June 17, 1924. 1,498,393

K. B. McEACHRON

APPARATUS AND PROCESS FOR PRODUCING COMBINATIONS OF GASES

Filed Sept. 26, 1921

Fig. 1.

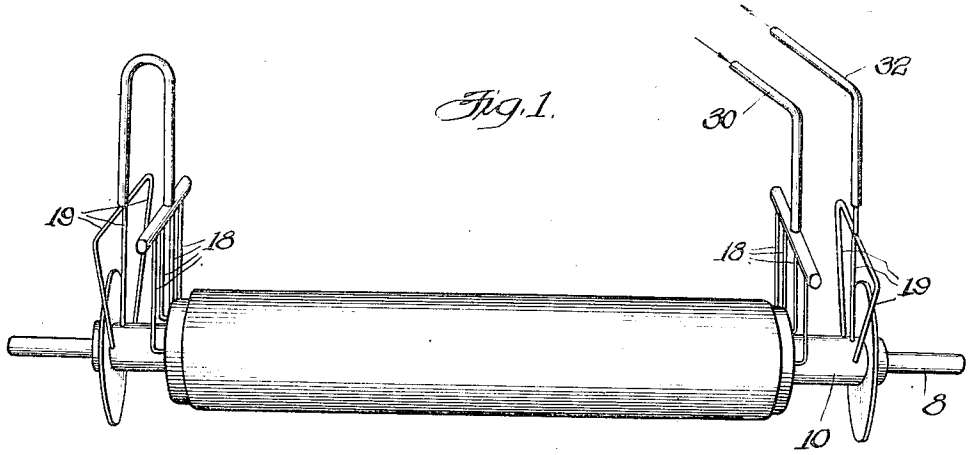


Fig. 2.

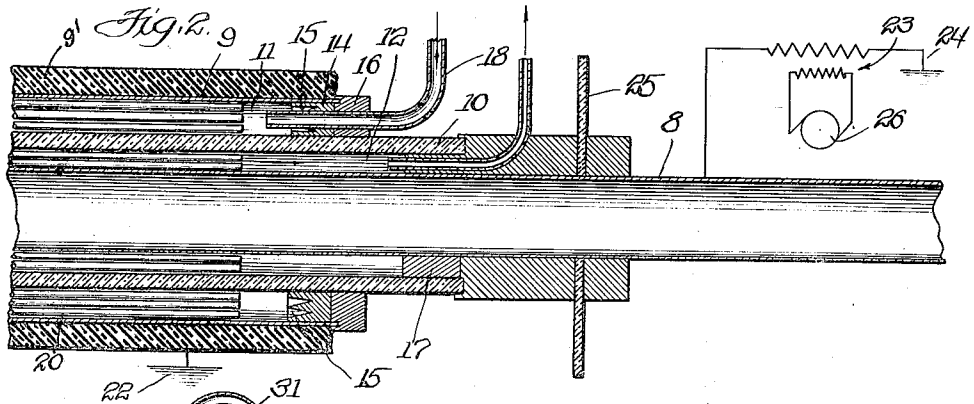


Fig. 3.

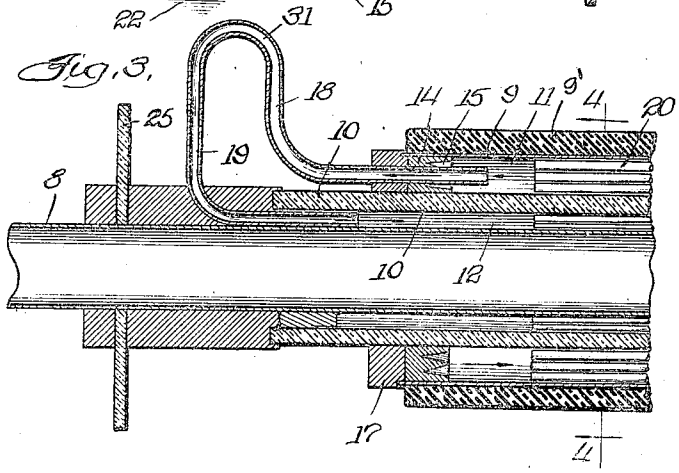
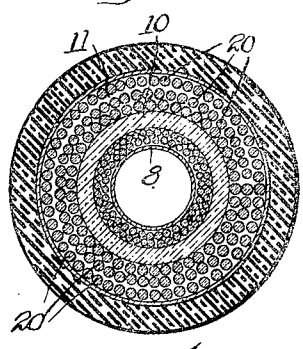


Fig. 4.



