May 12, 1970 A. TRUHAN 3,511,162

APPARATUS AND METHOD FOR ISOLATING A PATIENT ZONE

Filed Feb. 20, 1969 3 Sheets-Sheet 1

Fig. 1.

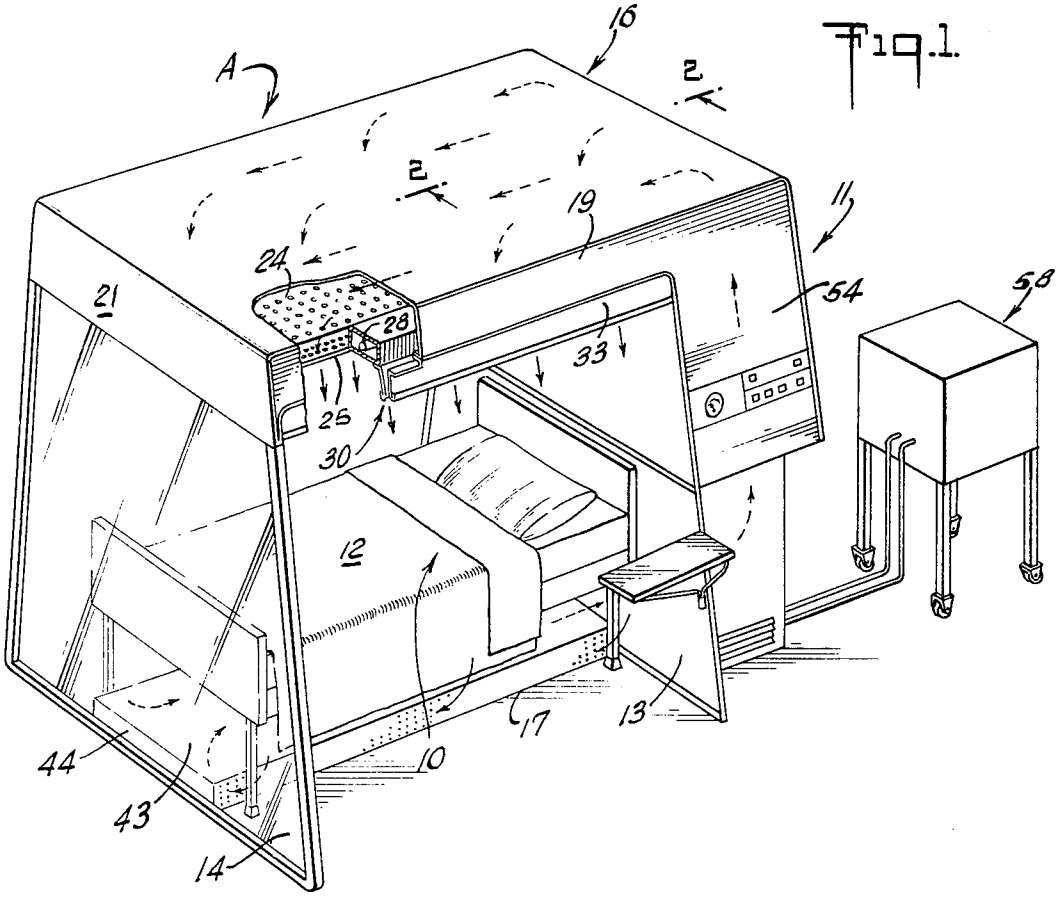
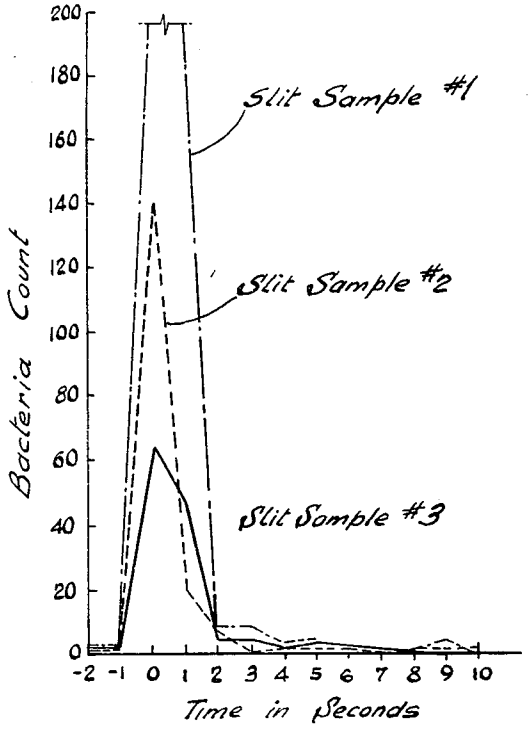


Fig. 5.



