Dec. 1, 1931. F. E. HARTMAN 1,834,705

OZONE GENERATOR

Filed Feb. 14, 1930

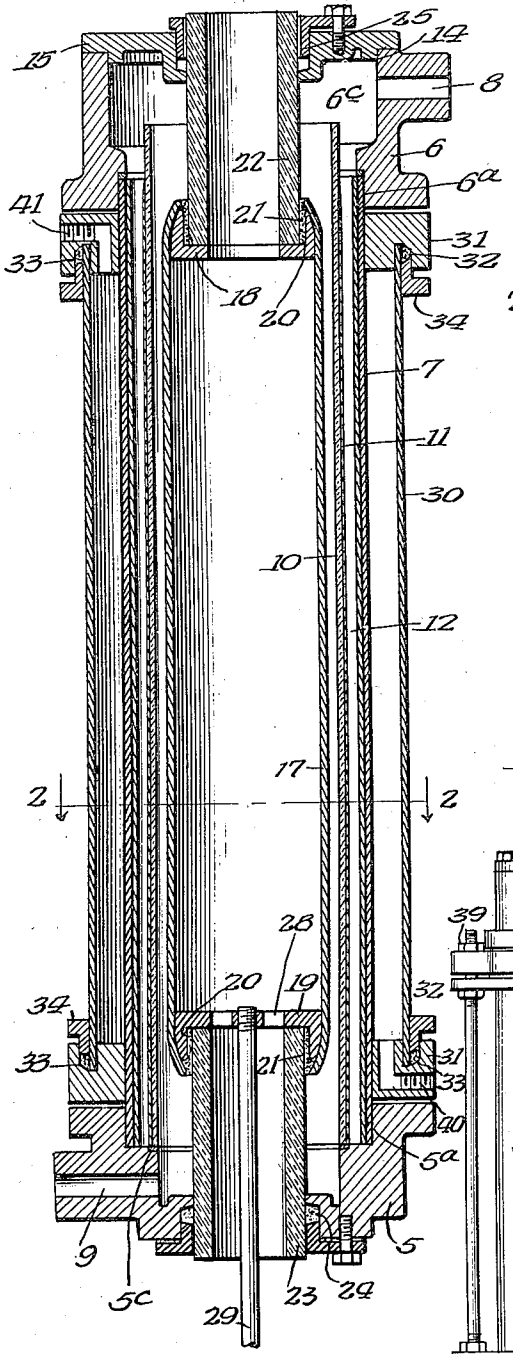


Fig. 1

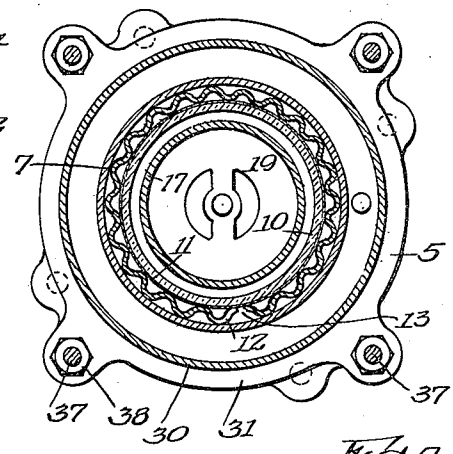


Fig. 4

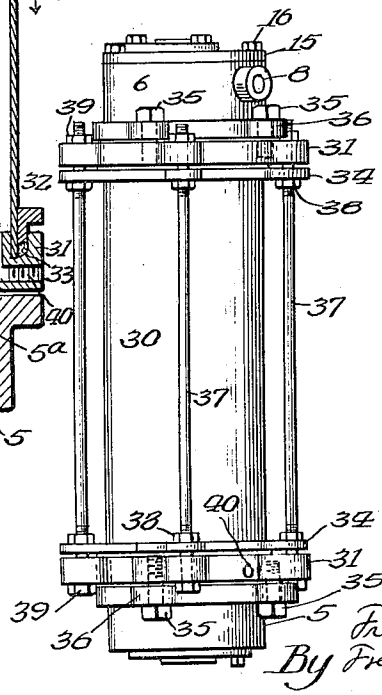
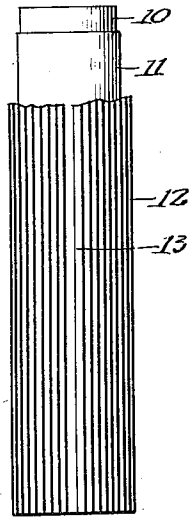


