

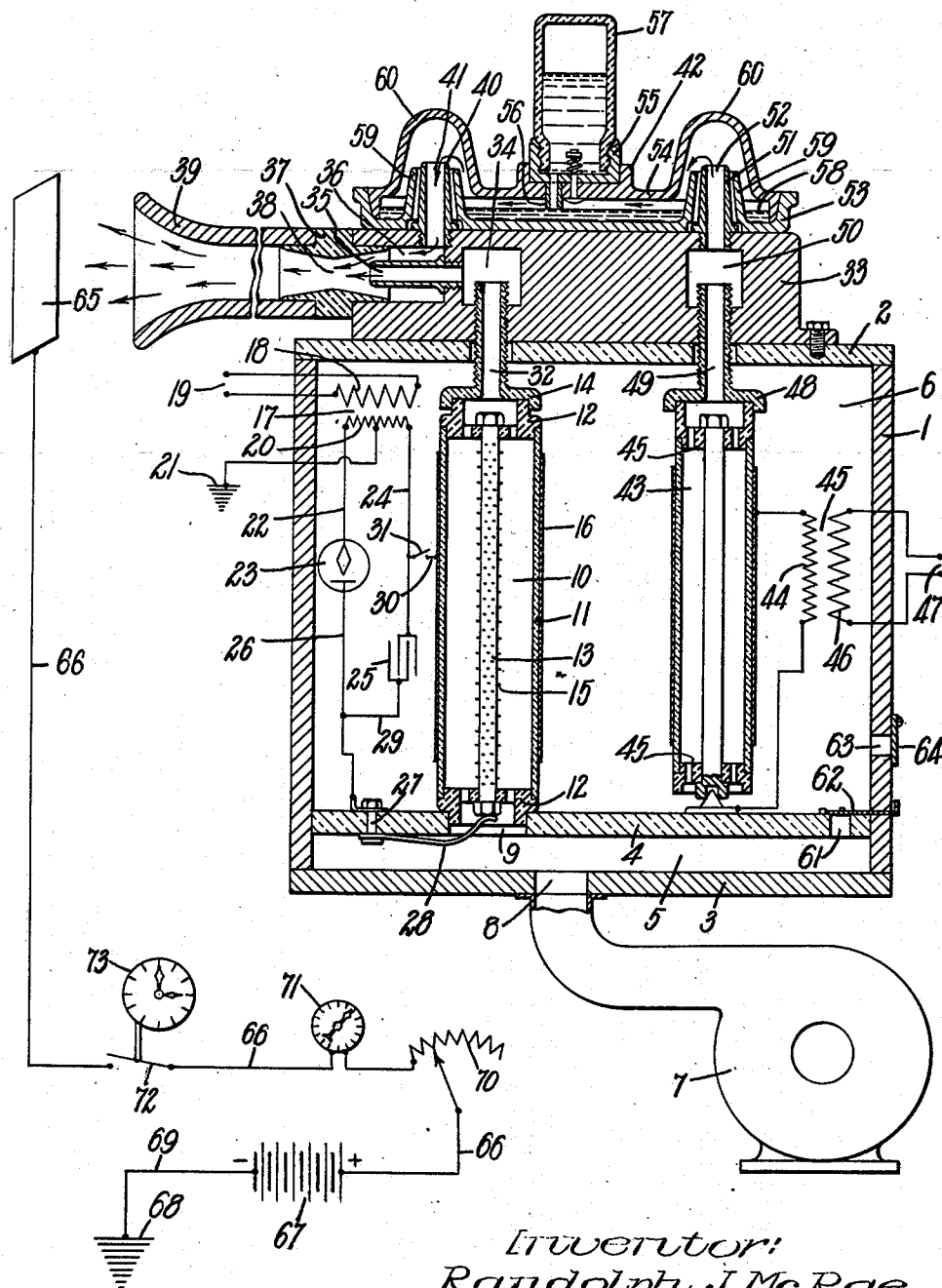
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PROCESS FOR PRODUCING LARGE IONS

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## PROCESS FOR PRODUCING LARGE IONS

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This invention relates broadly to improvements in processes for the production of large ions. More particularly the invention relates to the production of large ions of chosen polarity by ionizing a gas such as air, oxygen, or the like, and fixing ions of said gas on nuclei consisting of solid or liquid particles.

