

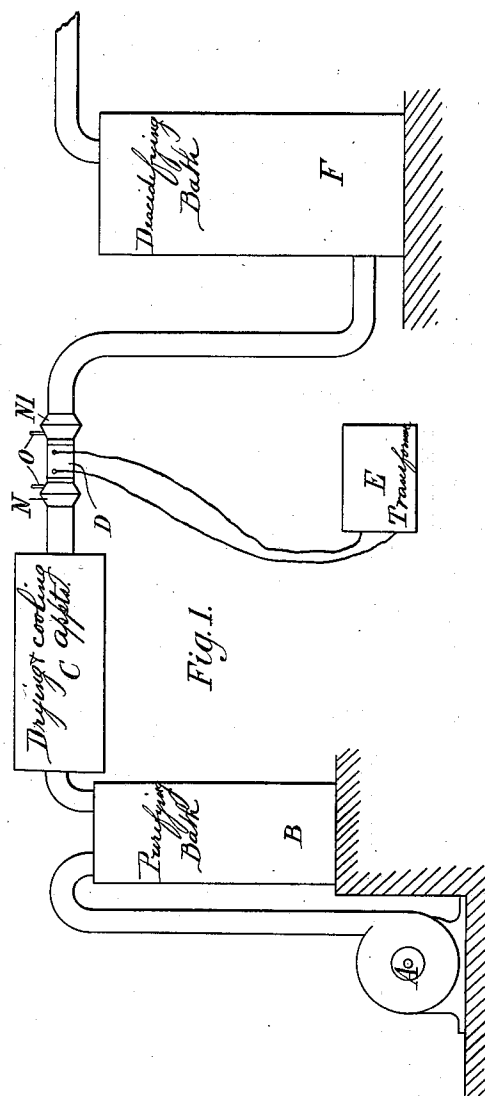
(No Model.)

3 Sheets—Sheet 1.

C. J. YARNOLD.  
APPARATUS FOR MANUFACTURING OZONE.

No. 580,244.

Patented Apr. 6, 1897.



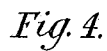
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Inventor:  
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his Attorneys.

3 Sheets—Sheet 2.

No. 580,244.

Patented Apr. 6, 1897.



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Charles J. Gamold,  
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(No Model.)

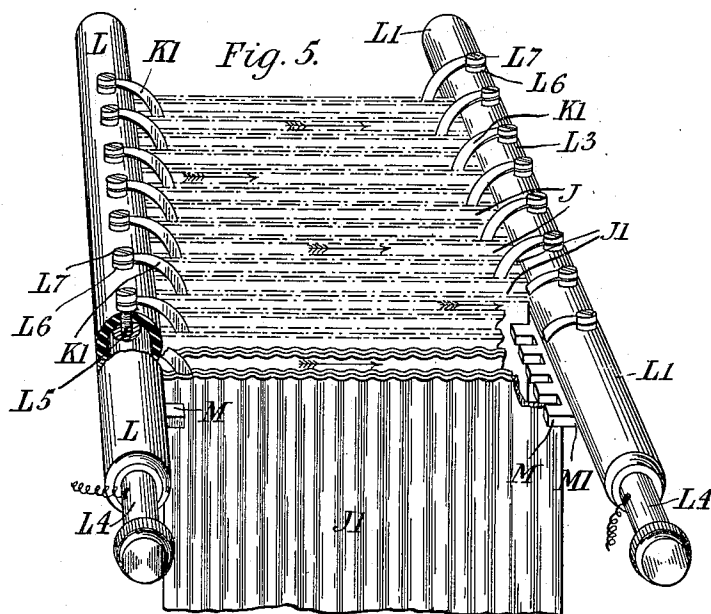
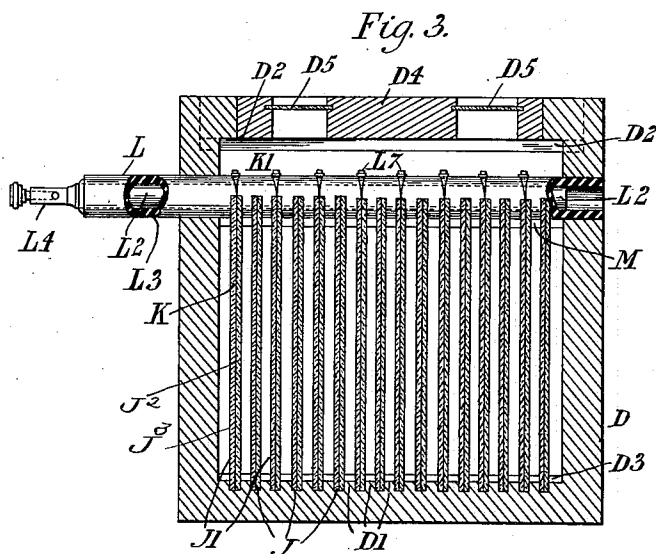
3 Sheets—Sheet 3.

C. J. YARNOLD.

## APPARATUS FOR MANUFACTURING OZONE.

No. 580,244.