Fig. 3



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UNITED STATES PATENT OFFICE

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OZONE GENERATOR

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The invention relates to tubular ozone generators, and the objects of the invention are to provide an improved construction; in which the tubular dielectric is held concentrically around the inner electrode by a resilient element which leaves the dielectric free to expand and contract to avoid stresses, which will rupture the dielectric; in which the dielectric is held by a yielding heat radiating element; in which the electrodes are properly insulated around their boundaries to prevent formation of creeping discharges, sliding sparks, and edge effects; in which the dielectric is efficiently cooled so as to prevent its temperature from rising to a point where catalytic decomposition of ozone occurs; in which the outer electrode is placed on the outside of the tubular dielectric, and the inner electrode is tubular, and both are mounted so they can be quickly and conveniently removed and polished to prevent sparking in the ozone producing discharge which will produce oxides of nitrogen and local high temperatures and tend to bring about the destruction of the dielectric material and exert a destructive effect upon the ozone produced; which is simple in construction and can be produced at a low cost; in which a corrugated metal sheet performs the function of a heat conductor from the outer electrode on the dielectric to the wall of the casing to cool the dielectric, and also functions to yieldingly hold the dielectric concentrically around the inner electrode in such manner as to permit unequal expansion and contraction of the metal parts and the dielectric and to provide for commercial inequalities or variations in the thickness of the glass walls of the dielectric; in which both electrodes and the dielectric can be conveniently removed without disconnecting the air and water connections with the casing, to permit replacement of the dielectric; in which the packing boxes for the tubular dielectric are dispensed with; which is adapted to be used, either with or without a water jacket; and which can be manufactured at a low cost and is efficient in operation.

The invention consists in the several novel features hereinafter set forth and more particularly defined by claims at the conclusion hereof.

In the drawings: Fig. 1 is a vertical central section of an ozone generator embodying the invention. Fig. 2 is a section on line 2—2 of Fig. 1. Fig. 3 is a side elevation. Fig. 4 is an elevation of a portion of the dielectric and the corrugated radiator.

The invention is exemplified in a generator provided with a casing consisting of a lower head 5, an upper head 6, and a tube 7 extending vertically between the heads and terminating in annular recesses 5^a and 6^a in the heads respectively. These heads and tube 7 are made of suitable metal, such as aluminum, and are secured and clamped together by bolts, as hereinafter set forth. An inlet duct 8, through which air passes to the polar space, is formed in the upper head 6 and is adapted for connection to a pipe for delivering the air to be ozonized into the generator. An outlet duct 9 for the ozonized air is formed in the lower head 5.

A tubular dielectric 10 of suitable material, such as glass, and substantially cylindrical from end to end, has its lower end resting on a lead gasket 5^c in the bottom of the recess 5^a in head 5. The upper end of the dielectric terminates in the chamber 6^c in the upper head C, and both ends are free or left unclamped to permit expansion and contraction of the dielectric in the casing.