Gases may be ionized by any of several well-known methods such as, by X-rays, a high voltage brush discharge, high frequency currents, radioactive substances, incandescent materials, spark gaps, flames, and by creating a dielectric strain in a gas. Normally when a gas is ionized by any of the above-mentioned methods, both positive and negative ions are produced and in substantially equal numbers. Recombinations of positive and negative ions under such circumstances usually proceeds quite rapidly and only a smaller number of the ions remain after a relatively short period of time, the remaining ions so produced having been neutralized by recombination or by other forces destructive to the ion.

Various methods and means have been employed to obtain a gas containing a preponderance of ions of chosen polarity, for example, the obtaining of a gas containing a preponderance of negative ions. A gas containing a preponderance of negative ions may be referred to as a negatively charged gas, or a negatively ionized gas. The process by which such a negatively ionized gas is obtained may be defined as negatively ionizing a gas. Such methods of negatively ionizing a gas have included the use of an electric field whereby a segregation of the ions of different polarity is obtained and the ions of chosen polarity are carried along by a current of gas. Another method consists broadly of the adsorption on conducting surfaces of ions of the undesired polarity.

The ions so generated in a gas have relatively high mobilities and the rates of diffusion are high. For example, an ordinary ion generated in a gas, such as air, may have a mobility of the order of 1.5 cm./sec. volt/cm. Ions produced by the use of this invention may have mobilities as low as  $\frac{1}{3000}$  cm./sec. volt/cm. or several thousand times less than the mobility of the ordinary air ions. Ions of low mobility have a lesser probability of meeting forces destructive to the ion than have ions of high mobility. Accordingly the normal life of the ion having low mobility is much longer.

Ions of such low mobility are large ions usually formed by the settling or clustering of ordinary gaseous ions around a nucleus consisting of a liquid or a solid particle. If the particle possesses high specific inductance, it is possible that electric charges on the ordinary ions may undergo rearrangement as these ordinary ions settle or cluster around the particle and that ordinary ions may give up their charges to the particle in which event many of the ordinary ions cease to exist as such and the large ion consists essentially of a charged particle.

In the specifications and claims hereof, the word "ion" is meant to include the broad definition which defines an ion as a charged particle capable of conducting the electric current. The term "ion" as used herein shall include the electron, the ordinary ions formed by ionizing a gas, the ions formed by chemical reaction, and also the large ions as described. The word "fixing" is meant to include the settling or clustering of electrons, or ordinary ions, or ions formed by chemical reactions, each or all, on a liquid or solid particle.

One effective and efficient method of forming nuclei of the large ions is the utilization of chemical reaction. For example, air may be ionized with the formation of ozone and the action of ozone on certain unsaturated organic compounds, such as terpenes, yields particles of a liquid or solid compounds which act as the nuclei for the large ions.

Conventional ozonizers, for example, the brush discharge, yield ozone in sufficient amounts to react with suitable substances and produce many times the number of nuclei effectively required for fixing all the ordinary ions contained in the gas normally accompanying the ozone. In some instances, in the operation of the invention, it is desired that an excess of ordinary ions over and above those fixed on the nuclei, be present. Moreover, the passing of the ozone carrying gas in contact with the liquid causes the vaporization of particles of the liquid, and such vaporization is augmented by the reaction of the ozone. Accordingly, under such circumstances there is present a great excess of vaporized and reacted particles over those required for fixing the ions that may be present, even if the new ions formed as a result of the vaporization and also formed by the chemical reaction be added to those in the stream of air coming from the ozonizer.

The quantity of liquid required to yield a sufficient number of particles for effectively fixing

ions thereon may be estimated on a basis that includes certain assumptions. For example:—

Assume

1. Average molecular weight of liquid=136
- 136 grams contains  $6.06 \times 10^{23}$  molecules.
- 1 gram contains  $4.45 \times 10^{21}$  molecules.
2. Ionized air containing  $10^7$  negative ions per c. c. equivalent to  $10^{10}$  ions per liter.
3. Average size of particles in vapor 15,000 molecules.
4. Probability of ion fixation=

$$\frac{\text{ordinary ions}}{\text{particles of liquid}} = \frac{1}{12,000}$$

Accordingly:—

To fix one (1) ordinary ion requires 15,000  $\times$  12,000=180,000,000 molecules of liquid.

One liter of ionized gas requires 180,000,000  $\times$   $10^{10}$ = $1.8 \times 10^{18}$  molecules of liquid.

