

Aug. 15, 1933.

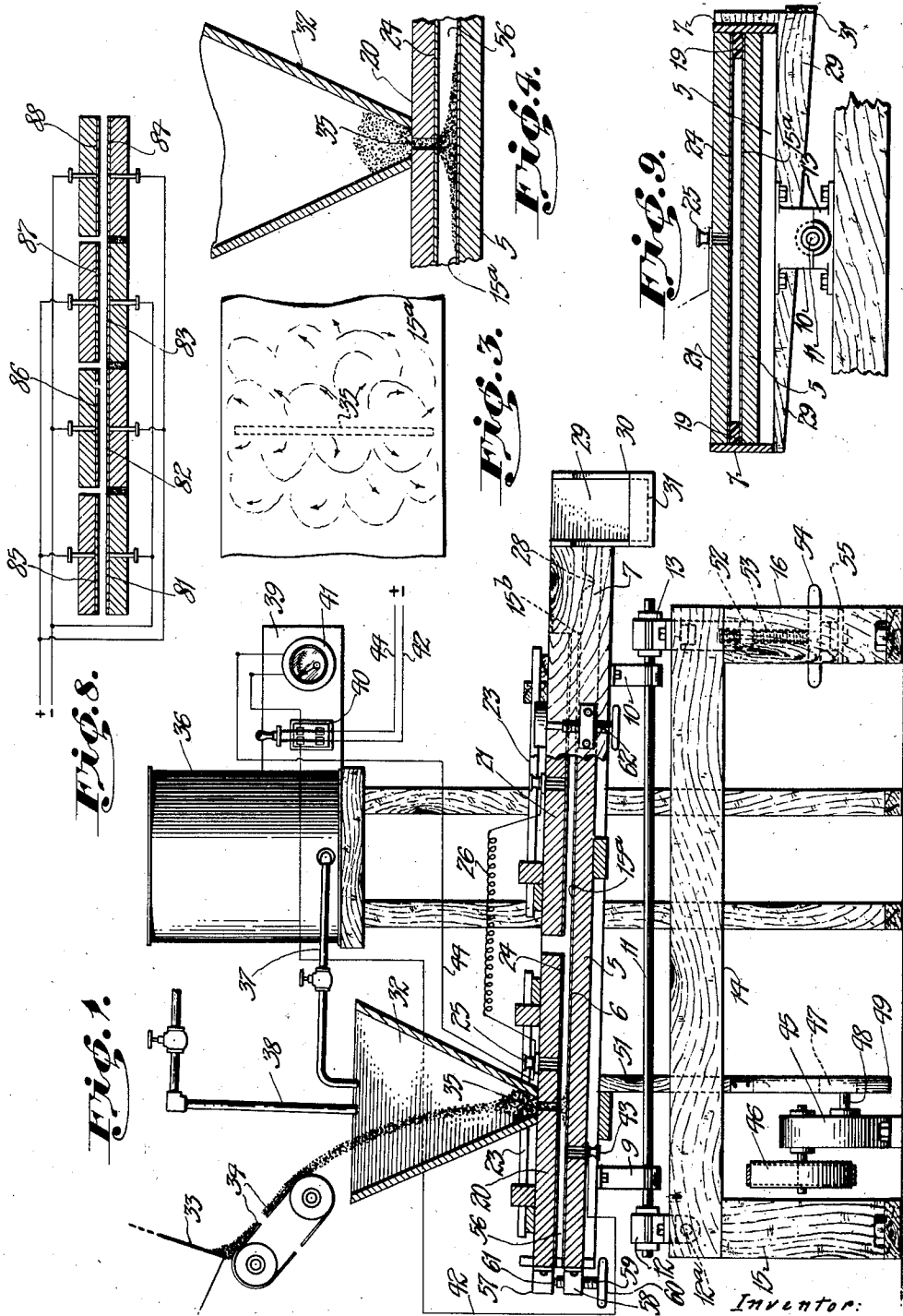
V. C. J. NIGHTINGALL

1,922,975

MEANS FOR THE RECOVERY OF PRECIOUS METALS SUCH AS
GOLD, PLATINUM, AND THE LIKE FROM ORE BODIES

Filed April 15, 1931

