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(54) MODULAR RADIATION SHIELDING SYSTEM AND RELATED METHODS

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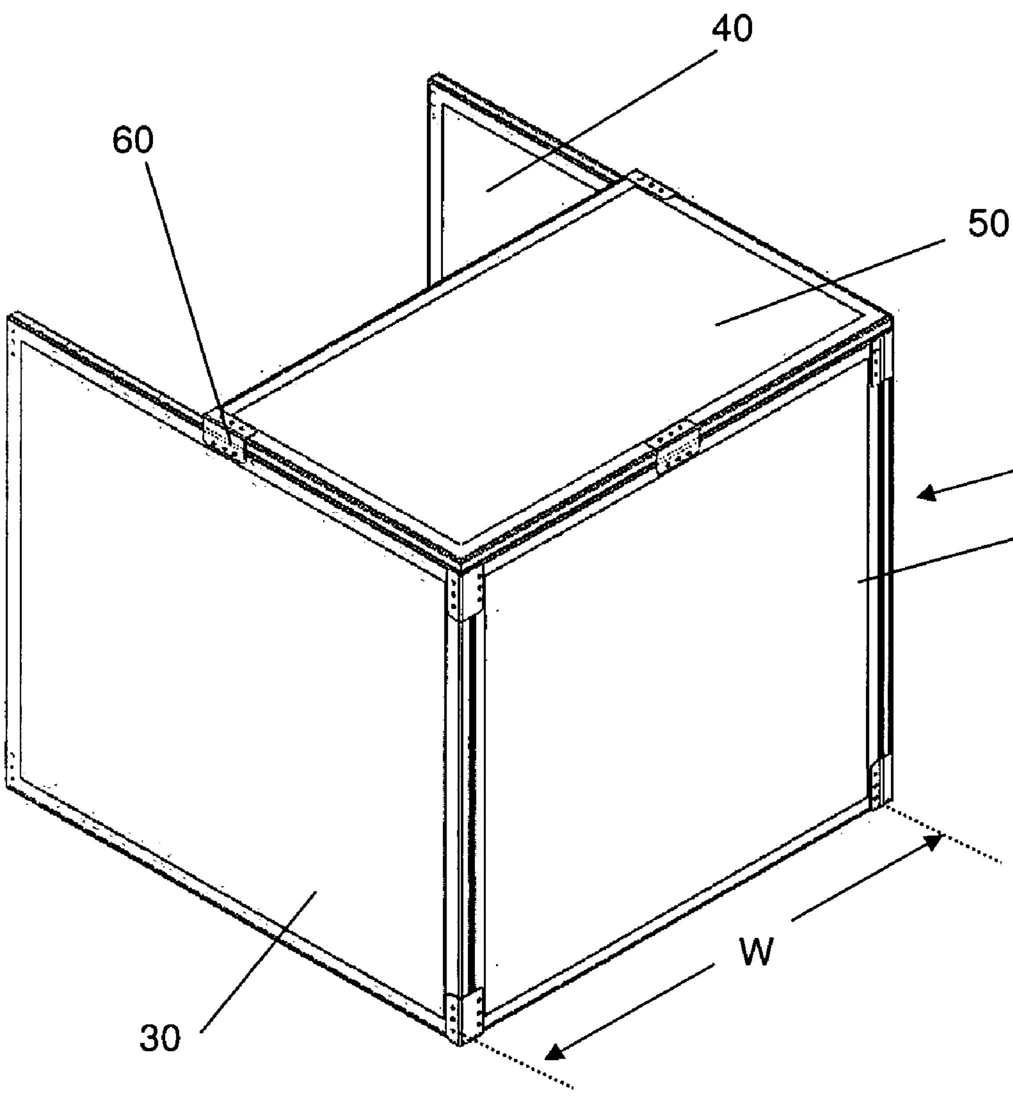
(57) ABSTRACT

Provided herein is a portable cubicle useful for environmental shielding of patients undergoing radiation treatment for diagnostic or therapeutic purposes, for example, ^{18}F-FDG uptake prior to Positron Emission Tomography (PET scanning).



