Oct. 6, 1964 G. POTAPENKO 3,151,929

ASEPTIC AIR ISOLATION APPARATUS

Filed Feb. 13, 1961 4 Sheets-Sheet 1

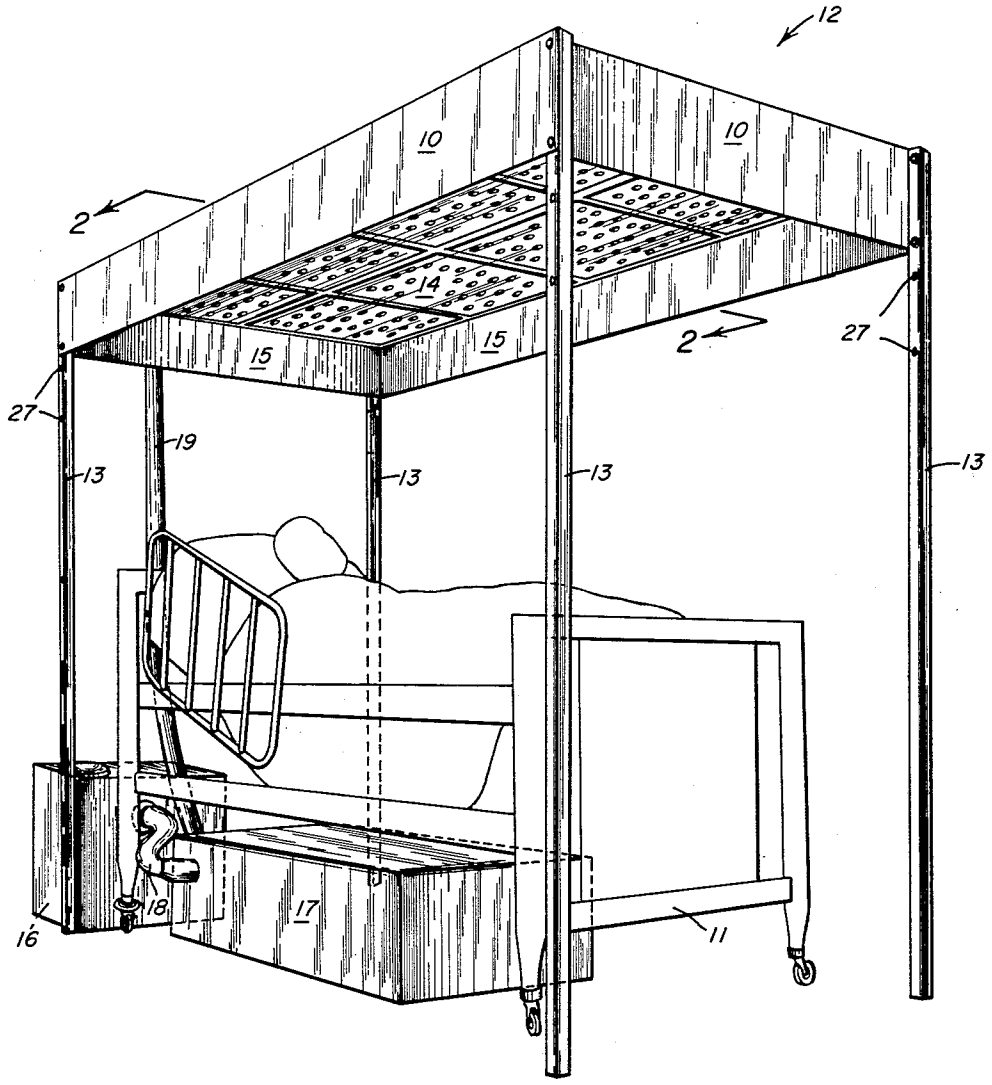


Fig. 1.

