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(54) **MODULAR SUSPENDED CEILING AND METHOD OF INSTALLATION SAME**

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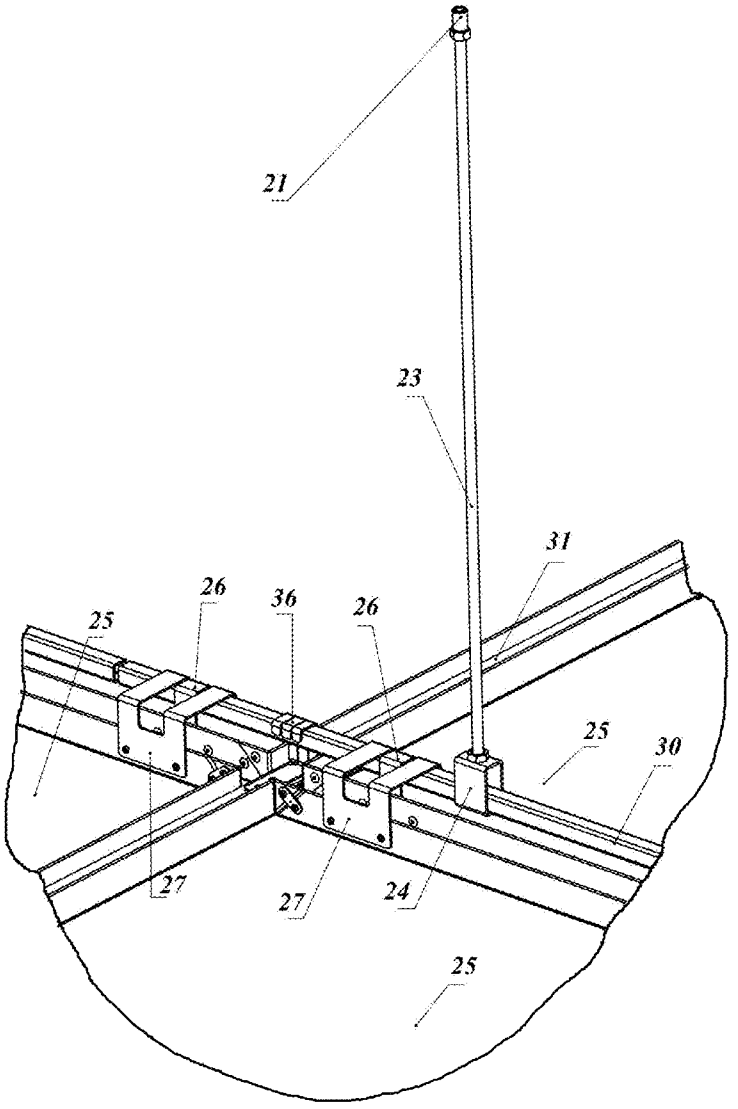
(57) **ABSTRACT**

A modular suspended ceiling assembly is provided having by multiple panels formed by spaced from each other first and second connecting walls, with first and second main brackets connected to the first connecting wall. First and second auxiliary brackets connected to the second connecting wall. A plurality of suspension members with each suspension member being connected to a hollow support structure. A guide passes through the hollow support structure. A module is formed by adjacent panels supported by the single guide passing through the support structure and accompanied by engagement of the main and auxiliary brackets.



