No. 607,007. Patented July 12, 1898.

E. ANDREOLI.

APPARATUS FOR MANUFACTURING OZONE.

(Application filed Oct. 15, 1897.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 3.

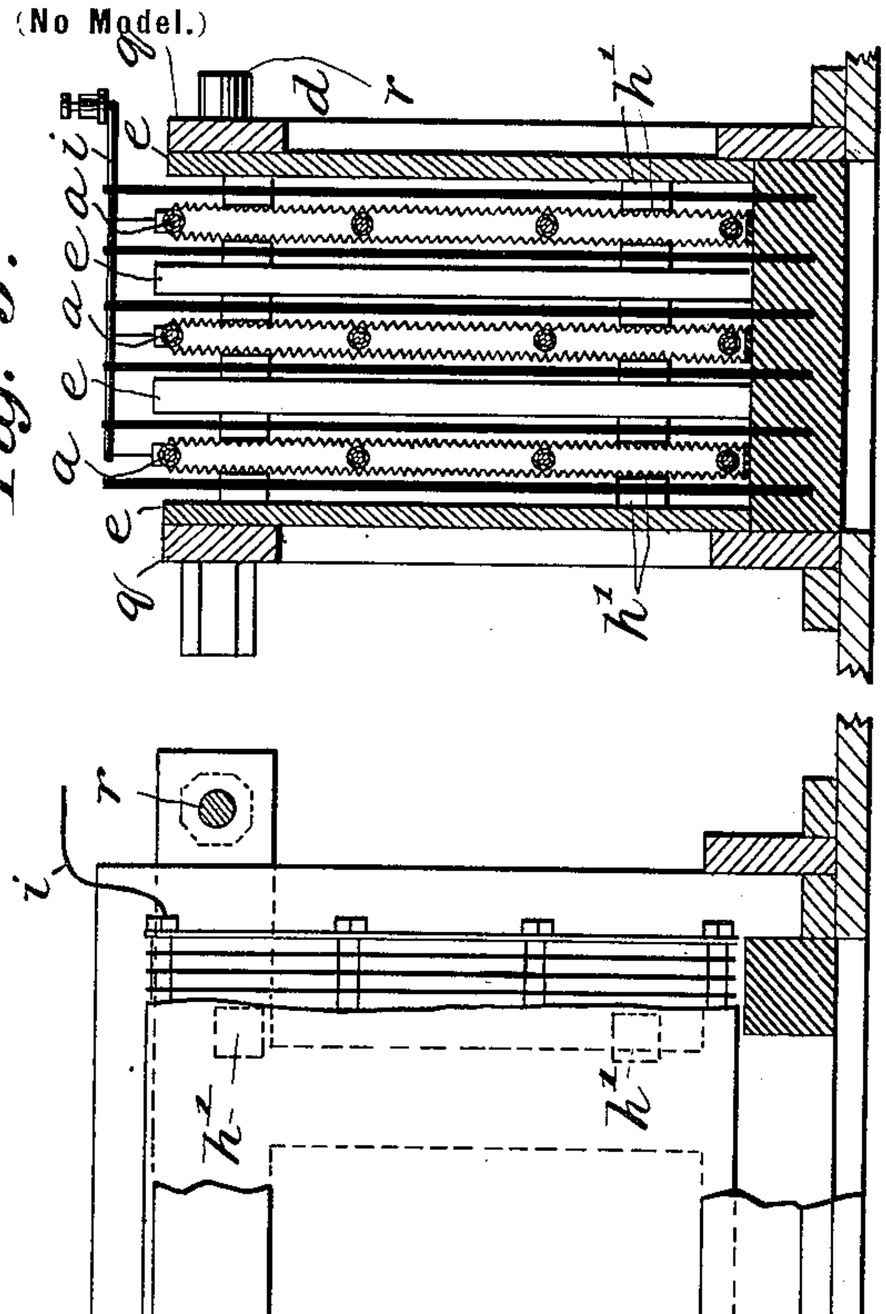


Fig. 1.

Fig. 4.