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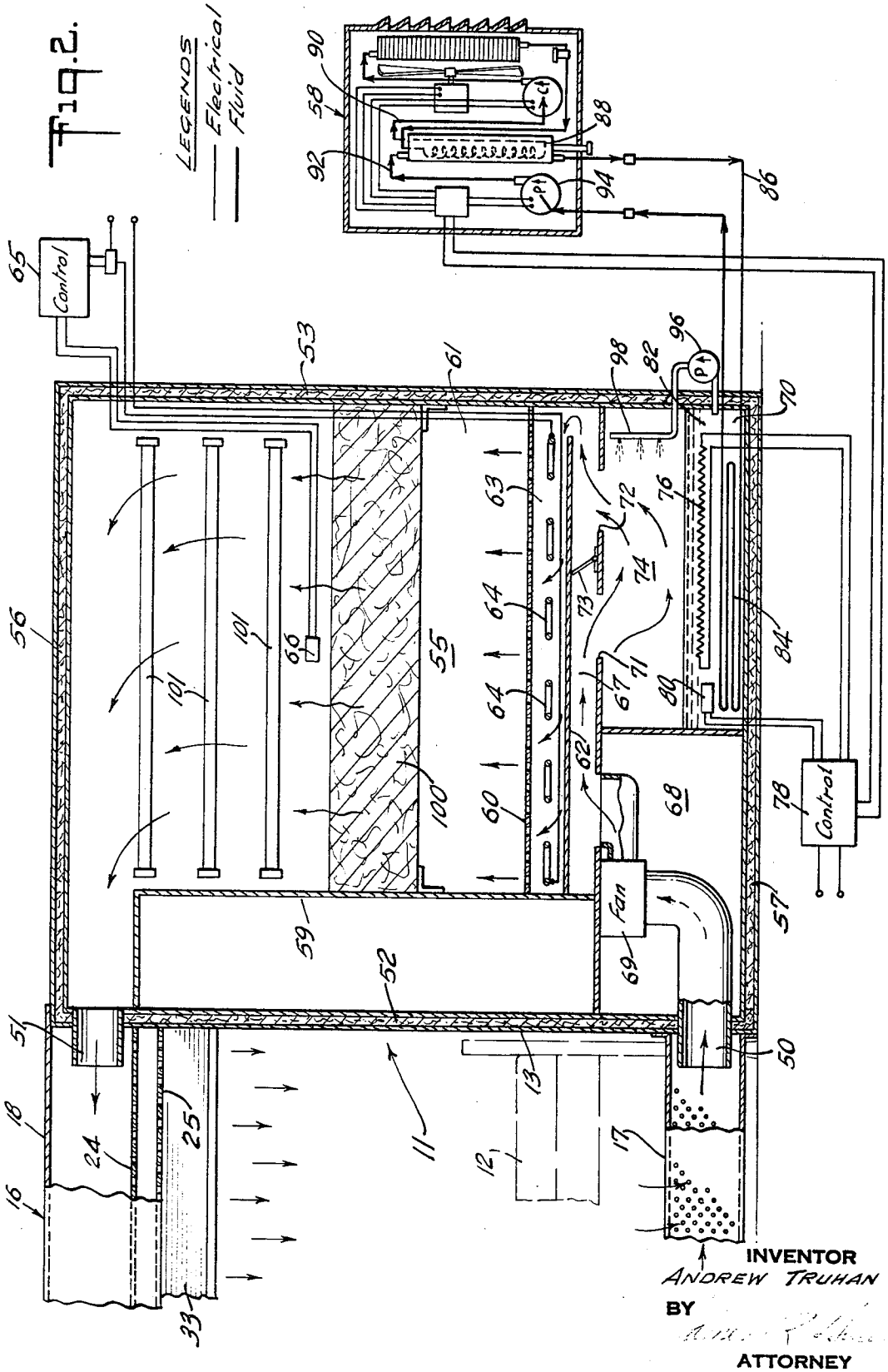
APPARATUS AND METHOD FOR ISOLATING A PATIENT ZONE

Filed Feb. 20, 1969 3 Sheets-Sheet 2

Fig. 2.



May 12, 1970 A. TRUHAN 3,511,162

APPARATUS AND METHOD FOR ISOLATING A PATIENT ZONE

Filed Feb. 20, 1969 3 Sheets-Sheet 3

Fig. 3.