One gram of liquid is sufficient for,

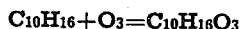
$$\frac{4.45 \times 10^{21}}{1.8 \times 10^{18}} = 2472 \text{ liters of gas}$$

In this manner it appears that one gram of oil having a molecular weight of 136 is sufficient for the fixation of the ions in approximately 2500 liters of gas ionized to an intensity of  $10^7$  ions per. c. c. It is believed that the basis of calculation is conservative because it is predicated upon reasonable probabilities with respect to ion fixation and with respect to the size of the particles in the vapors. Furthermore, the basis of calculation assumes that only one ordinary ion will become fixed on a particle, whereas it is known that such particles form the nuclei for large ions which may each carry as much as fifty times or more the quantity of electricity carried by the ordinary ion. It would appear, therefore, that one gram of oil is sufficient to produce nuclei for the fixation of the ordinary ions contained in many times 2500 liters of gas ionized to an intensity of  $10^7$  ions per cubic centimeter.

If 2500 liters of a gas were brought into contact with a liquid having a molecular weight of the order of 136 and at room temperatures of 70° F., for example, more than one gram of oil would be vaporized, especially so if the gas were reactive with fractions of the liquid. For example, consider the reaction of ozone in air with a liquid such as a terpene having a molecular weight of 136.

Assume

1. Molecular weight of liquid 136
- 1 gram contains  $4.45 \times 10^{21}$  molecules.
2. Air, with low ozone content of 1500 parts of ozone in 1,000,000 parts.
3. 50% of molecules of liquid reacted with ozone.
4. All ozone molecules reacted



Accordingly:—

One (1) liter of air contains  $2.705 \times 10^{22}$  molecules of which ozone molecules= $4.05 \times 10^{19}$ .

Ozone in one (1) liter of air reacts with

$$\frac{4.05 \times 10^{19}}{3} = 1.35 \times 10^{18} \text{ molecules of the liquid.}$$

One gram of the liquid is sufficient for

$$\frac{4.45 \times 10^{21}}{1.35 \times 10^{18}} \times 2 = 659 \text{ liters of air.}$$

With higher concentration of ozone and a lesser oxidizing action on the terpenes, less than 659

liters of air would be required for one gram of the liquid.

It is apparent that a smaller volume of gas may be passed over the liquid and carry the particles of the liquid or of the products of reactions of ozone or the like therewith, into a much larger volume of ionized gas wherein the particles form nuclei for the fixation of ions thereon and a balanced operation be established with a minimum consumption of the liquid. In this invention it is preferred that a volume of gas more than three times the volume of gas passing over the liquid, be used to carry the ordinary ions.

While the reaction of ozone with unsaturated hydrocarbons, such as terpenes, produces products whose particles constitute suitable nuclei for the formation of large ions, nevertheless the ionic content of air containing ozone produced therein by conventional methods is quite low.

By the use of this invention not only a balanced operation is brought about with a minimum consumption of liquid but it is also possible to produce an ionized gas having a high degree of ionic content of large ions. In this invention a gas, such as air, is ionized in one stream without substantial production of ozone and a separate stream of gas is ionized with substantial production of ozone. Ions of chosen polarity are removed from one or both streams of gas and the ozone containing stream is then flown into contact with a liquid reactive with ozone in a vaporizing chamber on which a negative voltage potential is preferably imposed. Escaping from said vaporizing chamber, the products of reaction and the vaporized particles of the liquid together with new ions formed during vaporization and reaction within the vaporizing chamber, are then commingled with the stream of gas ionized without substantial production of ozone. The particles of the liquid and the products of reaction are then presented to the ordinary ions in the ionized gas and large ions are formed.

Any suitable method of ionizing a gas may be used for ionizing the stream of gas in which substantially no ozone is produced providing such ionized gas contains a substantial preponderance of ions of chosen polarity. The method now preferred for negatively ionizing a gas comprises the direct ejection of negative electrons into a stream of gas under controlled conditions. In this manner the ionizing agent is the fundamental negative electric charge or the negative electron. Some ionization by collision takes place in the gas with the resulting formation of both positive and negative ions but the negatives are so largely in excess that a vast preponderance of negative ions exists in the gas after neutralization of positives has occurred.

The stream of gas, such as air, containing ozone and the separate stream containing the negatively ionized gas flow through different passages or chambers respectively in the same metallic manifold. The said passages or chambers are therefore electrically connected. The said metallic manifold is well and thoroughly insulated and adsorbs negative electrical charges from the negative ions of the negatively ionized gas flowing therethrough. Accordingly said metallic manifold acquires a negative voltage potential that may be quite high. The voltage potential so acquired by said metallic manifold, or by parts in electrical connection therewith, for purposes of brevity herein, may be termed "ionic voltage potential".

