No. 629,070. Patented July 18, 1899.

P. GARUTI & R. POMPILI.

APPARATUS FOR PRODUCING OXYGEN AND HYDROGEN.

(Application filed Dec. 15, 1896.)

(No Model.) 2 Sheets—Sheet 1.

Fig: 1.

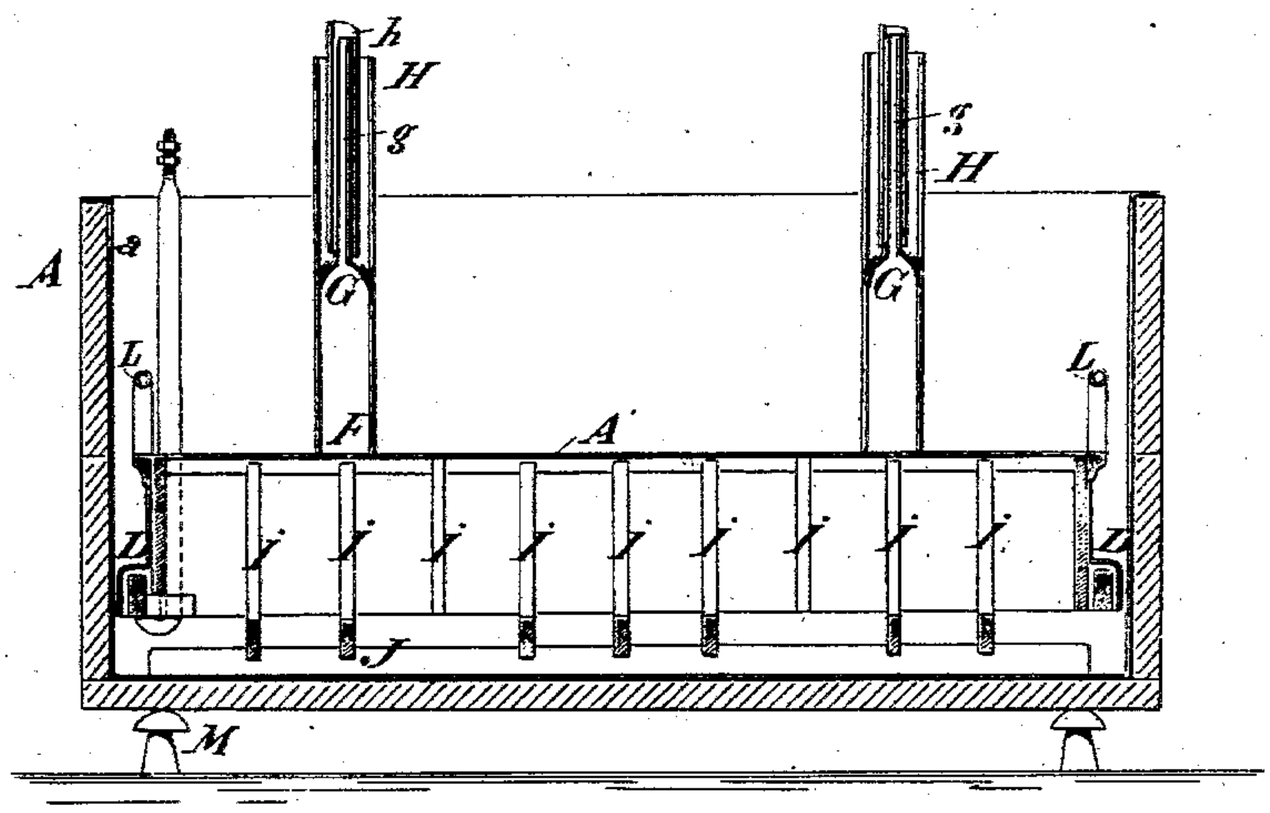

Fig: 2.