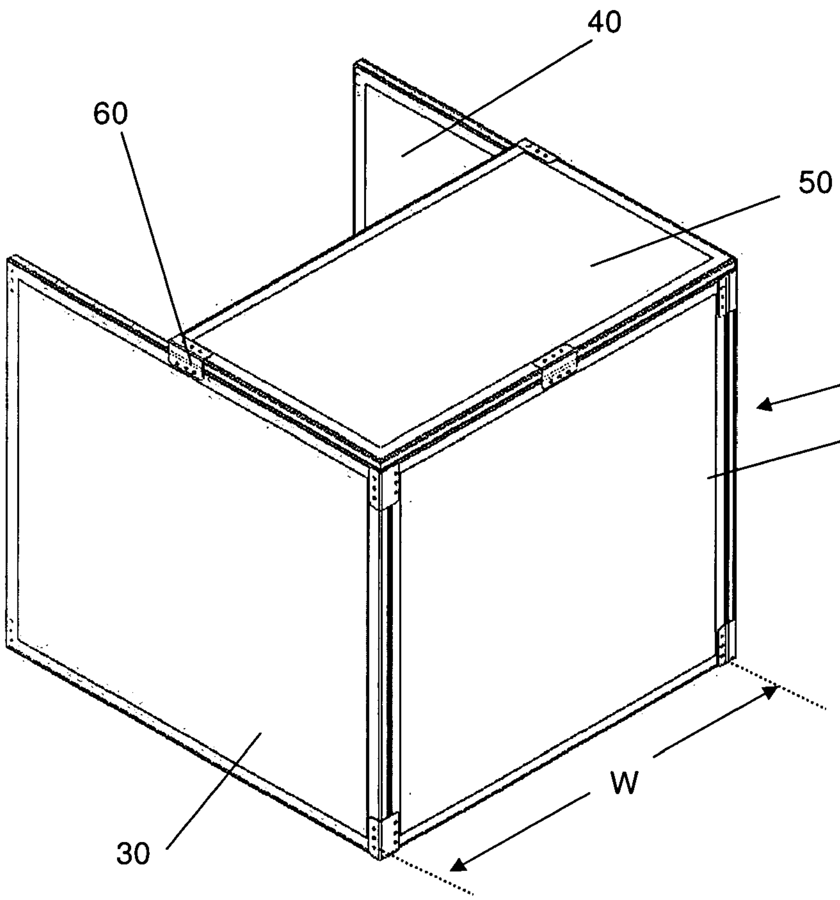


Fig. 1A

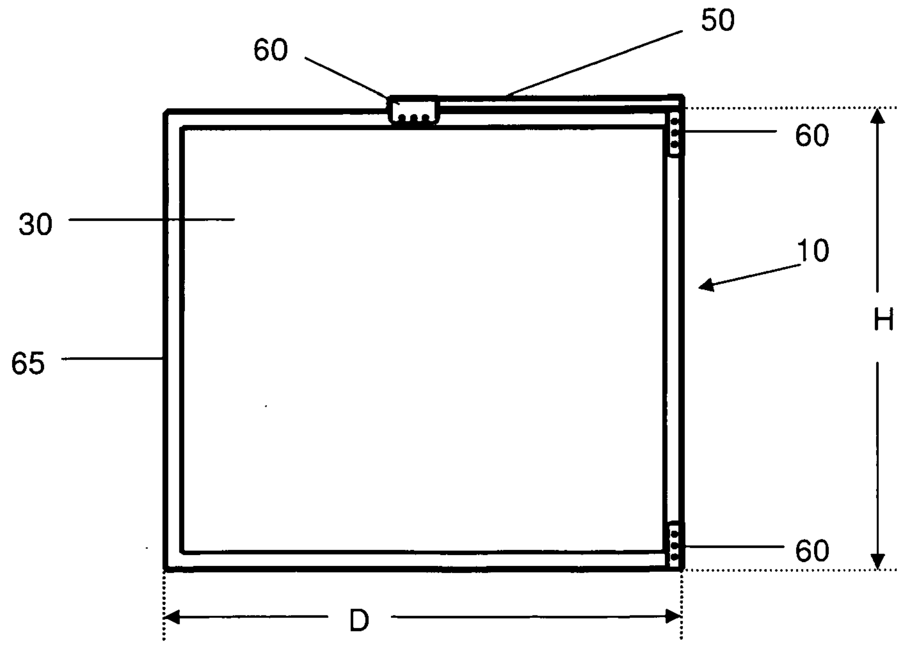


Fig. 1B

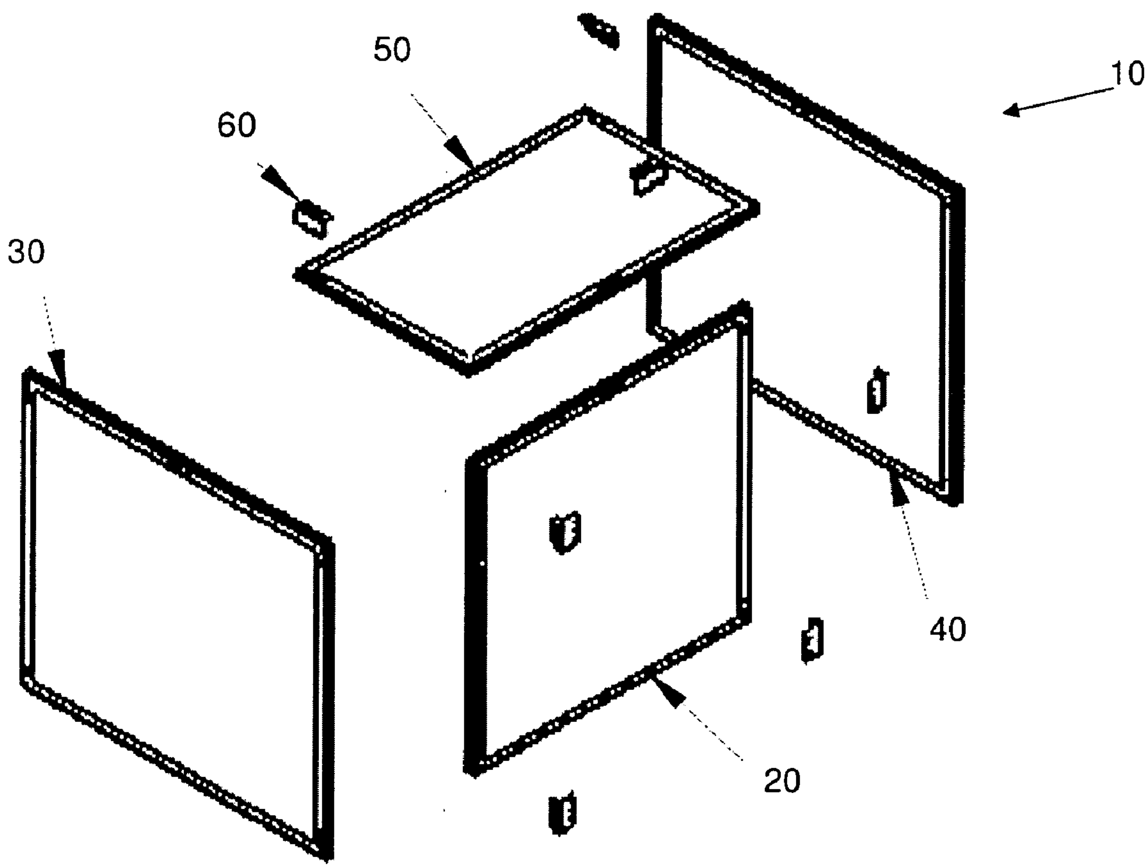


Fig. 1C

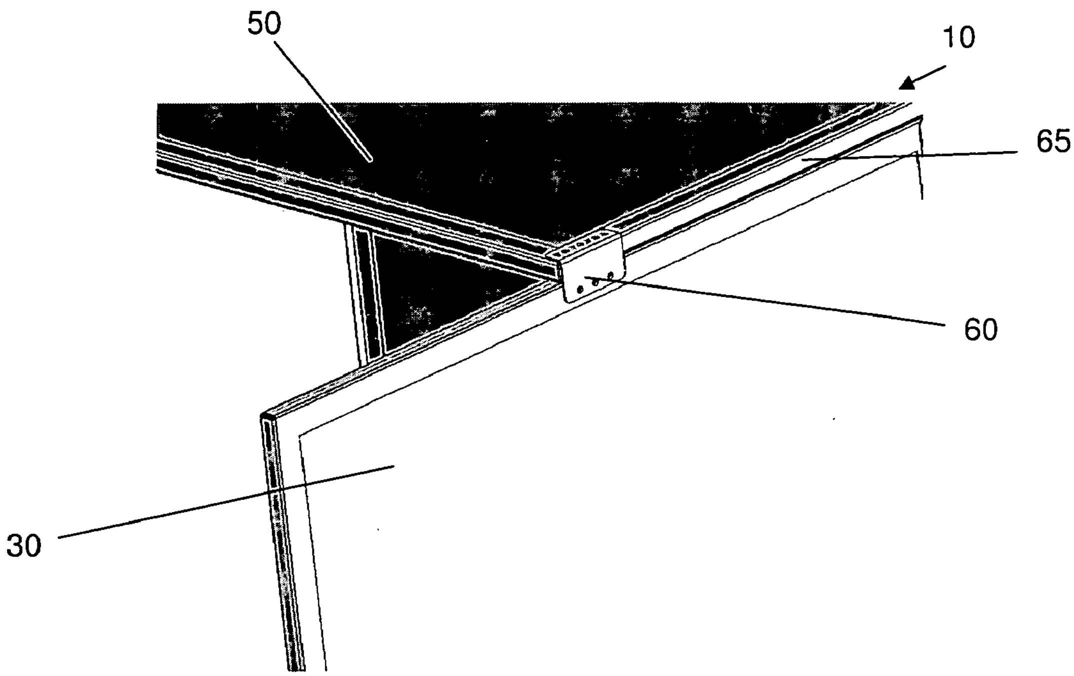


Fig. 1D

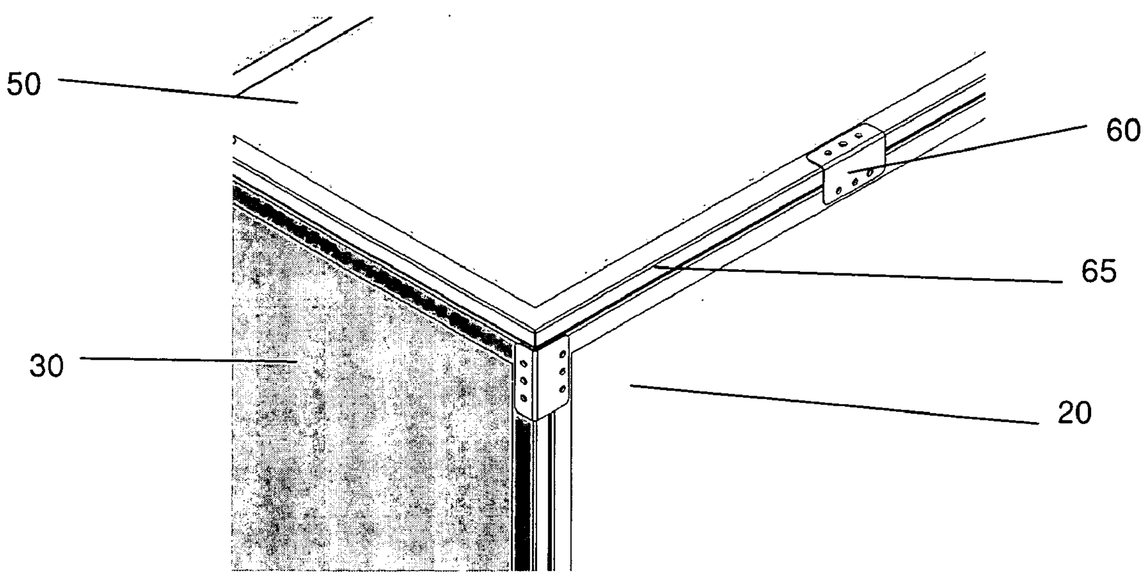


Fig. 1E

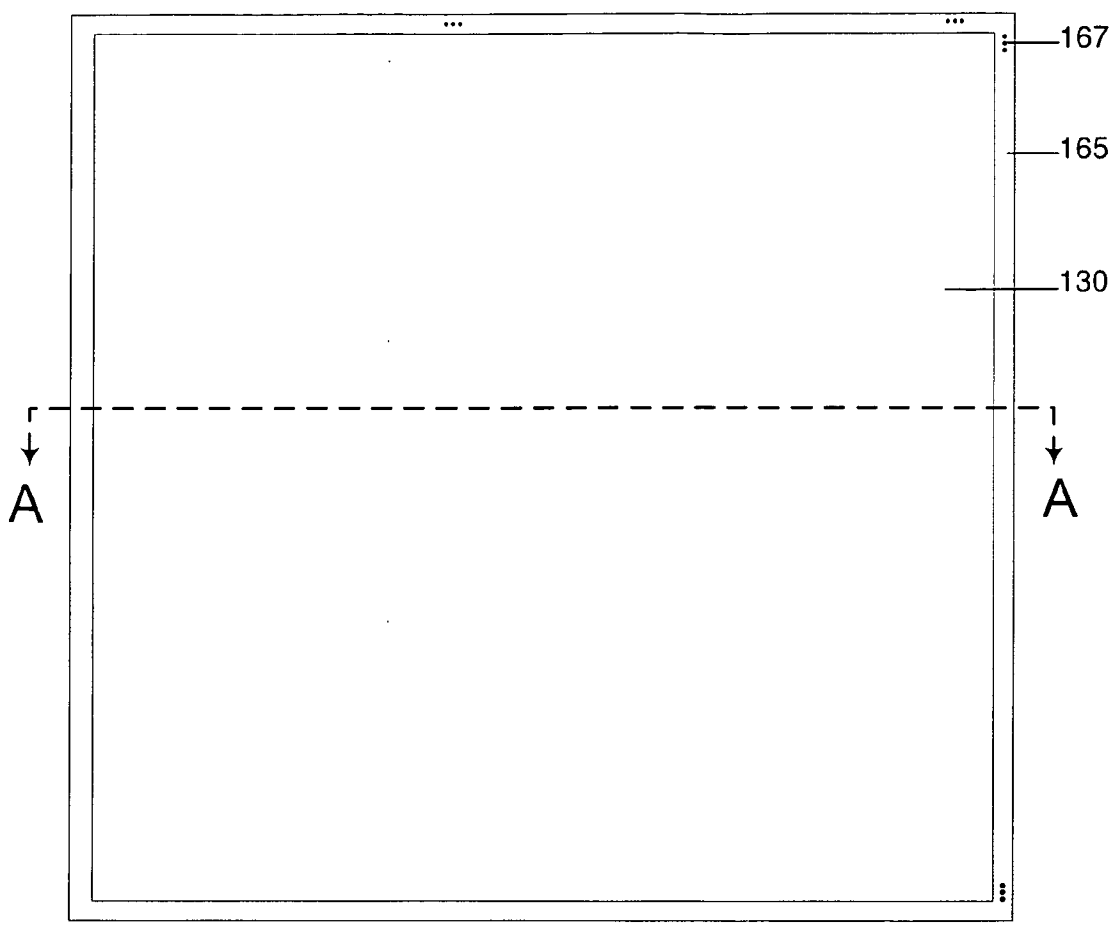


Fig. 2A

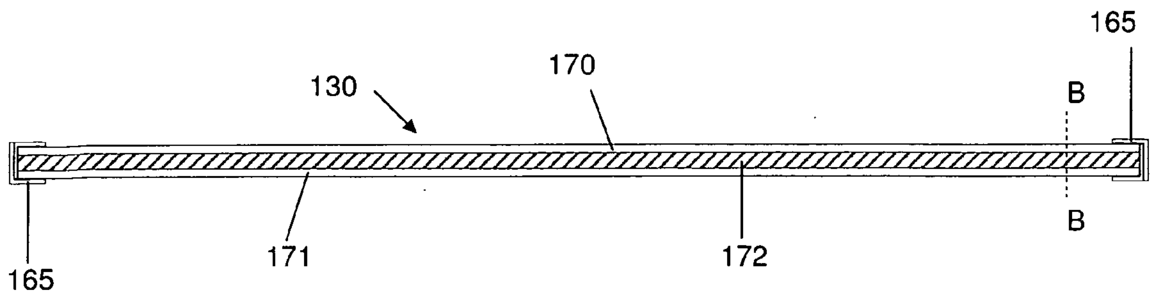


Fig. 2B

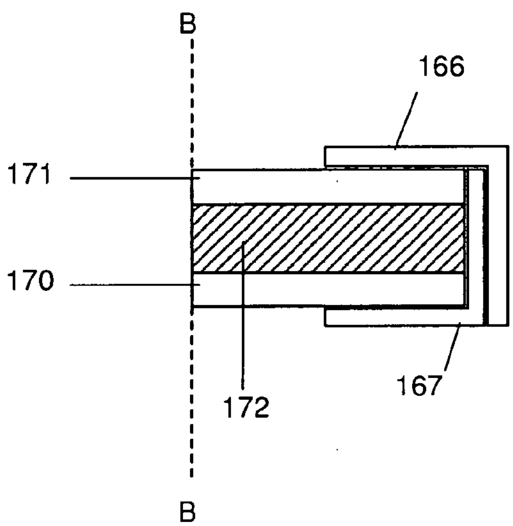


Fig. 2C

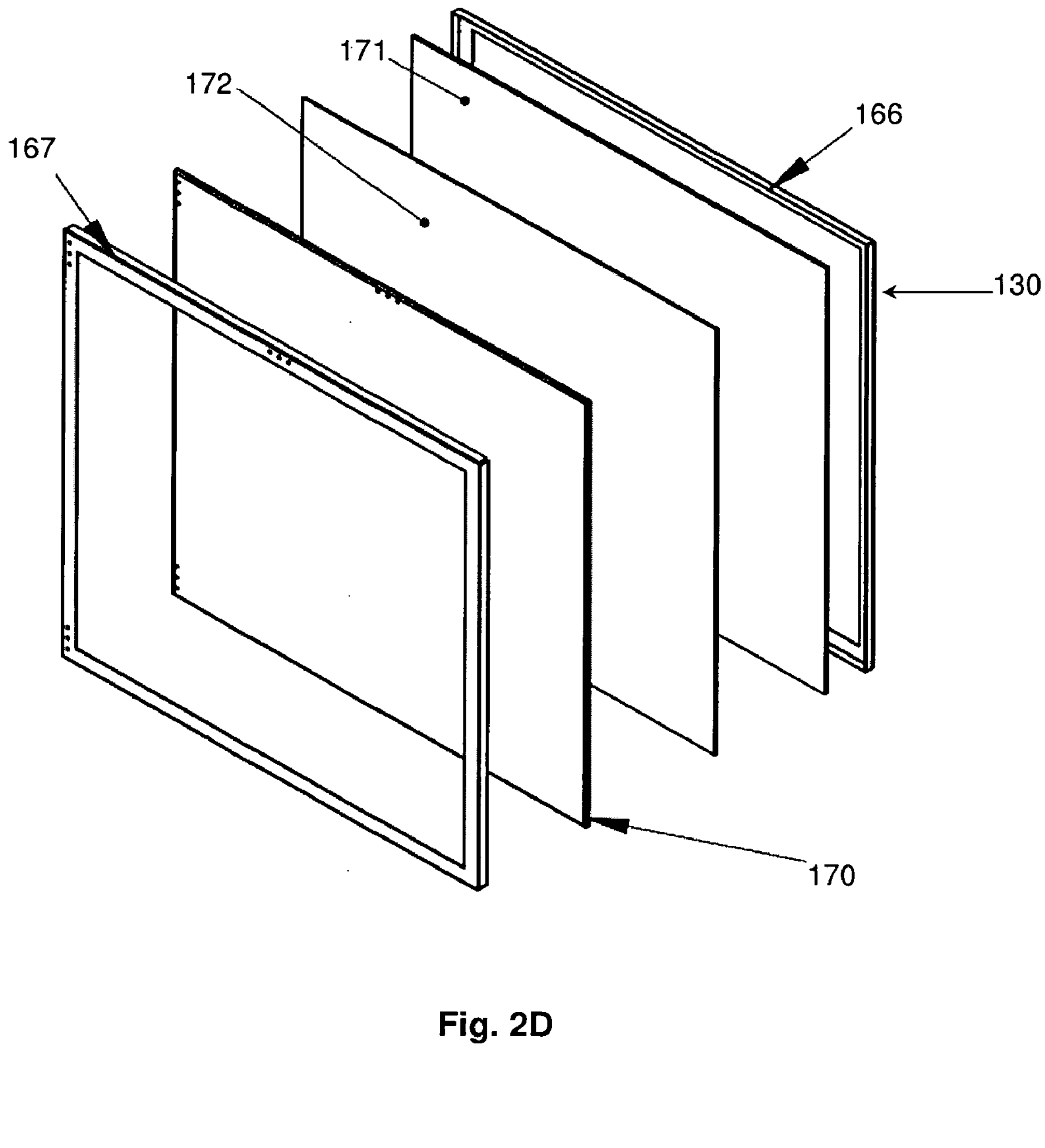


Fig. 2D

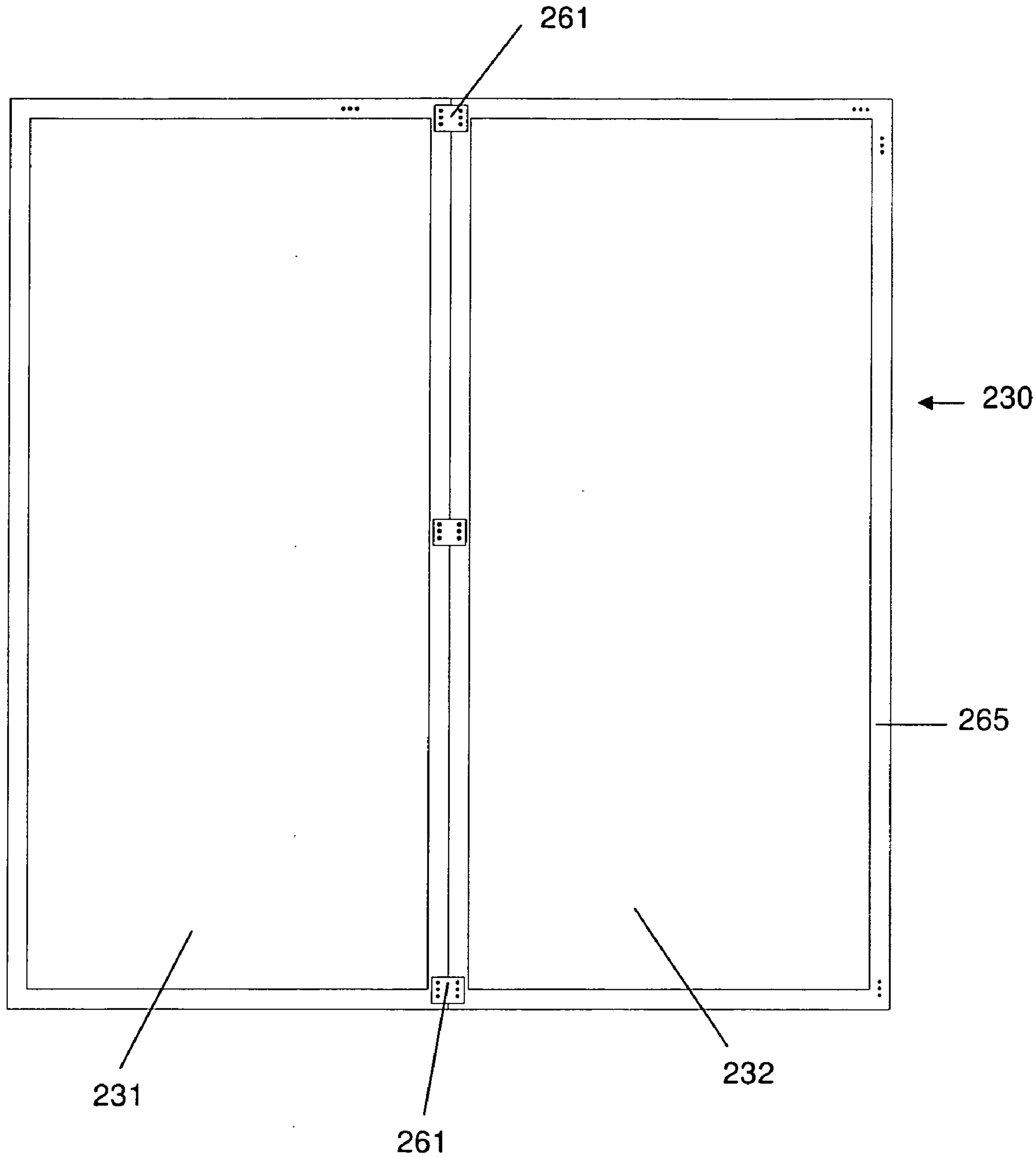


Fig. 3

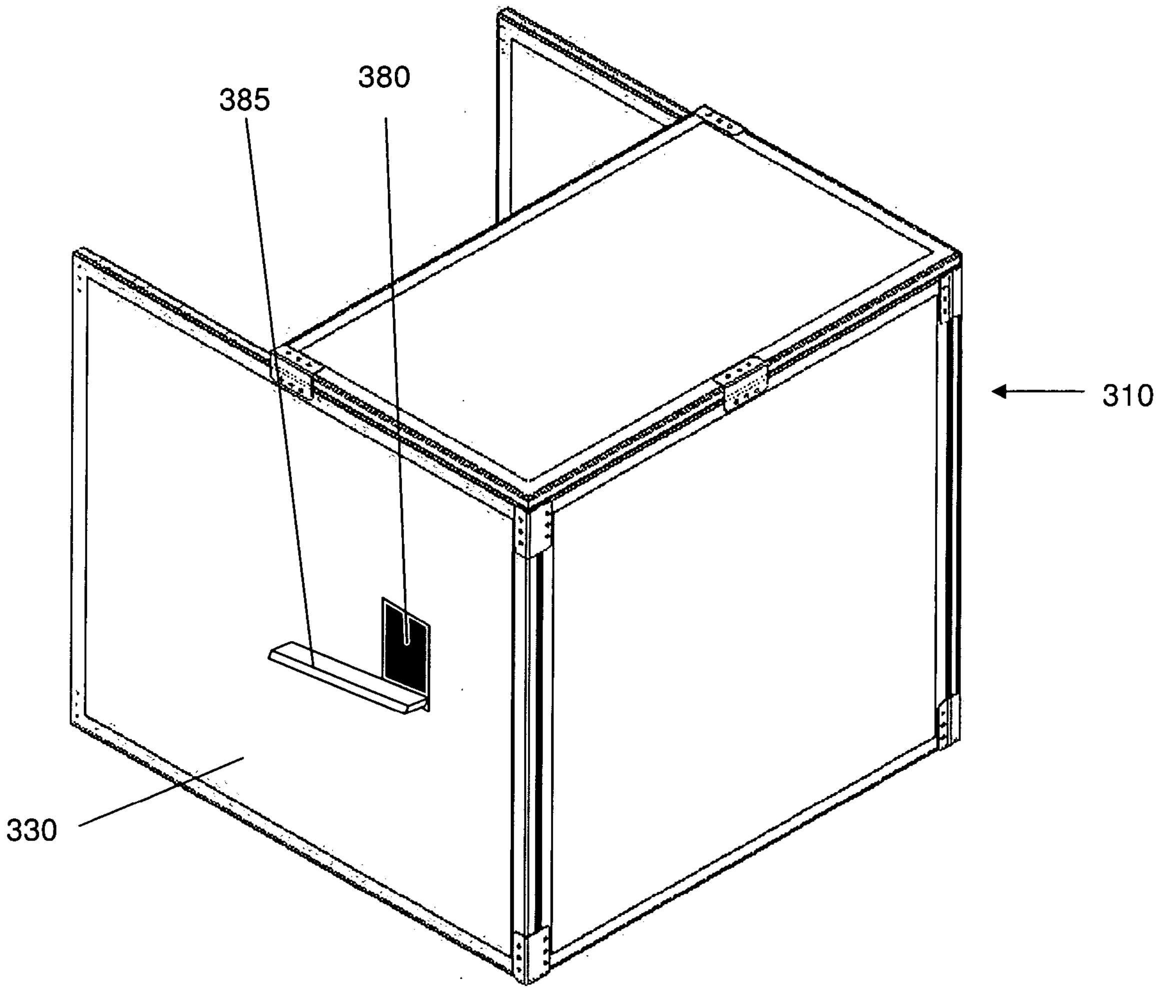


Fig. 4

MODULAR RADIATION SHIELDING SYSTEM AND RELATED METHODS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] Pursuant to 35 U.S.C. § 119(e), this application claims the benefit of U.S. Provisional Patent Application No. 60/928,020, filed May 7, 2007, which is incorporated herein by reference in its entirety.

[0002] Patients administered ^{18}F FDG (^{18}F-2-fluoro-deoxy-D-glucose), or other ^{18}F-labeled compounds for Positron Emission Tomography (PET) scanning present a potential radiation exposure concern to personnel in the surrounding area during the uptake (waiting) period prior to their scan. Normally, the room in which they reside during this time period, including mobile scanning facilities configured in a trailer or standard transportable container (e.g., Sea-Land container), is shielded with lead in the walls, floors and ceiling to keep exposures As Low As Reasonably Achievable (ALARA) and below regulatory limits. Limitations on this method include high costs of design, materials and labor in constructing a lead-lined room, as well as the requirement of construction, which is highly frowned-upon in a health-care setting for the release of dust and gasses, as well as noise. Further, once the room is modified, that room typically is permanently relegated for its intended duty, unless a new room is to be constructed with associated expense and disruption due to construction.

SUMMARY