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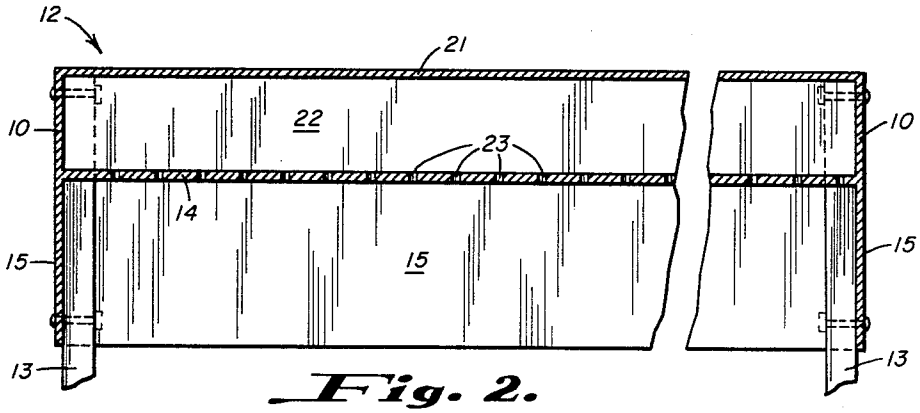


Fig. 2.

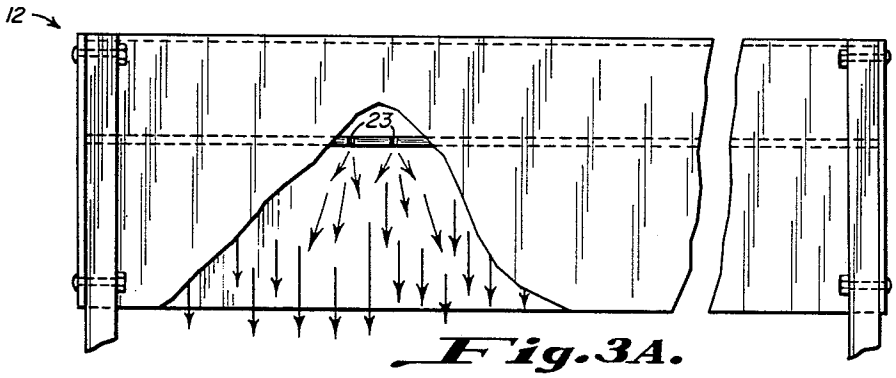


Fig. 3A.

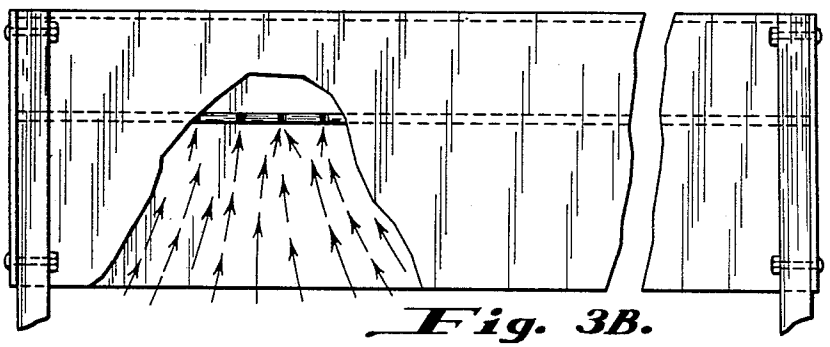


Fig. 3B.

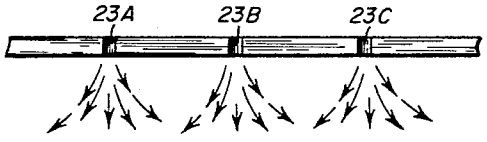


Fig. 3C.

