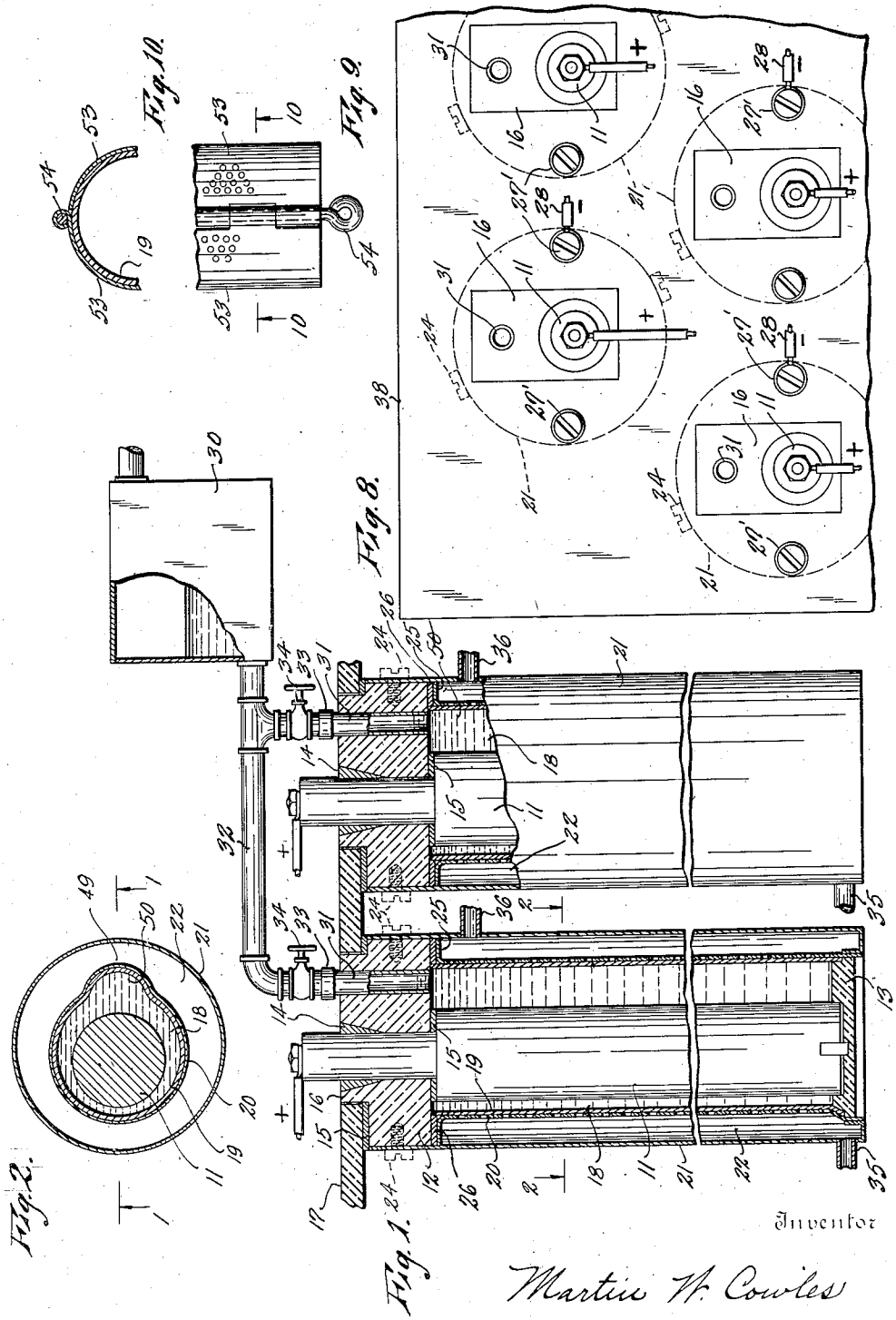
Dec. 8, 1925. 1,564,406

M. W. COWLES

ELECTROLYTIC CELL

Filed May 2, 1924 2 Sheets-Sheet 1



Inventor

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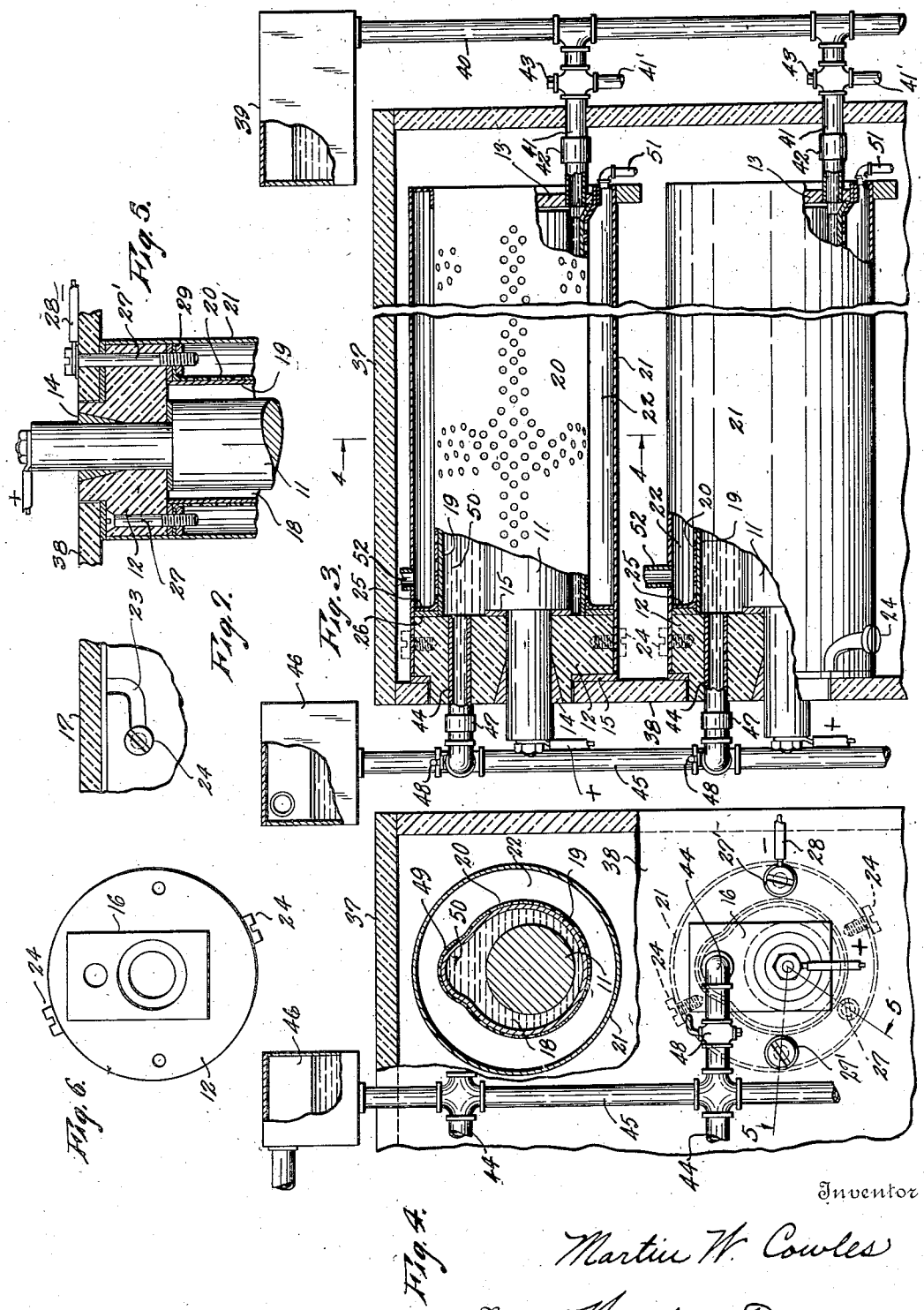


Fig. 5.

Fig. 2.

Fig. 3.

Fig. 6.

Fig. 4.

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1,564,406

UNITED STATES PATENT OFFICE.

MARTIN W. COWLES, OF FAIRFIELD, CONNECTICUT.

ELECTROLYTIC CELL.

Application filed May 2, 1924. Serial No. 710,572.