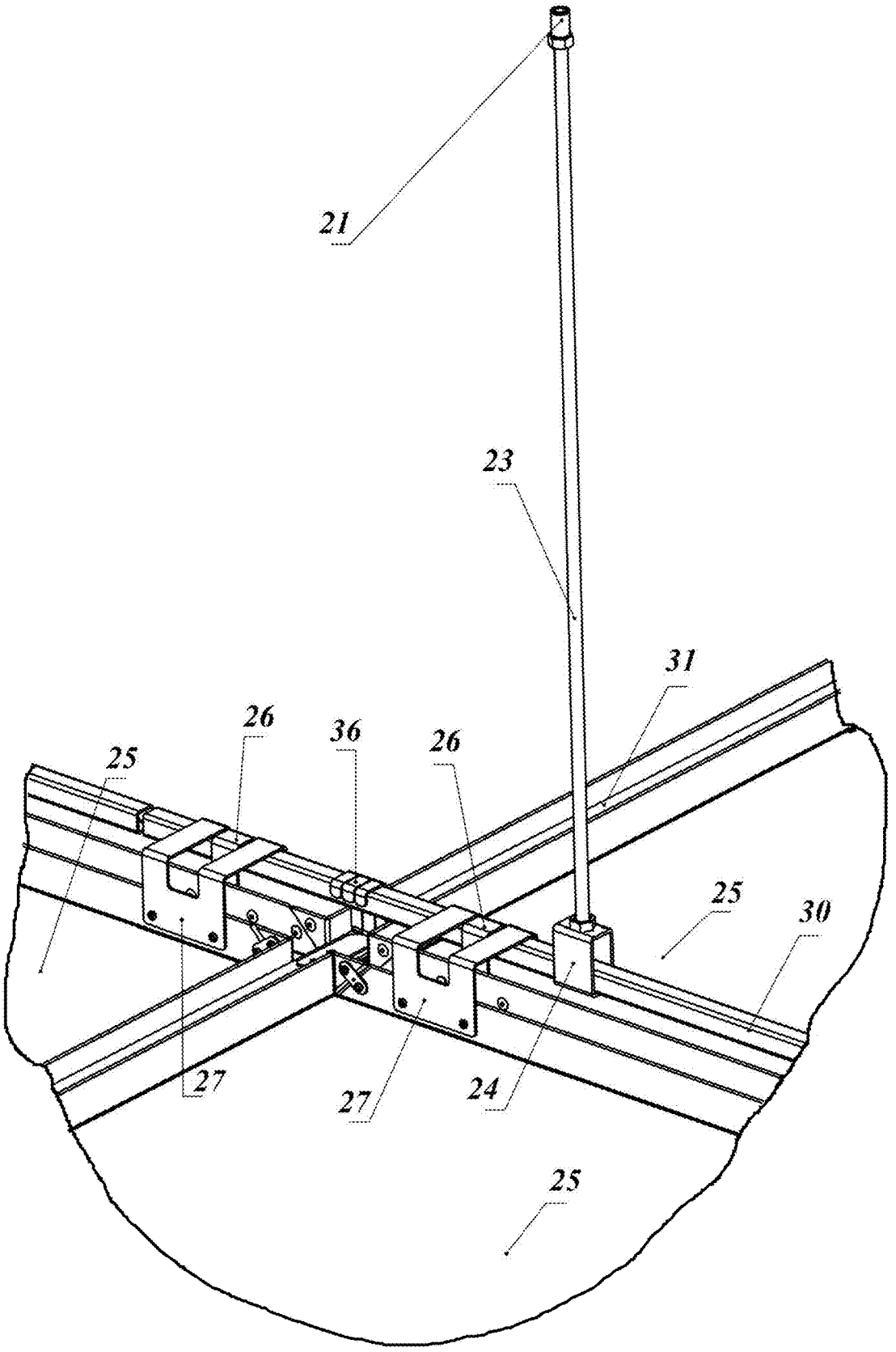


Fig. 1

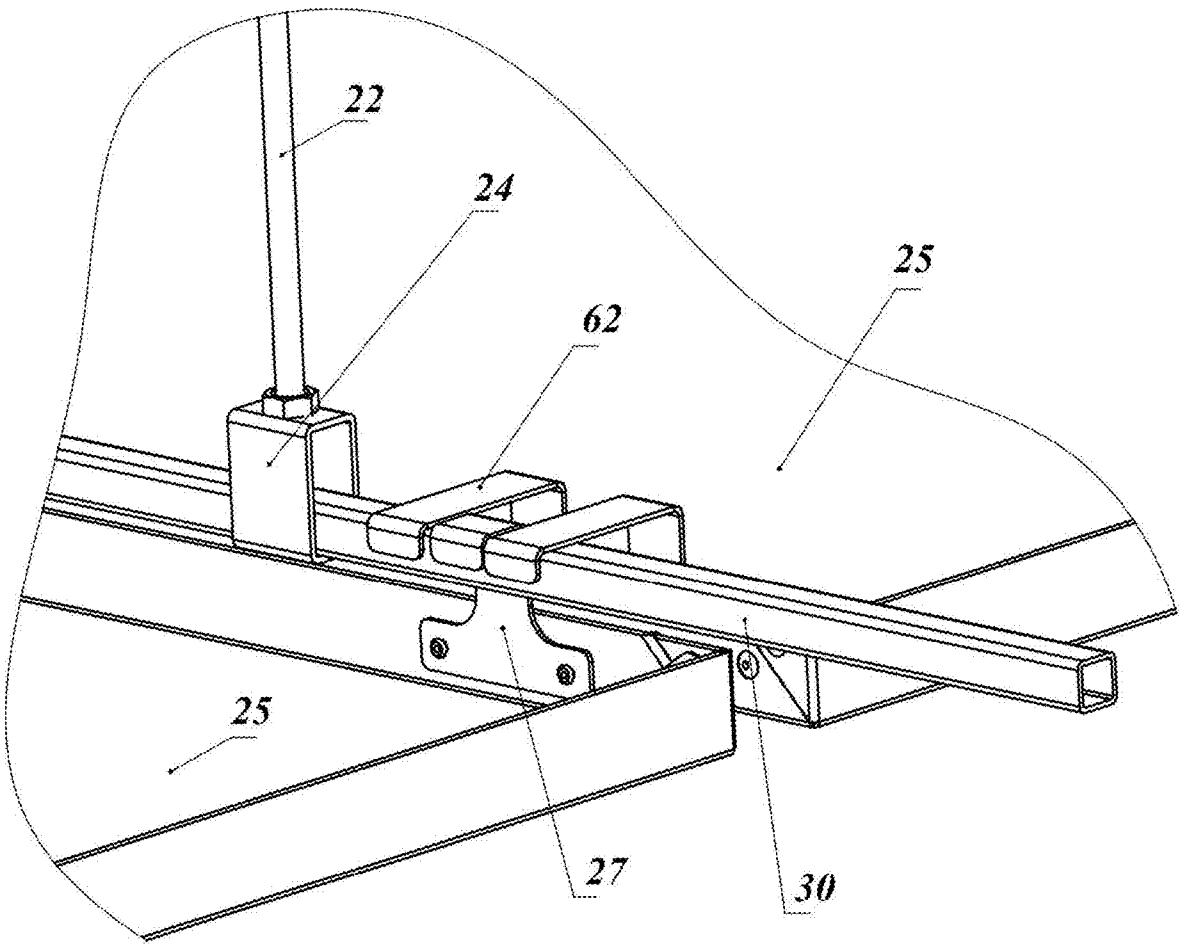


Fig. 2

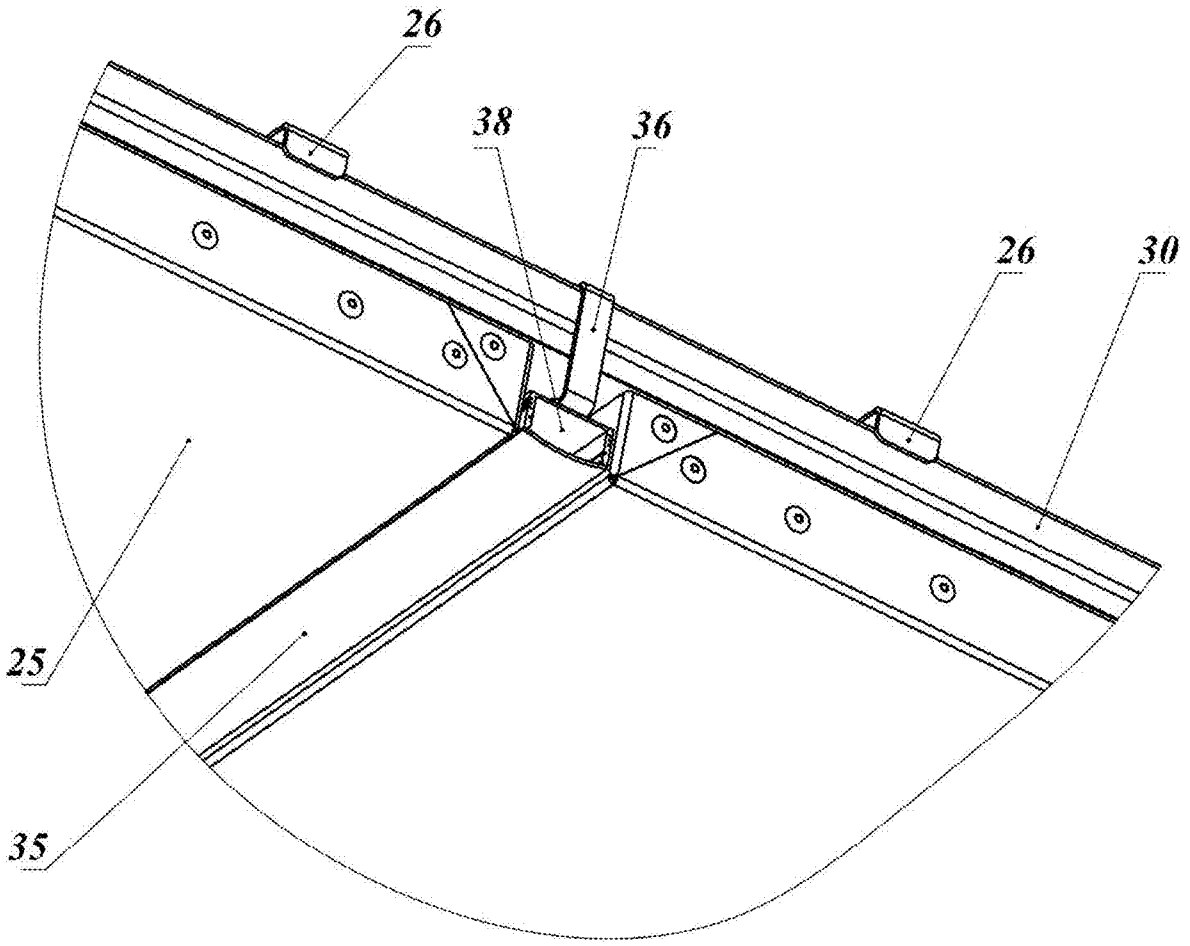


Fig. 3

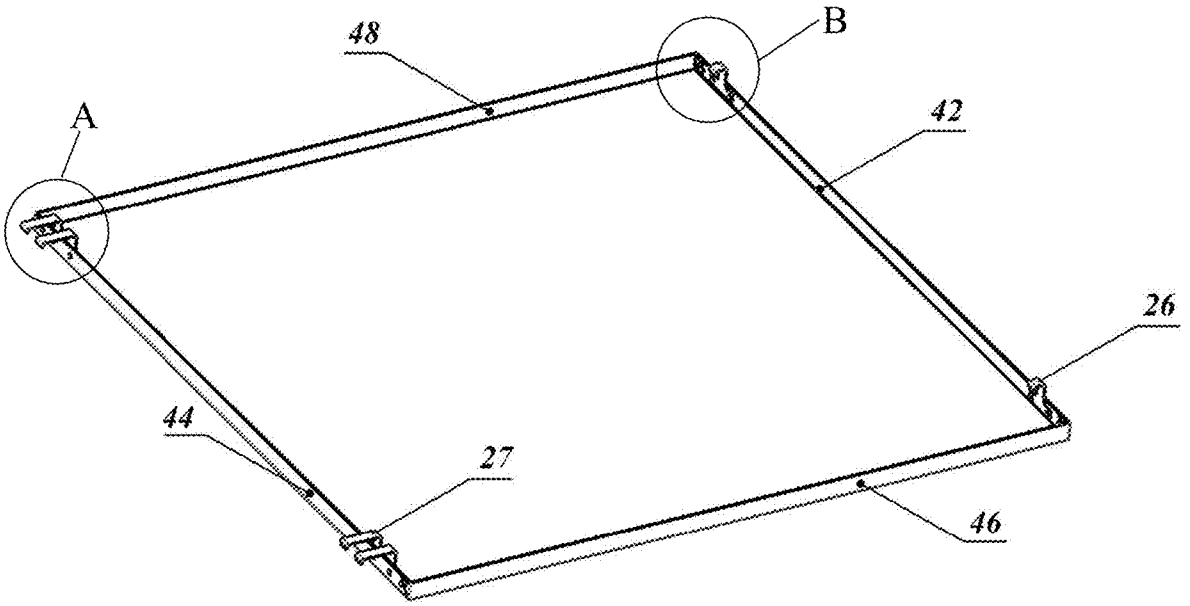


Fig. 4

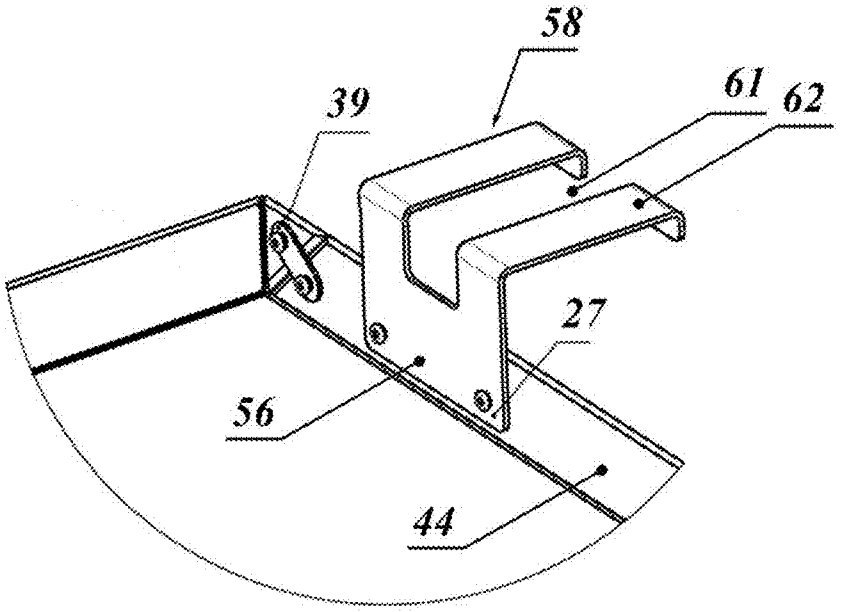


Fig. 5

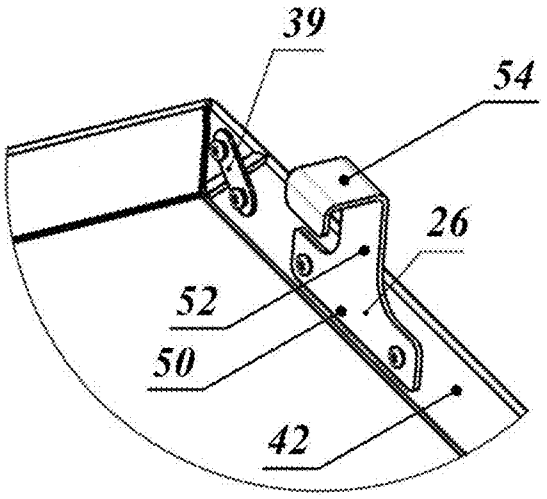


Fig. 6

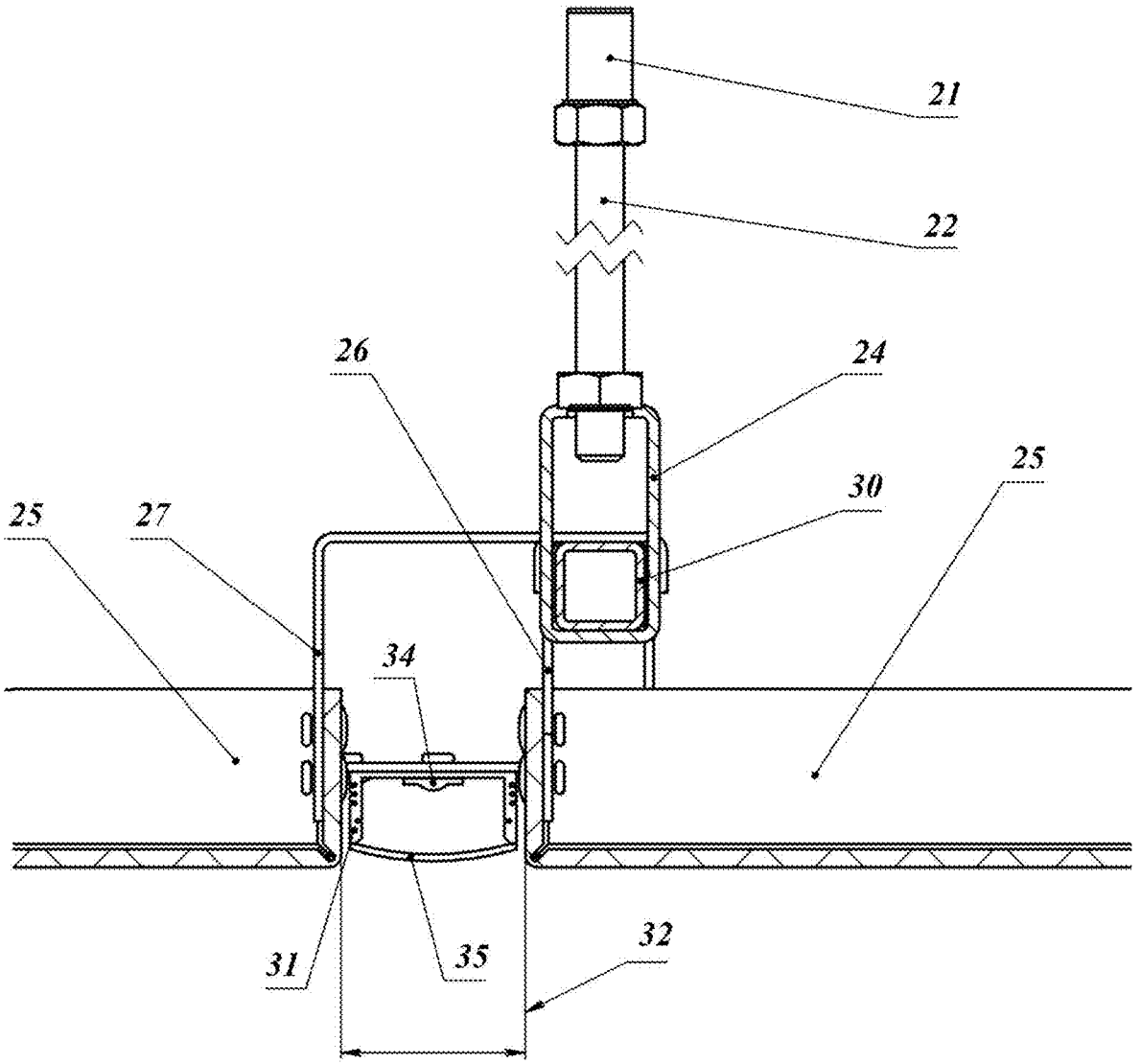


Fig. 7

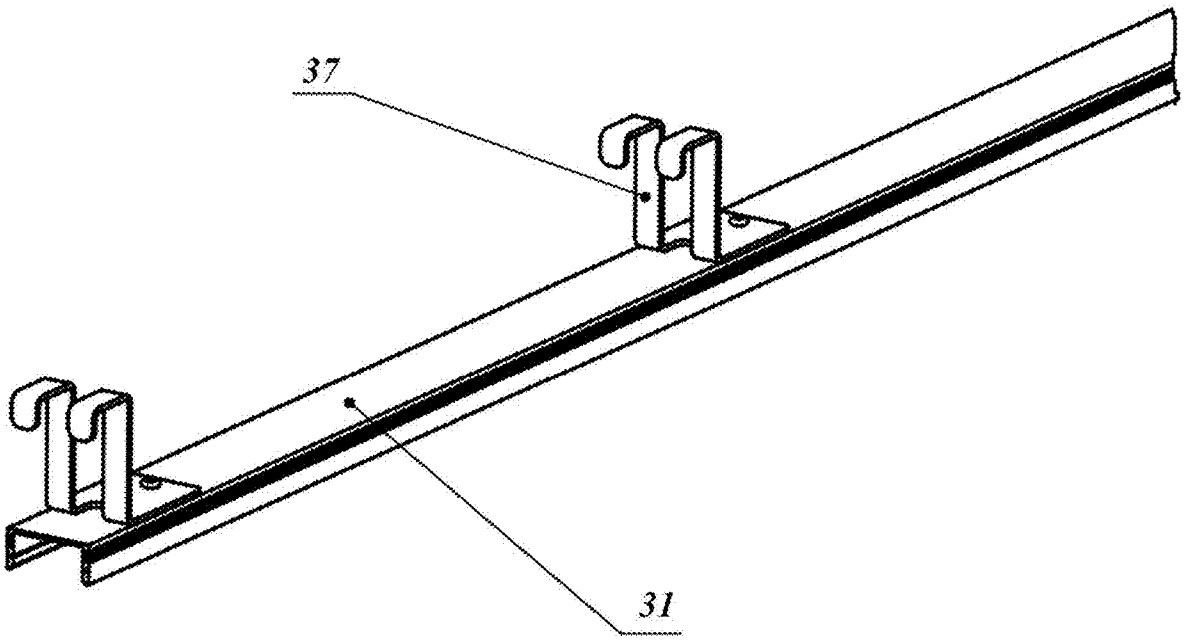


Fig. 8

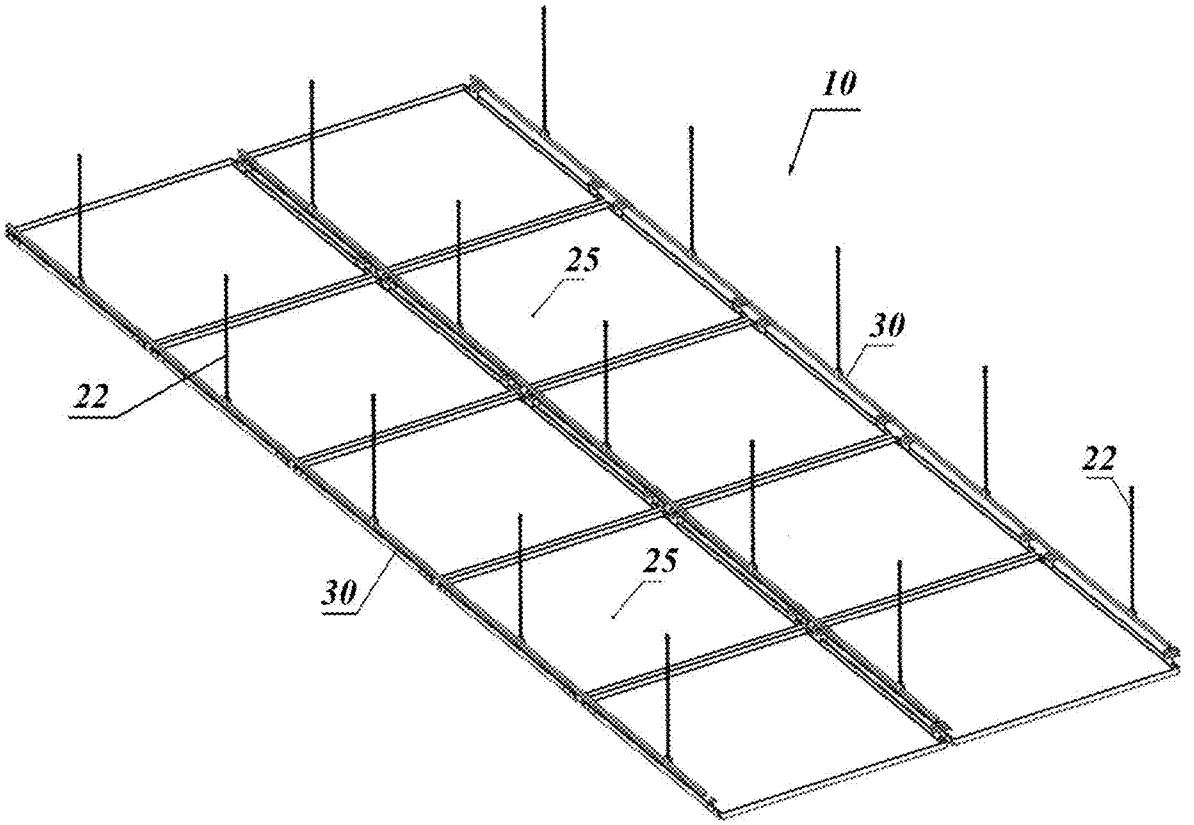


Fig. 9

MODULAR SUSPENDED CEILING AND METHOD OF INSTALLATION SAME

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of priority from U.S. Provisional Patent Application Ser. No. 63/233,901 filed Aug. 17, 2021, the entire disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention pertains generally to suspended ceilings and more particular it relates to suspended ceilings used in combination with lighting fixtures and methods for installation thereof.

BACKGROUND OF THE INVENTION

[0003] Finished ceiling is a modular suspended structure that serves to cover over the rough ceiling, as well as over various utilities and supply networks located directly in the space over it and affixed to the rough ceiling, such as air conditioning units and mains, ventilation ducts, heating piping and electrical wiring. Aesthetic appearance of the room is of no small importance when considering suspended ceiling installation.

