(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 889 374 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
18.10.2023 Bulletin 2023/42

(21) Application number: **19888380.3**

(22) Date of filing: **08.02.2019**

(51) International Patent Classification (IPC):
E04H 1/00 (2006.01) ***B28B 5/00*** (2006.01)
E04B 1/348 (2006.01) ***B28B 5/02*** (2006.01)
B28B 7/02 (2006.01) ***B28B 7/22*** (2006.01)
B28B 15/00 (2006.01) ***E04H 1/04*** (2006.01)

(52) Cooperative Patent Classification (CPC):
E04H 1/005; B28B 5/021; B28B 7/02; B28B 7/22; B28B 15/00; E04B 1/34823; E04B 1/34853; E04H 1/04

(86) International application number:
PCT/RU2019/000080

(87) International publication number:
WO 2020/111966 (04.06.2020 Gazette 2020/23)

(54) **METHOD FOR CONSTRUCTING BUILDINGS**

VERFAHREN ZUR HERSTELLUNG VON GEBÄUDEN

PROCÉDÉ DE CONSTRUCTION D’IMMEUBLES

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **30.11.2018 RU 2018142384**

(43) Date of publication of application:
06.10.2021 Bulletin 2021/40

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Description

FIELD OF THE INVENTION

[0001] The invention relates to the field of construction, in particular to modular three-dimensional-block construction, and can be used for construction of low-rise and multi-storey residential buildings, public buildings and structures, as well as other buildings of any other purpose.

BACKGROUND OF THE INVENTION

[0002] From the state of the technologic construction, a method of constructing buildings from three-dimensional blocks is known, which consists in installing a three-dimensional block in a vertical position, side walls of which are rigidly connected to side walls of a next block through gaskets. The blocks are installed one by one around the perimeter of the building. The lower part of the connected blocks can serve as a foundation when they are installed below the zero mark of the building. Depending on the intended purpose, internal walls, floors and openings can be formed in buildings (see patent RU 2076178C1 , convention priority: 09.12.1994 RU 94 94044472).

[0003] A disadvantage of the known method is that the blocks used are block rooms at best case, and not module apartments, the blocks do not have interior finishing and are not ready for use for their intended purpose, low productivity, small space-planning characteristics of the block and the lack of quickly changing the configuration possibility of the blocks, there are no free layouts, the lack of possibility for an architect to offer his solutions, since the plant dictates and offers only its manufacturing capabilities.

[0004] Also known from the state of the technologic construction is a method for buildings constructing using a modular frame, which consists in assembling the lower floor panel - floor beams, installing a pre-assembled metal frame on the floor beams, and installing metal frame racks. On the frame assembled in this way, the upper binding beam of the frame is laid on top, which forms ceiling, then parts of the frame and the metal frame are bolted together. Utilities elements are installed in the assembled frame, according to planning solutions. After casing the frame and laying the insulation, there is a start for the module interior finishing. Doors, windows are installed and walls are being prefabricated, flooring and ceiling are being put in position. The module manufactured at the factory is transported to the construction site, where final assembly of the building is carried out (see patent RU128219U1, published on 20.05.2013).

[0005] The disadvantage of the known method is high mass of the module structure per one meter of square area, low productivity, lack of possibility of rapid changes in the module's configuration, their shapes and sizes, modules' small overall dimensions with a limited area, lack of possibility of rapid changes in the planning solutions of premises.

[0006] The closest approach to the proposed solution is a method of buildings construction, which consists in manufacturing three-dimensional blocks, after which prefabricated three-dimensional blocks are formed using construction components, including engineering communications, by means of installing engineering communications and performing interior finishing, then the prefabricated three-dimensional blocks are transported using vehicles to a construction site, where, by means of lifting devices, prefabricated three-dimensional blocks are installed in an appropriate place and the prefabricated three-dimensional blocks are installed and connected to each other, while the prefabricated three-dimensional blocks are installed on top of one another in a similar position (see, for example, the website on the Internet https://studfíles.net/preview/5193963/).

[0007] The disadvantage of the known method is the lack of possibility to quickly change configuration of blocks, their shapes and sizes, when implementing the method, it is possible to manufacture only the same type of blocks, low productivity, small overall dimensions of blocks with a limited area, lack of possibility to change quickly planning solutions of premises and finishing and engineering preparation at the factory is no more than 20-30%.

[0008] US 3,714,304 A and SU 495208 A1 disclose conveyors used for manufacture of prefabricated three-dimensional modules, installation during manufacture of engineering communications, performing interior and exterior finishing, forming internal partitions installing built-in furniture, etc.

[0009] US 3,884,613 A and JP 3 236834 B2 constitute further prior art.

SUMMARY OF THE INVENTION

[0010] The invention is defined in claim 1.

[0011] The technical problem solved by the invention is an increase in area of buildings constructed and in volume of daily output, an increase in productivity, a reduction in time and labor costs for construction of buildings, an increase in comfort of premises constructed and a significant increase in their quality.

[0012] The technical result of the invention, which provides a solution to the technical problem, is the reduce in complexity and cost of construction, simplicity of three-dimensional modules installation, ensuring building versatility for any three-dimensional planning solutions due to the possibility of rapid changes in size and shape of three-dimensional modules in all coordinates, increase in rigidity, reliability and stability of the building due to the floor-by-floor re-laying of three-dimensional modules during their installation, increase in accuracy of the buildings assembling due to provision of high-precision dimensions of three-dimensional modules, ensuring the possibility of rapid changes in three-dimensional planning solutions.

[0013] The technical result of the invention is achieved by implementing a method for constructing buildings, wherein on robotic conveyors located in a plant workshop, prefabricated three-dimensional modules are made, moreover, on the first robotic conveyor, a formwork system is formed and a monolithic reinforced-concrete three-dimensional module including a base plate and/ or pillars and/ or walls and/ or beams and/ or crosspieces and/ or ceiling panels is manufactured in said formwork system, said manufactured three-dimensional module is transferred to a second robotic conveyor, where the prefabricated three-dimensional module is formed, using construction components, including engineering communications, by means of installing engineering communications, performing internal and/ or external finishing, and/ or installing built-in furniture, then at the end of the second robotic conveyor the prefabricated three-dimensional module is packaged in a protective material, and other prefabricated three-dimensional modules are manufactured in the same way, the packaged prefabricated three-dimensional modules are transported to a construction site by means of vehicles, where, by means of lifting devices, the packaged prefabricated three-dimensional modules are installed in the appropriate place, unpacked, assembled and connected to one another, moreover, the installation of the prefabricated three-dimensional modules is carried out floor-by-floor resulting in the formation of a building so that a portion of the prefabricated three-dimensional modules of even-numbered floors is installed relative to a portion of the prefabricated three-dimensional modules of odd-numbered floors so that, in plan view, some of the walls intersect.

[0014] In addition, it is possible to form a formwork system on the first robotic conveyor with the possibility of changing its dimensions in plan and height.

[0015] In addition, it is possible to manufacture the monolithic reinforced-concrete three-dimensional module, mainly with the width of 3 to 7.2 meters, the length of 8 to 21 meters, and the height of 3 to 3.5 meters.

[0016] In addition, the manufacture of a prefabricated three-dimensional module on robotic conveyors can be carried out with the help of industrial robots.

[0017] In addition, as at least one lifting device, a crawler-mounted heavy boom-type crane with a lifting capacity of mainly up to 750 tons can be used.

[0018] In addition, the second robotic conveyor can be used, which can include two levels, while the first level can include at least one longitudinal part for moving the monolithic reinforced-concrete three-dimensional module, and the second level can include transverse parts for manufacturing construction components and supplying them to the first level.

[0019] In addition, after the installation and connection of the corresponding prefabricated three-dimensional modules to each other, the building can be constructed with the possibility of dismounting and transporting the prefabricated three-dimensional modules to another construction site by means of a vehicle.

[0020] In addition, the three-dimensional module can have internal walls, and after the installation of engineering communications, the execution of internal and/ or external finishing and/ or the installation of built-in furniture, spatial arrangement of the internal walls, as well as engineering communications and/ or built-in furniture can be changed.

[0021] In addition, the formation of the formwork system on the first robotic conveyor can be carried out on a pallet, which is cleaned and covered with a layer of oil-air lubricant before the formation of the formwork system.

[0022] In addition, some of the prefabricated three-dimensional modules have protrusions from the side of the beams, some of the prefabricated three-dimensional modules have recesses from the side of the base, and all the prefabricated three-dimensional modules have through holes in some of the sides, so that while connecting the prefabricated three-dimensional modules of the overlying floors with the prefabricated three-dimensional modules of the underlying floors by inserting the protrusions into the recesses, and connecting the prefabricated three-dimensional modules of one and the same floor by threaded connection through said through holes.

DESCRIPTION OF THE DRAWINGS

[0023] The invention is illustrated using drawings, where:

Fig. 1 shows a general view of one of the embodiments of a monolithic reinforced-concrete three-dimensional module with protrusions on the upper part for connection (during installation) with overlying three-dimensional modules, as well as with places for connection with neighboring modules of the same floor;

Fig. 2 shows an example of one of the options for installing three-dimensional modules on top of each other (basement and the first two floors);

Fig. 3 schematically shows an example of the floor-by-floor rearrangement of three-dimensional modules during their installation;

Fig. 4 schematically shows an example of the three-dimensional modules location in the plan, for example, odd floors;

Fig. 5 schematically shows an example of the three-dimensional modules location in the plan, for example, even floors;

Fig. 6 schematically shows the location of connected three-dimensional modules, for example, odd floors, a view in axonometry;

Fig. 7 schematically shows the location of connected three-dimensional modules, for example, even floors, a view in axonometry;

Fig. 8 shows the underside of the base panel of the module forming an apartment or room, or a pre-apartment hall, or an office space, etc.;

Fig. 9 shows the section A-A in Fig. 8;

Fig. 10 schematically shows a part of one load-bearing body of the first conveyor in plan view with a pallet placed on it and a product (a three-dimensional module);

Fig. 11 schematically shows an example of the formwork formation for manufacture of three-dimensional modules in plan view;

Fig. 12 shows the same as on Fig. 11 in axonometry;

Fig. 13 shows the section B-B in Fig. 11 (in the manufacture of a three-dimensional module);

Fig. 14 schematically shows interior space of one of the pre-apartment module variants;

Fig. 15 schematically shows an example of coupling of an apartment module with a pre-apartment module at the junction of engineering communications (section C-C in Fig. 14);

Fig. 16 schematically shows the location of engineering communications between three-dimensional pre-apartment modules (when installing three-dimensional modules);

Fig. 17 schematically shows the conveyors on which the prefabricated three-dimensional modules are formed, and transporting of three-dimensional modules on the conveyors;

Fig. 18 schematically shows the second conveyor with movable three-dimensional modules (view D in Fig. 17);

Fig. 19 schematically shows an example of construction (installation) of a building from prefabricated three-dimensional modules using a lifting device (floor-by-floor laying of the prefabricated three-dimensional modules);

Fig. 20 schematically shows bolted connection (without welding) of adjacent prefabricated three-dimensional modules during their installation;

Fig. 21 shows an example of assembling and connecting modules to each other during floor-to-floor laying without welding;

Fig. 22 shows the junction of the overlying floors' three-dimensional modules with the underlying ones, the disassembly of E in Fig. 21;

Fig. 23 shows the connection point of adjacent three-dimensional modules of one floor, the disassembly ofF in Fig. 21;

Fig. 24 shows an example of a formwork for the manufacture of a base plate with longitudinal and transverse ribs.

EXAMPLES OF EMBODIMENTS OF THE INVENTION

[0024] The method for constructing buildings of any type and purpose consists in the preliminary manufacture of three-dimensional-block products (three-dimensional modules) and their subsequent installation and connection with each other. Prefabricated three-dimensional modules are made in a warm and bright premise of a modular residential construction technopolis (plant of reinforced-concrete products). Prefabricated three-dimensional modules form prefabricated residential or public premises with 99% finishing with full readiness for their use, including living. Being manufactured in factory conditions, three-dimensional modules, when assembled and connected to each other on a construction site, form a prefabricated building of a residential or public type, or any other purpose.

[0025] To implement the method, robotic conveyors 1 and 2 (Fig. 17) are used with industrial robots, manipulators and other robotic equipment (using special software and hardware complexes, not shown), which are fully automated, and which are located in a workshop of modular residential construction technopolis (in a warm premise). Moreover, two robotic conveyors 1 and 2 are mainly used, or a larger number of conveyors, depending on the need and the necessity of performing a certain operation with three-dimensional modules, while each of the conveyors 1 and 2 is equipped with industrial robots, both stationary and mobile. Also, for the implementation of the method, in particular for transporting prefabricated three-dimensional modules to the construction site, special vehicles 3 (module-transporters) are used, which have large platforms for placing prefabricated three-dimensional modules on them. Directly on the construction site for the implementation of the method, in particular for lifting prefabricated three-dimensional modules, assembling them and connecting them to each other, a heavy boom-type crane 4 (Fig. 19) is used, mainly on a crawler track, with a load capacity of up to 750 tons (for example, by Liebherr). This crane 4 allows one to lift and install large three-dimensional modules (weighing more than 60 tons) to a height of up to 100 meters (and higher, i.e. to construct a building of up to 30 floors or more). Also, other lifting devices, such as a gantry crane and any other lifting devices, can be used for lifting, installing and mounting three-dimensional modules.

[0026] The implementation of the proposed method allows one to construct buildings of any type and purpose (multi-storey or low-rise residential buildings, public buildings and structures, including hospitals, kindergartens, schools, sanatoriums, office buildings, etc.), of any configuration, of any planning solution, of any area, depending on the need, requires and design documentation.

[0027] Further, we will consider the implementation of the proposed method for the construction of a residential building, however, it should be understood that a similar sequence of actions is applicable for the construction of buildings of any other purpose and differs only in size, shape and planning solutions of corresponding three-dimensional modules that form buildings of a particular purpose.

[0028] The proposed method for constructing buildings is as follows.

[0029] On the robotic conveyors 1 and 2, located in a workshop of a plant (technopolis), prefabricated three-dimensional modules 6, 7, 8, 9, 10 with 100% internal and external finishing are manufactured (hereinafter referred to as "prefabricated modules"). At the same time, on the first conveyor 1 (located, for example, in the molding workshop of the factory), a formwork system (form-installation, hereinafter referred to as the formwork) is formed first, wherein monolithic reinforced-concrete three-dimensional modules 12 (hereinafter referred to as "modules") are manufactured. The first conveyor 1 can have either one load-bearing body 13, or a larger number of load-bearing bodies 13 (two, three or more), on each of which, with the help of industrial robots and manipulators, the corresponding formwork 11 is formed, wherein the corresponding module 12 is manufactured. For example, on the first body 13, a formwork 11 is formed for the manufacture of one module 12 (for example, a one-room apartment), on the second body 13, a formwork 11 is formed for the manufacture of another module 12 of a different size or shape (for example, a two-room apartment), on the third body 13, a formwork 11 is formed for the manufacture of a third module 12 (for example, a pre-apartment hall), on the fourth body 13, a formwork 11 is formed for the manufacture of another module 12 (for example, a stair-lift unit), and so on. In the variant version, the same formwork can be formed on each load-bearing body 13 And, wherein the same modules 12 are manufactured (for example, only apartments), or on one part of the bodies 13, one formwork 11 is formed (for example, for the manufacture of apartments), on another part of the bodies 13, other formwork 11 is formed (for example, for the manufacture of apartment halls), etc. Moreover, each formwork 11 on each load-bearing body 13 of the conveyor 1 has the possibility of operational readjustment, i.e. operational changes in its size and shape in all three coordinates (in plan and height, i.e. changes in length, width, height, configuration), depending on the required nomenclature configuration of the building, as well as taking into account the specified parameters, characteristics, shapes and standard sizes of the modules 12. The possibility of rapid changeover of the formwork 11 to the required dimensions, configuration and shape of the modules 12 is provided by the use of industrial robots and manipulators on the robotic conveyor 1, which are controlled by an operator using a special software and hardware complex, while special software allows robots to quickly select and form the necessary formwork 11 of a given size and shape.

[0030] Depending on the type of modules 12 (a module forming a room

or an apartment (one -, two -, three-room, etc.), or an apartment hall, or a stair-lift unit, or an office space in a residential building, etc.), the corresponding module 12 (Fig. 1) may include a base plate 14, and/ or pillars 15, and/ or load-bearing walls 16, and/ or ceiling beams 17 (longitudinal and transverse), and/or ceiling crosspieces 18, and/ or ceiling panels 19. So, for example, if it is necessary to manufacture a module 12 that forms an apartment, then such a module includes a base plate 14, and pillars 15 (or solid walls 16 instead of pillars both with window openings, doorways, and without them), and ceiling beams 17 (or ceiling panel 19 instead of beams) and special crosspieces 18. If it is necessary to make a stair-lift unit, then the corresponding module 12 may not have a base plate 14 and a ceiling panel 19, and such a module 12 will include pillars 15 or solid walls 16 and beams 17. And so on, depending on the purpose of the corresponding module 12, and the module 12, which forms the apartment hall, includes, mainly, both the base plate 14 and the ceiling panel 19.