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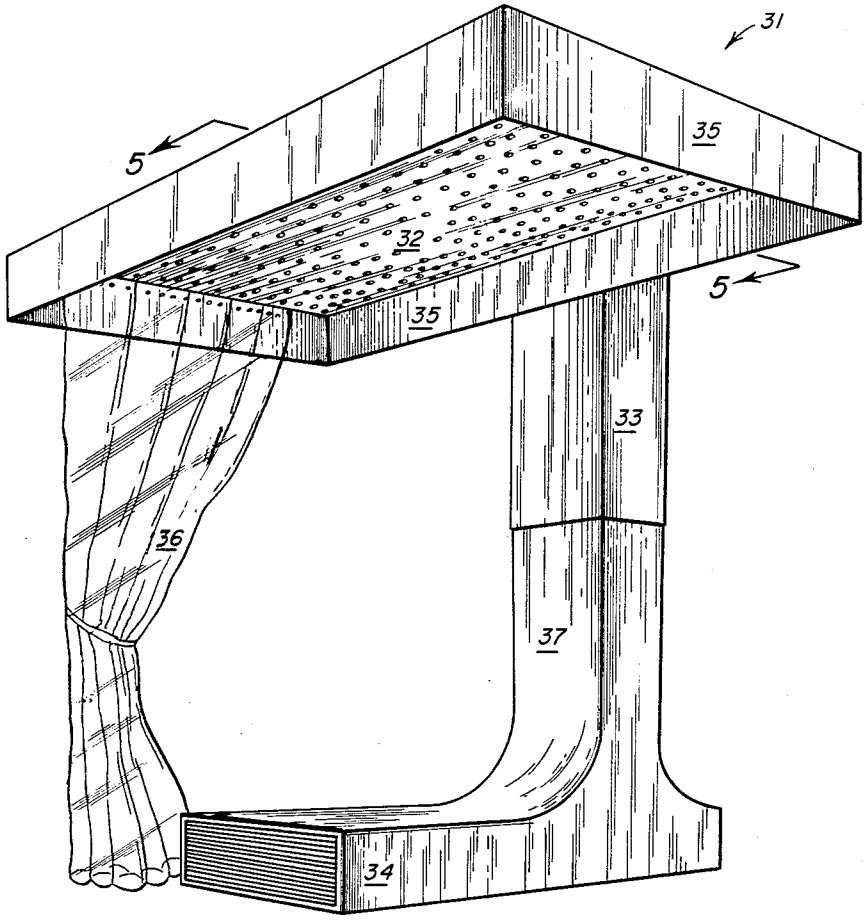


Fig. 4.

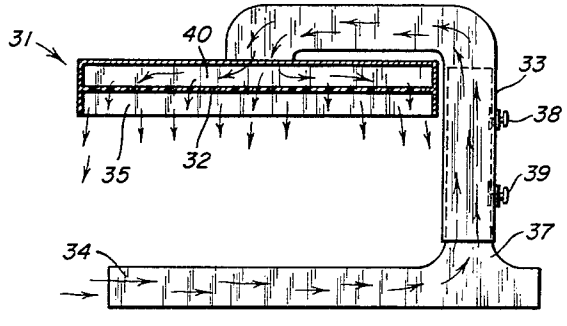


Fig. 5.

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ASEPTIC AIR ISOLATION APPARATUS

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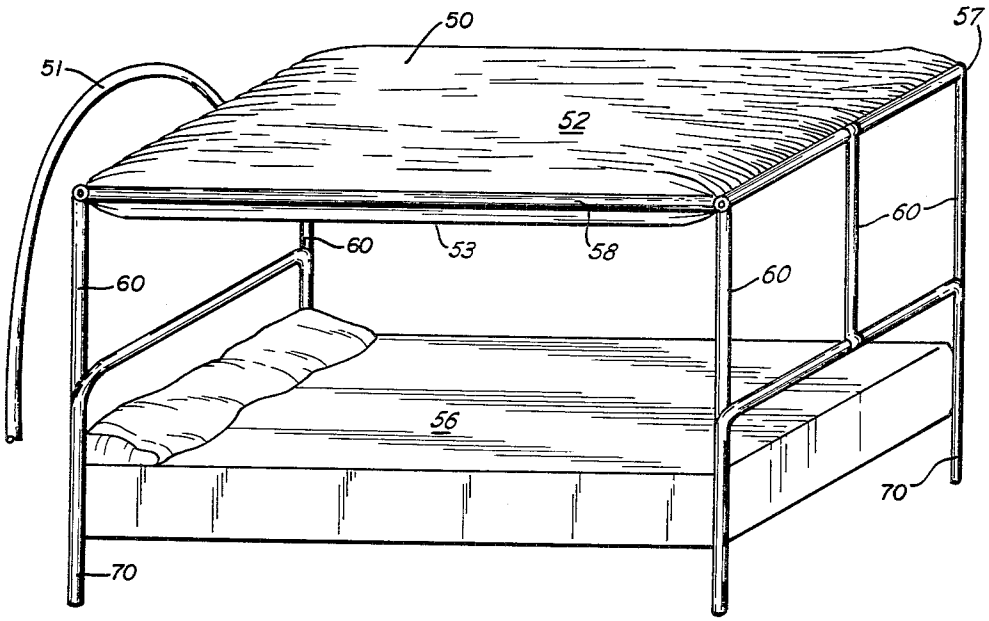


Fig. 6.