2 Sheets-Sheet 1



Inventor:
V. C. J. Nightingall
by *B. F. Oudenoord*
Att'y

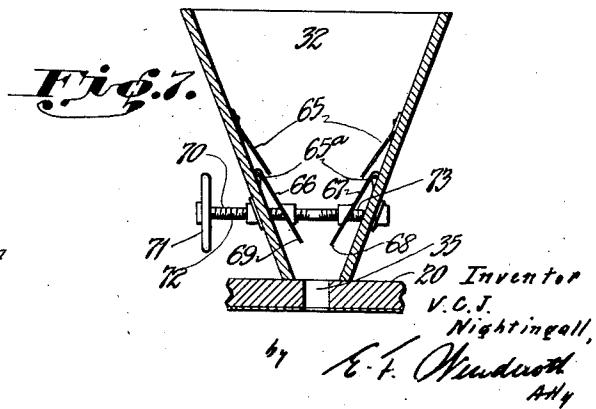
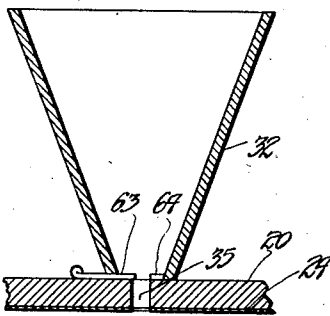
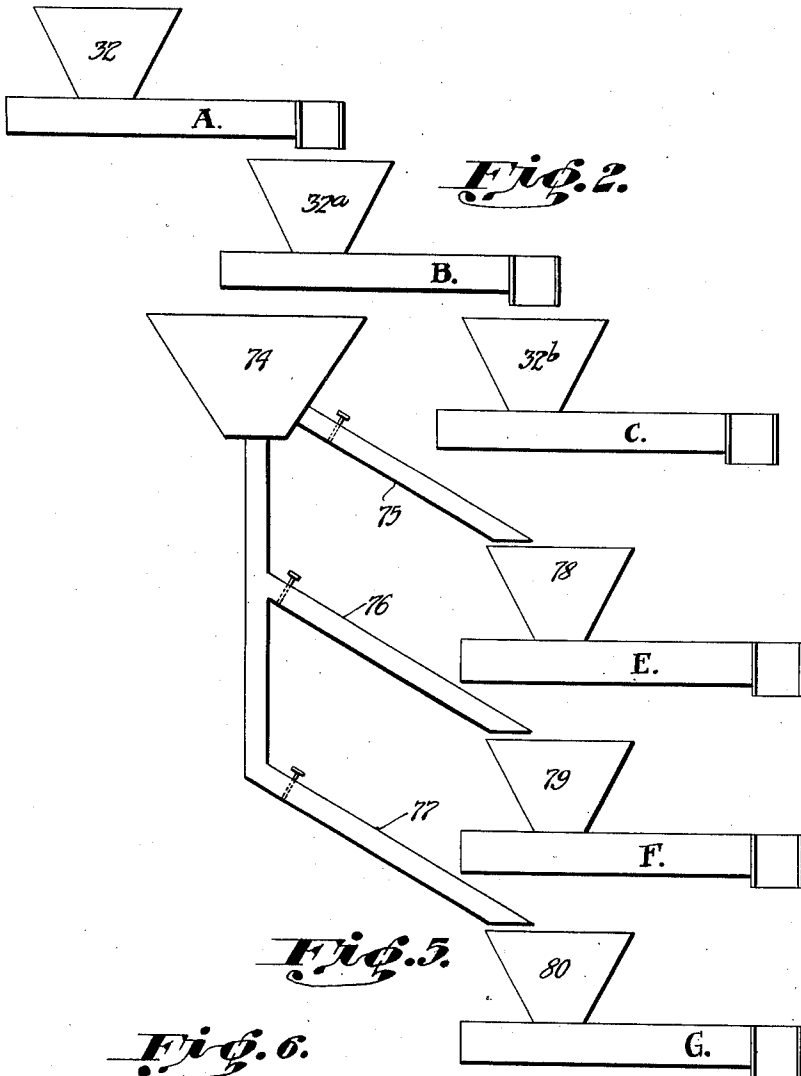
Aug. 15, 1933.