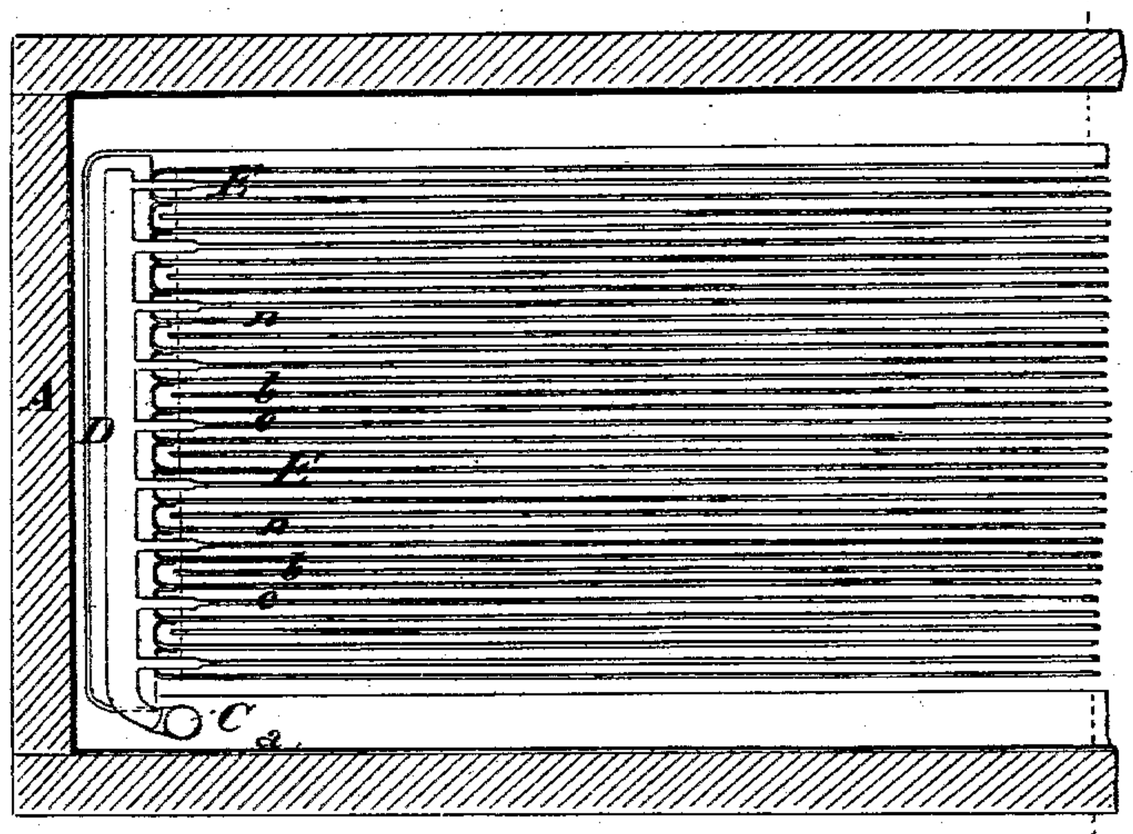

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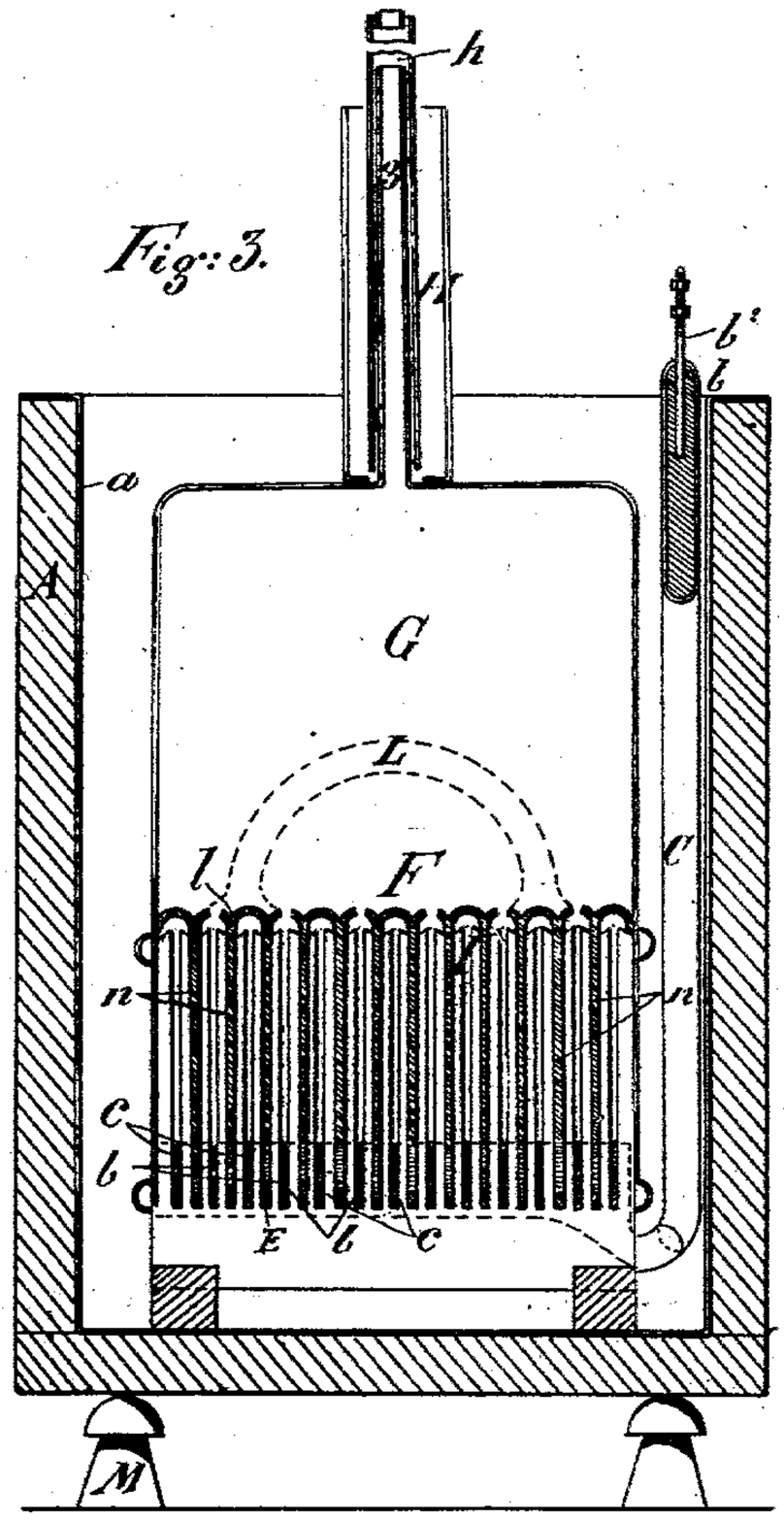
Fig: 3.



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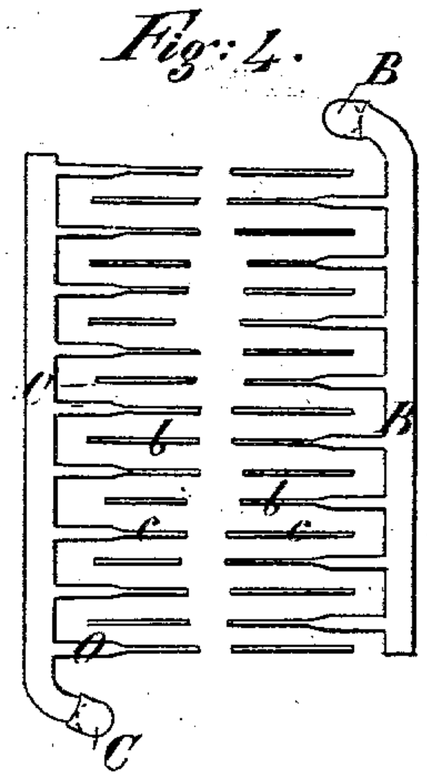

Fig: 5.