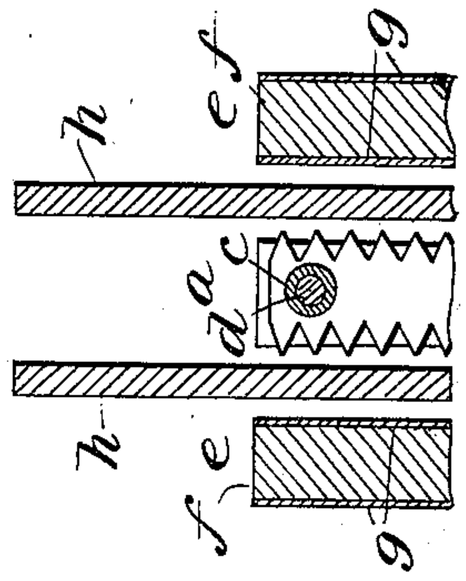
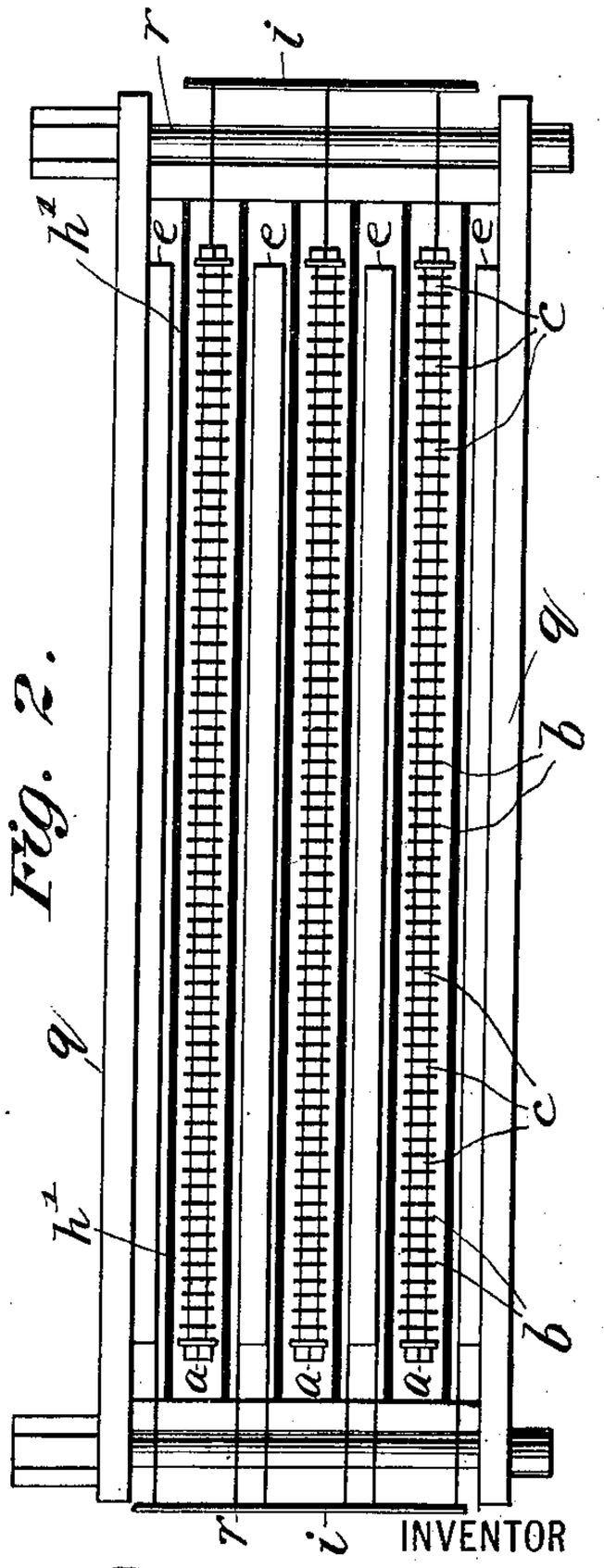


Fig. 2.