[0004] There are known many different suspended ceiling systems. A simple system contains just a ceiling suspension system, usually of lattice type, attached to a ceiling slab and also provided with various ceiling decorative elements usually square in shape. The known advantages of this system include ease of installation and maintenance, as well as relative affordability. However, modern suspended ceilings are facing growing number of new requirements to provide for a comfortable living premises environment. Therefore, suspended ceiling systems have also undergone a number of improvements. For instance, patents U.S. Pat. No. 7,338,182B1 and JP2007184812A describe lighting systems and their installation methods in previously installed suspended ceiling systems. US Patent Publication US20040213003A1 describes a separate system consisting of ceiling lattice for suspension, decorative trim elements and lighting fixtures fastened to the ceiling lattice and located between adjoining decorative ceiling elements.

[0005] US Patent Publication US20130239493A1 discloses an exhaustive variety of modifications of ceiling trim elements, including those related to the output of known types of supply mains and networks.

[0006] At the same time, an increase in the number of ceiling elements moves professionals away from the desired versatility and simplicity ideal. The purpose of this invention is to keep the suspended ceiling design simple to retain its versatility capabilities, while meeting the needs of modern interior design of premises.

SUMMARY OF THE INVENTION

[0007] The invention relates to interior decoration of the ceiling including the suspended ceiling systems. The invention is aimed at creation of a three-dimensional decorative prefabricated finished ceiling providing a considerable number of planning solutions, simplification of design, increase of factory readiness and installation rate, rapid change of furnishings.

[0008] The invention is directed to the modular suspended ceiling including a single-level arrangement suspended from a support structure or an overhead floor slab of the building (rough ceiling) and adjustable to different elevations relative to its level, decorative panel modules of different shapes, mainly rectangular and square, made of metal, metal composite or other materials capable of preserving a predetermined shape and allowing bending, as well as lighting modules located in the gaps between adjoining panels of decorative modules, combined into single uninterrupted flat finished ceiling plane.

[0009] The gaps between the installed decorative panels primarily exist to avoid isolation of the space above the finished ceiling from the rest of the room space. A set of longitudinal and transverse slits is formed to allow, without introducing unnecessary elements into the suspended ceiling system, to carry out heat and mass exchange of the air volume within the common room space. In particular, this greatly facilitates operation of exhaust and supply ventilation, among other things. This makes air inflow into and air outflow from the room more unperturbed and laminar. Similarly, air conditioner ducts or fan coil mains also operate in this concealed space. This arrangement also facilitates use of household split air conditioning systems. At the same time, decorative ceiling panels function as a cold and heat accumulator.

[0010] Bracket devices and their arrangement are conceived in such a way as to ensure their smooth and effortless dismantling.

[0011] If necessary, to reduce total noise level in the room, decorative panels can be supplemented with layers of sound insulation or be completely manufactured of sound-absorbing material.

[0012] Decorative panels are strong and rigid enough to use them as an independent bearing surface for additional devices on the ceiling (lighting elements, CCTV cameras, etc.).

[0013] It is also acceptable to replace the panels disclosed by the invention with other inserts, for example, additional elements for IR heating or UV sterilization of premises, to be equipped with mounting brackets.

