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E. HERMITE.

APPARATUS FOR PURIFYING OR DISINFECTING.

No. 575,645. Patented Jan. 19, 1897.

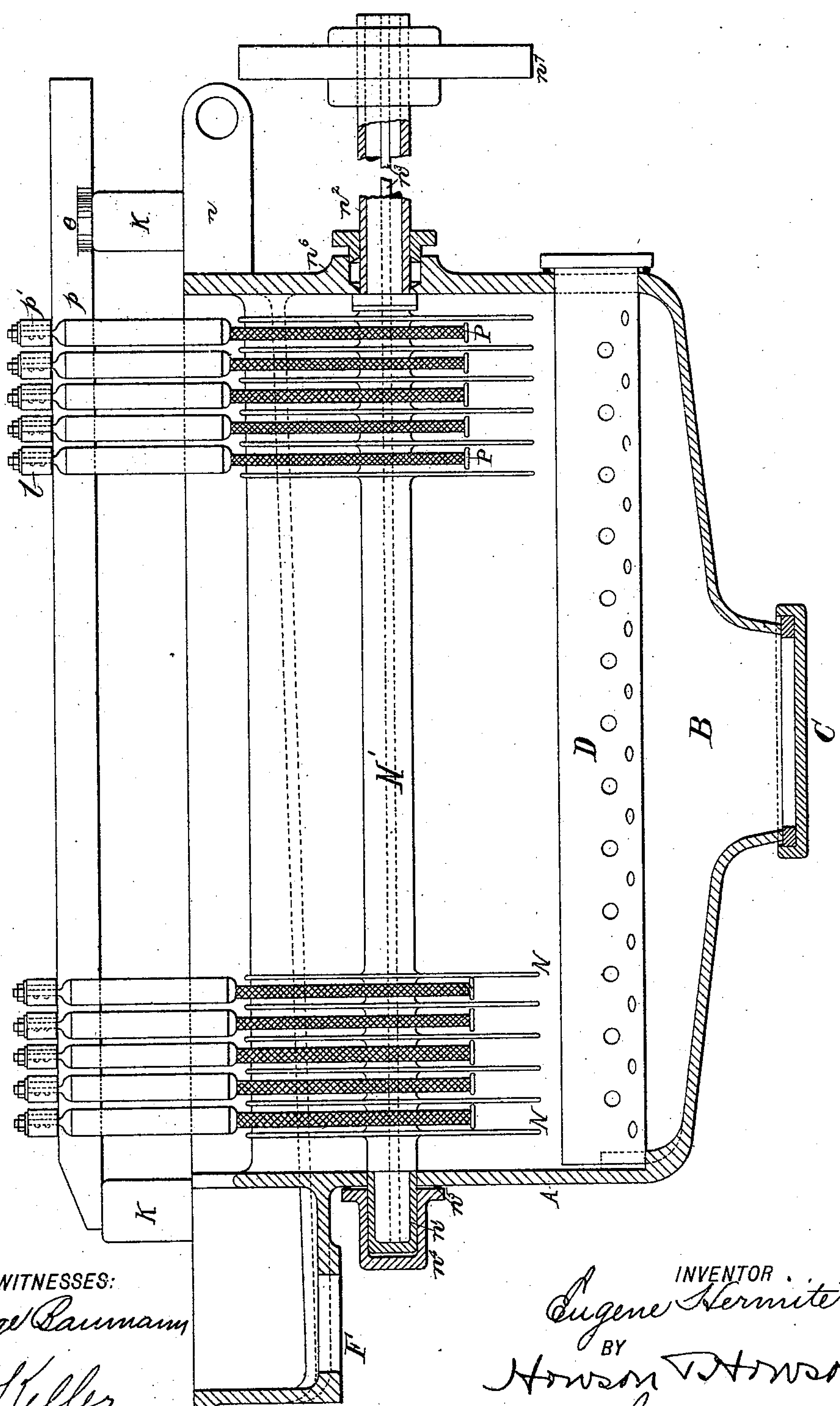

Fig. 1.

