C. S. BRADLEY.

APPARATUS FOR OZONIFYING.

APPLICATION FILED OCT. 29, 1906.

971,244. Patented Sept. 27, 1910.

3 SHEETS—SHEET 1.

Fig. 1.

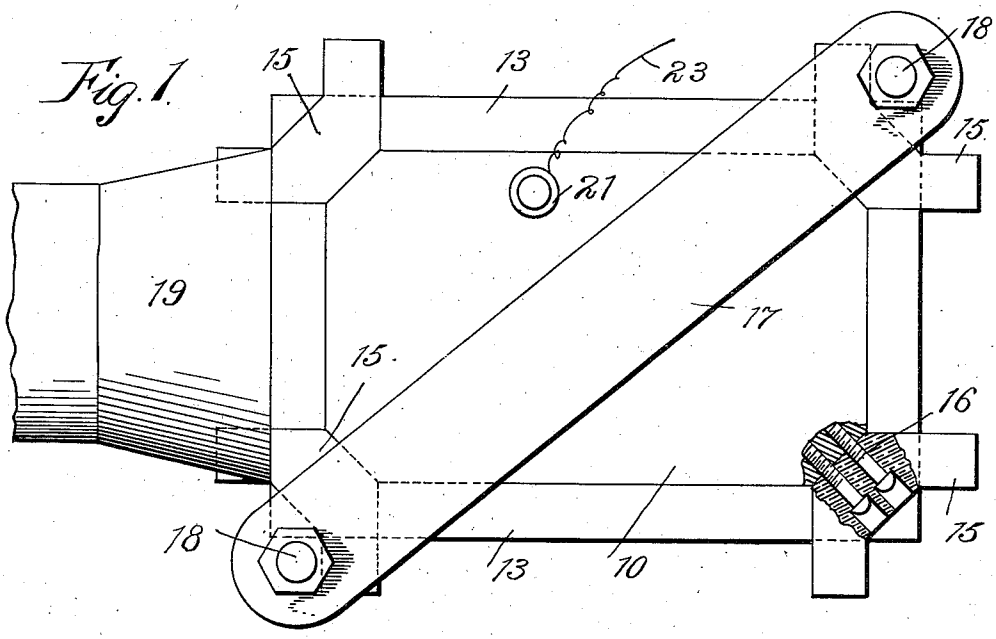
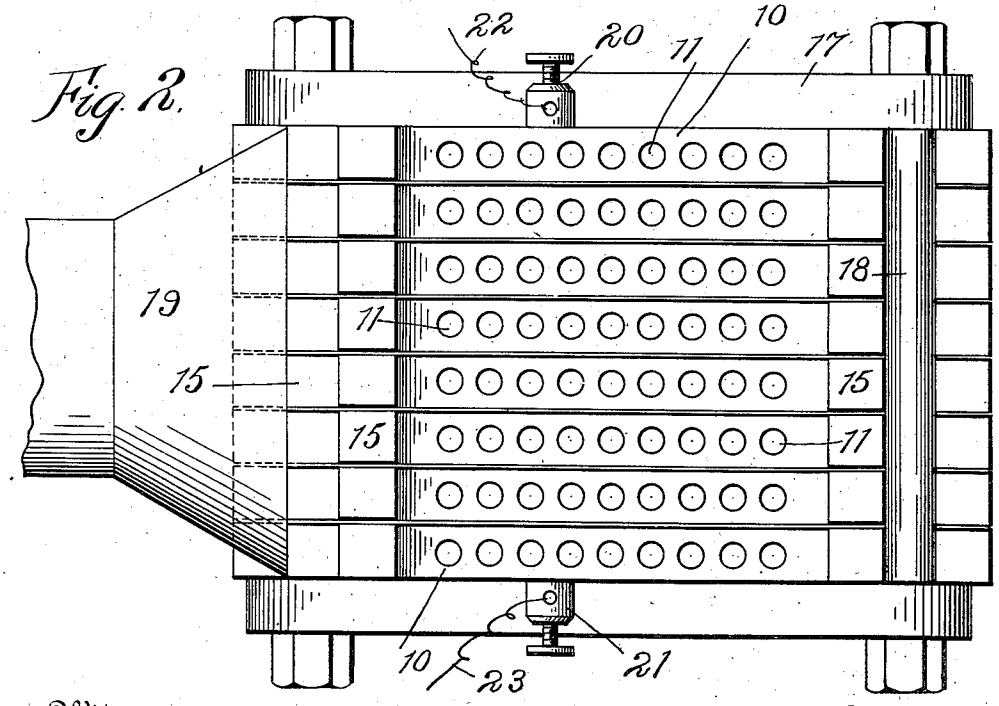



Fig. 2.




