

Feb. 1, 1966

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3,232,292

IONIZED AEROSOLS

Filed Oct. 12, 1962

3 Sheets-Sheet 1

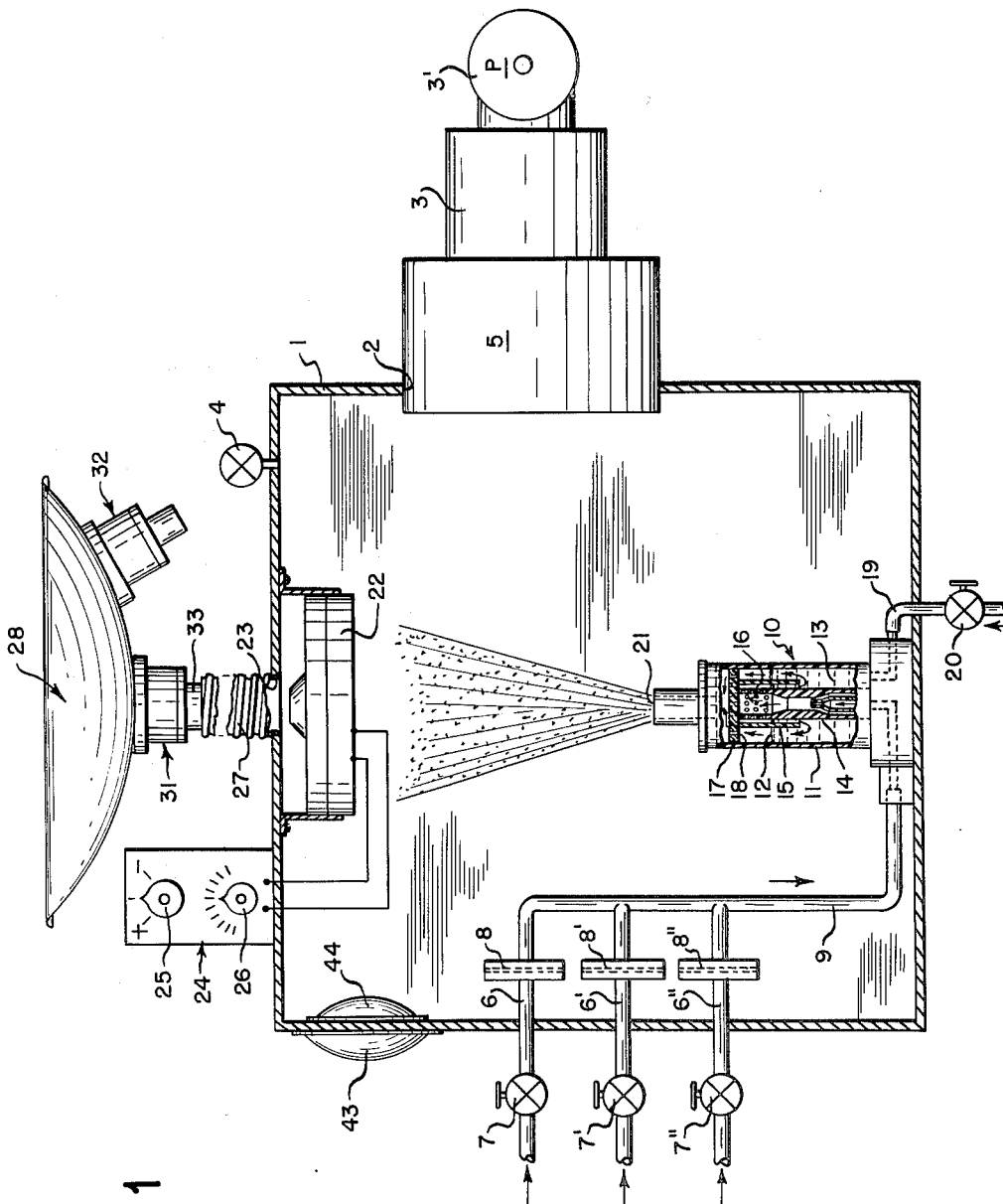


FIG. 1