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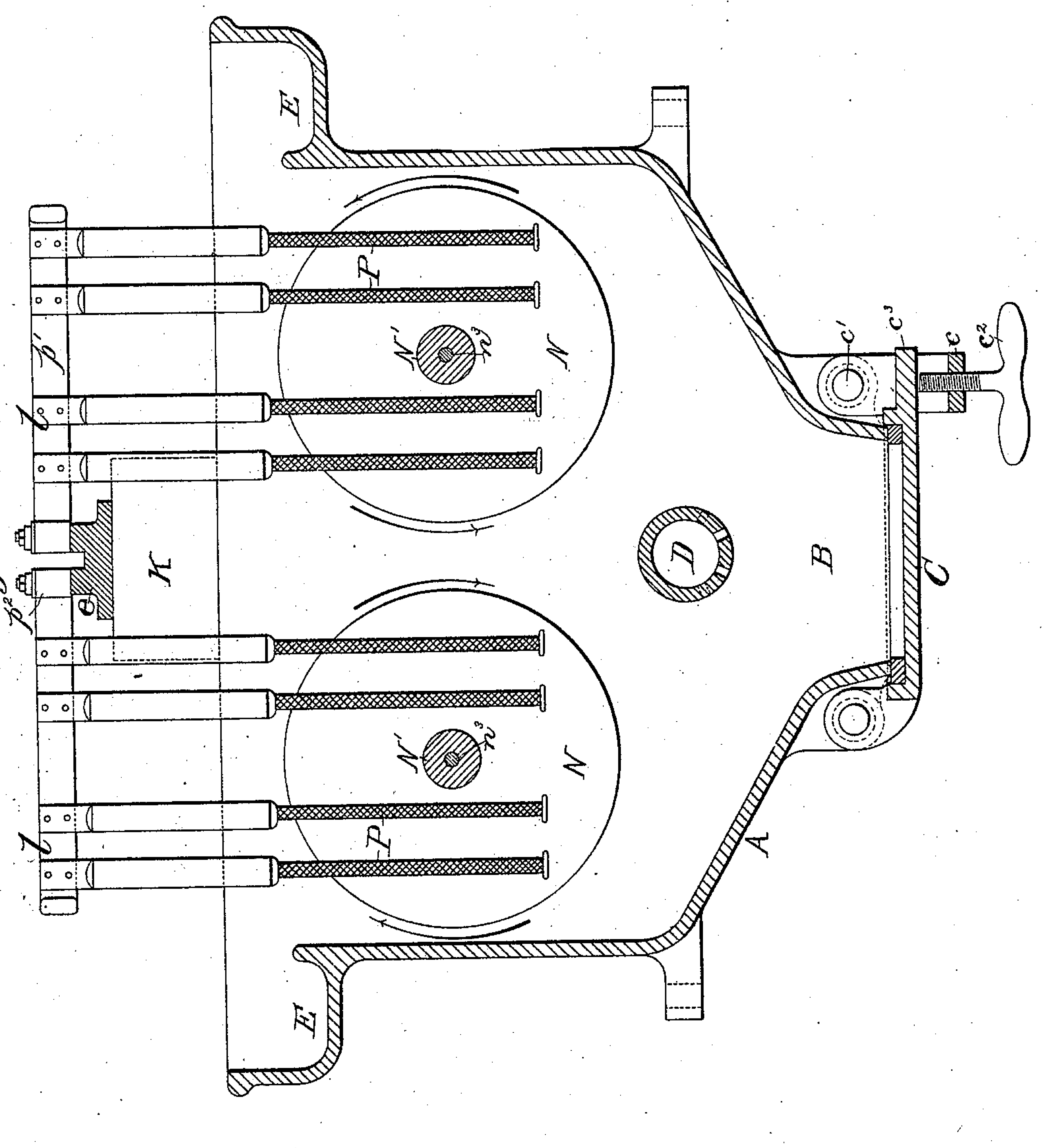
Fig. 2.