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By Jones, Addington, Ames & Seibold Attys.

Patented June 17, 1924. 1,498,393

UNITED STATES PATENT OFFICE.

KARL B. McEACHRON, OF LA FAYETTE, INDIANA, ASSIGNOR TO TRUSTEES FOR PURDUE UNIVERSITY, AN INSTITUTION OF INDIANA.

APPARATUS AND PROCESS FOR PRODUCING COMBINATIONS OF GASES.

Application filed September 26, 1921. Serial No. 503,123.

To all whom it may concern:

Be it known that I, KARL B. McEACHRON, a citizen of the United States, residing at La Fayette, in the county of Tippecanoe and State of Indiana, have invented new and useful Improvements in Apparatus and Process for Producing Combinations of Gases, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing forming a part of this specification.

This invention relates to an improved apparatus and process for producing combinations of gases and more particularly for an improved process and apparatus of this character to obtain gas combinations from the air through the agency of electrical discharges.

The apparatuses used for combining gases through the agency of electrical discharges are commonly known in the art as discharge tubes. The principle upon which substantially all of these tubes operate consists in impressing upon the air or other gas passing through the tube a sufficient electrical potential to cause the air to break down more or less completely to effect a recombination of the gases and to so arrange the electrical circuit that electrical arcs will not occur. Apparatuses of this character generally take the form of two metal surfaces which are separated from one another by a distance the length of which is determined by the voltage which is to be impressed upon the apparatus.

It is common practice in the art to place between these two metal surfaces a dielectric of some character, such as porcelain, glass, bakelite, or the like, which dielectric will be unaffected by the chemical products formed by the discharge, and which dielectric is sufficiently strong to prevent a weakening and consequent rupture.

It is one of the objects of this invention to provide an improved apparatus and process of this kind in which the gas combination in the apparatus is more efficiently accomplished, and in which the space between the discharge plates or electrodes is substantially filled with a discontinuous dielectric.

Another object of the invention consists in the provision of an improved apparatus to more efficiently effect the combination of gases by electrical discharges, and in which the number of discharge gaps between the plates of the apparatus is increased by the introduction of a suitable filler.

The improved process and apparatus herein illustrated and described can be used for the production of ozone from the air for the production of nitric oxides from the air, or may be used for the combination of other gases which, when passed through the discharge tube and subjected to the proper conditions of temperature and pressure, as well as electric voltage and frequency and other variables such as the presence of impurities, in moisture content of the incoming gas, etc., will result in the combinations desired.

For the purposes of description the invention is illustrated in the accompanying drawings in which—

Fig. 1 is a view in perspective of the complete apparatus;

Fig. 2 is a longitudinal section of the right end thereof;

Fig. 3 is a longitudinal section of the left end thereof; and,

Fig. 4 is a view in cross-section of the apparatus taken on the plane indicated by the line 4—4 in Fig. 3.

The invention is obviously not limited to the specific embodiment illustrated in these drawings, which are illustrative only, for the purpose of describing one of the preferred methods for practicing the improved process.

As illustrated in the drawings, the apparatus consists of two metallic tubes 8 and 9, preferably made of aluminum. The outer tube 9 is preferably covered with some suitable insulating means such as 9′. These tubes 8 and 9 are concentrically arranged, and positioned between said tubes is the porcelain tube 10. The two tubes 8 and 9, together with the tube 10 form the two gas conducting chambers 11 and 12. The porcelain tube 10 constitutes a solid dielectric barrier between the tubes 8 and 9. The use of this dielectric barrier is not essential in the operation of the apparatus and process and consequently can be used or dispensed with as operating conditions warrant. The apparatus will operate without this dielectric barrier porcelain tube 10. In the specific apparatus herein described the porcelain tube 10 serves to form the two gas conducting chambers 11 and 12, whereby the air

which is subjected to the electrical discharge may be conducted first through one chamber, as for example 11, and then returned through chamber 12. If the tube 10 were not utilized the gas conducting chambers 11 and 12 would be united into one large chamber and the air could only be conducted through this chamber in one direction and not be conducted through the chamber 11 and then returned through the chamber 12, thereby being subjected to the electrical discharge for two passages through the apparatus, as hereinafter described.