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FIG. 2

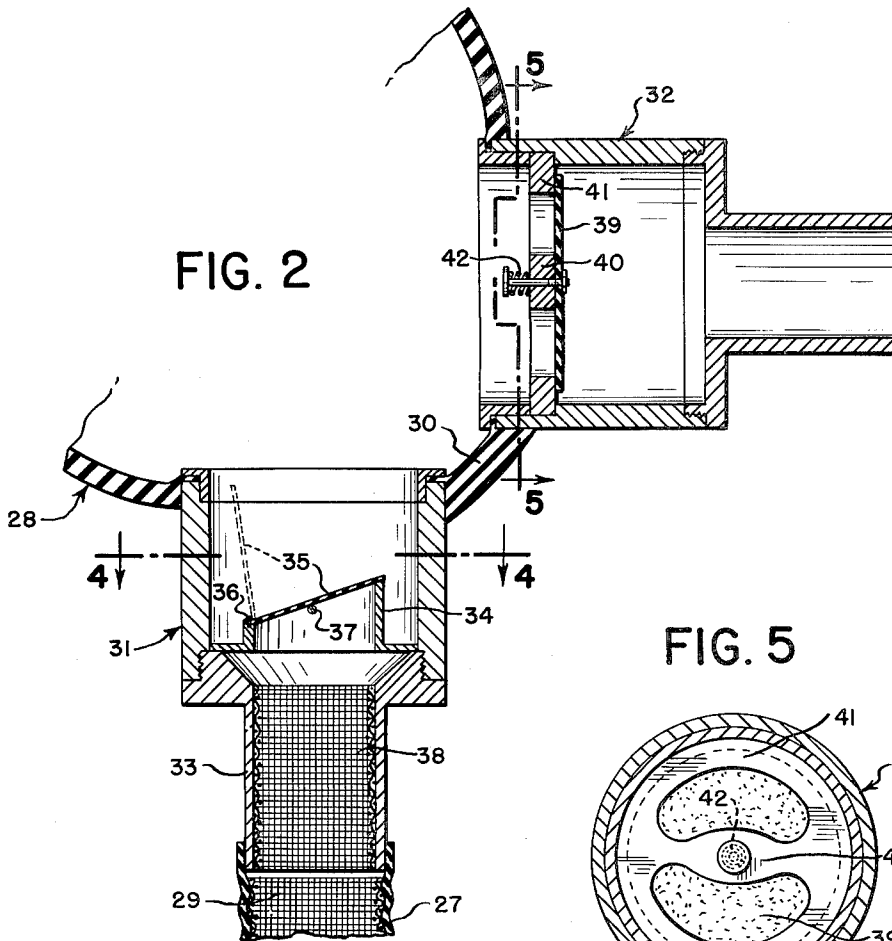


FIG. 5

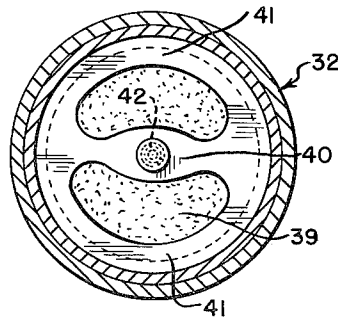
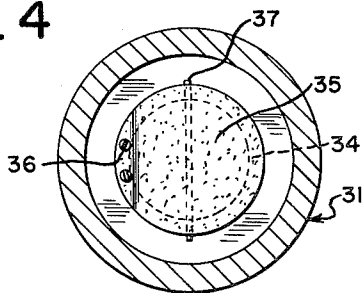