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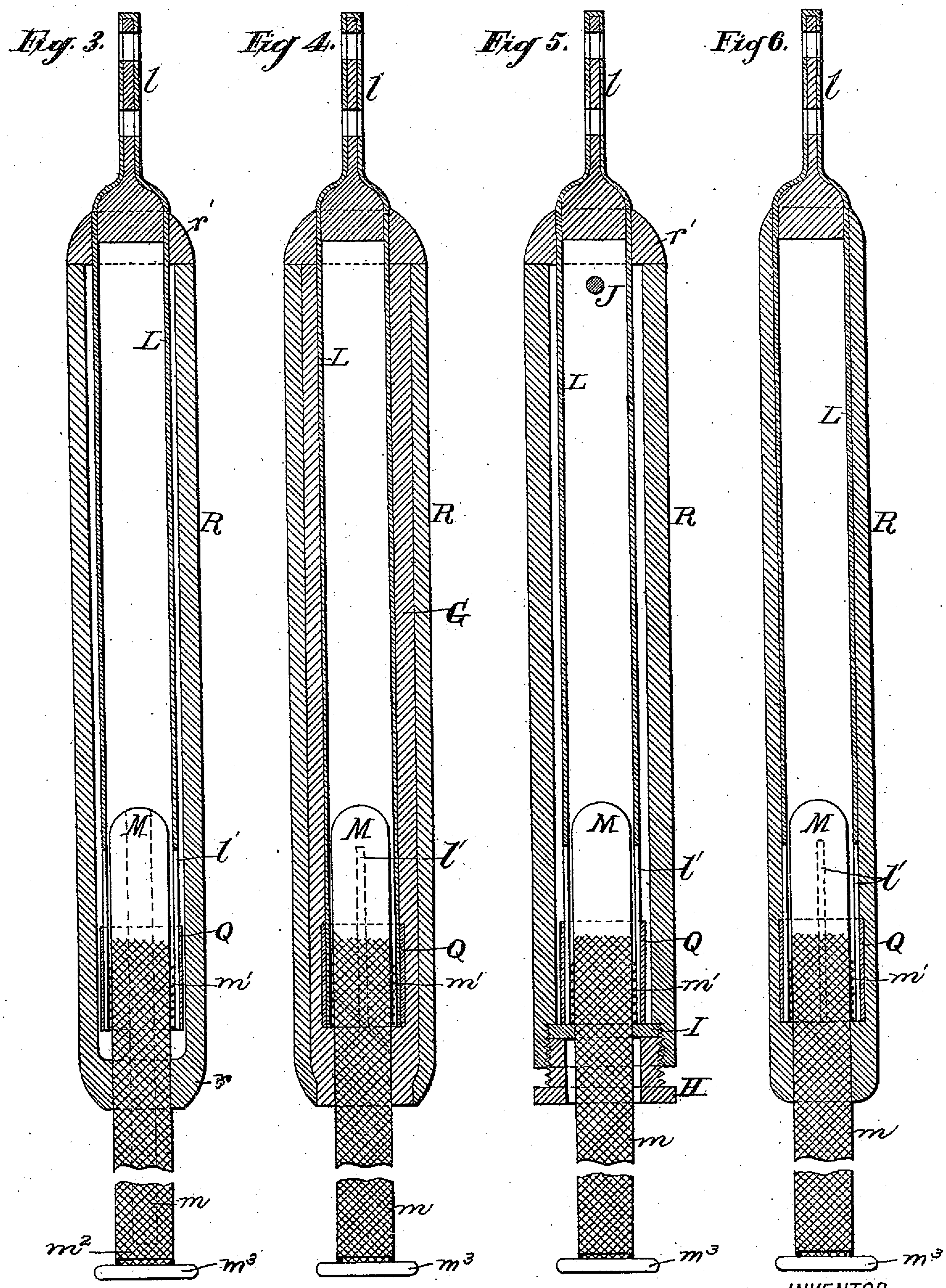

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UNITED STATES PATENT OFFICE.

EUGÈNE HERMITE, OF PARIS, FRANCE.

APPARATUS FOR PURIFYING OR DISINFECTING.

SPECIFICATION forming part of Letters Patent No. 575,645, dated January 19, 1897.

