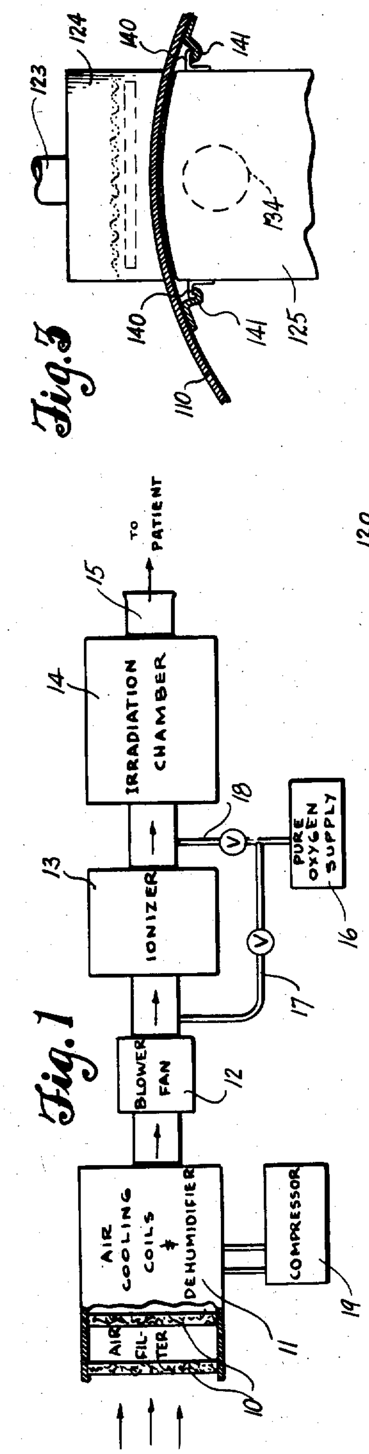
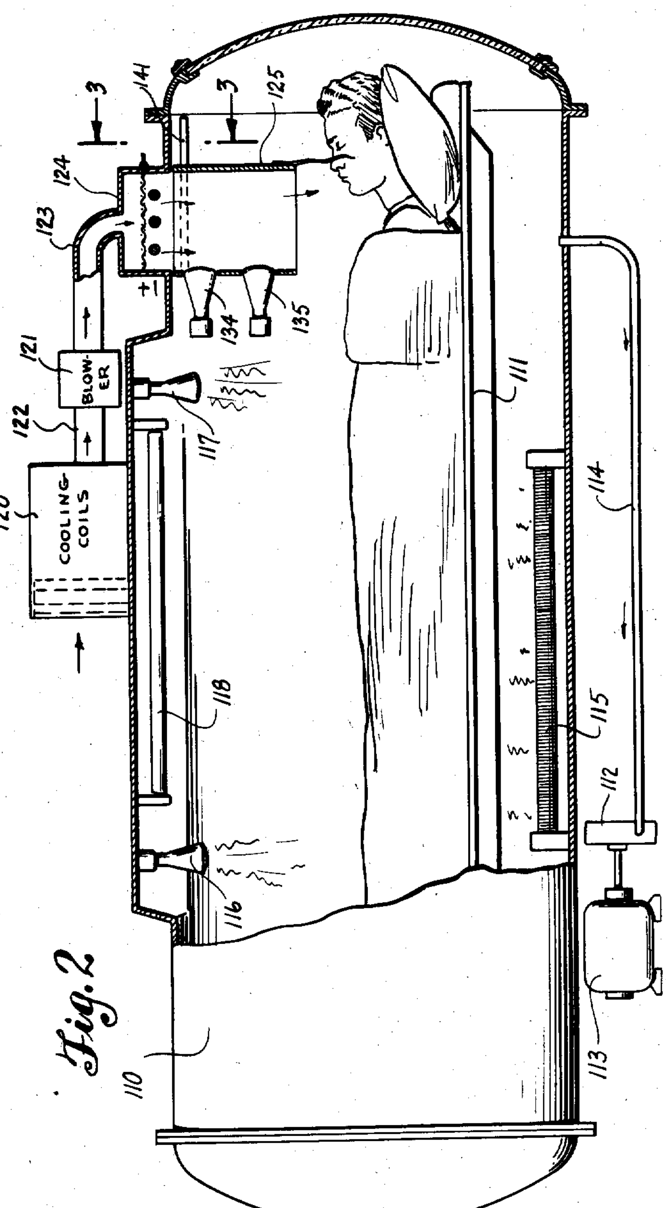
Jan. 12, 1960 V. H. STEEL 2,920,622

