

CLAIMS

1. A soundproof enclosure (10) comprising:

5 a plurality of acoustical wall panels (12) interconnectable each to another at opposing vertical side edges (12f) for enclosing an interior space (41), each of the acoustical wall panels (12) having a bottom edge provided with a bottom flange (12e) adapted to be supported on a floor base unit (11) or on a floor and a top edge provided with a top flange (12d), wherein at least a portion of a front wall panel (12a) is movably connected at one vertical side edge between an open
10 position and a closed position for providing and covering an access opening (15) in which the portion forms at least one access door panel of rigid material; and

a multilayer decoupling ceiling unit (13) disposed on the top edges of the acoustical wall panels (12) for forming the enclosure, the multilayer decoupling ceiling unit (13) comprising:

15 a plurality of ceiling layers (17) having an intermediate core layer (19) supported by the top flanges (12d) at the top edges of the acoustical wall panels (12), the ceiling layers are vertically spaced apart from one another; and

a vertical wall member (16) upwardly extending from an outer periphery end of the intermediate core layer (19),

20 wherein the intermediate core layer (19) of the multilayer decoupling ceiling unit (13) which is disposed on the top flanges (12d) at the top edges of the acoustical wall panels (12), includes a decoupling element interposed between contacting surfaces of the intermediate core layer (19) and the top flanges (12d) for isolating and decoupling the ceiling unit (13) from the acoustical wall panels (12) to
25 provide the soundproof enclosure (10) with a desired sound impedance, and to enhance the sound absorption and insulation characteristics of the soundproof enclosure (10).

2. The soundproof enclosure (10) as claimed in claim 1, wherein the plurality of
30 ceiling layers of the ceiling unit (13) further comprises:

at least one upper covering layer (18) raised and suspended over the intermediate core layer (19) by bracket means (28) for defining at least one air flow passages (24) therebetween; and

at least one lower suspended layer (20) disposed suspended beneath the intermediate core layer (19) by bracket means (27) for defining at least one air flow passage (37) therebetween,

wherein the ceiling unit (13) includes an open exterior space within the vertical wall member (16) and the upper covering layer (18), which is divided into an air flow passage for intake (24) at one side and an air flow passage for exhaust (24) at the other side, for accommodating one or more air ventilation units within the air passages to circulate the exterior air into the enclosure (10) and to exhaust the interior air out from the enclosure (10); and

wherein the ceiling unit (13) includes an interior space in between the at least one lower suspended layer (20) and the intermediate core layer (19) which is divided into an air flow passage (37) for intake at one side and an air flow passage (37) for exhaust at the other side, for accommodating one or more air ventilation units within the air passages to circulate the exterior air into the enclosure (10) and to exhaust the interior air out from the enclosure (10).

3. The soundproof enclosure (10) as claimed in claim 1 or 2, wherein the ceiling unit (13) includes more than one upper covering layer (18) and more than one lower suspended layer (20) which are spaced apart from one another to provide sufficient surfaces for installation of various implements such as air circulation fans, split system air conditioner components, air-filters and sound silencers within the air passages.

4. The soundproof enclosure (10) as claimed in claim 2 or 3, wherein the lower suspended layer (20) of the ceiling unit (13) provides a corresponding gap (65) in between an inner wall layer (32) of the acoustical wall panel (12) and inner corners (47) of the lower suspended layer (20) for trapping sound waves and reducing sound reflection properties within the interior space (41), and wherein the inner corners (47) are formed with any surface topological treatment, such as jagged edges or rounded edges.

5. The soundproof enclosure (10) as claimed in any one of claims 1 to 4, wherein the ceiling unit (13) further comprises a plurality of ceiling units (13)

disposed on top of the plurality of acoustical wall panels (12) or a ceiling beam (80) for forming a whole ceiling unit of larger diameter.

6. The soundproof enclosure (10) as claimed in any one of claims 1 to 5, wherein the ceiling unit (13) having the intermediate core layer (19) formed with an extended diameter portion extending over and larger than the diameter of the constructed acoustical wall panels (12) and wherein the ceiling unit provides additional sound proofing features, weather protection features or aesthetic features.

7. The soundproof enclosure (10) as claimed in claim 1 or 2, wherein the vertical wall member (16) of the ceiling unit (13) is formed with its height being at least substantially the same as that of the height of the upper covering layer (18) and located at an appropriate distance from the openings (25) of the air flow passages (24) in the exterior space to form a sound barrier to the openings (25).