Witnesses

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3 SHEETS—SHEET 2.

Fig. 3.

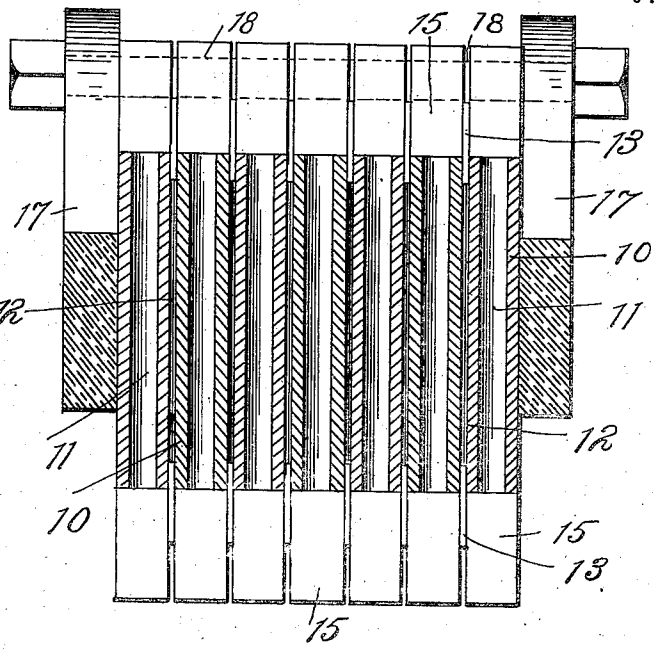



Fig. 4.

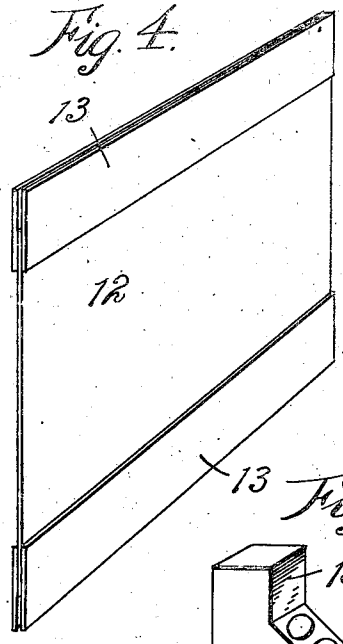



Fig. 5

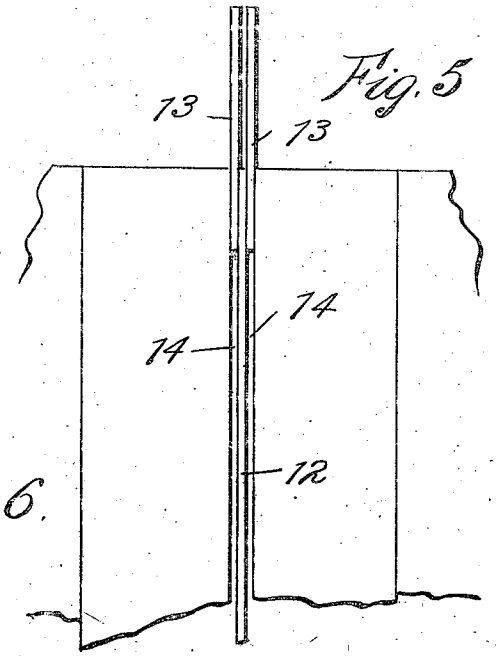
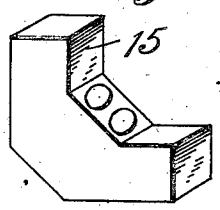



Fig. 6.




Witnesses

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3 SHEETS—SHEET 3.