A coating of suitable metal is deposited on the outer periphery of the dielectric and constitutes a tubular outer electrode 11 of the generator, and with the dielectric constitutes a combined electrode and dielectric. A member 12, formed of copper sheet or other suitable heat conducting metal is vertically corrugated from end to end and extends annularly and fits between the inner periphery of the cylindrical wall 7 and the outer periphery of the electrode 11 on the dielectric 10. This corrugated member is sufficiently resilient to contact with the outer periphery of electrode 11 and inner periphery of wall 7, so as to efficiently conduct heat from the electrode 11 and the dielectric to the wall 7 and to permit the unequal expansions of the dielectric and the metal of the

casing, and also to provide for the commercial inequalities or variations in the thickness of the glass of the dielectric or its diameter without subjecting the dielectric to stresses which tend to rupture the dielectric material. The corrugated member 12 is split or open longitudinally, as at 13, to provide the desired degree of resiliency. Besides functioning as a heat radiator, corrugated member 12 serves to position the dielectric and the outer electrode 11 carried thereby concentrically around the inner electrode and in the casing. To permit the easy removal of the tubular dielectric and the electrode 11, an opening is formed in the upper end of head 6 which is closed by the cap 15 which is removably secured to said head by screws 16. This construction permits a dielectric to be removed and replaced without requiring disconnection of the pipes connected to the casing. The gasket 5^c of lead is secured in the head 5, to engage the lower end of the dielectric, and prevents the passage of air from the polar space inside of the dielectric to the space between the outer electrode and wall 7.

The inner electrode 17 consists of a tube of suitable material, such as aluminum. The upper end of electrode 17 is pressed tightly around an upper aluminum ring 18, and the lower end of which is contracted and pressed around an aluminum ring 19. Each of these rings is chambered or recessed, as at 20, to receive one end of an insulator tube for supporting the inner electrode from the heads 5 and 6 respectively. These recesses are adapted to receive a suitable cement 21 for securing the insulators to the ends of the electrodes. An insulator 22, which is tubular from end to end, extends through the cap 15 and the upper end of the dielectric and to the ring 18, where it is secured to said ring and the upper end of the inner electrode 17. An insulator 23, also tubular from end to end, extends through the lower head 5 and the lower end of the dielectric into ring 19 where it is secured to said ring. These insulators are made of porcelain, and cement 21 has sufficient dielectric strength not to permit sliding sparks between the ends of the inner electrode and the heads of the casing. Insulator 23 extends through a packing box 24 in the lower head 5, and insulator 22 extends through and is held in a packing box 25 which is provided in the cap 15 on the upper head 6.

A bridge bar 28 is formed on the ring 20, and a rod 29, threaded into said bar, extends downwardly through and below the insulator 23 for electrically connecting the inner electrode to a suitable conductor through which electric current is supplied to the generator. The return conductor may be secured to either of the heads 5 or 6 to return the current from the outer electrode, the corrugated member 12 being of conducting material and in contact with the casing and the outer periphery of the outer electrode 11.

The upper end of the outer electrode terminates below the upper end of the dielectric, and the ends of the inner electrodes terminate inwardly of the outer electrode sufficiently to prevent sliding sparks at or to insulate the boundaries of the electrodes. The upper end of the dielectric is extended so it can be grasped and passed through opening 14 in cap 15.

A water jacket is formed around the tubular wall 7 of the casing and between the heads 5 and 6. This jacket is formed by a tube 30 and rings 31 which are pressed and secured on the tube 30, and are provided with grooves 32 for the ends of tube 30 and packings 33. Annular glands 34, slidable on tube 30, are provided to compress the packings around said tube. Cap screws 35, passing through ears 36 on heads 5 and 6 respectively, are threaded into rings 31 respectively to jam the ends of tube 7 in said heads and form tight joints between the ends of the tube and said heads for preventing air from leaking from the casing. Bolts 37 pass through ears on the glands 34, and rings 31 and are provided with nuts 38 for adjusting the glands to compress the packings and with nuts 39 for engaging the rings to prevent excessive tightening of the screws 35 from loosening the rings 31 on the tube 30. The space between tubes 7 and 30 and rings 31 is adapted to receive water through an inlet duct 40 in the lower ring 31, which is adapted for connection to a supply pipe. An outlet duct 41 is formed in the upper ring 31, and is adapted for connection to a discharge pipe. The construction described permits the packings 33 to be adjusted and replaced without disturbing the water connections with rings 31. While the invention has been illustrated with a water jacket, it will be understood that the tube 30 and glands 34 may be omitted, so that the tube 7 may be cooled by air.

