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Matthews

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[54] **BED PATIENT ISOLATION SYSTEM**

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[52] **U.S. Cl.** ..... **128/1 R**, 128/191, 312/1, 312/3, 108/143

[51] **Int. Cl.** **A61b 19/00**

[58] **Field of Search** ..... 128/1 R, 1 B, 191; 312/1, 3, 312/4; 5/70, 332; 108/137, 143; 160/84, 330, 346

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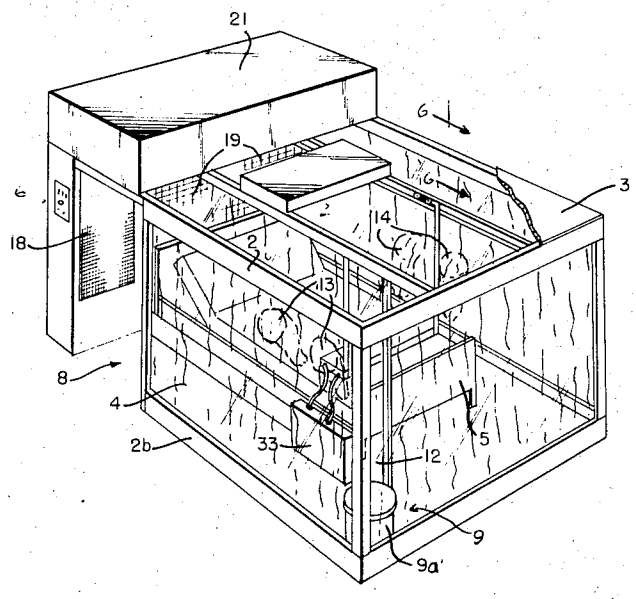
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[57] **ABSTRACT**

A bed patient isolation unit for isolating infection-susceptible patients from their environment or vice versa has a rigid frame of specially-formed beams supporting an enclosure including flexible side walls of transparent plastic sheeting equipped with pseudopodal sleeve-glove arms by means of which sterile manual access to the interior isolation area of the unit is provided. A filter-pump device at one end of the unit has air inlet and air outlet areas in the end wall providing a laminar flow of filtered air from the outlet area at a slight positive pressure with respect to the ambient, so that external contaminated air cannot enter the isolation area.

12 Claims, 10 Drawing Figures



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SHEET 1 OF 2

FIG. 1.