V. C. J. NIGHTINGALL
MEANS FOR THE RECOVERY OF PRECIOUS METALS SUCH AS
GOLD, PLATINUM, AND THE LIKE FROM ORE BODIES

1,922,975

Filed April 15, 1931

2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

1,922,975

MEANS FOR THE RECOVERY OF PRECIOUS METALS SUCH AS GOLD, PLATINUM, AND THE LIKE FROM ORE BODIES

Victor Charles John Nightingall, Heidelberg,
near Melbourne, Victoria, Australia

Application April 15, 1931, Serial No. 530,366,
and in Australia December 10, 1930

4 Claims. (Cl. 209—195)

This invention has reference to a process of and means for the recovery of precious metals such as gold, platinum and the like from ore bodies and the object of the invention is to provide a process and means whereby, in particular, sulphide ores may be stripped of their precious metals.

It will be observed that I refer to gold and platinum, but this is not to be construed as a limitation on the possibilities of the process, on the contrary, I may recover any metal desired by the means to be described but in order to simplify description, I will refer to the recovery of gold.

It has been definitely proved that the cyanide process and amalgamation fail to recover or free the fine gold associated with sulphide ores, for on the one hand, the absorption of cyanide is so great that the gold will not go into solution, while on the other, the mercury "sickens" and "flours" which prevents the gold being caught by it as is the objective.

Now the present invention has been devised to recover the gold associated with sulphides by setting the gold free and allowing it to be collected as an amalgam to be treated in the ordinary way, the process and apparatus being cheap, simple and efficient in operation.

The basic principle embodied in the invention consists in the use of any salt of an alkali base metal that can be dissociated electrolytically, whereby the alkali metal is deposited in the mercury to act in such a manner that when water flows through the apparatus together with the alkali salt dissolved therein, the alkali metal deposited on the plates reacts with the water to form an alkali hydrate such as caustic soda and sets free nascent hydrogen which functions to protect the plates from the action of sulphide ore bodies.

The most important feature of the invention consists in the use of a copper or other metal plate or plates, which are capable of being amalgamated with mercury and which are mounted on a moving or movable table which is adapted to rock, oscillate or vibrate and which forms the cathode of an electrical circuit, while disposed above said cathode is a lead or other suitable anode which may be mounted upon wood or other suitable material which may or may not move with the cathode.

A further essential feature consists in means for adjusting the distance between the anode and cathode respectively.

A further and very essential feature of the invention resides in the disposal of a slot trans-

versely or longitudinally of the table or at any angle in relation thereto, said slot being disposed to register with a hopper or other feed device which may be provided with a variable opening whereby the feed of ore or other material from the hopper and the space between the anode and cathode may be regulated.

A further essential feature consists in mounting the table carrying the cathode and/or anode whereby it may be rocked, oscillated or vibrated, whereby the surface tension of the fluid disposed between the anode and cathode may be interrupted in order that the metallic particles in the ore body may sink and contact with the amalgamated surface of the cathode which has means combined therewith for maintaining the amalgam free from the action of the sulphide content of the ore body.

A further essential feature consists in the means employed for causing an ore body to be distributed upon the cathode surface in such a manner that the metal it is desired to recover will be precipitated and caught by the amalgamated surface of the said cathode.

The invention is characterized by a movable table carrying a cathode and anode, the said cathode being a copper or other plate or plates amalgamated with mercury, while the anode is a suitable metal plate or surface such as lead which is adjustably spaced from the cathode by any suitable means and the space between the said cathode and anode being the channel through which the ore body passes, said ore body before it reaches the said space passing from a mill or the like, to a hopper or other suitable receptacle which, at the bottom, is provided with a slot either transversely of the anode and cathode, or longitudinal or at an angle thereto, whereby the finely ground ore body is caused to fall in a stream of defined width and length in relation to the table and in falling through the said slot, it will be caused to spread in a substantially uniform thickness upon the cathode whereon the gold is caught and retained, the said cathode being maintained bright and active by the evolution of hydrogen from the cathode and oxygen from the anode with or without the addition of a sodium salt.

I desire to state that I may use a battery of units fed from a common hopper or other suitable distributor which would receive the ore from the grinding mill, the said hopper having a number of conduits or conveyors to conduct the ground ore to the respective hoppers on each recovery table, moreover, where fine recoveries are

necessary as in known low grade ores, I would arrange my recovery table so that the ore passed from the uppermost to the lowermost table, the said ore entering the respective hoppers and be subjected to the same treatment as when only one recovery table is employed.