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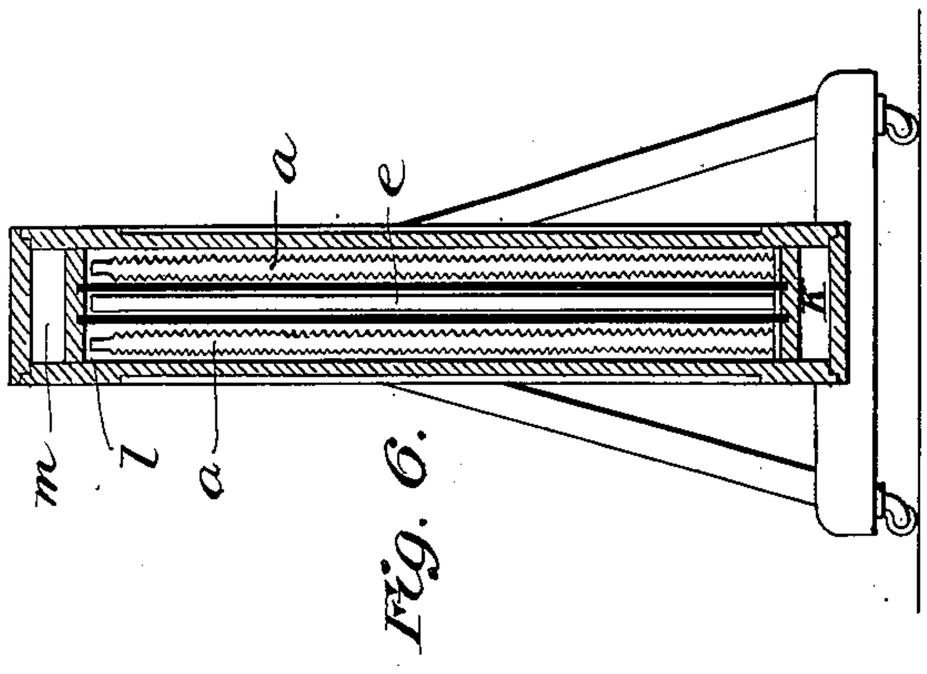

Fig. 6.

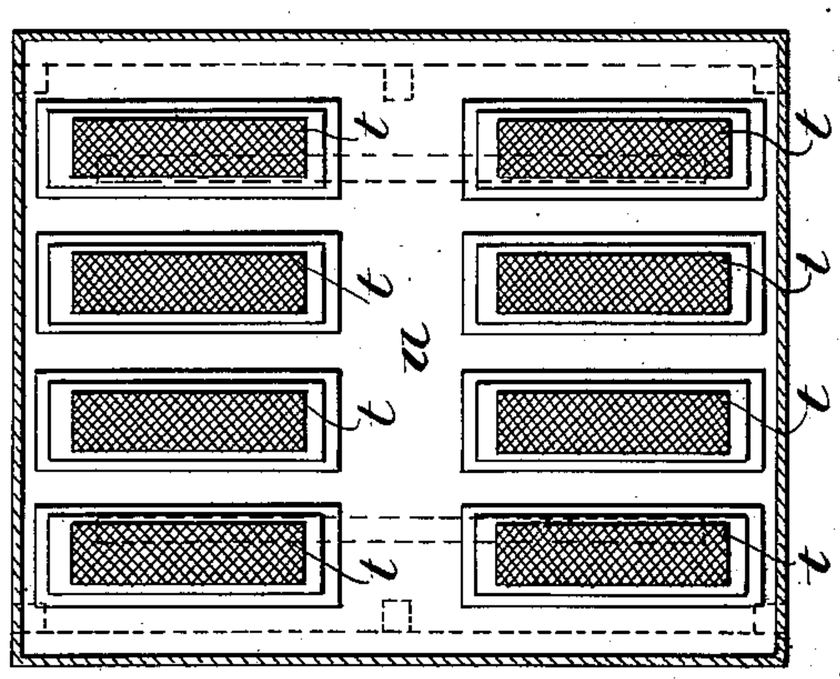

Fig. 8.

