(No Model.) 2 Sheets—Sheet 1.

E. ANDREOLI.

APPARATUS FOR PRODUCING OZONE BY ELECTRICITY.

No. 512,265. Patented Jan. 9, 1894.

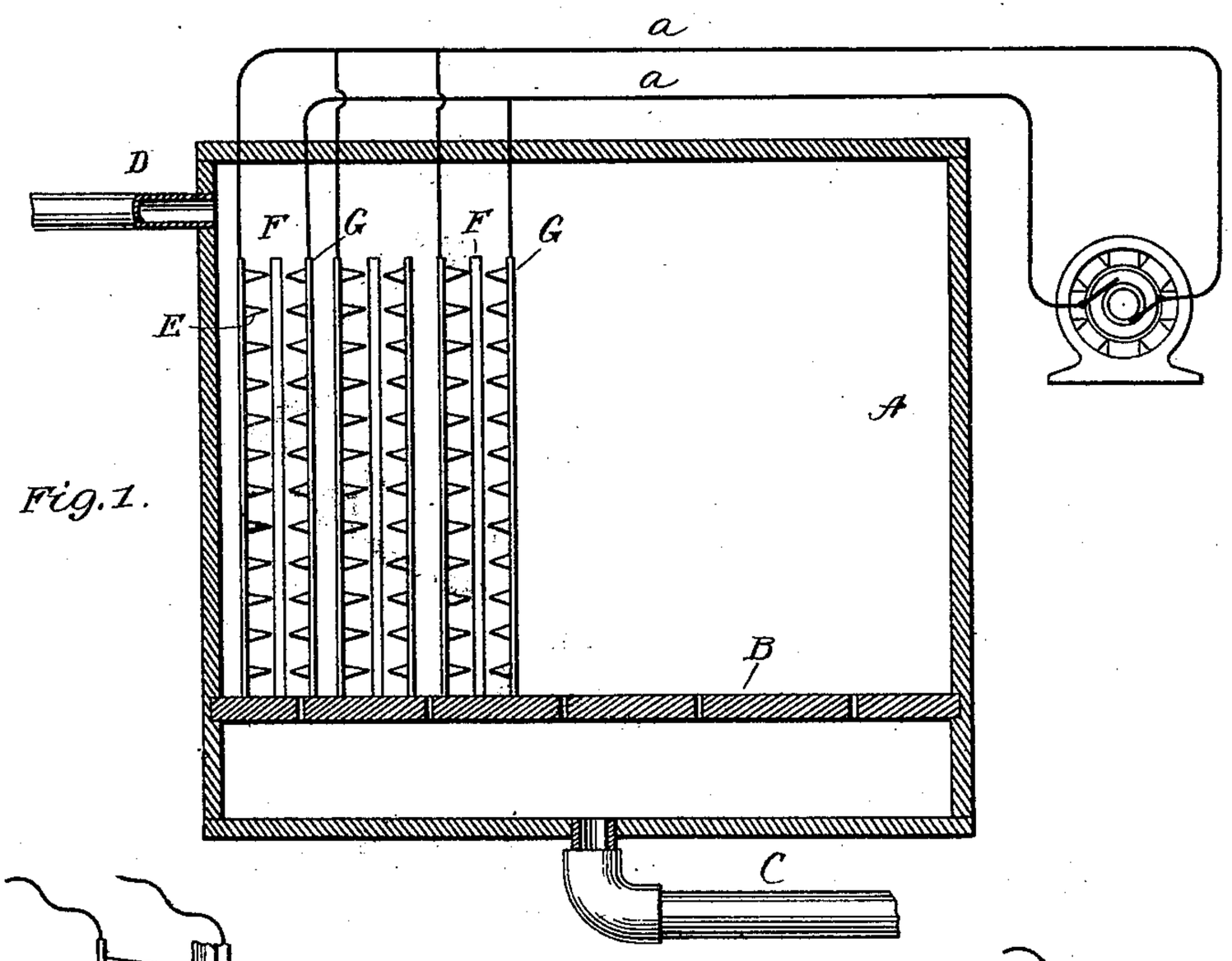


Fig. 1.