To all whom it may concern:

Be it known that I, MARTIN W. COWLES, a citizen of the United States, residing at Fairfield, county of Fairfield, State of Connecticut, have invented a new and useful Electrolytic Cell, of which the following is a specification.

This invention relates to electrolytic cells for the electrolysis of various salt solutions such as sodium chloride to secure caustic soda and chlorine for any desired purpose.

It is an object of the invention to provide a cell of this type which may be more easily repaired, and in which a portion of the cell may be cut out of service for this purpose but the remainder of the cell may remain in service.

It is also an object of the invention to produce a cell which will not require a large amount of the salt solution for a given capacity, so that in starting the operation it will not require a great amount of time to bring the cell to capacity, or when discontinuing service the production of chlorine will be discontinued in a shorter time.

It is a further object of the invention to provide a construction in which any desired capacity of cell may be produced without requiring different sized elements, but in which cells having different capacities may be built with the same elements.

With the foregoing and other objects in view, I have devised the construction illustrated in the accompanying drawings forming a part of this specification, the showing being merely illustrative of the preferred form of my invention as understod at the present time. I make the cell of a plurality of individual units, each unit being complete in itself and capable of carrying out the electrolysis of the salt solution.

In the drawings,

Fig. 1 shows a portion of a cell made according to my invention, there being two units shown, one in longitudinal section and the other in partial elevation, the units being arranged in the vertical position, the section being taken substantially on line 1—1 of Fig. 2.

Fig. 2 is a transverse section through a unit substantially on line 2—2 of Fig. 1.

Fig. 3 is a section through a portion of a cell showing the units arranged in substantially horizontal relation, a portion of the units being broken away to more clearly show the construction.

Fig. 4 is a partial front elevation looking from the left of Fig. 3 and a transverse section through a unit substantially on line 4—4 of Fig. 3.

Fig. 5 is a detail section of the front end of a unit taken substantially on line 5—5 of Fig. 4.

Fig. 6 is an end elevation of one of the units.

Fig. 7 is a detail section showing a form of removable connection, which may be employed for the outer casing of a unit.

Fig. 8 is a front elevation of a cell showing a slightly different arrangement of the units.

Fig. 9 is a side elevation showing a detail of a separable shield which may be employed, and

Fig. 10 is a transverse section substantially on line 10—10 of Fig. 9.

This electrolytic cell is made up of a plurality of individual units, each unit being complete in itself for the purpose intended and of any practical size as limited by details of construction. The cell may be made any desired capacity by merely increasing the number of units, and each unit is so arranged that it may be cut out of service and readily removed for inspection, cleaning and substitution of parts or new units, without placing the entire cell or any of the remainder of the cell out of commission during such time. The units consist of an anode 11 (positive terminal) of graphite or other suitable material, preferably substantially round in cross section as this is easier to make and gives a better functioning electrode, but it may, of course, be square in cross section or any other shape desired, and it is placed and fastened between ends 12 and 13 of non-absorbent, non-corrosive and non-electrical conducting material, made tight at the joints by the use of some plastic material, as shown at 14, where the anode passes through the end 12. A suitable gasket 15 is also provided between the shoulder on the anode and the end wall 12. The front end wall 12 is also preferably provided with a substantially rectangular reduced portion 16 seated in an opening in the

top wall 17 of the cell, though of course, other shapes may be used if desired.

Extending about this anode, and spaced therefrom to provide a brine chamber 18, is a porous diaphragm 19 preferably of asbestos, as for example asbestos cloth or paper, or other suitable material. This diaphragm as shown extends between the end walls 12 and 13. Over this diaphragm is placed a sheet of foraminous metal 20 forming a cathode plate (negative terminal). The cathode plate is surrounded and enclosed by a shield or casing 21 spaced therefrom and forming a gas chamber 22. The individual units may have single anodes or they may be provided with multiple anodes and when used with single anodes will probably not exceed five inches in outside diameter and with multiple anodes may be made any size depending upon the length that can be readily handled. The length may vary from a few inches to several feet without materially varying the construction as herein shown. I do not, however, wish to be limited to this specific construction as other constructions will readily suggest themselves to a person skilled in this class of devices.