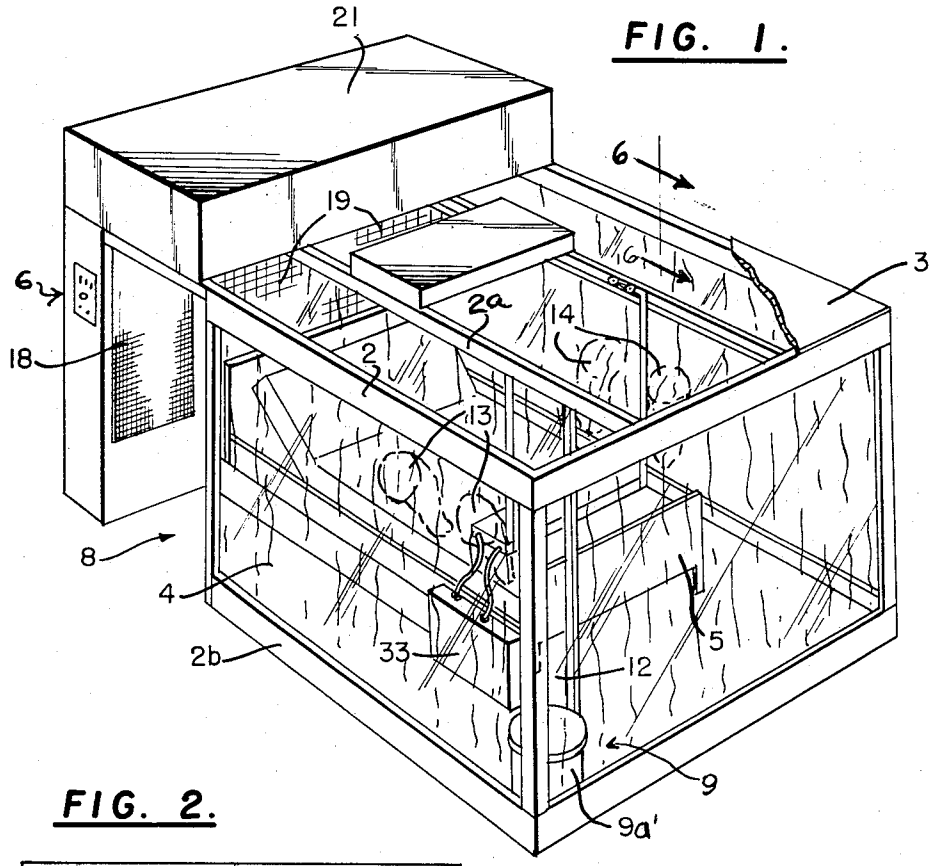


FIG. 2.

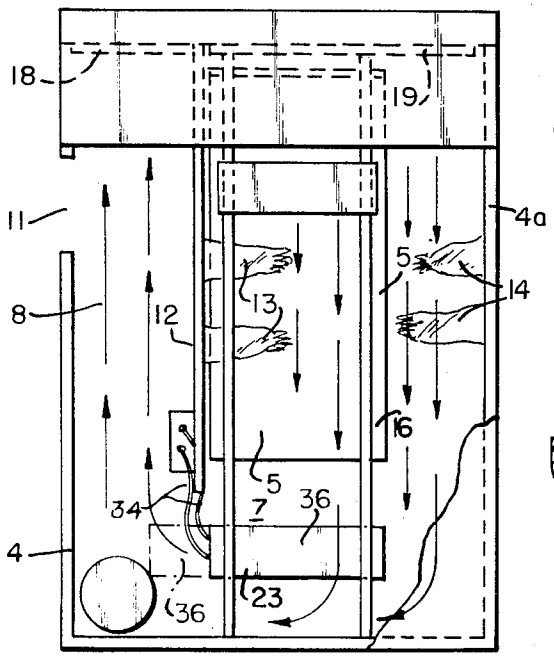


FIG. 9.

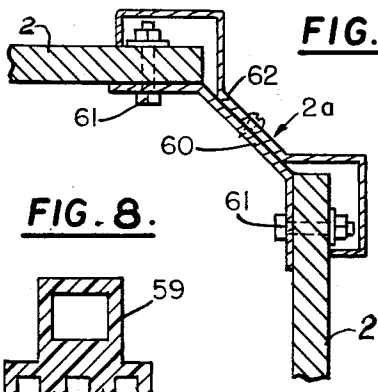


FIG. 8.

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FIG. 6.

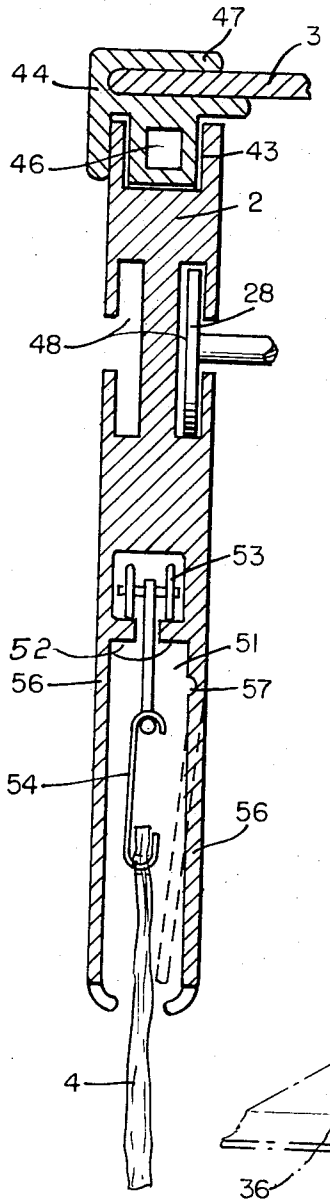


FIG. 7.