8. The soundproof enclosure (10) as claimed in claim 7, wherein when the vertical wall member (16) of the ceiling unit (13) is not at an appropriate distance to the openings (25), additional vertical wall members are constructed at the openings (25) to form additional sound barriers (79) to the openings.

9. The soundproof enclosure (10) as claimed in any one of claims 1 to 8, wherein the ceiling unit (13) further comprises an intersecting locking member (62) with sound and electrical insulating material (21) provided in between the intermediate core layer (19) of the ceiling unit (13) and the top flange (12d) at the top edge of the acoustical wall panel (12) or a horizontal wall member (16b) extended from the vertical wall member (16), and having the intersecting locking member (62) partially extended into the acoustical wall panel (12), and

whereby the intersecting locking member (62) can also be partially extended into the interior space (41) of the soundproof enclosure.

10. The soundproof enclosure (10) as claimed in any one of claims 1 to 9, wherein the ceiling unit (13) further comprises a layer of acoustic impedance material and electrical insulating material on a portion surface or all of the surfaces

of the intermediate core layer such that the entire ceiling unit (13) is completely sound and electricity isolated from the entire soundproof enclosure (10) by having all the contact surfaces between the top edge (12d) and the bottom contacting surface of ceiling unit (13) to be isolated accordingly, and

5 whereby the edge of the intermediate core layer (19) further comprises of a layer sound and electrical isolating material when the retaining wall (16) is attached to the top edge (12d) of the acoustical wall panel (12).

11. The soundproof enclosure (10) as claimed in claim 1 or 2, or any dependent
10 claim thereon, wherein each of the ceiling layers of the ceiling unit (13) further comprises a layer of low acoustic impedance material or sound insulating material on a portion surface or all of the surfaces of the ceiling layer.

12. The soundproof enclosure (10) as claimed in claim 1, wherein the multilayer
15 decoupling ceiling unit (13) is constructed into a portion or the whole of an acoustical wall (12) to obtain any or all the performance features of the ceiling unit (13).

13. The soundproof enclosure (10) as claimed in claim 2 or 3, or any dependent
20 claim thereon, wherein the intermediate core layer (19) comprises peripheral wall (16) or additional vertical flanges (79) of at least the same height added at locations of appropriate distance from the openings (25) of the air flow passages (24) in the exterior space to further enhance the sound barrier performance, whereby the vertical flanges (79) are extended downwardly from the upper covering layer (18)
25 and may be curved inwardly or outwardly.

14. The soundproof enclosure (10) as claimed in claim 2 or any dependent claim
thereon, wherein the air flow passage (24) for intake includes an intake opening (25)
and the air flow passage (24) for exhaust includes an exhaust opening (25) in the
30 exterior space which are on the opposite sides or substantially far apart from one another to allow for effective disposal of stale exhaust air from the interior space (41) and provide the fresh air intake into the interior space (41), and wherein the air flow passage (37) for intake includes an intake opening (43) and the air flow

passage (37) for exhaust includes an exhaust opening (43) in the interior space (41) which are on the opposite sides or substantially far apart from one another to allow for effective air circulation within the interior space (41) by allowing fresh air intake to be spaced apart from the air exhaust outflow.

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15. The soundproof enclosure (10) as claimed in claim 3, wherein the various implements may be disposed on top of the surface of the upper covering layer (18) in the open exterior space within the vertical wall member (16) of the ceiling unit (13).

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16. The ceiling unit (13) as claimed in claim 3 or 15, wherein the implements of the air-filters and sound silencers within the ceiling unit (13) are sufficiently porous to allow convectional air flow through such implements so that it does not require mechanical air circulation unit for air circulation.

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17. The soundproof enclosure (10) as claimed in claim 1, wherein the floor base unit (11) comprises a floor base plate (11a) formed of rigid material, at least one base frame (11b) for supporting the floor base plate (11a) and to allow for insertion of lifting arms of a pallet truck or forklift-vehicle below the floor base plate (11a) for elevating the floor base unit (11) to a level above the floor level, and a decoupling element to acoustically isolate and decouple the acoustical wall panels (12) from the floor base unit (11), and one or more layers of flooring material (55) provided on a top surface of the base frame (11a).