The invention exemplifies a tubular ozone generator in which both electrodes can be conveniently removed from the casing without disturbing either the air or water connections to the casing. This is of importance in practice, because it is occasionally necessary to polish the electrodes, when they become roughened by the oxides of nitrogen formed through the presence of moisture which results in the formation of nitric acid which tends to etch or corrode the electrodes, which is conducive to sparking. To remove the dielectric and outer electrode, it is only necessary to remove the cap 15, and the inner electrode can be removed by loosening the packing boxes 24 and 25. This is also of importance in facilitating the replacement of a ruptured dielectric. The invention

also exemplifies a generator of this type in which the boundaries of the electrodes are protected against sliding sparks. The invention also exemplifies a generator in which the dielectric consists of a cylindrical glass which is supported in the casing without clamps or packing boxes, so that all portions thereof are free to expand and contract responsively to heat changes without danger of breaking the glass. The corrugated tubular member between the outer electrode and the casing constitutes simple and efficient means for yieldingly, but accurately, positioning the dielectric concentrically around the inner electrode, as well as an efficient heat conductor for keeping the dielectric cool and conducting the heat to the wall of the casing which may be cooled by water or air. The generator in its entirety may be produced at a low cost and is efficient and economical in its operation.

The invention is not to be understood as restricted to the details set forth, since these may be modified within the scope of the appended claims, without departing from the spirit and scope of the invention.

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

1. In an ozone generator, the combination of a tubular dielectric, an outer electrode on the periphery of the dielectric, an inner tubular electrode spaced from the outer electrode, and a tubular heat conductor of sheet metal extending longitudinally between and contacting with the metal wall and the outer electrode.

2. In an ozone generator, the combination of a tubular dielectric, an outer electrode on the periphery of the dielectric, an inner tubular electrode spaced from the dielectric, a casing comprising a tubular metal wall spaced from the outer electrode, and a resilient heat conductor of sheet metal extending longitudinally between and contacting with the metal wall and the outer electrode.

3. In an ozone generator, the combination of a tubular dielectric, an outer electrode on the periphery of the dielectric, an inner tubular electrode spaced from the dielectric, a casing comprising a tubular metal wall spaced from the outer electrode and a heat conductor of corrugated metal extending longitudinally between and contacting with the metal wall and the outer electrode.

4. In an ozone generator, the combination of a tubular dielectric, an outer electrode on the outer periphery of the dielectric, an inner tubular electrode spaced from the dielectric, a casing comprising a tubular metal wall spaced from the outer electrode, a tubular resilient heat conductor of sheet metal extending longitudinally between and bent to contact with the inner periphery of the metal wall and the outer periphery of the electrode, and a water-jacket around said wall.

5. In an ozone generator, the combination of a tubular dielectric, an outer electrode on the outer periphery of the dielectric, an inner tubular electrode spaced from the dielectric, a casing comprising a tubular metal wall spaced from the outer electrode, a resilient heat conductor of corrugated sheet metal extending longitudinally between and bent to contact with the inner periphery of the metal wall and the outer periphery of the electrode, and a water-jacket around the wall.

6. In an ozone generator, the combination of a tubular dielectric, an outer electrode on the outer periphery of the dielectric, an inner tubular electrode spaced from the dielectric, a casing comprising a tubular metal wall spaced from the outer electrode, and a corrugated tubular resilient member extending longitudinally between and bent to contact with the inner periphery of the metal wall and the outer periphery of the electrode.

7. In an ozone generator, the combination of tubular inner and outer electrodes, a removable tubular dielectric spaced from the inner electrode, a casing comprising a tubular wall, and provided with a rest for the lower end of the dielectric, the dielectric being supported on said rest with all portions thereof free to expand and contract, and resilient means around the outside of the dielectric for concentrically positioning the dielectric around the inner electrode.