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witnesses!

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# UNITED STATES PATENT OFFICE.

CHARLES JOHN YARNOLD, OF LONDON, ENGLAND.

## APPARATUS FOR MANUFACTURING OZONE.

SPECIFICATION forming part of Letters Patent No. 580,244, dated April 6, 1897.

Application filed August 20, 1896. Serial No. 603,404. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES JOHN YARNOLD, a subject of the Queen of England, residing at Brixton, London, England, have invented certain new and useful Improvements in Apparatus for the Manufacture of Ozone, of which the following is a specification.

This invention relates to the manufacture of ozone and apparatus therefor and comprises the treatment of oxygen, atmospheric oxygen, or a suitable oxygen-containing gaseous fluid in such a manner that a very large proportion of the said gas is rendered nascent or active and also is purified or freed from acid-forming or injurious constituents.

In the accompanying drawings, Figure 1 is a diagram showing in elevation one arrangement of apparatus for use in the production of ozone according to this invention. Fig. 2 is a longitudinal section, slightly to one side of the center line, of an improved ozone-generator and its appurtenances according to this invention. Fig. 3 is a transverse section on the line 3 3 of Fig. 2. Fig. 4 is an end elevation of a detail of Fig. 2, and Fig. 5 is a perspective view of part of Fig. 2.

Like letters indicate like parts throughout the drawings.

With reference first to Fig. 1, in preparing ozone from atmospheric oxygen I prefer to first pass air, by means of a blower A, for instance, through a caustic alkali or other suitable bath B to free it from atmospheric impurities and thence through drying and cooling apparatus C. The air thus dried and cooled to, say, about 32° Fahrenheit is now passed along passages existing between compound plates in an ozone-generator D, such as is hereinafter described, these plates each comprising a layer of metal foil carried on or between sheets of insulating material and connected to a suitable source of electric energy—for instance, to a transformer (indicated diagrammatically at E)—producing an alternating current of electricity of high potential.

Each sheet of insulating or dielectric material is preferably let into the sides or casing of the apparatus, which is also made of insulating material, or the apparatus may be otherwise arranged as may be suitable, care being taken that the electrical discharges do

not pass over the edges of the layers of dielectric. A high-potential alternating current conducted by the foils of metallic layers produces between the dielectrics what may be termed a "silent discharge." The atmospheric oxygen in being forced or pumped through the passages between the insulating material is brought under the influence of the silent discharge, a portion of the oxygen being thereby turned into ozone. At the same time certain oxids of nitrogen are formed and may be dealt with as hereinafter described. The percentage of ozone formed is of course dependent upon the supply of electric energy and of oxygen and still more upon the temperature of the gas supplied.

A low temperature in the gas and high tension and frequency in the alternating current tend to increase the amount of ozone formed.

The gas having been subjected to the electric discharge in the ozone-generator D may then pass through one or more "deacidifying baths" F, containing pumice or other suitable porous material and pure or distilled water, the whole so arranged that the gas in going through comes into intimate contact with the water in a manner well understood. The oxids of nitrogen contained in the gas being soluble in water will be retained in the "baths" as nitrous and nitric acids, and the gas containing nothing but allotropic, nascent, or active oxygen or ozone will pass on for utilization.

It is found that with an ozone-generator of the usual construction only a portion of the gaseous fluid passed through it is electrically ozonized, and consequently the resulting ozone is diluted to an extent which seriously impairs its commercial value. This inefficiency of the apparatus results from the sides of the passages being flat and smooth, so that the flow of fluid between them is uniform and unbroken, and only such parts of each stream as are in immediate proximity to the surface of the compound plates are sufficiently subjected to electrical influence, such influence, as is well known, decreasing very rapidly as the distance from the electrified body increases.

According to this invention the ozone-generator is so constructed that the oxygen or oxygen-bearing fluid is caused to swirl or

eddy during its passage between the compound plates. Thus a very large percentage of the fluid is subjected to the desired intensity of electrical action, the yield of ozone being therefore much greater and the resultant mixture much less dilute than in ozone-generators as hitherto made, and the waste of electric energy is diminished also. For example, the compound plates or the surfaces of the plates may be corrugated or ribbed in a direction transverse to that of the flow of fluid; or there may be projections or obstructions of any desired form made in or on the plates or on the other walls of the passages or placed in the spaces between them. Such devices break up the current of fluid. They need not extend throughout the length or width of the passages, but may occupy only a part or parts of the same.

Preferably wherever there is a projection at one side of a passage there should be a recess at the opposite side. Thus in a wavy corrugated plate the summits of the waves of one plate should be opposite the hollows of the opposite plate.

With reference now to Figs. 2, 3, 4, and 5, which illustrate one construction of such a generator, the main casing D is a tube of rectangular cross-section, through which the oxygen-containing fluid is caused to flow by some such apparatus as is illustrated in Fig. 1.