METHOD AND APPARATUS FOR CREATING ENERGY CARRIER STATES OF OXYGEN IN INSPIRED AIR

Filed June 6, 1955 8 Sheets-Sheet 1





INVENTOR.
VAN H. STEEL
BY Cook & Robinson
ATTORNEYS

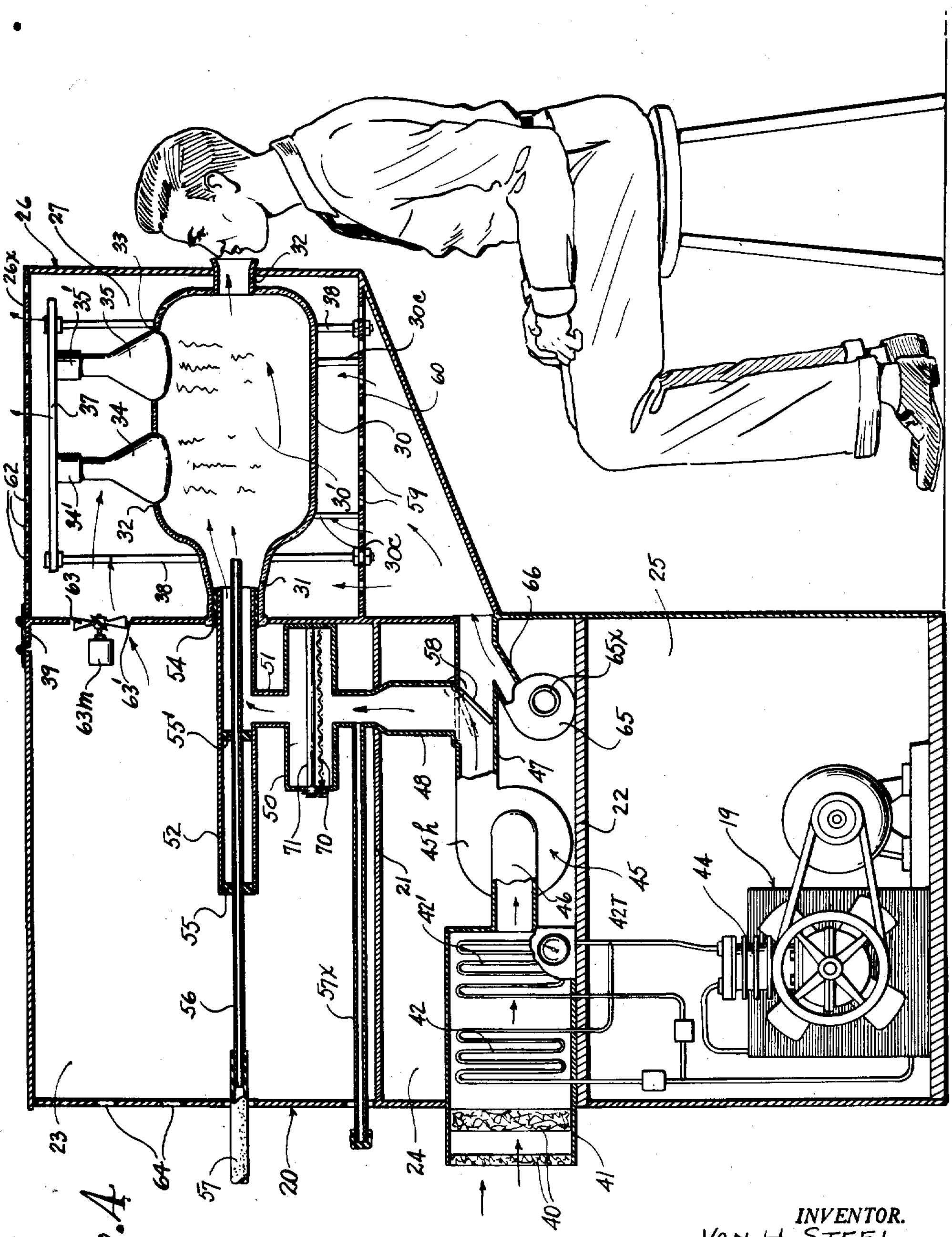


Fig. 4

INVENTOR.
VAN H. STEEL
BY Cook & Robinson
ATTORNEYS

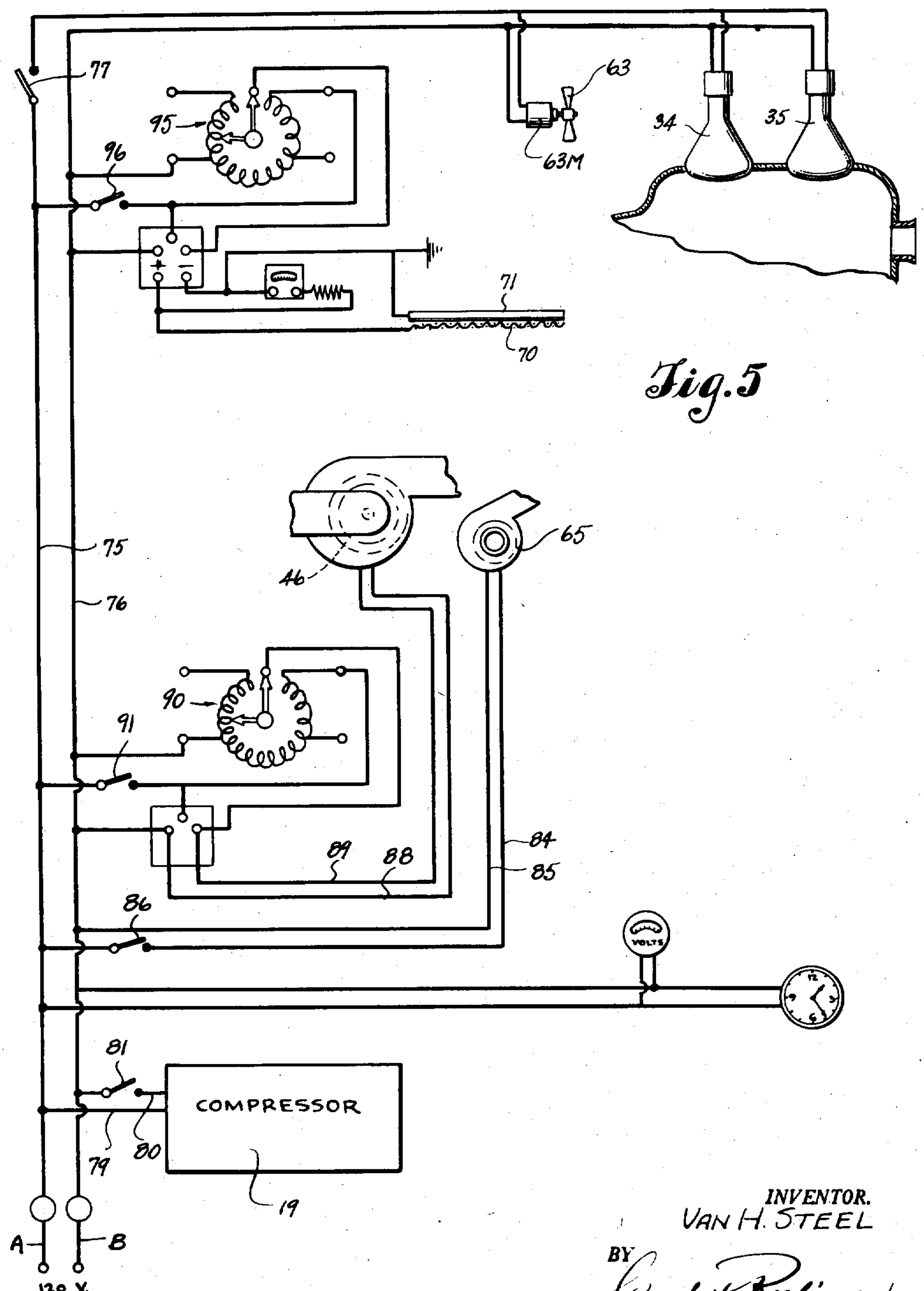


Fig. 5

INVENTOR.
VAN H. STEEL
BY Cook & Robinson
ATTORNEYS

Fig. 6

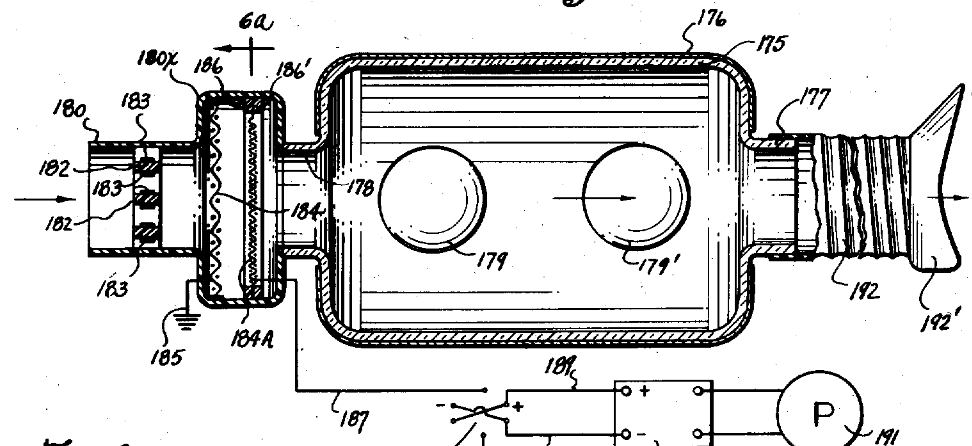


Fig. 6a

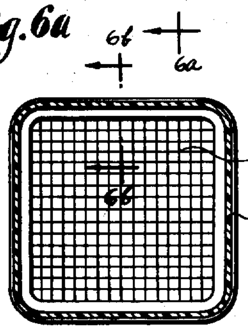


Fig. 6b

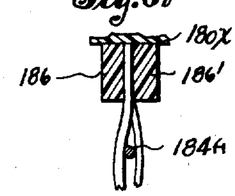
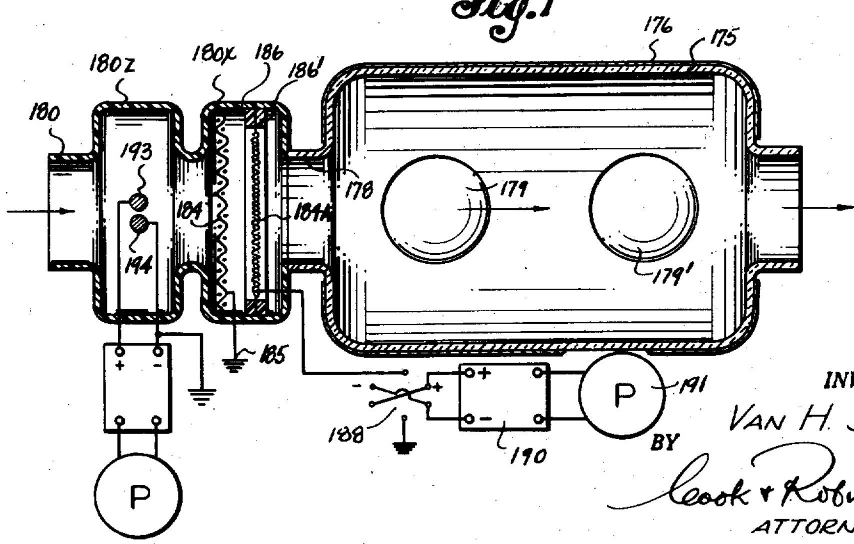
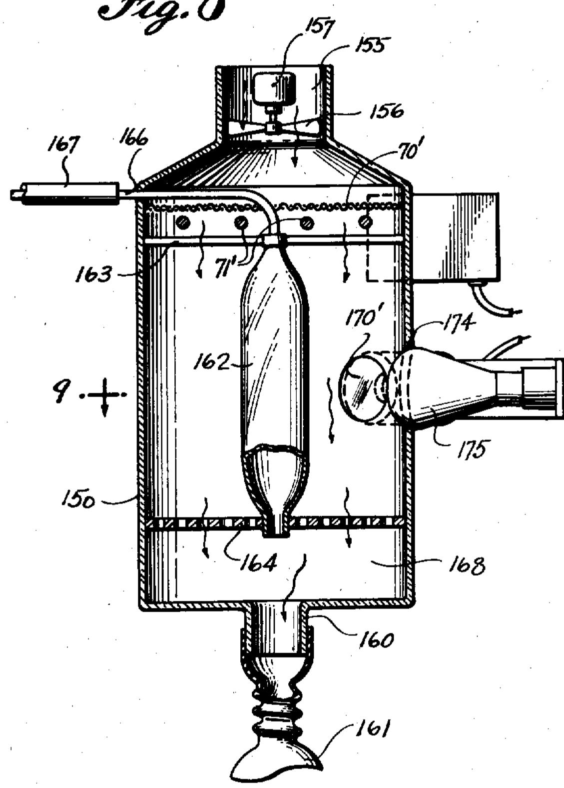


Fig. 7



INVENTOR.
VAN H. STEEL
BY
Cook & Robinson
ATTORNEYS

Fig. 8



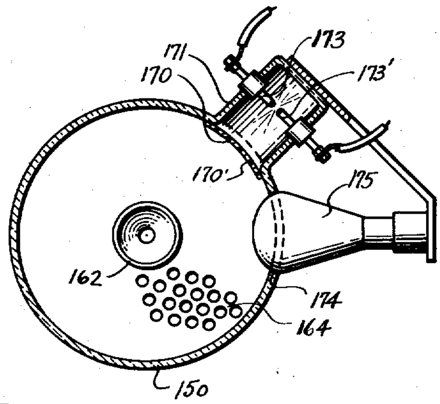
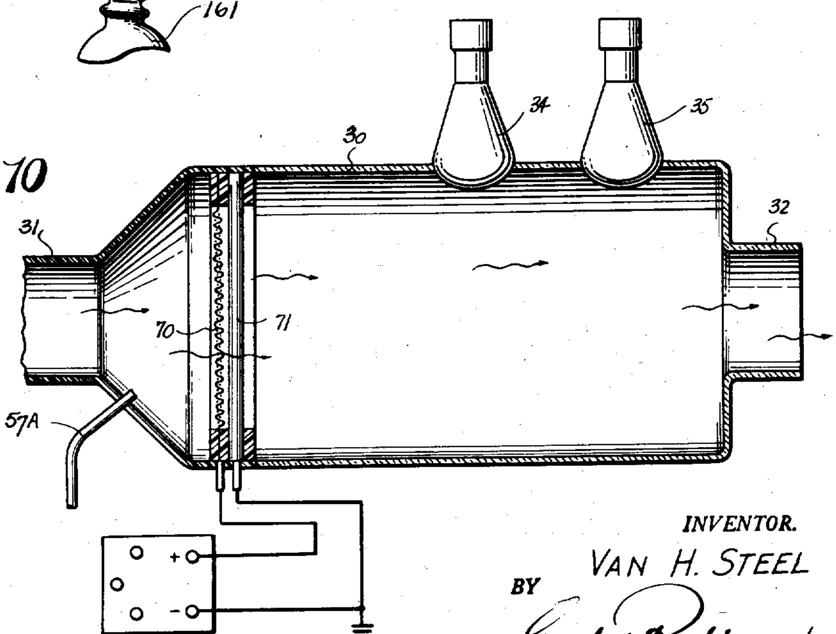


Fig. 9

Fig. 10



INVENTOR.
VAN H. STEEL
BY
Cook & Robinson
ATTORNEYS

Jan. 12, 1960 V. H. STEEL 2,920,622

METHOD AND APPARATUS FOR CREATING ENERGY CARRIER STATES OF OXYGEN IN INSPIRED AIR

Filed June 6, 1955 8 Sheets-Sheet 6

Fig. 11

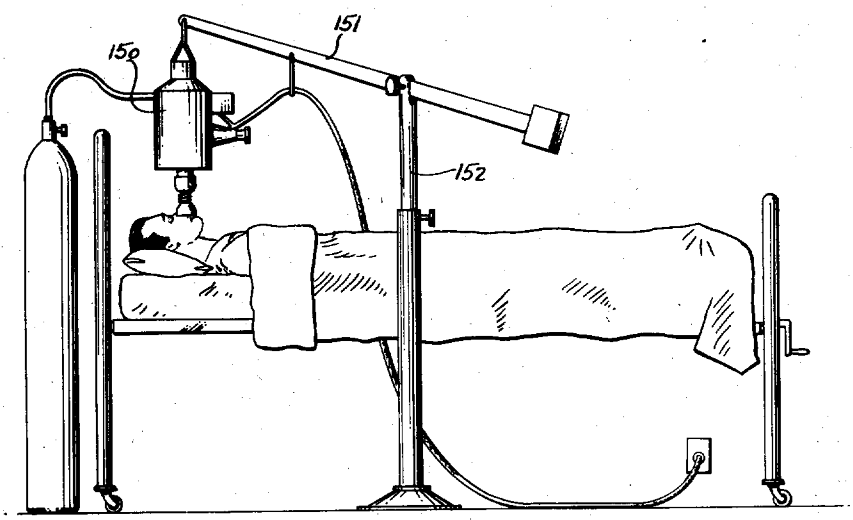
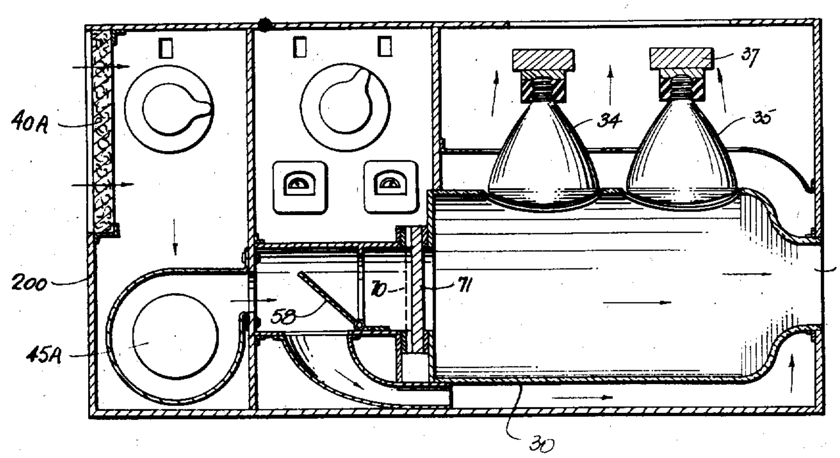