[0014] Thus, along with the simplicity of the design, the following advantages of suspended ceiling of the invention can be noted:

[0015] 1. Simplicity and high installation rate. Due to high installation/dismantling rate of the decorative panel, the units and supply mains located within the space over the finished ceiling become easily accessible.

[0016] 2. Due to the gaps existing between panels, there is circulation taking place between the room air volume and the air volume in the space above the suspended ceiling, and it is also possible to suspend other elements from it, such as lighting.

[0017] 3. Due to changing color, size and material of the decorative panel there exist numerous variations of ceiling design.

[0018] 4. The possibility of employing panels as heat and cold accumulator when used in conjunction with heating and air conditioning systems located in the under-ceiling space of the building.

[0019] 5. Concealment of ceiling mains and supply networks.

[0020] 6. Additional care is not required.

[0021] 7. High panel strength and maintainability of the ceiling brings about long-lasting operational life.

[0022] 8. The possibility to make decorative ceiling perfectly level under almost any degree of unevenness of the building's load-bearing rough ceiling.

[0023] 9. Ceiling height adjustment within a wide range of 100 . . . 600 mm.

[0024] 10. Possibility of carrying out almost any technical or engineering activity in the under-ceiling space after suspended ceiling installment.

[0025] 11. Possibility to install spotlights at any place.

[0026] The method of installation of the modular suspended ceiling assembly of the invention comprises of the following essential steps:

[0027] 1) Insertion into the load-bearing surface of the elements for mounting of a rod which can be in the form of a threaded stud.

[0028] 2) Installation of vertical suspension arrangements, which may consist of threaded stud, a guide or a rail inserted into a special guide retainer or a support structure mounted at a distal end of the rod/stud.

[0029] 3) Installation of ceiling decorative panels. Installation of decorative panels is carried out by hooking onto metal guides of special brackets forming a part of the panels. The arrangement of the brackets is such that after installing two panels, a space or distance between them is acceptable or at least 30 mm.

[0030] 4) Optional lighting profile setting is utilized. The design is installed in the inter-panel gaps and attached to the suspended frame using a special bracket.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] In the following drawings, the same parts in the various views are afforded the same reference designators. Referring now to the drawings which are provided to illustrate and not to limit the invention, wherein:

[0032] FIG. **1** is a general view a modular assembly of the invention.

[0033] FIG. **2** is an enlarged view of one embodiment of a detail of the assembly shown in FIG. **1**.

[0034] FIG. **3** is an enlarged view of a detail of the modular assembly.

[0035] FIG. **4** illustrates a decorative pane.

[0036] FIG. **5** is an enlarged view of a detail A shown in FIG. **4**.

[0037] FIG. **6** is an enlarged view of a detail B shown in FIG. **4**.

[0038] FIG. **7** is a sectional view the modular assembly.

[0039] FIG. **8** illustrates LED lighting profile.

[0040] FIG. **9** is a general view (from the rear) of the suspended ceiling.

DETAILED DESCRIPTION OF THE INVENTION

[0041] The devices and methods discussed herein illustrate specific ways of making and using this invention and should not be interpreted as an exclusive and complete description of the technology's capabilities.

[0042] While the devices and methods are described herein with a certain degree of specificity, it should be noted that many modifications can be made to the design details and arrangement of the devices and components without departing from the spirit and scope of this disclosure. It is understood that the devices and methods are not limited to the embodiments set forth herein for purposes of illustration.

[0043] In general, the invention relates to a new, lightweight modular suspended ceiling suspension system that has an improved appearance and accommodates a variety of applications. More specifically, the system allows quickly and by utilizing a minimum number of elements to install suspended ceilings of various complexity, to level unevenness of the bearing ceiling in the buildings.

[0044] One of the advantages of the system of the invention is the ability to ensure the full and uniform functioning of a majority of the systems hidden by a suspended ceiling, including ventilation and air conditioning of the room without use of additional devices. The design of this system assumes the possibility of uniform placement of lighting systems between the decorative panels of the suspended ceiling, for example, LED equipment with or without a diffuser. The suspension system of the decorative ceiling panels allows to quickly mount and dismantle such panels. This provides an additional advantage in quick and full access to any sector of the space covered by the suspended ceiling, as well as the ability to quickly change decorative panels. The latter might occur when changing a design of a room, replacing a damaged panel, adding additional functional devices, etc.

[0045] Due to a predetermined distance (for example, 30 mm) between the installed ceiling decorative panels, a full-fledged heat and mass transfer between the air mass of the room and the space above the suspended ceiling is ensured. Further, the distribution of supply and/or cooled and heated air is improved. Thus, the system of the invention does not require the introduction of special gratings, diffusers and other elements on the surfaces of decorative panels. At the same time, the invention can provide a uniform distribution of various flows due to the system of slots between the panels. In the absence of ventilation and air conditioning systems in the space above the suspended ceiling, the system of slots between the decorative panels can be used, for example, for the location of lighting devices. In practice, however, a compromise use for both needs at the same time is more common.

[0046] When using materials with a relatively high heat capacity in the manufacturing of the ceiling decorative panels, it is possible to achieve some accumulation of heat or cold when blowing these panels with air at a given temperature. Efficient heating or cooling can also be achieved by the direct contact of the heating/cooling circuits with decorative panels having suitable characteristics for the efficient heat exchange.

[0047] Additional options can include, for example, the installation of a layer of soundproofing material as part of decorative panels. This may occur in the case of using a suspended ceiling in crowded places or in industrial premises.

[0048] Due to the sufficient rigidity of the finishing ceiling panels, it is possible to suspend a variety of devices on/from their surfaces. Such devices might include additional lamps, heaters, surveillance cameras, sprinklers and other fire-fighting devices, all kinds of sensors. antennas, small audio and video devices, fans, devices for cleaning, humidification, aromatization, ionization, UV sterilization, etc., the devices which can be relevant for the industrial and home usage.

[0049] It is possible to simplify the manufacture/assembly of the suspended ceiling according to the present invention. Most of the applicable items can be assembled in five minutes or less, keeping labor costs at a reasonable level.

[0050] Practically all parts of the modules have standard dimensions and are made with sufficient accuracy and assembled into finished products without additional fasteners.

[0051] Thus, the system of the invention provides not only a decorative partition, but also is a full-fledged element of a modern room, which not only complements the functionality of the existing systems and at the same time elevates the shortcomings of the ceiling space.