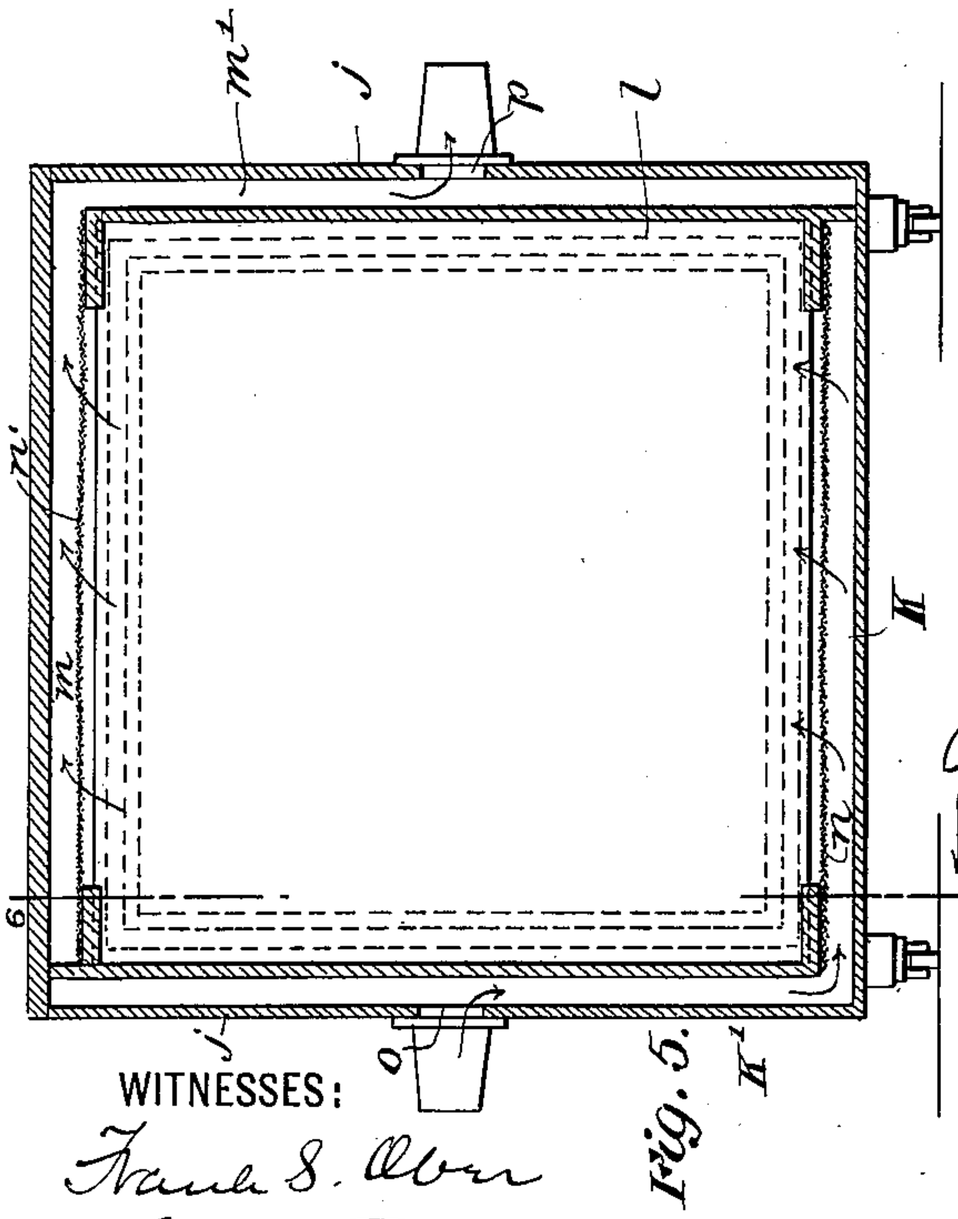

Fig. 5.