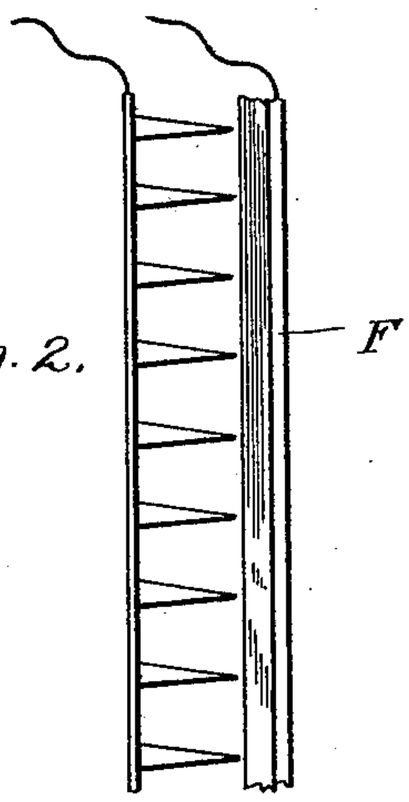


Fig. 2.

Fig. 3.

Fig. 4.

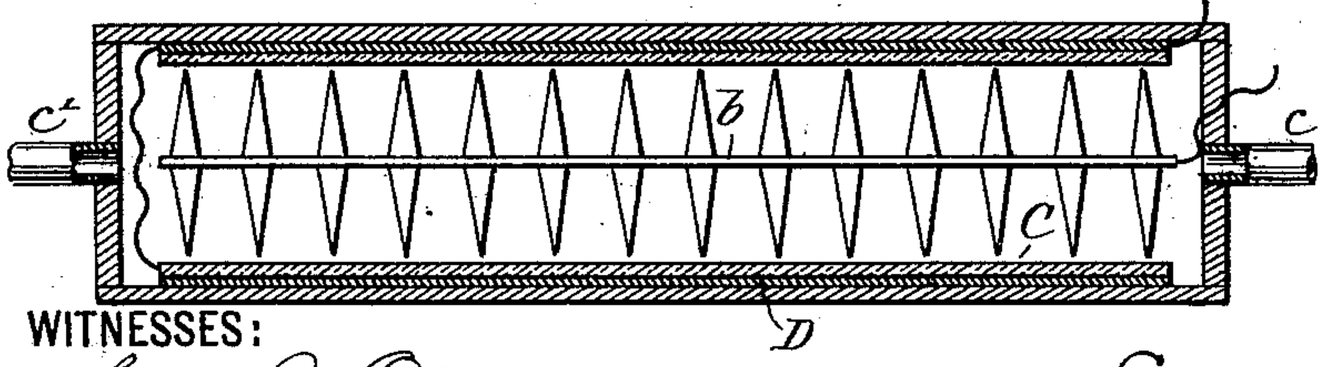
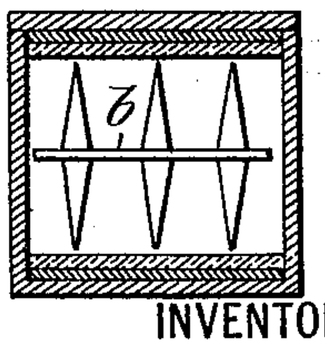


Fig. 5.



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(No Model.) 2 Sheets—Sheet 2.

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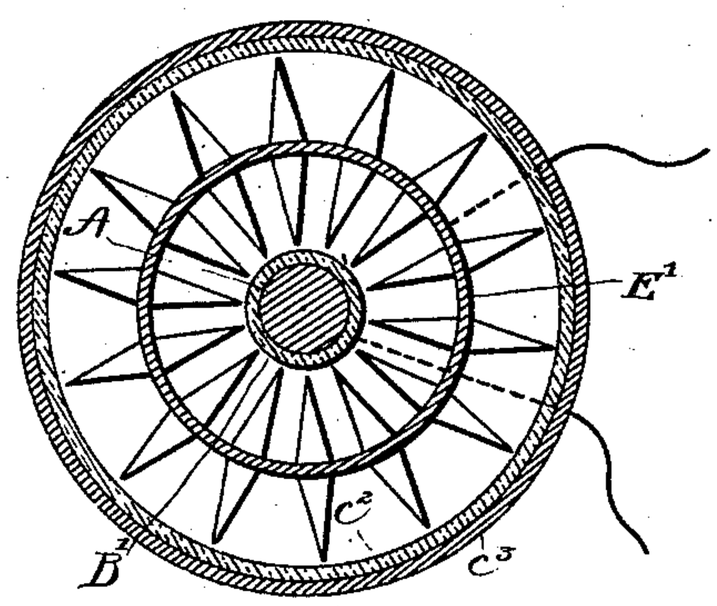
Fig. 6.