The so acquiring of a negative voltage poten-

tial by the insulated manifold is possible because of a greater volume of the negatively ionized gas than the volume of the ozone containing gas passing into the said manifold per unit of time and also because of the greater number of negative ions in the negatively charged gas per unit of volume. In other words, there are more negative charges of electricity flowing through one passage or chamber of the manifold per unit of time than there are positive charges of electricity flowing through the other passage or chamber of the manifold in the same unit of time. In applying this invention the ratio of negative charges to positive charges entering the respective passages or chambers per unit of time is maintained at a value of more than five.

As a result of the negative voltage potential so acquired by the manifold, positive charges in the ozone-containing gas are adsorbed on the walls of the manifold before such gas enters the vaporizing chamber. The source of the negative voltage potential on the vaporizer having been the negative charges in the ionized gas, the adsorption of the positive ions is brought about by flowing negative charges from the negatively ionized gas through a metallic conductor to the positive ions in the ozone-containing gas.

The metallic container or vaporizer containing the liquid to be vaporized is supported by the metallic manifold and therefore is in electrical connection with said manifold and assumes substantially the same negative voltage potential as the manifold itself. Vaporization of the liquid and chemical reactions taking place within the vaporizer are under the influence of the negative voltage potential imposed on the vaporizer as aforesaid. New ions are formed within the vaporizer. Negative ions so formed are repelled from the metallic walls of the vaporizer and thereby preserved while new positive ions generated within said vaporizer during vaporization, during chemical reaction and afterwards are adsorbed on the walls of said vaporizer.

Excess particles of liquid and solids without electrical charges thereon, new ions formed in the vaporizer, and large ions may escape from the vaporizer entrained in the gas and commingle with the negatively ionized gas. Negative ions may then become fixed on nuclei so presented and large ions be thereby produced. If the ordinary negative ions are in excess of those becoming fixed on the particles so presented free ordinary ions may be present in the commingled gases as well as large ions.

The large ions are not good producers of conductivity because their mobilities are low. However, this is offset to an extent by the larger quantity of electricity carried by the large ion which quantity may be as much as fifty times, or more, the quantity of electricity carried by the ordinary ion. The large ion has a longer normal life and the ability to utilize its charges is thereby facilitated.

In this manner available charges of electricity accompanying the ordinary ion and as free electrons, are fixed on liquid or solid particles and are available for use in electrical circuits. Energy is required to remove an electrical charge from an ion. Accordingly it is often desirable when utilizing the charges on the ions, as will be hereinafter described, to impose a voltage potential on the objective being contacted by the ion in order that the removal of the charge from the ion may be facilitated.

Accordingly, one object of this invention is to

provide a process whereby large ions may be produced.

Another object of the invention is to provide a process whereby large ions of chosen polarity may be produced.

Another object of the invention is to provide a process whereby the electrical charges carried by the large ions may be utilized.

Still another object of the invention is to provide a process whereby a minimum quantity of liquid is required to provide the necessary particles for nuclei of the large ions.

Another object of the invention is to provide a process whereby ordinary ions may be fixed on liquid or solid particles and still have an excess of free ordinary ions present commingled with the large ions.

The invention consists in a process for producing large ions as set forth in the following specification and particularly as pointed out in the claims thereof.

The figure of the drawing represents a vertical, sectional elevation of an apparatus for carrying out the process of this invention, certain portions of said apparatus being illustrated diagrammatically.

In the drawing 1 represents a cabinet constructed of any suitable material such as wood, steel, fibre, or the like. A top member 2 for the cabinet is constructed of a suitable electrical insulating material as, for example, Bakelite, phenol-fibre, or the like. The cabinet 1 is provided with a bottom member 3 and a false bottom 4, the latter being constructed of insulating material and dividing the interior of the cabinet into a lower air chamber 5 and an upper air chamber 6. A blower 7 of any suitable type forces air or other gases at pressure greater than atmospheric through a port 8 in the bottom 4 into the chamber 5 and from thence through a port 9 provided in the false bottom 4 into and through an ionizer 10 mounted in the upper chamber 6. A plurality of ports 9 and a corresponding number of ionizers 10 may be provided in the chamber 6, if it is desired to increase the capacity of the apparatus, said ionizers being mounted side by side in said chamber.

The ionizer 10 consists of a dielectric tube 11 and interchangeable end members 12 constructed of insulating material and all held securely together by a metal rod 13 having a nut at each end. A plurality of passages are provided in the end members 12, said passages extending upwardly therethrough. The lower end member 12 is seated upon the false bottom 4 above the port 9 and the upper end member 12 projects into a holding member 14 hereinafter to be more fully described. Fine metallic points 15 are fastened to the rod 13 and extend radially therefrom. A metallic covering 16 may be placed on the outer surface of the tube 11.