[0003] Provided herein is a patient cubicle having a radiation-shielding lining. The cubicle is portable and typically modular in design in order to facilitate moving the cubicle. When modular (the cubicle comprises two or more sub-assemblies), the sub-assemblies are capable of disassembly and re-assembly in order to facilitate transport of the cubicle. The cubicle may comprise an access opening to facilitate injection of a patient, typically in the arm, with a radioactive substance. The access opening may comprise a shield extension and/or an arm-rest, to facilitate safe intravenous injection. The cubicle is constructed and used in a room which would provide radiation shielding of patients administered, e.g., ^{18}F-FDG, and which would eliminate the high cost and time involved in installing conventional shielding in the walls and ceiling or floor. Conventional whole-room shielding typically costs on the order of ten times more than cubicle shielding, when the cost of materials and facility customization and construction is considered. Further cost savings may be realized if the sub-assemblies are mass-produced, adding significant efficiency to the manufacturing process, and thus further lowering costs to the end-used. This concept also allows for versatility in relocating the shielding to a different room or adding additional shielding with minimal down time.

[0004] According to one non-limiting embodiment, a portable cubicle is provided. The cubicle comprises one or more walls comprising radiation shielding and is configured to house a patient. The radiation shielding is of sufficient thickness to reduce, at a point outside the cubicle, exposure from the cubicle from a source of ^{18}F γ radiation emitted within the cubicle by at least one of about 60%, about ⅔, about 70%, or about 90%, including any integer and non-integer increment within those ranges, in other words to reduce to acceptable levels radiation exposure from radioactive substances administered to a patient, when the patient is within the cubicle.

[0005] One or more of the walls, and typically all walls of the cubicle comprise radiation shielding between a plurality of outer layers. The outer layers can be any material, for example and without limitation, fabrics, laminates (e.g. Formica, a melamine laminate with paper or plastic), plastics, metals such as foamed aluminum, glass, composites such as Corian, etc. In a typical assembly, walls facing the outside of the cubicle can be any material, which can be selected solely on an aesthetic basis. The same can be true for surfaces facing