and the hydrogen escapes or is drawn away by a slight suction through the pipe *p′*.

In Fig. 3 the anodes and heating coils are disposed above the liquid in the cell as in Fig. 1, and the exhauster will create sufficient suction to raise the electrolyte to a corresponding height in the tubes.

The wells *i* of the iron cell which forms the cathode may be formed of or lined with cement or other non-conducting material as indicated at *n* in order that hydrogen liberated in the electrolyzing operation may be kept away from the wells into which the tubes depend.

In some cases I may provide a heat insulating covering of asbestos or other heat insulating means around the heated portion of the anode tubes especially if any part of this heated portion should lie below the level of the liquid outside in the cell. I may also employ separate cathodes instead of using the cell itself as a cathode. For example I may employ annular cathodes, such as indicated in dotted lines at C, Fig. 1, around the anode tubes and situated at a suitable level. Or the cathode may consist of wires, wire gauze, rods or the like of iron, nickel or other suitable metal. The cathode of whatever kind, may be disposed or provided near the open lower end of the anode tubes, but preferably around or not opposite the mouth of same, as otherwise the hydrogen liberated at the cathode would tend to rise into the anode tube and be drawn away with the chlorin or gaseous anion. Such cathode may be separate or be formed by the wall of the cell itself by making this of a suitable metal.

In the form of apparatus illustrated in Fig. 4, *b* represents an anode tube of earthenware or the like extending below the level of the electrolyte in a cell *c* of slate or other insulating material, and fitted at its upper part with an anode *a* surrounded by a steam heating coil *g* as before, a pipe *f* being likewise provided for connection to an exhauster for drawing up the electrolyte around the anode in the tube and drawing off the chlorin. G is a gage for indicating the level of the liquid in the pipe *b*. The brine is supplied by a pipe B terminating in a perforated coil B′ which discharges the brine in the tube *b* below the anode *a*. In this case the cathode consists of one or more wire gauze sheets K of nickel, iron or other suitable metal (three are shown) disposed around the anode tube between same and the wall of the cell and near the lower end of the anode tube. It will be understood that any desired number of anode tubes thus arranged and provided with heating coils, brine supply pipes and suction pipes may be employed in one cell, and the cathode sheets K may be common to all the anode tubes, being formed with holes to accommodate them, or separate cathode sheets may be employed for each anode tube. Instead of wire gauze sheets K wires, rods or other suitable devices may be employed.

O repsesents an overflow outlet for the electrolyte from the cell and the hydrogen can escape or be drawn away with slight suction by the pipe *p*′. The hydroxid solution that passes away at O may be led away for further treatment as required.

It is to be understood that the forms of apparatus illustrated are given by way of example only, and that any other suitable arrangements may be employed based upon the application of combined heat and exhaust to a portion of electrolyte contained near the anode in an anode chamber communicating below with the electrolyte in the cell, without the interposition of a diaphragm.

By means of the invention in the electrolysis of sodium or potassium chlorid solutions, the chlorin liberated can be so efficiently separated and removed from the electrolyte without necessity for quickly removing or leading away the caustic liquor formed that it is possible to produce liquors or relatively high concentration in a practical and reliable manner. Moreover it is possible by the invention to work with a low expediture of current and with a high efficiency of cell.

If desired, carbonic acid gas may be led in to the electrolyte in the cell during the operation, so as to combine with the caustic soda or caustic potash produced by the electrolysis and form sodium or potassium carbonate. When the invention is applied to the electrolysis of solutions of sodium or potassium nitrate, similar apparatus to that above described may be employed. The nitrogen oxid or oxids liberated at the anode or anodes will be removed, and a solution of caustic soda or caustic potash will be formed by the electrolysis. In this case also, carbonic acid gas may be led into the bath to form corbonate if so desired.

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

1. Process for the electrolysis in non-diaphragm cells of sodium or potassium chlorid or nitrate or other solutions which evolve a gaseous body at the anode, comprising the application of local heat and exhaust to a portion of the electrolyte contained near the anode in an anode chamber communicating below the anode with the electrolyte in the cell outside, the locally heated portion of the electrolyte being drawn up around the anode above the level of the electrolyte in the cell by the exhaust substantially as described.

2. Process for the electrolysis in non-diaphragm cells of sodium or potassium chlorid or nitrate or other solutions which evolve a gaseous body at the anode, comprising the application of local heat and exhaust to a portion of the electrolyte contained near the anode in an anode chamber communicating below the anode with the electrolyte in the cell outside, the locally heated portion of the electrolyte being drawn up around the anode above the level of the electrolyte in the cell by the exhaust and cooling the solution below the locally heated portion for the purpose of confining the heat more closely to the portion of the solution in the immediate neighborhood of the anode, substantially as described.

3. Process for the electrolysis in non-diaphragm cells of sodium or potassium chlorid or nitrate or other solutions which evolve a gaseous body at the anode, comprising the application of local heat and exhaust to a portion of the electrolyte contained near the anode in an anode chamber communicating below the anode with the electrolyte in the cell outside, the locally heated portion of the electrolyte being drawn up around the anode above the level of the electrolyte in the cell by the exhaust, and cooling the solution in the chamber below the locally heated portion by means of the liquid to be electrolyzed, substantially as and for the purpose described.