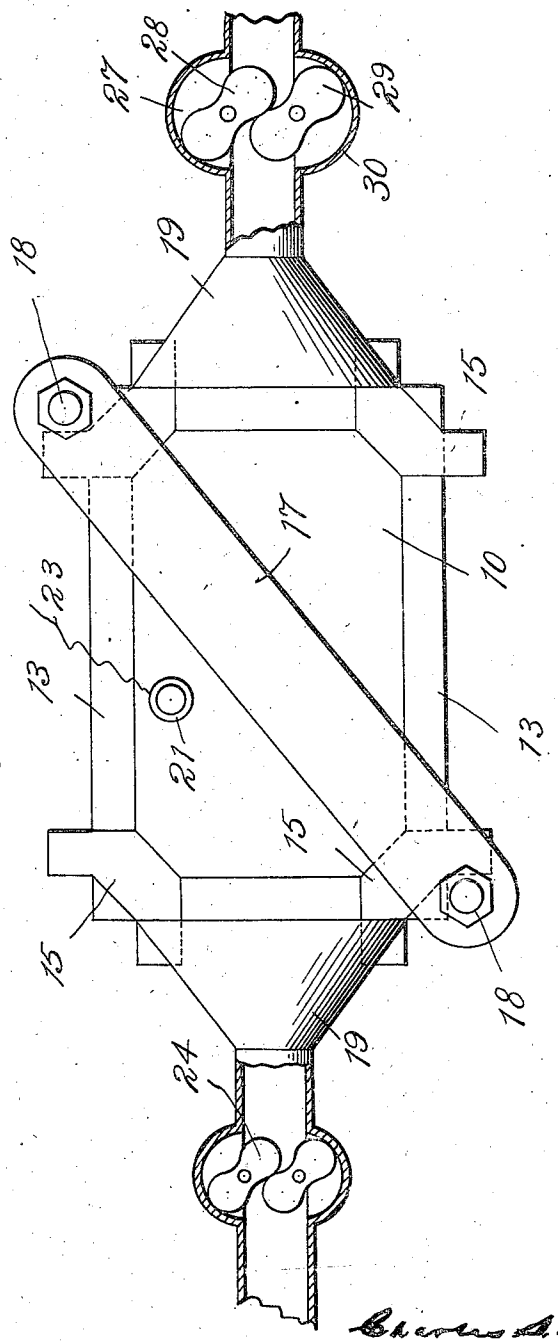


Fig. 7.

WITNESSES

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# UNITED STATES PATENT OFFICE.

CHARLES S. BRADLEY, OF NEW YORK, N. Y.

## APPARATUS FOR OZONIFYING.

971,244. Specification of Letters Patent. Patented Sept. 27, 1910.

Application filed October 29, 1906. Serial No. 341,120.

*To all whom it may concern:*

Be it known that I, CHARLES S. BRADLEY, a citizen of the United States, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Apparatus for Ozonifying, of which the following is a specification.

My invention relates to the production of ozone, and is especially concerned with an improved form of apparatus for converting oxygen into ozone.

The object of my invention is to provide an ozonifier in compact form which will produce ozone efficiently.

Experiments made by me have led me to believe that the conversion of oxygen into ozone is a surface action; that is, the conversion takes place at the surface of the plates confining the space in which the gas is treated, and is due to the impact or bombardment of the charged molecule against the surface. Any means for increasing the bombardment will therefore induce an increased efficiency. This increase in bombardment may be accomplished by placing the confining plates closer together than heretofore, so that the charged molecule has less distance to travel. Furthermore the velocity of the molecule may be increased by reducing the pressure of the gas which is treated, and the bombardment in this way increased. Another method of increasing the velocity of the molecule and consequently the bombardment is to employ a higher electromotive force. When this electromotive force is increased, however, the current density tends to increase, and since increased current density causes increased heat which impairs the efficiency, as is well known, the dielectric sheets must be made thicker to permit the higher electromotive force to be used without lowering the efficiency. A still further consideration which must be borne in mind in the construction of ozonifying apparatus is, that the rise in temperature due to the treatment of the gas must be prevented or kept within a comparatively low range. For the purpose of preventing as far as possible the detrimental rise in temperature, it is well to make the electrodes of such thickness that perforations may be made in them through which air or other cooling medium may be forced or permitted to circulate so as to cool the electrodes.