A step up transformer 17 well known to those skilled in the art, has its primary circuit 18 connected to a convenient source of electricity 19, and the secondary circuit 20 of said transformer is grounded to earth as at 21. The secondary voltage of the transformer 17 may be of the order of 12,000 volts, but higher or lower voltages may be used. A lead 22 of the secondary circuit 20 is connected to the filament of a high voltage rectifying tube 23 while the other lead 24 of the secondary is connected to a condenser 25. The plate of the rectifying tube 23 is electrically connected to the metallic rod 13 by means of wire 26, bolt 27 and spring member 28, the latter being

secured to the under side of the false bottom 4 by means of said bolt. A conductor 29 connects the wire 26 to the condenser 25.

The rectifying tube 23 performs the function of a valve and when the secondary lead 24 is positive, negative electrons flow freely through the rectifier 23, and a portion of said electrons flow into the condenser 25 which becomes a reservoir for said electrons, and a portion flow into the rod 13. When the current in the secondary of the transformer 17 changes and lead 24 becomes negative, the negative electrons stored in the condenser 25 are repelled therefrom. These negative electrons cannot pass back through the rectifier 23 and are ejected in great numbers from the fine metallic points 15 into the current of air flowing through the ionizer 10. The result is a high degree of negative ionization in the gas passing through the ionizer 10. The current voltage potential imposed on the metallic points 15 is of the unidirectional pulsating type and is negative.

An electrical conductor 30 may be used to connect the lead 24 with the metallic covering 16 on the dielectric tube 11. A switch 31 is interposed in this conductor 30. When this connection 30 is used a higher capacity is given to the rod 13 and a dielectric strain is created in the gas passing through the ionizer 10. Also, any alien negative electrons adhering to the inner surface of the dielectric tube 11 are repelled into the gas stream when the lead 24 is negative.

The gas, under a pressure greater than atmospheric, flows through the ionizer 10 where it is ionized preferably with a minimum production of ozone and nitrous products, and then flows through a passage 32 in the upper holding member 14. The member 14 is formed from a material having a high electrical insulating value such as Bakelite, hard rubber, or the like, and is threaded into a member 33 constituting a manifold.

The holding member 14 may be moved upwardly and downwardly in the manifold 33 and with respect to the ionizer 10, holding said ionizer in place when in a downward position and permitting the removal of the ionizer when the member 14 is in an upward position.

The manifold member 33 is formed from material having good electrical conducting properties and is fastened to the top member 2 of the cabinet 1 in any suitable manner. A chamber or passage 34 is provided in the member 33 and receives the ionized gas flowing through the passage 32 from the ionizer 10. The chamber 34 may be of sufficient size to accommodate a plurality of holding members 14 to correspond with the number of ionizers 10 provided. A nozzle member 35 is threaded or otherwise secured in the manifold 33 and forms an outlet for the flow of ionized gases from the chamber 34. The nozzle 35 projects through a circular chamber 36 provided in the manifold 33 and into a Venturi member 37 which may be constructed of insulating material. The Venturi member 37 projects into and fits the inside periphery of the chamber 36.

The ionized air at a pressure greater than atmospheric is discharged from the nozzle 35 into a Venturi passage 38 formed in the member 37, thereby creating a partial vacuum in the chamber 36. Secured to the Venturi member 37 in any suitable manner is a discharge tube or member 39. The longitudinal median lines of the tube 39, Venturi passage 38 and nozzle 35 may

be co-incidental. Secured to the top of the manifold 33 is an inlet member 40 having a passage 41 extending therethrough which is adapted to place a vaporizer 42, hereinafter to be more fully described, into communication with the chamber 36.

Mounted in the upper chamber 6 upon the false bottom 4 is an ozonizer 43. This ozonizer is illustrated diagrammatically as a conventional brush discharge apparatus actuated by a secondary circuit 44 of a step-up transformer 45. A primary circuit 46 of the transformer 45 is connected to any convenient source of alternating current 47. The secondary 44 of the transformer 45 is connected to the ozonizer 43 in a conventional manner. Any compact and efficient type of ozonizer is suitable for use in this invention. The stream of gas passing through the ozonizer 43 is subjected to the influence of an alternating current voltage imposed thereon.