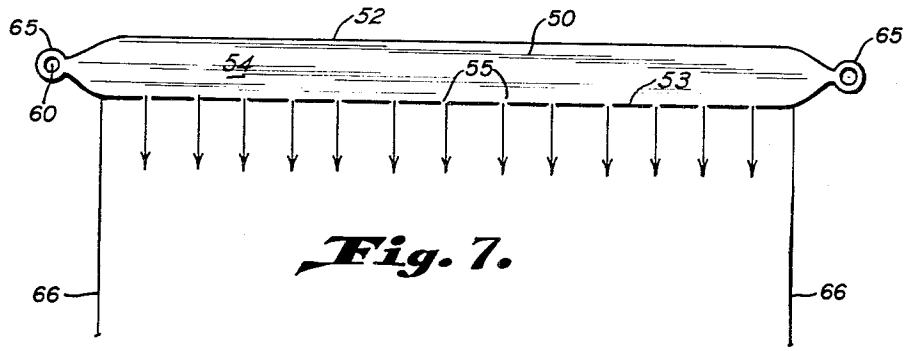


Fig. 7.

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ASEPTIC AIR ISOLATION APPARATUS

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Filed Feb. 13, 1961, Ser. No. 88,691
7 Claims. (Cl. 21—74)

This invention relates to air sterilization and more particularly to air sterilization apparatus which incorporates the use of substantially sterile air for preventing the spread of infectious disease to or from patients.

This application is a continuing application from U.S. patent application Serial Number 704,485, filed December 23, 1957, by Gennady Potapenko and entitled "Method and Apparatus for the Sterilization of Air," now Patent Number 3,011,230.

It is well known in the prior art that when a patient is treated for some diseases such as cancer, his resistance to communicable diseases usually drops to a very low level and extreme care must be taken to maintain his immunity at as high a level as possible under the circumstances. The immunity level must be maintained so the patient's system can counteract and cope with the various disease carrying organisms which may be communicated to the patient. In accordance with the prior art, if the immunity as shown by the white blood cell count is permitted to drop below a predetermined level, referred to as the "permissible level," the patient may contract highly dangerous and communicable diseases known as secondary infection, which in many cases is likely to be fatal. Since the precaution must be taken, the types or extent of treatment which may be given a patient for a particular disease is in many instances limited. This is due to the fact that when a particular treatment is carried to a degree which is practicable to counteract and arrest the disease from which the patient is suffering, it also lowers the white blood cell count to a point below the "permissible level." Therefore, even though a patient may be treated to eliminate or arrest the disease from which he is suffering, such treatment must be halted short of this point. Frequently this results in an insufficient treatment being given and the patient is likely to succumb to the disease.

An individual who has been badly burned is also very susceptible to secondary infections and particularly to those carried by airborne organisms. It is well known that medication which will heal a burn is not presently available. The human body must replace the tissue that has been destroyed or at least must assimilate other tissue which has been grafted. During the period of tissue replacement or assimilation the natural protective covering of the body in those areas where the skin was destroyed, does not exist and the individual is exceedingly susceptible to the secondary infections which may be caused as a result of organisms being precipitated from the surrounding air upon the destroyed skin area. It can be seen that the more severe the burn, the more acute is the problem of protecting the patient.

Communicable diseases which patients having a low immunity level are likely to contract are transported from person to person within a given area by transmission of disease carrying organisms through the air. This being the case, patients having infectious diseases must be isolated from other patients within a particular hospital or other area by being kept in separate rooms or on separate floors thereof. Such procedure, however, has not always proven effective in preventing the spread of many infectious diseases which are spread by airborne organisms. The results in not only ineffective measures being taken to isolate persons with such diseases, but also a waste of badly needed hospital space.

Accordingly it is an object of the present invention to provide an apparatus which is capable of maintaining a patient within a substantially sterile atmosphere to thereby permit the patient to be protected even though his natural protective body covering is partially destroyed or his immunity to disease drops to a point below the accepted "permissible level."

It is another object of the present invention to provide an apparatus for surrounding a patient with a continuously moving column of substantially sterile air.

It is another object of the present invention to provide apparatus which permits treatment of patients to a degree resulting in the reduction of the immunity level to a point heretofore considered impossible.

It is another object of the present invention to provide apparatus by which a patient may be effectively isolated from the surrounding area.

It is another object of the present invention to provide an apparatus which prevents the spread of infectious diseases by airborne organisms which may be emanated from a patient or his immediate surroundings.