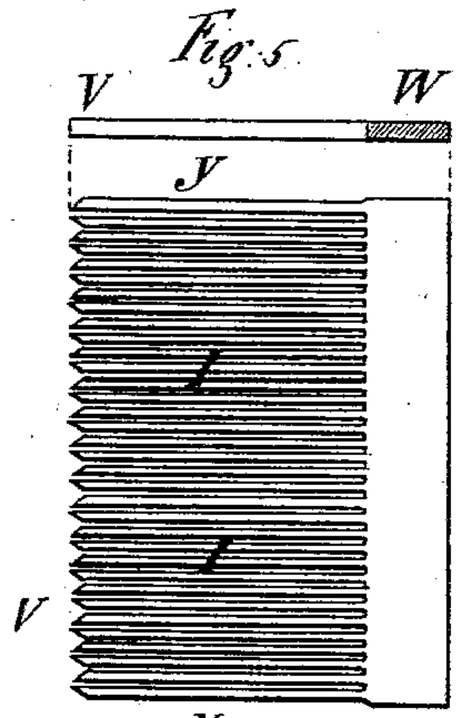

Fig: 6.

Fig: 9.

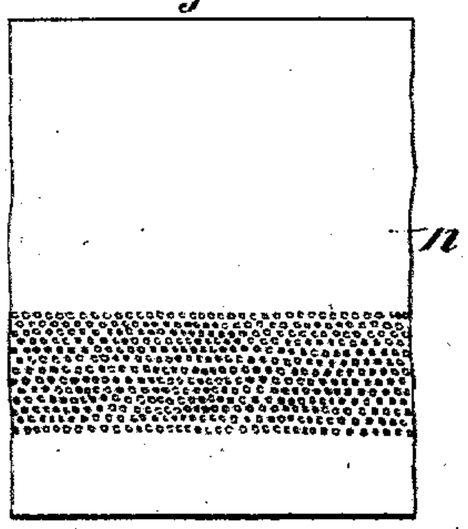

Fig: 7.

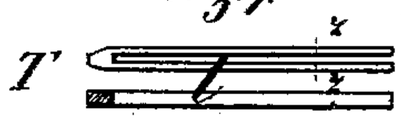

Fig: 8.

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UNITED STATES PATENT OFFICE.

POMPEO GARUTI AND RICCARDO POMPILI, OF NAPLES, ITALY.

APPARATUS FOR PRODUCING OXYGEN AND HYDROGEN.

SPECIFICATION forming part of Letters Patent No. 629,070, dated July 18, 1899.

Application filed December 15, 1896. Serial No. 615,783. (No model.)

To all whom it may concern:

Be it known that we, POMPEO GARUTI, professor, and RICCARDO POMPILI, proprietor, subjects of the King of Italy, residing at Naples, in the Kingdom of Italy, have invented certain new and useful Improvements in Apparatus for the Production of Oxygen and Hydrogen; and we do hereby declare the following to be a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to the process and apparatus for producing oxygen and hydrogen by means of electrolysis, and especially to improvements upon Letters Patent No. 534,259, dated February 19, 1895; and the object of this invention is to introduce a new and useful improvement and apparatus of this character for the production of oxygen and hydrogen by means of electrolysis; and the same consists, essentially, in the use of perforated metallic diaphragms, and by this means one obtains the perfect separation of the gases and the resistance to the passage of the current is diminished, which forms a very essential feature in the process and apparatus, and with these and other objects in view the invention consists in the construction, arrangement, and combination of parts hereinafter described in the specification and illustrated in the accompanying drawings, in which—

Figure 1 is a longitudinal vertical section through the center of the apparatus. Fig. 2 is a horizontal section of one end of the same. Fig. 3 is a vertical cross-section of the apparatus. Fig. 4 is a plan view of the conductors and electrodes. Fig. 5 is a detail of construction. Fig. 6 is a vertical longitudinal section of Fig. 5. Fig. 7 is a front view of a fork which I employ and also a longitudinal section thereof, and Fig. 8 a transverse section of Fig. 7 on the line 2 2. Fig. 9 is a detail of a perforated diaphragm.