[0031] Manufacturing of the corresponding modules 12 on the load-bearing bodies 13 of the conveyor 1 in the formwork 11 is carried out as follows (for example, manufacturing of modules 12 that form an apartment, a pre-apartment hall and an office space). On the load-bearing bodies 13, pallets 20 are placed, on which a corresponding formwork 11 is formed for the manufacture of a module 12 of required size and shape (the dimensions of the pallets 20-25 meters by 8 meters (length/ width), or a smaller size, preferably 17 meters by 8 meters (length/ width), depending on the size of the manufactured module 12). Each pallet 20 is made of metal and has a smooth, flat surface. Before forming the formwork 11 on the pallet 20, the surface of the pallet 20 is treated, cleaned and covered with a thin layer of oil-air lubricating.

[0032] The pallets 20 are mostly of the same size and they transport along the factory floor along the roller conveyor. At the same time, at the first stage, on one load-bearing body 13 of the conveyor 1, a plate 14 of the base of the module 12 forming an apartment (6) is manufactured, on another load-bearing body 13, a plate 14 of the base of the module 12 forming an apartment hall (7) is manufactured, and on the third body 13, a plate 14 of the base of the module 12 forming an office space is manufactured.

[0033] Each pallet 20, after preparation, transported to the position of the line (conveyor 1), where the industrial robot positions the module 12 of a specific brand. The base plates 14 in the lower part have a cellular structure with longitudinal and transverse ribs 21 (see Fig. 8). For the manufacture of base plates 14, the external sides 22 of the formwork 11 are installed on the pallet 20 using a robot according to the specified geometric dimensions, as well as special calibrated inserts 23 for forming square or rectangular cells 24 (recesses) in the lower part of the base plate 14 (inserts 23 for cells 24 have slopes for demoulding). The sides 22 are positioned and promptly placed by the robot under the module 12 of a specific brand in accordance with the documentation available in the computer. Placement and fixing of the sides 22 to the pallet 20 is carried out by means of magnets 51, by means of which the sides 22 are fixed on the pallet 20 from four sides, forming the formwork dimensions of the lower base plate 14. Initially, the sides 22 are located in the so-called "store" of the conveyor line 1. Moreover, the outer sides 22 are different in length and, depending on the geometric dimensions of the base plate 14, the robot independently determines the set of end sides 22. The height of the sides 22 is mainly 250 mm. Next, it is laid the reinforcement 25, the frames in the ribs 21. In the base plate 14 that has not yet been formed, reinforcement frames 26 are installed in the places where the pillars 15 are installed to form the pillars 15. Further, by means of, for example, a concrete paver, the concrete is supplied and the base plate 14 is formed in the corresponding formwork 11 for the base plate 14. In a variant implementation of the invention, before pouring the formwork 11 with concrete, fire insulation and sound insulation are installed in the forms, as well as engineering communications are laid with the possibility of replacing them during operation. After setting the concrete, the base plate 14 (the upper flat part) is treated with special devices (power trowels, not shown) in order to obtain an ideal flat surface. When processing the plate 14 with turntables, the reinforcement frames 26 are not touched, while the release points of the reinforcement frame 26 may remain untreated in order to better further bond the concrete.

[0034] Each base plate 14 can be changed in overall dimensions depending on the required size of the module 12, for this purpose, on the corresponding pallet 20, unnecessary inserts 23 for cells 24 are removed by a robot (or manually) and the sides 22 of the formwork 11 are narrowed (in case of reducing the overall dimensions of the module 12). Also, the dimensions of the base plates 14 during their manufacture can vary in length and width due to the sets of end sides 22 and inserts 23 to form cells 24, which are stored in a special place near the conveyor 1 (in the "store"). The robot takes the necessary sides 22 and inserts 23 from the "store" at the necessary time to form cells 24 and places them on the pallet 20 in the appropriate places and in the appropriate position. On one pallet 20, one can make both one base plate 14 and two plates 14, if they have small overall dimensions. The dimensions of the plates 14 in the plan are mainly 15 meters by 6.5 meters (length/ width) or 16 meters by 7 meters (length/ width), which corresponds to a certain area of the manufactured, for example, apartment module (6), but the dimensions of the plates 14 can be different (smaller or larger) depending on the required area. The ribbed plate 14 has both external longitudinal and transverse ribs 21 and internal ribs, with the size of the external ribs 21 being mainly 250 mm in height (the total height of the plate 14) and 180 mm in width, and the internal ribs in cross-section have a constant size (except for the places where the pillars 15 are installed), which is mainly 100 mm in width and 160 mm in height. The thickness of the "field" of the plate 14 has, mainly, a thickness of 50 mm. However, the specified dimensions may vary, depending on the purpose and type of module 12. In addition, for the manufacture of base plates 14, a formwork system can be used, having instead of inserts 23 for the formation of cells 24 a certain set of sides, which includes both end sides 22 and inner sides 52 and 53 for the formation of longitudinal and transverse ribs, and the sides 52 and 53 also have magnets 51, with which the sides 52 and 53 are placed and fixed on the pallet 20 (Fig. 24). The sides 52 and 53 are installed using a robot, which, depending on the size of the plate 14, independently determines the necessary set of sides 52 and 53, their size and placement on the pallet 20 by means of software. The sides 52 and 53 are also located in the "store" and, when placed by the robot, have the ability to change their position on the pallet 20 in order to change, if necessary, the dimensions (height and width) of the internal longitudinal and transverse ribs of the base plate 14. When using such a formwork system for the formation of cells 24, special, for example, plywood sheets 54 are used, which are installed on the stops 55, fixed on the sides 52 and 53. The sides 52 and 53 also have slopes to ensure that the base plate 14 is demoulded after it is formed. The replaceable sides 22, 52 and 53 with magnets 51, which are quickly installed by the robot on the pallet 20, depending on the required size of the plate 14, provide an operational change in the spatial location on the pallet 20 and the possibility of manufacturing the plate 14 with ribs (external and internal, longitudinal and transverse) of any required size. The use of such sides 22, 52 and 53 allows one to significantly save time on the formation of the formwork 11 for the base plate 14 and increase labor productivity.

[0035] After forming and finishing the upper part of the plate 14, the entire surface of the plate 14 can be covered with special decking, and before that can be covered with a coating so that when the cement interacts (reacts) with water in the concrete mass of the plate 14, isothermal processes begin, and the product begins to warm itself 20. It is necessary to ensure that the fresh concrete of the pillars 15 "goes" to the surface of the already not sufficiently hardened concrete of the plate 14. At the same time, certain concrete compositions are selected so that when pouring pillars 15, the concrete does not squeeze the set concrete of the plate 14 out from under the formwork 11.

[0036] After forming the base plate 14, the pallet 20 (with the base plate 14 formed on it and the outlets of the reinforcement frame 26) on the first conveyor 1 (along the roller) is supplied to the installation post of the vertical formwork 11 (the vertical molding post), i.e. it transports to the installation form for the manufacture of vertical pillars 15 and beams 17 (it drives under the installation form, which forms the formwork 11, Fig. 11 and 12). The number of mold units in the factory is preferably not less than sixteen units, but there can be any other number of such mold units, depending on the required capacity. In advance, the robot puts the inserts 28 (pillar formers 15) on the longitudinal and transverse sides 27. Such inserts 28 are typeset and, depending on the location, are attached to magnets, taking into account the horizontal forces of the robot. Similarly, with the help of the robot, other inserts are installed, which form the geometric dimensions of the pillars 15 and the upper binding beams 17 around the entire perimeter of the module 12. Then a formwork for intermittent floor slabs can be installed (separately) on the closed plate 14 (in the middle and ends of the module 12, and depending on the width of the module 12, the dimensions of such a formwork may change).

[0037] The longitudinal and transverse sides 27 of the formwork 11 for the manufacture of pillars 15 and beams 17 with inserts 28 already attached to them (in accordance with the drawings) are transported only in the horizontal plane to the desired size. At the same time, these sides 27 with inserts 28 have, mainly, a fan arrangement (and work on the "shutter" principle). Such sides 27 "hover" over the pallet 20 and the end sides 22 of the base plate 14, and they have the possibility to "drive" inside a forming system of the pillar 15 of the vertical reinforcement 26. In addition, the sides 27 of the formwork 11 for pillars 15 (or walls 16) and beams 17 have the ability to quickly change their spatial position relative to the base plate 14 with the help of a robot and make pillars 15 of any size and in any position (in any place) on the base plate 14 (including rotates by 90° with different brands of the module 12). Void formers (inserts 28) between the pillars 15 are attached to the moving end sides 27 of the installation form, and they allow one to design any gaps between the pillars 15, as well as to design doorways 29, panoramic windows 30, etc. Further, after preparing the formwork 11 for pillars 15 and beams 17, fill the formwork 11 with concrete to form pillars 15, made at the same time as the base plate 14, and with the formation of longitudinal and transverse beams 17 for the ceiling (or, if necessary, immediately the ceiling panel 19). Between the pillars 15 (if necessary), a wall 16 of rigidity can be formed, which is solved by the absence of an insert 28. In this case, in some of the pillars 15 (on top of the module 12), for example, located in the corners of the base panel 15, or in all the pillars 15, special loops (catchers, not shown) can be formed to lift the module 12, or special sleeves can be formed with threaded holes for reinforced bolts or studs (not shown), with the help of which the subsequent high-precision installation of the prefabricated modules and their connection to each other on the construction site. If necessary, using the formwork 11 with inserts 28 instead of pillars 15 or along with them, it is possible to form load-bearing walls 16 in the module 12 with window and/ or door openings 30, 29 in any place in accordance with the design documentation and drawings. Due to the manufacture of the modules 12 completely monolithic, i.e. the monolithic connection of the base plate 14 with the pillars 15, and the pillars 15 with the beams 17 in the longitudinal and transverse direction, high rigidity of the modules 12 is ensured. And due to the use of quickly changeable formwork 11 (with the help of industrial robots), the highest precision of manufacturing modules 12 is provided, which is very important during subsequent assembly during installation. The dimensions of the pillars 15 in the plan are preferably 180/500 mm, but the pillars 15 may have other dimensions (smaller or larger). The number of pillars 15 in the module 12 is preferably eight, but there may be a different number of pillars 15 (more or less) depending on the size and configuration of the modules 12.

[0038] On the first conveyor 1, the modules 12 can be manufactured in any size, while depending on the area of the modules 12 to be manufactured, the purpose and type of modules 12 (apartment, apartment hall, stairlift unit, etc.), the modules 12 can have, mainly, a width of 3 to 7.2 meters, a length of 8 to 21 meters, a height of 3 to 3.5 meters (however, there may be smaller sizes in the corresponding direction). That is, for example, if it is necessary to make a module 12 that forms an apartment (6), then it can have dimensions (depending on the area of the apartment), for example, 6,5/ 15/ 3 m (width/ length/ height, respectively) or 7/ 10/ 3 m, etc. If it is necessary to make, for example, a module 12 forming a pre-apartment hall (7), then such a module 12 may have dimensions, for example, 3/ 18/ 3 m. Or, if it is necessary to make, for example, a module 12 that forms an office space, then it may have dimensions, for example, 7,2/ 21/ 3,5 m. And so on, depending on the purpose of the corresponding module 12, it should be understood that, if necessary, the corresponding module 12 can also be made smaller, for example, in length, have the same size as in width (for example, 3 meters in length and width, or 4 meters in length and width, or, for example, 3,5 meters in width and 6 meters in length).

[0039] In addition, when manufacturing the modules 12 on the first conveyor 1, it is possible to form protrusions 31 and recesses 46 in the modules 12. Moreover, the protrusions 31 (rod protrusions) are formed on top of the modules 12, and the recesses 46 are formed on the bottom of the modules 12 (from the bottom of the plate 14 in the ribs 21). Protrusions 31 and recesses 46 are formed mainly in the places where the pillars 15 are executed and are directed along the pillars 15. The protrusions 31 and the recesses 46 are designed for high-precision connection and installation of prefabricated modules on top of each other when they are installed on a construction site. When installing the prefabricated modules 6-10 of the overlying floors on the prefabricated modules 6-10 of the underlying floors, the projections 31 enter the recesses 46, as a result of which high-precision positioning of the prefabricated modules 6-10 is provided during construction of the building and, as a result, high-precision installation of prefabricated modules 6-10. Such protrusions 31 and recesses 46 can also be formed on the second conveyor 2 after manufacturing of the prefabricated modules 6-10.

[0040] Also, when manufacturing the modules 12 on the first conveyor 1 with the help of the formwork 11, it is possible to form special places 47 in the modules 12, made in the form of recesses and through holes 49. The places 47 are formed in pillars 15 (or in solid walls 16, if available) and provide the possibility of connecting the prefabricated modules 6-10 to each other when they are installed on the construction site using threaded connections (without welding). Such places 47 allow to connect prefabricated modules 6-10 of one (own) floor to each other by inserting through the holes 49, for example, reinforced bolts 50 and fixing them, for example, with reinforced locking nuts. The places 47 can also be formed already on the second conveyor 2 after manufacturing of the prefabricated modules 6-10.

[0041] Thus, due to the use of industrial robots and manipulators on the conveyor 1, which quickly form the formwork 11 of any shape and size, it is possible to quickly change the dimensions and shapes of the formwork 11 in order to manufacture modules 12 of any size, shape and configuration. As a result, productivity increases, time for manufacturing modules 12 of the desired shape, type and size is significantly reduced, need for manual labor for forming the formwork 11 is eliminated, accuracy of the specified dimensions of the modules 12 is increased, as well as quality of the manufactured modules 12.

[0042] After the first conveyor 1 has produced the corresponding frame-monolithic module 12 (modules forming apartments (6), pre-apartment halls (7), stair-lift units (8, 9), basements (10), etc.), it (they) is transported to the second robotic conveyor 2 (located, for example, in the conveyor workshop, where the temperature corresponds to room temperature), where a prefabricated module (prefabricated modules 6-10) is formed from it (them) using construction products and components. At the same time, the formation of prefabricated modules 6-10 can also be carried out with the help of industrial robots (not shown), as well as through manual labor.

[0043] Construction products and components include: construction materials for engineering communications; materials for ventilation and roofing, as well as insulation materials; materials for the waterproofing process; materials for connecting any articles; materials for all types of finishing works (both for internal roughing and finishing of the room, and for external finishing); materials for creating built-in furniture; as well as any other materials necessary for the implementation of 99.9% of the premise finishing and the preparation of the prefabricated module 6-10 for its intended use.

[0044] The corresponding prefabricated modules 6-10 (depending on the purpose) are formed on the conveyor 2 by installing engineering communications, by forming internal partitions (internal walls separating the premises in the corresponding module), by forming external walls, if only pillars 15 were originally made in the formwork 11 instead of load-bearing walls 16, by performing internal finishing (as well as external finishing, if necessary, i.e. if part of the external walls of the corresponding prefabricated modules 6-10 form the facade of the building), by installing built-in furniture. Engineering communications (engineering support networks) used to form prefabricated modules 6-10 include (but are not limited to): external power supply systems (power transmission lines, transformer and tracking substations, etc.); internal power supply systems (including low-current ones); external heat supply systems; internal heat supply systems (hot water and heating systems); external water supply and sewerage systems (water supply sources, hydraulic structures, water and sewer treatment plants, collectors, pumping stations, etc.); internal water supply and sewage systems; ventilation and air conditioning systems; lighting systems; gas supply systems (gas distribution sites, pressure regulators, filters, safety valves, meters, gas pipelines, etc.); external communication networks; internal communication networks (telephone network, structured cabling system, automated dispatch control system, access control system, visualization system, video surveillance, Internet, smart home system, etc.); sewerage; drainage; fire water supply and security systems; etc.

[0045] Thus, on the second conveyor 2, prefabricated modules 6-10 are formed with 100% finishing, completely ready for use. In this case, the conveyor 2 has, mainly, two levels 32 and 33 (Fig. 18). The first level 32 (for example, the lower one) includes one or two or more longitudinal parts 34 (lines) that transport the manufactured modules 12 on load-bearing bodies, and on which the prefabricated modules 6-10 are directly formed, both using robots and by manual labor. The number of longitudinal parts 34 and load-bearing bodies of the first level 32 depends on the number of modules 12 that are transported simultaneously on the first level 32. The second level 33 includes several transverse parts 35 (lines), with the help of which prefabricated construction articles and components are transported to the first level 32 in the corresponding zone to form the prefabricated modules 6-10. In addition, the second level 33 can also produce construction articles and components necessary for formation of the prefabricated modules 6-10, which are subsequently also transported to the first level 32 for formation of the prefabricated modules 6-10. The second conveyor 2 can have a special lift 36 in each zone, with the help of which the corresponding construction products and components are supplied from the second level 33 to the first level 32. The workshop of the conveyor 2 can be combined with storage spaces where construction products and components are stored, which are subsequently supplied by means of the transverse parts 35 of the second level 33 of the conveyor 2 to the first level 32. In this case, the transverse supply can be either on one side or on both sides relative to the first level 32. In addition, on the first level 32 of the conveyor 2 in the corresponding zone (at each stage of the prefabricated module 6-10 formation), monitors 45 (screens, televisions, projectors, etc.) can be installed, which broadcast to the workers the sequence of formation of the prefabricated modules 6-10 (when using manual labor to form the prefabricated modules 6-10), i.e. the sequence of certain communications installation, room finishing, etc. The broadcast can be carried out, for example, by playing animated video files, or playing special video scenes that demonstrate the complete sequence of actions when forming the prefabricated modules 6-10 in the corresponding zone. Due to the use of such monitors 45, which broadcast to workers the entire sequence of actions for the formation of the prefabricated modules 6-10, it eliminates the need for workers to study in detail the design documentation, to select certain construction products and components, as a result of which workers quickly begin to form prefabricated modules 6-10 by installing certain articles, which significantly reduces the time for formation of the prefabricated modules 6-10 and increases labor productivity.