Application filed January 17, 1894. Serial No. 497,148. (No model.) Patented in France February 26, 1887, No. 181,832, and September 7, 1887, No. 185,699; in England April 13, 1887, No. 5,393, and in Belgium November 24, 1887, No. 79,699, and July 3, 1893, No. 105,383.

To all whom it may concern:

Be it known that I, EUGÈNE HERMITE, a citizen of the United States of America, residing in Paris, France, have invented a System of Purifying or Disinfecting, (for which I have obtained patents in France, No. 185,699, dated September 7, 1887, and No. 181,832, dated February 26, 1887; in Belgium, No. 79,699, dated November 24, 1887, and No. 105,383, dated July 3, 1893, and in Great Britain, No. 5,393, dated April 13, 1887,) of which the following is a specification.

The system of purifying or disinfecting forming the object of the present invention is based on the employment of a very energetic liquid disinfectant obtained by the electrolysis of chlorid of magnesium or of a mixture of chlorid of magnesium and chlorid of sodium, or, what is equivalent, by the electrolysis of sea-water or of the mother liquors of salt-works. This electrolysis is effected in an apparatus called an "electrolyzer," which will be described hereinafter, by way of example.

Numerous experiments have enabled me to prove the enormous advantages which the electrolysis of chlorid of magnesium presents above all chlorids for the production of oxygen compounds possessing considerable oxidizing, and therefore considerable disinfecting power, at a very low price. These experiments have allowed me to establish the theory of the method of decomposition of chlorid of magnesium under the action of a current of electricity. This theory is capable of being applied in the same way to the electrolysis of a mixture of chlorid of magnesium and chlorid of sodium or sea-water, since, as hereinafter explained, when the electrolysis takes place in the presence of the materials to be treated, the chlorid of sodium is not decomposed by the electric current, the chlorid of magnesium acting alone and in the same way as if the chlorid of sodium did not exist in the mixture, the latter body only serving as the conductor of the electricity.

To demonstrate in a better manner the advantages resulting from the employment of chlorid of magnesium, I will take up the question from a general point of view and indicate, summarily, the results of my experiments in that which concerns the electrolysis of alkaline or earthy alkaline chlorids.

When the alkaline or earthy alkaline chlorids are electrolyzed with inattackable electrodes, the water is decomposed by the current, the chlorin and the nascent oxygen go to the positive pole, where they combine immediately to form an oxygenated compound of chlorin, possessed of a high oxidizing power, and the metal passes to the negative pole, where it decomposes the water forming an oxid and liberating hydrogen.

If by any means whatever the oxygenated compound of the chlorin is absorbed in proportion to its production, there is obtained in the liquor an excess of the base formed at the positive pole. If, on the other hand, the base is left in the presence of the oxygenated compound, they combine, forming complex salts. The proof that these actions take place is that if the electrolytic operation takes place in a partitioned vessel the oxygenated compound of chlorin is obtained at the positive pole and the base at the negative pole. Another proof is that if these same chlorids be decomposed under the ordinary conditions it will be found that the base formed at the negative pole is largely in excess. In the electrolysis of chlorid of calcium, for example, there is obtained at the negative pole a deposit of oxid of calcium which accumulates in the liquor.