As a convenient means of connecting the shield or casing 21 to the end wall 12 I may provide this shield with curved or bayonet slots 23 through which may extend suitable screws 24 threaded in the end wall. This connection will render the casing easily removable for inspection or repair of the enclosed elements. At its upper end the cathode 20 is preferably provided with an outwardly projecting flange 25 between which and the wall 12 is a gasket 26, and these flanges are clamped to the wall by suitable screw bolts 27, one of which 27′ extends through the end wall and the wall 17 of the cell for connection with one of the negative leads 28 to the source of current supply, and to provide a better electrical connection the nut 29 is welded to the cathode plate.

For the purpose of illustration an electrolyte of sodium chloride is used, but any other salt may be employed yielding different products and requiring different materials and slightly different methods of construction, depending on the physical and chemical properties of the substances produced. When the sodium chloride solution is used chlorine is given off at the anode and hydrogen gas and caustic soda is produced at the cathode. The diaphragm 19 is in contact with the surface of the cathode and its function is mainly to prevent chlorine passing through. It does not, however, prevent passage of the sodium ion ($Na+$) which passes through to the cathode and units with water forming caustic soda ($NaOH$) and hydrogen.

The electrolyte or salt solution is fed to the space 18 between the anode and the diaphragm from a suitable source of supply, as a tank 30 placed above the tops of the units so as to flow to the units by gravity. In the form shown in Fig. 1 the brine is fed to the cell by the pipes 31 leading to each unit at the top thereof, and the chlorine gas escapes from the cell through this pipe. If preferred, however, these pipes may be led to the bottom of the brine chamber 18 and separate pipes provided to carry off the chlorine from the top of the cell. Each branch pipe 31 is connected to the main pipe 32 leading from the supply tank by a union 33 so that any unit may be disconnected as desired, a suitable valve 34 being provided to prevent loss of the brine solution. Leading from the bottom of the gas chamber 22 is an outlet 35 for the caustic soda, and from the top of this chamber is an outlet 36 for the hydrogen gas. These outlets are also connected by a suitable union, not shown, the pipes leading to a common outlet, so that when it is desired to cut out any given cell it may be readily disconnected from the outlets as well as the brine supply.

In Figs. 3 and 4 I have shown the units in a substantially horizontal position, though they are preferably somewhat inclined to facilitate the escape of the gas generated and reduce polarization. As in the first form they are preferably enclosed in a suitable container or casing 37 the front wall 38 of which has suitable rectangular openings to receive the reduced portion 16 of the end wall 12. The construction of the unit is practically the same as when the unit is placed in the vertical position. The brine inlet and the chlorine outlet may be the same connection, although it is preferred to feed the brine to the lower part of the brine chamber and have a separate outlet for the chlorine at the upper part of the chamber. In these figures a common brine supply tank 39 is connected with a supply pipe 40 from which branches 41 lead to the individual units at the lower rear part of the brine chamber 18, and these pipes have unions 42 so that they may be readily disconnected. A three-way cock 43 is provided in the branch pipe to cut off the brine supply from the unit, and when this supply is cut off to drain the brine from the unit through the pipe 41′. Each unit is also provided with a chlorine outlet 44 leading to a common pipe 45 connected with a tank 46 where the chlorine may be collected and led to any desired place of use. The outlets 44 are provided with unions 47 and suitable valves 48 between these unions and the common outlet pipe 45. It will be apparent that by closing the valves 43 and 48 and disconnecting the unions 42 and 47 any cell may be cut out of service and disconnected and disassem-

bled for inspection, cleaning, repair or renewal without in any way interfering with the operation of any of the other units of the cell, and so it is not necessary in making repairs or renewals to place the entire cell out of commission, but only a very small part thereof.