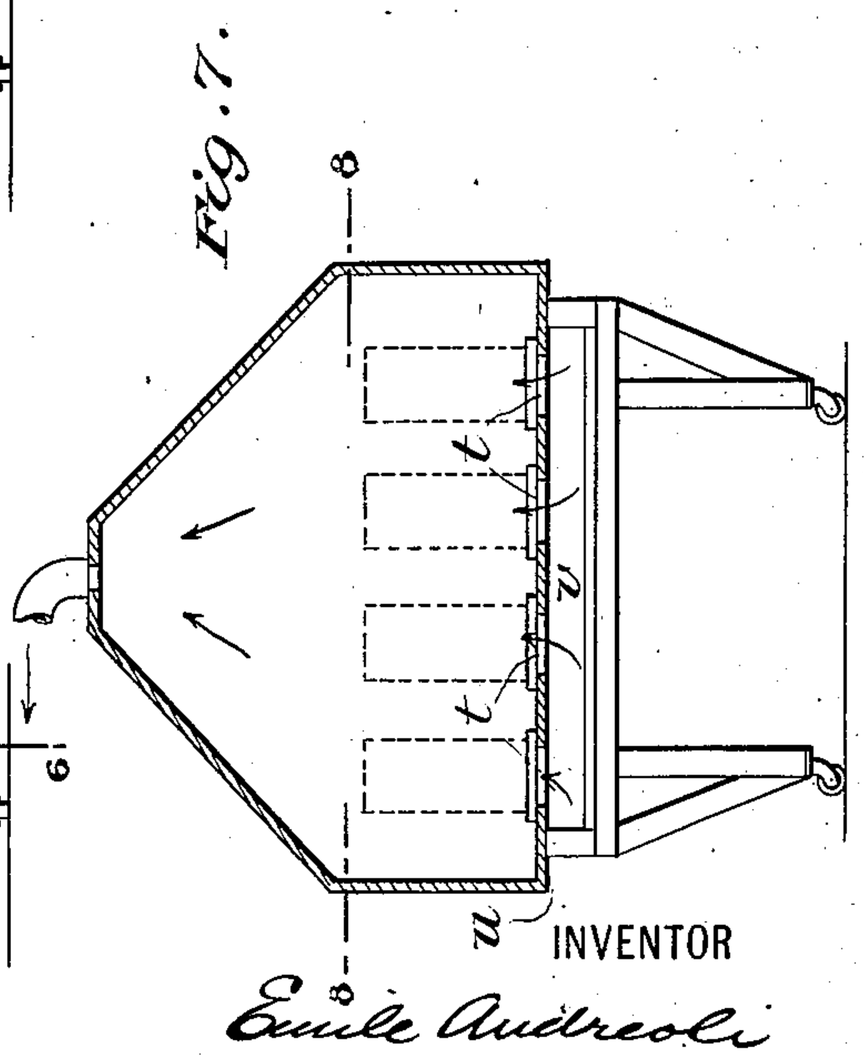

Fig. 7.

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EMILE ANDREOLI, OF LONDON, ENGLAND.

APPARATUS FOR MANUFACTURING OZONE.

SPECIFICATION forming part of Letters Patent No. 607,007, dated July 12, 1898.

Application filed October 15, 1897. Serial No. 655,348. (No model.)

To all whom it may concern:

Be it known that I, EMILE ANDREOLI, a citizen of France, residing at 147 Cold Harbour Lane, London, in the county of Surrey, England, have invented certain new and useful Improvements in and Connected with the Manufacture and Production of Ozone and in Apparatus Therefor, of which the following is a full, clear, and exact description.

This invention refers to the production of ozone on a commercial scale by means of improved apparatuses worked in such a manner that the yield of ozone is increased, the formation of nitrous compounds and the generation of excessive heat by the electric effluvia on the dielectric and on the electrodes are prevented, and the ozone is collected and utilized in the nascent state for its commercial applications in a more efficient and cheaper way than by the usual methods.

The electrodes of my ozonizers are either point-bearing grids one facing the other or point-bearing grids facing flat electrodes. I may also use flat plates, which cost a great deal less than point-bearing electrodes.

My flat electrodes are made of boards of wood or other convenient material, which are plane and true and on the two sides of which are fixed by convenient means thin sheets of copper, tin-plate, or aluminium, or other metal. I obtain in this way perfectly even and plane plates at a moderate cost. Instead of metal sheets layers of metal can be obtained by electroplating. The said metallic sides, if desired, are coated with one or several layers of non-oxidizable paint or enamel, which protects them against the action of ozone. The two metallic sides of these flat electrodes are electrically connected one to the other and to one of the poles of the transformer, its other pole being connected with the other electrodes.

When economy is a question, I use flat plates on both sides of the dielectric; but in such a case the yield of ozone per horse-power hour will not be quite as high as with point-bearing plates or grids. My experience is that the most satisfactory results are obtained with point-bearing grids one facing the other or point-bearing grids opposite flat metallic surfaces.

I use any convenient insulating material, such as glass, to separate the electrodes, and I may have between the electrodes, instead of a single sheet of glass or other dielectric, two thin sheets of glass placed one against the other to prevent the polarization of the dielectric by the compensating action of the vibrations of each sheet under the stress of the electrostatic discharge in presence of a flat plate and of a point-bearing grid or other electrodes.