The ozonizer 43 is held securely in position upon the false bottom 4 by an upper holding member 48 which may be similar in all respects to those utilized for holding the ionizer 10 and is adapted to be manipulated in a similar manner. The holding member 48 has a passage 49 extending therethrough which communicates with a chamber 50 provided in the manifold 33. Secured to the top of the manifold 33 is an inlet member 51 having a passage 52 extending therethrough which is adapted to place the chamber 50 into communication with the vaporizer 42.

Under the influence of the partial vacuum created in the chamber 36, as hereinbefore described, air or other gases from the chamber 6 enter the ozonizer 43 through suitable ports provided in the lower end member 45. As the gases pass through the ozonizer the gas is ionized and ozone is produced and this ozone and ionized gas pass outwardly from the ozonizer at the top thereof through ports provided in the upper end member 45. The ozone and ionized gas then pass through the holding member 48, chamber 50 and inlet member 51 into the vaporizer 42.

The vaporizer 42 rests upon the manifold 33 and embodies therein a pan or bottom member 53 constructed of metal, a cover 54 fitting into the pan 53, a valve member 55 rotatably mounted in the cover 54, a level controlling tube 56 attached to the cover 54 and a liquid container or reservoir 57 threaded into the valve member 55. A suitable liquid is placed in the reservoir 57 and when the valve 55 is opened the liquid will flow into the vaporizer 42 through the level controlling tube 56 and assume a level as indicated at 56.

Extending upwardly from the pan member 53 and preferably formed integral therewith are either cylindrical or conical projections 59. These projections 59 register with and fit over the inlet members 40 and 51 which project upwardly from the manifold 33. In this manner the vaporizer 42 is held in position resting upon the manifold 33 and making electrical contact therewith. Ionized gases enter the vaporizer 42 through the bottom thereof and pass from the vaporizer through the bottom thereof. This feature is important as it permits of easy removal of the vaporizer 42 from the manifold 33 when it is desired to replenish the liquid in the reservoir and permits easy replacement thereof. Dome shaped portions 60 are provided upon the cover 54 above the projections 59 and the latter project upwardly into said dome portions.

The ionized air and ozone entering the vapor-

izer 42 through the inlet member 51 flow over the liquid in the vaporizer in the direction indicated by the arrows. Particles of the liquid having been vaporized, and ozone reactions having taken place, the ionized gas and particles of the liquid and of the products of chemical reaction in the form of vapors entrained in the stream of gas flow out of the vaporizer 42 through the passage 41 of the inlet member 40 into the chamber 36.

The commingled ionized gas, vapors and particles then flow through the Venturi passage 38 and mix with the ionized air or other ionized gases escaping through the nozzle 35.

It is apparent that the amount of vacuum created in the chamber 36 will govern the flow of gases or vapors, or both, into the chamber 36 through the inlet member 40. The amount of vacuum created will depend on several conditions such as the velocity of the ionized gas through the nozzle 35, the size and shape of the Venturi passage 38 with respect to the size of the nozzle 35, the relative location of the nozzle 35 with respect to the Venturi passage, and the resistance to flow of other gases and vapors through the inlet passage 41 into the chamber 36. It is therefore possible to regulate the volume of the ionized gas flowing through the nozzle 35 relative to the volume of gas and vapors flowing through the inlet passage 40 into the chamber 36. In this invention several times as much highly ionized gas by volume is passed through the nozzle 35 as the volume of gas and vapors flowing into the chamber 36, and if it is so desired many times the volume of the stream of air or other gas and ozone passing through the vaporizer 42 per unit of time may be passed through the nozzle 35 in the same period of time. The control of the relative volumes is important if only because of the lesser amount of liquid required. Other important advantages will be hereinafter set forth.

In certain desired operations the gas, such as air, flowing through ozonizer 43, vaporizer 42 and chamber 36 may be at pressures greater than atmospheric. In order that this may be accomplished a port 61 is provided in the false bottom 4 in order that there may be communication between the chambers 5 and 6. A valve 62 is provided for the port 61. A port 63 is also provided in a side of the cabinet 1 to permit air to enter the chamber 6. This port is provided with a valve 64. When operating at pressures less than atmospheric in the stream passing through the ozonizer 43, the valve member 62 is closed over the port 61 in the false bottom 4 and the valve member 64 is opened at the port 63 thereby permitting air or other gas at substantially atmospheric pressure to enter the chamber 6 where it forms the supply for the ozonizer 43. If operations under pressures greater than atmospheric are desired, the valve member 64 is closed at the port 63 and the valve member 62 is opened at the port 61 thereby permitting the air to enter the chamber 6 from the chamber 5. In this manner the air within the chamber 6 will have a pressure greater than atmospheric and accordingly the stream of gas passing through the ozonizer 43 will be at a pressure greater than atmospheric. The relative volumes passing through the nozzle 35 and chamber 36 are still under control. It is also apparent that when the pressure of the stream through the ozonizer is greater than atmospheric the ionizer may be disconnected. At all times the ionizer 10 may be operated without operating the ozonizer 43.