The invention also apprehends the use of two distinct chemical reactions associated with arsenic and antimony, the reactions being found necessary for the reason that arsenic and antimony in ore bodies form one of the greatest problems in metallurgy due to the stable nature of both these products and I have found that these difficulties may be overcome by the use of the two chemical reactions as follow:—

1. The combining of hydrogen preferably of the nascent state with arsenic, the action producing a body analogous to ammonia and phosphine, this body being named arsenuiretted hydrogen, sometimes known as arsine and having a chemical equation AsH_3 .

2. The combining of hydrogen preferably in the nascent state with antimony, the action producing antimonuretted hydrogen, the chemical equation being SbH_3 , this compound being produced usually in the same way as arsine.

Functioning with the above referred to chemical reactions and which assists in the said reactions taking place, is the retardation of the mineral particles in relation to the solution carrying them in their course over the table, such retardation permitting gravity to overcome surface tension and allowing the particle to sink to the mercury table or cathode where it is held until purposely removed therefrom, such particle or particles being electrostatically charged immediately when it or they enters or enter the space between the anode and cathode respectively.

Another essential feature consists in the use of an anode of metal such as lead which, when acting as an anode will form an insoluble body on the surface, such as oxide of lead, the same metal also acting towards chlorine, that is, when same is used for lowering the resistance between the electrodes and forming chloride of lead, which, for all practicable purposes, is insoluble in cold water.

In order to more readily understand the invention, reference will now be made to the accompanying drawings in which:—

Figure 1 is a side sectional view of the apparatus employed for carrying my invention into practical effect.

Figure 2 shows a cascade arrangement of units which I may employ.

Figures 3 and 4 are diagrammatic plan views showing physical action of the ore body when in contact with the negative or cathode of the unit.

Figure 5 shows, in elevation, one form of unit arrangement for treating large quantities of material.

Figure 6 is a detail view of one means of adjusting the ore feed to the table, and

Figure 7 is a detail view of modified means for adjusting the feed to the table.

Figure 8 is a view of an alternative arrangement.

Figure 9 is a detail view.

In one form, the invention is carried into practical effect by providing a movable table 5, which may be rocked, oscillated or vibrated by any suitable means and in the present invention, the table 5 is rocked laterally providing a swinging motion and means for accomplishing this will be hereinafter described.

The table 5 comprises a floor portion 6 of suitable material and properly reinforced to prevent warping or shrinking, the said floor carrying a fence or marginal ridge 7 whereby the liquid or fluid will be prevented from leaving the surface of the table other than in a predetermined direction.

The table 5 is fitted with bearings 9, 10 through which a shaft 11 passes, said shaft being in the centre of the table 5 longitudinally, bearings 12 and 13 which also accommodate the shaft 11 and consequently support the table 5, said bearings being mounted on a framework comprising longitudinal beams as 14 or legs 15 and 16 which are bolted or otherwise affixed to the ground or floor of the building.

The upper surface of the floor 5 is covered with sheet copper 15a, that is, the copper extends from side to side of the table and over the effective working surface thereof, such copper sheet or sheets being amalgamated with mercury by any of the well known methods.

The copper sheet 15a which forms the cathode of an electrical circuit may be affixed to the table in any suitable way, such as by screws or copper tacks, providing that an even surface is obtained which is essential to obtain the best results.

Disposed along each side of the table 5 and approximately the full length thereof, are rubber or other suitable strips 19 which are adapted to non-conductively support detachable sections as 20 and 21, which form the anode or upper surface of the table 5, said sections being suitably constructed from wood or other suitable material and provided with handles as 23 by which the sections are readily removed from the table 5.

Disposed on the underside of each section is a lead or other suitable sheet 24 which forms the anode of an electrical circuit, while each section as 20, 21 carries a terminal 25 adapted to receive the wiring as 26 whereby the sections described are electrically connected together.

The copper sheet 15a terminates at a point as 15, 15b and forwardly of the said terminating point is a trough or channel 28, while forwardly of the said trough or channel 28 is a concentrates box 29 which is inclined towards the outlet side 30, a lip 31 being provided thereon which is adapted to act as a riffle and prevent the concentrates passing away with the water.