The aluminum tube 9 is supported on the porcelain tube 10 at either end of said tube by a paraffin treated wooden disk such as 14. This disk is provided with grooves, such as 15, at its inner end in order to increase the surface resistance of the block, and thus prevent electrical discharge at this point. The aluminum tube 9 is further supported on the porcelain tube 10 by an insulating disk 16, which disk is sealed to the tubes 9 and 10 and the block 14 by any suitable form of sealing compound, whereby an airtight joint is obtained between these tubes.

The tube 10 is supported on the tube 8 by a similar paraffin treated wooden disk 17 and said disk 17 is sealed to the tubes 8 and 10 by a suitable sealing compound to obtain an airtight connection. The disks 15 and 16 are fitted with suitable perforations, preferably four in number, to permit the entrance of the tubes, such as 18, through which the air is permitted to enter and leave the chamber 11. In a like manner the disks 17 are provided with suitable perforations to receive the tube 19 in which the air is fed to and removed from the chamber 12. Obviously any number of these tubes 18 and 19 may be used, and the design of the apparatus for supplying the air to and removing the air from the chambers in which it is submitted to the electrical discharge can take any one of the large number of commercial forms, depending upon commercial operating conditions and the degree of uniformity of distribution of air entering and leaving the tube which is desired.

The air conducting chambers 11 and 12 are filled with a plurality of rods such as 20, which rods are preferably made of glass. These rods, however, may be made of any dielectric material and the chambers 11 and 12, instead of being filled with rods, can be filled with glass beads, broken pieces of glass tubing or any other form or character of dielectric, and substantially the same results can be obtained. The important feature in the operation of the improved process and apparatus resides in substantially filling the chambers 11 and 12 with some form of discontinuous dielectric.

In the operation of the apparatus the outer aluminum tube 9 is preferably grounded as indicated at 22. When this tube is grounded a transformer such as diagrammatically illustrated at 23, or any other source of electrical supply, has one of its terminals grounded as indicated at 24, and the other terminal of the source of supply is connected to the inner aluminum tube 8. To increase the creepage distance between the tube 8 and the tube 9, it is ordinarily desirable to use an insulating collar, such as 25, which, as is well known to those skilled in the art, increases the amount of surface resistance between these two tubes. The source of electrical energy supplied to the transformer may be of any character with respect to potential, frequency, etc., depending upon the operating conditions and the ultimate results which are desired. The source of electrical supply is preferably a generator such as is diagrammatically illustrated at 26. If desired, the apparatus may also be operated with direct current. If it is not desired to ground the outer tube 9, as indicated at 22, the other side of the circuit can be connected to this outer tube, as well known to those skilled in the art.

With the connections as illustrated in Fig. 3, a difference of potential will exist between the tubes 8 and 9, depending upon the voltage of the source. When the potential is raised to the value necessary for the successful operation of the particular gas that is being operated upon the spaces between the porcelain tube and the glass rods 20 and between the glass rods 20 and the aluminum tubes 8 and 9, and also between the glass rods themselves will be filled with an electrical discharge, which discharge is effective in breaking down the molecules of the gas flowing through the apparatus, and thereby allowing new chemical combinations to take place. Thus for example, when air is passing through the apparatus by properly adjusting the electrical potential and the temperature and pressure of the air, ozone will be generated and some of the air which enters the apparatus at one set of tubes 18 will leave the apparatus at the opposite set of tubes 19 as ozone. The flow of the gas through the apparatus is indicated by the arrows on Figures 1, 2 and 3, from which it will be evident that the gas enters through the tube 30, passing through the tubes 18 to the outer chamber 11, through said chamber and by the glass rods 20 in said chamber to the other end of said chamber 11, then through tubes 18 to the inter-connecting tube 31, then by the way of tubes 19 into the second chamber 12 by the second set of glass rods 20 out through the tubes 19 to the discharge tube 32.

Obviously the direction and manner of flow of gas just described through the ap-

paratus is merely illustrative since the gas may be passed through the apparatus in the opposite direction, or the manner of passing the gas through the apparatus can be changed completely from that described without affecting the operation. In passing the gas through the apparatus it is merely essential that said gas be subjected to the electrical discharge taking place in either chambers 11 and 12, or in both of said chambers operated either in series or parallel. The glass rods in said chambers serve to give very intimate contact between the gas to be treated and the electrical discharge. Since these rods are made of a dielectric material whose dielectric constant is higher than that of air, the dielectric flux finds a more ready path through the glass rods and there is a resultant intense concentration of flux surrounding each rod which produces an intensified electrical discharge which is desirable for the breaking down of the molecules of the air and the recombination of the gases. Without the use of these glass rods, or some other discontinuous dielectric, an apparatus of the character described, when operated in the manner outlined, would give a good many static sparks, which sparks would in some cases interfere more or less with the operation of the tube and would prevent the formation of good yields of the combined gas ultimately desired. In the manufacture of ozone the production of these static sparks is extremely detrimental.