If, contrary to the foregoing theory, it be admitted that the decomposition of the chlorid produces free chlorin given off at the positive pole and alkali given off at the negative pole and that the chlorin, being in the presence of this alkali, combines to form a hypochlorite, no deposit should be obtained at the negative pole in the electrolysis of chlorid of calcium, because hypochlorite of lime and chlorid of calcium are both of them soluble. My general theory being thus fully verified by my experiments, I shall now examine what passes in the special case of the electrolysis of chlorid of magnesium. This electrolysis is effected in quite a characteristic manner. As in the case of the other chlorids the water and the chlorid are decomposed simultaneously, and there is formed at the positive pole the same oxygenated compound of chlorin. At the negative pole there is deposited the magnesium, which decomposes the water to form hydrate of magnesia with the liberation of hydrogen; but by a well-known reaction the hydrate of magnesia immediately reacts on the chlorid of magnesium of the bath, giving insoluble oxychlorid of magnesium, so that the oxygenated compound of chlorin formed at the positive pole is accumulated in a free state in the bath. Finding no oxid with which it can combine and when the solution is saturated with it, it comes off in the gaseous state and is recognizable by a particular odor, which is not that of chlorin. Further, the solution becomes strongly acid. From what precedes it will therefore be easily seen that the electrolysis of chlorid of magnesium differs clearly from that of the other chlorids. By virtue of the formation of oxychlorid, a substance which is not produced in the electrolysis of the other chlorids, the oxygenated compound of chlorin formed at the positive pole is found free in the liquor and preserves completely its remarkable properties of oxidation, and as no secondary phenomena is produced there is obtained the maximum production of mechanical work. It may therefore be safely affirmed that the electrolysis of chlorid of magnesium is distinguished in a decided manner from that of the other chlorids and that by virtue of the characteristic phenomena which accompany its decomposition by electricity it occupies a place apart in the chlorid family and cannot be compounded with any of the other bodies or members of this family.

If it be added that chlorid of magnesium is to be obtained at a low price and in abundance, whether obtained from mines or by evaporation, that its solutions offer a very feeble resistance to the passage of an electrical current, and that it is decomposed more easily by the action of a current of electricity than the other chlorids, because less heat is generated in its formation, it will be admitted that the selection of this body, which my researches had led me to make, is fully justified from all points of view. These preliminaries being settled, it is easy to explain how the oxygenated compounds of chlorin, thus obtained in the free state and in abundance by the employment of chlorid of magnesium, act upon the substances or matters to be disinfected. They act by oxidation, the oxygenated compound is decomposed, the oxygen acts upon the matters to be disinfected and destroys the infectious or corrupting organic constituents, depriving them of carbon and producing carbonic acid, while the chlorin combines with the hydrogen, so as to produce hydrochloric-acid gas, which is recovered, either free or in combination with magnesia, if an excess of the latter has been placed in the liquor, so that after the deoxygenation or deoxidizing of the disinfectant compound the whole of the chlorin is regenerated or recovered. As, in short, the oxygen is borrowed from the water the electric current constantly regenerates the disinfecting compound, the chlorin in which is restored or brought back to its original condition by the same action of disinfection. It is therefore a complete cycle in which the same molecule of chlorin is by turns oxidized and reduced, the water of the bath being consumed and the chlorin acting as a vehicle for the oxygen. This theory of disinfection being defined, thus it remains to be demonstrated that the action is in all respects the same when there is employed a mixture of chlorid of magnesium and chlorid of sodium or sea-water, in place of chlorid of magnesium alone.

If during the electrolysis of a mixture of these two chlorids the solution is made to circulate on the matters to be disinfected in the usual manner, the action produced is as follows:

The oxygenated compound of the chlorin oxidizes the putrid matters to be disinfected, as hereinbefore described, producing carbonic-acid and hydrochloric-acid gas, which, if care has been taken to put a certain quantity of gelatinous magnesia into the bath, combines with the latter to recover the chlorid of magnesium.

The proportion of chlorid of magnesium remaining thus constant in the bath, it is always this chlorid, being the more easily decomposable, which is so acted upon, and the chlorid of sodium undergoes no decomposition. It performs, therefore, a purely physical function and acts simply as a conductor.

To demonstrate that the action hereinbefore described is taking place, it is sufficient to add some caustic soda to a filtered portion of the bath and there is obtained an abundant precipitate of magnesia. Now if the chlorid of sodium were decomposed by the current caustic soda would be formed, which would precipitate the magnesia of the bath, and no chlorid of magnesium would remain in the solution, so that no precipitate could be produced by the action of the caustic soda.

The disinfecting liquid obtained by the electrolysis of the chlorid of magnesium, either alone or as a mixture with chlorid of sodium, is, as hereinbefore explained, applicable to the disinfection of all sorts of matter and can in consequence be utilized with great success for sanitation of towns and dwellings, treatment of sewage, cesspools, holds of ships, stagnant waters, &c.