I sometimes dispense with the usual sheet of dielectric, such as glass, interposed between two electrodes and simply apply on the flat electrodes, or when I use flat electrodes on one side of them by means of an adhesive material, some pieces of mica or powdered mica or other insulating powder or the like, so as to cover the whole of their surface. Some thin distance-pieces made of glass keep the plates apart from the dielectric.

The construction of an open ozonizer composed of point-bearing grids and flat electrodes or of flat electrodes separated by sheets of dielectric material will be clearly understood by reference to Figures 1 to 4, Fig. 1 being a sectional elevation, Fig. 2 a plan, Fig. 3 a section on the line 3 3, Fig. 1, and Fig. 4 a view of a portion of Fig. 3 drawn to a larger scale. In the figures, *a a* indicate the point-bearing electrodes, each of which is composed of a series of pieces of serrated wire *b b*, separated by washers *c c* and united by bolts *d d* in the ordinary manner, and *e e* are the flat electrodes, each of which is composed, as hereinbefore stated, of a flat board *f*, of hard wood or other material, having thin sheets of metal *g g* fixed upon the two surfaces. *h h* are the sheets of dielectric material arranged between the electrodes and which may be supported in grooves in the frame of the apparatus. *h' h'* are glass distance-pieces between the dielectrics and the electrodes, and *i i* are the conductors.

In Figs. 5 and 6, which are respectively a longitudinal section and a transverse section on the line 6 6, Fig. 5, I show an ozonizer consisting of a number of electrodes *a a*, of large area, connected together and inclosed in an air-tight receptacle *j*, which is itself composed of three separate compartments *k l m*, the lower one *k* being used to insure the uniform distribution of the air over all the electrodes

and the upper one *m* being used as a collecting-compartment, from which the ozonized air is drawn, while the intermediate or ozonizing compartment *l*, which contains the electrodes, is provided with grooves in which the dielectric separators are placed, the electrodes being maintained in position and parallel with the dielectrics by distance-pieces, as described with reference to Figs. 1 to 4.

Between the distributing-compartment *k* and the ozonizing-compartment *l* is a perforated plate or partition *n*, through which the air is evenly distributed. I also place a similar perforated partition *n'* between the ozonizing-chamber *l* and the collecting-chamber *m*. At the ends of the casing *j* are passages *k' m'*, the former of which establishes communication between an inlet-opening *o* and the distributing-compartment *k*, while the latter establishes communication between the collecting-chamber *m* and an outlet *p*.

The above-described apparatus belongs to the ordinary type of closed ozonizers which are contained each in a receptacle or casing; but when large quantities of ozone have to be produced in a continuous manner in works or mills I prefer to work several and sometimes many open ozonizers in a large chamber or in large chambers, as hereinafter described. In this case I dispense entirely with the usual receptacle or boxes in which each ozonizer must be separately inclosed. The electrodes of each open ozonizer, as well as their dielectric separators, are clamped or screwed together in suitable inexpensive frames—for instance, as shown in Figs. 1 to 3, in which *q q* indicate the bars of the frame, and *r r* the wooden clamping-screws which connect the said bars *q q*.

An arrangement of several open ozonizers in a chamber is shown in Figs. 7 and 8, which are respectively a sectional elevation of a chamber and a sectional plan on the line 8 8, Fig. 7. In these figures, *s* indicates the chamber which I call the "ozone-chamber," in which I place on the floor, over some apertures at convenient distances one from the other, a sufficient number of ozonizers such as that shown in Figs. 1 to 3, supposed, for example, to give per hour a quantity of ozone representing the expenditure of one or several electric horse-power hours or of part of one electric horse-power, as the case may be.

Each ozonizer is placed over an aperture or a grating *t* (also shown in Figs. 1 and 3) in the floor *u* of the chamber *s*, over a second chamber *v*, which I call the "air" or "gas" chamber. In some cases I may dispense with the air-chamber. The air or gas to be ozonized is drawn or blown, as shown by the arrows, through the chamber *s* and flows rapidly through the plates and grids of each set of electrodes, so that part of the oxygen is transformed into ozone, the ozonized air or oxygen then passing through a pipe *w* to the receptacles where it has to be utilized.