[0046] The proposed method is carried out using the conveyor 2 as follows.

[0047] After manufacturing the corresponding module 12 in the molding workshop on the conveyor 1 and transferring it to the conveyor 2, complete finishing of the modules 12 is carried out on the first level 32.

[0048] Further, we will consider the option of finishing the modules 12 that form the apartments (prefabricated module 6). However, it should be understood that other modules 12 (apartment halls (7), stair-lift units (8, 9), office premises, basements (10), etc.) are also prefabricated, but maybe with the use of other components, or excluding part of the components, depending on the type of module.

[0049] The load-bearing bodies of the first level 32 of the conveyor 2 transport with the modules 12, mainly continuously (or may have short stops). At the same time, for example, in the first zone (at the first stage) of the conveyor 2, all the necessary construction articles and components are supplied to the first level 32 from the second level 33, and inside the module 12 they do (both with the help of manual labor and with the help of robots), for example, pour the floor, install, for example, metal crosspieces 18 of the overlap (in the absence of a ceiling panel 19), carry out cladding work, cover the ceiling with drywall, prepare ventilation, insulate the walls and carry out other rough finishing. Prepare internal interior partitions, internal walls, and such partitions and walls have the possibility of transformation, i.e., changing their spatial location by performing special guides, fasteners, latches and connections in the module 12 (for example, in the base plate 14 and/ or in the walls) (not shown). In addition, in this zone, on the second level 33, they can, for example, cut dry wall to the required dimensions, form ventilation products, prepare insulation of the desired size, make material for plaster, etc. Also, in this zone, exterior finishing is carried out, the necessary materials and components are also supplied from the second level 33, and, for example, prepare facades, balconies, etc.

[0050] Then, after performing all the necessary preparatory work (rough finishing) at the first level 32, the corresponding module (6) is transferred to the second zone of the conveyor 2 (second stage), where all necessary materials and components are also supplied from the second level 33 to the first level 32 and, for example, all plumbing work is carried out on the first level 32 inside and outside the modules (6), all plumbing communications are laid, pipelines, wiring, mortgages, sewer pipelines are installed, risers or connectors with risers are installed outside the apartment module (6) (if the risers are installed in the module 7 of the apartment hall), etc. Access points are being prepared for servicing pipe connections or for replacing pipes. Plumbing communication 40 is installed outside the modules 6, including on the side of the base plate 14 in special cells 24.

[0051] Then the apartment module 6 (originally module 12) is transferred to the third zone (the third stage), where the necessary materials and components are also supplied from the second level 33, and, for example, all electrical work is carried out, cables are laid, electric shields, weak points, lighting, etc. are installed. Necessary cables are laid, for example, for fire safety, for the "smart home" system, video surveillance, etc. Places of access to service electricians are prepared, special hatches 37 are installed (adjacent to the module 7 of the apartment hall), niches 38 are prepared for terminal blocks, etc. Electrical wiring 39 is performed mainly in the intermodule space, i.e. outside the modules, including from the side of the base plate 14 in special cells 24 (as well as through the inter-storey floors of adjacent apartment modules 7).

[0052] Then the module 6 is transferred to the next zone on the first level 32 (the fourth stage), where the necessary materials and components are also supplied from the second level 33 and, for example, complete interior decoration is carried out, for example, wallpaper is pasted, walls are painted, tiles are laid, parquet or linoleum or parquet board is laid, etc.

[0053] Then the module 6 is transferred to the next zone (the fifth stage), where the necessary materials and components are also supplied from the second level 33 and, for example, sockets, switches, a smart home system, video cameras, etc. are installed. Also in this area, for example, built-in water filters, sinks, showers, bathtubs, etc. can be installed. That is, at this stage, all the necessary work related to electrical and plumbing communication is completed.

[0054] After that, the module 6 is transferred to the next zone (the sixth stage), where the necessary materials and components are also supplied from the second level 33 and, for example, the installation of built-in furniture in the appropriate specially prepared places is carried out.

[0055] At the same time, if the consumer of the prefabricated module 6 wants,
for example, to change the spatial location of the internal walls, i.e., for example, to change the area of the rooms (or kitchen, or corridor, etc.), the installers change the spatial location of the internal walls, as well as engineering communications and/ or built-in furniture. Changing the spatial location of the internal walls with communications is carried out quickly by moving (transforming) the walls with communications and built-in furniture along special guides (niches in the floor and walls), as well as by using special fasteners, clamps, connections, etc. In addition, the consumer can make a change in the spatial location and after the completion of the building construction, when he settled in the apartment (either on his own

or with the involvement of specialists). This transporting (transformation) of walls with communications and built-in furniture allows consumers to quickly change the space-planning solutions of their apartments (offices, etc.), depending on their needs, requires and wishes.

[0056] After all the finishing work is done, when the prefabricated module 6 is formed and ready to transport to the construction site, it is transported to the next zone, where electricians, plumbers and other persons conduct a control inspection of the prefabricated module 6, conduct crimping and testing, and make a conclusion about the readiness of the module 6.

[0057] Then the prefabricated module 6 is transferred to the next zone of the conveyor 2 (the last zone is the end of the second conveyor 2), where the prefabricated module 6 is packed in a protective material that prevents dust, moisture, dirt, etc. from entering the prefabricated module 6, as well as which eliminates any impact on the prefabricated module 6 that can damage it, and generally excludes access to the prefabricated module 6 by anyone. A thick coating or a special cover is used as a protective material.

[0058] In the same way, all prefabricated modules 6-10 are made, while in the case, for example, of the modules 8, 9 manufacture, forming a stair-lift unit, then on the second conveyor 2 (in the corresponding zone) inside such a module 7, lift shafts, staircases, etc. are prepared, railings, pipeline and/ or garbage disposal units, electrical communications (lighting, pipes and slats for electrical wiring, terminals, sockets, junction boxes, fuses and plugs, automatic fuses, switches, plug connections, distributors, etc.) are installed, walls are painted or tiled.

[0059] If, for example, a module 7 of an apartment hall is made, then life support systems, engineering boxes with hoods, air exchange shafts, fire valves, transit cabinets 41 with sewer risers, water supply, transit electrical cabinets 42, electrical shields, boxes with terminal blocks (mainly coincide with the niches 38 for terminal blocks of apartment modules 6), distributors, panels for meters together with meters (water, electricity, gas, etc.), form other engineering communications, etc. In the inter-panel space (floor and ceiling of the underlying module 7), all communications 39 and 40 are located, going away from the electrical system and from the risers. Such communications 39, 40 are located between the ribs 21 of plates 14 and 19, and they must enter each apartment through the bottom of the doorway 29 or next to the doorways 29. In such places, special niches 43 are made for servicing and connecting prefabricated modules 6 and 7 for engineering communications (separately for electrics and separately for plumbing), for example, hatches 44 with lower or upper wiring are placed. Painting the walls or laying tiles, preparing lighting, etc. are also performed.

[0060] Similarly, the prefabricated modules 10 are made, forming basements (lower modules). At the same time, all external networks enter and exit the lower modules 10 (for example, sewage and wastewater for heat ("return")). In addition, the lower (basement) modules 10 have perfect waterproofing on the outside. Some modules 10 have solid ribbed walls 16 (around the perimeter of the building), and some modules 10 may not have solid walls (internal modules 10 in the basement). Between the adjacent modules 10, passageways are organized along the entire building, there are separate entrances and exits to the basements. Such modules 10 should have floor slabs 19, to which engineering pipes can be fixed. In the basement modules 10, all engineering equipment is mounted on the conveyor 2 (individual heat points, water pumping stations, centralized water and heat meters, etc.), i.e., 99.9% finishing is also carried out.

[0061] All prefabricated modules 6-10 are fully factory-ready, with the corresponding prefabricated modules 6-10 having the following (but not limited to): glazed window and balcony door blocks; door blocks with architraves and door devices; built-in cabinets and mezzanines; mounted wiring of central heating, cold and hot water supply, sewerage networks with sanitary and technical devices; mounted hidden electrical wiring with fittings for connection; ventilation units with exhaust radiators; floors on balconies (loggias); barrier constructions on the balconies; fully prefabricated facade surface of the exterior walls; interior finishing that meets the requirements of the building project, etc.

[0062] Due to the use of the second conveyor 2, which has two levels 32 and 33, combined with storage facilities, time is saved for the manufacture of prefabricated modules 6-10, and labor productivity is significantly increased. In addition, due to the presence of separate zones (stages) wherein certain finishing works are carried out for prefabricated modules 6-10, it eliminates the need for workers of the relevant specialties (electricians, plumbers, finishers, etc.) to transport from one zone to another in order to carry out certain works. Each worker is located in his own zone and only the products, components and tools necessary for his work are supplied to this zone from the second level 32. As a result, the workers do not need to transport around the entire plant workshop, and the time for carrying out all types of finishing work in each zone on the first level 32 of the conveyor 2 is significantly reduced. Monitors 45 in each zone of the conveyor 2, demonstrating the sequence of certain works, also reduce the time for carrying out the corresponding works.

[0063] After the corresponding prefabricated modules 6-10 are fully formed and have a full 99% finish, and after they are packed, such prefabricated modules 6-10 are installed (from the second conveyor 2) on the platform of a special vehicle 3 for transporting prefabricated modules 6-10 (one prefabricated module 6-10 per vehicle 3) and transport the prefabricated modules 6-10 to the construction site. Transportation is carried out accompanied by special services and special equipment, mainly at night, as well as on pre-prepared and agreed routes that allow one to transport large-sized heavy cargo.

[0064] At the construction site, where the foundation 5 has already been prepared, the packed prefabricated modules 6-10 are installed in the appropriate place by means of a lifting device 4. In this case, the installation of prefabricated modules 6-10 is carried out on a floor-by-floor basis with the formation of a building by the method of floor-by-floor re-laying, i.e. a part of the prefabricated modules 6 (7) of even floors is installed relative to a part of the prefabricated modules 6 (7) of odd floors with an intersection in the plan of part of the load-bearing walls 16 (part of the prefabricated modules 6 is rotated 90° relative to a part of the lower prefabricated modules 6).

[0065] The building is constructed as follows. Basement (lower) prefabricated modules 10 are installed, unpacked, mounted and connected to each other. In this case, the connection is carried out without the use of welding due to the places 47, where threaded connections are used. Then, on the basement prefabricated modules 10, prefabricated apartment modules 6 of the first floor, prefabricated apartment modules 7, prefabricated modules of stair-lift units 8 and 9 are installed (by introducing projections 31 into recesses 46), workers unpack them and mount the prefabricated modules 6-9 and connect them to each other and to the prefabricated basement modules 10 (also without the use of welding due to the presence of places 47 for connecting adjacent modules using threaded connections). Due to the presence of specially prepared protrusions 31 and recesses 46 in prefabricated modules 6-9 (10), respectively, in the upper and lower parts, through which the overlying prefabricated modules 6-9 are connected to the underlying ones, high-precision installation of the prefabricated modules 6-10 and their reliable connection to each other is ensured. The places 47 for the threaded connections of the adjacent modules 6-10, as well as the use of threaded connections, also ensure a reliable and rigid connection of the prefabricated modules 6-10 with each other. Then the prefabricated apartment modules 6, pre-apartment modules 7 and modules 8 and 9 of the stair-lift units of the second floor are installed, while part of the prefabricated modules 6 (7) of the second floor is rotated by 90° relative to part of the prefabricated modules 6 (7) of the first floor. Then the prefabricated apartment modules 6, pre-apartment modules 7 and modules 8 and 9 of the stair-lift units of the third floor are installed, while part of the prefabricated modules 6 (7) of the third floor is also rotated 90° relative to part of the prefabricated modules 6 (7) of the second floor, and the position of the prefabricated modules 6 (7) of the third floor corresponds to the position of the prefabricated modules 6 (7) of the first floor. And so on, to construct a building of the desired number of storeys. Some prefabricated modules (8, 9) of even floors do not transport (do not rotate) relative to the prefabricated modules (8, 9) of odd floors and are installed relative to them in the same way. This refers, for example, to prefabricated modules 8, 9 of stair-lift units, where floor-by-floor re-laying is not allowed. This floor-by-floor layout ensures high rigidity of the entire building, its stability and durability. When connecting the prefabricated modules 6-10, a bolted connection is mainly used, while ensuring that the modules 6-10 are vertically and horizontally adjacent to each other without a gap. The size of the external joints between the modules is 14 mm (according to the previously conducted thermal engineering calculations (Mosstroy Research Institute), sizes less than this value are not allowed due to changes in the ambient temperature).

[0066] Thus, factory- prefabricated modules 6-10, as well as buildings constructed from such prefabricated modules 6-10, have the necessary durability, rigidity, stability and provide the load-bearing capacity of the building for the entire period of its operation. The maximum degree of factory readiness is ensured, it is possible to preserve the prefabricated modules 6-10 during storage, transportation and installation, as well as to preserve the exterior and interior finishes. The required operational qualities of buildings are insured: the necessary sanitary and hygienic conditions, sound insulation, thermal protection, fire safety. The prefabricated modules 6-10 are manufactured with high dimensional accuracy (±1 mm), ensuring equality of their heights at the extreme points, equality of diagonals, accuracy of compliance with the thickness of the faces and the configuration of the support parts, ensuring the correct transmission of loads. At the same time, the prefabricated modules (for example, 6, 8, 9) have a reduced weight, mainly due to absence of the monolithic slabs 19 floors, as a result of which the weight of the constructed building as a whole is reduced.

[0067] Due to absence of welded joints, presence of the prefabricated modules 6-10 special docking units (protrusions 31, recesses 46, places 47 of the connection of adjacent modules 6-10), the speed and accuracy of mounting and connecting modules 6-10 to each other significantly increases. Also due to this, the building is made with the possibility of dismantling and transporting (if it is required in exceptional cases) with the help of vehicles 3 prefabricated modules 6-10 to another construction site, where such a building is re-constructed with similar rigidity and stability.

[0068] The use of pallets 20 of the described size, the possibility of changing the dimensions of the formwork 11 formed on pallets 20 in all three coordinates, as well as the use of different sizes of sets of inserts 23, 28 and the hydraulic system 48 (hydraulic cylinders that drive the formwork 11) for the formwork 11 allows one to increase the area of the buildings constructed, to ensure the versatility of buildings for any space-planning solutions. The use of robotic conveyors 1 and 2, as well as the presence of the conveyor 2 separate zones wherein certain operations are carried out to form prefabricated modules 6-10, allows one to significantly increase the volume of daily manufacture of prefabricated modules 6-10 and increase productivity. In addition, due to the use of formwork 11 with constantly changing sizes and shapes, as well as due to the separation of zones for finishing prefabricated modules 6-10 on the conveyor 2, the time and labor costs for construction of buildings are significantly reduced, the labor intensity and cost of construction of buildings are reduced. 99.9% factory finish of the prefabricated modules 6-10 with the possibility of changing the space-planning solutions (including due to the possibility of rapid changes in the spatial position of the internal walls inside the room) allows one to increase the comfort of the constructed premises. High-precision manufacturing of the prefabricated modules 6-10 with specially prepared connection nodes (protrusions 31, recesses 46, places 47 connections) allows one to simplify installation of three-dimensional modules on the construction site without the use of welded joints and increase the accuracy of the placement of modules relative to each other. Floor-by-floor re-laying of prefabricated modules 6-10 during the construction of buildings, i.e., turning part of the prefabricated modules of even storeys relative to part of the prefabricated modules of odd storeys, mainly by 90° (or at a different angle), ensures high rigidity, durability and stability of buildings even in the absence of welded joints.

[0069] Due to all of the above mentioned, one of the main principles of the invention is that the architect manages the factory manufacture, and not vice versa. Module-apartments are large in size and have free layout. During conveyor manufacture, the workplace (the place of labor application) of the module, materials and components transfer to the performer of the work, and not vice versa, as in existing construction technologies.

Claims

1. A method for manufacturing a prefabricated three-dimensional module (6, 7, 8, 9, 10), the method comprising

   placing a pallet (20) on a first robotic conveyor (1), on which, with the help of industrial robots, a formwork system is formed,

   the formwork system including a first and a second formwork for the manufacture of a monolithic reinforced-concrete three-dimensional module (12), including a base plate (14), lateral pieces, namely pillars (15) and/ or walls (16), beams (17), and ceiling pieces, namely cross-pieces (18) and/or ceiling panels (19),

   the method further comprising positioning, placing and fixing sides (52, 53) on the pallet (20) using magnets (51) to form the first formwork for the base plate (14) with the help of said industrial robots, such that longitudinal and transverse ribs (21) of the base plate (14) are formed,

   reinforcement (25) is laid, and in the places where the pillars (15) are to be located, reinforcement frames (26) are installed for formation of the pillars (15),

   the base plate (14) is formed by supplying concrete to the first formwork with the formation of longitudinal and transverse ribs (21) with recesses (24) between them, placed at the locations of the pillars (15) and directed along the pillars (15),

   the pallet (20) with the base plate (14) formed on it with reinforcement frames (26) for the formation of pillars (15) is supplied on the first robotic conveyor (1) to a vertical formwork installation post, where industrial robots form the second formwork (11) for the lateral pieces, beams (17), and ceiling pieces from longitudinal and transverse sides (27), as well as a set of inserts (28) fixed with magnets (51) on the longitudinal and transverse sides (27),

   the monolithic reinforced concrete three-dimensional module (12) is made by supplying concrete into the second formwork (11) with the formation of protrusions (31) on the beams (17), placed at the locations of the pillars (15) and directed along the pillars (15),

   the manufactured monolithic reinforced concrete three-dimensional module (12) is transferred to a second robotic conveyor (2), where, with the help of industrial robots, the prefabricated three-dimensional module (6, 7, 8, 9, 10) is manufactured by installing engineering communications, performing interior and exterior finishing, forming internal partitions and/ or installing built-in furniture.