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25 18. The soundproof enclosure (10) as claimed in claim 17, wherein the floor base unit (11) may comprise a plurality of floor levellers (11c) and a set of peripheral side covers (11d) which can be disassembled and removed.

19. The soundproof enclosure (10) as claimed in claim 17 or 18, wherein the floor base unit (11) further comprises a set of castors (73) attached to the floor base frame (11b) at an elevated level above the floor level to allow the soundproof enclosure (10) to be easily moved, and

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wherein the soundproof enclosure (10) comprises of a plurality of floor levellers (11c) which adjusted to raise the floor base (11) above the caster levels such that the floor base (11) is subsequently resting solely on the set of casters (73) and hence the floor base (11) is secured from moving about, and

5 wherein in replacement of the set of casters (73) a plurality of lifting devices such as car jacks or lifting actuators (71) may perform the similar functions of the set of floor levellers (11c), and whereby lifting actuators may also be installed in the acoustical wall panels (12) or coupling poles (14).

10 20. The soundproof enclosure (10) as claimed in claim 17, wherein the decoupling element of the floor base unit (11) includes a set sound insulating gaskets (55) and a set of plurality of protruding rigid material (53) attached to the floor base (11) of thicknesses which are above the height level of the sound insulating gaskets (55) to elevate the acoustical wall panel bottom edge (12e) to
15 allow for easy and smooth movement of the acoustical wall panel (12) by opposing the weight of the acoustical wall panel (12) using the reduced friction of the two opposing rigid materials of the acoustical wall panel bottom edge (12e) and the protruding rigid material (53) until the precise assembly position between the acoustical wall panel (12) and the floor base (11) is arrived, and the two assembly
20 components will then lodge into precise position of protruding rigid material (53) matched to corresponding matching cavity in the acoustical wall panel bottom edge (12e), and

whereby instead the set sound insulating gaskets (55) and the set of plurality of protruding rigid materials (53) are attached to the acoustical wall panel bottom
25 edge (12e) and the matching cavity is found on the decoupling surface of the floor base unit (11) to achieve the same purpose, and

whereby instead of the set of plurality of protruding rigid materials (53), the same purpose is achieved by a set of plurality of upstanding rounded tip pins of rigid material (52), and

30 wherein the decoupling element of the ceiling unit (13) includes a set sound insulating gaskets (55) and a set of plurality of rigid materials protruding (53) attached to the ceiling unit (13) of thicknesses which are below the height level of the sound insulating gaskets (55) to elevate the ceiling unit (13) coupling surface to

allow for easy and smooth movement of the ceiling unit (13) by opposing the weight of the ceiling unit (13) using the reduced friction of the two opposing rigid materials of the acoustical wall panel top edge (12d) and the protruding rigid material (53) until the precise assembly position between the acoustical wall panel (12) and the ceiling unit (13) is arrived, and thereby the two assembly components will lodge into precise position of protruding rigid material (53) matched to corresponding matching cavity in the ceiling unit (13) coupling surface, and

whereby instead the set sound insulating gaskets (55) and the set of plurality of protruding rigid materials (53) are attached instead to the acoustical wall panel top edge (12d) and the matching cavity is found on the decoupling surface of the ceiling unit (13) to achieve the same purpose, and

whereby instead of the set of plurality of protruding rigid materials (53), the same purpose is achieved by a set of plurality of upstanding rounded tip pins of rigid material (52).

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21. A multilayer decoupling ceiling unit (13) comprising:

a plurality of ceiling layers having an intermediate core layer (19), at least one upper covering layer (18) raised and suspended over the intermediate core layer (19) by bracket means (28), and at least one lower suspended layer (20) disposed suspended beneath the intermediate core layer (19) by bracket means (27), wherein the ceiling layers are vertically spaced apart from one another to form air passages therebetween;

a vertical wall member (16) upwardly extending from an outer periphery end of the intermediate core layer (19); and

a decoupling element disposed at a bottom surface of the intermediate core layer (19) for isolating and decoupling the ceiling unit (13) from a contacting area of an enclosed space for the ceiling unit (13) to be supported thereon.