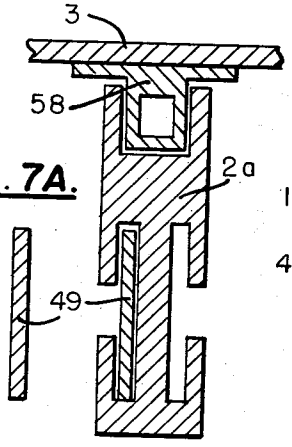
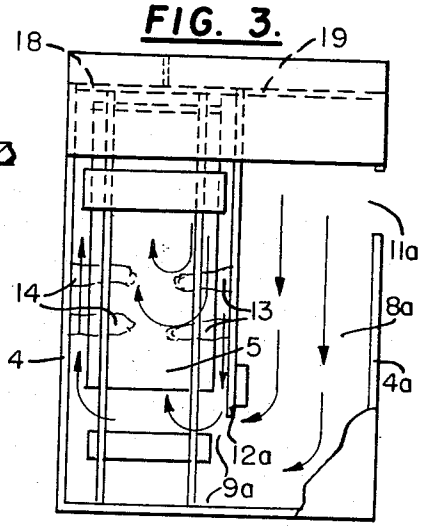


FIG. 7A.

FIG. 3.



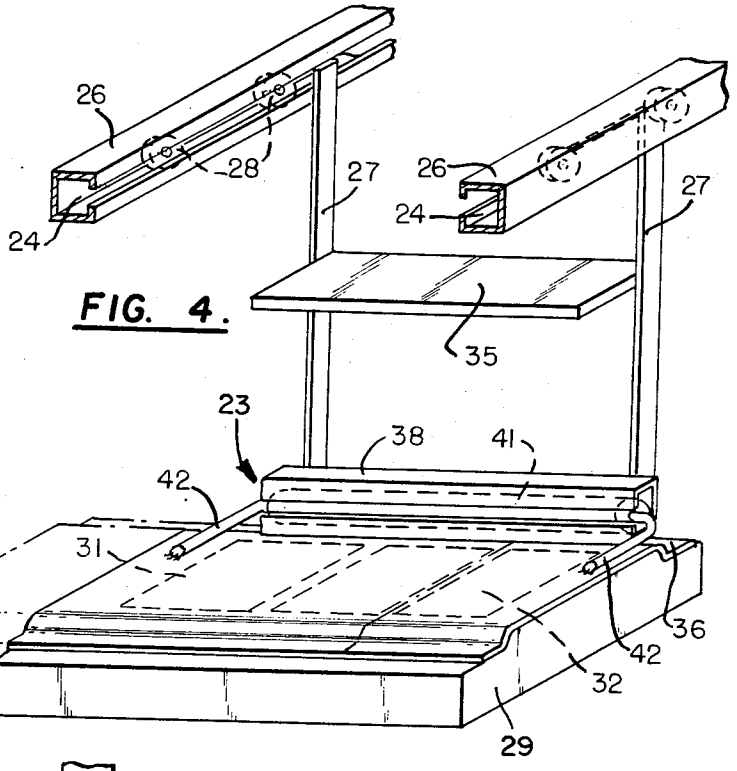
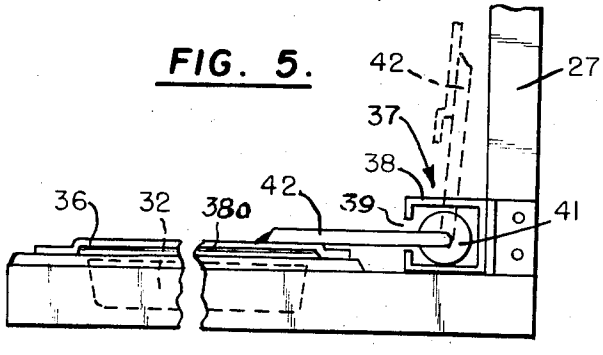


FIG. 4.

FIG. 5.