[0052] Referring now specifically to FIGS. **1-7** illustrating various features of a modular suspended ceiling assembly **10** of the invention including multiple decorative panels **25** spaced from each other and suspended from a support structure by a plurality of suspension members **22**. Each panel is formed by spaced from each other first **42** and second **44** connecting walls interconnected by front **46** and rear **48** walls. First and second spaced from each other main brackets **26** extend outwardly from the first connecting wall **42**. First and second separated auxiliary brackets **27** extend outwardly from the second connecting wall **44**. Each main bracket **26** is formed by a connecting portion **50** connected to an inner part of the first connecting wall **42** and an engaging portion **52** extending from the connecting portion and having a hook formation **54** oriented towards an inner region of the panel. Each auxiliary bracket **27** is formed by a connecting portion **56** attached to an inner part of the second connecting wall **44** and an engaging portion **58** extending from the connecting portion and having a hook formation **60** having two hook members **62** separated by a space **61** and oriented towards an exterior of the panel. A plurality of suspension members **22**, with each member including a rod **23** extending between distal and proximal ends thereof, wherein the distal end is adjustably attached to a hollow support structure **24**.

[0053] A plurality of guides/rails **30** and cross members arranged in a generally rectangular grid. The guides/rails **30** pass through and supported by said hollow support structure **24** for each respective suspension member **22**.

[0054] The module **12** is formed by the adjacent panels **5** supported by a single rail **30** passing through and supported by the support structure **24** through the engagement of the respective hook formations of the main and auxiliary brackets with the rail **30**, wherein each hook formation **54** of the main bracket **26** of one panel is disposed within the space **61** between the hook members **62** of the auxiliary bracket **27** of the other panel. The assembly of the invention also includes a lighting (LED) profile **31**, a lighting profile bracket **29** with a gap **32** between decorative modules and connecting plates **39** for connecting edges of the decorative panel.

[0055] Among essential elements of the suspension arrangement are fasteners **21** associated with the supporting structure, threaded rods/studs **23** for adjusting the elevation/height of the ceiling plane, hollow support structures or guide retainers **24** used, among other things, to adjust the position of the ceiling plane, guides or rails **30** for positioning the decorative panels **25** within the system.

[0056] A significant part of the ceilings, rooms or otherwise enclosed interior spaces defined by simple geometric shapes, in particular, they have rectangular and square shapes. In such cases, it is often not necessary to design and manufacture special decorative panels, and the task of installing a false ceiling is solved with the help of universal elements, in the extreme case, converted using relatively simple and commonly available tools at the installation site. This approach is generally applicable for rooms with more complex ceiling configuration.

[0057] According to the method of the invention, surface preparation for mounting begins with marking the surface of the ceiling (or other supporting structure) for fastening the adjustable elements of the suspended support structure for the guide or rail. In this example, the metal rods or studs **23** are utilized. This function can be performed by any other more accessible or more suitable fastener for a specific task.

[0058] In this example, the number of the rods or studs and the distance between them is determined by the materials of the suspended ceiling, its planned load, as well as the material and load-bearing capacity of the ceiling or the structure on which the suspended ceiling is mounted.

[0059] The system allows installation in a reinforced concrete floor application, made in-situ, including a concrete floor with a profiled metal sheet as a fixed formwork, or prefabricated from individual reinforced concrete slabs, in wooden beams, metal beams of various sections, channels, pipes, orthotropic slabs and other structures, with sufficient strength and bearing capacity. In the standard version, which involves the use of steel for the manufacture of the ceiling suspension system and aluminum composite with a thickness of 5 mm for the manufacture of decorative panels, the weight of the ceiling without lighting is about 13 kg/m2.

[0060] The ceiling suspension system can be made from a variety of materials such as steel pipes (coated or uncoated), aluminum (coated or uncoated), tough engineering plastics, fiberglass, or a suitable combination. If desired, you can also use some types of wood that have sufficient strength and load-bearing capacity, especially certified sustainable lumber. In the example described, it is assumed that rolled metal (steel and/or aluminum) is used to manufacture the flow suspension system. It is recommended to use a protective powder coating (for steel) or anodizing (for aluminum) when using this system in coastal, tropical or cold temperate regions. In the case of using wood, it is recommended to use protective compounds against insect pests, mold, fungi and the effects of high humidity.

[0061] The fixing of the studs for hanging the ceiling guide is carried out mainly by fasteners, threaded members or dowels **21**. The design and size of the dowel is selected based on the material of the bearing surface and the expected loads. In the case of fastening to metal structures. In the case of fastening to a concrete ceiling with a profiled metal sheet, both weld nuts and dowels can be used as permanent formwork. Do not install rods or studs **23** by welding directly to the metal of the supporting structure. In the case of a wooden floor, it is recommended to use, for example, square plates with a nut welded in the center and at least four holes for suitable wood screws at an equal distance from the nut closer to the corners of the plate.

[0062] After marking the places for hanging the rods or studs **23** and installing suitable fasteners **21**, the studs are mounted by screwing them into such fasteners. Usually, the rods or studs **23** are located at a distance of 600 to 1200 mm from each other. Some error in the length of the rods or studs **23** is permissible in the case of a flat or relatively flat topography of the bearing surface. In case of large irregularities, the cutting of the necessary studs should be planned

in advance. Usually, the length of the rods or studs **23** is from 100 to 600 mm, however, it does not limit the use of longer studs up to 2000 mm in special cases.

[0063] After attaching or screwing all the rods or studs **23** with one end into the fasteners **21** of the bearing surface, the retainers or support structures **24** are attached/provided for the guides/rails **30** at their opposite distal free end. In one embodiment the guide retainer or a support structure **24** can be a tubular element, for example, 20×40 mm and a length, for example, up to 50 mm, with a threaded element attached or welded to one of the narrow sides of the pipe from the outside. To expand the possibility of adjusting the height/elevation of the suspension of the guide in the section of the retainer pipe, a round through hole is drilled, located under the threaded element in such a way as to ensure the free entry of the thread stud into the retainer pipe. As the main element of the retainer or support structure **24**, the use of a pipe section other than the section and/or size indicated here is not excluded. It is allowed to screw the retainers onto the studs before screwing the studs into the fasteners on the bearing surface.

[0064] After installing and adjusting to the predetermined height of all the clamps, it is possible to place the horizontally oriented rail or guide **30** of the suspended ceiling in them. In this example, a square pipe 15×15 mm is described, but this does not limit the choice of material, section profile and thickness of the guide. The pipe can in principle be inserted both longitudinally and transversely with respect to the selected room coordinate system. It is desirable that the length of the guide in this case be only slightly shorter than the distance between the walls in the room, wherein a particular guide is installed between such walls. For ease of installation, the guide **30** is cut, for example, into two separate elements with the location of the joint in the pipe of one of the guide clamps. In such cases, it is recommended to make a connecting spacer inside the guide tube to securely connect the guide. The second option for reliable fixation can be the addition of two horizontal clamping screws to the design of the latch—one at the end of each of the joined elements of the guide.