Other objects and advantages of the apparatus in accordance with the present invention will become apparent from the following description taken in conjunction with the accompanying drawings which are presented by way of example only and are not intended as a limitation upon the scope of the present invention, and in which:

FIG. 1 is a perspective view of an aseptic air isolation apparatus in accordance with the present invention as it would appear during use;

FIG. 2 is a cross sectional view taken about the lines 2—2 of the apparatus as illustrated in FIG. 1;

FIGS. 3A, 3B and 3C illustrate air flow patterns which may be accomplished when utilizing aseptic air isolation apparatus in accordance with the present invention;

FIG. 4 is an alternative embodiment of an aseptic air isolation apparatus in accordance with the present invention;

FIG. 5 is a cross sectional view of the apparatus of FIG. 4;

FIG. 6 is a perspective view of another alternative embodiment of an apparatus in accordance with the present invention; and

FIG. 7 is a side view of a portion of the apparatus of FIG. 6.

In accordance with one aspect of the present invention, there is provided a hood or canopy which may be placed adjacent a patient's bed. The canopy includes first and second spaced apart planar members defining an enclosed space. The first member is solid or imperforate and the second member includes a number of perforations or openings spaced throughout. Means is provided for suspending the canopy over the patient's bed. The canopy is of such dimensions that it extends beyond the patient's bed in all directions. A means for sterilizing air is provided as well as air moving means. The air sterilizing and air moving means are interconnected with the enclosed space in order to move air through the perforations or openings in the second planar member.

In using the apparatus in accordance with the present invention, the air moving means passes air through the sterilizing chamber and into the space between the first and second planar members. Sterile air is thus forced through the openings in the second planar member in such a manner as to cause a column of continuously moving substantially sterile air to pass over the patient thereby completely encompassing and surrounding the patient and his bed with sterile air. Means extending from the second planar member is provided to direct the air in a column over the patient's bed. In this manner a patient may be effectively isolated from his surroundings by the sterile air thereby preventing airborne organisms from

penetrating the sterile air column which in turn prevents the patient from becoming secondarily infected by a contagious disease the carrier of which may be present within the surrounding air.

In accordance with a more specific aspect of the present invention, apparatus as above described may operate in such a manner as to causes the air which surrounds a patient having an infectious disease to be drawn through the second planar member having the openings therein. The air is then drawn from the space between the first and second members and into the sterilizing means where the infectious organisms contained within the air are subjected to the sterilizing means and are killed. In this manner an individual isolation area is provided for a patient having a highly infectious and contagious disease which may be spread by way of organisms which may become airborne.

Referring now to the drawings and more particularly to FIG. 1, there is illustrated an aseptic air isolation apparatus in accordance with the present invention as it would appear in actual use. As is therein shown a patient is disposed within a bed **11**. Positioned over the bed **11** is a hood or canopy **12** which is supported upon legs **13**. Provision may be made for adjusting the position of the canopy **12** upon the legs **13** as will be more fully described below. It should be noted that the canopy **12** extends in all directions slightly beyond the exterior of the bed **11**. The canopy **12** includes side members **10** and a first planar member such as ceiling member **14** having a number of openings therethrough. The ceiling member **14** may be constructed of one single unit or may be a series of panels as is illustrated in FIG. 1. An air directer **15** extends below the ceiling **14**. The air directer may be an extension of the side members **10** of the canopy **12** as is illustrated in FIG. 1 or alternatively it may be constructed as a separate member and attached to the canopy **12**.

An air moving means such as a blower **16** is interconnected with a sterilizing chamber **17** by way of a conduit or flexible hose **18**. The output of the sterilizing chamber **17** is applied by way of a conduit or hose **19** to the canopy **12**.

As can be seen by referring to FIG. 2, the canopy **12** also includes a second planar member such as ceiling member **21** spaced from the ceiling member **14** in such a manner as to provide a space **22** between the ceiling members **14** and **21** which is enclosed by side members **10**. The air which is provided by way of hose **19** (FIG. 1) enters the enclosed space **22** between the ceiling members **14** and **21**. The ceiling member **14** has a plurality of openings **23** throughout its entire area. It has been found that the ceiling member **14** should have approximately $\frac{1}{100}$ of its area open in order to provide the air flow pattern as will be described more fully hereinafter. This amount of open area may be provided by utilizing openings having a radius of one tenth inch and spaced one and one half inches apart, ceter to center. Therefore, the air which is provided by way of hose **19** (FIG. 1) into space **22** between the ceiling members **14** and **21** is forced through the openings **23** in ceiling **14**. The air directer **15** then causes the air to flow downward as viewed in FIG. 1 to completely encompass the patient and his bed in a column of substantially sterile air.