2. The method according to claim 1, wherein the formation of the formwork system for the manufacture of a monolithic reinforced concrete three-dimensional module is carried out with the possibility of changing its dimensions from 3 to 7.2 meters in width, from 8 to 21 meters in length and from 3 to 3.5 meters in height, in which the production of the monolithic reinforced concrete three-dimensional module is carried out, the width of which is from 3 to 7.2 meters, the length from 8 to 21 meters, the height from 3 to 3.5 meters.

3. The method according to claim 1, wherein the lateral pieces of the monolithic reinforced concrete three-dimensional module are formed with recesses and through holes for connecting the prefabricated three-dimensional modules.

4. The method according to claim 1, wherein the first robotic conveyor (1) is used to manufacture a monolithic reinforced concrete three-dimensional module having at least six pillars (15), the dimensions of which in the plan view are 180/500 mm.

5. The method according to claim 1, wherein, before supplying concrete to the first formwork, fire insulation and sound insulation are installed in the first formwork, as well as engineering communications are laid.

6. The method according to claim 1, wherein, after the formation of the base plate (14), its upper part is treated with a power trowel to form a smooth, flat surface.

7. The method according to claim 6, in which, after processing the upper part of the base plate (14), it is covered with decking.

8. The method according to claim 1, in which, in the manufacture of the monolithic reinforced concrete three-dimensional module, at least some of the pillars form loops in their upper part for lifting the module.

9. A method for constructing buildings from prefabricated three-dimensional modules manufactured according to any of claims 1-8, consisting in the fact that on the construction site, by means of at least one lifting device, the prefabricated three-dimensional modules are installed in the appropriate place floor-by-floor, while basement prefabricated three-dimensional modules are installed on the foundation, on the basement prefabricated three-dimensional modules, prefabricated three-dimensional modules of the first floor are installed by introducing protrusions of the basement prefabricated three-dimensional modules located in the upper part at the locations of the pillars, in the recesses of the prefabricated three-dimensional modules of the first floor located in the lower part at the pillars, the prefabricated three-dimensional modules of the first floor are assembled and connected with each other by means of threaded connections passing via through holes in the pillars or the walls of adjacent prefabricated three-dimensional modules of the first floor, prefabricated three-dimensional modules of the first floor are installed on prefabricated three-dimensional modules of the second floor by introducing protrusions of prefabricated three-dimensional modules of the first floor, located in the upper part at the pillars, in the recesses of prefabricated three-dimensional modules of the second floor, located in the lower part at the pillars, and a portion of the corresponding prefabricated three-dimensional modules of the second floor is rotated relative to a portion of the corresponding prefabricated three-dimensional modules of the first floor by 90°, the prefabricated three-dimensional modules of the second floor are assembled and connected to each other by means of threaded connections passing via through holes in the pillars or walls of adjacent prefabricated three-dimensional modules of the second floor, prefabricated three-dimensional modules of the following floors are successively installed on the prefabricated three-dimensional modules of the second floor by introducing the protrusions of the prefabricated three-dimensional modules of each previous floor, located in the upper part at the pillars, into the recesses of the prefabricated three-dimensional modules of each next floor, located in the lower part at the pillars, the prefabricated three-dimensional modules of each floor are assembled and connected with each other using threaded connections, passing via through holes in the pillars or walls of adjacent prefabricated three-dimensional modules of the corresponding floor, and a portion of the corresponding prefabricated three-dimensional modules of each subsequent floor are rotated relative to a portion of the corresponding prefabricated three-dimensional modules of the previous floor by 90° and form a building so that a portion of the prefabricated three-dimensional modules of even-numbered floors is installed relative to a portion of the prefabricated three-dimensional modules of odd-numbered floors so that, in plan view, some of the walls intersect.

10. The method according to claim 9, wherein a crawler-mounted heavy boom-type crane with a lifting capacity of up to 750 tons is used as at least one lifting device.

11. The method according to claim 9, wherein the installation of prefabricated three-dimensional modules using at least one lifting device is carried out using loops on the pillars (15).

Patentansprüche

1. Verfahren zur Herstellung eines vorgefertigten dreidimensionalen Moduls (6, 7, 8, 9, 10), wobei das Verfahren umfasst

Aufsetzen einer Palette (20) auf einen ersten Roboterförderer (1), auf dem mit Hilfe von Industrierobotern ein Schalungssystem gebildet wird,
wobei das Schalungssystem eine erste und eine zweite Schalung für die Herstellung eines monolithischen dreidimensionalen Stahlbetonmoduls (12) umfasst mit einer Grundplatte (14), Seitenteilen, nämlich Säulen (15) und / oder Wänden (16), Trägern (17), und Deckenteilen, nämlich Querstreben (18) und/oder Deckenplatten (19),
wobei das Verfahren ferner das Positionieren, Anordnen und Befestigen von Seiten (52, 53) auf der Palette (20) unter Verwendung von Magneten (51) umfasst, um die erste Schalung für die Grundplatte (14) mit Hilfe der Industrieroboter zu bilden, so dass Längs- und Querrippen (21) der Grundplatte (14) gebildet werden,
wobei eine Bewehrung (25) verlegt wird, und an den Stellen, an denen die Säulen (15) stehen sollen, Bewehrungsrahmen (26) zur Bildung der Säulen (15) angebracht werden,

wobei die Grundplatte (14) durch Einbringen von Beton in die erste Schalung mit der Bildung von Längs- und Querrippen (21) mit dazwischenliegenden Aussparungen (24) gebildet wird, die an den Stellen der Säulen (15) angeordnet und entlang der Säulen (15) ausgerichtet sind,

wobei die Palette (20) mit der darauf gebildeten Grundplatte (14) mit Verstärkungsrahmen (26) für die Bildung von Säulen (15) auf dem ersten Roboterförderer (1) zu einem vertikalen Schalungsmontagepfosten zugeführt wird, wo Industrieroboter die zweite Schalung (11) für die Seitenteile, Träger (17) und Deckenteile aus Längs- und Querseiten (27), sowie einen Satz von Einsätzen (28) bilden, die mit Magneten (51) an den Längs- und Querseiten (27) befestigt sind,

wobei das monolithische dreidimensionale Stahlbetonmodul (12) hergestellt wird durch Zuführen von Beton in die zweite Schalung (11) unter Bildung von Vorsprüngen (31) an den Trägern (17), die an den Stellen der Säulen (15) angeordnet und entlang der Säulen (15) ausgerichtet sind,

wobei das gefertigte dreidimensionale Modul (12) aus monolithischem Stahlbeton zu einem zweiten Roboterförderer (2) transportiert wird, wo mit Hilfe von Industrierobotern das vorgefertigte dreidimensionale Modul (6, 7, 8, 9, 10) hergestellt wird, indem die technischen Verbindungen installiert, die Innen- und Außenarbeiten durchgeführt, die inneren Trennwände gebildet und/oder die Einbaumöbel installiert werden.

2. Verfahren nach Anspruch 1,
wobei die Bildung des Schalungssystems zur Herstellung eines dreidimensionalen Moduls aus monolithischem Stahlbeton mit der Möglichkeit der Veränderung seiner Abmessungen von 3 bis 7,2 Metern Breite, 8 bis 21 Metern Länge und 3 bis 3,5 Metern Höhe erfolgt, in denen die Herstellung des dreidimensionalen Moduls aus monolithischem Stahlbeton mit einer Breite von 3 bis 7,2 m, einer Länge von 8 bis 21 m und einer Höhe von 3 bis 3,5 m erfolgt.

3. Verfahren nach Anspruch 1,
bei dem die seitlichen Teile des dreidimensionalen Moduls aus monolithischem Stahlbeton mit Aussparungen und Durchgangslöchern für die Verbindung der vorgefertigten dreidimensionalen Module versehen sind.

4. Verfahren nach Anspruch 1,
wobei der erste Roboterförderer (1) zur Herstellung eines dreidimensionalen Moduls aus monolithischem Stahlbeton verwendet wird, mit mindestens sechs Säulen (15), deren Abmessungen in der Draufsicht 180/500 mm betragen.

5. Verfahren nach Anspruch 1,
bei dem vor dem Einbringen von Beton in die erste Schalung eine Brand- und Schalldämmung in der ersten Schalung installiert und eine technische Verbindung hergestellt wird.

6. Verfahren nach Anspruch 1,
wobei nach der Bildung der Grundplatte (14) ihre Oberseite mit einer Glättkelle bearbeitet wird, um eine glatte, ebene Oberfläche zu erhalten.

7. Verfahren nach Anspruch 6,
bei dem nach der Bearbeitung der Oberseite der Grundplatte (14) diese mit einem Belag versehen wird.

8. Verfahren nach Anspruch 1,
bei dem bei der Herstellung des dreidimensionalen Moduls aus monolithischem Stahlbeton, zumindest einige der Säulen in ihrem oberen Teil Schlaufen zum Anheben des Moduls bilden.

9. Verfahren zur Errichtung von Gebäuden aus vorgefertigten dreidimensionalen Modulen, hergestellt nach einem der Ansprüche 1-8, bestehend darin, dass auf der Baustelle mit Hilfe von zumindest einer Hebevorrichtung die vorgefertigten dreidimensionalen Module geschossweise am passenden Platz installiert werden, während vorgefertigte dreidimensionale Module des Kellers auf dem Fundament installiert werden, wobei auf den vorgefertigten dreidimensionalen Modulen des Kellers vorgefertigte dreidimensionale Module der ersten Etage installiert werden, indem Vorsprünge der vorgefertigten dreidimensionalen Module des Kellers, die sich im oberen Teil an den Stellen der Säulen befinden, in die Aussparungen der vorgefertigten dreidimensionalen Module der ersten Etage, die sich im unteren Teil an den Säulen befinden, eingeführt werden, wobei die vorgefertigten dreidimensionalen Module der ersten Etage zusammengebaut werden und mit Hilfe von Gewindeverbindungen, die durch Durchgangslöcher in den Säulen oder den Wänden der benachbarten vorgefertigten dreidimensionalen Module der ersten Etage verlaufen, miteinander verbunden werden, wobei vorgefertigte dreidimensionale Module der ersten Etage auf vorgefertigte dreidimensionale Module der zweiten Etage montiert werden, indem Vorsprünge von vorgefertigten dreidimensionalen Modulen der ersten Etage, die sich im oberen Teil an den Säulen befinden, in die Aussparungen von vorgefertigten dreidimensionalen Modulen der zweiten Etage, die sich im unteren Teil an den Säulen befinden, eingeführt werden, und ein Teil der entsprechenden vorgefertigten dreidimensionalen Module der zweiten Etage relativ zu einem Teil der entsprechenden vorgefertigten dreidimensionalen Module der ersten Etage um 90° gedreht wird, wobei die vorgefertigten dreidimensionalen Module der zweiten Etage zusammengebaut und mit Hilfe von Gewindeverbindungen, die durch Durchgangslöcher in den Säulen oder Wänden benachbarter vorgefertigter dreidimensionaler Module der zweiten Etage verlaufen, miteinander verbunden werden, wobei vorgefertigte dreidimensionale Module der folgenden Etagen nacheinander auf den vorgefertigten dreidimensionalen Modulen der zweiten Etage installiert werden, indem die Vorsprünge der vorgefertigten dreidimensionalen Module jeder vorherigen Etage, die sich im oberen Teil an den Säulen befinden, in die Aussparungen der vorgefertigten dreidimensionalen Module jeder nächsten Etage, die sich im unteren Teil an den Säulen befinden, eingeführt werden, wobei die vorgefertigten dreidimensionalen Module jeder Etage zusammengebaut und mit Hilfe von Gewindeverbindungen miteinander verbunden werden, die durch Löcher in den Säulen oder Wänden benachbarter vorgefertigter dreidimensionaler Module der entsprechenden Etage hindurchgehen, und wobei ein Teil der entsprechenden vorgefertigten dreidimensionalen Module jeder folgenden Etage relativ zu einem Teil der entsprechenden vorgefertigten dreidimensionalen Module der vorherigen Etage um 90° gedreht werden und ein Gebäude bilden, derart dass ein Teil der vorgefertigten dreidimensionalen Module der geradzahligen Etagen relativ zu einem Teil der vorgefertigten dreidimensionalen Module der ungeradzahligen Etagen installiert wird, derart dass sich in der Draufsicht einige der Wände schneiden.

10. Verfahren nach Anspruch 9, wobei als mindestens eine Hebevorrichtung ein raupenmobiler schwerer Auslegerkran mit einer Tragfähigkeit von bis zu 750 Tonnen verwendet wird.

11. Verfahren nach Anspruch 9, bei dem die Montage von vorgefertigten dreidimensionalen Modulen mit mindestens einer Hebevorrichtung über Schlaufen an den Säulen (15) erfolgt.

Revendications

1. Procédé pour fabriquer un module tridimensionnel préfabriqué (6, 7, 8, 9, 10), le procédé comprenant

la mise en place d'une palette (20) sur un premier transporteur robotique (1), sur lequel, à l'aide de robots industriels, un système de coffrage est formé,

le système de coffrage incluant des premier et second coffrages pour la fabrication d'un module tridimensionnel monolithique en béton armé (12), incluant une plaque de base (14), des pièces latérales, à savoir des piliers (15) et/ou des murs (16), des poutres (17), et des éléments de plafond, à savoir des traverses (18) et/ou des panneaux de plafond (19),

le procédé comprenant en outre le positionnement, la mise en place et la fixation de côtés (52, 53) sur la palette (20) en utilisant des aimants (51) pour former le premier coffrage pour la plaque de base (14) à l'aide desdits robots industriels, de telle sorte que des nervures longitudinales et transversales (21) de la plaque de base (14) soient formées,

une armature (25) est posée, et dans les emplacements où les piliers (15) doivent être situés, des cadres d'armature (26) sont installés pour la formation des piliers (15),

la plaque de base (14) est formée en fournissant du béton au premier coffrage avec la formation de nervures longitudinales et transversales (21) avec des évidements (24) entre celles-ci, placés aux emplacements des piliers (15) et dirigés le long des piliers (15),

la palette (20) avec la plaque de base (14) formée sur celle-ci avec des cadres d'armature (26) pour la formation de piliers (15) est fournie sur le premier transporteur robotique (1) à un poste d'installation de coffrage vertical, où des robots industriels forment le second coffrage (11) pour les pièces latérales, les poutres (17), et les éléments de plafond à partir de côtés longitudinaux et transversaux (27), ainsi qu'un ensemble d'organes d'insertion (28) fixés avec des aimants (51) sur les côtés longitudinaux et transversaux (27),

le module tridimensionnel monolithique en béton armé (12) est réalisé en fournissant du béton dans le second coffrage (11) avec la formation de saillies (31) sur les poutres (17), placées aux emplacements des piliers (15) et dirigées les long des piliers (15),

le module tridimensionnel monolithique en béton armé fabriqué (12) est transféré à un second transporteur robotique (2), où, à l'aide de robots industriels, le module tridimensionnel préfabriqué (6, 7, 8, 9, 10) est fabriqué en installant des communications techniques, en réalisant une finition intérieure et extérieure, en formant des cloisons internes et/ou en installant un ameublement incorporé.

2. Procédé selon la revendication 1, dans lequel la formation du système de coffrage pour la fabrication d'un module tridimensionnel monolithique en béton armé est réalisée avec la possibilité de changer ses dimensions de 3 à 7,2 mètres de largeur, de 8 à 21 mètres de longueur et de 3 à 3,5 mètres de hauteur, dans lequel la production du module tridimensionnel monolithique en béton armé est réalisée, dont la largeur est de 3 à 7,2 mètres, la longueur de 8 à 21 mètres, la hauteur de 3 à 3,5 mètres.

3. Procédé selon la revendication 1, dans lequel les pièces latérales du module tridimensionnel monolithique en béton armé sont formées avec des évidements et des trous débouchants pour relier les modules tridimensionnels préfabriqués.

4. Procédé selon la revendication 1, dans lequel le premier transporteur robotique (1) est utilisé pour fabriquer un module tridimensionnel monolithique en béton armé ayant au moins six piliers (15), dont les dimensions en vue en plan sont de 180/500 mm.

5. Procédé selon la revendication 1, dans lequel, avant de fournir du béton au premier coffrage, une ignifugation et une insonorisation sont installées dans le premier coffrage, et des communications techniques sont posées.

6. Procédé selon la revendication 1, dans lequel, après la formation de la plaque de base (14), sa partie supérieure est traitée avec une truelle électrique pour former une surface lisse plate.

7. Procédé selon la revendication 6, dans lequel, après le traitement de la partie supérieure de la plaque de base (14), elle est couverte avec un platelage.

8. Procédé selon la revendication 1, dans lequel, dans la fabrication du module tridimensionnel monolithique en béton armé, au moins certains des piliers forment des boucles dans leur partie supérieure pour lever le module.