The apparatus employed to prepare the electrolyzed solution of chlorid of magnesium or mixture of chlorid of magnesium (sea-water, mother-water from salt-works, &c.,) with a view to practically realizing my system of sanitation and disinfection is hereinafter described with reference to the annexed drawings.

In the drawings, Figure 1 represents a longitudinal section of the "electrolyzer;" Fig. 2, a transverse section of the same; and Figs. 3, 4, 5, and 6 represent, respectively, in vertical section, several varieties of construction of the positive electrode employed in the said electrolyzer.

The apparatus consists of a vat A, having at its base a discharging-hole B, closed by a hinged lid C. This closing is effected by the aid of a catch c, pivoted at c', and carrying a screw c^2, which can be pressed against the lug c^3, forming part of the lid C. In this vat or tank are placed the positive electrodes P and the negative electrodes N, and in it also the solution to be electrolyzed circulates. The solution is introduced into the vat through a hole arranged at the base, either directly or by means of a perforated pipe D, which distributes it uniformly over the whole length of the apparatus. The electrolyzed solution overflows into a gutter E, extending all around the vat, and which is inclined toward the discharge-orifice F, through which the electrolyzed solution leaves the apparatus.

The negative pole of the source of electricity from which the current is obtained is electrically connected by means of the lug n with the body of the vat A, and consequently with the series of negative electrodes N, which are in contact with the said vat. The positive pole is connected to the positive electrode P by means of the bar p, which extends across the whole length of the apparatus.

The positive electrode is made up of a series of zinc disks carried by one, two, or more shafts N'.

The construction to which I give the preference consists in casting the shaft N' and the disks N in one piece in zinc, and inserting in the interior of the shaft one or more iron rods n^3 in order to strengthen it.

The shaft N' is furnished at its two ends with bronze bushes or sleeves n' n^2, which project through the sides of the vat. The bush n' is inclosed in a cap n^4, bolted to the vat, but having an india-rubber packing-ring n^5 interposed to make a liquid-tight joint, and the lining n^2 projects through the vat and passes through a gland n^6. On this bush n^2 there is keyed, at the extremity of the shaft, a gear-wheel n^7, employed to transmit, by any well-known means, a slow rotary movement to the zinc disks.

The positive electrode is made up of a series of rods P, divided into groups of four or any other number and fixed by rivets, screws, or in any other manner to transverse bars p', provided at their extremity with an eye p^2, which enables them to be bolted on the longitudinal bar p, which in turn is connected to the positive pole of the source of electric energy. This bar p is fixed by two lugs e on two insulating-supports K. The rods P, constituting the positive electrodes, are each suspended between the zinc disks N, forming the negative electrode.

Each positive electrode is constructed in the following fashion, as shown drawn to a larger scale in Figs. 3, 4, 5, and 6:

A tube L, made of copper or other conducting material, conveys the current to a platinum-wire cloth m, rolled round a rod or tube M, made of glass, crystal, ebonite, or other insulator which is not liable to be affected by the solution. This tube L is fixed to the transverse bar p' at its upper extremity l, which is flattened out and provided with holes, enabling it to be secured in position. The metallic cloth m and its support M are immersed into the solution to be electrolyzed. The support M may have a flanged lower end m^3, as shown.

The connection between the conducting-tube L and the tube or rod M must be made in such a manner that the said tube or rod M fits tightly the interior of the tube L and that a perfect contact is obtained between the said tube L and the platinum cloth m, surrounding the rod M. With this object I provide at the base of the tube L two, four, or any other number of slots l', and I wrap around the upper end of the platinum cloth m a thin wire m', of lead or any other compressible and conducting metal. I introduce the upper end of the rod or tube, as well as this wire m', into the slotted part of the tube L. The pressure and perfect contact of this tube L on the lead wire m', and consequently on the platinum cloth, is obtained by means of a copper ring Q. The lead wire is compressed by the pressure of this ring and establishes a perfect contact between the copper tube L and the platinum cloth m.

The copper tube L and the portion of the tube where the junction is formed between it and the platinum cloth m must be perfectly isolated from the solution.