Fig. 12



INVENTOR.
VAN H. STEEL
BY
Cook & Robinson
ATTORNEYS

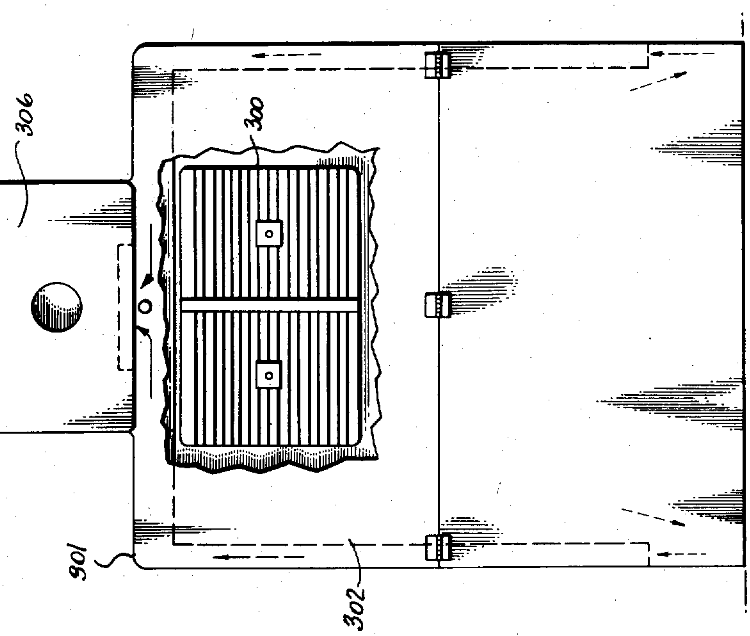


Fig. 14

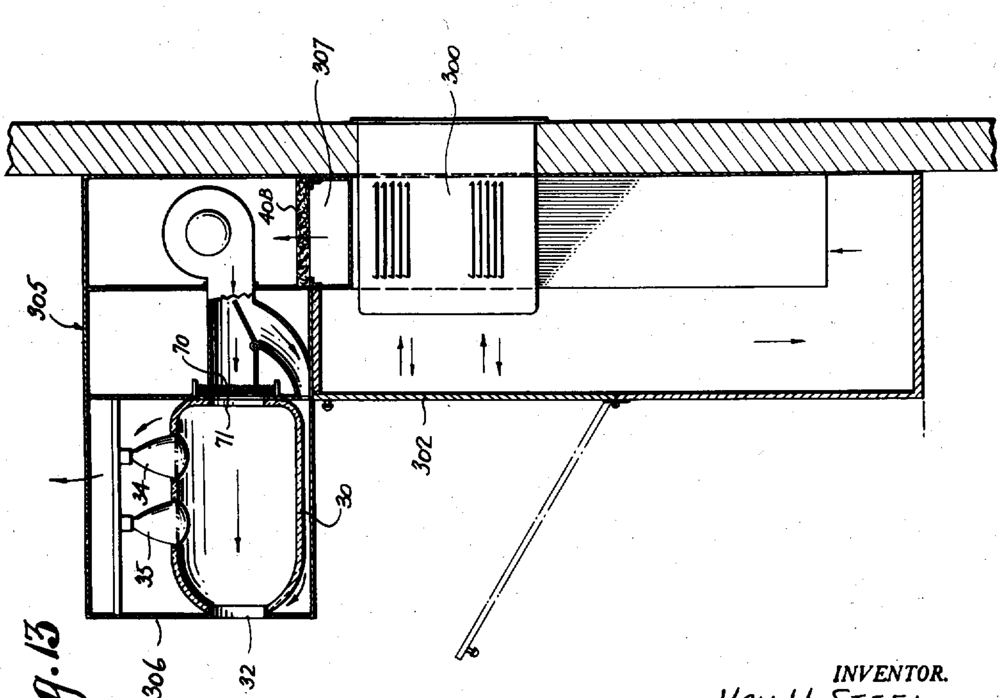
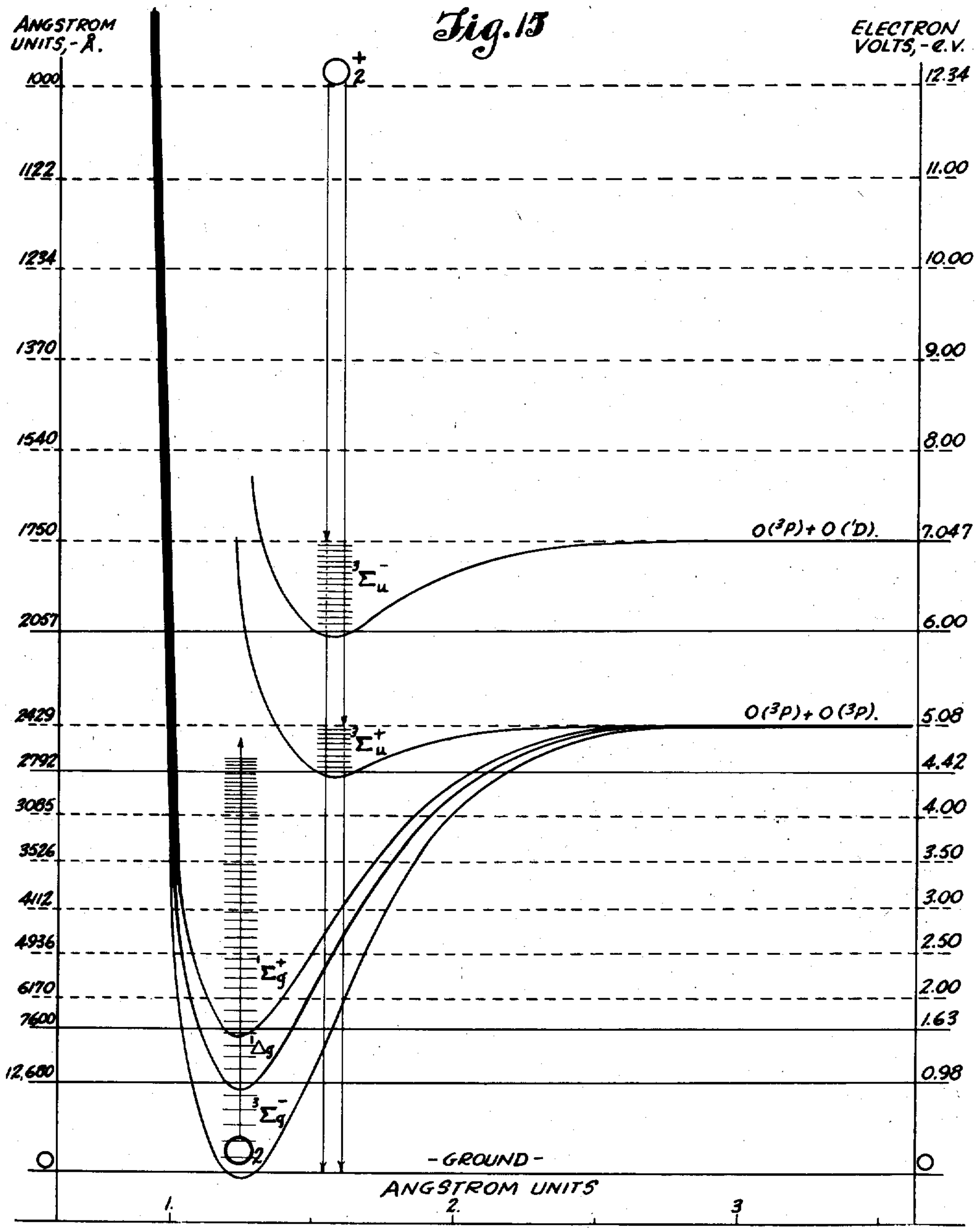


Fig. 13

INVENTOR.
VAN H. STEEL
BY Cook & Robinson
ATTORNEYS

Fig. 15



INVENTOR.
VAN H. STEEL
BY Cook & Robinson
ATTORNEYS

2,920,622
Patented Jan. 12, 1960

2,920,622

METHOD AND APPARATUS FOR CREATING ENERGY CARRIER STATES OF OXYGEN IN INSPIRED AIR

Van H. Steel, Portland, Oreg.

Application June 6, 1955, Serial No. 513,341

13 Claims. (Cl. 128—191)

This invention relates to a method of and means for the processing or treating of oxygen and to the utilization of energy-carrier states of oxygen of inspired air by human beings and animals for the correction or treatment of existing pathological conditions in said human beings or animals. Furthermore, the invention relates to apparatus useful for the building up of an energetic defense against the development of pathological conditions or dysfunctions that are the result of bacterial or virus invasions of said organisms.

This invention pertains to energy-carrier states of raw oxygen such as may be obtained from storage tanks for therapeutic purposes, or to atmospheric oxygen of inspired air. Heretofore, therapeutic oxygen as used in oxygen tents or as administered by mask, has been used with no attempt being made to energize it, that is, to raise its energy level by creating energy-carrier states prior to its utilization.

Relatively pure dry oxygen taken from storage tanks has a high potential as a carrier of energy of inspired air. Such oxygen normally is in its ground state, or in a low vibrational energy level of its ground state. In either of these states, it is relatively inactive chemically. Atmospheric oxygen of low vibrational energy levels of its ground state is normally exposed to the energizing effects of radiant and kinetic energy of the outdoor environment. By absorption of this energy, its energy level is raised, and outdoor air is freshened and made suitable for normal respiratory purposes. Oxygen of outdoor air is a normal carrier of energy, and the amount of energy carried may be subnormal, normal, or excessive as it is inspired by animals or by human beings.

It has heretofore been recognized in the electro-chemistry of gases that certain mixtures of molecules, such as oxygen molecules of air, do not react chemically unless one or both of the potentially reacting molecules are in an abnormal, excited or energy-rich state. They must be brought into a chemically reactive state, because they show no tendency to change while in their ground state, or in the lower vibrational energy levels of their ground state. The inherent ionization of atmospheric oxygen produced by cosmic rays, and lower vibrational levels of the metastable state produced by infra-red absorption, may provide adequate energy in atmospheric oxygen to support life. However, this life sustaining energy may be inadequate to support a defense of an organism against pathogenic bacterial or virus invasions. It may likewise be inadequate to overcome pathological conditions in an organism once they have become established.

The vital importance of energy-carrier states of oxygen of inspired air seems not heretofore to have been fully understood or adequately appreciated biologically or therapeutically. The importance of the chemical activity of oxygen becomes even greater in tissue cells than in the alveoli of the lungs. In tissue cells, the energy level of oxygen received from the blood must be raised by means of iron-porphyrin-protein respiratory cell catalysts before the said oxygen can unite chemically with cy-

tochrome oxidase and oxidize its ferrous iron atom to a ferric state. This latter reaction is basic to the continuity of living processes. Without this oxidation of ferrous iron, oxidation-reduction reactions cannot function in a living cell, and life within an organism cannot continue. Activated or metastable oxygen, i.e. molecular oxygen that has had its energy level raised, is the ultimate electron acceptor of the entire oxidation-reduction sequence of a living cell.

Oxygen in its diatomic or molecular state is a potential carrier of energy of inspired air. Energy is normally imparted to atmospheric oxygen by the kinetic energy of alpha, beta, gamma and cosmic rays of the earth, the air and the cosmic universe, and by the radiant energy of sunlight. In my prior patents, issued under Nos. 2,343,-338 and 2,415,659, I have disclosed methods and means for the creation of positively ionized and metastable states in oxygen of inspired air by the kinetic energy of electron impact in an ionizer utilizing comparatively low velocity electrons.

As a general statement, it may be said that the principal object of this invention is to provide a method and means whereby positively and negatively ionized states, metastable states and vibrational energy levels of metastable states of molecular oxygen can be produced for animal or human consumption in inspired air.