As is illustrated in FIGS. 3A and 3C, the air passes through the openings **23** in the ceiling member **14** in such a manner that within a short distance below it there is provided a continuous mass or column of moving air. For example, the air passing through the opening **23A** (FIG. 3C) diverges and meets the air passing through the opening **23B** while the air passing through the opening **23C** also diverges and joins with the air passing through opening **23B**. In this manner a complete and continuous column of downwardly flowing air is formed. The downwardly flowing air is directed by means of air directer **15** so that it passes over the bed of a patient which is positioned beneath the canopy **12**.

If the air passing through the perforated ceiling **14** were not contained in some fashion or directed in the desired manner it would tend to diffuse in all directions into the surrounding area. The purpose of the air directer **15**, therefore, is to shape the air passing through the openings **23** in the ceiling **14** into a column of air and to direct it to completely encompass and surround the patient. In this manner the column of continuously flowing sterile air prevents airborne organisms which may be within the surrounding air from reaching the patient. By so doing, the patient and his immediate surroundings are maintained in a substantially sterile condition at all times.

Since the column of sterile air is continuously moving, it will have a tendency at its outermost edges to pick up a portion of the surrounding air and carry it along. The column of sterile air gradually expands as it moves downward. The gradual expansion of the sterile air column, therefore, forces any of the surrounding air which may be picked up to move downwardly and outwardly away from the patient. The particular shape of the sterile air column is determined by the air flow rate, amount of positive pressure, the distance which the air directer **15** extends below the ceiling member **14**, and the distance between the floor and the ceiling member **14**.

The air moving means may be provided with a variable speed motor to permit control of the air flow rate. The air flow rate is not particularly critical but should be adjusted in each case to provide maximum comfort for the patient. It has been found that an air flow rate, when using an apparatus as illustrated in FIG. 1 which has a canopy that is 48 inches wide and 96 inches long and is positioned approximately seven feet above the floor, of about twenty-five cubic feet per minute provides excellent results and comfort for the patient. It has also been found that when using an apparatus with dimensions and placement as above described that air directers extending approximately six inches below the ceiling member **14** provide excellent results in forming a column of sterile air and directing it to completely encompass the patient.

When the dimensions of the canopy are slightly greater than those of the patient's bed as above described, then the sterile air column, which extends completely about the patient and his immediate surroundings, precludes the possibility of surrounding air being picked up and moved toward the patient. The dimensions of the canopy may of course vary in accordance with the other parameters above described to long as a continuously moving column of substantially sterile air is provided about the patient.

As above pointed out, the canopy may be placed at any desired distance above the floor. The particular distance desired will be determined by the circumstances surrounding the patient being treated. For this purpose the supporting legs **13** for the canopy **12** may be provided with a plurality of openings **27** therein. The canopy may then be lowered or raised as desired by placing bolts through the openings **27** and into the legs **13** and securing the canopy thereto.

The air directer **15** may be of any length desired so long as it shapes the sterile air into a column which will reach and completely encompass the patient. It has been found that an air director extending below the ceiling member **14** a minimum of approximately two inches is necessary. It should of course be understood that the air directer may take the form of a curtain, screen or other member which extends the entire distance between the canopy **12** and the floor. When using an aseptic air isolation apparatus having an air directer which extends from the canopy to the floor, it should become apparent that a positive pressure is maintained throughout the entire sterile air column and that the particular shape of the air column is determined by the shape of the air directer.

Apparatus of the type above described has been suc-

cessfully used to prevent patients having a very low immunity level from contracting secondary infection during the period of treatment. For example, a 69-year-old female having a diagnosis of rabdomyosarcoma of the right thigh was treated by performing a femoral perfusion on the right side using antinomycin as the cancerocidal drug. As is well known, when using the present chemotherapeutic drugs, such as antinomycin, in cancer treatment, the white blood cell count of the patient may show a drastic decrease. This indicates a depression of the bone marrow function and, therefore, a very high susceptability to secondary infections. In this case, the patient's white blood cell count dropped from a normal level of between 6,000 to 10,000 to a remarkably low level of 340.

The patient was maintained in a substantially sterile atmosphere by using apparatus of the type above described for a period of five days. During this time, the patient contracted no secondary infection and the white blood cell count returned to its normal level. The patient was then discharged and returned home.