22. The multilayer decoupling ceiling unit (13) as claimed in claim 21, wherein the ceiling unit (13) comprises:

an open exterior space within the vertical wall member (16) and the upper covering layer (18), which is divided into an air flow passage for intake (24) at one side and an air flow passage for exhaust (24) at the other side, for accommodating

one or more air ventilation units within the air passages to circulate the exterior air into the enclosed space and to exhaust the interior air out from the space; and

an interior space in between the at least one lower suspended layer (20) and the intermediate core layer (19) which is divided into an air flow passage (37) for intake at one side and an air flow passage (37) for exhaust at the other side, for
5 accommodating one or more air ventilation units within the air passages to circulate the exterior air into the space and to exhaust the interior air out from the space.

23. The multilayer decoupling ceiling unit (13) as claimed in claim 21 or 22,
10 wherein the ceiling unit (13) comprises a drainage trough (88) provided along at least one of the edges of the intermediate core layer (19) and an outlet (86) extended outwards through the vertical wall member (16) for draining and channelling rain water out from the ceiling unit (13), and whereby the outlet (86) can extended into or along the acoustical wall panels (12) or the coupling poles
15 (14).

24. The multilayer decoupling ceiling unit (13) as claimed in any one of claims 21 to 23, wherein the ceiling unit (13) includes more than one upper covering layer (18) and more than one lower suspended layer (20) which are spaced apart from one
20 another to provide sufficient surfaces for installation of various implements such as air circulation fans, split system air conditioner units, air-filters and sound silencers within the air passages.

25. The multilayer decoupling ceiling unit (13) as claimed in any one of claims 21 to 24, wherein the lower suspended layer (20) of the ceiling unit (13) provides a
25 corresponding gap (65) in between a wall of the enclosed space and inner corners (47) of the lower suspended layer (20) for trapping sound waves and reducing sound reflection properties within the enclosed space, and wherein the inner corners (47) are formed with any surface topological treatment, such as jagged edges or rounded edges.
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26. The multilayer decoupling ceiling unit (13) as claimed in any one of claims 21 to 25, wherein the ceiling unit (13) further comprises one or more ceiling units in a

form of modular ceiling units disposed on top of the enclosed space or a ceiling beam (80) for forming a whole ceiling unit of larger diameter.

27. The multilayer decoupling ceiling unit (13) as claimed in any one of claims 21 to 26, wherein the ceiling unit (13) having the intermediate core layer (19) formed with an extended diameter portion extending over and larger than the diameter of the enclosed space and wherein the ceiling unit provides additional sound proofing features, weather protection features or aesthetic features.

28. The multilayer decoupling ceiling unit (13) as claimed in any one of claims 21 to 27, wherein the vertical wall member (16) of the ceiling unit (13) is formed with its height being at least substantially the same as that of the height of the upper covering layer (18) and located at a minimum distance from the openings (25) of the air flow passages (24) in the exterior space to form a sound barrier to the openings (25).

29. The multilayer decoupling ceiling unit (13) as claimed in claim 28, wherein when the vertical wall member (16) of the ceiling unit (13) is not at an appropriate distance to the openings (25), additional vertical flanges (79) are constructed at the openings (25) to form additional sound barriers to the openings, and whereby the vertical wall member (16) and the additional vertical flanges (79) are extended downwardly from the upper covering layer (18) and can be curved inwardly or outwardly to further enhance the sound barrier performance.

30. The multilayer decoupling ceiling unit (13) as claimed in any one of claims 21 to 29, wherein the ceiling unit (13) further comprises an intersecting locking member (62) with sound and electrical insulating material (21) provided in between the intermediate core layer (19) of the ceiling unit (13) and the contacting area of the enclosed space or a horizontal wall member (16b), and having the intersecting locking member (62) partially extended into the contacting area, and whereby the intersecting locking member (62) can also be partially extended into the interior space of the enclosed space.

31. The multilayer decoupling ceiling unit (13) as claimed in claim 21, wherein the ceiling layers of the ceiling unit (13) further comprises one or more layer(s) of low acoustic impedance material or sound insulating material on a portion surface or all of the surfaces of each of the ceiling layers.

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32. The multilayer decoupling ceiling unit (13) as claimed in claim 21, wherein the decoupling element is a layer of low acoustic impedance material or a sound insulating material (21) on a portion surface or all of the surfaces of the intermediate core layer (19) of the ceiling unit (13).

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33. The multilayer decoupling ceiling unit (13) as claimed in claim 23, wherein the various implements may be disposed on the upper covering layer (18) in the open exterior space within the vertical wall member (16) of the ceiling unit (13).