Further objects of the present invention are:

To provide an apparatus including an ionizer wherein kinetic energy of electron impact is utilized upon oxygen molecules of a gas and whereby positive and negative molecular oxygen ions and metastables are created, in combination with means for irradiation of said gas whereby additional oxygen metastables will be formed and subsequently raised to higher vibrational energy levels.

To provide apparatus for treating or processing the oxygen of inspired air, primarily for use by human beings, for the purposes previously given, without creating ozone or deleterious nitrogen compounds in the air.

To provide an apparatus of the above character including an irradiation chamber through which the gas is caused to flow and to effect the irradiation of said gases by means of a continuous spectrum provided by a carbon arc, or certain standard types of tungsten filament infra-red and photospot lamps or other standard means.

To provide apparatus of the character stated wherein means is provided for controlling the rate at which the oxygen-containing gas is caused to move through the ionizer and irradiating chamber.

Yet another object is to adapt the present ionizer and irradiation means for use in combination with present day types of air conditioning means.

Before describing in detail the apparatus for and methods of achieving the objects of my invention, I will first present certain background theory, and in particular I will describe the energy-states of oxygen as shown in a schematic energy chart comprising Fig. 15. In this graphic view, the vertical scale at the right-hand side expresses the energy levels of oxygen in terms of electron volts. Similarly, the vertical scale at the left-hand side expresses the same energy values in wavelengths emitted from the oxygen molecule, and the horizontal line across the bottom expresses the varying distances between the atoms of an oxygen molecule in terms of Angstrom units. In this view, I have shown five energy curves for molecular oxygen. Four of these are seen to converge at the right at 5.08 electron volts or 2430 Angstrom units. This represents the first dissociation potential for molecular oxygen, at which energy level the molecule dissociates to form two normal ^3P atoms. The second dissociation potential, as shown by the fifth curve, is at 7.047 volts or 1750 Angstrom units, at which level the molecule dissociates to form a normal ^3P atom and an excited ^1D

metastable atom. At 12.3 volts or 1000 Angstrom units, we have the ionization potential of molecular oxygen at atmospheric temperature and pressure. At this energy level an electron is removed entirely from the influence of the nucleus of an atom of an oxygen molecule, thus creating a positive molecular oxygen ion and releasing a free electron.

In order that the energy curves shown in Fig. 15 may be more clearly understood, I will explain the electronic transition from the ($^3\Sigma_g^-$) ground state to the ($^1\Delta_g$) metastable state of molecular oxygen. The energy state of molecular oxygen depends primarily upon electronic arrangement, and secondarily upon the extremes of variation of the separation or distance between the atoms. The simplest way to look upon vibrational energy levels of oxygen metastables is to regard the molecule as two separate atoms held together by means of a coiled spring. At the transitional level from the ground state to the ($^1\Delta_g$) metastable state, we may regard the tension of this coiled spring as being in equilibrium. Absorption of an adequate intensity of infrared irradiation of the critical wavelength of 12,680 Angstrom units will produce a unique electronic transition or change of electron position in a relatively few molecules of the gas irradiated, whereby these molecules will be transformed from the ($^3\Sigma_g^-$) ground state to the ($^1\Delta_g$) metastable state.

The electronic configuration of a metastable state is difficult to create in a gas by irradiation, but once created it is equally difficult for the electrons to return to their normal positions. This is what makes the molecule a metastable, i. e., it may hold its electronic and vibrational energy for a period of from one to ten seconds more or less. The actual life of an oxygen metastable depends primarily upon its metastable state, its vibrational energy level and the conditions of its immediate environment. If an oxygen molecule absorbs energy and becomes activated without being changed to a metastable state, its energy-carrying life will be a small fraction of a second. Its value as a carrier of energy in inspired air will then be little, if any, compared with that of a metastable molecule or atom.

As soon as a ($^1\Delta_g$) metastable oxygen molecule is formed, it may absorb a high intensity photon of a shorter wavelength from the same irradiation source. We may assume that this metastable is raised by this photon absorption to a vibrational energy level of 4936 Angstrom units or 2.5 electron volts with respect to ground. It requires absorption of a wavelength of approximately 8118 Angstrom units to produce this end result. This wavelength represents the difference between 12,680 Angstrom unts, or the energy level at which the metastable is formed, and the vibrational energy level to which the metastable is raised. At this higher vibrational energy level the coiled spring is stretched, so to speak, to a degree commensurate with the energy absorbed. This vibrational level would represent the addition of vibrational energy of the order of 1.52 electron volts to the initial electronic energy of 0.98 electron volt when the metastable was formed.

After this radiant or photon energy is absorbed, the resulting vibrational energy will normally remain with a molecule for a period commensurate with its actual metastable life. Vibrational energy may be given off as photon emission as the distance between the atoms decreases. If all of this electronic and vibrational energy is lost in one jump, the emission wavelength will be 4936 Angstrom units which corresponds with a total energy loss of 2.5 volts as the molecule drops to a ground state. Oxygen has a resonant emission and does not follow Stokes' Law governing energy transfers. If the energy loss takes place in a sequence of jumps or energy drops, the emission wavelengths will be correspondingly longer.

Under conditions of relatively clean dry air, the earth's lower atmosphere has a definitely positive space charge. Rain, fog, increased humidity, or even abrupt changes in atmospheric humidity, are destructive of positive light atmospheric ions of high mobility. The life of these positive ions in relatively clean dry air of the earth's lower atmosphere may be of the order or 40 to 60 seconds, while at high altitudes they may have a life of 300 seconds or more. These positive molecular ions have a high affinity for water vapor, and in the presence of moisture, to which they readily pass their energy by collision, they are abruptly reduced. The reduction of these positive molecular ions to a ground state involves intermediate excited and metastable molecular states (Fig. 15).

The higher energy levels of molecular oxygen produced at sea level are of kinetic origin rather than of radiant origin. There are four separate conditions under which molecular oxygen may emit short-wave ultraviolet photons as a result of its absorption of kinetic energy, and one condition under which it may emit longer-wave ultraviolet photons as a result of its absorption of radiant energy. Ultraviolet photons produced under these different conditions have different wavelengths. The abundance of wavelengths of ultraviolet photons which may be emitted by molecular oxygen under these varying conditions seems well established betwen 1570 Angstrom units and 3800 Angstrom units. The different conditions under which molecular oxygen may emit, or cause the emission of, ultraviolet photons are as follows: These processes are listed in the order of their wavelength emission:

First (1570 Angstrom units to 1760 units).—As a positive molecular oxygen ion is reduced by collision with a water molecule as it simultaneously attaches a free electron, it may drop from 12.3 volts to any one of the various vibrational energy levels of the ($^3\Sigma_u^+$) metastable state. Energy transferred to water molecules by these positive molecular oxygen ions as they are reduced may be of the order of 7.0 volts to 7.86 volts. This would result in ultraviolet photon emission of the order of 1570 Angstrom units to 1760 Angstrom units.

Second (1760 Angstrom units to 2060 Angstrom units).—As a positive molecular oxygen ion is reduced by collision with water molecules, it may drop in one jump to any one of the various vibrational energy levels of the ($^3\Sigma_u^-$) non-metastable excited molecular state depending upon the exact amount of energy lost. Radiation from this excited state as it in turn drops to ground, immediately converts this excitation energy into radiant energy. The net amount of energy lost by these various vibrational energy levels as they drop to ground may vary from 6.0 volts to 7.0 volts. Ultraviolet photons given off will then be of wavelengths of the order of 1760 Angstrom units to 2060 Angstrom units.

Third (2060 Angstrom units to 2430 Angstrom units).—As a positive molecular oxygen ion is reduced by collision with water molecules, it may drop to any one of the non-metastable excited energy levels of the ($^3\Sigma_u^-$) state. In the one jump drop from 12.3 volts to this excited state, the net amount of energy imparted to water molecules by collision may vary from 5.0 to 6.0 volts. The wavelengths of ultraviolet photons emitted by these water molecules as they drop to zero volts will be commensurate with the net amount of energy received, which may be of the order of 2060 Angstrom units to 2430 Angstrom units.

Fourth (2430 Angstrom units to 2800 Angstrom units).—The ($^3\Sigma_u^+$) metastable state is created as a positive molecular oxygen ion collides with a water molecule and simultaneously attaches a free electron as it drops in one jump to any one of the various vibrational energy levels of this metastable state. As metastables of these various energy levels again collide with water molecules and transfer their energy, they drop to ground as the water molecules likewise drop to zero volts. Ultraviolet photons given off by these water molecules may vary from some 2430 Angstrom units to 2800 Angstrom units.

Fifth (2800 Angstrom units to 3800 Angstrom units).—The ($^1\Delta_g$) metastable state of molecular oxygen may be formed from the ground state by absorption of infra-red photons of 12,680 Angstrom units. This irradiation may be effected by means of a tungsten filament infra-red lamp, or by the infra-red rays of a carbon arc, or both. After this first step has taken place, further absoption of photons of a photospot or carbon arc spectrum may raise the combined electronic and vibrational energy of the oxygen molecule, for example, to a 3.25 volt or a 4.42 volt level, or higher with respect to ground. This represents absorption of vibrational energy of 2.27 volts to 3.44 volts with respect to the first-formed metastable level, i. e., 0.98 volt. As these metastables collide with water molecules and drop to ground, they give off their combined electronic and vibrational energy in one jump. Ultraviolet photons given off will be of the order of 2800 Angstrom units to 3800 Angstrom units.

Under certain variable conditions which may be present in inspired air, oxygen molecules in their positively ionized, excited and metastable states have the potential of producing emission of wavelengths varying from 1570 Angstrom units to 3800 Angstrom units by giving up their energy to water molecules on the mucous surfaces of the respiratory tract or in the alveoli of the lungs. By means of equipment specified herein, combined metastable states and vibrational energy levels up to some 5.08 volts can be created in diatomic molecular oxygen by means of radiant energy. Above this energy level, positively ionized, excited and metastable molecular and atomic states of oxygen are created in this equipment by means of the kinetic energy of electron impact in an electric field. The end effects of radiant energy and kinetic energy overlap in the ($^3\Sigma_u^+$) metastable state of molecular oxygen.

Oxygen of inspired air is the means by which ultraviolet rays are expressed and delivered in an organism. Positive molecular oxygen assumes the role of a catalyst in the lungs as it is reduced. Blood protein and other "carriers" absorb radiation photons from metastable diatomic and atomic oxygen and positively charged diatomic oxygen ions of inspired air, and carry this energy to cells of an organism. Molecular oxygen and atomic iron of cytochrome oxidase of a cell combine to furnish energy for the cell. Both positively ionized and metastable oxygen are present in controlled amounts in the oxygen of inspired air supplied by the methods and means disclosed herein.

The electronic transition from the ($^3\Sigma_g^-$) ground state of molecular oxygen to the ($^1\Delta_g$) metastable state takes place at 12,680 Angstrom units. The infra-red drying lamp operating at 2500° K. has its relative energy peak at about 11,500 Angstrom units, which is the closest available means to this transition wavelength. A continuous spectrum rather than a line spectrum is essential to bring about this transition. A line spectrum such as that produced by a mercury vapor lamp, for example, may not have the discrete line of transition and would thus be of no effect.

The number of metastables created will be directly proportional to the volume of the gas and the number of photons per second of that specific wavelength produced. In other words, the rate of absorption of that wavelength is proportional to its intensity. Where the volume of the gas is larger, there will be a greater number of molecules available in the path of the photons. More photons per second of a critical wavelength produced, and more oxygen molecules in the path of these photons to absorb them, results in a greater metastable population being created in the gas.