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BED PATIENT ISOLATION SYSTEM

This invention relates to a bed patient isolation system having walls of transparent plastic sheeting surrounding a bed, in which a differential atmospheric pressure is maintained between the bed area and the outside area so as to prevent contamination of one area by the other. This is accomplished by means of a known air filtration and pump system, and pseudopodal sleeve-glove arrangements are provided by means of which a person on the outside of the sterile area can administer to the needs of the patient. The unit is divided by an interior partition of plastic sheeting, which is preferably pleated or draped, especially in the pseudopal areas, so as to provide considerable lateral movement of the pseudopods; this provides a bed space and a corridor having access to the bed space at one end of the corridor and access to the exterior at the other end. This partition can be moved as a whole with respect to the inlet and outlet areas so as to change the direction of airflow in the bed area and thus isolate an infection-susceptible patient from the ambient environment in one position of the partition or isolate the environment from a contagious patient in another position of the partition wall. For serving the patient in either condition with supplies and materials, an over-bed table is provided which is arranged to move in a fixed path along the length of the bed and is equipped with a top which can be slide from one side to the other so as to make it accessible to a nurse or doctor by partially projecting it into the corridor so that sterile supplies can be placed on it, the slidable top can also be swung up to uncover a multi-storage compartment for personal effects, and a small sink provided with sterile water for washing. The rigid frame is formed with drapery slide means for supporting the flexible plastic wall sheeting and valence means for obstructing the flow of air from one side of the curtain to the other over the top or bottom of the sheet wall are also provided.

The specific nature of the invention, as well as other objects and advantages thereof, will clearly appear from a description of a preferred embodiment as shown in the accompanying drawings, in which:

FIG. 1 is a perspective schematic view of the unit as a whole;

FIG. 2 is a schematic plan view showing the air flow with the interior partition positioned for reverse isolation;

FIG. 3 is a similar view showing the partition and air flow in the position for direct isolation;

FIG. 4 is a schematic perspective view of the over-bed unit;

FIG. 5 is an end view of the over-bed unit;

FIG. 6 is a transverse sectional view taken on line 6—6 of FIG. 1 showing the detail construction of a beam element;

FIG. 7 is a similar sectional view showing a modified beam element;

FIG. 7*a* is a transverse sectional view of a joining bar used for connecting two of the elements shown in FIG. 7;

FIG. 8 is a transverse sectional view of a sealing gasket used in connection with the beams of FIGS. 6 and 7; and

FIG. 9 is a transverse sectional view of a corner of the unit showing the manner in which the beams are assembled.

FIGS. 1, 2 and 3 show the general arrangement of the system. A framework of rigid beam-like members 2, 2*a*, which can be assembled in place by suitable fastening means, as will be shown in more detail below, supports exterior walls 4, 4*a*, which are preferably of flexible sheet plastic material and, together with end wall 6 define an enclosed space. Although some of the exterior walls could be of rigid material, the walls defining the actual bed space of the unit should be flexible, preferably transparent sheeting, since access by means of pseudopodal sleeve-glove devices is required, in order to allow movement of the glove ports so as to enable all parts of the interior to be reached.

Beams 2 may support a roof 3 preferably of translucent rigid plastic panels, or, as in the case where a hospital is especially designed for this type of isolation unit, the beams 2 may extend to (or depend from) the ceiling of the room in which the unit is located.

The enclosed space of the unit is itself divided into two areas 7 and 8, of which the first is for a bed, while area 8 is a corridor area having an access opening 9 to the bed area 7, and another access opening 11 to the exterior of the unit. The dividing wall 12 between the corridor and the bed area is also of flexible transparent plastic sheeting, preferably draped or pleated so that glove-sleeve pseudopods 13, which extend from suitable armports in the sheeting, can have considerable lateral freedom of movement whereby all of the bed length can be reached from the corridor side by a nurse or doctor's hands thrust into the pseudopods. The remaining area of the bed space can be reached by similar pseudopods in the opposite wall 4*a* of the unit. The other two walls 4 and 9 of the unit need not be heavily pleated or transparent, as they do not contain pseudopods, but can be stretched fairly flat if desired, or be of rigid material.