Within the casing D is a series of compound plates J J'. The plates are disposed side by side in vertical planes parallel with the direction in which the oxygen-bearing fluid passes through the generator, so that narrow spaces are left between them (see Figs. 3 and 5) for the passage of the aforesaid fluid in eddying currents, the general direction of which is indicated by the arrows.

Each compound plate consists of two sheets of corrugated glass J<sup>2</sup> J<sup>3</sup>, Fig. 5, inclosing between them a layer K of silver-foil or other metallic foil or coating, extending not quite to the edges of the sheets except at one corner of the compound plate, where a tab or extension K' of the foil is provided to connect the layer with one or other of two electric terminals L L', coupled to a transformer in a manner which need not be particularly described. The two sheets of glass inclosing the foil may be secured together by cement applied to them near the edges of the meeting surfaces. Each terminal comprises a metal rod L<sup>2</sup>, held in a sleeve L<sup>3</sup>, of insulating material, extending transversely across the generator and secured in the walls thereof. On each rod L<sup>2</sup> is a binding-post L<sup>4</sup> to enable it to be readily connected to the aforesaid converter or other source of electric energy. The compound plates J have their layers of foil electrically connected with the rod L<sup>2</sup> of the terminal L, while the plates J', alternated with the plates J, have their layers of foil connected with the opposite terminal L'. A good electrical connection between the tabs K' and the rods L<sup>2</sup> is afforded by screws L<sup>5</sup>,

which pass through the sleeves L<sup>3</sup> into the rods and at their outer ends are each encircled by a washer L<sup>6</sup>, between which and the head L<sup>7</sup> of each screw one of the tabs K' is held.

In order that the compound plates J J' may be retained at the desired distance apart from each other, their lower edges are placed between ribs D', formed on the floor of the casing, and their upper edges are kept apart by fingers M, intercalated between the plates J J' and extending from a bar M', of insulating material, secured to each sleeve L<sup>3</sup>.

D<sup>3</sup> are bars or strips of insulating material to prevent the compound plates from being accidentally displaced.

D<sup>4</sup> is a hinged cover or lid provided with windows D<sup>5</sup>, through which latter the glow of the silent discharge is observable, the amount of electric current being regulated, as aforesaid, until the desired violet-colored glow ensues. The bars D<sup>2</sup>, of insulating material, drop into sockets in the wall of the casing D and support the cover D<sup>4</sup> and are readily removable to enable the compound plates to be lifted out of the generator, when desired, through the opening ordinarily closed by the cover D<sup>4</sup>.

Preferably expansion-chambers N and N' are provided at each end of the ozone-generator D as continuations of the passage-way for the gaseous fluid, or one such chamber only is provided, in which case it should be at that end of the generator D at which the oxygen-containing fluid enters. These chambers should be of greater cross-sectional area at the middle of their length than at their ends and conveniently of some such form as is indicated in Figs. 2 and 4. It is found that their use equalizes the flow of the oxygen-containing fluid through the spaces between the different pairs of compound plates, and also that they equalize the fluid-pressure in the several spaces of the generator and aid materially in making the product uniform. To enable the temperature of the gas to be observed as it enters and leaves the generator D, a thermometer is inserted therein, so that the bulb is about at the center of the current of gas flowing through the apparatus, and the graduated portion of the thermometer-stem is extended so as to be readable from the outside of the generator.

In the example chosen for illustration a thermometer O is inserted through a stuffing-box N<sup>2</sup> in the wall of each chamber N N'.

I claim—

1. In an ozone-generator, the combination with the casing, of the series of plates each consisting of a layer of conducting material, held between sheets of non-conducting material disposed side by side in vertical planes parallel with the direction in which the oxygen-bearing fluid passes, and having the non-conducting sheets ribbed or corrugated in a direction transverse to the direction of the flow of the fluid; the electric terminals, and

connection between the terminals and the layers of conducting materials, substantially as described.

2. In an ozone-generator, the combination  
5 with the casing, of the series of compound plates arranged side by side so that narrow passages will be left between them, each of said plates consisting of a layer of conducting material as metallic foil, held between  
10 sheets of non-conducting material, as glass, the face of said outside sheets being ribbed or corrugated, the elevations in one plate occurring opposite the depressions in the next plate, substantially as described and for the  
15 purpose specified.

3. In an ozone-generator, the combination with the casing, the plates formed of glass and metal foil, as described, the tab or extension on said metallic foil, the rods suit-  
20 ably connected to a source of electric energy,

the sleeve of insulating material surrounding said rods, and the screws passing through the sleeves into the rods and connected at the opposite end with the tabs on the metal plates; substantially as described.

4. In an ozone-generator, the combination  
25 with the casing provided with passage-ways for the gaseous fluid, of the expansion-chambers at the ends of the generator, of greater cross-sectional area at the middle than at  
30 their ends, substantially as and for the purpose set forth.

In testimony whereof I have hereto set my hand in the presence of the two subscribing witnesses.

CHARLES JOHN YARNOLD.

Witnesses:

HARRY B. BRIDGE,  
GEORGE F. WARREN.