Likewise more photons per second at 10,000 Angstrom units which is the approximate relative energy peak of a 375 w. infrared lamp operating at 2960° K.; or at approximately 8,500 Angstrom units which is the relative energy peak of a photo-spot lamp operating at 3400° K.; will result in a relatively high incidence of photons per second of wavelengths between 8500 Angstrom units and 12,680 Angstrom units being absorbed by the ($^1\Delta_g$) metastables created. However, the photo-spot lamp has a relative energy of some 90% at about 6800 Angstrom units, so a relatively large number of photons per second of wavelengths between 6800 Angstrom units and 8500 Angstrom units will be available.

At the electronic transitional level to the ($^1\Delta_g$) metastable state, i.e., 12,680 Angstrom units, the oxygen molecule carries electronic energy of 0.98 volt. As these metastable molecules absorb additional photons, they take on vibrational energy. For example an 12,000 Angstrom units photon corresponds with an energy of 1.03 volts; an 11,000 Angstrom units photon corresponds with an energy of 1.12 volts; a 10,000 Angstrom units photon corresponds with an energy of 1.23 volts; a 9,000 Angstrom units photon corresponds with an energy of 1.37 volts; and an 8,000 Angstrom units photon corresponds with an energy of 1.54 volts.

If a ($^1\Delta_g$) metastable is created which carries 0.98 volt of electronic energy, and to this is added from 1.03 volts to 1.54 volts of vibrational energy, the total energy carried by the metastable will be of the order of 2.0 volts to 2.5 volts. Since these vibrational energy levels are discrete or specific and known, there may be several of them in the level between 2.0 and 2.5 volts. As these metastables collide with water molecules and give up their combined electronic and vibrational energy in one jump to the water molecules, their emission spectrum, via the water molecules, will likely be a continuous spectrum as they drop to ground. Water molecules are closely packed, contrasted with a gas, and will likely produce a continuous spectrum under these conditions. Incidentally, the life of the vibrational energy levels of these metastables runs concurrently with the life of the metastable states.

Thus by means of photon absorption of wavelengths starting with the critical wavelength of 12,680 Angstrom units, and adding to it photon absorption of wavelengths varying from some 8000 Angstrom units to 12,680 Angstrom units, we can build up a combined electronic and vibrational energy in ($^1\Delta_g$) metastable oxygen molecules of from 2.0 volts to 2.5 volts. Since 2.5 volts correspond with 4936 Angstrom units and 2.0 volts correspond with 6170 Angstrom units, with a potentially continuous spectrum between these energy levels, the drop from these energy levels to ground in one jump would result in an emission spectrum by these molecules which would likely carry all lines and vary from some 4936 Angstrom units to 6170 Angstrom units. As these metastables drop their combined electronic and vibrational energy to water molecules in one jump in the alveoli of the lungs, hemoglobin, oxyhemoglobin and other energy carrier entities of the blood will be irradiated by these wavelengths. Hemoglobin, oxyhemoglobin, and also cell cytochromes are known to have critical energy absorption lines or bands which fall within this range of wavelengths.

Having now described the positively ionized and metastable states, and the vibrational energy levels of these metastable states of atmospheric oxygen and how they are created, I will now describe my apparatus whereby these energy states in storage-tank oxygen and in atmospheric oxygen can be created in air to be inspired. Referring to the drawings:

Fig. 1 is a diagram, in the nature of a flow chart, indicating the character of the various parts used in combination in the present apparatus, and their relationship to each other.

Fig. 2 is a side view of an apparatus embodied by the present invention for the treatment of oxygen of inspired air, and illustrating its mode of use.

Fig. 3 is an enlarged sectional detail, taken on the line 3—3 in Fig. 2.

Fig. 4 is a vertical section taken through an oxygen treating apparatus of another, or alternative form, embodying the principal features of the present invention therein.

Fig. 5 is a wiring diagram for the electrical devices or parts of the apparatus of Fig. 4.

Fig. 6 is a longitudinal, central sectional view of an alternative or modified form of ionizer and irradiation chamber using radio-active material for the creation of both positive and negative air ions.

Fig. 6*a* is a cross section on line 6*a*—6*a* in Fig. 6.

Fig. 6*b* is an enlarged sectional detail on line 6*b*—6*b* in Fig. 6*a*.

Fig. 7 is an enlarged, central sectional view of another similar form of apparatus.

Fig. 8 is a vertical section of still another form of ionizer and irradiation means, especially for use with apparatus of the type shown in Fig. 11.

Fig. 9 is a horizontal section taken on the line 9—9 in Fig. 8.

Fig. 10 is a central longitudinal section of yet another modified form of apparatus, equipped to receive tank oxygen.

Fig. 11 is a view illustrating the mode of use of the apparatus of Fig. 8.

Fig. 12 is a sectional view of ionizing and irradiation means in combination with a present day type of air conditioner.

Fig. 13 is a vertical section of a combined air conditioning unit and ionizing and irradiation means.

Fig. 14 is a front elevation of the same.

Fig. 15 is a graph that is explanatory of the energy states and spectra of diatomic molecules of oxygen, the vibrational energy levels being schematically represented.

In the following specification, the invention has first been discussed with respect to the end effects of both radiant and kinetic energy in producing certain positively ionized and metastable states of oxygen of outdoor air; secondly, it has been considered in respect to different means whereby the various electronic energy states and vibrational energy levels of oxygen can be created mechanically for human or animal consumption in inspired air, and finally it has been considered in respect to the physiological and biochemical end effects produced directly or indirectly as a result of energy carried by these various created energy states of oxygen of inspired air.

The flow chart illustration of Fig. 1 is applicable to each of the various types of apparatus herein illustrated and described. It is indicated in Fig. 1 that air is drawn through air filtering pads **10** into an air cooling and dehumidifying chamber, designated in its entirety by numeral **11**, and from this the cooled and dehumidified air is drawn by action of a suction blower **12**, and forcibly discharged through an ionizer **13**, and thence into an irradiation chamber **14**, from which it is expelled through an outlet nozzle **15** to be received directly into the respiratory tract of the patient being treated.

It is also indicated in Fig. 1, that pure oxygen from a source of oxygen supply **16** may be admitted to the air stream at a point between the blower **12** and ionizer **13** or between the ionizer **13** and irradiation chamber **14**. The air cooling and dehumidifying equipment is here shown to include a compressor unit designated at **19**.

In the several other views of the drawings, I have shown various modifications, or alternative forms of apparatus to be used for the present treatment of oxygen, each of which alternative or modified form conforms, in a general way, to the arrangement and use of parts shown diagrammatically in Fig. 1. Each of these various apparatuses will hereinafter be individually described, and its mode of use explained. First, the apparatus that has been illustrated in Fig. 4, and which is typical of devices for general use will be described. This apparatus comprises an enclosing housing or cabinet of upright, box-like form, which is designated in its entirety by reference numeral **20**. It may be constructed of wood, or be made of other suitable materials according to requirements. This housing is horizontally divided intermediate its ends by two vertically spaced, horizontally disposed partitions, **21** and **22**, thus defining three separate compartments in the housing which are herein designated, respectively, as the upper compartment **23**, the intermediate compartment **24**, and the lower compartment **25**.

Extending laterally from one side of the main portion of the housing or cabinet **20** and at the level of the upper compartment **23** for practical purposes, is a box-like housing designated generally by numeral **26** which encloses a compartment **27**. Supported within the compartment **27** is the irradiating equipment comprising a horizontally disposed, cylindrical vessel **30** of jar or bottle form, having an outwardly tapering neck portion **31** at its receiving end, and equipped at its opposite or base end with a centrally located discharge or respiratory nozzle **32**. The vessel **30** provides therein the irradiation chamber **30'**. The neck portion **31** and the nozzle portion **32** extend through opposite end walls of the compartment **27**. For the functional support of the vessel **30**, I provide the supporting cradles **30*c*** beneath its forward and rearward end portions as shown. For most satisfactory results, the irradiation chamber **30'** is cylindrical, from ten to twelve inches in diameter and from sixteen to eighteen inches in length. The vessel **30** is formed of Pyrex glass, or other similar material of suitable kind and its surface is exteriorly silvered or otherwise plated or coated to provide it with a reflective inner surface.

In view of the fact that silvering eventually oxidizes and its reflectivity is thus impaired, I prefer at present to cover the vessel **30** with thin aluminum foil which has excellent durability as well as reflectivity. This I cover with sheet copper to eliminate oxidation. Aluminum has an ultraviolet reflective efficiency of approximately 90 percent, and also is adequately reflective of infra-red and visible rays.

Formed in the top wall portion of the cylindrical irradiation vessel **30** in alignment longitudinally thereof, are two circular openings, **32** and **33**, in which the glass bulb portions of electric irradiation lamps **34** and **35** are supported in the manner shown in Fig. 4. In apparatus presently being used, the lamp **34** is a 375 w. infrared drying lamp designated in trade as an R–40 type. The joint between lamp bulb **34** and edge of the opening **32** in which it is fitted preferably is sealed by insertion of an asbestos cloth gasket, or other suitable heat resistant material whereby, in use of the device, escape of gas or air from the chamber at this joint is prevented. The lamp **35** applied to the opening **33** is an R–40 type photo-flood or photo-spot lamp of 500 w. capacity. It, likewise, has the bulb portion thereof sealed in the opening **33** by an asbestos gasket to eliminate possibility of gas leakage through the joint.

The two lamps, **34** and **35**, are mounted in the usual manner, in sockets **34'** and **35'** that are fixed to a horizontal panel **37**. The panel is supported by elongated bolts **38** that extend upwardly from a supporting diffusion wall in the lower part of the compartment **27**. The housing **26** has a top wall **26*x*** attached by hinges as designated at **39**, for upward opening.

Air that is supplied to the irradiation chamber initially enters the present air treating apparatus through one or more air filtering pads **40** that are suitably mounted in one end of an air entry duct **41** that is contained horizontally in the compartment **24** with its inlet end extended from the compartment. It is in the inlet end of this duct that the filter pads **40** are fitted for easy removal or replacement when such is desired or necessary.

The air duct will be extended only slightly from the cabinet, as seen in Fig. 4, when room air is to be utilized. However, it is ordinarily desired that outside air be used and in such case the duct would be extended, as may be required, to a window or to any other opening provided for reaching an outside air supply.

The air filtering pads **40** preferably are of the pliotron type, that is, they employ filtering material therein that has a natural charge of static electricity with the property of attracting and holding the very finest of dust particles.

Contained in the duct **41** at the inside of the filter pads **40** are two sets of air cooling coils **42** and **42'** through which a cooling medium is caused to be circulated. For this purpose the coils are connected, as herein shown, with the pump **44** of the compressor unit **19**; this being contained in the lower compartment **25** of the housing **20**. Outside or room air is drawn into the duct **41** through the filter pads **40** and cooling coils **42** and **42'** by action of a common type of suction and blower unit which is herein designated in its entirety by numeral **45**. This unit employs a pressure type, or squirrel cage type, of fan and has a housing **45*h*** of involute form with a centrally located air inlet connected by an air tube **46** to receive air from the discharge end of duct **41**. This communicates with a duct **48** leading upwardly therefrom and opening into the base end of a box-like ionizer housing **50** that is contained in the lower part of the cabinet compartment **23**. The ionizer presently will be further described.

From the top of the ionizer housing **50**, the ionized air is discharged through a tubular connector **51** into the medial portion of a horizontally disposed tube **52** that has an open end portion extended coaxially into the neck portion of the irradiation vessel **30**; the tube passing through a sleeve **54** of Lucite or other suitable non-conductive material that is fitted within the bottle neck.