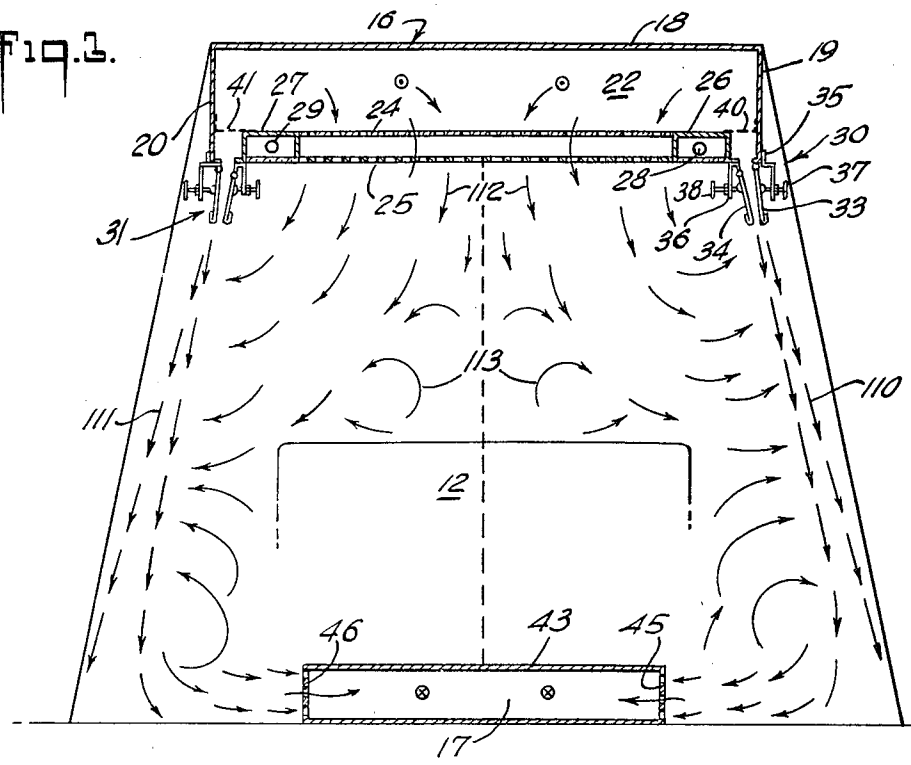
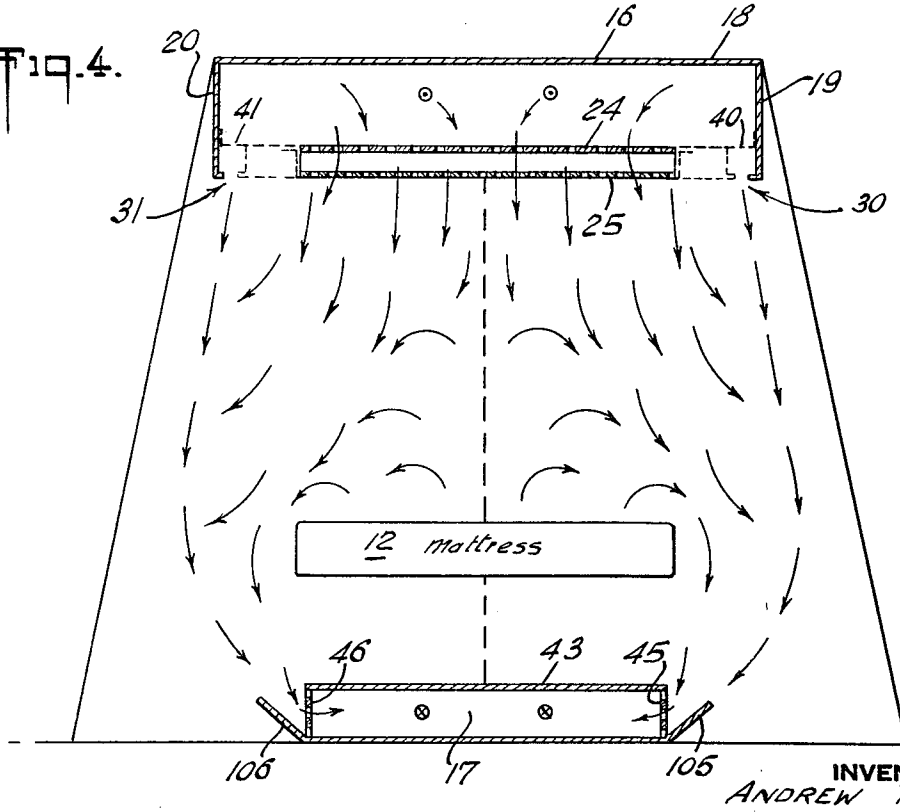


Fig. 4.



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3,511,162

APPARATUS AND METHOD FOR ISOLATING A PATIENT ZONE

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Continuation-in-part of application Ser. No. 671,625, Sept. 29, 1967. This application Feb. 20, 1969, Ser. No. 801,131

Int. Cl. F24f 9/00

U.S. Cl. 98—36 10 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus and method for providing a controlled environment in a localized patient zone. An air distributing structure, having at least two opposed enclosed sides and two opposed open sides for surrounding the patient zone, is equipped with an overhead inlet plenum and an exhaust duct adjacent the bottom of the zone. The periphery of the plenum along the open sides of the zone is provided with structure for forming a high velocity air curtain between the plenum and the exhaust duct to effect the complete enclosure of the zone. An air treating apparatus feeds purified air into the plenum and withdraws air from the exhaust duct for recirculation through the system.