Prior to placing the apparatus above described over the patient, a blood agar petri dish was placed on the patient's bed for a period of one hour and a count made to determine the presence of micro-organisms in the hospital air. This disclosed a colony count of 43 which represented the following micro-organisms: *Staphylococcus epidernutis,* gamma streptococci, micro-coccoceal, diptheroids, aerobic spore forming rods, yeast, and a *Staphylococcus aureus* coagulase positive which was montypeable with bacteria phage.

The aseptic air isolation apparatus in accordance with the present invention was then placed over the patient's bed and actuated. Another blood agar petri dish was then placed on the patient's bed for a period of one hour and the count showed the presence of only three colonies and each was *Staphylococcus epidermis* which is a non-pathogenic normal skin inhabitant.

Although the above description has been particularly directed to maintaining a sterile air column about a patient to thus isolate him from the surrounding air, it should be expressly understood the aseptic air isolation unit of the present invention may also be used to isolate patients having highly contagious diseases. The flow of air through the apparatus may be reversed as is illustrated in FIG. 3B thereby causing the air to be drawn in through the perforated ceiling **14**. The air is then directed to the sterilizing unit to kill the micro-organisms present therein. By so doing the area surrounding the patient may be protected from infectious airborne carriers. The airborne micro-organisms which emanate from the body, clothing and other surroundings of the patient are picked up by the air flow and by being passed through the sterilizing chamber are killed. The thus sterilized air may then be exhausted into the surrounding area without danger to other persons.

The apparatus described herein preferably utilizes an air sterilizing device of the type described in the Potapenko application Serial No. 704,485 referred to above. This device provides for the destruction of airborne organisms contained in a flowing air stream by subjecting such streams to high intensity ultraviolet radiation at very close range. The irradiation occurs in a chamber or duct which is preferably in the form of a cylinder having an inner surface which is highly reflective for radiation in the germicidal range. Inside the chamber is a baffle system which produces turbulence and directs the air flow in a cyclonic pattern to insure complete exposure of all airborne particles to the lethal rays which emanate from the ultraviolet generator. This generator or tube extends longitudinally through the core of the chamber. In a typical unit of this type, for example, one such chamber operating at an air flow rate of 100 cubic feet per minute kills in excess of 99.9 percent of all organisms present in the air in a single passage.

Although the air moving means and sterilizing chamber have been illustrated in FIG. 1 as separate units which are interconnected with hoses or conduits, it should be expressly understood that these units may be incorporated as an integral part of the apparatus. For example, the air moving and sterilizing means may be mounted on and affixed to the upper surface of ceiling **21**.

Referring now more particularly to FIGS. 4 and 5, there is illustrated an alternative embodiment of an aseptic air isolation apparatus in accordance with the present invention. As is therein illustrated a hood or canopy **31** includes an air directer **35** projecting beneath the perforated ceiling **32**. A curtain **36** may be affixed to the air directer **35** if such is desired for partially or completely enclosing the bed of a patient as above described. The air moving means and the sterilizing means (not shown) may be housed with the foot **34** of the apparatus as illustrated in FIG. 4. The canopy **31** may be suspended on the upstanding member **33** in such a manner that it is partially rotatable thereby permitting the air to be directed in any direction which is desired. The apparatus shown in FIG. 4 permits the entire unit to be readily transferable from point to point within a hospital. For this purpose the foot **34** may be placed upon rollers or casters to facilitate movement thereof. Upstanding member **33** may be raised or lowered on post **37** by properly manipulating the cranks **38** and **39**.

As can be more clearly seen in FIG. 5, air may enter the foot **34**, be sterilized as above pointed out, be directed through post **37** and member **33** and into the space **40** in the canopy **31**. From the space **40** the air moves through openings in the ceiling **32** to form a continuous mass of moving air. The air directer **35** then forms the air into a continuously moving column and directs it toward the patient as above described.

If such is desired, the curtain **36** may be drawn around the patient's bed to partially or completely enclose it. As above described, the air column is then shaped by the curtain and a slight positive pressure may be maintained about the patient if such is desired.

In some applications it may be desirable to provide an aseptic air isolation apparatus in accordance with the present invention which is light weight and can be easily stored or disposed of. Such a structure is illustrated in FIGS. 6 and 7 to which reference is hereby made.