The manifold 33 may be well insulated from earth and from the other electrical circuits. The Venturi member 37 may be formed from a material having high insulating value. In this manner the manifold 33 and the vaporizer 42 resting thereon may be insulated and self-contained electrically and subject only to the electrical influence of the adsorption of ions thereon. By the use of this invention a greater number of negative ions per unit of time enter the chamber 34 than the number of positive ions entering the chamber 50 in the same unit of time. The assembly of the manifold 33 and vaporizer 42 assumes a negative voltage potential because the adsorption of negative ions on the walls of the chamber 34 and nozzle 35 is more than sufficient to neutralize the positive ions adsorbed on the metallic walls of the chamber 50 and the metallic walls of the vaporizer 42. A point of equilibrium exists with respect to the degree of negative voltage that the manifold 33 and the vaporizer will attain. At voltages higher than the equilibrium voltage negative ions will cease to be adsorbed and will continue with the stream of gas through the nozzle 35.

Positive ions formed during vaporization and chemical action within the vaporizer 42 will also be subject to adsorption on the negatively charged walls of the vaporizer and on the walls of the chamber 36 and substantially only negative ions in association with particles of liquid and solids will escape from the chamber 36 to commingle with the negatively ionized gas escaping through the nozzle 35, when negative ions may become fixed to liquid and solid particles and form large ions.

In the operation of the invention it is preferred that several times the number of negative ions enter the chamber 34 per unit of time as enter the chamber 50 in the same unit of time. The number of negative ions entering the chamber 36 per unit of time depends on the degree to which the gas has been negatively ionized and also on the volume. Accordingly the number of ions entering the chamber 36 may be controlled by altering the volume, by altering the degree of ionization, or by a combination of the two, assuming that the stream of gas passing through the ionizer 10 is constant and ionization therein is also constant. It is apparent that the relative proportions of volume and degree of ionization in the ionizer stream may be varied also.

Chemical reactions and vaporization within the metallic vaporizer 42 take place in a zone of reaction defined by the top and sides of the vaporizer and the surface of the liquid within the vaporizer. A voltage potential may be imposed on said zone of reaction by placing a negative voltage potential on the vaporizer, and vaporization and chemical action taking place in the liquid and in said zone of reaction are under the influence of said negative voltage potential imposed on said vaporizer.

In producing ozone nitrous products are often produced which are usually objectionable. Experiments have been conducted with an oil of pine needles containing the usual pinene, phellandrine, camphene, bornylacetate and dipentene. Phellandrine is an exceedingly unstable terpene. Pinene readily forms pinoyl-formic acid and pinonic acid on exposure to the oxidizing action of ozone. It also forms a nitrosyl compound. Pinene also breaks down and forms formaldehyde. When such an oil was reacted with ozone accompanied by nitrous products under the in-

fluence of a negative voltage potential imposed on the zone of reaction no substantial nitrous products remained in the gases and vapors escaping from the vaporizer.

5 The imposing of a negative voltage potential on the zone of reaction as in this invention is important as an aid to desired chemical reactions and also as a remover of new positive ions formed during vaporization and chemical reactions within the said zone of reaction. When  
10 both positive and negative ions are present the tendency is toward neutralization as ions settle or cluster around the particles forming the nuclei of the larger ions. A negative voltage potential  
15 on the zone of reaction causes removal of positive ions by adsorption on the conducting walls of said zone of reaction and greater proportions of negative ions are thereby present to form the large ions. Accordingly the tendency is for the  
20 large ion to carry a larger charge of negative electricity than would be the case if the negative voltage potential were not imposed on said zone of reaction.

The discharge tube 39 is utilized as a means  
25 for conducting and directing the ions, vapors, compounds and gases after they have passed through the Venturi member 37 into contact with an objective 65. The Venturi member 37 has been hereinbefore described as constructed of insulating material. In some desired conditions of  
30 operation, however, this Venturi member may be formed of metal having good electrical conducting properties. Likewise the discharge tube 39 may be constructed of similar metal. Under such  
35 circumstances any voltage potential imposed on the manifold 33 will be communicated to the Venturi member 37 and to the discharge tube 39. The tube 39 serves the purpose of maintaining intimate proximity of the ordinary ions to nuclei  
40 thereby expediting the fixation of ions on the nuclei and formation of large ions thereby. The ions escaping from the tube 39 may be utilized in various ways, for example the creating of a voltage potential on insulated objectives or the causing  
45 of current flow in electrical circuits separate and distinct from the source of the ions.