A standard hospital bed 16 is ordinarily located in the bed area, which is typically about five feet wide, while the corridor is about 2 feet in width, and the entire unit about 7 by 10 feet. The dimensions should be such that all of the bed area can be reached by the pseudopods 13 and 14, although if desired, more than one pair of pseudopods can be provided in each wall. The two service walls in which the pseudopods are located are preferably loosely draped or pleated, and are suspended from the frame members on slidable hangers so that the pseudopods can be moved a considerable distance laterally, i.e., along the length of the bed area, so that all parts of the bed area can be reached for servicing from the outside of the bed area.

The head end wall of the unit, 6, is of solid construction and contains an air pump and filter unit, the details of which are not per se a part of the present invention except to note that the air enters the unit at the inlet grill 18 and is discharged through a porous grill or screen wall 19, which occupies most of the rest of the head wall area, in such manner as to produce an essentially laminar flow of air from the outlet base at a slight positive pressure with respect to the ambient pressure outside the unit, from the head end of the bed area to the foot end, with the corridor wall 12 placed as shown in FIG. 2. With the corridor wall placed as shown in FIG. 3, the bed area will be at a slight negative pressure, in order to insure that no contamination can pass from the patient to the ambient air. Means are provided

between the air inlet and outlet openings to clean the air of any deleterious organisms such as baterial, molds, pollen, etc., so that the air emerging from the outlet is essentially sterile. Such cleaning means are known in the art and do not per se form a part of the invention; one such cleaning means successfully used in practice may be a mechanical filter, such as a HEPA filter, commercially available; these are tested to remove in excess of 99.97 of particles over 0.3 microns in size. However, in place of, or in addition to these filters, other suitable means such as electrical precipitators, ultraviolet sterilizers, etc. may also be used.

The necessary motor, pump and other mechanical equipment of the air unit may be conveniently located in housing **21** on top of the unit, and suitable lighting means for the interior may be provided either within or without the bed space, or both, although it is noted that external lighting is easier to maintain. The unit as a whole must be provided in small enough component sub-units so that they can be readily transported and carried through an ordinary doorway, in order that the isolation unit may be set up in any ordinary room.

In the case where the patient must be bacterially isolated from the outer world, all supplies and materials furnished him must, of course, be sterile, which is readily possible with known techniques, but entering such supplies and materials into the bed area in an antiseptic manner is more of a problem. In order to accomplish this needed function, a special over-bed table **23** is provided, which is arranged to be moved in a fixed path along the length of the bed. This could be done by means of a pedestal on wheels or casters, but a preferred arrangement is to suspend the table over the bed by means of tracks **24**, provided in overhead beams **26** (FIG. **4**), and hangers **27** extending downwardly from the rollers **28** riding in the tracks and supporting table **23** at the lower end of the hangers so that the table can be readily moved from a position at the head end of the bed, where it can serve the patient, to a position where it is opposite the access opening **9** which leads into the corridor **8**. The table is provided with a bottom portion **29** which is deep enough to accommodate a multi-storage compartment having recesses as at **31** and a shallow sink **32**, preferably of molded plastic, which is supplied with sterile water from a tank **33** and flexible rubber tubes **34**.

The top of the table has a flat cover **36** which can be swung up on a hinge arrangement **37** into the position shown in dotted lines in FIG. **5**, to provide access by the patient to the storage compartments **31** and the water sink **32**. The underside of the top may contain a mirror **38***a* for the patient's use when the top **36** is swung up. Alternatively, the top **36** may be slid out to either side of the bed as shown in FIGS. **2** and **4**, so that part of it projects into the service corridor **8** from which sterile supplies can be put by a nurse or attendant onto the table top. It will be noted that this is done at the point where the air stream turns and reverses direction, so that the sterile articles are unwrapped or uncovered and placed on the table in the reverse airstream of the corridor, so that there is no chance of contamination from the attendant or from the unsterile outer containers reaching the patient or contaminating the table top if sterile procedures are used. On the other hand, if the environment is to be kept from contamination by the patient (e.g., in the case of a contagious disease), as will be shown below, the airflow would be coming from the back of the attendant into the bed area across the table top.