FIG. 4



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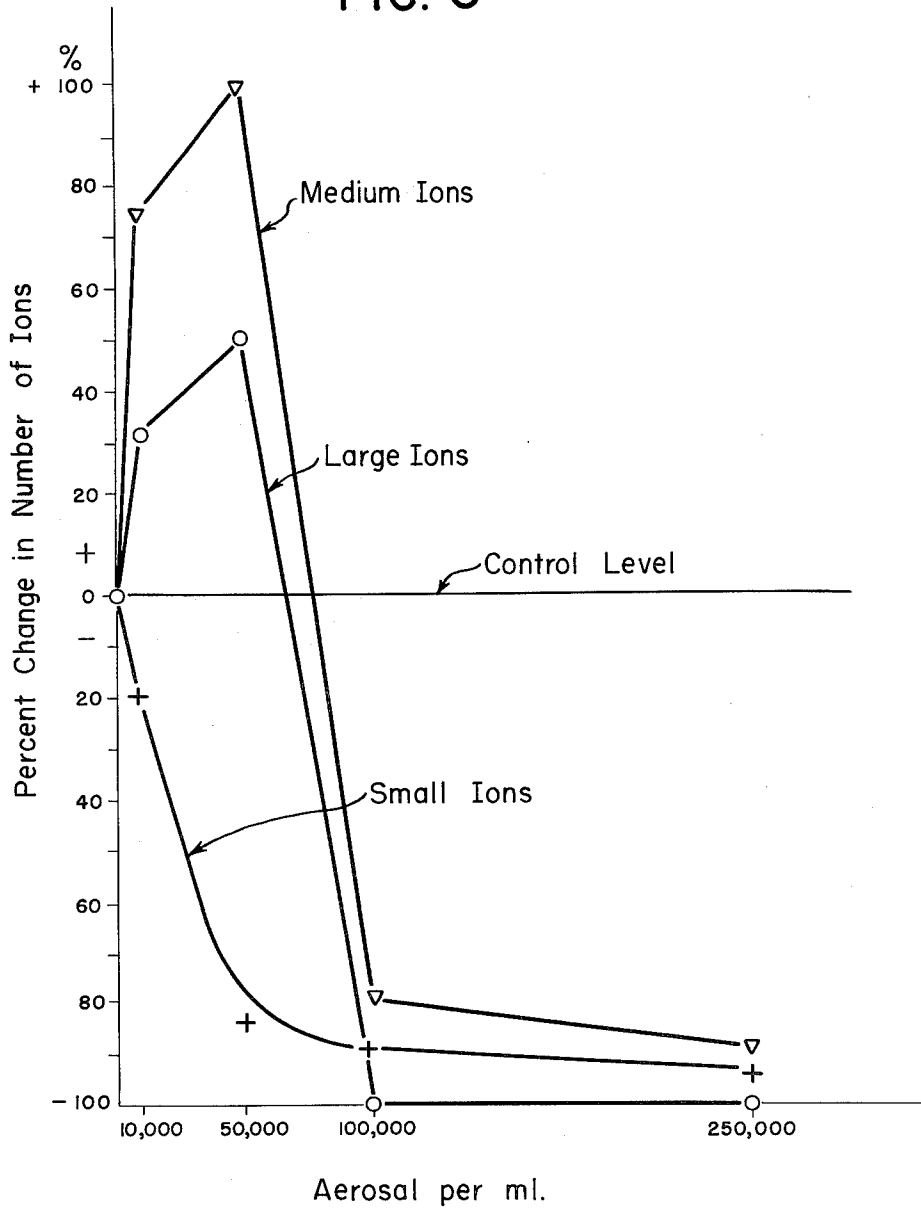
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IONIZED AEROSOLS

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FIG. 3



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3,232,292 IONIZED AEROSOLS

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9 Claims. (Cl. 128—172)

This invention relates to a system and means for introducing ions into the respiratory tract of the human system, and more particularly to a method and device whereby ions may be introduced into the respiratory system in predetermined concentrations and directed to predetermined specific parts of the respiratory tract.

The ions contained in the atmosphere are believed to produce beneficial effects in the health of humans. For example, it is believed that a person's blood pressure may be controlled by changing the concentration of negative ions inhaled, an increase in the concentration of negative ions increasing the blood pressure while a decrease in the concentration having the opposite effect.

The concentration of negative and positive ions in the atmosphere, however, depends on a number of varying factors, such as elevation, humidity and air circulation and, although it is accepted that certain atmospheres may be detrimental to a person's health, the medical profession has been reluctant to accept claims of the beneficial effects alleged to be produced by negative or positive ions since no dose-effect relationship has been established, that is, the relationship between the number of ions actually inhaled by an individual and the effect this predetermined quantity of ions has on his health has not been scientifically shown.