4. Process for the electrolysis in non-diaphragm cells of sodium or potassium chlorid or nitrate or other solutions which evolve a gaseous body at the anode, comprising the application of local heat and exhaust to a portion of the electrolyte contained near the

anode in an anode chamber communicating below the anode with the electrolyte in the cell outside, the locally heated portion of the electrolyte being drawn up around the anode above the level of the electrolyte in the cell by the exhaust, and cooling the solution in the anode chamber below the locally heated portion by delivering the liquid to be electrolyzed into the anode chamber at a point below the anode, substantially as described.

5. Apparatu for use in the electrolysis of solutions of the character referred to, comprising an anode-containing tube depending into an electrolytic cell and open to the liquid in the cell at a point below the anode, an anode in said tube, means for heating the electrolyte in the neighborhood of the anode, and means for removing the gaseous anion and drawing up the locally heated portion of the electrolyte around the anode substantially as described.

6. Apparatus for use in the electrolysis of solutions of the character referred to, comprising an anode-containing tube depending into an electrolytic cell and open to the liquid in the cell at a point below the anode, an anode in said tube, heating coil for heating the electrolyte in the neighborhood of the anode, and means for removing the gaseous anion and drawing up the locally heated portion of the electrolyte around the anode substantially as described.

7. Apparatus for use in the electrolysis of solutions of the character referred to, comprising an anode-containing tube depending into an electrolytic cell and open to the liquid in the cell at a point below the anode, an anode in said tube, means for heating the electrolyte in the neighborhood of the anode, and a pump for removing the gaseous anion and drawing up the locally heated portion of the electrolyte around the anode substantially as described.

8. Apparatus for use in the electrolysis of solutions of the character referred to, comprising an anode-containing tube depending into an electrolytic cell and open to the liquid in the cell at a point below the anode, an anode in said tube means for heating the electrolyte in the neighborhood of the anode, and means for removing the gaseous anion and drawing up the locally heated portion of the electrolyte around the anode and means for cooling the liquid in the anode tube at a point below the locally heated portion of electrolyte substantially as described.

9. Apparatus for use in the electrolysis of solutions of the character referred to, comprising an anode-containing tube depending into an electrolytic cell and open to the liquid in the cell at a point below the anode, an anode in said tube means for heating the electrolyte in the neighborhood of the anode, and means for removing the gaseous anion and drawing up the locally heated portion of the electrolyte around the anode and means for admitting the liquid to be electrolyzed to the anode tube at a point below the locally heated portion of electrolyte substantially as described.

10. Apparatus for use in the electrolysis of solutions of the character referred to, comprising an anode-containing tube depending into the electrolytic cell and open at bottom, an anode mounted in the said tube and extending downward, means for drawing up the electrolyte around the anode in the tube and removing the gaseous anion, means for heating the electrolyte around the anode, and a cathode surface near the open lower end of the anode tube, substantially as described.

11. Apparatus for use in the electrolysis of solutions of the character referred to, comprising an anode-containing tube depending into the electrolytic cell and open at bottom, an anode mounted in the said tube and extending downward means for drawing up the electrolyte around the anode in the tube and removing the gaseous anion, means for heating the electrolyte around the anode, and a cathode surface near the open lower end of the anode tube but not opposite the same, substantially as described.

12. Apparatus for use in the electrolysis of solutions of the character referred to, comprising an anode-containing tube depending into the electrolytic cell and open at bottom, an anode mounted in the said tube and extending downward means for drawing up the electrolyte around the anode in the tube and removing the gaseous anion, means for heating the electrolyte around the anode, and a cathode surface near the open lower end of the anode tube, and a pipe for admitting liquid to be electrolyzed to the anode tube at a point below the anode.

13. Apparatus for use in the electrolysis of solutions of the character referred to, comprising an anode-containing tube depending into the electrolytic cell and open at bottom, an anode mounted in the said tube and extending downward, means for drawing up the electrolyte around the anode in the tube and removing the gaseous anion, means for heating the electrolyte around the anode, and a cathode of foraminous metal disposed near the open lower end of the anode tube, substantially as described.

14. Apparatus for use in the electrolysis of solutions of the character referred to, comprising an anode-containing tube depending into the electrolytic cell and open at bottom, an anode mounted in the said tube and extending downward, means for drawing up the electrolyte around the anode in the tube and removing the gaseous anion, a heating coil for heating the electrolyte around the anode, a cathode of foraminous metal disposed around the anode tube near

the open lower end thereof, and a pipe for admitting liquid to be electrolyzed to the anode tube at a point below the anode, substantially as described.

15. Process for electrolyzing solutions by applying local heat and exhaust to the anolyte whereby to draw off the gases evolved at the anode.

16. Process for electrolyzing solutions by applying local heat and exhaust to the anolyte, and cooling the electrolyte beyond the locally heated portion.

17. Apparatus for use in electrolyzing solutions, comprising an anode chamber depending into the electrolyte, means for heating the anolyte in such chamber, and means for establishing suction in such chamber above the solution for lifting the anolyte and removing the gaseous anion.

18. Apparatus for use in electrolyzing solutions, comprising an anode chamber depending into the electrolyte, means for heating the anolyte in such chamber, means for establishing suction in such chamber above the solution for lifting the anolyte and removing the gaseous anion, and means for cooling the electrolyte beneath such chamber.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

CARTER WHITE.

Witnesses:

ROBERT MILTON SPEARPOINT,

THOMAS L. WHITEHEAD.