As is therein shown the hood or canopy is constructed of a large plastic bag **50** having an air inlet apparatus such as a hose **51** connected to it. The plastic bag **50** has an imperforate substantially planar top surface **52** and a substantially planar lower surface **53** which are brought together at the edges to provide a closed space **54**. The lower surface **53** has a plurality of openings **55** spaced therein in the manner above described. The plastic bag **50** may be constructed of any plastic material desired but preferably is foldable into a relatively small package.

The plastic bag **50** is supported over a patient's bed **56** upon a rectangular frame member having end sections **57** and side sections **58**. The bag **50** may be attached to the frame member in any desired manner such as, for example only, a plurality of plastic strips **65** extending from bag **50** and encircling the frame member sections. The frame member may be supported upon posts or legs **60** which are affixed to the bed frame **70** or alternatively may be an integral part thereof.

An air directer in the form of a curtain **66** (FIG. 7) is attached to the bag **50** by being constructed as an integral part thereof or alternatively may be detachable as by zippers therefrom.

In operation, sterile air is directed by way of hose **51**, from apparatus of the type above described, into the space **54**. The air inflates the bag **50** into the position shown in FIG. 6. Thereafter the air is forced through the openings **55** and is directed by way of curtain **66** as a con-

tinuously moving or flowing column of air which completely surrounds the patient's bed 56.

There has thus been disclosed an apparatus for isolating a patient in order to prevent his being subject to airborne micro-organisms capable of imparting an infectious disease to him or which is in the alternative capable of isolating a patient having a communicable disease from a surrounding area.

What is claimed is:

1. Apparatus for effectively isolating a patient from his surrounding area, said apparatus comprising a canopy including first and second spaced apart planar members and a side member disposed between said planar members and enclosing the space therebetween, said first planar member defining a plurality of discrete spaced apart openings positioned over the entire area thereof and extending therethrough, said side member having an extension which completely surrounds and extends below said first planar member, supporting means for maintaining said canopy means disposed with said first planar member adjacent said patient, said canopy extending completely over and in all directions outwardly beyond the periphery of said patient's bed, air sterilizing means, air moving means, and means interconnecting said air sterilizing means, said air moving means and said space whereby air is forced through said plurality of openings and forms a column of moving air which surrounds said patient.

2. Apparatus for effectively isolating a patient from his surrounding area by providing a directed and continuously moving column of substantially sterile air which completely surrounds the patient, said apparatus comprising canopy means defining an enclosed space and having one surface defining a plurality of discrete spaced apart openings positioned over the entire area thereof and extending therethrough, supporting means for maintaining said canopy means disposed with said one surface adjacent said patient, said canopy extending completely over and in all directions outwardly beyond the periphery of said patient's bed, a source of substantially sterile air flow, means for conducting said sterile air flow into said space, and an air directer surrounding said one surface and extending therebelow for a distance sufficient to shape air passing through said openings into a downwardly flowing column.

3. Apparatus according to claim 2 in which said air directer is a metallic member affixed to said one surface and extending therebelow for a distance of at least approximately two inches.

4. Apparatus according to claim 2 in which said supporting means is an upstanding member mounted upon a unitary base.

5. Apparatus according to claim 2 in which said canopy means is a plastic bag.

6. Apparatus according to claim 5 in which said air directing means is a curtain attached to said plastic bag and said support means is frame member positioned over said patient's bed.

7. Apparatus for effectively isolating a patient from his surrounding area by providing a directed and continuously moving column of substantially sterile air which completely surrounds the patient, said apparatus comprising a canopy including first and second spaced apart planar members and a side member disposed between said planar members and enclosing the space therebetween, said first planar member defining a plurality of openings therethrough, said plurality of openings being spaced apart over the entire area of said first planar member to provide an open area which is on the order of $\frac{1}{100}$th of the total area of said first planar member, supporting means for adjustably supporting said canopy over said patient, said canopy extending completely over and in all directions outwardly beyond the periphery of said patient's bed, a source of substantially sterile air flow, means for conducting said sterile air flow into said space, and an air directer completely surrounding said one surface and extending therebelow for a distance sufficient to shape air passing through said openings into a downwardly moving column which surrounds said patient.

References Cited in the file of this patent

UNITED STATES PATENTS

2,159,741	Kettering et al.	May 23, 1939
2,681,061	Modell	June 15, 1954
2,737,695	Soklik	Mar. 13, 1956
3,011,230	Potapenko	Dec. 5, 1961