In order to show that ions produce beneficial effects on an individual, it is necessary to provide some means whereby these ions may be controlled so that in a given situation, a desired result may be obtained. Basically, two factors need to be controlled; first, the concentration of ions actually inhaled by the individual, and second, the path and extent of movement of the inhaled ions within the respiratory system. In other words, it is necessary to provide a system and means whereby it is possible to (1) introduce a predetermined concentration of ions into an individual's respiratory system, and (2) pass these ions along a predetermined distance within the respiratory system to deposit them at prescribed locations therein.

According to the present invention, applicant has devised a system and apparatus whereby ions of either polarity may be introduced into the respiratory system in predetermined concentrations, passed along the tract to any specified location and made to stay in the designated location for a certain length of time. Additionally, the present invention includes a system and corresponding means for depositing these ions in various branch sinus cavities or areas along the respiratory tract.

In general, the apparatus constructed in accordance with the present invention comprises a container into which filtered air is introduced and ionized to produce negative or positive ions. This container is provided with means for producing aerosols of predetermined size and concentration so that the ions may attach themselves thereto within the chamber. In order to pass the charged aerosols into the respiratory tract of the individual, the container is provided with an outlet to which is connected a respiratory mask. The mask conduit leading to the inlet diaphragm contained within the mask together with the feed tube used for attaching the mask to the container is provided with a space charge screen of specific con-

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struction which allows the ions to pass freely therethrough and into the respiratory tract of the individual and prevents them from attaching themselves to the mask. To enable the ions carried by the aerosols within the respiratory tract to move into cavities or sinus areas branching out from the respiratory tract, the container is further provided with an acoustic vibrator for vibrating the aerosols at certain frequencies as they exit therefrom. In this manner, the aerosols and attached ions are made to change their normal path of movement through the tract and move into these branch cavities. The distance through the respiratory system that the ions are moved is controlled according to the present invention by controlling the size of the aerosol carriers, it being known that the smaller the aerosols, the further they will travel through the system. Finally, the spectrum or concentration of different sized ions may be controlled according to the invention by changing the concentration of a given size aerosol within the container. This is of particular importance when it is desirable to change the period of time the ions will remain in any particular area of the respiratory tract, it being known that the larger the ion, the longer its life.

A fuller understanding of the invention will be obtained from the following description with reference to the accompanying drawings of which:

FIGURE 1 is a schematic view of the apparatus employed for producing ions and combining them with aerosols;

FIGURE 2 is a partial cross-sectional view of the respiratory mask constructed according to the present invention;

FIGURE 3 is a chart showing the percent change in the number of different sized ions with changes in the concentration of aerosols;

FIGURE 4 is a cross-sectional view taken along lines 4—4 of FIGURE 2; and

FIGURE 5 is a cross-sectional view taken along lines 5—5 of FIGURE 2.

As shown schematically in FIGURE 1, the device includes a closed container 1 of plastic, metal or other non-porous material which is provided on one side with an air inlet 2. Through this inlet, air is pumped with sufficient force by a suitable air intake fan 3 and pump 3' to produce a predetermined positive pressure within the container. This pressure is controlled by the pressure release valve 4 as more fully described below. An air filter 5 of conventional construction is connected to the container at the inlet 2 for filtering out substantially all of the particulate matter contained in the air source before it enters the container. The opposite wall of the container is provided with a number of gas inlet pipes 6, 6', 6'' leading from suitable sources of compressed gas, not shown, into the interior of the container and to one end of a common pipe 9. Each of these pipes 6, 6', 6'' is provided with a valve 7, 7', 7'', respectively, for controlling the introduction of the gas into the container; and in order to remove any particulate matter contained in the gas, suitable air filters 8, 8', 8'' are provided between the respective valves and common pipe 9.