In the other end portion of tube **52**, beyond the juncture of the connector **51**, the tube is fitted with spaced insulating plugs **55—55'** which are of rubber and of Lucite respectively, and extending centrally through these, coaxially within the tube into the neck portion of the chamber **30'**, is an oxygen supplying tube of glass **56** of small diameter. Connected to the outer end of tube **56** is a flexible rubber tube **57** leading from a suitable source of supply of oxygen, such as a tank; valve means being provided at the tank or in the connection in the usual way for controlling the supplying of oxygen through this tube to the irradiation chamber.

It is to be understood that the various parts of this apparatus that are directly contacted by the treated air, especially in the ionization and irradiation operations, are made of glass, or of a similar non-conductive material of that character. This applies especially to the housing **50**, tube **52**, tube **56**, chamber **30** and connecting parts.

A small glass tube **57*x*** is shown in Fig. 4 to extend from outside the cabinet into the duct **48** just below the ionizer housing. This is provided for the delivery of storage tank oxygen to the cooled air therein if such should be desired.

It is shown in Fig. 4 that the duct **47** extends beyond duct **48** and opens into the lower end of chamber **27** and that a gate valve **58** is hinged therein in such manner that it can be adjusted by a suitable handle means located outside the cabinet, to a position as shown in full lines, whereby all air from the fan unit **45** will be caused to be diverted through duct **48** to the ionizer, or it may be adjusted to various intermediate positions, one of which is indicated in dotted lines, at which desired proportionate amounts of the conditioned air will be caused to be discharged into the base of the chamber **27** for upflow through the perforations **59** of a diffusion plate or partition wall **60** that horizontally divides the chamber **27** below the irradiation vessel **30**, for cooling the chamber and walls of the vessel.

To permit the desired circulation of cooling air about the cylindrical vessel **30**, the top wall **26*x*** of compartment **27** is formed with a plurality of air discharge perforations or ports **62**. Additional air circulation in the compartments of the cabinet is effected by use of a small fan **63** set in an opening **63'** formed in the vertical wall between compartments **23** and **27**; the compartment **23** having air inlet openings in its opposite wall as shown in Fig. 4 at **64**.

In order that cooling of the vessel **30** may be effected without utilizing any of the cooled air from duct **47**, I have provided an auxiliary suction blower unit **65** with an intake **65*x*** that opens through a sidewall of the cabinet to receive room air. A discharge duct **66** leads from blower **65** and opens into the duct **47** beyond the valve **58** for delivery of this room air into the lower portion of chamber **27** for upward diffusion through the perforated partition wall **60**.

It is immaterial just what type of refrigerating or cooling unit **19** be used. However, it is preferred that the cooling coils **42—42'** be maintained at such temperature that moisture in the entering filtered air will be collected as frost thereon, and thus the air will be de-humidified. In order to obtain such sharp cooling, the capacity of compressor **44** should be substantially greater than the cooling coil capacity. In the present instance the ratio is approximately 2 to 1. The first coil **42** may be designated as a "frost magnet" in that it will collect the major portion of the moisture from the air passing by. The second coil **42'** remains relatively free of frost, which acts as an insulating medium, and will cool the incoming air even further. For example, where the air is cooled to 0° F. at this point, the maximum grains of moisture per cubic foot of air that it could carry would be .560. To show the temperature of air after passing the coil **42'**, I provide the dial thermometer **42T**; this being located exteriorly of the housing **20** where it can be easily seen. As this air passes through the ionizer and irradiation chamber of the unit it picks up heat and especially from the walls of the irradiation chamber, so that upon its reaching the outlet **32**, of the irradiation chamber, it will be approximately at room temperature, i.e. about 70° F. This air will then have a relative humidity of the order of 6%. The desirability for removing a major portion of the moisture from the air is due to the fact that water vapor is poisonous to all of the energy-carrier states of oxygen which have been considered herein, except negative ions. The air intaken through the filter pads and then subjected to the cleaning, cooling, and dehumidifying operation is hereinafter referred to as "conditioned air."

The ionizer of this apparatus, as contained in housing **50**, comprises a horizontally disposed metallic screen **70**, constituting a positive electrode. Extended across the housing, immediately above the screen, are one or more metal tubes **71** constituting the negative electrode. The positive electrode is up stream from the negative electrode. These two electrodes are connected to a source of supply of electricity, as presently explained in connection with the description of the wiring diagram in Fig. 5. When voltage, impressed across the electrodes, is increased to a value corresponding to a voltage gradient between them of about 10,000 volts per centimeter, the free electrons produced at the rate of several per second per cubic centimeter of indoor air by cosmic rays and by other agencies, will begin to be accelerated between collisions with air molecules to sufficient velocity to ionize oxygen molecules. With this voltage gradient, a few electrons will attain a sufficient velocity to remove electrons from the oxygen molecules with which they collide, and the resulting free electrons will free other electrons so that an avalanche of free electrons will move rapidly toward the positive electrode. I prefer to utilize electrodes of sufficient area that enough ionization of oxygen will occur at a voltage gradient below that required to ionize nitrogen molecules.

This above means for and method of ionization is in accordance with that which has been fully described and illustrated in my U.S. Patent No. 2,415,659 and will not be further discussed herein.

The wiring diagram for the electrical devices used in the apparatus has been shown in Fig. 5. In this view, power or current supply lines are designated at A and B. Circuit lines **75** and **76** lead from these power lines directly to the lamps **34** and **35** which are connected thereto in parallel, as is also the motor **63***m* of the air circulating fan **63**. A switch **77** is interposed in wire **75** to open or close this lamp and motor circuit.

The compressor unit **19** is connected to the current supply lines **75—76** by connecting lines **79—80**, and this circuit is under control of a switch **81** interposed in wire **80**. The motor which operates blower unit **65** is connected to the current supply lines **75—76** by wires **84** and **85** and this circuit is under control of a switch **86** interposed in line **84**. The motor of auxiliary blower unit **45** has a circuit connection **88** that leads to the supply line **76**, and has a circuit connection **89** that leads to the supply line **75** through a variable transformer **90**, preferably of the type available on the market under the trademark "Powerstat." This circuit is controlled by a switch **91**.

The ionizer electrodes **70—71** are connected with the circuit lines **75—76** through a variable transformer **95** that is controlled by a switch **96**. Other instruments used in the electrical system are as indicated diagrammatically.

Assuming the apparatus of Fig. 4 to be constructed as illustrated and described, its mode of use is as follows:

Before seating the patient for treatment, the circuit control switches of the electric circuits for the compressor unit **19**, the blower **45** and blower **65** are closed. The variable transformer **90** for the blower **45** is then so set as to cause the blower to move the intaken air quite slowly past the cooling coils **42** and **42'** in order to prevent the formation of any excessive amount of frost on the coils before treatment of the patient is started.

As soon as the temperature of the air passing the coils reaches some 20° F. or lower, the ionizer control switch **96** is closed and the ionizer variable transformer **95** is adjused to about 1.0 kv. to let the transformer-rectifier warm up. The patient, equipped with dark glasses, is then seated in a proper position relative to the machine, for example as seen in Fig. 4. The valve damper **58** is then adjusted to a position to direct conditioned air through the ionizer, and to shut off air being delivered by blower **45** to the chamber **27**. The variable transformer for the blower **45** is then turned up to cause air to be forced through the ionizer and irradiation chamber in a gentle breeze. Lamp switch **77** is then turned to "on" and the variable transformer **95** of the ionizer is adjusted to a voltage reading of approximately 9.0 kv. at which voltage current measured across some 300 megohms resistance will register of the order of some ten to twenty thousandths of a microampere, thus indicating a substantial degree of ionization between electrodes **70–71**.

Air to be treated will be drawn inwardly through the filter pads **40** and cooling coils **42—42'** by action of the suction blower **45**. This intaken air is thus first cleaned of substantially all particles of dust and other foreign matter. In its contact with the cooling coils **42—42'**, moisture is extracted from the air and is retained as frost on the coils. The amount of moisture removed from the air can be regulated by controlling the temperature of the air at the coils, and thus the absolute humidity of the air as it enters the ionizer and irradiation chamber can be controlled within desired limits.

The filtered and dehumidified air is discharged through ducts **47** and **48** into the ionizer **50** where it is ionized and discharged into tube **52** and thence into the irradiation chamber **30'**. Lucite plug **55'** centers the oxygen line, and prevents a backlash of air in tube **52**. Through the establishment and proper control of voltage, as impressed across the electrodes **70—71** of the ionizer **50**, the desired ionization of oxygen will occur without substantial ionization of nitrogen. Insofar as ionization of the oxygen is concerned, I follow, in the construction and mode of use of the ionizer **50**, the teachings of my previously mentioned U.S. Patents Nos. 2,343,338 and 2,-415,659.

The flowing air stream passes from the ionizer **50** through duct **51** and tube **52** into the irradiation chamber **30'** and, under the influence of the regulated pressure of constantly entering air, it is caused to progress through the chamber and to be discharged through the nozzle **32**. A patient taking treatment, positioned with the entrance of his respiratory passages immediately in front of the discharge end of the nozzle **52**, receives the benefit of the ionized and irradiated air in the normal respiratory function. The rate of flow of air through the irradiation chamber is so regulated that the metastable states of molecular oxygen created therein will be carried to the intake of the respiratory passages of the patient during the early part of their normal life span, and yet will not be excessively wasted to the outer atmosphere. The actual life of an oxygen metastable depends primarily upon its metastable state, its vibrational energy level and the conditions of its immediate environment, and may vary from some two to ten seconds. The positively ionized state, under conditions as indicated above, will have a life expectancy of some sixty seconds or more.

In consideration of the above, it is important that the outlet port or inspiring mask as used in the previously described devices, and those later to be described, be located between three and thirty inches down stream from the last point of maximum intensity of irradiation of the stream of air or gas in the irradiating chamber or conduit. Furthermore, the conduit or chamber through which the air is caused to flow for irradiation purposes should be of such diameter that a maximum cross-sectional area of the gas to be irradiated in the chamber will be within the optimal range of maximum intensity of radiation produced by the means employed.

The normal treatment period of a patient is from five to fifteen minutes per day, the average time being about ten minutes per day and three days per week. For patients with stubborn cases of rheumatoid arthritis this treatment period may be increased to fifteen minutes per day. When the treatment period is over and the patient removed, the ionizer variable transformer **95** is turned back to zero and the switch **96** opened. Also, the lamp switch **77** is opened. The air damper **58** is adjusted to close the entrance to duct **48** and force the cold defrosting air up around the irradiation chamber. The compressor switch is opened, and the variable transformer for the blower **45** is turned up to full power. This causes a large volume of air to be drawn through the coils to effect quick defrosting. This is continued until the coils are completely defrosted. The machine is then ready for repetition of the cycle of treatment.

Next describing the apparatus of Fig. 2 which is an improvement upon that disclosed in my U.S. Patent No. 2,415,659 in that it employs heating and direct air irradiation means in the decompression chamber in addition to the ionizing means.

In this view, a closed cylindrical decompression chamber **110**, horizontally disposed, is equipped with a bed **111** for support of the patient thereon in position for treatment, as shown. A vacuum pump **112**, operated by an electric motor **113**, is connected by an air pipe **114** with the chamber for air extraction. Also, electric heating coils **115** are provided in the lower part of the chamber. At the top are infra-red irradiation lamps **116**, **117** and an ultraviolet lamp **118**.

Mounted upon the chamber **110** is a housing **120** containing air filtering pads, and air cooling coils which may be like, and used for the same purpose as those described in connection with the air filtering and cooling apparatus of Fig. 4. A blower unit **121** is connected by a duct **122** with the housing **120** to draw air thereinto and through the cooling coils, and to then deliver the cold, dehumidified air through a duct 123 into an ionizer 124, which comprises electrodes like those of Fig. 4, previously described and used in the same manner for the ionizing of air that passes through the ionizer. The ionized air is discharged from the ionizer housing downwardly and directly into the upper end of a cylindrical irradiation chamber 125 that is open at its lower end to deliver the irradiated air directly to the patient.