8. In an ozone generator, the combination of inner and outer tubular electrodes, a tubular dielectric spaced from the inner electrode, a casing comprising a tubular wall, and provided with a rest for the lower end of the dielectric, the dielectric being supported on said rest with all portions thereof free to expand and contract, and a corrugated resilient member engaging said wall, for centering the dielectric around the inner electrode.

9. In an ozone generator, the combination of tubular inner and outer electrodes, a tubular dielectric spaced from the inner electrode, a casing comprising a tubular wall provided with a packing gasket forming a rest for the lower end of the dielectric, the dielectric being supported on said gasket with all portions thereof free to expand and contract, and yielding means for positioning the dielectric concentrally around the inner electrode.

10. In an ozone generator, the combination of a tubular inner electrode, a tubular dielectric spaced from the inner electrode, an outer electrode on the dielectric, a casing comprising a tubular wall provided with a rest for the lower end of the dielectric, the dielectric being supported on said rest with all portions thereof free to expand and contract, and yielding means between said wall

and the outer electrode for positioning the dielectric concentrically around the inner electrode.

11. In an ozone generator, the combination of tubular inner and outer electrodes, a removable tubular dielectric spaced from the inner electrodes, a casing comprising a tubular metal wall and provided with a rest for the lower end of the dielectric, the dielectric being supported on said rest with all portions thereof free to expand and contract, and resilient heat conducting means between the outer electrode and the wall, for positioning the outer electrode concentrically around the inner electrode.

12. In an ozone generator, the combination of an inner tubular electrode, a tubular dielectric spaced from the inner electrode and having an outer electrode on its outer periphery, a casing comprising a tubular body and heads at the ends of the body provided with air ducts leading to and from the polar space between the dielectric and the inner electrode, and tubular insulators open at both ends and secured to the ends of the inner electrode and extending through said heads to the outside of the casing to permit air to pass directly through said casing and the inner electrode.

13. In an ozone generator, the combination of an inner tubular electrode, a tubular dielectric spaced from the inner electrode and having an outer electrode on its outer periphery, a casing comprising a tubular body and heads at the ends of the body provided with air ducts leading to and from the polar space between the dielectric and the inner electrode, tubular insulators secured to the ends of the inner electrode and extending through said heads to the outside of the casing, one of said heads having an opening through which the dielectric is endwise removable, and a removable cap for said opening.

14. In an ozone generator, the combination of an inner tubular electrode, a tubular dielectric spaced from the inner electrode and having an outer electrode on its outer periphery, a casing comprising a tubular body and heads at the ends of the body provided with air ducts leading to and from the polar space between the dielectric and the inner electrode, tubular insulators secured to the ends of the inner electrode, one of said heads having an opening through which the dielectric is endwise removable, a removable cap for said opening provided with a packing box, one of the insulators being extended through said cap and packing box, and a packing box in the other head through which the other insulator passes.

15. In an ozone generator, the combination of inner and outer electrodes, a tubular dielectric between the electrodes, a casing comprising a tubular body, and heads at the ends of the body provided with air ducts leading to and from the polar space, rings secured on the tubular body, a tube between the rings forming a water jacket around the body and packings between the rings and the ends of the tube, and adjustable glands on the tube for said packings.

16. In an ozone generator, the combination of inner and outer electrodes, a tubular dielectric between the electrodes, a casing comprising a tubular body, and heads at the ends of the body provided with air ducts leading to and from the polar space, rings secured on the tubular body, a tube between the rings forming a water jacket around the body and packings between the rings and the ends of the tube, adjustable glands on the tube for said packings, screws between the rings and the caps respectively, and tie bolts between the rings.

Signed at Chicago, Illinois, this 11th day of February, 1930.

FRANK E. HARTMAN.