The other end of pipe 9 is connected to an aerosol generator 10 of conventional construction, and, as shown, the generator comprises a housing 11 filled to the level 12 with a suitable solution, as for example, a saline solution 13. Removably mounted inside the housing are two concentric tubes 14 and 15 with the outer tube 15 spaced from the inner tube 14 and surrounding it at its upper end. The inner tube is provided with orifices 16 at its upper end and the outer tube 15 is provided with an en-

larged flange 17 of a diameter substantially equal to the inner diameter of the housing 11. This flange is also provided with a number of orifices shown at 18 in FIGURE 1. The solution is supplied to the generator by means of a pipe 19 connected to a suitable source, not shown, and a valve 20 is provided for controlling such supply to the generator. Gas entering the generator from the pipe 9 will flow under pressure in the direction of the arrows through the solution and exit from the housing at 21 in a form of aerosols. The size of the particular aerosols is dependent on the particular solution contained in the housing and the size of the orifices 16 and 18. As stated, the pipes 6, 6', 6'' are connected to different sources of compressed gas. The purpose of this is to permit a varying of the characteristics of the aerosols issuing from the generator. With oxygen passing through the generator, the combination of negative ions with the aerosols will be enhanced since these aerosols will more readily attract negative charges. On the other hand, if it is desired to produce positive ions and combine them with the aerosols, a gas such as carbon dioxide may be passed through the generator. Also, for varying effects, a mixture of gases may be used.

To produce ions in predetermined concentrations, an ionizer 22, also of conventional construction, is mounted within the container 2 at the outlet 23. It has been found advantageous to employ a radio-active ion generator for this purpose because the elementary charges produced by this type of ionizer is more uniform as compared with the charges produced by other types of ionizers. To produce ions of either a negative or positive charge, a conventional power and control unit 24 is connected to the ionizer 22 whereby changing the position of the control switch 25 will change the polarity of the ions produced. The control unit is also provided with a switch 26 for changing the voltage supplied to the ionizer 22 so as to change its output of ions. It has been found that the number of ions produced varies directly with the voltage supplied to the ionizer, that is, the higher the voltage, the greater the number of ions produced. This relationship remains substantially the same with both positive and negative ions. Also, with any particular voltage setting the concentration of negative or positive ions remains more or less the same over extended periods of time.

The size of the ions produced by the ionizer 22 may be generally classified into large, medium and small, depending on their respective mobilities. Large ions are considered to be those having a mobility or speed in an electrical field of less than 0.03 cm./sec./volt/cm., while medium sized ions are those having a mobility ranging between 0.03 and 0.3 cm./sec./volt/cm., and small ions are those having a mobility greater than 0.3 cm./sec./volt/cm. It has been found that the spectrum of large, medium and small ions produced in this container 2 may be changed by varying the concentration of the aerosols therein contained. In other words, the relative concentration of the different sized ions is dependent on the concentration of the aerosols. This is of particular importance when it is desired to control the period of time the ions remain within the respiratory tract, it being known that the larger the ion, the longer its life. The chart of FIGURE 3 shows that increasing the number of aerosols increases the number of large and medium sized ions up to a certain point and from then on, an increase in the number of aerosols decreases the concentration of large and medium sized ions. With small ions, however, any increase in the number of aerosols was found to continually decrease the concentration of the small ions. The control level shown in FIGURE 3 represents the concentration of large, medium and small ions initially produced by the ionizer, which for purposes of example, is 50,000/ml. for both large and medium sized ions and 100,000/ml. for small sized ions. It will be noted from the chart that once the number of aerosols becomes

greater than the concentration of large and medium ions (50,000/ml.), the concentration of these particular ions will then decrease along with that of the small ions. If it is found desirable to produce predominantly small ions, FIG. 3 shows that the number of aerosols produced should be at a minimum. If on the other hand, it is desired to produce predominantly large and medium sized ions, the concentration of aerosols should be approximately equal to the concentration of the large and medium sized ions produced by the ionizer.