9. Procédé pour construire des bâtiments à partir de modules tridimensionnels préfabriqués fabriqués selon l'une quelconque des revendications 1 à 8, consistant en le fait que, sur le chantier de construction, au moyen d'au moins un dispositif de levage, les modules tridimensionnels préfabriqués sont installés dans l'emplacement approprié étage-par-étage, alors que des modules tridimensionnels préfabriqués de sous-sol sont installés sur les fondations, sur les modules tridimensionnels préfabriqués de sous-sol, des modules tridimensionnels préfabriqués du premier étage sont installés en introduisant des saillies des modules tridimensionnels préfabriqués de sous-sol situés dans la partie supérieure aux emplacements des piliers, dans les évidements des modules tridimensionnels préfabriqués du premier étage situés dans la partie inférieure, au niveau des piliers, les modules tridimensionnels préfabriqués du premier étage sont assemblés et reliés les uns aux autres au moyen de liaisons filetées passant par des trous débouchants dans les piliers ou les murs de modules tridimensionnels préfabriqués adjacents du premier étage, des modules tridimensionnels préfabriqués du premier étage sont installés sur des modules tridimensionnels préfabriqués du deuxième étage en introduisant des saillies de modules tridimensionnels préfabriqués du premier étage, situées dans la partie supérieure, au niveau des piliers, dans les évidements de modules tridimensionnels préfabriqués du deuxième étage, situés dans la partie inférieure, au niveau des piliers, et une portion des modules tridimensionnels préfabriqués correspondants du deuxième étage est tournée de 90° par rapport à une portion des modules tridimensionnels préfabriqués correspondants du premier étage, les modules tridimensionnels préfabriqués du deuxième étage sont assemblés et reliés les uns aux autres au moyen de liaisons filetées passant par des trous débouchants dans les piliers ou murs de modules tridimensionnels préfabriqués adjacents du deuxième étage, des modules tridimensionnels préfabriqués des étages suivants sont successivement installés sur les modules tridimensionnels préfabriqués du deuxième étage en introduisant les saillies des modules tridimensionnels préfabriqués de chaque étage précédent, situées dans la partie supérieure, au niveau des piliers, dans les évidements des modules tridimensionnels préfabriqués de chaque étage suivant, situés dans la partie inférieure, au niveau des piliers, les modules tridimensionnels préfabriqués de chaque étage sont assemblés et reliés les uns aux autres en utilisant des liaisons filetées, passant par des trous débouchants dans les piliers ou murs de modules tridimensionnels préfabriqués adjacents de l'étage correspondant, et une portion des modules tridimensionnels préfabriqués correspondants de chaque étage suivant est tournée de 90° par rapport à une portion des modules tridimensionnels préfabriqués correspondants de l'étage précédent, et forment un bâtiment pour qu'une portion des modules tridimensionnels préfabriqués d'étages de nombres pairs soit installée relativement à une portion des modules tridimensionnels préfabriqués d'étages de nombres impairs pour que, en vue en plan, certains des murs se croisent.

10. Procédé selon la revendication 9, dans lequel une grue type flèche pour charges lourdes, montée sur chenilles, avec une capacité de levage de 750 tonnes au maximum est utilisée en tant qu'au moins un dispositif de levage.

11. Procédé selon la revendication 9, dans lequel l'installation de modules tridimensionnels préfabriqués utilisant au moins un dispositif de levage est réalisée en utilisant des boucles sur les piliers (15).