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34. The multilayer decoupling ceiling unit (13) as claimed in claim 33, wherein the implements of the air-filters and sound silencers within the ceiling unit (13) are sufficiently porous to allow convectional air flow through such implements so that it does not require mechanical air circulation unit within the enclosure (10).

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35. The multilayer decoupling ceiling unit (13) as claimed in any of claims 21 to 34, wherein the ceiling unit (13) may be constructed in a portion or the whole of a wall panel of an enclosure.

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36. The multilayer decoupling ceiling unit (13) as claimed any of claims 21 to 35, wherein the ceiling unit (13) further comprises one or more sound mufflers (57) to regulate sound exiting and entering the soundproof enclosure (10) at the air flow passages (24, 37) between the exterior and the interior of the soundproof enclosure (10) that provide external fresh external air circulation.

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37. A method of constructing a soundproof enclosure (10), the method comprising the steps of:

prefabricating a peripheral wall by:

interconnecting a plurality of acoustical wall panels (12) each to another at opposing vertical side edges to form an assembly of interconnected acoustical wall panels for enclosing an interior space (41), where each of the acoustical wall panels (12) having a bottom edge (12e) and a top edge (12d) opposite the bottom edge (12e);

providing at least a portion of one acoustical wall panel movably connected at one vertical side edge between an open position and a closed position for providing and covering an access opening (15); and

positioning the assembly of interconnected acoustical wall panels (12) at the bottom edge (12e) on a floor or floor base unit (11);

prefabricating a multilayer decoupling ceiling unit (13) by:

providing a vertical wall member (16) extending upwardly from an outer periphery end of an intermediate core layer (19) of the ceiling unit; and

abuttingly supporting a plurality of ceiling layers on top flanges at the top edges of the acoustical wall panels (12), the ceiling layers are vertically spaced apart from one another;

disposing the multilayer decoupling ceiling unit (13) on the whole or portion of top edges (12d) of the acoustical wall panels (12); and

attaching the ceiling unit (13) to the peripheral wall by a decoupling element interposed between the contacting surfaces and the peripheral wall for isolating and decoupling the ceiling unit (13) from the peripheral wall.

38. The method of constructing a soundproof enclosure (10) as claimed in claim 37, wherein the acoustical wall panel (12) having one or both the vertical side edges coupled to the coupling pole (14) to form a single unit of acoustical wall panel (12) to replace the need of use of one or both the coupling poles (14).

39. The method of constructing a soundproof enclosure (10) as claimed in claim 37 or 38, wherein the acoustical wall panels (12) are formed of varying sizes and shapes which may comprise of curved shape on one vertical side edge or both vertical side edges to form different typological top views profiles such as rectangular, hexagonal or octagonal that can be formed by flat shaped acoustical wall panels (12).

40. The method of constructing a soundproof enclosure (10) as claimed in any one of claims 37 to 39, wherein the method further comprises the step of providing at least a piece of handles (87) which can be releasably secured to components in the sequence of assembly needing to be carried, positioned, and assembled to form the soundproof enclosure (10) starting with releasably securing the set of handles (87) to the first component to assembly on to the floor base unit (11), and in the sequence to assemble the soundproof enclosure (10) begins with placing the floor base unit (11) onto a floor space, then installing all the acoustical wall panels (12), and finally placing the ceiling unit (13) on the top whereby the handles (87) will then be left on the ceiling unit (13) for future use.

41. The method of constructing a soundproof enclosure (10) as claimed in any one of claims 37 to 40, wherein the method includes the step of providing a piece of interlocking shape plate (81) of rigid and strong material to be releasably secured onto a matching cavity on a top edge (12d) of each of the two interconnected acoustical wall panels (12) to lock the two wall panels (12) together.

42. The method of constructing a soundproof enclosure (10) as claimed in any one of claims 37 to 41, wherein the acoustical wall panels (12) with the vertical side edges (12f) releasably coupled to one another or to a coupling pole (14) by conventional tongue and groove joining method or by conventional overlapping flanges joining method.

43. The method of constructing a soundproof enclosure (10) as claimed in any one of claims 37 to 42, wherein the acoustical wall panels (12) comprise of varying sizes, and bended on the vertical axis to form varying curved shapes, are interconnected to one another on the vertical side edge or to a coupling pole (14), to form a soundproof enclosure (10) of different typological top views profiles .