In order to transport these aerosols and attached ions from the container 2 to the respiratory tract of the individual, the outlet 23 is provided with a feed tube 27 leading to a respiratory mask generally designated by 28. It has been discovered, however, that a conventional feed tube and respiratory mask will not assure one that all of the ions issuing from the container 2 will pass into the respiratory tract of the individual. This is because many ions tend to attach themselves to the tubing wall and mask interior rather than pass freely therethrough. To avoid interference by the feed tube 27, applicant has provided the tubing with a wire screen 29 as shown in FIGURE 2. The mask itself comprises a flexible face portion 30 adapted to fit over a person's mouth and nose and secured to this face portion at spaced locations is an inlet tube 31 and outlet tube 32. The inlet tube is provided at its free end with a female coupling member 33 which is adapted to receive the extending end of the feed tube 27. The end of the coupling member disposed within the inlet tube 31 is provided with an inlet valve seat 34 against which abuts a light and flexible inlet diaphragm 35. The diaphragm, as more clearly shown in FIGURE 4, is pivotally secured to the valve seat at 36 and is adapted to open when only a slightly greater pressure is created on its under surface as compared to that existing within the face portion of the mask. It is therefore normally in its opened position when a positive pressure is created in the container 2 and the mask is not placed on the individual's face. On the other hand, the inlet valve is adapted to close when in use as soon as the individual exhales. A retaining pin 37 is preferably secured across the inlet valve 34 as shown to prevent the diaphragm from inadvertently moving into the valve during exhalation. The female coupling member 33 attached to the inlet tube 31 is provided with a wire screen 38 similar to that used in the feed tube. This screen together with screen 29 may be electrically charged by separate means not shown with a polarity the same as that of the ions issuing from the container 2 so that when negatively charged, for example, negative ions will be repelled from the walls of the tube 27 and interior structure of the mask 28 and pass freely through the mask and into the respiratory tract. Alternatively, the screens 29 and 38 may be charged with the appropriate polarity by passing the aerosols and ions from the container 2 through the mask for a short period of time before the mask is used by the individual. This will cause the screens to become saturated with ions of the particular polarity so that subsequent ions of the same polarity passing into the mask will be repelled by the screen and pass therethrough. To further facilitate the passage of ions through the mask, it will be noted that the diaphragm 35 is constructed to move substantially out of the path of the ions when in open position as shown by dotted lines in FIGURE 2. The outlet tube 32 of the mask is provided with an outlet diaphragm 39 slidably secured at its center to a member 40 extending across the outlet opening and integral with the outlet valve seat 41. The diaphragm is urged toward the valve seat by suitable means such as a spring 42. In order to prevent the outlet valve 39 from opening if the air entering the mask is greater than the air being inhaled, the release valve 4, mentioned above, is constructed so that it takes less force to open it than it does to open the outlet valve. Therefore, the outlet valve

can only be opened by the force created when the person exhales. This construction is necessary so one can be certain of the number of ions actually inhaled. Suitable means, such as a conventional light scattering meter, ion counter, may be attached to the output 23 of the container 2 to measure the ions entering the mask, and if the outlet valve is constructed to open only upon exhalation, one can be assured that the ions entering the mask can only go into the individual's respiratory system.

The extent of movement of the aerosols and attached ions within the respiratory tract after they leave the mask 28 may be controlled by changing the size of the aerosols originally produced. It is known that the distance which aerosols travel through the respiratory system is dependent on their sizes. More specifically, aerosols of a small particle size will reach the alveoli of the lungs while larger aerosol particles will be picked up by the upper respiratory tract. Knowing this, it is possible to direct the ions to different parts of the respiratory tract by changing the size of the aerosols carrying them. As stated above, this may be accomplished by draining the particular solution from the aerosol generator and replacing it with a different solution or by replacing the tubes 14, 15 with ones having different sized orifices 16, 18.

Although it is possible to deposit the ions at predetermined distances along the respiratory system by controlling the size of the aerosols, this does not assure one that the ions will enter branch sinus cavities or areas extending off from the respiratory tract. To effect this result, applicant has provided the contained 2 with a conventional acoustic vibrator 43 for vibrating the aerosols within the container at specified frequencies. The vibrator as shown is provided with a loud-speaker 44. Vibration of the aerosols in the container 2 causes them to vibrate as they pass through the respiratory tract and this, in turn, will cause them to move out of their normal flow and into adjacent cavities. The movement of these aerosols into the cavities may further be controlled by changing the amplitude and frequency at which the aerosols are vibrated. The propagation of vibratory energy transmitted from the loud-speaker into the container occurs in the tube 27, mask passageway and respiratory tract of the human in the form of longitudinal compressional waves and by changing the frequency and amplitude of the vibrations, different pressure gradients can be established in the wave at various predetermined distances along the respiratory tract and the aerosols can thereby be directed and deposited not only at various locations but may be moved into branch cavities existing at these predetermined distances along the tract.