If desired, one or more additional small shelves may be provided above the table top as shown at **35**.

The special sliding hinge arrangement **37** which makes the above-described use of the table top **36** possible is shown in more detail in FIG. **5**, and comprises a tubular hinge member **38**, shown as a square tubular member, but which could equally well be round, and which has a narrow axial slot **39** on the side facing the patient. A hinge pin **41** lies in the tube **38** and has a maximum diameter greater than the width of the slot **39** so that it cannot be pulled through the slot. The ends of the hinge pin extend out beyond the ends of the tube **38**, and from these ends project rodlike members **42** which are fixed, as by welding, to the table top **36**; members **42** (or at least one of them) are dimensioned so that they can pass freely into the slot **39** when the table top **36** is to be slid transversely into the service corridor, and the one member which is in the slot when the tray top **36** is slid partially into the service corridor also serves to prevent the top from being inadvertently swung up, which would cause articles to fall off it, and also enables objects to be put on the projecting end of the tray top **36** without its falling off due to unbalance. However, when the top **36** is in its normal position on the table **23**, the members **42** are clear of tubular hinge member **38** and the top **36** can be hingedly swung up into the position shown by the dotted line in FIG. **5**, with the top **36** resting against members **27**, uncovering the storage compartments **31** and basin **32**, while presenting the mirror **38***a* in a position where it can be used by the bed patient.

The beams **2**, **2***a*, of which the framework of the unit is made are preferably of a special construction as shown in FIGS. **6–8**. The top and bottom horizontal beams which hold the flexible plastic curtain walls are shown in FIG. **6**. At one edge of the beam **2** is a groove **43** adapted to frictionally retain a rubber or soft plastic extrusion such as is shown at **44**, which has a hollow center portion **46** which may be used to conceal electrical wiring for light and power, and also has a groove **47** for the reception of the edge of a panel **3**, which may be a translucent fiberglass plastic panel forming the roof or ceiling of the isolation unit. The beam **2** (or **2***a*) also has at least one and preferably two longitudinal slots **48** which can serve as tracks to retain rollers **28** of the bed table unit, and also serve to retain connecting bars **49** (FIGS. **7** and **7***a*) whereby two beams may be connected end-to-end to form a single longer beam. At the bottom of the beam is a very deep slot **51** having at its end tracks **52** for the reception of drapery-type sliders or rollers **53** carrying hooks **54** on which the flexible plastic sheets **4**, **4***a* are supported. These may be stretched fairly tight horizontally and vertically to form those walls of the unit which are not carrying pseudopods, or left in pleated condition as above explained for those walls which carry pseudopods and which must be capable of considerable lateral movement.

At least one of the skirts **56** of slot **51** is preferably provided with a longitudinal weakening groove **57** so that it may be bent inwardly as indicated by the dotted line so as to reduce the width of the aperture at the bot-

tom of the slot 51 to a minimum so that the flow of air from one side of the unit 4 (or 4a) to the other is reduced, thus tending to reduce the amount of blower power required to maintain the desired pressure differential on both sides of the wall.

Where the beam is not used to support a curtain wall, e.g., the center beams which support only the roof and the bed table, the lower skirt portion may be omitted as shown in FIG. 7, which is, in effect, only the upper half of the beam shown in FIG. 6. It will be understood that the lower beams of the framework, as at 2b, which hold the lower edge of the plastic curtain wall are the same as shown in FIG. 6, except that they are inverted, with the slot 51 facing up and retaining the bottom edge of the curtain wall. For those beams of the type shown in FIG. 7, which do not support the edge of a roof panel 3 but instead support it at some intermediate location, extrusions 58 or 59 may be used, and these are also used at the bottom of the frame to seal the crack between it and the floor, the form shown at 59 (FIG. 9) being particularly useful where the floor is irregular or uneven.