BACKGROUND OF THE INVENTION

This is a continuation-in-part of my copending application Ser. No. 671,625 filed Sept. 29, 1967.

This invention relates to an apparatus and method for controlling the environment in a localized zone and, more particularly, to an apparatus and method for effectively isolating a patient zone from the external environment.

Despite the flourishing in recent years of improved aseptic techniques and antibiotic drugs, hospital-acquired infections continue to harass the most efficiently operated hospitals. These infections are particularly threatening to severely injured or debilitated patients and those whose resistance is lowered by disease or the action of immunosuppresive drugs. Patients with extensive burns, premature infants, and those who have undergone organ transplants are examples of people who are seriously threatened by pathogenic microorganisms. Yet, at the same time, patients are brought for treatment in the same hospitals for infections in which the most dangerous of pathogens are proliferating.

The need to prevent cross-contamination is obvious and has led to well-known methods of prevention, such as antiseptic scrubs, sterilized equipment and clothing, and meticulous housekeeping methods. Yet one pathway remains for pathogenic microorganisms to travel—the air currents within hospital rooms and corridors.

The danger of airborne contaminants has been recognized for decades and previous attempts to reduce infection rates by purifying hospital air and/or directing its flow have shown promising results.

All of the known devices designed to isolate a patient zone from the environment have been objectionable for one or more of the following and other reasons: the adverse effect of the patient's morale occasioned by total confinement; the high cost and complexity of rebuilding or modifying an existing room construction; the inaccessibility of the patient to the hospital attendants; and the cost and difficulty of training personnel to operate the systems.

The present invention was designed to overcome all of the above-mentioned objections and, yet, to provide an extremely effective and simply constructed isolation unit.

SUMMARY OF THE INVENTION

The present invention provides a portable unit for protecting vulnerable patients from airborne bacterial contamination by utilizing a curtain of high velocity, purified air to isolate the patient, yet at the same time permitting easy access to the patient for hospital personnel. The unit is preferably designed to house a standard hospital bed and to be assembled and disassembled easily, so that it can be relocated within the hospital wherever it is needed. In addition to protecting the patient in the bed where it is installed, the unit also serves to reduce bacterial contamination in the immediate environment by capturing and filtering air within the room where the unit is in operation.

By contrast with earlier developments in patient isolation, the present unit does not physically enclose the patient in a relatively inaccessible covering. Instead, the device enables hospital personnel to approach the bed when necessary, taking up airborne contaminants that are introduced and filtering and/or purifying the air before the air is recirculated. In addition to the advantage to hospital personnel, the protected patient derives the psychological advantage of not feeling confined and cut off from his surroundings. The patient can see and hear visitors without being conscious of the air curtain that protects him and his visitors.

The objects and advantages of the invention are accomplished by providing a structure that isolates the patient zone with controlled air flow patterns produced by the inductive effect of symmetrically positioned high velocity air curtains. In a preferred embodiment, a unit is constructed with two opposed structural walls and two opposed openings therebetween to form an essentially rectangular patient zone. A perforated plenum overlies the entire patient zone and an exhaust duct is located near the floor and preferably under the patient's bed to exhaust downwardly moving air from the enclosure.

The lateral edges of the plenum along the open sides of the zone are also provided with structure for directing curtains of high velocity air across the openings to effectively seal the openings against airborne contaminants and completely enclose the patient zone. The air curtains, because of their unique symmetrical construction, not only enclose the zone but control the flow patterns of the air from the perforated plenum so that the zone is at all times maintained at an extremely low contamination level and is returned to that level within a short time after bacteria have been introduced into the zone.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be particularly described with reference to the following detailed description of the preferred embodiments of the invention when considered together with the attached drawings, in which:

FIG. 1 is a perspective view of a patient isolation unit constructed in accordance with the teachings of this invention;

FIG. 2 is a vertical sectional view taken through the air treating apparatus of FIG. 1;

FIG. 3 is a vertical sectional view through the controlled environmental patient zone of the apparatus of FIG. 1 and showing the air flow patterns created within the zone;

FIG. 4 is a vertical sectional view through another another embodiment of the controlled environmental patient zone illustrated in a somewhat schematic form and again showing the air flow patterns created within the patient zone; and

FIG. 5 is a graph illustrating the rapid return of the patient zone to a low contamination level after the zone has had bacteria introduced therein.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the patient isolation unit A comprises a controlled environmental patient zone shown generally at **10** and an integral air treating device shown generally at **11**. Air treating device **11** provides the main structural support for the entire unit and houses the air treating equipment that will be later described. It is an object of this invention to provide an apparatus and method for effectively isolating a patient who is confined to a bed **12** from the remainder of the room environment. Isolation unit A is provided with a first end wall **13**, which may also form an external wall for air treating device **11**, and with a second end wall **14** which may be formed of Plexiglas or some other suitable transparent material. Second end wall **14** provides a means for completely sealing the foot portion of bed **12** and at the same time supports one end of the isolation unit. Walls **13** and **14** are both angled laterally outwardly from both sides of the isolation unit to provide additional stability to the unit and to delineate the outer extremity of the air flow which will be described hereinbelow. To aid in the description of the unit, when used herein the word "longitudinally" shall mean in a direction from the head to the foot of the bed and "laterally" shall mean in a direction across the bed.