In accordance with the observations made in my experiments, I have constructed an ozonizing apparatus, the principles of which may be seen from the accompanying drawings, in which,

Figure 1 is a side elevation of one form of apparatus constructed in accordance with my invention, Fig. 2 is a top plan of the same, Fig. 3 is a central vertical section thereof, Fig. 4 is a perspective view of one of the dielectric sheets in position between the spacing strips hereinafter referred to, Fig. 5 is a detail view showing the disposition of the dielectric sheet with its spacing strips between a pair of the electrodes, Fig. 6 is a perspective view of one of the corner blocks hereinafter referred to, and Fig. 7 is a side elevation of the apparatus provided with pressure reducing means.

Referring now specifically to said drawings, 10 indicates the electrode plates which are preferably of aluminium, and of sufficient thickness to permit of vertical perforations 11 through which cooling air may be allowed or forced to pass. The dielectrics are preferably in the form of sheets of mica 12, which may be substantially the same length and height as the electrode plates 10. Spacing strips 13 (see especially Figs. 4 and 5) inclose the upper and lower edges of the dielectric sheets 12, and are held between the electrode plates 10. The spacing strips 13 are also preferably of mica and are extended some distance beyond the upper and lower edges of the electrodes, as clearly shown in Fig. 5, to prevent sparks from jumping around the dielectric from one electrode over to the other. I prefer to use mica for the dielectric sheets and spacing strips rather than glass, for the reason that it is less apt to become fractured and may stand a much higher strain when the elements of the ozonifier are drawn tightly together, in the manner hereinafter described. It will be seen that narrow ozonifying spaces 14 closed above and below but open at the two ends are formed between each pair of electrodes and the dielectric sheet. The electrode plate is therefore not protected from the oxidizing effect of the ozone, and it is for this reason that I prefer to make the electrode of aluminium since this metal is not attacked by ozone. In this construction it will be seen that four surfaces are present in the spaces between each pair of electrodes, two electrode surfaces and two dielectric spaces. There is thus a much greater bom-

bardment area than in forms of ozonizing apparatus in which the electrodes are secured upon the outer surfaces of the dielectrics and bombardment can only take place between the two surfaces of the dielectric sheets. A further advantage in making the electrode plates 10 of considerable thickness is to enable me to secure corner blocks 15 of insulating material, preferably of fiber, (Fig. 6) to their corners for securing the inlet and outlet funnels, at the ends of the ozonifying spaces 14. As shown in Fig. 1, the corner blocks 15 are secured to the beveled corners of electrode plates 10 by screws 16 countersunk in the corner blocks 15, the corner blocks being of the same thickness as the electrode plates 10, thus fitting between the projecting pairs of spacing strips 13.

For the purpose of clamping together the elements of the apparatus, I provide clamping plates 17 of insulating material, preferably fiber, and bolt these together diagonally across the outer electrode plates by insulating bolts 18 also preferably of fiber. On each end of the apparatus I then place suitable inlet and outlet funnels or hoods 19 each in communication with one end of the ozonifying spaces above referred to. These funnels are so formed as to permit of air-tight connection being made with the projecting ends of the corner blocks, so that there is then a tight passageway from the supply pipe into the inlet funnel through the ozonifying spaces and out by the outlet funnel.

Binding posts 20 and 21 of any suitable form may be secured to the outer electrodes for connecting the electric conductors 22 and 23 to the apparatus. The series of electrodes and dielectrics thus forms a plurality of condensers in series, in each of which a pair of ozonifying spaces 14 is provided for the passage of air or other gas to be treated. The number of electrode plates may of course be varied to suit the particular condition under which the apparatus is to be operated.

In order to obtain the desired reduction in pressure in the gas which is in the ozonifying spaces 14 I insert a suitable pump in the inlet funnel or hood 19 and in the outlet funnel or hood 19 I provide a suitable form of air pump. This portion of the apparatus is illustrated in Fig. 7. Referring to said figure it will be seen that in the inlet funnel 19 a pump 24 is placed. In the outlet funnel 19 is then placed the air pump 27. The pump 24 and pump 27 may be of any suitable form but preferably in the form shown, which comprises a pair of revolving blades 28 and 29 operating in a casing 30. Any suitable form of driving mechanism may be employed to actuate the air pump, and the pump 24 which is driven by atmospheric pressure is made of smaller capacity and suitably connected with the pump 27 so as to have the same velocity and thus the reduction of pressure is obtained.