The irradiation housing 125 mounts irradiation lamps 134 and 135 in sidewall openings thereof, in the same manner and in the same relationship relative to the direction of flow of ionized air, as the lamps are seen in Fig. 4, and these lamps have suitable circuit connections, and they operate in the same manner as lamps 34 and 35, previously described, to irradiate oxygen of the down flowing ionized air stream.

In this apparatus, the ionizer housing 124 is made of Plexiglas and the irradiation chamber 125 is made of Pyrex glass. The irradiation chamber 125 is exteriorly lined with aluminum foil, silvered, or otherwise coated, for light reflecting purposes.

Ionized and irradiated air is discharged from the irradiation chamber directly to the patient as supported by the bed 111; the treatment being similar to that of administering oxygen to a patient by oxygen tent method.

As a feature of construction, the irradiating housing 125, as seen in Fig. 3, is equipped at opposite sides of its upper end portion with suspending flanges 140, slidably engageable with opposedly related supporting flanges 141 fixed to the top wall of chamber 110. This means of support provides for easy removal of the irradiation unit from the treatment chamber when such is desired. The manner of use of this device is as described in connection with the device of my previously mentioned Patent No. 2,415,659.

Next describing the bedside apparatus illustrated in Figs. 8 and 9 and shown in use in Fig. 11. This apparatus is intended for use in lieu of the common form of oxygen tent used by hospitals. As seen in Fig. 11, the apparatus comprises a vertically disposed ionizing and irradiation chamber 150 of glass, in cylindrical form and exteriorly silvered or otherwise equipped to cause inward reflection of light. The chamber 150 is suspended for use from one end of a counter-balanced lever arm 151 that is adjustably supported by a base standard 152 that permits movement and easy adjustment of the apparatus in positions for use.

The irradiation chamber 150 is of the cylindrical form shown in Figs. 8 and 9. It is equipped at its upper end with an air inlet 155 containing a fan 156 operable by an electric motor 157 for drawing air into the inlet and then effecting its downward flow through air ionizing means contained within the upper end portion of the chamber. The ionizing means as here shown comprises the metal screen electrode 70′ and metal tube electrode 71′, like those of the apparatus of Fig. 4 and similarly connected in an electric circuit. At the lower end of the cylindrical housing 150 is an outlet neck 160 to which a respiratory mask 161 is adjustably fixed for application over the nose and mouth of the patient, as shown in Fig. 11.

Contained in the irradiation chamber 150, which is made of Pyrex glass and externally silvered, or otherwise equipped for inward reflection, is a glass irradiation tube 162 of cylindrical bulb-like form. This is supported coaxially of the chamber from its upper and lower ends, respectively, by a spider 163, and a horizontally disposed, perforated partition wall 164, each of non-conductive material. The housing 150 preferably is about 10″ in diameter and 18″ long. The tube 162 is about 2½″ in diameter. Oxygen is fed into the upper end of tube 162 through a glass tube 166 of small diameter that leads outside the chamber and to which a rubber tube 167, leading from a source of oxygen supply, is attached.

Irradiation of the oxygen in the tube and that of the air in the chamber is effected by use of a carbon arc and a lamp arranged as best shown in Fig. 9. The irradiated air and oxygen is discharged into the electrically non-conductive mixing chamber 168 formed between the perforated partitions wall 164 and lower end wall of the cylindrical housing 150, and from this is discharged through the outlet 160 and mask 161 to the patient.

Important in this apparatus is the fact that the tube 162 is made of Corning glass, Vycor brand No. 791, which is highly transmissive of infra-red wave lengths, and also of ultraviolet wave lengths as short as 2540 Angstrom units.

The chamber 150 is formed between its ends with an irradiation port 170 with a filter glass covering 170′ enclosed by a housing 171 containing electrodes 173—173′ between which the carbon arc is formed; this housing extending outwardly from the chamber, as in Fig. 9. Adjacent the housing, the chamber has an opening 174 containing an infra-red lamp 175 of 375W or higher wattage.

The first electronic transition from a ground state to the first molecular metastable state of oxygen takes place at 12,680 Angstrom units. The peak of the relative energy curve of a tungsten filament infra-red lamp is at about 11,500 Angstrom units, which makes it a suitable source of energy for increasing the ($^1\Delta_g$) metastable population of the irradiated gas.

The carbon arc lamp used can be operated on alternating or direct current, preferably a direct current is used. I prefer to use a modern carbon arc lamp as an irradiation source rather than a high pressure mercury arc lamp, because it supplies a continuous spectrum whereas the mercury arc produces a line spectrum. In a continuous spectrum all lines are present, and with an adequate intensity of irradiation energy, an adequate metastable population will be created in the gas.

The modified form of equipment illustrated in Fig. 6, which is a central sectional view taken in a horizontal plane and looking upward, comprises an irradiation chamber or conduit 175 of Pyrex glass, exteriorly covered with a light reflective covering designated at 176. The irradiation chamber has a discharge neck 177 at one end and an air intake neck 178 at its opposite end. Contained in or associated with the chamber, are the irradiating lamps 179—179′ which correspond to those used in the irradiating chamber of Fig. 4 and they will not be further described.

Located at the receiving end of the irradiating chamber and coaxially aligned therewith, is a duct 180 of Plexiglas; this duct being open at one end to receive conditioned air. The inner end portion of the duct, designated at 180*x*, is substantially enlarged, and it has a central opening, opposite the intake, that registers with the intake neck 178 of the chamber 175.

Mounted within the intake portion of duct 180 are a plurality of spaced Plexiglas bars 182 and applied to the side faces of these bars are strips 183 of polonium foil. Air entering the duct 180 passes between the polonium strips, which are optimally spaced from each other to obtain the maximum efficiency of ionization by means of alpha particles as the entering gas passes the strips.

Located in the enlarged portion 180*x* of the duct, downstream from the polonium strips, are screens 184 and 184A. The screens are in parallel planes placed several inches apart. The screens are of wire mesh; the screen 184 being of approximately ¾″ mesh while the screen 184A is of a relatively fine mesh.

The screen 184 is positioned across the air entrance end of the enlarged portion 180*x* of the duct 180, and it is grounded as indicated at 185.

The screen 184A has its peripheral portion laminated between Plexiglas plates 186—186′. These plates are fitted to the duct walls, and they have their central portions cut away for easy flow of the gas through the screens and thence into the chamber **175**. An electrical connection **187** leads from the screen **184A** to one side polarity reversing switch **188** which in turn is electrically connected by wires **189—189'** to the secondary of a transformer-rectifier **190**. This enables the screen to be selectively charged, either positively or negatively. A resistance, not indicated, of the order of 1000 ohms may be placed in the ground connection of **188** and switched into the ground circuit when said ground circuit is made positive. A variable transformer **191** in the primary circuit permits the intensity of the electrical charge to be varied. The main purpose of screen **184** is to act as an equalizer of the field across the face of screen **184A**. Since it is grounded and of relatively large mesh, few if any negative or positive ions will be attracted to it.

As ion pairs are created in the air stream by the kinetic energy of alpha particle impact with air molecules as they pass the polonium foil strips, said ions will be carried by the air stream through screen **184** and for the most part to screen **184A**. When the screen **184A** is positively charged, the negative ions will be attracted to it and largely removed from the air stream, while the positive ions will be repelled and will pass through the screen. When the screen **184A** is negatively charged, the positive ions will be attracted to it and largely removed from the air stream, while the negative ions will be repelled and will pass through the screen. The screen **184** should be of relatively large mesh so that the repelled ions can readily pass through it and not be excessively repelled, and yet it should be substantially smaller than the mesh of screen **184A**. By varying the intensity of the electric charge, as by means of the variable transformer **191**, the relative space charge of the air down stream from said screen **184** can be varied within a substantially wide range before it enters the irradiation chamber **175**.

In the use of this equipment, as is also true in the use of the devices of other modifications, the outlet part of the irradiation chamber may have an extension tube **192** of suitable material leading therefrom to an aspirating mask **192'**; such a tubular extension being of suitable material and from twenty-four to thirty inches long. This provides for the accommodation of wheel chair and bed patients.

The device shown in Fig. 7 is similar to that of Fig. 6 especially in the form and use of the irradiating chamber, and to this like reference numerals have been applied to corresponding parts. The gas intake duct, however, is provided with an additional enlargement **180*z*** up stream from the screen containing enlargement **180*x*** and in this an electric field is created between two electrodes **193–194** one of which is positively and the other negatively charged. This particular ionizer is operated like that described in my prior patents, previously mentioned, except instead of the positive electrode being a metal screen, it is a metal tube of the same type used for the negative electrode. Ion pairs are thus created primarily in the diatomic oxygen molecule of the air stream as these molecules pass through the electric field and are bombarded by electrons in place of by alpha particles as previously cited.

The method and means of air ionization disclosed by the device of Fig. 7 gives a substantial qualitative and quantitative control of ionization of air molecules. Due to the relatively high velocity and number of electrons present, with respect to alpha particles, previously cited, this method and means is especially well adapted for the ionization of air molecules in air conditioning apparatus wherein a substantial air volume and air velocity is essential.

The design and relationship of the two screens in Fig. 7 is the same as that of Fig. 6. Care should be taken, however, to place the ionizing electrodes far enough upstream from the electrically charged screen that field interference will be largely eliminated.

Fig. 10 illustrates a slightly modified form of ionizing and irradiating means that is equipped to have the entering air stream supplemented with tank oxygen. In this sectional view the parts have been given reference numerals corresponding to like parts shown in Fig. 4, that have previously been described and they will not herein be further described. The oxygen supply pipe is designated by reference numeral **57A** and it enters the ionizing portion of the chamber upstream from the ionizing element.

Fig. 12 illustrates use of the present ionizing and irradiating method and means in combination with an air filter. This shows room or outside air being drawn into the unit housing **200** through a filtering pad **40A** and forced by fan **45A** to the ionizer and irradiating means which have here been given reference numerals corresponding to like or equivalent parts as shown in Fig. 4.

In Figs. 13 and 14, I have illustrated a combined room air conditioner with my ionizing and irradiating means, and have provided for use of the room air conditioner independently of the latter. Briefly described, the air conditioning unit is designated in its entirety by reference numeral **300**, and it is of conventional form, typical of those which are disposed in a window or wall opening for reception of outside air. This unit **300** is enclosed by a housing **301** having opposite side, top, bottom and front walls, the latter including a hingedly mounted door **302** which comprises the upper half of the front wall and is adapted to be swung downwardly from its closed position, to an open position so that air from the unit **300** can flow directly into the room.

Mounted on top of the housing **301** is the ionizing and irradiating unit which is designated in its entirety by numeral **305**. This unit, enclosed in a box-like housing **306**, is shown as being substantially like the unit of Fig. 12, previously described, except that its air intake, as fitted with a filter pad **40B**, is in the bottom wall and is arranged to receive conditioned air from a top opening **307** in the housing **301**. Reference numerals as applied to the ionizing and irradiating apparatus of Fig. 12 are employed in Fig. 13 where they designate parts of like kind.

In the use of the combination of Fig. 13, this patient positions himself properly to receive the irradiated air from chamber **30** in a manner like that shown in Fig. 4.