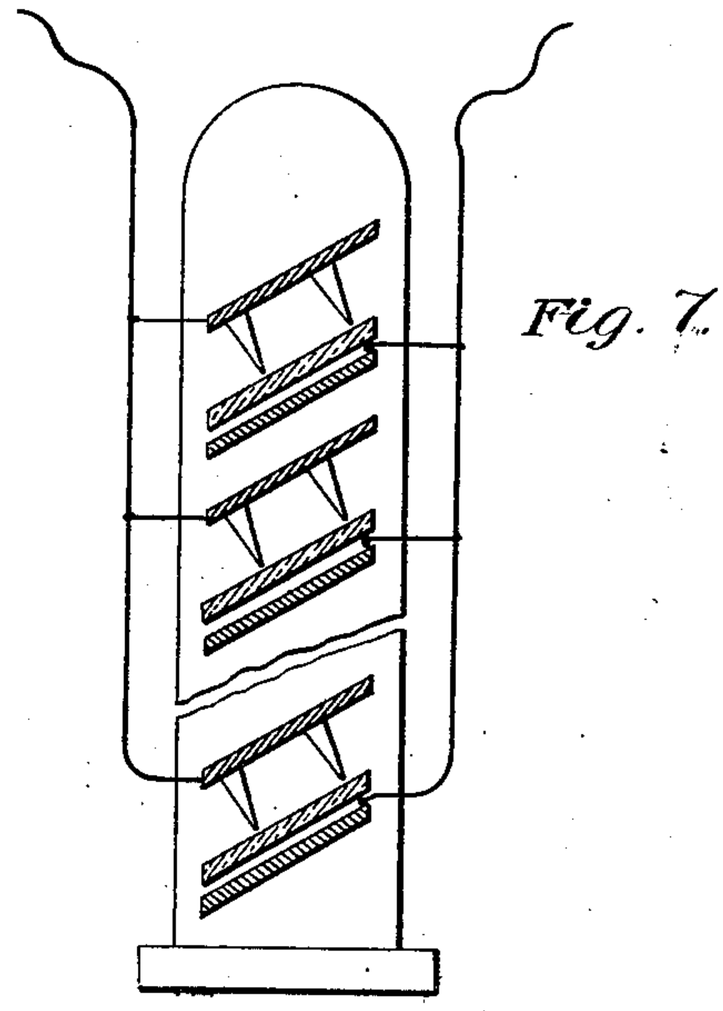


Fig. 7.

Fig. 8.