Under each ozonizer I may have a piece of fabric or a strainer to filter the air to be ozonized.

When condensed ozone is required, the ozonized air can be introduced from one chamber into a second or third ozonizing-chamber and so on; but if dilute ozone is wanted I have only one ozonizing-chamber, from which the ozonized air is discharged or is sent by convenient means to the place where it will be utilized. In order to prevent in my ozone-generators a detrimental rise of temperature, I reduce almost to its minimum the glow of the silent electric discharge, and I increase the surface of electrodes and of dielectrics. Thus, the glow being very feeble, its calorific power is insignificant and is constantly counteracted by the cooling effect of the air to be ozonized, which for the commercial applications of ozone where large masses of liquids—such as oils, for instance—have to be oxidized, must pass at a great velocity between the electrodes. By adopting this method for the commercial production of ozone I require more ozonizers than hitherto; but the increase of the plant and machinery is more than compensated for in that the yield of ozone is much greater (as with a given expenditure of energy a smaller output of ozone is generated by each ozonizer, but a larger one is obtained from the whole of the apparatus) and that the ozonizers can work almost indefinitely without injurious rise in temperature.

Another reason for adopting for the production of ozone the hardly-visible glow of the silent electric discharge (which, as much as possible, I combine with great frequency) is that it does not form nitrous compounds, which can only be produced by powerful effluvia due to a very high electrostatic tension.

To the best of my knowledge I have been the first to construct open ozonizers—*i. e.*, apparatuses consisting simply of a number of electrodes and sheets of dielectric kept apart one from the other for the free passage of the air and fastened together by means of clamps or screws instead of being packed each in an air-tight box—and also to combine them with a reservoir or ozone-chamber for the production and the direct supply of ozone in the nascent state for commercial applications. This apparently unimportant mode of constructing and of working open ozonizers for the production in a continuous process of large quantities of ozone in chambers and its supply from such reservoirs possesses several great advantages as compared with former arrangements.

First. No separate air-tight box or receptacle being required for each set of electrodes or ozonizers, there is a saving of expense and labor.

Second. The apparatus can be worked continuously, because it cannot get out of order or seriously heat.

Third. Only one inlet for the air and one outlet for the ozonized air are required for a number of open apparatuses simultaneously

electrified in ozone-chambers, while a complicated series of pipes is unavoidable when closed ozonizers are used. Therefore according to this invention not only the air can be distributed at the same rate of velocity over the whole range of electrodes of the open ozonizers, but the cost of separate pipes for the inlet and outlet of each closed ozonizer is avoided.

Fourth. The working of the whole of the ozonizers can be controlled, which is not possible when the several ozonizers are inclosed in separate air-tight cases.

Fifth. In case of accident or in case cleaning is required the apparatus can be quickly pulled to pieces and then put together.

Any desirable number of ozonizers may be arranged in a chamber, as shown in Figs. 7 and 8, according to the area of the chamber, or several ozone-chambers may be used, each containing a number of open ozonizers, according to the electric current which is used for each set of electrodes. The open ozonizers or sets of electrodes are arranged over suitable openings or gratings in the floor, through which apertures the air is forced or drawn, or the ozonizers may be placed in apertures made in the wall or walls of ozone-chambers and several partitions can be erected parallel to each other, in each of which there are openings wherein ozonizers are placed, the ozonized air being drawn or forced by means of convenient apparatus. By this electrification of a number of open ozonizers in such ozone chambers or reservoirs large quantities of ozone can be economically generated without heat and free from nitrous compounds and the ozone in the nascent state can be sent direct and in a simple and efficient manner through recipients containing substances to be subjected to its action.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

An ozonizer built up as follows: an electrode consisting of a series of metallic strips having serrated edges, said strips being placed face to face in a row, and supported by rods passing through and mechanically connecting them together, a dielectric located opposite each set of serrated edges, a plate of wood or similar non-conducting material opposite each dielectric, said plate of wood provided on its opposite faces with a thin metallic layer constituting an electrode of opposing polarity to that first named, and so on, thus forming a series or plurality of ozonizers into a compact structure.

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

EMILE ANDREOLI.

Witnesses:
FRANCIS W. FRIGOUT,
ALFRED NUTTING.