The framework members may be connected together in any suitable fashion, but a preferred typical form of interconnection is shown in FIG. 9, where two beams 2 are joined to a vertical beam 60 by means of threaded bolts 61 and a cover plate 62 covers the ends of the beam 2 and the bolt 61, while the vertical space between 60 and 62 below the beams 2 serves to contain the ends of the curtain wall 4 so as to combine a neat appearance with an effective closure for retaining the desired pressure differential.

FIG. 2 shows the condition of so-called "reverse isolation," in which the air in the bed area is maintained at a slight positive pressure, to insure that the patient is not subjected to contaminated external air. FIG. 3 shows how, by a very simple change, the unit can be adapted to isolate the patient, in the case of contagious diseases, so that air contaminated by the patient is always filtered before it can mix with external air. In order to accomplish this, the partition 12 of FIG. 2 is reversed and moved to the position 12a of FIG. 3, so that the corridor is now at 8a, and is supplied with air from a part of the exhaust grill 19, while the bed area now includes the inlet grill 18 and a part of the exhaust grill 19. Since the inlet grill 18 must take in as much air as is exhausted from the entire outlet grill 19, it is clear that there will now be a net diminution of atmospheric pressure within the bed area, and that air must be brought in through opening 9a from the corridor 8a in order to supply this deficiency. Therefore, the net flow of air in the bed area will be through the filter unit 18, and any air reaching the exterior from the bed area will have passed through the filter system. It will be apparent that the entire arrangement involves only rehanging of the transparent plastic sheeting and can be accomplished in a few minutes.

A small portable toilet 9a' is also provided, being preferably placed in the corner as shown in FIG. 1, at the inner end of the corridor, so that it is always in an airstream of the proper direction to provide the desired protection. This corner is preferably provided with opaque drapes, not shown, in order to provide privacy for the user.

I claim:

1. a. Isolation unit for bed patients comprising

b. a bed compartment provided with support means and having top, bottom, and end walls and side members of material impervious to air attached thereto,

c. a service corridor compartment formed by top, bottom and side walls adjacent one of the side walls of the bed compartment and having a common wall therewith, and having also a service access opening between one end of the service compartment and the foot end of the bed compartment, and an exit access opening at the other end of the service corridor for access of service personnel to the outside of the unit from the service corridor,

d. the side walls of the bed compartment being at least partly of flexible sheet plastic material having flexible sleeve and glove devices incorporated thereinto for providing a bacterially impervious means of manual access to the interior of the bed area from outside of the bed area,

e. means for maintaining a pressure differential between the air in the bed area and the ambient air, including the air in the service corridor,

f. a service unit attached to said support means and movable from a position over the bed area into a position adjacent said access opening where it can be reached by personnel in said service corridor compartment without entering said bed compartment.

2. The invention according to claim 1, said unit also including a rigid framework of readily dissemblable members supporting the wall and side members of the unit, said framework comprising rigid horizontal beams at the upper portion of the framework, said horizontal beams containing in the underside thereof a deep downwardly opening valence slot having a guide track therein for slidably supporting the upper edge of said flexible plastic wall material in pleated condition, said slot providing a deep valence skirt on either side of the upper edge of the flexible wall to retard the passage of air from one side of the flexible wall to the other side while permitting the pleated flexible wall material to slide laterally for a limited distance on said guide track within said slot so that the glove and sleeve devices can be moved laterally to service an extended area within said bed area.

3. The invention according to claim 2,

said framework comprising individual lengths of rigid extrusions held together with removable fasteners for rapid assembly and disassembly.

4. The invention according to claim 3, said rigid extrusions having a cross-section including track means for supporting drapery sliders to retain said walls of flexible material.