the inside of the cubicle, though typically, this inward-facing surface will be solid and thus non-porous and therefore, easily cleaned. Non-limiting examples of non-porous solid surfaces are stainless steel or a polymer or polymer-mineral composite, such as Corian (polymethyl methacrylate combined with aluminum trihydrate, DuPont) surfaces. In one embodiment, the wall comprises a layer of foamed aluminum. In one non-limiting embodiment, one or more of the outer layers comprises a non-porous surface facing away from the radiation shielding, which typically faces the inside of the cubicle, to facilitate cleaning. The walls may further comprise an additional layer of material between the outer layers, for example and without limitation to add thickness and/or structural integrity to the wall. The layer(s) may be a material selected from one or more of wood, wood boards, plywood, medium or high density particle board, fiber board, wafer board, oriented strand board, a metal or metal alloy, steel, stainless steel, aluminum, a wood composite material, fiberglass, a polymeric compound, a polymeric honeycomb, or combinations thereof. In certain non-limiting embodiments, the radiation shielding comprises one or more of: lead, tungsten, steel and/or alloys and/or combinations thereof. In one particular embodiment, the radiation shielding comprises lead, and typically, lead sheet of between from about 0.25" to about 0.5" in thickness.

[0006] To facilitate administration of radioactive substances to a patient within the cubicle, the cubicle may comprise an opening of any shape, including square, rectangular, circular, oval, etc., in one or more walls configured such that a patient within the cubicle can extend an arm outside the cubicle (located in one or more walls of the cubicle at a level and position so that a patient within the cubicle can extend an arm outside the cubicle to receive an intravenous injection in that arm). The cubicle may further comprise an arm-rest attached to an outer wall of the cubicle adjacent to the opening. The arm rest may comprise radiation shielding.