When the units are arranged in the horizontal position or slightly inclined, the the anode is preferably arranged eccentric to the cathode and below the center of the cathode so as to give a larger space in the brine chamber 18 above the anode for escape of the bubbles of chlorine gas. This tends to prevent the formation of large bubbles of chlorine gas closely adjacent to the anode by producing a more even concentration of small gas bubbles over the surface of the anode, and thus reduce the effect of polarization. To further facilitate this operation the cathode is preferably provided with an enlargement 49 projecting outwardly at the top thereof to provide a channel 50 extending longitudinally of the unit, as shown in Fig. 4, and the chlorine outlet 45 leads from the upper portion of this channel. If a square anode or one of some other shape is used a similar construction may be employed. A pipe 51 is provided leading from the bottom of the gas chamber 22 for exit of the caustic soda and a hydrogen outlet 52 is provided leading from the upper portion of this chamber as in the first form. If desired the cathode may be made in two sections 53 connected together by removable pins 54 as shown in Figs. 9 and 10. By withdrawing the pins the two sections are readily removable. The same construction may also be employed for the shield or outer casing 21. When the vertical arrangement of the electrodes is used the cathode may be tapered somewhat from the lower to the upper end to give a larger gas chamber at the top and reduce polarization.

In Fig. 4 the individual units are shown as placed one above the other. In Fig. 8, however, I have shown them in staggered relation so as to reduce the height required for a cell composed of a given number of units.

All the electrical connections for the anodes and cathodes of the individual units are led to a suitable switch board, not shown, and these connections are arranged so that any unit or units can be disconnected or rendered inactive by means of well-known electrical devices, and the cell proper or the balance of the units remain in continuous operation at the same or at an increased rate. The units may be connected in series, in parallel, or in series-parallel. These electrical connections are not shown as they are of the common constructions well known in the electrical art.

The units differ from the electrolytic cells formerly used by the absence of the so-called gas domes. The brine level or level of the electrolyte is kept well above the uppermost unit, and the gas bubbles rise up through the brine in a suitable sized pipe and then can be drawn off. The absence of a gas dome reduces the time required for the units to come up to capacity from an inactive condition, and also to cease delivering chlorine sooner after the current is shut off. The arrangement of individual units also greatly reduces the total amount of brine required to start up the cells when empty or which must be wasted after the current and the brine are shut off, thereby making this cell of individual units well adapted for intermittent use without undue operating expense caused by waste of electrolyte during the periods when the cell is idle. The usual type of cell requires an appreciable time to fill with electrolyte and the electric current cannot be turned on until the cell is very nearly filled, and then there is a still further lag before capacity is reached. Where such large volumes of cold brine are used the total amount of energy required to heat this brine causes a considerable waste of electric power.

In large cells of ordinary construction a very large volume of electrolyte is required to insure an electrolyte of proper concentration in the immediate vicinity of the anode or anodes. Individual brine inlets for each individual unit insure a satisfactory and continuous supply of nearly saturated electrolyte and thereby increase the efficiency of the units.

Another advantage of the multiple unit cell is that a stock of parts for all sizes of the individual units may be kept and the cell then built up to the capacity required. I do not need different sizes of parts to secure cells of different capacities. Furthermore, in small units with a single anode I can secure a greater cathode area in proportion to the anode area, which, within limits, is a desirable feature.

In cells of small capacity the chlorine outlet and brine inlet pipes may be combined provided the pipes are made sufficiently large, and also the hydrogen and caustic soda may also be withdrawn through a single pipe. This feature of combining the supply and delivery pipes simplifies the construction and facilitates the ready disconnection of the individual units. It is considered better, however, especially in larger units, to allow the fresh brine to enter at the base of the unit so that the flow of brine to the various portions of the cell to replace that which passes through the diaphragm will be freer and not interrupted by the rising current of chlorine gas around the anode and in the inverted U-shaped channel along the top of the unit. Caustic drips may be pro-

vided for each unit at some easily accessible position for test purposes to determine the actual operating condition of each unit.

The cathode plate and the anode, either or both, may, if desired, be arranged with corrugations to secure additional surface area and lower current density. The use of the casing or container 21 not only provides a compartment for collecting the hydrogen gas but it also serves to hold moisture in this space to prevent evaporation of the electrolyte causing salt crystals to form on the cathode and the diaphragm. It also prevents carbonation of the caustic soda by the carbon dioxide of the air. Both of these actions tend to clog the diaphragm resulting in increased resistance and decreased efficiency.

Having thus set forth the nature of my invention, what I claim is:

1. An electrolytic cell comprising a plurality of individual units, each unit comprising an anode and a cathode spaced from each other, and means for feeding an electrolyte to the space between the anode and cathode of each unit independently of the other units.