An overhead plenum shown generally at **16** and an exhaust duct **17** cooperate to form the air distributing structure necessary to completely enclose the patient zone **10** and to isolate the patient from the external environment. Referring to FIGS. 1 and 3, plenum **16** comprises a top wall **18**, two side walls **19** and **20** and two end walls **21** and **22**. End wall **22** may conveniently be constructed as a portion of the back panel for air treating device **11** as shown in FIG. 3.

The internal construction of plenum **16** is best illustrated in FIG. 3 wherein a first perforated plate **24** is located intermediate top wall **18** and a second perforated plate **25**. A pair of florescent light housings **26** and **27** are supported by plenum **16** and extend the entire length of the patient zone **10** for supplying light within the isolation unit. Outwardly of housings **26** and **27** a pair of air directing structures shown generally at **30** and **31** are secured between the perforated plates **24** and **25** and the side walls **19** and **20**, respectively.

Referring to FIG. 3, air directing structure **30** is constructed with two elongated plates **33** and **34** which are pivotally secured to the underside of plenum **16**. A pair of depending brackets **35** and **36** support adjusting screws **37** and **38**, respectively, which may be turned to adjust the pivotal location of plates **33** and **34** and the space between the plates. With this construction, it is possible to direct the flow of air from the plenum **18** at any desired angle within certain limits, to adjust the width of the current of air emitting from between the plates, and to regulate the velocity of the air curtain. The air directing structure **31** on the opposite side of plenum **16** is constructed in a manner identical to structure **30** and no further description of this device is deemed necessary. Perforated plates **40** and **41** are also positioned above air directing structures **30** and **31**, respectively, to provide an even flow of air from the upper plenum construction into the air directing apparatus.

The function of perforated plates **24**, **25**, **40** and **41** is to establish an even flow of air under static pressure from the upper plenum chamber into the patient zone **10** so that undesirable turbulance may be avoided.

Exhaust duct **17** is constructed in a generally rectangular configuration with a solid top portion **43** and a solid end portion **44**. The sides **45** and **46** of duct **17** are essentially vertically positioned and are perforated to enable the air to be drawn into the interior of the duct and circulated to the air treating device **11**.

The unique air flow patterns and the advantages derived therefrom will be fully discussed below, however,

the air treating device **11** will first be thoroughly described in order that the invention may be more fully understood. Referring to FIG. 2, the essential structural components of air treating device **11** are shown in cross section with an inlet duct **50** shown in communication with exhaust duct **17** and an outlet duct **51** shown in communication with plenum **16**.

Air treating device **11** comprises a cabinet made up of double walled, insulation-filled panels **52** and **53**, front and back panels **54** (FIG. 1) and **55**, and top and bottom panels **56** and **57**, respectively. A refrigeration unit, shown generally at **58**, is mounted separate from the main device **11**, preferably in a window or other access to outside atmosphere to avoid heating attendant with the operation thereof. Such units are well known in the art and preferably comprise a device in which the refrigerant liquid is in heat exchange with an inert fluid such, for example, as brine within the unit for transmission to the point to be cooled to thereby avoid a possibility of contamination if the refrigerant lines are ruptured.

A vertical interior wall **59** and a perforate horizontal wall **60** are arranged within the enclosure defined by the aforedescribed walls and panels to form therein an air purifying chamber **61**. A horizontal wall **62** is disposed surjacent the perforate wall **60** and in spaced relationship thereto to define therewith a pre-treatment air chamber **63** has disposed therein a heating coil **64** connected, through a control **65**, to a suitable source of electric power (not shown). A temperature sensing device **66**, located in chamber **61**, is connected to control **65**.

A transverse channel **67**, formed in conjunction with horizontal wall **62**, interconnects air chamber **63** with a return inlet chamber **68**. Chamber **68** is, in turn, connected to exhaust duct **17** through return conduit **50** disposed through wall **52** of the device as hereinbefore described. A fan or blower **69** is disposed between the channel **67** and return duct **50** to circulate gas as shown by the arrows in the figure.

A fluid holding tank **70** is located surjacent channel **67** and is in communication therewith through openings **71** and **72**. A valve means, illustrated as a movable flapper valve **73**, is disposed in channel **67** between opening **71** and opening **72** whereby a portion of the air stream passing through the channel may be bypassed from an air treating zone **74** in the tank **70** and recirculated directly to chamber **63**. This valve means provides additional control for the controlled environment device and will be described below.