[0007] To facilitate shipping, placement, and re-location of the cubicle, according to one non-limiting embodiment, the cubicle is modular. In other words, the cubicle may comprise one or more sub-assemblies into which the cubicle can be disassembled and from which the cubicle can be re-assembled. In one instance, the cubicle comprises three side panels attached to each-other by fasteners. Panels are substantially planar elements having a nominal thickness (typically, though without limitation, in the range of from about 0.5" to about 2"), like panels found in typical office cubicles. To prevent radiation from escaping upwards or downwards, when necessary, the cubicle further comprises a top panel comprising the radiation shielding. To facilitate manufacture, the side panels are the same size and/or the side panels each comprise two sub-panels. In one embodiment, other than joinery (including, without limitation, fasteners and holes or other adaptations of the panels or parts thereof used in joining

parts of the cubicle together), the sub-panels of each of the side panels have identical dimensions (within acceptable tolerances in the relevant industry). The top panel may be identical to a single sub-panel used to make the side panels. In that embodiment, a cubicle can be made from seven sub-panels of identical size, further increasing manufacturing efficiency. Flooring comprising the radiation shielding also may be employed when necessary. The flooring may be tiles or may be panels or sub-panels, including sub-panels identical to those used for the sides and top.

[0008] Practically and typically, due to weight and location considerations, the cubicle has dimensions of from about 55" to about 72" in height, from about 36" to about 78" in width and from about 36" to about 78" in depth (see, FIGS. **1**A and **1**B for description of height (H), width (W) and depth (D)).

[0009] According to another embodiment, an environmental shielding method comprising employing a cubicle described herein, for example and without limitation, as described above, as a radiation shield to reduce at a point outside the cubicle exposure from the cubicle from a source of ^{18}F γ radiation emitted within the cubicle by at least about ⅔ (about 66.66%), including, without limitation, at least one of about 60%, about ⅔, about 70%, or about 90%, including any integer and non-integer increment within those ranges. The radiation source typically is a patient.