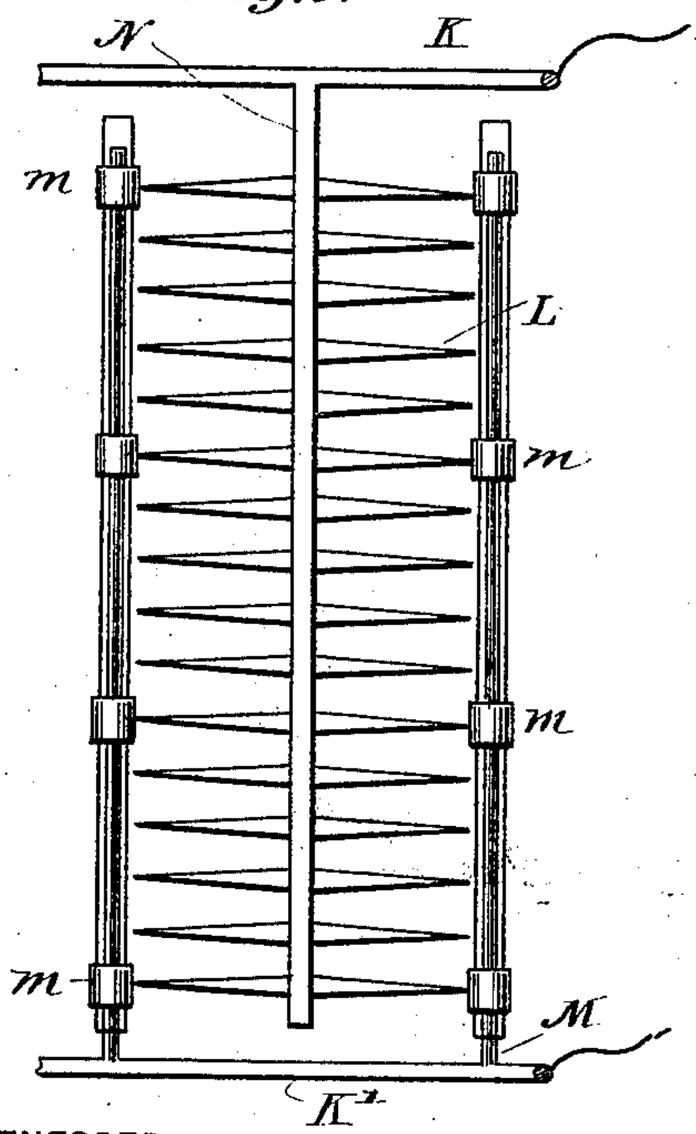
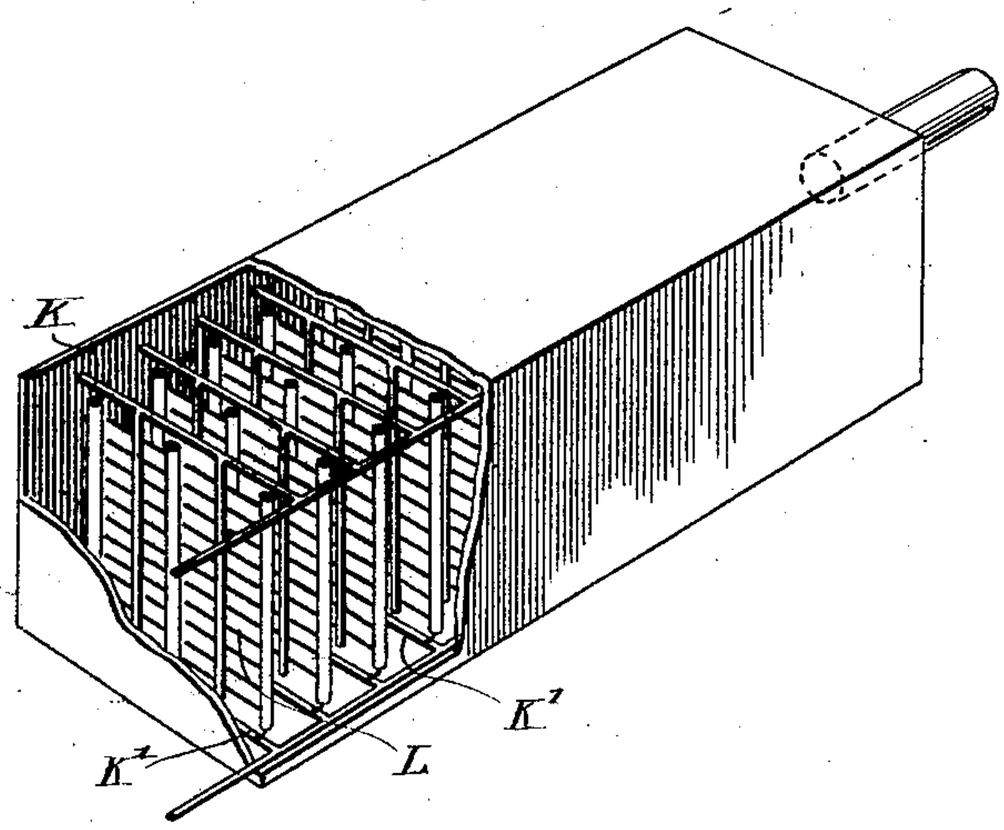


Fig. 9.



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EMILE ANDREOLI, OF LONDON, ENGLAND.

APPARATUS FOR PRODUCING OZONE BY ELECTRICITY.

SPECIFICATION forming part of Letters Patent No. 512,265, dated January 9, 1894.

Application filed August 25, 1892. Serial No. 444,064. (No model.) Patented in England October 13, 1891, No. 17,426, and May 20, 1892, No. 9,631; in France April 14, 1892, Nos. 207,706 and 207,707, and May 23, 1892, No. 208,654; in Belgium June 2, 1892, No. 75,564, and in Germany June 10, 1892, No. 13,954.