The velocity at which the gas is passed through the apparatus will depend upon the ultimate combined gas which is desired. The velocity of the gas through the apparatus affects the ultimate concentration of the combined gas and also the efficiency of this gas combination. As a general rule low velocities give high concentrations and low efficiency, whereas high velocities give lower concentrations and better efficiencies until a certain maximum is reached beyond which further increase in velocity means decreased efficiency as well as decreased concentration. The best operating conditions can be only ascertained by experimenting with the particular gas that is to be operated upon and depends entirely upon the ultimate results desired.

Obviously the apparatus and process are not limited to the specific preferred embodiment thereof herein illustrated and described, but are capable of many variations and other applications within the spirit and scope of the invention as set out in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The process of combining gases by electrical discharge, which consists in passing the gas which is to be disintegrated and recombined between electrodes and through a confined space which contains a discontinuous dielectric.

2. The process of combining gases by electrical discharge, which consists in passing the gas which is to be disintegrated and recombined between electrodes, and through a confined space which is substantially filled with a discontinuous dielectric.

3. The process of combining gases by electrical discharge, which consists in passing the gas which is to be disintegrated and recombined between electrodes, and through a confined space which is substantially filled with a discontinuous dielectric, which dielectric is arranged so as to permit the gases to circulate around said dielectric.

4. The process of combining gases by electrical discharge, which consists in passing the gas which is to be disintegrated and recombined between electrodes, and through a confined space which contains a plurality of dielectric bodies.

5. The process of combining gases by electrical discharge which consists in passing the gas which is to be disintegrated and recombined between electrodes and through a confined space which contains a plurality of glass rods.

6. The process of combining gases by electrical discharge which consists in passing the gas which is to be disintegrated and recombined between electrodes, said electrodes being separated by a solid dielectric barrier, and a discontinuous dielectric.

7. In a device of the character described, in combination, a gas conducting container, means for supplying a difference of electrical potential to opposite walls of said container, and a discontinuous dielectric positioned between the walls of said container.

8. In a device of the character described, in combination, a gas conducting container, means for supplying a difference of electrical potential to opposite walls of said container, a dielectric barrier separating said walls and a discontinuous dielectric positioned between said barrier and said walls.

9. In a device of the character described, in combination, a gas conducting container, means for supplying a difference of electrical potential to opposite walls of said container, and a plurality of dielectric bodies positioned between the walls of said container.

10. In a device of the character described, in combination, electrical conductors comprising the inner and outer walls of the container, a dielectric barrier positioned between said walls, gas conducting chambers positioned between each of said walls and said barrier, a discontinuous dielectric positioned in each of said chambers, and means for producing a difference of electrical potential between the said walls.

11. In a device of the character described,

electrical conductors comprising the inner and outer walls of a container, a dielectric barrier positioned between said walls, gas conducting chambers positioned between each of said walls and said barrier, means for circulating gas first through one of said chambers and then the other of said chambers, a discontinuous dielectric positioned in each of said chambers, and means for impressing a difference of potential on said walls.

12. In a device of the character described, electrical conductors comprising the inner and outer walls of a container, a gas conducting chamber positioned between said walls, a discontinuous dielectric positioned between said walls, and means for impressing a difference of electrical potential on said walls.

13. In a device of the character described, electrical conductors comprising the inner and outer walls of a container, a gas conducting chamber positioned between said walls, means for increasing the surface resistance between said walls, a discontinuous dielectric positioned between said walls, and means for impressing a difference of electrical potential on said walls.

14. In a device of the character described, in combination, a gas container, means to supply a difference of electrical potential to opposite walls of said container, and means within said container permitting an increased space between said walls for a given applied potential and which last mentioned means serves to accentuate the disintegration of the gas being treated and the recombination of the gas desired.

In witness whereof, I have hereunto subscribed my name.

KARL B. McEACHRON.

Witnesses:
C. FRANCIS HARDING,
D. D. EWING.