[0010] Also provided herein is a kit for producing the cubicle described herein, for example and without limitation, as described above, comprising three side panels and fasteners for assembling the side panels into a cubicle, wherein each of the side panels comprise radiation shielding of sufficient thickness to reduce at a point outside the cubicle exposure from the cubicle from a source of ^{18}F γ radiation emitted within the cubicle by at least about ⅔ (about 66.66%), including, without limitation, at least one of about 60%, about ⅔, about 70%, or about 90%, including any integer and non-integer increment within those ranges. The kit may further comprise a top panel comprising the radiation shielding.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIGS. **1**A-**1**E show schematically a first non-limiting embodiment of a cubicle as described herein. FIG. **1**B is a side view of the cubicle of FIG. **1**A. FIG. **1**C is an exploded view of the cubicle of FIG. **1**A. FIGS. **1**D and **1**E are close-up views of joinery of the cubicle shown in FIG. **1**A.

[0012] FIGS. **2**A-**2**D show schematically the structure of one non-limiting embodiment of a panel used in constructing a cubicle as described herein, for example and without limitation, as is shown in FIG. **1**A. FIG. **2**B is a cross-section of the panel shown in FIG. **2**A. FIG. **2**C is a close-up of the details of the frame shown in FIG. **2**B. FIG. **2**C is an exploded view of the panel shown in FIG. **2**A.

[0013] FIG. **3** shows schematically the structure of one non-limiting embodiment of a panel comprising two sub-panels used in constructing a cubicle as described herein, for example and without limitation, as is shown in FIGS. **1**A and/or **2**A.

[0014] FIG. **4** shows schematically one non-limiting embodiment of a cubicle as described herein comprising an opening and an arm rest.

DETAILED DESCRIPTION

[0015] Described herein is a portable cubicle for use in shielding a single radiation-emitting patient. The cubicle is designed to reduce exposure to others outside the cubicle from radiation emitted from the patient. As described above, without limitation, radiation typically is emitted from ^{18}F-labeled compounds injected into patients in preparation for PET scanning. Without shielding, health-care providers and others in the vicinity of the patient emitting radiation can suffer exposure to the radiation above acceptable limits. By "acceptable limit(s)" it is meant the maximum acceptable environmental exposure to radiation acceptable under any relevant standard, including regulatory standards (for example and without limitation, ALARA), or facility-specific standards promulgated by any authority, person(s) (for example and without limitation, radiation safety officers), etc. The (maximum) acceptable limit(s) may be determined by any useful method, including, without limitation, monitoring of radiation badges on health-care workers and/or monitoring devices (for example and without limitation, badges, counters, etc.) placed in the vicinity of the cubicle. A sheet of lead ranging in thickness of between ¼" and ½" is one example of a product that will reduce radiation levels to below acceptable limits in a typical setting where a patient is injected with an amount of ^{18}F FDG in typical amounts useful for PET scanning procedures. This amount of shielding is capable of reducing exposure to ^{18}F radiation by at least about ⅔, which is considered to be an "acceptable amount".

[0016] By "portable", it is meant that the radiation shielding is not installed as part of the walls of a building, trailer or container (facility), e.g., of a room or other internal space of a facility, in which it is housed, though one or more walls of the cubicle can be attached to one or more walls of the room for stability. Like a piece of furniture, the cubicle is free-standing, though it may abut one or more walls of a facility and even partly rely on abutting or attachment to the wall(s) for support, it is smaller than the room of the facility in which it is housed, and it can be moved to different locations within the room, or removed from the room either in its fully assembled state, or when disassembled into subassemblies, such as panels. Once again, like a piece of furniture, movement of the cubicle within a room or into another room does not require room, space or facility design or re-design considerations, engineering or construction, unless the place where the cubicle is being moved to is simply unable to accommodate the size and/or weight of the cubicle, or is being re-designed for other reasons, such as aesthetic or logistical reasons. As an example, though the cubicle may be attached to or abut one or more walls of a facility for stability, portions of the portable cubicle are not designed and/or engineered into or onto a wall of any given facility, though a scanning facility, especially a modular facility such as a shipping container or trailer, may be designed or engineered to include a portable cubicle.

[0017] A "cubicle" is a furniture-like structure in which a person can sit or stand and is not necessarily cubical in shape. In the context of the present disclosure, although a cubicle may completely surround a person on all sides by including a door in one side, it typically has an opening through which a person can enter or exit the cubicle, rather than a door, so as to prevent claustrophobic reactions. In one embodiment a cubicle has a square or rectangular profile when viewed from above, and the opening comprises all or part of one of the four sides of the rectangle or square. In another embodiment, the cubicle when viewed from above has one or more curved walls. In either case, the opening may be without limitation from about 24" to about 72" wide, in other words, sufficiently large to facilitate comfortable entry and egress of a patient and/or health care workers into and out of the cubicle.

[0018] The size of the cubicle can be any useful size. It is constrained on the minimum end by the size of a typical patient, the desire to avoid claustrophobia in that patient, and the desire to shield portions of the patient's body in which the radioactive substance accumulates (e.g., for ^{18}F FDG, brain, heart and bladder). At the maximum end, the cubicle is constrained by considerations such as the weight of the cubicle or sub-assemblies thereof in order to facilitate portability, the size of a typical room into which the cubicle is placed in order to provide space to move about the room around the cubicle, and/or to place more than one cubicles in the same room, and the cost unnecessarily large panels. Thus, the cubicle may be, without limitation, from about 3 to about 6 feet wide (including increments (including fractional increments) therebetween, such as 3, 3.5, 4, 4.5, 5 and 5.5 feet), from about 4 to about 6 feet tall (including increments (including fractional increments) therebetween, such as 4, 5 and 6 feet), and from about 2 to about 5 feet deep (including increments (including fractional increments) therebetween, such as 2, 3, 4, and 5 feet).

[0019] Provided herein is a portable cubicle comprising one or more walls configured to house a patient, the walls comprising radiation shielding in an amount effective to block to acceptable levels radiation emitted from a patient from escaping the cubicle. The radiation shielding is of sufficient thickness to reduce, at a point outside the cubicle, exposure from the cubicle from a source of ^{18}F γ radiation emitted within the cubicle by at least one of about 60%, about ⅔, about 70%, or about 90%, including any integer and non-integer increment within those ranges, in other words to reduce to acceptable levels radiation exposure from radioactive substances administered to a patient, when the patient is within the cubicle. The cubicle can have any acceptable shape, with curved or planar walls (meaning substantially or essentially planar walls or panels). In practice, the walls more typically might be planar due to cost, placement and manufacturing considerations, though curved portions of the cubicle are possible and may be more aesthetically pleasing in one or more instances. In use, a patient is typically sitting and reclining in a chair or recliner. The cubicle extends around the sides and a roof of similar or identical shielding qualities and structure as the side walls might extend above a patient, if needed. To prevent claustrophobia, the cubicle typically will have an opening. Because radiation will escape through any openings, the openings would face unoccupied or transiently occupied (hallways) portions of the facility in which the cubicle is housed. For example, the opening could face an outer wall of the facility in which the cubicle is placed, or a lesser-used part of the facility. The cubicle may comprise a floor portion comprising radiation shielding useful when occupied or potentially occupied rooms are located below the cubicle. A floor portion would be unnecessary if an unoccupied part of the building, or nothing (e.g., soil) is located below the cubicle. The floor portion can have the same structure and/or radiation shielding qualities as a wall or roof of the cubicle. Similarly, the cubicle may not need a roof section if there are no occupied areas above the patient.

[0020] For ease and efficiency of manufacture and ease of shipping and handling, according to one non-limiting embodiment, the cubicle may be modular and manufactured from planar sub-assemblies. The planar sub-assemblies can be formed from single-sized panels, thus further increasing the efficiencies of manufacture and assembly. Walls of the cubicle typically are multi-layered, and comprise a layer of radiation shielding between suitable outer layers. The radiation shielding can be any useful material, including without limitation, lead, tungsten, steel and/or alloys and/or combinations thereof, lined plywood or gypsum, lead wool, strips or corner strips. Though less desirable for the thickness of material required for effective shielding, lead oxide glass and/or leaded acrylic may be used for viewing, or to let light enter the cubicle. As described above, the amount of radiation shielding is effective to reduce radiation escaping the cubicle by a factor of three to ten (0.25 to 0.5 inches of lead).