[0065] After installing all the guides **30**, it is possible to directly mount the decorative panels **25**. In the described embodiment square/rectangular aluminum composite panels (ACP) with a thickness of 5 mm can be utilized. However, a wide range of materials can be used for the system—metal, various plastics, wood, glass, fabrics and/or their various combinations, providing sufficient rigidity of the resulting element and allowing reliable fastening of brackets for hanging a decorative panel to it. The shape of the panel, other than square/rectangular, in the first approximation also does not play a decisive role, however, it creates a number of conditions and limitations for the described system. In the case of square/rectangular ACP, to give the finished element of the decorative panel the properties described above, for example, box-shape with smooth rib rounding radii. After that, the actual bending and final assembly of the panels is carried out, for example, by riveting small metal plates **39**. Strengthening the rigidity of the panels can be achieved in other ways, for example, by increasing the thickness, the number of layers of material or by installing individual stiffeners, as well as other well-known means.

[0066] The decorative panel acquires its finished form after attaching the brackets, which in essence are a bent sheet steel product, in which it is possible to select a base for attaching to the panel and a hook for fixing the panel on a horizontal guide **4**. A different design of brackets is allowed, in particular with a different engagement system, including for a guide with different dimensions and profile cross-section. Brackets can be divided into two types—main **26** and auxiliary **27**. The main difference between the brackets described here is the length and number of hook formations. The auxiliary bracket **27** has two hooks **60** at a small distance/space **61** between them, and the main brackets **26** are formed with a single hook **54**. This design allows, for example, to fix a number of decorative panels on one guide in the longitudinal direction relative to each other and makes it possible to obtain equal gaps between the panels by placing the hook **54** of the main bracket on one guide between the two hooks **62** of the auxiliary bracket of the other panel. A prerequisite for this is that the brackets must be positioned in the same way on all decorative ceiling panels, for example by using a suitable template.

[0067] The orientation of the hooks can be either inside the panel or outside. The type of brackets and the orientation of their hooks are determined mainly by the location of the guides relative to the walls.

[0068] The main brackets **26** are located on the opposite side of the decorative panel with respect to the auxiliary brackets **27**. The number of such pairs is determined mainly by the weight of the decorative panel and the expected load on it; however, it cannot be less than two, in which case the pairs of brackets are located closer to the edges of the panel.

[0069] Suspension of decorative panels **25** is carried out in two steps: first, hooking is carried out to the first guide using auxiliary brackets with wider hooks, then final hooking is made to the second guide opposite using the main brackets. This approach allows you to position the decorative panel on the guide quickly, effortlessly and without the use of special tools.

[0070] Between the installed decorative panels **25**, a certain distance of 32 is maintained, for example 30 mm. Such distance **32** can be greater, but this introduces additional requirements for the brackets of the decorative panel. In the specified gap between the decorative panels, for example, LED lamps can be mounted. In this case, it is possible to use, for example, a standard extruded aluminum profile **38** for LED lamps **31** having a strip with LEDs **34** and a light diffuser **35**.

[0071] For an expedited installation, as a fixation device to the suspended ceiling a bracket **36** is used comprising a base for attachment to LED and two small hooks **37** for hanging on the guide **30**.

[0072] The above-described invention results in a system containing a small number of standard elements, which can be manufactured on ubiquitous equipment without tight tolerances in terms of accuracy.

What is claimed is:

1. A modular suspended ceiling assembly comprising: multiple panels spaced from each other and suspended from a support structure by a plurality of suspension members;

each said panel formed by at least spaced from each other first and second connecting walls, first and second spaced from each other main brackets extend outwardly from said first connecting wall, first and second separated auxiliary brackets extend outwardly from said second connecting wall, each said main bracket is

formed by at least an engaging portion having a hook formation oriented towards an inner region of the panel;

each said auxiliary bracket is formed by at least an engaging portion having a hook formation having two hook members separated by a space and oriented towards an exterior of the panel;

a plurality of suspension members, each said suspension member including a rod extending between distal and proximal ends thereof, the distal end is adjustably attached to a hollow support structure; and

a plurality of guides/rails, said guides/rails passing through and supported by said hollow support structure of each said respective suspension member, wherein a module is formed by adjacent panels supported by the single rail passing through and supported by said support structure through engagement of said respective hook formations of said main and auxiliary hook formations with said single rail, wherein each said hook formation of the man bracket of said one panels is disposed within the space between the hook members of the auxiliary bracket of the other panel.

2. The modular suspended ceiling assembly according to claim **1**, wherein each said main bracket further comprises a connecting portion connected to an inner part of the first connecting wall and said engaging portion extends from the connecting portion.

3. The modular suspended ceiling assembly according to claim **1**, wherein each said auxiliary bracket further comprises a connecting portion connected to an inner part of the second connecting wall and said engaging portion extends from the connecting portion.

4. The modular suspended ceiling assembly according to claim **1**, wherein said first and second connecting walls are interconnected by front and rear walls.

5. A method of installation of a modular suspended ceiling assembly, wherein the modular suspended ceiling assembly comprises multiple panels spaced from each other and suspended from a support structure by a plurality of suspension members; each said panel formed by at least first and second connecting walls, first and second spaced from each other main brackets extend outwardly from said first connecting wall, first and second auxiliary brackets extend outwardly from said second connecting wall, each said main bracket is formed by at least an engaging portion having a hook formation oriented towards an inner region of the panel, each said auxiliary bracket is formed by at least an engaging portion having a hook formation with two hook members separated by a space and oriented towards an exterior of the panel, a plurality of suspension members, each said suspension member including a rod extending between distal and proximal ends thereof, the distal end is adjustably attached to a hollow support structure;

and a plurality of guides/rails;

said method comprising by at least the following step:

mounting said panels into the modular suspended ceiling assembly,

by supporting said adjacent panels by the single rail by passing through and supporting said rail using said support arrangement through engagement of said respective hook formations of said main and auxiliary hook formations with said single rail, wherein each said hook formation of the man bracket one said panels being disposed within the space between the hook members of the auxiliary bracket of the other panel.

6. The method of installation of a modular suspended ceiling assembly of claim **5**, further comprising the following steps prior to the step of mounting the panels:

marking a surface of the support structure and installing suitable fasteners;

mounting the suspension members into the fasteners; and adjusting a predetermined elevation of the panels through rotation of the suspension members within the fasteners.

* * * * *