In the drawings forming part of this specification the separate parts of our improvement are designated by the same letters of reference in each of the views, and in the practice of our invention we employ a tank A, of wood or other material, lined internally with an iron plate *a* and in which is placed the electrolyzing apparatus, immersed in the liquid to be electrolyzed. The tank is insulated from the ground by insulators M.

The electrolyzing apparatus consists of a case A′ turned upside down, which by means of longitudinal diaphragms is divided internally into cells E. This case is made of iron, steel, or other metal and is open only at the bottom, so as to permit the water to enter in the cells. The anodes *b* and the cathodes *c* are placed one in each cell alternately, taking care that each anode is between two cathodes, the gas passing through an opening made at the upper part of the said chambers into the cells that contain the same gas. The electrodes are insulated from the diaphragms *n* by combs I, made of wood or other non-conducting material, the teeth of which enter in the cells and fill out the spaces between the electrodes and the diaphragms and prevent them from coming into contact one with the other. The combs are fastened to longitudinal beams lying on the bottom of the tank and are cut out at the joints of the teeth, so as to allow free passage of the gases to the top of the cells E.

The electrolyzing apparatus does not extend quite to the bottom of the tank, but rests upon transversal beams, as shown in the drawings, so that any sediment which the water deposits does not interfere with the working of nor damage the apparatus.

To prevent the electrodes from touching the top of the cells, every electrode has at each end, at the top, a fork *l*, of material similar to that of the combs I. This fork *l* has two teeth T, between which the electrode enters. The whole fork resting between two diaphragms occupies transversely the whole width of the cell, touching the top of the cell, and the tank is provided with handles L, by which it may be lifted out. In this form of our invention the arrangement of diaphragms and of the cathodes and anodes prevents the mixing of the gases, which as they form pass the oxygen only in the anode-cells and the hydrogen in the cathodes.

The cells E have openings F at the top, through which the gases escape and enter the chambers G, situated at the top of the apparatus. There are two chambers G. One serves to receive the oxygen and communicates with all the anode-cells, and the other receives the

hydrogen and communicates with the cathode-cells. On the chambers G are mounted small copper pipes *g*, which are connected to the distributing-pipes by means of the insulating-tubes *h*, made of glass or porcelain. The tubes *h*, made of glass or other insulating material, are necessary in order to insulate the electrolytic apparatus in which the current is to act and form at the same time an air-tight junction between the small tubes *g*, through which pass the gases from the collecting-cells E, and the outer conduit of the gases, by which they are conducted to the gasometers or the like. To the top of each chamber is soldered a receptacle H of sufficient diameter and height, which forms a hydraulic closing, preventing the escape of gas at the junction of the said tube *g* with the tube *h*.

Two conductors—one positive, B, and one negative, C—rest over the top of the tank and extending down to the bottom of the apparatus enter through chambers D without having electrical contact therewith. Arms O branch off from the conductors and connect themselves with the electrodes. These conductors in their passage through the water are covered up to the height of the chambers D with a coating of caoutchouc *b'*, insulating them from the liquid, and their extremities terminate in a coupling of copper b^2, where the current enters. The coupling b^2, with which the conductors end, is made of copper in order to perfect the contact with the conductors of the dynamo, because if they were made of iron they would oxidate very easily, and thus prevent the contact. The chambers D serve to collect the gas that forms on the surface of the conductors. We use an alkaline electrolyte—that is, drinking-water or rain-water—with twenty-five per cent. of soda or caustic potash. The said conductors are covered with caoutchouc up to the height of the chambers D, but could not be conveniently covered with the same material at the bottom part, where they divide themselves. These chambers D are consequently constructed in order to receive the gases which are produced by the electrolysis at the upper surface, so that in the chamber above the lower part of the conductor of the positive pole B is collected the oxygen and in the chamber placed above the lower part of the negative pole C the hydrogen. These gases are forced afterward by means of the hydraulic pressure of the electrolyte and special outlets in communication with the respective cells in the collecting-chambers F, which already contain gases of the same nature. The insulating-covering of the conductors B should be limited to the height of the chamber D.