[0021] Outer layers of the walls of the cubicle may be of any suitable material, including fabrics, laminates (e.g. Formica, a melamine laminate with paper or plastic), plastics, metals, glass, composites, etc. In a typical assembly, walls facing the outside of the cubicle can be any material, which can be selected solely on an aesthetic basis. The same can be true for surfaces facing the inside of the cubicle, though typically, this inward-facing surface will be solid and thus non-porous and therefore, easily cleaned. Non-limiting examples of non-porous solid surfaces are stainless steel or a polymer or polymer-mineral composite, such as Corian (polymethyl methacrylate combined with aluminum trihydrate, DuPont) surfaces. In one embodiment, the wall comprises a layer of foamed aluminum, for example and without limitation, as described in United States Patent Application Publication No. 20060243095. This material is lightweight and can be layered adjacent to the radiation shielding and/or on an outer surface of the wall to provide structural support to the wall. Other materials for use a structural support include, without limitation: a wood, such as wood boards, plywood, medium or high density particle board, fiber board, wafer board, oriented strand board and/or a wood composite material; a metal or alloys thereof, such as steel, stainless steel, aluminum; fiberglass; a polymeric compound, such as a polymeric honeycomb (e.g, Nida-Core H8PP structural polymeric honeycomb, available from Nida-Core of Port St. Lucie, Fla.).

[0022] The cubicle may be an assembly of sub-assemblies, such as substantially planar panels. The sub-assemblies preferably are attached in a manner that permits disassembly and reassembly of the cubicle at the same or different location. Any useful attachment (joinery) option may be used for this purpose. For example and without limitation, metal brackets can be used to attach panels together. Brackets can be "L" brackets, or any other useful brackets. In another embodiment, interlocking joinery, such as, without limitation, tongue and groove or notch and tab mechanisms, or any other joinery may facilitate assembly and disassembly of the sub-assemblies and creating a joint between sub-assemblies of sufficient strength and stability. So long as the joinery is sufficiently strong to support the structure, it is useful. Joinery variations will be appreciated and understood by those of skill in the relevant art, and any such variations are considered to be within the scope of the present invention. As used herein any joinery, such as without limitation, screws, bolts, brackets interlocking joinery, hooks, hook and loop fasteners, hinges, etc., used to attach sub-assemblies are considered to be "fastener(s)," and the use of such fasteners is considered to be "fastening."

[0023] Sub-assemblies typically are fastened to one another (joined) in a manner that minimized gaps between the sub-assemblies. Overlapping the sub-assemblies typically will suffice, though lead strips, lead wool (caulking) or other shielding strips may also be used.

[0024] One or more openings may be provided in one or more walls of the cubicle. In one embodiment, the opening is configured into a wall at a position to facilitate extension of a patients arm from within the cubicle to outside the cubicle. This will allow a health care provider to inject the patient with the radioactive compound with minimal exposure. The armrest may be provided so that the patient has a place to rest his/her arm during injection. The arm rest may comprise radiation shielding to further minimize exposure of the health-care provider to radiation.

[0025] The cubicle also may comprise microphones, speakers, call buttons, video cameras, and monitors.

[0026] FIGS. **1**A-**1**E are schematic drawings of one non-limiting embodiment of a cubicle described herein. FIG. **1**A shows the structure of the assembled cubicle **10**. FIG. **1**C is an exploded view of the same cubicle **10**. Rear panel **20** is attached to side panels **30** and **40** and, optional, top panel **50** using brackets **60**. Rear panel **20** is opposite the opening **25** of the cubicle. FIG. **1**B is a side view of cubicle **10** shown in FIG. **1**A, viewed from the side of side panel **30**. Brackets **60** are one embodiment of fasteners useful for assembling cubicle **10**. Variations in the size of brackets **60**, as well as their structure, or joinery alternatives to brackets **60** are contemplated, and a matter of design choice to one of average skill in the relevant field(s). For reference and to facilitate description, and without any intent to limit the scope of the present disclosure, relative orientation of the width (W), height (H) and depth (D) are illustrated in FIGS. **1**A and **1**B and, along with relative terms front, rear, top and side, are used as a convention herein to describe the relative position and orientation of elements of the cubicles described herein. Nevertheless, those terms are descriptive of a typical orientation of a described cubicle when in use. FIGS. **1**B, **1**D and **1**E show frames **65**, described in further detail below, and used to increase structural integrity and facilitate joinery of the cubicle **10**. FIGS. **1**D and **1**E are close-up views of portions of cubicle **10**, showing joinery between panels **30** and **50** (FIG. **1**D) and panels **20**, **30** and **50** (FIG. **1**E).

[0027] In certain non-limiting embodiments, cubicle **10** is about 5.5' (5.5 feet) deep (D), 5' wide (W), and 5' or 5.5' tall (H), not accounting for about 1-4" (1 to three inches) additional width, height and depth when accounting for panel overlap at the joined edges of the panels. All panels typically are about 1.5±0.5" in thickness. In this embodiment, side panels **30** and **40** and rear panel **20** are about 60-66"×60-66" and top panel is about 60-66"×24-48".

[0028] FIGS. **2**A-**2**D show schematically the structure of one embodiment of a panel useful in constructing a cubicle, for example and without limitation, as shown in FIG. **1**A. Shown in FIG. **2**A is a side panel **130** showing frame **165** and holes **167** drilled/tapped in frame **165** and into panel **130** to accommodate screws or bolts when assembled into a cubicle. FIG. **2**B shows a cross-section of panel **130** along plane A of FIG. **2**A. FIG. **2**D is an exploded view showing the structure of the panel **130** of FIG. **2**A. In FIGS. **2**B and **2**D, along with frame **165**, shown are first outer layer **170**, second outer layer **171** and inner layer **172** sandwiched between outer layers **170** and **172**. Inner layer **172** is a radiation shield, for example and without limitation ¼" to ½" thick lead sheeting. FIG. **2**C is a close-up of one end of the cross-section shown in FIG. **2**B, cut off at phantom line B of FIG. **2**B. Details of frame **165** of FIG. **2**B are shown. FIG. **2**C shows the frame **165** comprises a first "L" bracket **166** and a second "L" bracket **167**. "L" brackets **166** and **167** of frame **165**, independently can be made of any suitable structural material, including, without limitation, steel, stainless steel, aluminum, and can be finished in any suitable manner, by coating with a paint, resin, etc. by spray-coating, dipping, electrodeposition, etc. Outer layers **170** and **171** can be the same or different materials, such as laminate, plastic, glass, metal, composite, etc. In one embodiment, the layer of outer layers **170** and **171** that is to face the inside of the cubicle when assembled is a solid, non-porous surface, such as, without limitation, stainless steel, a polymer or a composite, such as Corian (DuPont).

[0029] Layers of panels may be attached to each-other by use of adhesives, screws, fasteners, heat lamination, or by any other useful method. The frame may be used to keep layers of the panel together. Depending on the nature of the layers, different methods can be used to apply, attach or affix the layers to each-other. For example and without limitation, a layer that faces outward from the cubicle may be spray-coated or heat-laminated. Due to the malleable qualities of lead, however, it is preferred that one or both of the layers afford structural strength to the panel. In one embodiment, an additional layer is sandwiched between the outer layers. This additional layer can comprise plywood, steel, plastic (polymer), composites, aluminum or any other material that could add structural integrity to the panel.