To all whom it may concern:

Be it known that I, EMILE ANDREOLI, a citizen of France, residing at Brixton, London, in the county of Surrey and Kingdom of Great Britain, have invented certain new and useful Improvements in Apparatus for Producing Ozone by Electricity, of which the following is a full, clear, and exact description, and patented in the following countries: Great Britain October 13, 1891, No. 17,426, and May 20, 1892, No. 9,631; France April 14, 1892, Nos. 207,706 and 207,707, and May 23, 1892, No. 208,654; Belgium June 2, 1892, No. 75,564, and Germany June 10, 1892, No. 13,954.

This invention relates to the production of ozone by electrifying oxygen or atmospheric air in an apparatus which enables me to produce, in a cheaper and simpler manner than has been done heretofore, ozone for commercial uses such as bleaching paper pulp or fibers, yarns, tissues, treating oils, liquids, and organic and inorganic substances or applying to therapeutic or hygienic purposes.

Briefly described, my invention consists in effecting silent discharges by aid of point bearing electrodes, separated from the electrodes of the opposite pole by a layer of dielectric placed close to the points.

Heretofore in ozone producing apparatus, the points of the electrodes touch the dielectric, while in my apparatus, the points are only close to the dielectric which increases the action of the effluvia. Where the points touch the dielectric, the glow which appears on the points, due to the silent discharges, produces a greater rise in temperature.

In the forms of my invention where the ozonizers are open, hardly any heat is developed.

In the accompanying drawings, in which similar letters of reference indicate like parts, Figure 1, indicates one form in which my invention is employed, showing a series of plates with points and dielectrics inclosed in a casing. Figs. 2 and 3 are detail views showing detail constructions in which the points are arranged close to a single plate or dielectric. Fig. 4 is another form or arrangement of the invention in a closed box. Fig. 5 is a form to be used as an inhaler. Fig. 6 is a cylindrical form, termed the "hedgehog" type. Figs. 7, 8, and 9 represent other forms.

In the accompanying drawings, Fig. 1 shows a closed box A, made of marble or other suitable non-conducting material or of wood internally coated with pitch, or lined with glass or other convenient non-conducting material, not acted upon by ozone. In this box are shown mounted three pairs of a series of plates E and G on an electric circuit, between which plates E G, a dielectric plate F of glass, mica or other equivalent is situated. This box is provided with a false bottom B, which is pierced with many small holes to admit dry air or oxygen, to be forced at a convenient speed into the box, by a pump or injector, through a pipe C, for the purpose of being acted upon in its passage through the box, by the electric effluvia generated therein. The plates E and G are respectively connected with the opposite poles of an induction coil, or an alternating current dynamo, for the purpose of producing silent discharges into the air passing through the box. The air thus submitted to the electric effluvia is more powerfully ozonized than if instead of points I used flat surfaces, or if instead of an induction coil, an influence electric machine had been used. The ozonized air escaping through the pipe D may be conducted to some suitable receptacle or utilized at once.

The box A which I will call the ozonizer may be provided with several outlets and inlets instead of one.

To facilitate the production of ozone, from atmospheric air or oxygen, it is advisable to cool the air or oxygen, either by passing it through a coil surrounded by ice and salt or other refrigerating compound or by cooling down the compartment below the false bottom B, or the whole box B to a low temperature; this can be done by any known means.

The ozonized plates E G are made of tinned iron, copper aluminum or other convenient metal or alloy, but especially tin or an alloy of tin, fitted with pins and disposed in such a way that the points of one plate correspond, as nearly as may be, with the points on the opposite plate. Each plate E of the series of pairs will be connected with one terminal of

a Ruhmkorff coil or of an alternate current dynamo or some other convenient apparatus for producing high potential electricity and the plates G of the series will be similarly connected with the other terminal of the same apparatus. When the current flows through the receiving plate a phosphorescent glow, which is the characteristic feature of the silent discharge, appears between all the points and illumines the surface of the interposed dielectric plates F. This is accompanied by the strong peculiar smell of ozone. Through the walls of the ozonizer A, pass the wires *a*, which connect the plates with the source of electricity, care being taken that the wires are thoroughly insulated. Instead of having the plates arranged in the ozonizer so as to have their points opposite each other, I may have, as in Fig. 2, the points of one plate facing a plain plate, or as in Fig. 3, facing balls or small disks, carried by a pinned plate. The point bearing plates will be preferably made after the manner of gill-bars and the pins may be protected from oxidation by a coating of tin, or the points for diffusing the electric discharge may be obtained by the employment of wire brushes, composed of copper of other suitable material.