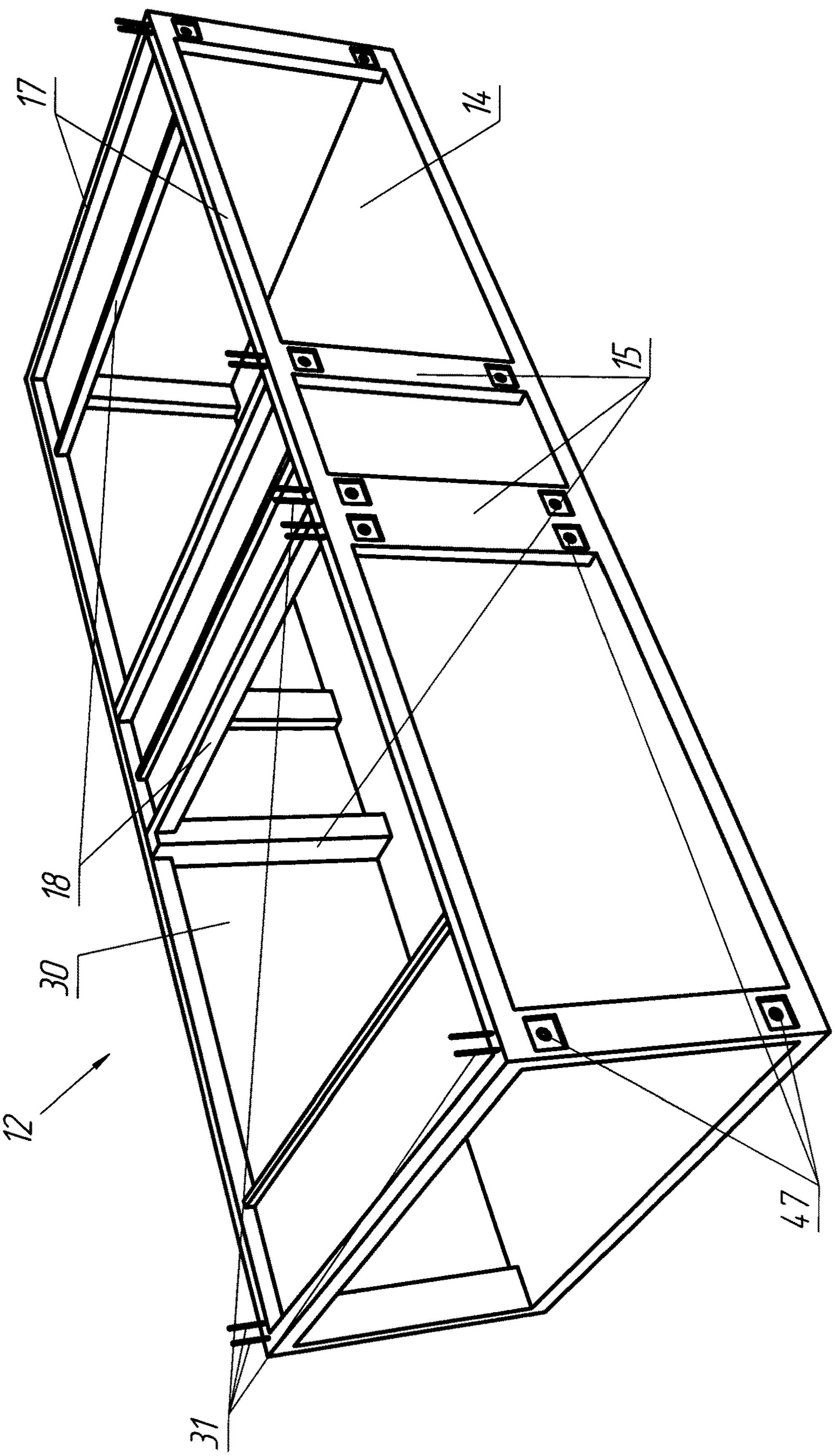

Fig. 1

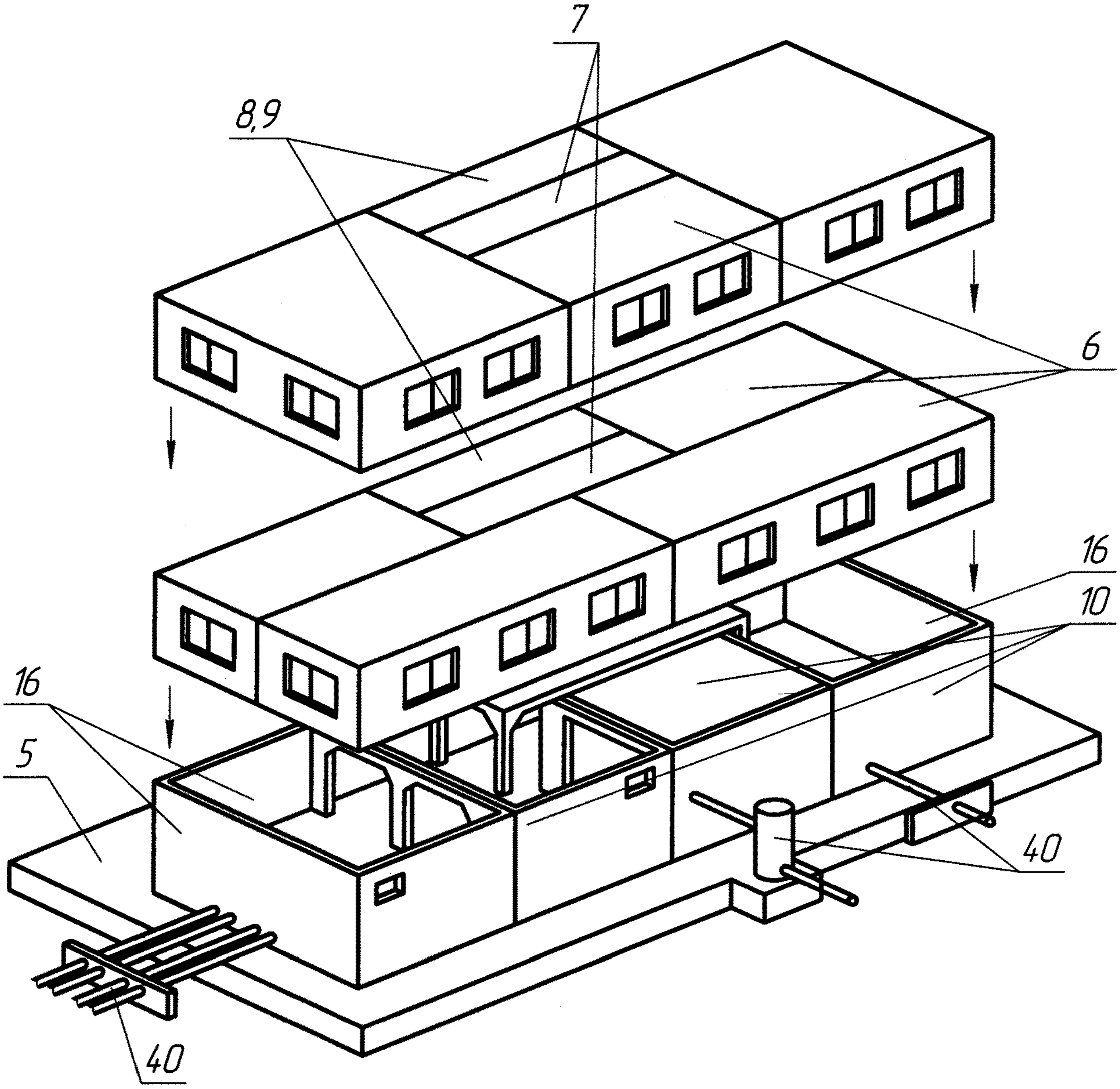

Fig. 2

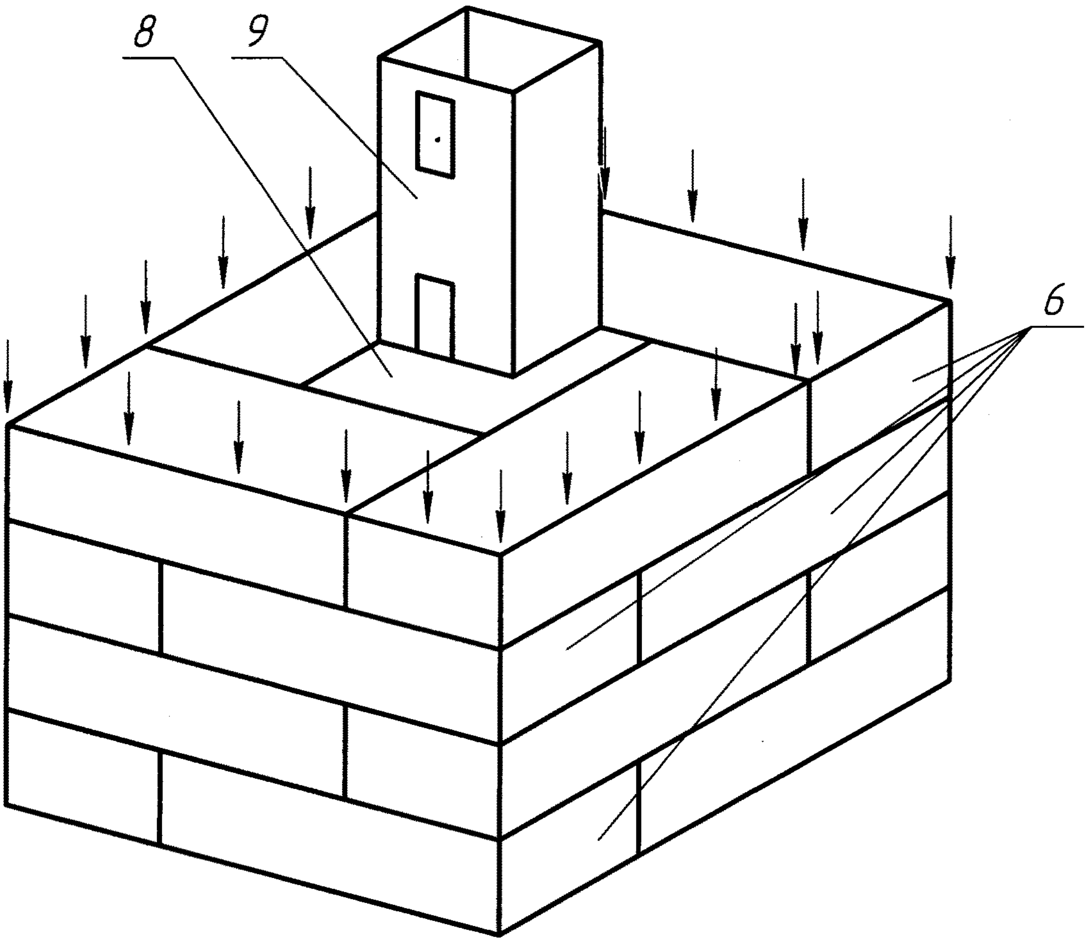

Fig. 3

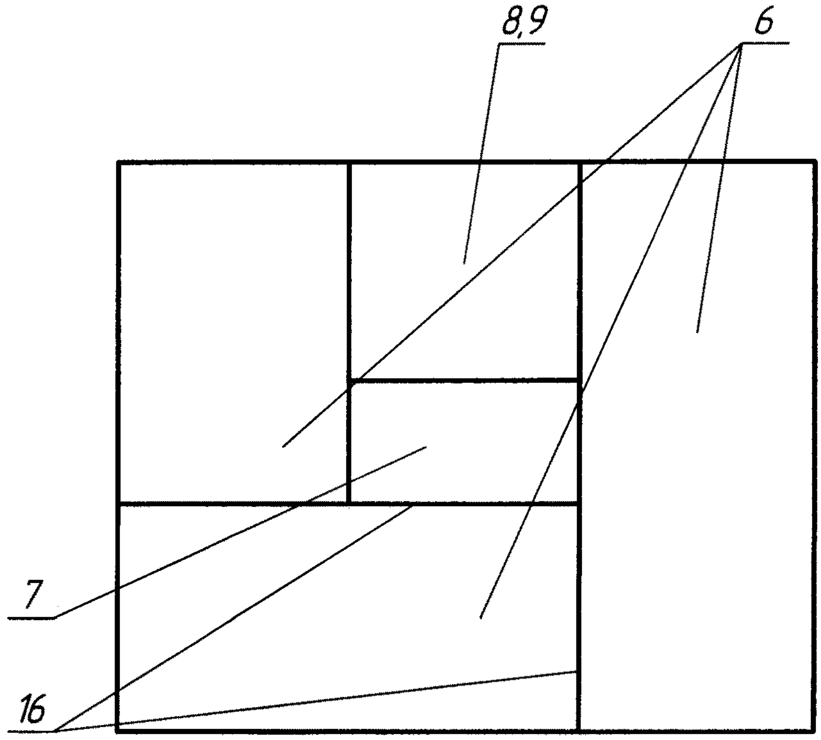

Fig. 4

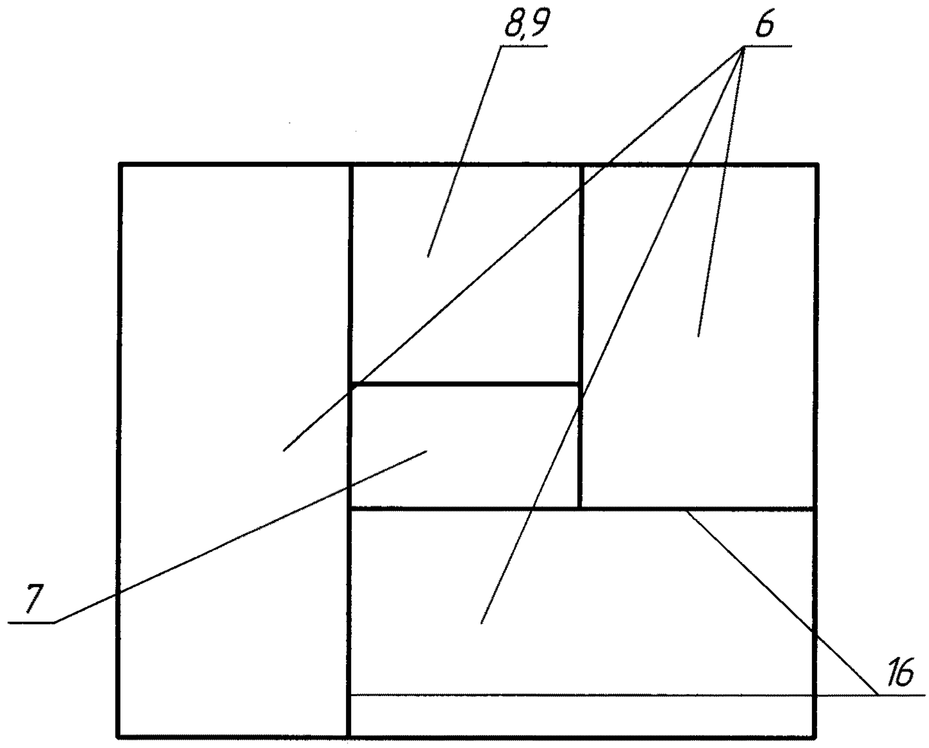

Fig. 5

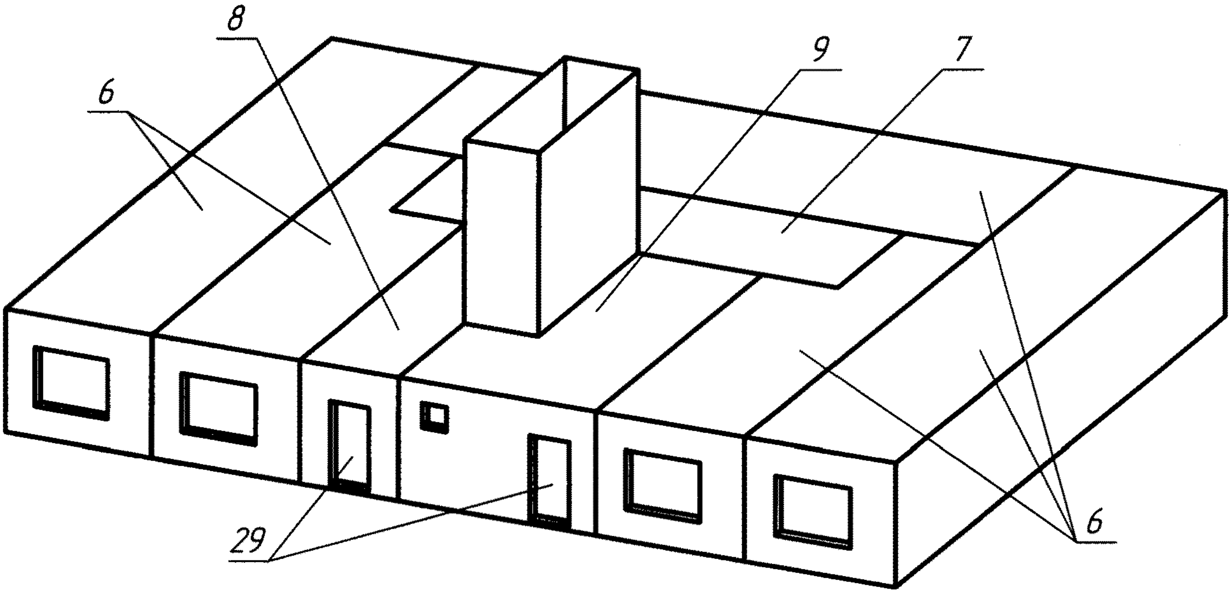

Fig. 6

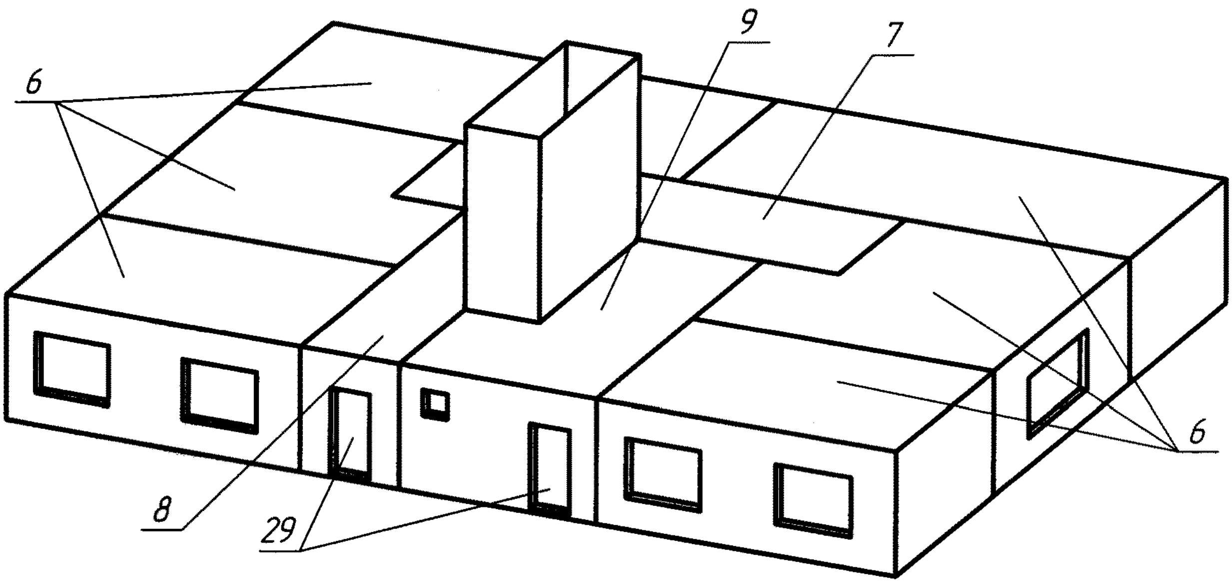

Fig. 7

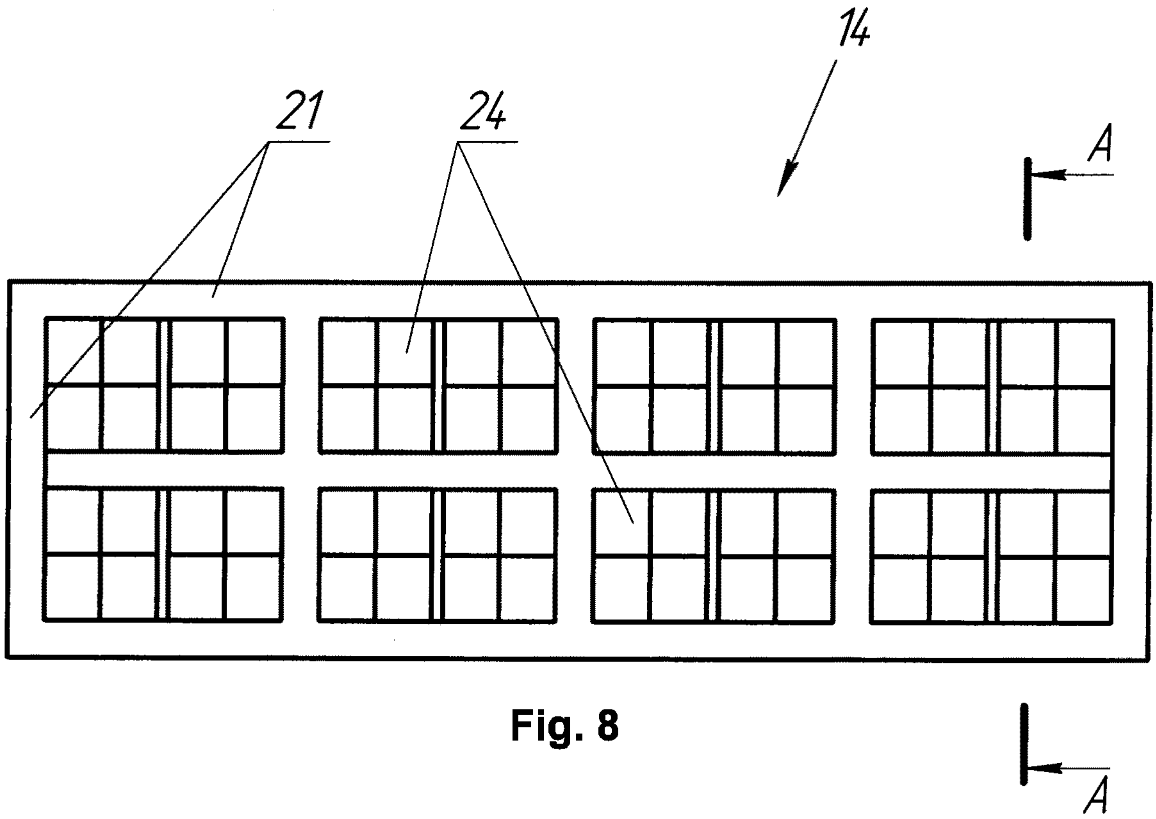

Fig. 8

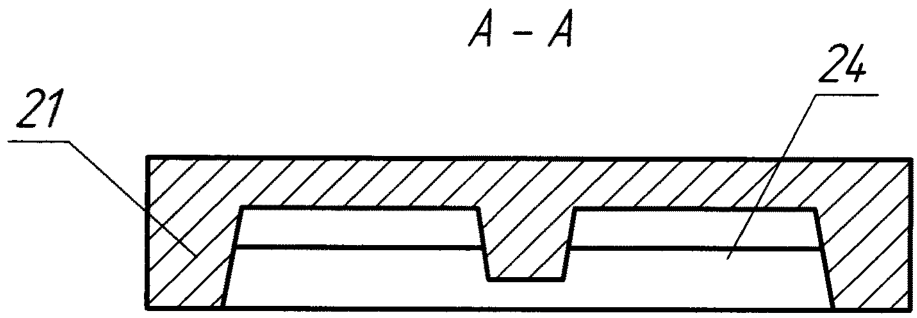