While I have shown specific details and described a specific form of the apparatus, this form has been shown and described merely as an example of my invention, and not as an indication of the full scope of the same. Various details of construction may be modified to suit the conditions of operation.

In constructing the apparatus, the ozonifying spaces should have as small a volume with respect to the electrode surface as the conditions of operation will permit, or in other words, the electrodes should be at the minimum permissible distance apart and thus leave a space having minimum cross-section and volume. In this way the electromotive force used can be materially reduced without lowering the yield and thus the efficiency increased.

Having thus described my invention, the following is what I claim as new therein and desire to secure by Letters Patent:—

1. An ozonifier comprising a plurality of electrodes and dielectrics spaced between them, said dielectrics being twice as thick as the width of the spaces between them and the electrodes.

2. An ozonifier comprising a plurality of electrodes, dielectrics spaced between them, said dielectrics being as thick as or thicker than the width of the space between them and the electrodes, and means for maintaining the pressure in the space below atmospheric pressure.

3. An ozonifier comprising a plurality of electrodes, dielectrics between said electrodes, means for maintaining spaces between said dielectrics and the electrodes as small as or smaller than the thickness of said dielectrics and means for maintaining the pressure in said spaces below atmospheric pressure.

4. An ozonifier, comprising a plurality of electrodes, dielectrics spaced between them, said dielectrics being twice as thick as the space between them and the electrodes, and means for maintaining the pressure in said spaces below atmospheric pressure.

5. In an ozonifier, the combination with electrodes, dielectrics and spacing means; of a pair of clamping plates, means for causing the clamping plates to approach each other and thus clamp between them the electrodes, dielectrics and spacing means, and means for maintaining the pressure in the spaces formed between the dielectrics and electrodes below atmospheric pressure.

6. In an ozonifier, the combination with electrodes, dielectrics and spacing means, said spacing means being as thin as or thinner than said dielectrics; of a pair of clamping plates, means for causing the

clamping plates to approach each other and thus clamp between them the electrodes, dielectrics and spacing means and means for maintaining the pressure in the spaces formed between the dielectrics and electrodes below atmospheric pressure.

7. In an ozonifier, the combination with electrodes, dielectrics, spacing means between said dielectrics and electrodes, and funnels leading to and from the spaces formed between the dielectrics and electrodes, of means for clamping together the electrodes, dielectrics and spacing means, and means for maintaining the pressure in the spaces between the dielectrics and electrodes below atmospheric pressure.

8. In an ozonifier, the combination with electrodes, dielectrics, spacing means as thin as or thinner than said dielectrics, and funnels leading to and from the spaces formed between the dielectrics and electrodes; of means for clamping together the electrodes, dielectrics and spacing means, and means for maintaining the pressure in said spaces between the electrodes and dielectrics below atmospheric pressure.

9. In an ozonifier, the combination with electrodes, dielectrics, corner blocks on the electrodes, and spacing means; of means for clamping together the electrodes, dielectrics, corner blocks, and spacing means, and funnels secured at the ends of the electrodes by said corner blocks.

10. In an ozonifier, the combination with electrode dielectrics, spacing corner blocks on the electrodes and spacing means as thin as this or thinner than said dielectrics; of means for clamping together the electrodes, dielectrics, corner blocks and spacing means, and funnels secured at the ends of the electrodes by said corner blocks leading to and from the spaces formed between the electrodes and dielectrics.

11. In an ozonifier, the combination with electrodes, dielectrics, corner blocks on the electrodes, and spacing means between said dielectrics and electrodes; of means for clamping together the electrodes, dielectrics, corner blocks and spacing means, funnels secured at the ends of the electrodes by said corner blocks and means for clamping together the electrodes, dielectrics, corner blocks and spacing means, funnels secured at the ends of the electrodes by said corner blocks and means for maintaining the pressure in the spaces formed between the electrodes and dielectrics below atmospheric pressure.

12. In an ozonifier, the combination with electrodes, dielectrics, corner blocks on the electrodes, and spacing means as thin as or thinner than said dielectrics, of means of clamping together the electrodes, dielectrics, corner blocks and spacing means, funnels secured at the ends of the electrodes by said corner blocks and means for maintaining the pressure in the spaces formed between the electrodes and dielectrics below atmospheric pressure.