Arranged in the tank **70** are a heater coil **76** connected to a suitable source of electric power (not shown). A sensing element, which may comprise a thermister **80**, is disposed in tank **70** and is connected to the control **78**. Coil **76** and sensing element **80** are submerged in a liquid sump **82** formed in tank **70**.

A cooling coil **84** connected by flexible conduits **86** to refrigeration apparatus **58**, is also submerged in sump **82** to provide cooling for the fluid therein as required. The refrigeration unit is also connected to the control **78** in such a manner that, by suitable adjustment of that control, heat may be added to sump **82** through heating coil **76** or removed therefrom through cooling coil **84** to maintain a desired temperature therein. Devices suitable for achieving such control are standard in the art and, since the device per se does not constitute a portion of this invention, further detailed description thereof is not included herein. As was discussed hereinbefore, refrigeration unit **58** is of the type wherein the cooling fluid transmitted to coil **84** is cooled in heat exchange relationship to the refrigerant in the unit. This is achieved, in the device illustrated, through means of a heat exchanger **88** in which refrigerant, circulated through a refrigerant line **90**, and brine, circulated through the cooling line **92** by a pump **94**, are passed in heat exchange relationship to one another. An electric pump **96** communicates with a plurality of spray nozzles **98** disposed in air

treatment zone **74** and with liquid sump **82**, whereby gas humidifying and temperature conditioning liquid is, in part, continuously recirculated.

A significant component of the air treating device is filter **100** which is designed to fill the entire cross sectional area of air purifying chamber **61**. Filter **100** is preferably a high efficiency particulate air (HEPA) filter which is designed to remove 99.97 to 99.99% of all particles and bacteria, 0.3 micron in diameter and larger. Smaller particles also are removed by this type of filter, but the amount of removal has not been established. Removal of smaller particles has not been a matter for concern, however, since bacteria range from 0.3 to 30 microns in size and very rarely exist in the air as single unattached cells but usually attached to particles of dust and skin scales considerably larger than themselves. The median diameter particles carrying pathogenic bacteria in the air has been reported to be about 12 microns, with a range of 4 to 24 microns. The organism chiefly responsible for post operative infection is the hemolytic *Staphylococcus aureus,* which is approximately 0.5 micron in diameter. The use of high efficiency particulate air filters for the filtration of minute particles is well known in the art and the success of these filters is well documented.

Additional filters may be employed in the air treating device, such as, pre-filters for removing large particles from the air prior to the contact of the air with the HEPA filter and charcoal filters for removing fumes and odors from the air. These filters have not been illustrated in the drawings since they are well known in the air filtration art.

Although the filter system provides virtually total purification of the air, it has been found to be desirable to provide a bank of ultraviolet lamps **101** within air purifying chamber **61**. Ultraviolet radiation has been found to be effective in inactivating living microorganisms and is utilized in this system as an additional safeguard. Although lamps **101** are shown in FIG. 2 in a location above filter **100**, the lamps may conveniently be located anywhere within air purifying chamber **61**.

The aforedescribed insulated walls help to reduce to a minimum heat transfer between the chamber **61** and the ambient atmosphere. Such insulation may be of any type standard in the art such, for example, as foam polyurethane, glass wool or the like, or may comprise an evacuated area between the double wall construction. Although any form of perforate wall is suitable within the chamber **61**, a hardboard wall having ¼" diameter perforation on, for example, ½" centers, will provide satisfactory uniform air flow through the chamber.

The heating coils **64**, positioned in chamber **63**, are conventional electric coils connected to a suitable source of electric current through a thermostat (not shown) whereby the temperature of the coils may be suitably adjusted and maintained to thereby finally adjust the temperature and humidity of the gas stream to the desired value immediately prior to entrance thereof into chamber **61**. This final adjustment provides means to closely control the properties of gas flow.

In operation of the device, the temperature regulating controls **65** and **78** are energized and the pump **96** and fan **69** initiate circulation of gas through conduits **50** and **51** and liquid through the gas treating zone **74**. Bypassed gas flowing through the gas treating zone **74** is saturated by the liquid spray from the nozzle **98** and is thereby humidified and simultaneously brought to a temperature condition proximate that in the sump **82**. The gas stream is then passed through the chamber **63**, through the heating coils **64** to finally adjust the temperature and the relative humidity of the gas stream to the value desired in the zone **10**. By suitably controlling the quantity of gas which is to flow through the zone **74** to become saturated at the predetermined temperature of the liquid in the sump **82**, the relative humidity and the final temperature of the gas after passing the heating coils **64** is critically maintained. The gas stream then flows through the perforate wall **60** and is purified by filtration through the filter **100** and exposure to the ultraviolet radiation from the lamps **101**.