5. a. Isolation unit for bed patients comprising

b. a rigid framework and flexible plastic wall curtains supported by said framework and providing two adjacent enclosed areas, one serving as a bed area and the other serving as a service corridor alongside the bed area, there being an access opening between the foot end of the bed area and said service corridor providing free access between the service corridor and bed area,

c. flexible glove and sleeve devices incorporated into part of the plastic material of said wall to provide a bacterially impervious means of manual access to

the interior of the bed area from outside the bed area,

d. means for maintaining a pressure differential between the air in the bed area and the ambient air to bacterially isolate the bed area from the ambient area;

e. said framework comprising rigid horizontal beams at the upper portion of the framework, said horizontal beams containing in the underside thereof a deep downwardly opening valence slot having a guide track therein slidably supporting the upper edge of said flexible plastic wall material in pleated condition, said slot providing a deep valence skirt on either side of the upper edge of the flexible wall to retard the passage of air from one side of the flexible wall to the other side while permitting the pleated flexible wall material to slide laterally for a limited distance on said guide track within said slot so that the glove and sleeve devices can be moved laterally to service an extended area within said bed area,

f. at least one of the slot walls having a weakening groove extending axially therealong so that it can be deformed toward the other wall to provide a close fit for one edge of the pleated curtain wall.

6. a. A patient isolation unit comprising

b. a rigid framework defining the walls and top of an isolation unit,

c. said unit having a bed area and a narrow service corridor area with internal access at one end thereof to the bed area, and external access at the other end thereof to the exterior of said unit, and an inner wall of flexible transparent material between said two areas,

d. an outer wall made at least partly of flexible transparent material suspended from said rigid framework,

e. said inner and said outer wall each containing a pair of flexible glove and sleeve devices providing bacteria-impervious sterile manual access to all parts of the bed area from outside the bed area,

f. one end wall of said unit comprising an air filtration unit having an inlet area and an outlet area, both areas communicating with the interior of the unit, and means for drawing ambient air from the interior of the unit in through said inlet area, then through a filter, and expelling said filtered air through said outlet area into said isolation unit at a positive pressure with respect to the ambient air pressure,

g. and means for reversing the direction of flow of air from the filtration unit with respect to the bed area so as to maintain the bed area optionally at a higher or lower air pressure than the ambient air outside of the unit.

7. The invention according to claim 6,

h. wall fastening means for optionally moving said inner wall into either of two positions within said unit between said inlet area and said outlet area of the end wall so that said bed area is in one of said positions of the wall under positive pressure so as to isolate the bed area from the ambient environment,

i. and in the other position of the inner wall the bed area includes said outlet area and is under a slight negative air pressure.

8. a. For use in a patient isolation unit having an enclosed bed compartment containing a bed area and a service corridor and supplied with a laminar flow of bacteria-free air under a slight positive pressure from a pressure source at one end of the compartment, over the bed in the compartment, to an access opening at the other end of the compartment, beyond the foot end of the bed,

b. the improvement comprising a patient service unit above the bed and movable over the bed from a position near the head end of the bed to a position adjacent said access opening,

c. said service unit being provided with compartments for holding patient supplies and needs,

d. said service unit having a top covering said compartments and serving as a bed tray,

e. and hinge means for said top for swinging it into an upright position to provide access to said compartments,

f. slide guide means for sliding said top on said service unit transversely of said bed,

g. whereby said top can be slid on the service unit partially into said access opening for supplying a patient in the bed without entering said compartment.

9. The invention according to claim 8,

h. and fixed overhead track means in said isolation unit above the bed area of the unit,

i. service unit suspension means slidably mounted on said track means and supporting said patient service unit above the bed.

10. The invention according to claim 8,

h. said slide guide and hinge means comprising a tubular element fitted to said service unit and having a longitudinal slot along its entire length,

i. a hinge pin lying within said slotted tubular element and projecting beyond it at both ends,

j. a short arm fixed at one end to said flat top and at the other end to the projecting end of said hinge pin, there being one short arm at each end of the hinge pin, at least one said short arms being slidable within the slot of said tubular element when said top is slid on the surface unit.

11. The invention according to claim 10,

k. said hinge pin having a maximum thickness greater than the width of the slot in said tubular element so that it can be slid along the slot but not pulled through it.

12. The invention according to claim 11,

l. and a mirror fastened to the underside of said top.

* * * * *