The water in the tank must be always level with the top of the chamber G, so as to give to the gases the requisite pressure.

The complete immersion of the apparatus permits quick detection of any contact between the electrodes and the diaphragms, such contact being indicated by gas-bubbles rising to the surface of the liquid in the tank.

In an electrolyzing apparatus the extension of the electrodes must be calculated according to the intensity of the current.

In the apparatus above described in order to obtain a perfect working the electrode must be one-half square decimeter of surface for each ampere of current and must have a height not exceeding 0.14 meters.

Having thus described our electrolyzing apparatus, we describe now in what the new improvement introduced in the same consists.

According to the above description the metallic diaphragm is uninterrupted and forms, therefore, from the top to the bottom a complete division of the cells and the electrodes.

We modify the structure of the diaphragms by piercing in its lower part up to the height of 0.05 meters and throughout the whole length of the diaphragm small holes of one millimeter of diameter, as shown in the drawings. These holes must be as near as possible one to the other without weakening too much the iron plate of the diaphragms *n*. The said holes can be made a few centimeters above the bottom of the diaphragm, and in this case the electrodes also do not extend in the bottom of cells lower than to the level of these holes. In order to understand the importance of this modification, it is necessary to know the scientific principle on which these apparatus are based. The diaphragms being of metal should act as secondary electrodes; but in order to do so it is necessary that the same can be polarized by induction, and then we have in our apparatus two distinct and independent apparatus in function, the one formed by the electrodes which communicates direct with the principal current and the other by the diaphragms which are perfectly insulated from the electrodes by means of the forks and the wooden combs. On the base of the electrochemical equivalents the necessary electromotive force for the decomposition of the water amounts to 1.5 volts and for two apparatus in series there would be necessary, theoretically, three volts. It is therefore clear that by keeping the current within the limits of three volts the electrolyte communicates with the anodes and with the cathodes by means of the openings at the bottom of the cells. The electrolysis produces itself only on the electrodes, while the diaphragms being insulated, and consequently not in direct communication with the current, remain neutral.

In order to obtain the greatest regularity and efficiency in the operation of our apparatus, the resistances are calculated so as to require only an electromotive force of about two volts, conveying into the same a current of one ampere for each half square decimeter of electrode-surface. When the electrolytic process of separation takes place between one electrode and the other, this latter would have to pass under the impermeable metallic diaphragm placed between and this would nat-

urally produce a loss of power. In order to avoid this inconvenience, make the electrodes very low, not higher than fourteen centimeters, as described in the specification, and make, further, a quantity of small holes in the lower part of the diaphragms, which establish a more direct communication between the electrodes in the electrolytic process of separation. As these holes have a diameter of not more than one millimeter and being made only up to the height of five centimeters in the lower part of the diaphragm which faces the electrodes, they do not permit the gases in the cells above and which are forced upward by the hydraulic pressure of the electrolyte to get mixed between themselves. Therefore this modification facilitates the orientation of the molecules of the water during the phenomenon of the electrolysis, diminishing the resistance to the decomposition of the water and conserving at the same time the perfect division of the two gases. Fig. 9 shows a part of the diaphragm *n* perforated by small holes, as described above.

Having fully described our invention, we claim as new and desire to secure by Letters Patent—

In an apparatus for producing oxygen and hydrogen by means of the electrolysis of water, a tank divided in cells by means of longitudinal metallic diaphragms, the lower portion only of which is perforated, and anodes and cathodes in each of the cells formed by said diaphragms, said anodes and cathodes being suitably insulated, whereby the mixing of the gases is prevented as they pass, the oxygen being retained in the anode and the hydrogen in the cathode cells, said cells being provided with openings at the top through which the gas escapes, consisting of chambers which communicate with said cells, as and for the purpose set forth.

This specification signed and witnessed the 28th day of October, 1896.

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