I do not confine myself to any size or shape of electrodes; it must also be understood that I can dispose together any number of couples in such electrodes. In all cases, I prefer tin among the cheap metals.

Fig. 4 shows an ozonizer, which instead of working in the air, so that the ozone circulates and spreads out in the room, is in the form of a rectangular box or tube made of glass or porcelain, or other insulating material. This ozonizer is fitted inside with a plate *b*, bearing points on both sides, between two sheets of tin or tin-plate D′, carefully tinned on the edges to prevent rust, the point bearing and flat electrodes being separated by a piece C′ of glass, mica, &c. At one end of this ozonizer is an inlet *c* for the air or oxygen which is forced into the apparatus; at the other end is an outlet *c′* through which the air escapes after its oxygen has been ozonized while passing between the points and the dielectric separating them from the opposite electrode under the influence of the electric effluvia. See Fig. 5. This form of apparatus may be used as an inhaler. Instead of having as dielectrics two sheets of glass fixed one on each side of the double point bearing electrode between it and the two flat electrodes which face it on either side, I may use enameled flat electrodes, that is metallic plates perfectly coated with a sufficient layer of enamel to avoid the formation of sparks. Enamel acts as a dielectric in the same way as glass or mica, and this device allows me to have three plates for each element instead of five plates, as in the arrangements shown in Figs. 4 and 5.

For the sake of saving labor and money, the numerous points, pins, &c., which are fixed on the plates can be obtained by casting the point bearing electrodes in appropriate molds so as to have a plate of uniform thickness, the pins of the same length and size having their ends more or less sharp or blunt, or of an arrow, angular or triangular shape, or otherwise, as desired. Another way of obtaining point bearing plates in an economical manner is to punch, stamp or emboss sheets of metal by mechanical means in such a way that on one side or on the two sides of the metal sheet angular portions of a convenient length and shape will protrude or project and will work exactly as pins fixed by riveting or soldering on metal; the same result may be obtained by using strips shaped like fret saws or band saws fixed on a metal frame their toothed edges being parallel with and close to a dielectric sheet with a plain plate as electrode on the other side of it. Instead of such parallel plates, disposed at a convenient distance in a closed box, I prefer in many cases to use cylindric ozonizers which I construct in the following manner:

Fig. 6 shows a transverse section of a cylindrical ozonizer, of what I call the hedgehog type. A′ is a metallic core, inserted in a glass or earthenware or other dielectric tube B′; this core is thoroughly tinned, in order to prevent corrosion, and provided with a wire which is connected to one of the poles of the source of electricity. The tube B′ is hermetically closed at both its ends which must be coated with insulating material. Instead of a tube or metallic core, I may have an iron or copper core, thickly coated with enamel and connected in the same manner to one of the poles of the source of electricity. Around this tube containing a tin or tinned metal core, or round the enamel cylinder is the double point bearing plate E′, rolled into the form of a cylinder, which communicates by means of a wire c^4 with the other pole of the coil or dynamo. This porcupine cylinder is closely enveloped by a metal tube enameled inside and outside or by a glass or earthenware tube C^2 surrounded with a metallic cylinder C^3 which is connected with the core by means of a wire.

When I have to produce large quantities of ozone for commercial purposes or to ozonize the air of hospital wards, assembly halls, &c., I use large ozonizers of the hedgehog type packed together and suitably connected with the source of electricity, in an air tight tank. The tank is made of insulating material, not acted upon by ozone, and provided with an inlet and outlet pipe. The ozonizers may be supported in position by built up partitions, which insure all the air or oxygen supplied to the tank passing through the ozonizers. The air or oxygen which I supply to the tank, by means of a pump, circulates through the ozonizers and emerges by the outlet charged with ozone, ready to be diffused through the

room or building, or employed for bleaching or other purposes or stored for subsequent use. I may have also larged closed boxes or tanks containing, instead of porcelain cylinders, as many couples as required of large double point bearing plates, of the kind shown in Fig. 5, and of the plain plates either enameled or having dielectric plates intervening between them and the points. Before being ozonized, the atmospheric air may be passed through filtering boxes containing cotton, wool or other suitable material so that all solid impurities in suspension are stopped and cannot penetrate into the ozonizer.