In order to obtain this separation in an effectual manner, I show in Figs. 3, 4, 5, and 6 four arrangements to which I give the preference, but I reserve the right to obtain this separation in any other suitable way.

In Fig. 3 the support M of the platinum cloth consists of a glass or crystal tube closed at its lower end m^2. The copper tube L is surrounded by a cylinder R, which is likewise constituted by a glass or crystal tube fitting loosely on the metal tube L. To insure perfect tightness of the joint at the lower end r of the tube R and to prevent the solution ascending into its interior, this tube R is welded or fused at r on the tube M, so as to engage the cloth m in the joint or weld m and so that the tubes L M form one piece. The upper extremity of the tube R is closed at r' with mastic or any other suitable insulating material. In this construction it is expedient to employ a tube and not a rod for the support M, with a view to providing for the necessary expansion to be able to make the fused joint.

In Fig. 4 the cylinder R is similarly a tube made of glass, crystal, or other insulator of a diameter sufficiently large to be able to pour into and fill it with insulating material G, such as wax, mastic, resin, or other convenient material, to make a tight joint from end to end of the tube R.

In Fig. 5 the cylinder R is a tube of ebonite or other insulator provided with an internal screw-thread at its lower end, so as to be able to receive a hollow nut H, of ebonite or other insulating material, compressing a washer I, made of india-rubber or other yielding and insulating material, so as to constitute a gland forming a tight joint. The upper end of the tube R and the metal tube L are traversed by a spindle J, allowing the tube R to be held fast during the tightening of the gland. Resin or other insulation r' closes the upper end of the tube R, which, if preferred, may be provided with a gland similar to that at the lower end.

In Fig. 6 the external insulating-casing R is composed of a thickness of ebonite, ivorine, or other insulator capable of being cast, molded, or compressed directly on the metal tube L and on the upper end of the rod M, surrounded by the platinum cloth *m*, so as to form one piece with this cylindrical rod and to insure the perfect tightness of the joint of the tube L and of the rod or tube M.

It is evident that I do not limit myself to the details of construction as hereinbefore described and that I reserve the right of introducing any modification which practice may suggest.

I claim as my invention—

1. The mode herein described of disinfecting consisting in electrolyzing a solution containing chlorid of magnesium and subjecting the material to be disinfected to the action of the electrolyzed solution, substantially as set forth.

2. The mode herein described of disinfecting, consisting in electrolyzing a solution containing a mixture of chlorid of magnesium and chlorid of sodium, such as sea-water or mother liquors from salt-works for instance, and subjecting the material to be disinfected to the action of such electrolyzed solution, substantially as described.

3. An apparatus for the electrolysis of solutions of chlorid of magnesium or of a mixture of chlorid of magnesium and chlorid of sodium, consisting of a vat in which are arranged one or several revolving shafts carrying a series of zinc disks and constituting the negative electrode, in combination with the positive electrodes situated between these disks and consisting of rods or tubes of glass, crystal or other insulating material having platinum cloth thereon, substantially as hereinbefore described.

4. In electrolytic apparatus, the positive electrode consisting substantially of a rod or tube of glass, crystal, or other insulating material, covered with a platinum cloth, in combination with a tube of copper or any other conducting metal, slotted at its lower end to receive the top end of the tube or rod of glass and of the platinum web, with a compression-ring around the conducting-tube, with a wire of lead or other soft conducting material wound around the end of the platinum cloth, and with a view of insuring the perfect compression and contact between the conducting-tube and the platinum cloth, and in combination with means for preserving the conducting-tube and the joint of this tube with the platinum cloth from contact with the liquid to be electrolyzed, substantially as hereinbefore described.

5. A positive electrode having a glass tube with a platinum covering, a glass insulating-casing R, fused or welded at its lower extremity to the glass tube, supporting the platinum cloth, so as to include this in the weld and form a tight joint at this point, substantially as hereinbefore described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EUGÈNE HERMITE.

Witnesses:

LÉON FRANCKEN,
DAVID T. S. FULLER.