The gas, now fully conditioned and purified, flows through outlet duct **51** into the upper chamber of plenum **16**. The gas then flows downwardly through perforated plates **24** and **25** and into the patient zone **10** where it is evenly distributed at a relatively low velocity. Simultaneously, air is ejected from the two air directing structures **30** and **31** as indicated by the arrows in FIG. 3 to form air curtains along the open sides of patient zone **10**. The air is then exhausted from the patient zone through the perforated sides **45** and **46** of the exhaust duct **17** and into inlet duct **50** of the air treating device for recirculation and purification of the air.

Where radiation such as that emitting from ultraviolet lamps **101** is utilized, a certain amount of heat will be added to the gas stream during the cycling thereof. By suitable regulation of the amount of heat added to the air stream by the heating coils **64**, however, and by having a substantial volume of gas flowing constantly through the zone, very uniform temperature and humidity conditions may be maintained through the zone. Where the desired humidity and temperature cannot be fully maintained by the steps of saturating and heating the gas stream, valve **73** may be adjusted to permit a predetermined portion of the air flowing in the channel **67** to be recirculated through the heating coils **64**. This bypassed, non-rehumidified air, mixing with the gas stream flowing from the gas treating zone **74**, provides a further measure of control for the chamber.

From the foregoing description of the preferred embodiment of the present invention, it can be seen that an improved device for maintaining controlled environment in a portable apparatus is provided. Throughout the discussion of this preferred embodiment of the invention the gas employed has been described as air; however, it will be apparent to those skilled in the art that, in a closed cycle device such as that disclosed herein, an inert atmosphere such as nitrogen may be maintained in the zone **10**. Further, the gas may comprise a mixture of gases which may be high in oxygen, high in CO_2, high in CO or the like, without departing from the principles of the invention. Further, in addition to injecting water into the gas stream to provide a saturated gas, other liquid treating agents may be employed so that an atmosphere having a bacteriacidal or fungicidal property may be maintained in the zone **10**.

It will be further recognized by those skilled in the art that, while specific controls for regulating the temperature of coils **64** or the temperature of the heating and cooling coils **76** and **84** are not illustrated, a wide variety of commercial means including recorders may be employed with the gas treating device of the invention.

Referring to FIG. 4, another embodiment of the invention is illustrated and like numerals are utilized to designate parts similar to those that appear in the FIG. 3 embodiment. This embodiment is illustrated in a somewhat schematic manner since the only modification to the device is found in the construction of exhaust duct **17**. Since the air curtains are moving at a rapid velocity, they have a tendency to scatter when they reach the floor level thus the unit has been modified to provide structural means for aiding the flow of air to duct **17**. Adjustable air direction baffles **105** and **106** are secured to the lower portions of sides **45** and **46**, respectively, and act to capture the curtain air and direct it into the perforated sides of the duct. As can be seen from the air flow as illustrated by the arrows, the air after reaching the zone of the exhaust duct is prevented from "splashing" over into the portion of the environment external of the patient zone.

The above description is primarily directed to the construction of the unique patient isolation unit and the manner in which this construction functions to maintain the patient zone at an extremely low contamination level and to avoid the invasion of the zone by airborne microorganisms.

This is obviously one of the important advantages of the unit, however, an equally important advantage is the ability of the unit to rapidly return the patient zone to the low operating level of contamination, i.e. the recovery rate, after bacteria have been introduced into the zone.

In order to optimize the recovery rate of the unit, the direction and velocity of air flow must be carefully selected. In other words, the air flow patterns must be designed to rapidly flush the patient zone free of bacteria and this must be accomplished with a minimum of air turbulence or roiling.

Referring to FIG. 3, it has been found that in order to maintain the integrity of air curtains **110** and **111**, the initial velocity of the air flowing from air directing means **30** and **31** should fall within the range of 500 feet per minute to 3000 feet per minute with a preferred value of 1700 feet per minute. This insures that the major portion of the curtain air and essentially all of the internal air will be retained within the system and exhausted from the patient zone by exhaust duct **17**. Tests have shown that for a normal volume of air supplied to the patient zone that the velocity of the air curtains with an initial velocity of 1700 feet per minute decreases to about 200 feet per minute at the floor level and again accelerates to about 500 feet per minute at the entrance to the exhaust duct **17**.

The velocity of the air entering the patient zone through wall **25** is also significant since this has a marked effect on the flow conditions within the zone and the ultimate recovery rate of the unit. As shown by arrows **112** within the zone, the air is initially distributed vertically downwardly into the zone and then a definite division or splitting of the air occurs along the approximate longitudinal centerline of the patient zone. This division is created by the inductive effect of the higher velocity air curtains and it is this phenomenon that is thought to be responsible for the very high recovery rate of the unit. It has been found by experiment that the velocity of air **112** should fall within the range of 5 feet per minute to 100 feet per minute and that the preferred velocity is 80 feet per minute. This velocity enables a portion of the air to descend to the bed level where it is induced to flow in a manner illustrated by arrows **113** in FIG. 3. Thus the entire body of air within the patient zone is continuously moving and sweeping the zone free of contamination without creating any stagnant or turbulant areas which would tend to impede the recovery of the system.