The object of the trough or channel 28 on the surface of the table 5 is to provide a catchment for the minerals or mercury which normally tend, by virtue of their weight and size to leave the copper amalgam table and when the clean-up is performed, any valuable materials in the trough may be readily removed and while I have only shown one such trough or channel, it will be obvious that I may employ any number according to the condition of the material being treated.

Disposed adjacent the table 5 is a tank 36 containing an alkali solution, a pipe 37 connecting said tank and being disposed so as to enter the hopper 32 together with the water supply from the pipe 38 connecting a main or reservoir (not shown), while adjacent the tank 36 an instrument board 39 is arranged accommodating a switch 40 and meter 41 for ascertaining the voltage and the fluctuation in amperes.

The electrical current is supplied by any suitable means and this may comprise a generator or battery system, the negative side 42 of which goes to the copper plate 15a by connection with the terminal 43, the positive side 44 of the electrical system going to the switch 40 and meter 41 and

then to the detachable sections 20, 21 on the upper portion of the table and which serves the anodes of the system.

Any suitable means may be employed for laterally moving the table 5 and one means comprises a system of reduction gears within a casing 45 driven by any suitable means, a belt engaging the pulley 46, an eccentric 47 being mounted on the spindle 48, said eccentric being disposed between depending plates 49, which are rigidly secured to a member as 51 securely strutted to the table 5.

As the eccentric 47 rotates, it obviously bears against each of the plates 49 in turn and since the table 5 is balanced upon the shaft 11, the rotation of the eccentric 47 causes a lateral swing or rock which forms a very essential feature of the invention.

If desired, the inclination of the table 5 may be adjusted to suit the material being treated, since some materials may require greater velocity than others and in one form the desired inclination can be obtained by pivoting the bearing 12 as at 12a and supporting the bearing 13 upon a shoe 52 which is carried on a feed screw 53 provided with a hand wheel 54 carried on a support 55, such an arrangement permitting a very easy and delicate adjustment of the table.

Means are also provided for adjusting the space 56 between the anode and cathode of the system and comprise lugs 57, 58 secured to the anode and cathode, the lug 58 being threaded to receive an adjusting screw 59 operated by a hand wheel 60, the end 61 of the adjusting screw 59 being adapted to engage with the lug 57 and by arranging similar fittings at the sides of the table as at 62, the space between the anode and cathode may be regulated as desired.

The slot 35 may be made adjustable in various ways so as to regulate the feed of ore to the cathode, such as by providing a slidable shutter 63 which could be arranged to operate in conjunction with a fixed ledge 64 in the bottom of the hopper, or the hopper 32 may be provided with fixed deflecting plates 65 which cover the pivots 65a of flaps 66, 67 converging towards the bottom 68, the space between the ends 69 of the plates being regulated by a feed screw 70, carrying a hand wheel 71 and having right and left hand threads 72, 73 respectively, whereby on the rotation of a hand wheel 71, the plates will be caused to open or close in order to obtain the desired width of ore feed.

The object of moving the table in the manner described is to cause the ore body to spread out in the manner shown more particularly in Figures 3 and 4, the slot 35 playing an important part in this operation, for it is the combination between the said slot and the moving of the table which causes the ore body to be spread in the desired manner and moved about so as to allow the metallic particles it is desired to recover to contact with the amalgamated cathode and be retained thereby, while the remainder of the gangue is allowed to pass on, the course of the material in relation to the fluid which is the conducting body being such that the metallics take a course independent of the fluid, the surface tension of which is continually broken, thus in addition to the electrostatic attraction offered to the particle, a gravitational force exerts an influence allowing the metallics to settle and move along the amalgamated surface of the cathode.

In carrying the invention into practical effect,

the material passes from the mill as 33 to a conveyor as 34 and thence to the hopper 32, and at the same time, as it passes to the hopper water is fed to the said hopper which acts as the conducting stream by which the ore is carried over the table 5 and along the space 56 between the anode and cathode respectively.

While the ore is being fed to the space 56, the table is being moved or rocked laterally which effects the purpose in combination with a slot 35 as spreading the ore body as shown in Figure 3 and breaking the surface tension of the water and allowing the particles it is desired to recover being caught by the amalgamated cathode which is covered with a film of hydrogen, the object of which is to prevent the action of sulphides on the mercury which has a detrimental effect thereon.