13. In an ozonifier, the combination with electrodes, corner blocks thereon, dielectric sheets between the electrodes and corner blocks, and spacing strips spacing apart the dielectrics and electrodes and closing the spaces at two sides; of means for clamping together the electrodes, corner blocks, dielectrics and spacing strips, and funnels secured to the corner blocks and leading to and from the open portions of the spaces between the dielectrics and electrodes.

14. In an ozonifier, the combination with electrodes, corner blocks thereon, dielectric sheets between the electrodes and corner blocks, and spacing strips as thin as or thinner than said dielectrics, spacing apart the dielectrics and electrodes and closing the spaces formed at two sides; of means for clamping together the electrodes, corner blocks, dielectrics and spacing strips and funnels secured to the corner blocks leading to and from the open portions of the spaces formed between the dielectrics and electrodes.

15. In an ozonifier, the combination with electrodes, corner blocks thereon, dielectric sheets between the electrodes and corner blocks and spacing strips spacing apart the dielectrics and electrodes and closing the spaces between them at two sides; of means for clamping together the electrodes, corner blocks, dielectrics and spacing strips, funnels secured to the corner blocks and leading to and from the open portions of the spaces formed between the dielectrics and electrodes, and means for maintaining the pressure in said spaces below atmospheric pressure.

16. In an ozonifier, the combination with electrodes, corner blocks thereon, dielectric sheets between the electrodes and corner blocks, spacing strips as thin as or thinner than the said dielectrics, spacing apart the dielectrics and electrodes and closing the spaces formed between them at two sides, of means for clamping together the electrodes, corner blocks, dielectrics and spacing strips, funnels secured to the corner blocks and leading to and from the open portions of the spaces formed between the dielectrics and electrodes and means for maintaining the pressure in said spaces below atmospheric pressure.

17. In an ozonifier, the combination with electrodes, dielectrics and spacing means spacing apart the dielectrics and electrodes; of insulating means for clamping together the electrodes, dielectrics and spacing means, and means for maintaining the pressure in the spaces formed between the dielectrics and electrodes below atmospheric pressure.

18. In an ozonifier, the combination with electrodes, dielectrics and spacing means spacing apart said dielectrics and electrodes; of insulating means for clamping together the said electrodes, dielectrics and spacing means, funnels leading to and from said spaces, and means for maintaining the pressure in said spaces below atmospheric pressure.

19. In an ozonifier, the combination with electrodes, dielectrics and spacing means as thin as or thinner than said dielectrics and spacing apart the dielectrics and electrodes and insulating means for clamping together the said electrodes, dielectrics and spacing means and means for maintaining the pressure in the spaces formed between the dielectrics and electrodes below atmospheric pressure.

20. In an ozonifier, the combination with electrodes, dielectrics and spacing means as thin as or thinner than said dielectrics and spacing apart the dielectrics and electrodes; of insulating means for clamping together the said electrodes, dielectrics and spacing means, funnels leading to and from the spaces formed between the dielectrics and electrodes, and means for maintaining the pressure in said spaces below atmospheric pressure.

21. In an ozonifier, the combination with means for producing electric discharge; of means for introducing gas into the electric discharge in minimum quantity per discharge area.

22. In an ozonifier, the combination with means for producing electric discharge; of means for introducing gas into the electric discharge, and means for facilitating the bombardment caused by said discharge.

23. An ozonifier having suitable means for producing electric discharge, and means for subjecting gas at a pressure below atmospheric to the electric discharge produced thereby.

24. An ozonifier having a pair of electrodes for producing between them electric discharge, and means for introducing gas between the electrodes at a pressure below atmospheric.

25. An ozonifier having a pair of electrodes for producing between them electric discharge, intermediate dielectric means between said electrodes, and means for introducing gas between the electrodes, at a pressure below atmospheric.

26. An ozonifier having a pair of electrodes forming between them the ozonifying space and placed substantially as near together as electrical considerations permit, and means for introducing gas at a pressure below atmospheric into the ozonifying space.

27. An ozonifier having a pair of electrodes and an intermediate dielectric, said dielectrics forming between them the ozonifying space and placed substantially as near together as electrical considerations permit, and means for introducing gas into the ozonifying space at a pressure below atmospheric.

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