The objective 65 illustrated diagrammatically in the drawing consists of electrical conducting material which may be an organism and is connected by a wire 66 to a positive source of direct  
50 current electricity as, for example, to the positive pole of a battery 67. The negative pole of the battery 67 is electrically connected to earth 68 by a wire 69.

55 The battery 67 represents a source of direct current electricity whereby a positive voltage potential may be imposed on the objective 65. It is apparent that any source of direct current may be substituted for the battery 67, such as a rectified alternating current or the current from a  
60 direct current generator. The positive voltage potential so imposed on the objective 65 is subject to control, as for example, by a variable resistance 70 and is separate and distinct from the circuit of alternating current actuating the ozonizer 43, is separate and distinct from any current  
65 on the manifold 33 and vaporizer 42 which are well insulated as hereinbefore set forth, and is also separate and distinct from the unidirectional pulsating current on the ionizer 10. The conductor 66, battery 67, and conductor 69 form an electrical circuit connecting the objective 65 to  
70 earth.

75 The negative ions escaping from the discharge tube 39 may be directed into contact with the ob-

jective 65 and upon contacting therewith negative charges will be removed from the ions and will flow through the said objective and thence through the conductor 66 thereby creating a current flow which may be measured by a current  
5 measuring device as indicated at 71.

A switch 72 is provided in the conductor 66 whereby current passing from the objective 65 through the conductor 66 may be interrupted.  
10 Upon interrupting the current flow in the conductor 66 when the objective 65 is insulated and when negative ions are flowing into contact with said objective, negative ions will continue to be adsorbed on the objective which will then assume a negative voltage potential. Upon then closing  
15 the switch 72 the current will again flow through the conductor 66 and a positive voltage potential will be imposed on the objective 65 from the battery 67. In this manner positive and negative voltage potentials may be imposed alternately on the objective 65, the rate of alterna-  
20 tions depending on the rate of movements of the switch 72. For regular and periodical alternations the switch 72 may be operated by a clock mechanism 73 so arranged that any desired rate  
25 of the opening and closing of the switch 72 may be obtained.

I claim:

1. The process of producing large ions which comprises ejecting electrons into a stream of air,  
30 ozonizing a second stream of air, contacting said second stream with liquid reactive with ozone thereby adding liquid nuclei of the compounds resulting from the reaction, removing positive ions from said second stream and commingling  
35 said streams.

2. The process of producing large ions which consists in projecting electrons into a first gas stream thereby effecting ionization, ozonizing a  
40 second gas stream with consequent ionization, removing positive ions from said second stream, contacting said second stream with liquid reactive with ozone thereby supplying liquid nuclei for the ions, uniting said two streams and maintaining  
45 said first stream of larger area than said second stream.

3. The process of producing large ions which consists in projecting electrons into a first gas stream thereby effecting ionization, ozonizing a  
50 second gas stream with consequent ionization, removing positive ions from said second stream by neutralization with negative ions from said first stream, contacting said second stream with liquid reactive with ozone thereby supplying liquid nuclei for the ions, uniting said two streams  
55 and maintaining said first stream of larger area than said second stream.

4. The process of producing large ions which consists in projecting electrons into a first gas stream thereby effecting ionization, ozonizing a  
60 second gas stream with consequent ionization, removing positive ions from said second stream by neutralization with negative ions from said first stream, contacting said second stream with liquid reactive with ozone, thereby supplying liquid nuclei for the ions and uniting said two  
65 streams.

5. The process of producing ions which consists in projecting electrons into a first gas stream thereby effecting ionization, ozonizing a  
70 second gas stream with consequent ionization, removing positive ions from said second stream by neutralization with negative ions from said first stream, contacting said second stream with liquid  
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to supply nuclei for the ions and uniting said two streams.

5 6. The process of producing ions which consists in projecting electrons into a first gas stream thereby effecting ionization, ozonizing a second gas stream with consequent ionization, removing positive ions from said second stream by neu-

tralization with negative ions from said first stream, contacting said second stream with liquid to supply nuclei for the ions, uniting said two streams and maintaining said first stream of larger area than said second stream.

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