2. An electrolytic cell comprising a plurality of individual units, each unit comprising spaced substantially cylindrical anode and cathode elements eccentrically arranged, said elements being in a substantially horizontal position with the greatest space over the anode, and means for feeding an electrolyte to the space between said elements.

3. An electrolytic cell comprising a plurality of individual units, each unit comprising spaced substantially cylindrical anode and cathode elements, and means for feeding an electrolyte to the space between the elements of each unit independently of the other units.

4. In an electrolytic cell, spaced substantially cylindrical anode and cathode elements eccentrically arranged, said elements being in a substantially horizontal position with the greatest space over the anode.

5. In an electrolytic cell, spaced substantially cylindrical anode and cathode elements placed one within the other, the outer element being provided with an outwardly projecting enlargement forming an internal channel extending longitudinally of said element.

6. In an electrolytic cell, spaced substantially cylindrical anode and cathode elements placed one within the other and eccentrically arranged, the outer element being provided with an outwardly projecting enlargement on the side farthest from the inner element forming an internal channel extending longitudinally of said element.

7. An electrolytic cell comprising a plurality of individual units, each unit comprising an anode, a foraminous cathode surrounding and spaced from the anode, a porous diaphragm adjacent to the inner wall of the cathode, and means for feeding an electrolyte to the space between the anode and cathode of each unit independently of the other units..

8. An electrolytic cell comprising a plurality of individual units, each unit comprising an anode, a foraminous cathode surrounding the anode and spaced therefrom, a porous diaphragm adjacent to the inner wall of the cathode, a container surrounding and spaced from the cathode, means for feeding an electrolyte to the space between the anode and cathode, and an outlet from the space between the cathode and the container.

9. An electrolytic cell comprising a plurality of individual units, each unit comprising an anode and a cathode surrounding and spaced from the anode, a brine supply, pipes leading from said supply to the spaces between the electrodes of the individual units, detachable connections in said pipes, and shutoff valves in said pipes beyond the detachable connections.

10. A unit for an electrolytic cell comprising a substantially horizontally arranged anode, a cathode extending about the anode and spaced therefrom, means for feeding a salt solution at the lower part of the space between said elements, and an outlet for gas at the upper part of said space.

11. A unit for an electrolytic cell comprising an anode, a cathode extending about and spaced from the anode, means for feeding a salt solution to the lower part of the space between said elements, and a gas outlet leading from the upper part of said space.

12. A unit for an electrolyte cell comprising spaced, substantially cylindrical anode and cathode elements eccentrically arranged in substantially horizontal position and with the axis of the anode below the axis of the cathode, means for feeding a salt solution at the lower part of the space between said elements, and a gas outlet from the upper part of said space.

13. An electrolytic cell comprising a plurality of individual units, each unit comprising spaced anode and cathode elements, means for feeding a salt solution at the lower part of the space between said elements, and means for leading gas from the upper part of said space.

14. An electrolytic cell comprising a plurality of individual units, each unit comprising spaced, substantially cylindrical anode and cathode elements eccentrically arranged and in substantially horizontal position with the greater space at the top of the unit, means for feeding a salt solution to the lower part of the space between said

elements, and means for leading the gases from the upper part of said space.

15. An electrolytic cell comprising a plurality of individual units, each unit comprising an anode, a cathode surrounding and spaced from the anode, an enclosing casing surrounding and spaced from the cathode, means for feeding a salt solution to the lower part of the space between the anode and cathode, an outlet for gas leading from the upper part of this space, an outlet for liquid leading from the lower part of the space between the cathode and the casing, and a gas outlet leading from the upper part of this space.

16. An electrolytic cell comprising a plurality of individual units, each unit comprising a substantially horizontally arranged anode, a substantially cylindrical perforated cathode surrounding and spaced from the anode and eccentric therewith with the greater space at the top of the element, a porous diaphragm on the inner side of the cathode, means for feeding a salt solution to the space between the anode and the diaphragm, a casing enclosing the cathode and spaced therefrom, and outlet means for conducting liquid and gas from said latter space.

In testimony whereof I affix my signature.

MARTIN W. COWLES.