As the precious metals are obtained by the mercury, the gangue follows on and passes into the concentrates box 29, the water passing away to settling tanks where it may be returned for further use.

Figure 2 illustrates a cascade arrangement for obtaining very high recoveries and in which the ore is fed to table A by means of the hopper 32, the gangue passing from the chute into the hopper 32a on table B being treated as herein-described, the gangue passing over the table B into the hopper 32B of the table C and so on, any desired number of times, each table being similar in construction to that described in reference to Figure 1.

In treating large bodies of ore, the tables are arranged as shown in Figure 5 or they may be arranged in a horizontal plane, the ore being fed from a common hopper 74, in communication with the mill, said hopper 74 being provided with a number of chutes as 75, 76 and 77 communicating with hoppers 78, 79 and 80 on tables E, F and G respectively or any number of tables may be employed.

I have determined that different materials require different potentials, that is to say, whereas one material may require a potential of, say, 2 volts, others may require up to 500 or 1000 volts, therefore I do not wish to be limited to the amount of potential used in my process, since such potential will be governed by the ore or metal being treated.

Furthermore, I may if desired, change the polarity of the apparatus i. e., I may change the anode to the cathode and vice versa with predetermined time limits between each change.

The construction shown in Figure 8 embodies alternate anodes and cathodes, i. e. along the bottom table would be disposed a cathode 81, anode 82, cathode 83 and anode 84, all of which are insulated from each other while the top section would contain an anode 85, cathode 86, anode 87, and cathode 88, the cathode 81 being enclosed by the anode 85, the anode 82 by the cathode 86 and so on, the object being to catch the final floor gold which would normally tend to pass away with the solution.

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

1. In apparatus for the recovery of precious metals from ore bodies, a table, means incorporated with said table to laterally rock the same, a mercurized cathode positioned in the bed of said table, a metal surface disposed above and spaced from the cathode to form the anode in an electrical circuit, said anode being composed of lead, detachable sections carrying said anode

mounted at one side of said table, a hopper mounted at one end of said table and a slot in the base of said hopper, in alignment with a slot formed in the anode member whereby the ore from the hopper is fed directly through the anode into the space between it and the cathode to be spread evenly over the mercurized surface thereof, means to deliver a solution of an alkaline base metal such as potassium sodium and water with the ore body through the aligning slots into the space between the anode and cathode, means to vary the space between the said anode and cathode and means to vary the working inclination of the table.

2. In apparatus for the recovery of precious metals, a table, a mercurized cathode mounted in said table, an anode spaced above said cathode and arranged in detachable sections, a slot feed from a hopper being provided through one end of the anode to deliver the ore, electrolyte and water into the space between the anode and cathode, to cause the ore to be delivered in a vertical stream of defined width on to the cathode surface, means to laterally rock said table and anode and cathode during the recovery of the metals to break the surface tension of the liquid to cause the ore to move independently of the water and electrolyte carrying it substantially as and for the purpose specified.

3. In apparatus for the recovery of precious metals, in combination a laterally rockable table arranged at an inclination, a mercurized cathode disposed in said table, a superimposed anode and said cathode being spaced from said superimposed anode, a slot in said anode in alignment with a slot in a feed hopper, the said slots being adapted to deliver the ore into the space between the anode and cathode for treatment together with a solution of an alkaline base metal such as potassium sodium and water.

4. An apparatus for the purposes specified, a table arranged at an inclination, a mercurized cathode supported in the base thereof, an anode surface disposed above the cathode and arranged in detachable sections, a feed hopper mounted at one end of the table, a feed slot in the base of said hopper in alignment with a slot in one of the anode sections to deliver ore, electrolyte and water into the space between the anode and cathode to be spread on the surface of the latter, means to vary the space between the anode and cathode within the table, which is mounted on a central shaft, spaced plates vertically arranged and attached to the underside of the table, an eccentric mounted between the lower end of the plates and reduction gear to drive the said eccentric from a prime mover to impart a lateral rock to the said table and the anode and cathode.

VICTOR CHARLES JOHN NIGHTINGALL.

5	80
10	85
15	90
20	95
25	100
30	105
35	110
40	115
45	120
50	125
55	130
60	135
65	140
70	145