Fig. 9

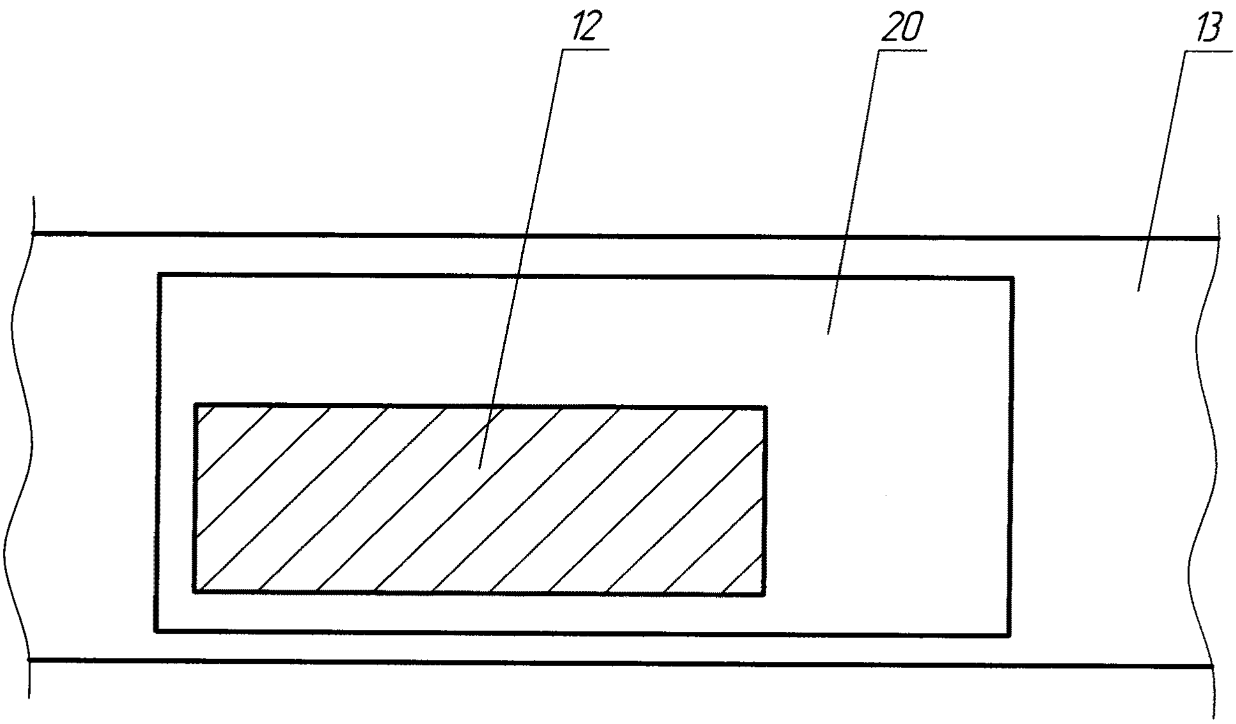

Fig. 10

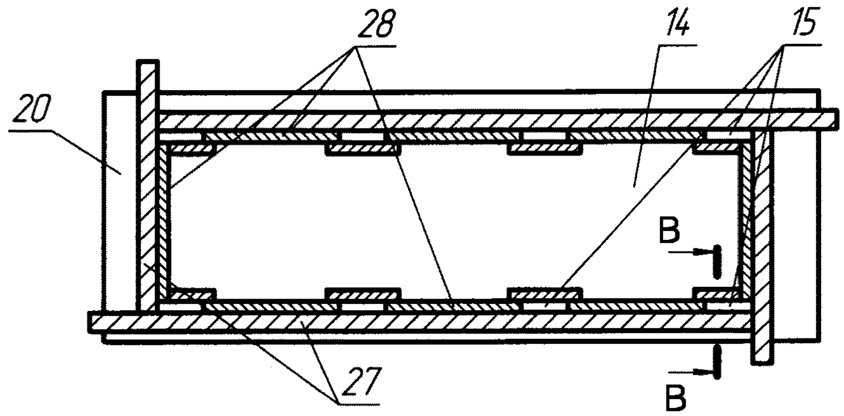

Fig. 11

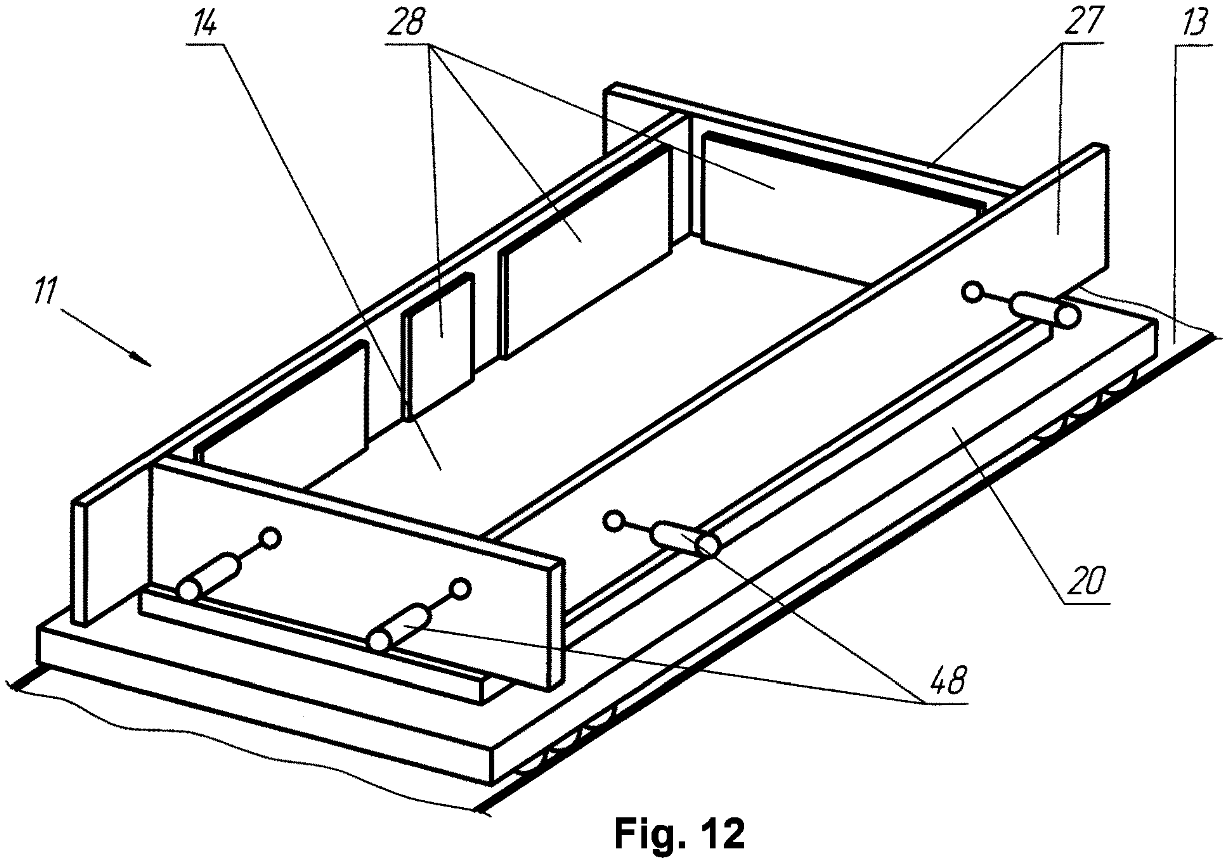

Fig. 12

B - B

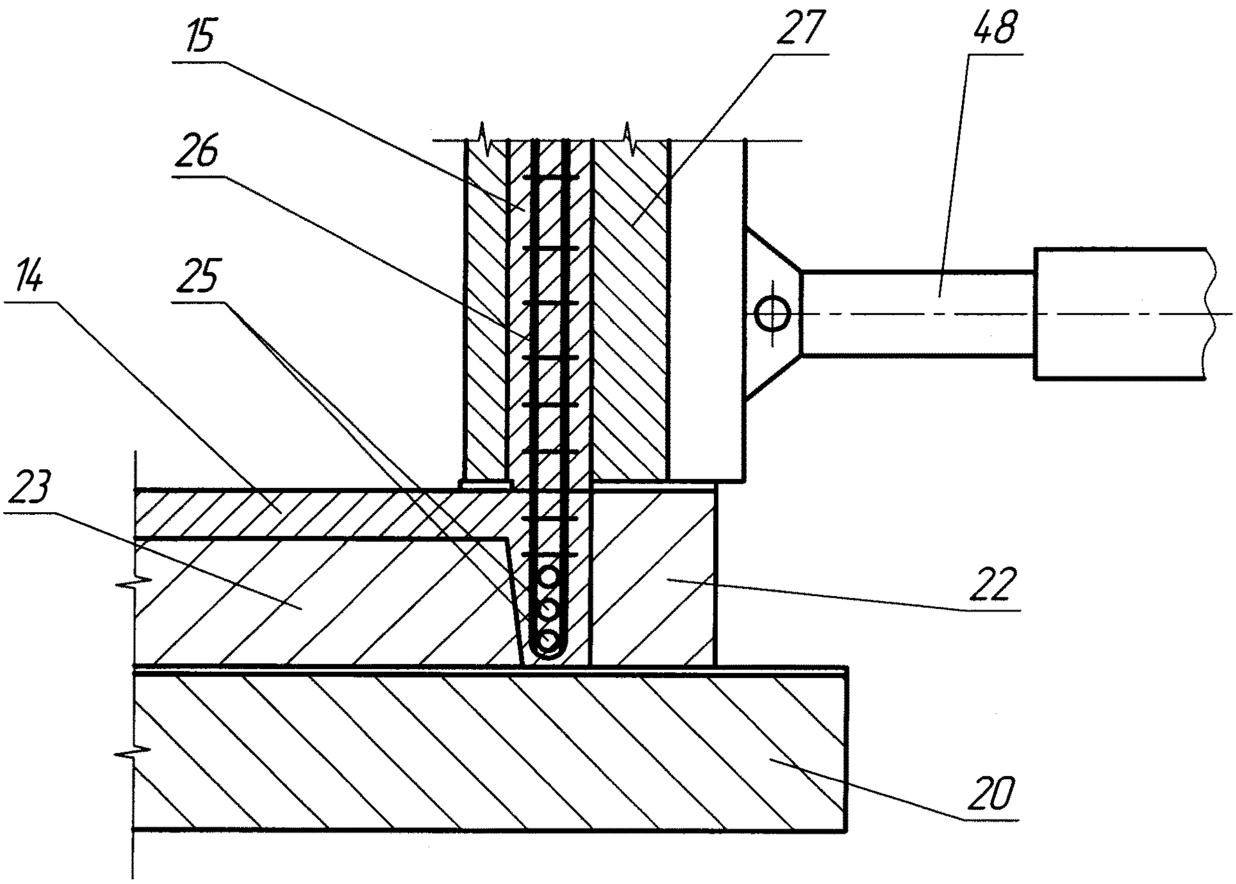

Fig. 13

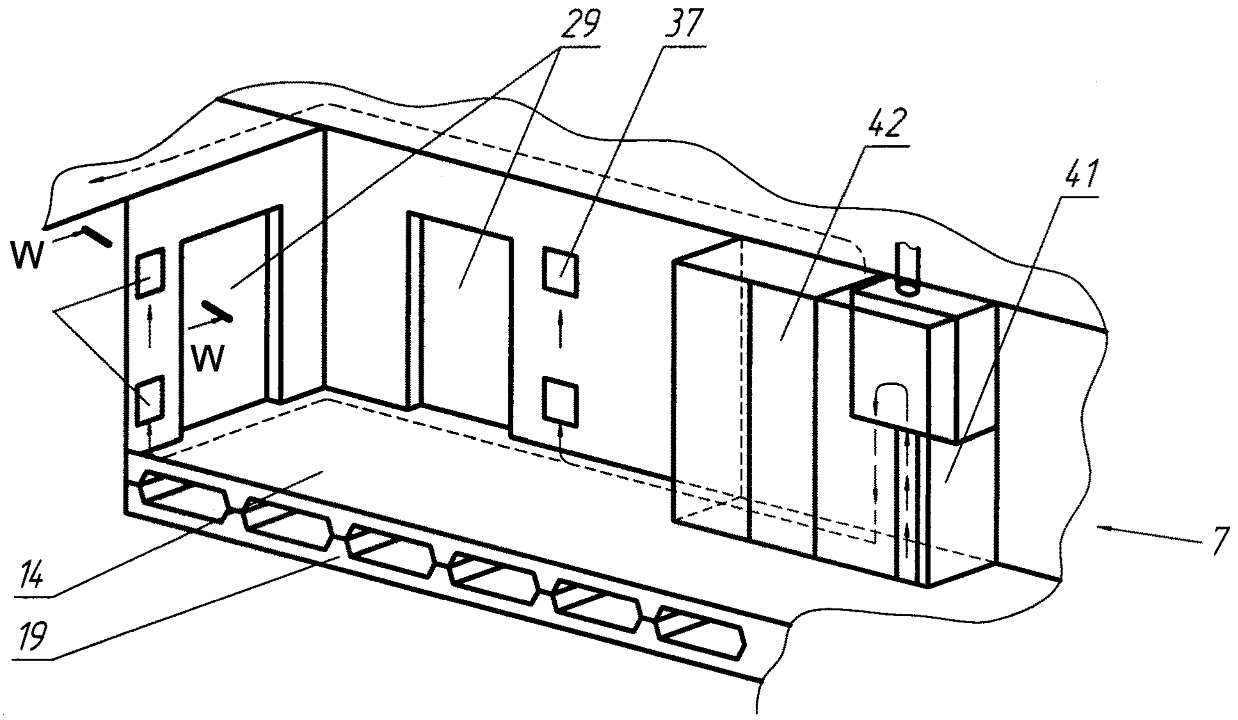

Fig. 14

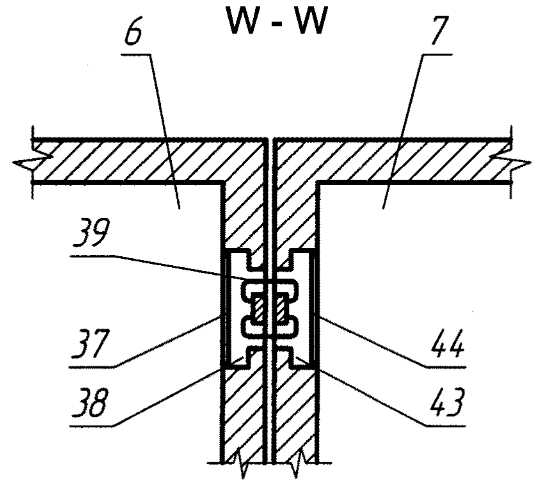

Fig. 15

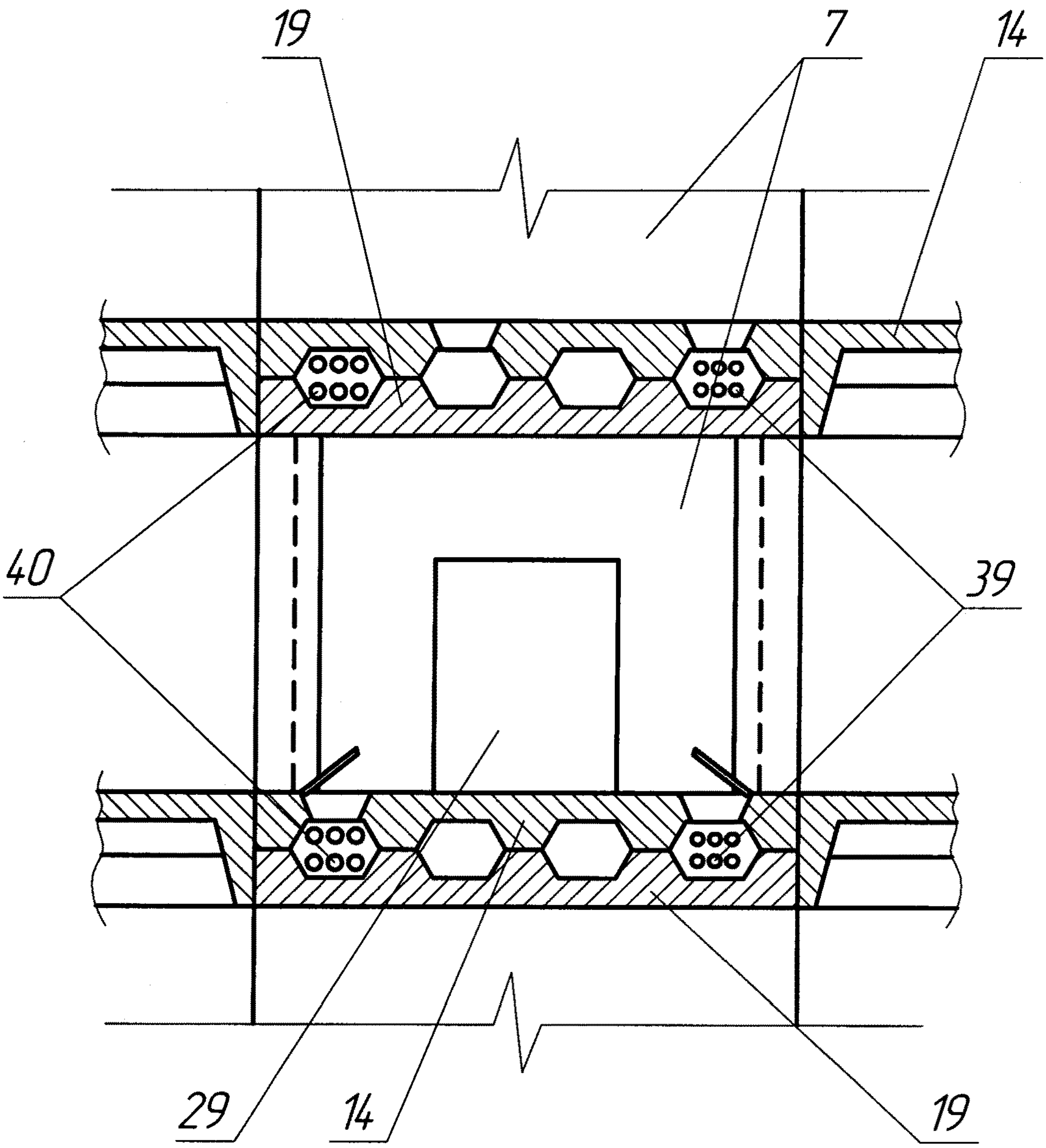

Fig. 16

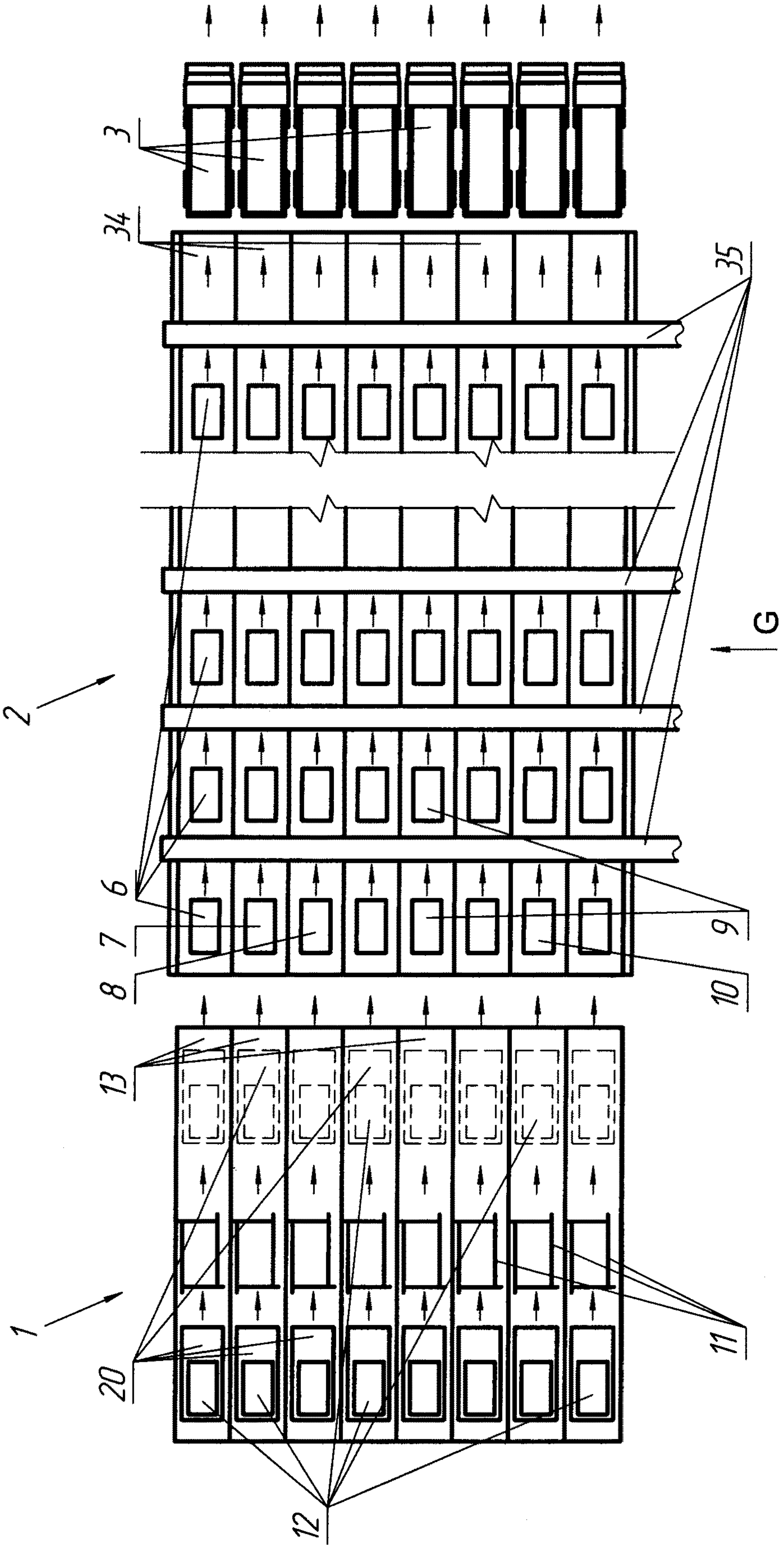

Fig. 17

View G