The results of a significant experiment are reproduced in FIG. 5 and these results dramatically illustrate the speed at which this unit can purge itself of bacteria. The experiment was performed in the following manner: with the unit running with the preferred air velocities indicated above, three Reynier slit samplers were placed on the bed with sampler No. 1 positioned approximately 22" from the head of the bed on the approximate longitudinal centerline of the patient zone, sampler No. 2 was placed approximately 22" from sampler No. 1 toward the foot of the bed and sampler No. 3 was placed approximately 22" from sampler No. 2 toward the foot of the bed. A four milliliter aliquot of a suspension of *Sarcina lutea* containing approximately 10 million viable bacteria per milliliter was put into a Devilbiss No. 40 nebulizer and nebulized by a jet or air from a combination vacuum-pressure pump under a pressure of approximately 20 pounds per square inch. The nebulizer was located within the patient zone approximately one foot from the head of the bed and one foot below the air supply plenum. The nebulizer was permitted to generate a bacteria laden mist for 2 minutes, which time is indicated on the graph of FIG. 5 as negative time. Zero time on the graph indicates the time at which the nebulizer was turned off and the bacteria count was begun. Since the number of bacteria colonies picked up by split sampler No. 1 during the first minute after nebulization was so extremely high and, in fact, "too numerous to count," the curve representing this sampler is broken off at the top and continued at approximately the first second. The second curve represents the number of bacteria colonies appearing in slit sampler No. 2 and the lowest curve represents those picked up by slit sampler No. 3.

There are two very significant conclusions that can be drawn from the results of this experiment. First, the patient zone of the isolation unit, when the unit is operated in accordance with the preferred conditions, will be virtually completely cleared of bacteria within 2 minutes after bacteria have been either deliberately or accidentally introduced into the patient zone. Secondly, the patient zone will be cleared within 2 minutes regardless of the number of bacteria introduced into the patient zone and regardless of the location at which the bacteria are introduced.

What is claimed is:

1. An apparatus for isolating a patient zone from the external environment comprising in combination:
- (1) a bed located adjacent the bottom of said zone;
- (2) structural means for enclosing two opposed vertical sides of said zone;
- (3) a plenum having at least one downwardly directed pervious wall positioned over said zone to enclose the upper portion thereof and to evenly distribute low velocity purified air vertically downwardly within said zone;
- (4) an exhaust duct located under said bed, and
- (5) means associated with the periphery of said plenum along the opposed structurally open sides of said zone for directing curtains of high velocity air between said periphery and said exhaust duct to completely enclose said zone.

2. The apparatus of claim **1** wherein said bed is positioned so that the longitudinal centerline thereof lies on the approximate longitudinal centerline of said zone and said structural means encloses the head and the foot portions of said bed.

3. The apparatus of claim **2** wherein said exhaust duct has a generally rectangular construction having a width not greater than the width of said bed and the vertical sides thereof are perforated to permit air to be drawn into said duct.

4. The apparatus of claim **3** further comprising baffle means associated with the lower portion of said exhaust duct for entrapping and directing air into said duct.

5. A method of isolating a patient zone from the external environment comprising the steps of:
- (1) positioning a bed adjacent the bottom of said zone;
- (2) structurally enclosing the top, bottom and two opposed sides of said zone;
- (3) evenly distributing purified low velocity air vertically downwardly into said zone through said enclosed top;
- (4) enclosing the remaining opposed two sides of said zone with high velocity air curtains; and
- (5) exhausting said low and high velocity air through an exhaust duct located under said bed.

6. The method of claim **5** wherein said bed is positioned with the longitudinal centerline thereof approximately coinciding with the longitudinal centerline of said zone.

7. The method of claim **6** wherein said air curtains are symmetrically formed on opposite sides of said zone and said low velocity air is formed into two controlled air flow patterns which are produced by the inductive effect of said air curtains.

8. The method of claim 7 further comprising the steps of purifying the exhausted air and recirculating said purified air through said enclosed top and into said zone.

9. The method of claim 5 wherein said low velocity air is distributed at an initial velocity of from 5 to 100 feet per minute and said high velocity air has an initial velocity of from 500 to 3000 feet per minute and a terminal velocity of from 300 to 700 feet per minute.

10. The method of claim 9 wherein the initial velocity of said low velocity air is approximately 80 feet per minute and the initial and terminal velocities of said high velocity air are approximately 1700 feet per minute and 500 feet per minute, respectively.

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U.S. Cl. X.R.

5—362; 98—115; 128—145, 191