Laws governing physics and physical chemistry are identical with laws governing biophysics and biochemistry, except that in the latter case these laws are projected into a different and more complex environment. It has been estimated that a single drop of water contains something of the order of 2×10^{21} water molecules, and one cubic inch of air at sea level contains an even larger number of air molecules. When we consider that some twenty percent of these air molecules by volume are oxygen, it seems apparent that the number of positively ionized and metastable oxygen molecules created in inspired air by the method and means disclosed herein will be relatively minute. As a result these energy carrier states of oxygen of essentially clean dry inspired air, in their rapid passage through the respiratory tract, are substantially surrounded and protected from contact with water molecules by millions of normal air molecules. However, a certain percentage of these energy carrier states of oxygen will collide with water molecules of the mucous surfaces of the respiratory tract, and will give up a part or all of their energy, as the case may be, to said water molecules in one jump.

Sympathetic nerve ends are common to the epithelial cells of the respiratory mucosa, just as they are to the outer skin surfaces of an organism, and they are subject to stimulation by the radiant emission of energy-carrier states of oxygen of inspired air. Others of these energy-carrier states of oxygen of inspired air will reach the alveoli of the lungs where they likewise will give up their energy to water molecules by collision, as previously shown, with resulting radiant emission. Radiant emission released in the respiratory passages and in the lungs by these energy-carrier states of oxygen of inspired air seemingly assumes the role of a continuously renewed catalytic action. As previously indicated, the emission spectrum produced by the reduction of positively ionized molecular oxygen will have actinic properties. The beneficial physiological and biochemical effects produced by irradiation of the outer skin surfaces by means of actinic rays of certain wave lengths are known to the healing arts. More immediate and direct results are obtained by the reduction of positively ionized oxygen molecules in the alveoli of the lungs, whereby blood in minute vessels is directly irradiated by a multiplicity and a sequence of infinitesimal ultraviolet radiations which are given off by positive molecular oxygen ions and by higher vibrational energy levels of metastable and excited non-metastable states of inspired oxygen.

Metastable states of oxygen of higher vibrational energy levels created by photon absorption, also give off radiations as they collide with water molecules in the respiratory tract and in the alveoli of the lungs. The wave lengths of these radiations are largely in the near ultraviolet, visible and near infra-red spectra. Hemoglobin, oxyhemoglobin and the cytochromes of cells are known to have their critical absorption bands or lines largely within the visible spectrum. The importance of the visible spectrum both biologically and therapeutically, seemingly has not heretofore been adequately understood or appreciated. The direct irradiation of the blood in the alveoli of the lungs by this multiplicity and sequence of infinitesimal amounts of visible and infra-red rays, is in reality an amplification of nature's normal method of delivering energy to an organism by means of energy-carrier states of oxygen of inspired air. Optimum conditions are not common to outdoor air, and my method and means corrects this. Clinical evidence obtained to date in hypertension cases indicates that the use of predominately positive ionization per se is contra indicated since it tends to increase blood pressure, while the use of the irradiation means by itself tends to produce a similar end effect. However, when these two means are combined, as indicated herein, a sudden drop of blood pressure produced in hypertension has been observed.

Results obtained by the use of this method and means as shown in Fig. 4, in certain types of pathological conditions have been good. One of the main end effects of this therapy seems to be the oxidation or disintegration of certain amounts of hyperplastic tissue to the end that chronic inflammatory conditions are relieved. In clinical tests conducted at General Hospital Clinic over a period of more than twelve months, positive results were obtained in various types of pathological conditions both for respiratory inflammation including bronchitis and for hypertension cases which responded under a schedule of one treatment per day.

Research with which I am familiar, and which was conducted with small animals, has shown that ACTH (adrenocorticotrophic hormone) is released from the pituitary by comparatively low concentrations of small positively charged atmospheric ions of inspired air. ACTH is known to release cortisone from the adrenal cortex. Negatively charged small atmospheric ions of inspired air produced different physiological end effects upon the pituitary-adrenal axis. Diatomic oxygen metastables and vibrational energy levels of these metastables of inspired air, seemingly produce physiological or biochemical end effects which act as a balance upon the end effects produced by positive and/or negative small ions of inspired air. Clinical results obtained suggest that optimal quantitative inter-relationships of these energy-carrier states of inspired oxygen, may produce in the pituitary adrenal axis an optimal hormone spectrum such as can be produced by the good or healthy emotions.

Clinical research conducted over a twelve month period has shown that oxygen of inspired air treated jointly by means of radiant and kinetic energy has therapeutic end effects which are superior to those produced by these means applied severally. Seemingly the joint and simultaneous application of these means in sequence produces a balanced effect, and avoids any undesirable end effects which previous investigators may have attributed to small positive ions of inspired air, such, for example, as producing headache.

In order to simplify the wording of the claims and to give more difiniteness to the elements thereof and to impart a better understanding of certain terms or expressions used therein, the following definitions are here given:

The term "conditioned air" has reference to room air or outside air that in its natural condition is suitable for the present use, or air which has been subjected to cleaning, filtering, cooling and dehumidification to that extent desired or required to prepare it for the present use, either by means like or similar to that herein shown and descibed or by other suitable means.

The term "conduit" as herein used to designate the chamber through which the conditioned air is caused to flow for irradiation, or for ionization and irradiation, designates any form of tubular duct or passage of suitable material, which is of such diameter or cross-sectional area as to confine the air stream within the limits for optimal irradiation by the irradiation means as therein used.

The expression "activating oxygen" as used herein includes adding energy to oxygen molecules or atoms either to move an electron from an inner orbit to an outer orbit, or to remove an electron entirely from the influence of the atomic nucleus. The expression "activating oxygen" also includes the addition of energy to an oxygen molecule whereby the distance between the atoms of the molecule is increased thus causing the molecule to vibrate.

A metastable atom or molecule is understood to be one to which energy has been added to move an electron from an inner orbit to an outer orbit where it reaches a more or less stable state of equilibrium, and from which state it drops back to its normal orbit as it gives up this energy.

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

1. Apparatus for treating conditioned air for respiratory purposes comprising an air duct for confining a flowing stream of air, a radioactive material disposed within the receiving end portion of said duct, a screen disposed within the duct down stream of the said radioactive material, means for applying a positive electric charge of potentially variable intensity to the screen, and means down stream of the screen for irradiating the air stream with light of wave lengths comprising a part of a continuous spectrum lying between 3000 Angstrom units and 13,000 Angstrom units, and means for causing a stream of conditioned air to flow through said tube to first subject it to the ionizing effects of said radio active material, thence through the screen to effect variation in the space charge in the air stream and thence to irradiation.

2. The method of treating air for respiratory purposes which comprises passing a stream of air through a first treating zone, in said treating zone ionizing oxygen molecules under conditions producing insubstantial ionization of nitrogen, passing the stream of air from said first treating zone through an electric field of selected polarity and thence through a second treating zone, and in said second treating zone applying to the stream of air a band of radiant energy extending between wavelengths of about 3000 Angstrom units and about 13,000 Angstrom units which includes the visible light

and infra-red portion of the spectrum to increase the percentage of oxygen metastables within the stream including ionized oxygen molecules.

3. The method of claim 2 in which oxygen molecules are ionized within said first treating chamber by application to said stream of air of an electric field extending between closely spaced positive and negative electrodes through which passes said stream of air and in which moisture is removed from said stream of air before passage through said first treating zone for substantially lowering the relative humidity thereof.

4. The method of treating air for respiratory purposes which comprises passing a stream of air through a first treating zone, in said treating zone ionizing oxygen molecules under conditions producing insubstantial ionization of nitrogen, passing the stream of air from said first treating zone through an electric field of selected polarity and thence through a second treating zone, and in said second treating zone applying to the stream of air a band of radiant energy extending between wavelengths of about 3,000 Angstrom units and about 13,000 Angstrom units which includes the visible light and infra-red portion of the spectrum to increase the percentage of oxygen metastables within the stream including ionized oxygen molccules.

5. The method of claim 4 in which, prior to entry of said stream of air into said first treating zone, there are performed the steps of cooling the stream of air to lower its temperature and removing moisture from said stream to provide for said first treating zone a stream of air of low relative humidity.

6. The method of claim 4 in which said stream of air in said first zone is ionized by application thereto of rays emanating from radioactive material.

7. The method of generating radiant energy with wavelengths in the ultraviolet band of the spectrum for application to moist surfaces inaccessible to direct radiation but accessible by way of a stream of air, which comprises dehumidifying a stream of air, passing the dehumidified stream through a first treating zone, in said zone ionizing oxygen molecules under conditions producing insubstantial ionization of nitrogen, passing said partially ionized stream through a second treating zone, in said second treating zone applying to the stream of air radiant energy from the visible portion of the spectrum and including wavelengths ranging from about 1750 Angstrom units to about 13,000 Angstrom units to increase the percentage of oxygen metastables within the stream relative to the ionized oxygen molecules, and thereafter applying said air to said inaccessible moist surfaces for generation of radiant energy in the ultraviolet range produced upon reduction of the energy levels of said oxygen molecules due to their contact with water molecules at said moist surfaces.

8. The method of treating filtered and dehumidified air for respiratory purposes which comprises directing a stream of air through an electric field extending between closely spaced positive and negative electrodes, said field being of sufficient intensity to ionize oxygen molecules and to produce some oxygen metastables but of insufficient intensity to ionize substantial amounts of nitrogen therein, thereafter passing said stream of air through an irradiation chamber, and applying to the stream of air passing through the irradiation chamber a band of radiant energy from that portion of the spectrum which includes visible light and infra-red and lying between about 1750 Angstrom units and about 13,000 Angstrom units for producing additional oxygen metastables to increase the ratio of oxygen metastables relative to the ionized oxygen molecules.

9. An apparatus for increasing the energy-carrier states of oxygen in air for air-conditioning and therapeutic purposes, comprising means for passing a stream of air through a treating chamber, ionizing means disposed across said stream of air for ionizing oxygen molecules without ionizing any substantial amount of nitrogen, an irradiation chamber, means for passing said partially ionized stream of air through said irradiation chamber, irradiating means mounted in relation to said irradiation chamber for applying to said partially ionized stream of air passing therethrough radiant energy within the band of wavelengths between about 1750 Angstrom units and about 13,000 Angstrom units and of sufficient intensity to raise some of the oxygen molecules to a higher energy level to increase the percentage of oxygen metastables within said partially ionized stream, and means for delivering to a point of use from said irradiation chamber said stream of air.

10. The apparatus of claim 9 in which there are provided filtering means and heat-exchange means for filtering, cooling and dehumidifying said stream of air before passage into said treating chamber.

11. The apparatus of claim 10 in which said ionizing means comprises closely spaced electrodes, means for applying a voltage thereto for establishing an electric field between said electrodes for ionization of oxygen molecules and without substantial ionization of nitrogen molecules, and means including a screen having an electric charge of selected polarity through which said partially ionized stream of air passes for removal from said stream of air of ions of polarity opposite to that of said screen.

12. The apparatus of claim 11 in which there is provided means for varying the intensity of the charge of said screen.

13. Apparatus of the character described comprising an ionizing chamber and means therein employing electrical voltage for the ionization of oxygen of air delivered through said chamber, an irradiation chamber providing an air-directing duct connected to receive ionized air from said ionizing chamber and to discharge it therefrom and containing therein an irradiating means for applying radiation to the air and oxygen passing through the chamber for raising the energy level of the oxygen, the walls of said irradiation chamber being transparent and having exteriorly thereof an inwardly directed reflecting means for reflecting inwardly of said chamber said radiation, and means for effecting a controlled flow of a stream of air through said ionizing chamber for ionization of oxygen molecules therein and thence through said irradiation chamber for irradiation of said stream.

References Cited in the file of this patent

UNITED STATES PATENTS

1,659,085	Cunningham	Feb. 14, 1928
2,213,403	Miller	Sept. 3, 1940
2,415,659	Steel	Feb. 11, 1947

FOREIGN PATENTS

429,352	Great Britain	May 28, 1935