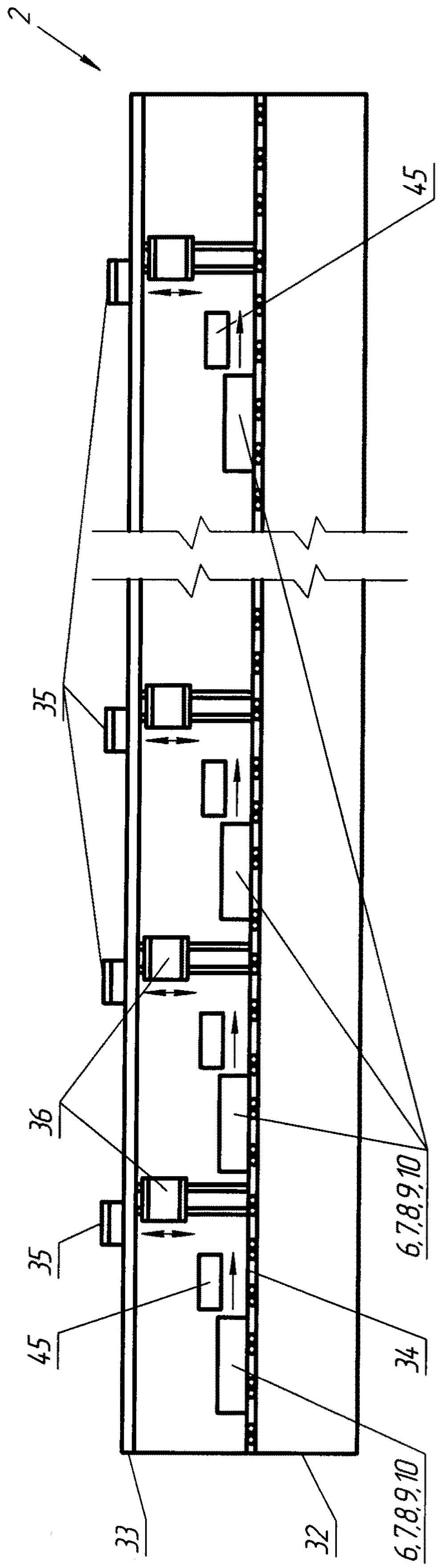

Fig. 18

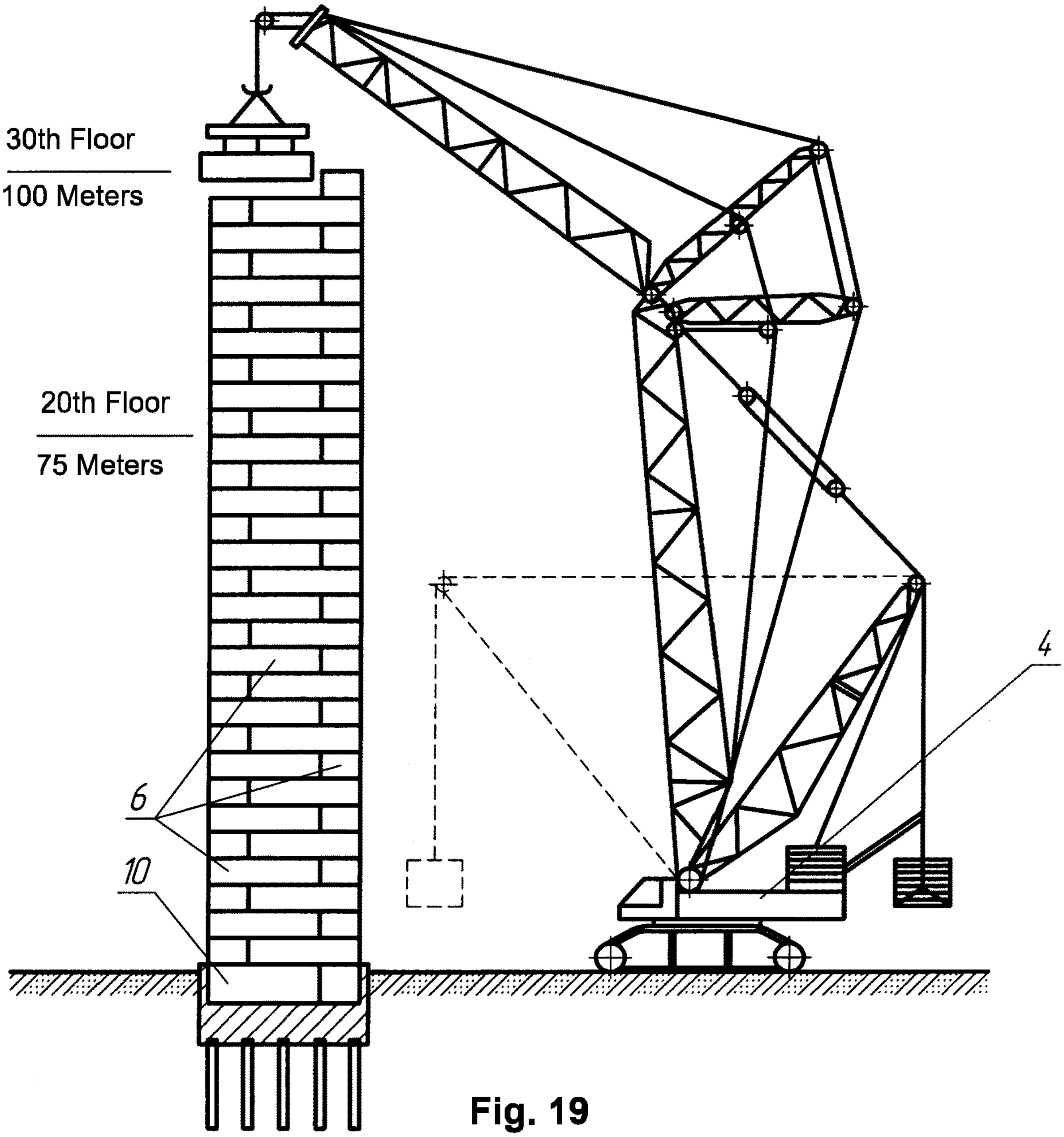

Fig. 19

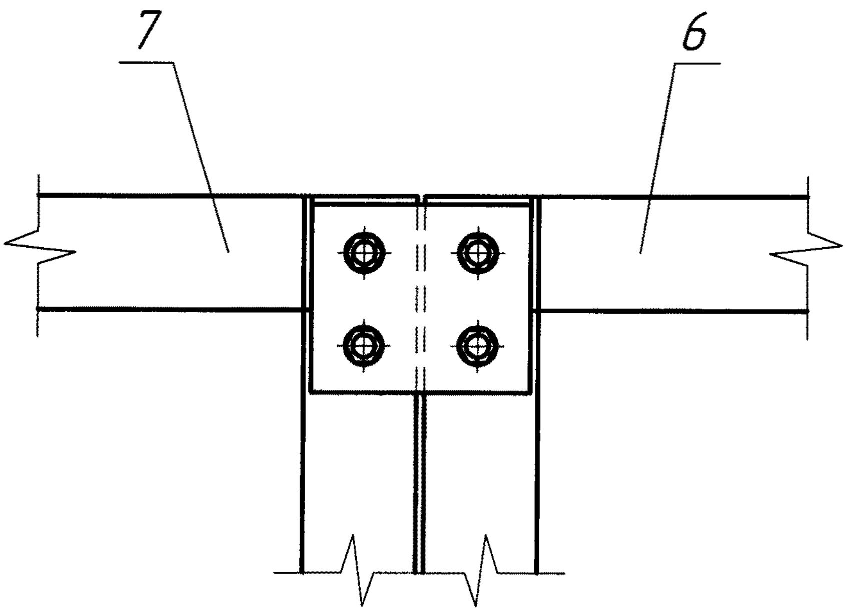

Fig. 20

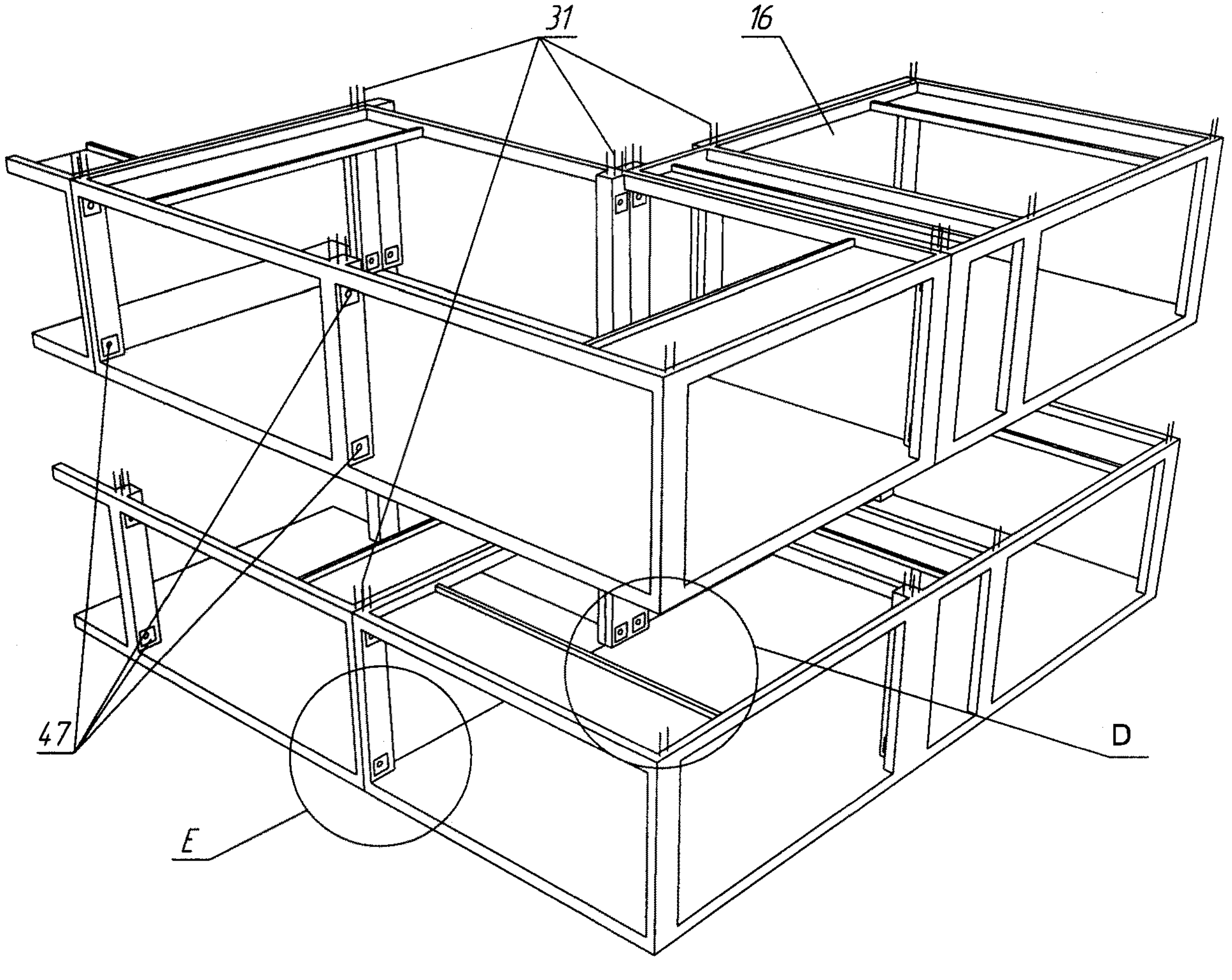

Fig. 21

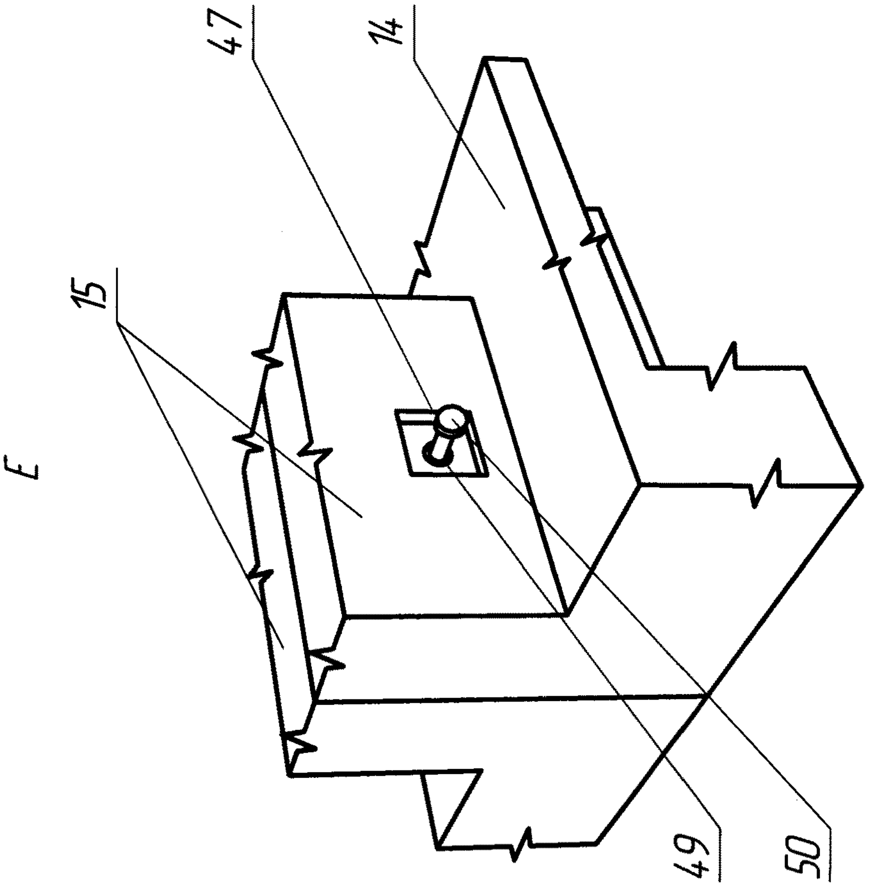

Fig. 23

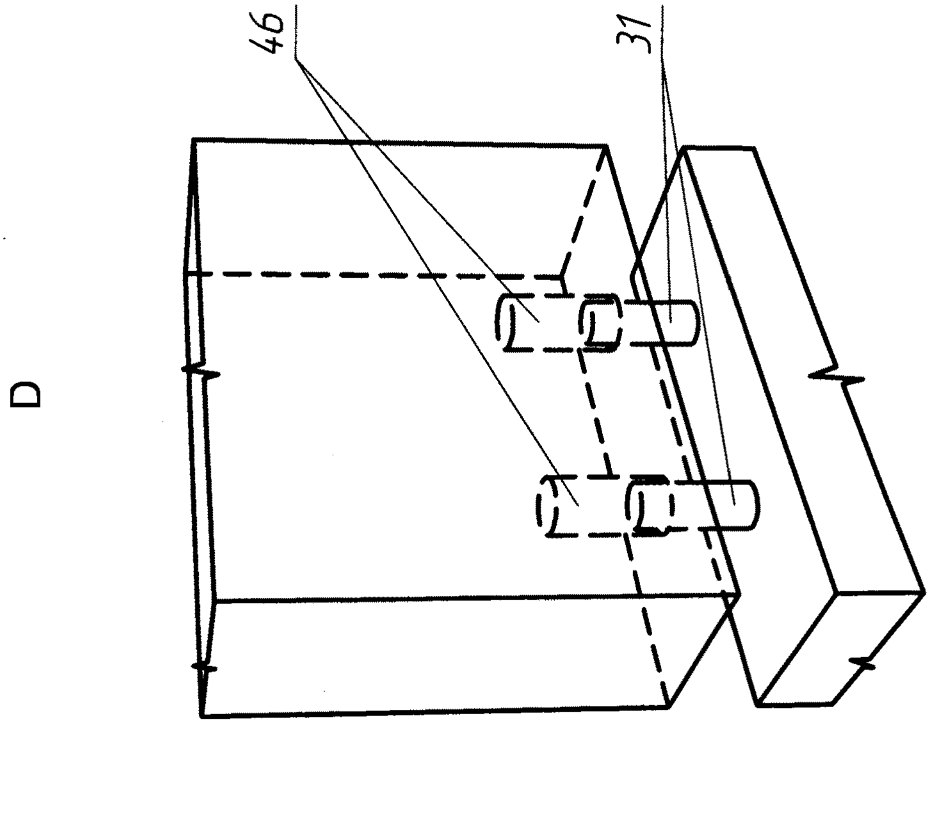

Fig. 22

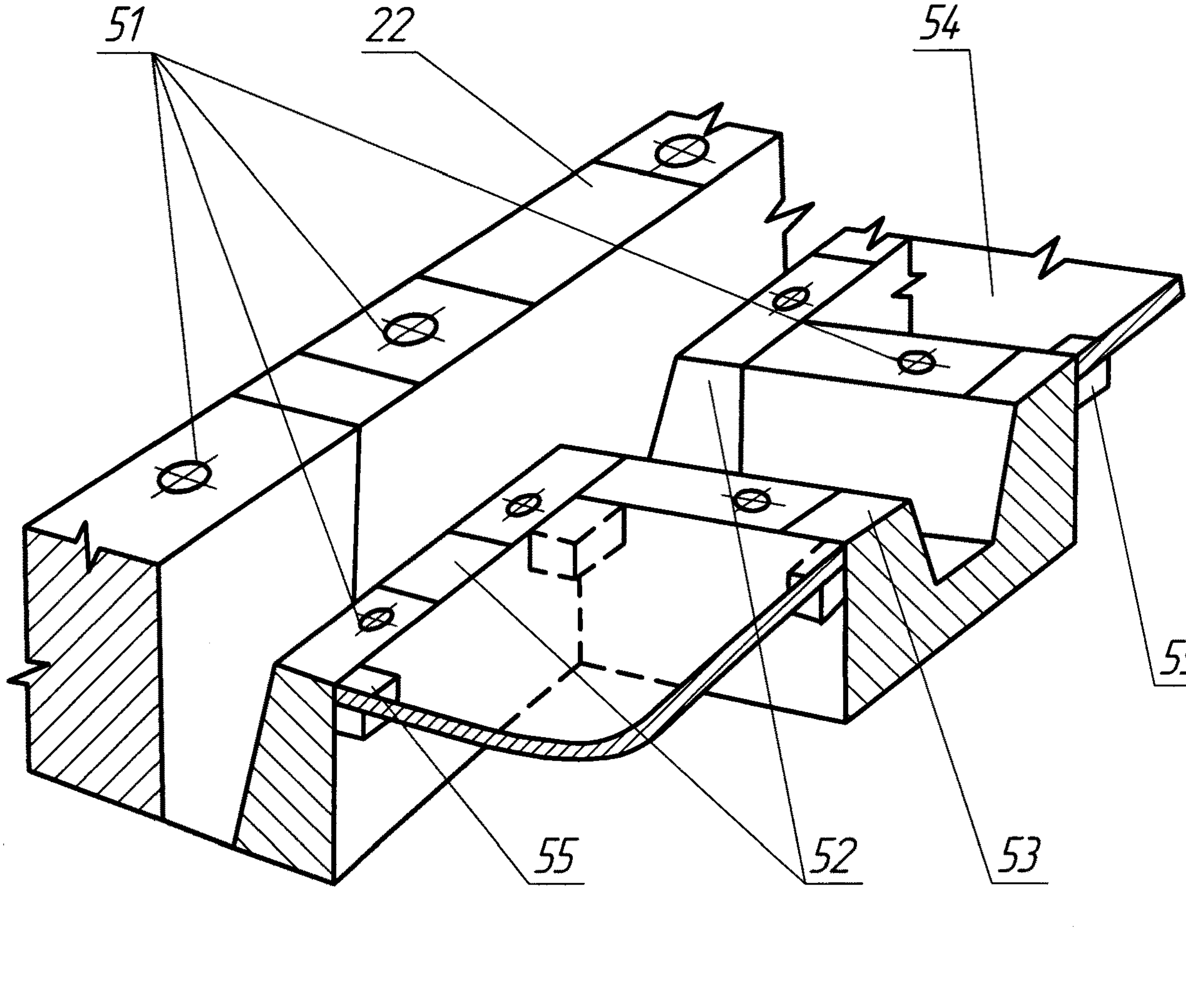

Fig. 24

REFERENCES CITED IN THE DESCRIPTION

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