[0030] FIG. **3** shows an alternate embodiment of side panels **30** of FIG. **1**A and **130** of FIG. **2**A. In this embodiment, side panel **230** is assembled from sub-panels **231** and **232**, which, in one non-limiting embodiment has the same overall structure of panel **130** of FIG. **2**A. Sub-panels **231** and **232** are joined by brackets **261**. The benefit of this structure is that, in reference to the schematic cubicle structure of FIG. **1**A, rear panel **20** and side panels **30** and **40** can be constructed in the manner of panel **230** of FIG. **3** from two sub-panels panels each, and top panel **50** of FIG. **1**A can be constructed of a single sub-panel. In one non-limiting embodiment the two sub-panels of each side panel and rear panel are identical except for drill hole placement, and top panel is identical to the sub-panels of the side and rear panels. In this embodiment, only one size panel needs to be produced to generate the seven panels needed for this cubicle structure, greatly increasing manufacturing efficiency. Dimensions of the panels, according to one non-limiting embodiment are 60-66"×24-36", for example and without limitation, 60"×30", 66"×30", 60"×36" or 66"×36". In another embodiment, the subpanels have dimensions n×2n so that when placed side-by-side, the sub-panels form a 2n×2n square panel. In another embodiment, sub-panels used to make the side and rear panels are the same size, but top panel is a single, wider panel to provide further coverage above a patient. For example and without limitation, sub-panels used to make the side and rear panels can be 60-66"×30", while top panel can be 60-66"×36".

[0031] FIG. **4** shows a schematic of one embodiment of a cubicle described herein, for example and without limitation, as described in relation to FIG. **1**A. Cubicle **310** is shown with an opening in side wall **330** including an opening **380** in side wall **330** with an arm rest **385**. Opening **380** is configured in side wall so that a patient within cubicle **310** can extend her arm out of cubicle **310** through opening. The patient can rest his/her arm on arm rest **385** to facilitate intravenous administration of ^{18}F FDG, or another radioactive compound. Arm rest **385** can comprise integral or additional radiation shielding material to block egress off γ-radiation to the extent the shielding is interposed between a patient and a health care provider. Cubicle **310** may comprise a door or other covering panel, comprising radiation shielding to cover opening **308** when not in use (not shown). Arm-rest can be any useful shape, and can curve upward (in the "H" axis shown in FIG. **1**B) as it extends away from cubicle **310** to afford greater protection to a health care worker administering a composition to a patient. An arm rest may be provided in one side wall or both, so that either arm of a patient may be used.

[0032] In use, a cubicle, such as, without limitation, the cubicles described in relation to the Figures, can be prepared as ready-to-assemble kits, comprising panels and joinery (fasteners, such as brackets and screws or bolts and nuts), and, optionally and tools necessary for assembly of the cubicle. Although quite heavy, due to the radiation shielding, the panels and necessary joinery, and optional accessories and tools can be co-packaged in one or more crates, pallets or any other suitable material, and shipped to the site of assembly. As with a typical office cubicle, the cubicles described herein can be readily assembled, disassembled and re-assembled on-site, so long as sufficient safety measures are taken into account due to the heavy weight of the panels and/or sub-assemblies. As described above, if necessary a roof panel and/or flooring material comprising radiation shielding may be co-packaged with the cubicle to shield areas below the cubicle. The flooring material can have the same structure as the panels, or may be shielding tiles. Once again, as described in relation to FIG. **3**, to achieve greater economy of scale, the same sub-panels used to make the side panels, rear panel and top panel may be used for flooring. The flooring need not be attached to the side and rear panels, though one may do so, perhaps to afford greater structural strength or superior shielding at the bottom of the cubicle.

EXAMPLE

[0033] The clinical use of fluorine-18 fluorodeoxyglucose (FDG) in positron emission tomography (PET) for metabolic imaging is expanding rapidly for the diagnosis and therapy management of oncological patients. Since the patient becomes the radioactive source after administration of the FDG, and with the 511 keV annihilation photons, shielding is often required in the room that the patient occupies during the one-hour uptake period prior to scanning. Our PET facility was designed 4 years ago using an estimated workload of 5 patients per day and a dosage of 370 MBq of FDG. This workload has increased up to 16 patients per day and a dosage of 555 MBq of FDG, with projections to scan even more patients using higher activities in the future. This level of radiation created the need to either install additional shielding or limit the number of studies being performed. Two lead lined cubicles were designed, substantially as described above, and installed in the patient uptake room which provided the necessary shielding to reduce exposures into the surrounding areas to acceptable levels. Use of the shielded cubicles have also resulted in a lowering of the PET technologist's exposures by reducing patient contact time and providing shielding of the body during administration of the FDG. The cost and down time for construction and installation of the shielded cubicles was estimated to be less than 10 percent of what it would have taken to install lead shielding in the walls and ceiling of the room. Use of the shielded cubicles in the patient uptake room has allowed our PET facility to continue to increase the number of studies being performed while reducing radiation exposures into the surrounding areas and to the PET technologists.

[0034] Having described this invention above, it will be understood to those of ordinary skill in the art that the same can be performed within a wide and equivalent range of conditions, formulations and other parameters without affecting the scope of the invention or any embodiment thereof.

We claim:

1. A portable cubicle comprising one or more walls comprising radiation shielding, configured to house a patient, wherein the radiation shielding is of sufficient thickness to reduce, at a point outside the cubicle, exposure from the cubicle from a source of ^{18}F γ radiation emitted within the cubicle by at least about 60%.

2. The cubicle of claim **1**, wherein the radiation shielding is of sufficient thickness to reduce exposure from the cubicle from a source of ^{18}F γ radiation emitted within the cubicle by at least about 75%.

3. The cubicle of claim **1**, wherein the radiation shielding is of sufficient thickness to reduce exposure from the cubicle from a source of ^{18}F γ radiation emitted within the cubicle by at least about 90%.

4. The cubicle of claim **1**, wherein one or more of the walls comprise a radiation shielding layer between a plurality of outer layers.

5. The cubicle of claim **4**, wherein one or more of the outer layers comprises a non-porous surface facing away from the radiation shielding.

6. The cubicle of claim **4**, wherein one or more of the walls further comprise an additional layer of material between the outer layers.

7. The cubicle of claim **6**, wherein the additional layer is a material selected from one or more of wood, wood boards, plywood, medium or high density particle board, fiber board, wafer board, oriented strand board, a metal or metal alloy, steel, stainless steel, aluminum, foamed aluminum, a wood composite material, fiberglass, a polymeric compound, a polymeric honeycomb, or combinations thereof.

8. The cubicle of claim **1**, wherein the radiation shielding comprises one or more of: lead, tungsten, steel and/or alloys and/or combinations thereof.

9. The cubicle of claim **1**, wherein the radiation shielding comprises lead.

10. The cubicle of claim **1**, wherein the radiation shielding comprises lead sheet of between from about 0.25" to about 0.5" in thickness.

11. The cubicle of claim **1**, comprising an opening in one or more walls configured such that a patient within the cubicle can extend an arm outside the cubicle.

12. The cubicle of claim **11**, further comprising an arm-rest attached to an outer wall of the cubicle adjacent to the opening.

13. The cubicle of claim **12**, wherein the arm rest comprises radiation shielding.

14. The cubicle of claim **1**, comprising one or more sub-assemblies into which the cubicle can be disassembled and from which the cubicle can be re-assembled.

15. The cubicle of claim **14**, wherein the cubicle comprises three side panels attached to each-other by fasteners.

16. The cubicle of claim **15**, further comprising a top panel comprising the radiation shielding.

17. The cubicle of claim **15**, wherein the side panels are the same size.

18. The cubicle of claim **17**, wherein the side panels each comprise two sub-panels.

19. The cubicle of claim **18**, wherein, other than joinery, the sub-panels of each of the side panels have identical dimensions.

20. The cubicle of claim **1**, having dimensions of from about 55" to about 72" in height, from about 36" to about 78" in width and from about 36" to about 78" in depth.

21. An environmental shielding method comprising employing the cubicle of claim **1** as a radiation shield to reduce at a point outside the cubicle exposure from the cubicle from a source of ^{18}F γ radiation emitted within the cubicle by at least about 60%, including any integer and non-integer increment within that range.

22. The method of claim **21**, wherein the radiation source is a patient.

23. A kit for producing the cubicle of claim **1**, comprising three side panels and fasteners for assembling the side panels into a cubicle, wherein each of the side panels comprise radiation shielding of sufficient thickness to reduce at a point outside the cubicle exposure from the cubicle from a source of ^{18}F γ radiation emitted within the cubicle by at least about 60%.

24. The kit of claim **23**, further comprising a top panel comprising the radiation shielding.

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