From the above description, it is clear that in the operation of the device, the effects on the individual are dependent on a number of factors, they are as follows: (1) the gas used to produce the aerosols, (2) the size of the aerosols, (3) the size of the ions, (4) the polarity of the ions, (5) the concentration of ions with respect to aerosols, and (6) the frequency at which the aerosols are vibrated. By controlling the above factors in accordance with the teachings of the present invention, ions of either polarity may be sent to any part of the respiratory system including sinus cavities in predetermined amounts and held there for different lengths of time.

I claim:

1. A device for producing and transporting ions in predetermined concentrations into the human respiratory system comprising:

- (a) a container having inlet and outlet openings,
- (b) means for pumping air into said container under a predetermined pressure,
- (c) a filter for removing substantially all particulate matter from the incoming air,
- (d) an aerosol generator disposed within said container for producing a predetermined number of aerosols,

- (e) means located within said container for producing ions of a predetermined polarity and predetermined concentration and attaching them to the aerosols,
- (f) conduit means connected at one end to said outlet opening,

(g) a space charge screen fixed to the interior wall of said conduit,

(h) a respiratory mask connected to the other end of said conduit and adapted to be positioned over an individual's nose and mouth during inhalation and exhalation,

(i) a straight inlet passageway extending through said mask,

(j) a space charge screen fixed to the interior wall of said inlet passageway,

(k) means for charging both of said space charge screens with a polarity the same as the polarity of said ions,

(l) an inlet diaphragm located in said inlet passageway and movable from a first position completely closing the passageway during exhalation by the individual to a second position adjacent said passageway when the individual is not exhaling whereby when in said second position the aerosols and ions will pass through said mask, along a straight line,

(m) an outlet passageway located in said mask at a distance spaced from said inlet passageway,

(n) an outlet diaphragm located in said outlet passageway and normally closing said passageway, and

(o) means for moving said outlet diaphragm to open said outlet passageway when said inlet diaphragm is in said first position.

2. A device for producing and transporting ions in predetermined concentrations into the human respiratory system comprising:

(a) a container having inlet and outlet openings,

(b) means for pumping air into said container under a predetermined pressure,

(c) a filter for removing substantially all particulate matter from the incoming air,

(d) an aerosol generator disposed within said container for producing a predetermined number of aerosols,

(e) means located within said container for producing ions of a predetermined polarity and predetermined concentration and attaching them to the aerosols,

(f) conduit means connected at one end to said outlet opening,

(g) a space charge screen fixed to the interior wall of said conduit,

(h) a respiratory mask connected to the other end of said conduit and adapted to be positioned over an individual's nose and mouth during inhalation and exhalation,

(i) a straight inlet passageway extending through said mask,

(j) a space charge screen fixed to the interior wall of said inlet passageway,

(k) means for charging both of said space charge screens with a polarity the same as the polarity of said ions,

(l) a pressure inlet diaphragm normally disposed adjacent said inlet passageway when a predetermined pressure is present within said container and adapted to close said inlet passageway when said individual exhales,

(m) an outlet passageway located in said mask at a distance spaced from said inlet passageway,

(n) an outlet diaphragm located within said outlet passageway,

(o) means for urging said outlet diaphragm in one direction to close said outlet passageway and adapted to permit said outlet diaphragm to move in the opposite direction when said individual exhales to open said outlet passageway, and