Other forms of apparatus are constructed as follows:—Fig. 7 shows a transverse section of the pairs of plates, one pointed and the other plain, suitably connected, with the sheet of glass or other dielectric between fixed in position resembling the laths of a Venetian blind.

The distinguishing feature of my invention is, as already shown, the use of points, angles or other projections located close to, but not touching the dielectric from which points the electric discharge occurs more rapidly than from a flat, corrugated or undulated surface. I do not confine myself to the use of points, needles, carding brushes, or other pointed things such as I have described above. As I can use, especially for the small ozonizers very fine band saws or other equivalents in the shape of very fine metallic wires of any shape convenient for the production of ozone. Fine metallic cords stretched upon glass, separating them from a metallic electrode, similar to the stretching of the strings of a piano, mounted upon the sounding board, can be used, as well as any metallic substance which has a sharp edge which can be considered as being equivalent to a series of points adjoining each other and forming a continuous chain on which the electric charge cannot stay and discharges, in a continuous stream, effluvia, as the surrounding air, which is in itself a dielectric, does not offer upon points, sharp edges or fine metallic wires the same resistance as on flat, curved, corrugated or undulating surfaces; hence the flow is relatively weakened.

Instead of perforated or non-perforated plates, provided with many points, nails, &c., or upon which are formed by stamping or otherwise, tongue-shaped projections from which the effluvia flows, I also use preferably, as supports, grids or metallic open work on both sides of which are conveniently fixed long metallic bands the edges of which are cut out into teeth like combs or saws.

Figs. 8 and 9 show an efficient arrangement of the above mentioned kind which constitutes an improvement both as regards working, economy and simplicity of construction. K is a tinned metallic rod, to which are perpendicularly fixed metallic bands N whose edges L are stamped into double combs, the points of which are of equal length. K′ is a metallic rod on which rest and are fixed all the metallic rods M which are inclosed in glass tubes and form the second electrode. Enameled metallic rods may be substituted for these.

At various places on the glass tubes I wind very tightly, and cement it to the glass, a fine copper wire so as to form a small ring *m*, or I can fix on these tubes, small thin bands of copper or other metal. From these rings, previously tinned, I allow a short wire to project one or two millimeters, formed by twisting the two ends of the wires, around the tube, and I solder to these the points of the opposite comb-like plates. Fig. 8 shows the comb N between the two glass tubes, each inclosing the metallic electrode M M, and *m*, *m*, *m*, *m*, the four rings or bands joined to the combs. Fig. 9 shows an ozonizer, in which can be placed, as many rows of the electrodes shown in Fig. 8 as is desirable. The air or oxygen is introduced at the required rate by means of an injector, and passes either through a false bottom or along the walls of the ozonizer which is preferably long and narrow. Instead of its passage being impeded by glass plates or metallic plates either plain or perforated preventing its uniform diffusion between the electrodes and its consequent ozonization, it circulates freely, and the action of the effluvia which arises on the numerous points is rapid and very powerful.

It will be easy to understand the advantages derived from the application of this new arrangement in the construction of ozonizers of every shape and dimension for the production of ozone on a small as on a commercial scale.

Having thus described my invention, I claim—

1. An apparatus for the production of ozone consisting of a closed chamber having inlet and outlet passages in combination with a pair of electrodes located therein, one of the same provided with a series of points or projections, close to, but not touching, the dielectric, a sheet plate or layer of dielectric material interposed between said electrodes and a source of alternating currents connected to said electrodes, substantially as described.

2. An apparatus for the production of ozone, consisting of a closed chamber having inlet and outlet passages in combination with a plurality of pairs of electrodes provided with a series of points or projections, close to, but not touching, the dielectric sheets, plates or layers of dielectric material interposed between said electrodes and a source of alternating currents of electricity, the terminals of which are respectively connected with one of each pair of the said electrodes.

3. In an apparatus for the production of ozone, point-bearing electrodes, in combina-

tion with a dielectric located between and facing the points of the electrodes, but not touching the same.

4. In an apparatus for the production of ozone, point-bearing electrodes, in combination with an enameled plate, located between and facing, but not touching, the electrode points.

In testimony whereof I subscribe my signature in presence of two witnesses.

EMILE ANDREOLI.

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