- (p) a normally closed pressure release valve connecting the interior of said container with the atmosphere and adapted to open when the pressure within said container rises above said predetermined pressure.
3. A device as set forth in claim 1 further comprising an acoustic vibrator and loudspeaker for vibrating said aerosols and attached ions to produce longitudinal compressional waves along the path of flow of said aerosols and attached ions as they exit from said container.
4. A device as set forth in claim 1 further comprising means for producing said aerosols in a predetermined size.
5. The method of producing within a confined space ions of three different size ranges with a maximum number of ions being in the first and second ranges with those in the first, range having a size greater than the ions in the second range and with a minimum number of ions being in the third range and having a size smaller than the ions in said second range comprising the steps of:
- (a) filtering a supply of air to remove substantially all of the particulate matter contained therein,
 - (b) moving said filtered air into a confined space,
 - (c) producing a predetermined concentration of ions in the three size ranges of large, medium and small with the ions in the first large size range having a mobility of less than about 0.03 cm./sec./volt/cm., with the ions in the second medium size range having a mobility ranging from between about 0.03 and 0.3 cm./sec./volt/cm., with the ions in the third small size range having a mobility greater than about 0.3 cm./sec./volt/cm., and with the concentration of ions in the large and medium size range being about equal to each other and together being about equal to the concentration of ions in the small size range,
 - (d) producing a concentration of aerosols within said confined space substantially equal to the concentration of the ions within said first large size range, and
 - (e) causing said aerosols to collide with the ions in each of said ranges.
6. A device for producing ions in predetermined concentrations for inhalation into the human respiratory system comprising:
- (a) a closed container,
 - (b) means for removing substantially all the particulate matter contained in a supply of air,
 - (c) means for filling said container with said air under a predetermined pressure after said particulate matter has been removed,
 - (d) means located within said container for producing a predetermined concentration of ions of a predetermined polarity,
 - (e) means for separately producing a predetermined number of aerosols in said container,
 - (f) means for attaching the ions to said aerosols,
 - (g) substantially unobstructed conduit means connected to the interior of the container and extending away therefrom for receiving said aerosols with the attached ions and carrying them directly into the respiratory system of the individual,
 - (h) space charge means positioned along the interior wall of said conduit means and surrounding the path of movement of said aerosols and attached ions through said conduit means, and
 - (i) means for charging said space charge means with a polarity the same as the polarity of said ions.
7. A device for producing ions in predetermined concentrations for inhalation into the human respiratory system comprising:
- (a) a closed container,
 - (b) means for removing substantially all the particulate matter contained in a supply of air,
 - (c) means for filling said container with said air under a predetermined pressure after said particulate matter has been removed,
 - (d) means located within said container for producing

- a predetermined concentration of ions of a predetermined polarity,
- (e) means for separately producing a predetermined number of aerosols in said container,
 - (f) means for attaching the ions to said aerosols,
 - (g) substantially unobstructed conduit means connected to the interior of the container and extending away therefrom for receiving said aerosols with the attached ions and carrying them directly into the respiratory system of the individual,
 - (h) a space charge screen fixed to the interior wall of said conduit means and surrounding the path of movement of said aerosols and attached ions through said conduit means, and
 - (i) means for charging said space charge screen with a polarity the same as the polarity of said ions.
8. A device as set forth in claim 7 further comprising an acoustic vibrator and loudspeaker for vibrating said aerosols and attached ions to produce longitudinal compressional waves along the path of flow of said aerosols and attached ions as they pass through said conduit means.
9. A device for producing and transporting ions in predetermined concentrations into the human respiratory system comprising:
- (a) a container having inlet and outlet openings,
 - (b) means for pumping air into said container under a predetermined pressure,
 - (c) filtering means for removing substantially all particulate matter from the incoming air,
 - (d) an aerosol generator for producing a predetermined number of aerosols in said container,
 - (e) means located within said container for producing ions of a predetermined polarity and predetermined concentration and attaching them to the aerosols in said container,
 - (f) conduit means connected at one end to said outlet opening,
 - (g) a space charge screen fixed to the interior wall of said conduit,
 - (h) a respiratory mask connected to the other end of said conduit and adapted to be positioned over an individual's nose and mouth during inhalation and exhalation,
 - (i) a straight inlet passageway extending through said mask,
 - (j) a space charge screen fixed to the interior wall of said inlet passageway,
 - (k) means for charging both of said space charge screens with a polarity the same as the polarity of said ions,
 - (l) an inlet diaphragm located in said inlet passageway and movable from a first position completely closing the passageway during exhalation by the individual to a second position adjacent said passageway when the individual is not inhaling whereby when in said second position the aerosols and ions will pass through said mask along a straight line,
 - (m) an outlet passageway located in said mask at a distance spaced from said inlet passageway,
 - (n) an outlet diaphragm located in said outlet passageway and normally closing said passageway, and
 - (o) means for moving said outlet diaphragm to open said outlet passageway when said inlet diaphragm is in said first position.

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