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New solution: cultivation and storage of soft fruits and vegetables in volumes, situated on rotating rings, and irrigated by a system that uses condensed mist moisture (in super skyscraper, London)

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Abstract

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The new solution reviewed in this paper refers to cultivation and storage of soft fruits and vegetables in volumes, situated on rotating rings in skyscrapers. The fruits and vegetables are irrigated by a specially-developed system which uses condensed mist moisture. The rotating rings allow for a unique dynamic design, whereas the internal planning can be substantially changed at any given moment. The processing of mist moisture from the surrounding environment, which passes through the micro wind turbines situated in tubular channels and is being condensed in water tanks, situated inside the core of a skyscraper, becomes an advantage of the technical solution. Furthermore, soft facade envelopes are able to transform the shape of the facade of the skyscraper. The envelopes are hanged over console bars, whereas wind pressure is partially reduced by channels, situated inside the structure of the floor plates of the skyscraper. The bars serve as pistons which transform the wind pressure into electricity that covers the energy consumption needs of the skyscraper. The reviewed volumes represent an innovative solution with inventive step which is protected by a patent for invention and a utility model.

Keywords: vertical farms; skyscraper; rotating rings; condensed mist moisture; storage of soft fruits and vegetables; patents

Introduction

In the dissertation work of the author innovative solutions are reviewed with inventive step, which refer to the chambers of fruit storehouses and refrigeration warehouses (Aleksandrov, 2014). The adaptation of this innovative solution to the structure of high rise buildings is of considerable importance. Besides offering a suitable residential and working environment, skyscrapers can serve as vertical farms, where soft fruits and vegetables are produced. The author suggests the following inventions for this purpose:

• Patent BG63644 (B1). Built-up refrigeration chamber (Aleksandrov, 2002);

• Patent Application BG111651 (A). Moveable cold storage chamber for positive temperatures (Aleksandrov, 2013a);

• Patent Application BG111658 (A). System for solar heating of cooling chamber with positive temperatures (Aleksandrov, 2013b).

All three patents represent an integral part of the dissertation work of the author (Aleksandrov, 2014).

Furthermore, in case of extreme situations, rotating rings can be adapted for medical purposes (operation halls) by using the technologies patented in the patented invention BG66192 (B1) – Solar energy application for hot water residential supply and air heating in a modular medical unit (operation theatre) in extreme situations (Aleksandrova, 2011).

In the reviewed skyscraper, external soft facade envelopes are designed as a result of the combination of various

innovation solutions, with or without inventive step (Aleksandrov, 2017a, 2017b). In such cases the proportions of the building material are of utmost importance (Ching, 2014). The torsion, which is characteristic for the work of Calatrava, achieved as a result of the wind pressure on the facade envelope (Calatrava et al., 2002). The new solutions which are described in this paper are protected by patents according to the Bulgarian patent law (Bulgarian law on patents, 2006) and have been listed in the International patent classification database (International patent classification system, 2017).

The concept

Office life is a scenic action, whereas the everyday functions related thereto should be able to change rapidly as well as the interior of the office place. The variable design in this project is developed on a modular basis, whereas every inhabitant can chose a unique design pattern and interior "a la carte". All elements related to the design are ordered from a portfolio catalogue and customised according to a selected color and other decorative requirements. Once a new inhabitant comes in or the existing one feels a need for change of environment, the old design materials will be taken apart and sent for recycling, and replaced by new materials. All materials are environmentally-friendly and recyclable, being reusable after a simple refurbishment process. The design pattern allows for a very individualistic approach to design and gives a unique opportunity to meet the changing needs according to function and taste.

DYNAMIC EXTERIOR DESIGN

Dynamic change of the facade envelope (Figure 1)

In this building the principle of proportional positioning in height and width is implemented (Figure 1). In height this is realized by a longitudinal modular integration . The entire process of "surface management" is fully automatic. As well, along the facade there are sensors that allow the transformation of design in order to create a new form of facade envelope (i.e. by controlling the materials used in order to achieve an effect of an inclined (or concave) surface).

Solution for the facade envelope

The facade envelope made of transparent elastic materials, reinforced with the help of transparent elastic fiber, stabilized by thicker transparent elastic ropes is organized according to the principle of similar geometric shapes. The facade envelope could be stretched at the heads, which form the intersection of the rods of the telescopic horizontal bearing elements. To these bearing elements are suspended the columns that will carry the load of the extension. The heads have the shape of a funnel, where minuscule wind turbines, capturing even the smallest wind streams, are integrated.

Fig. 1

Dynamic design of the facade envelope, realized by the horizontal extension of the building surface

The horizontal extension of the building surface is realized with the help of sectional consoles, resembling the "stem of an open umbrella". These consoles are telescopically pushed out from the inter-story floor construction. The length of pushing out is also controlled automatically. Columns are connected to the top of the consoles, forming the ends of the telescopic horizontal bearing elements. After reaching the programmed position, the columns are released from the ends of the horizontal bearing elements and are fixed vertically to the lower floor, i.e. to the lower horizontal bearing element.

After the attachment of the elastic facade envelope to the console bearing elements that are already fixed to their columns, a light sectional flooring, e.g. made of one-, two- or three-layered bamboo matting, is mounted. Because of the dynamic design and the free configurability of the transparent facade envelope between the end of the flooring and the envelope an aerial space with the height of two or three floors is formed. These space is secured by a transparent fence with a height of 1,60-1,80 m.

DYNAMIC INTERIOR DESIGN

Organization of the interior space (Figures 2, 3, 4)

Parts of the dynamic interior design are:

• the moving pathways, i.e. over the floor construction there is a moving platform;

• with the help of independent vertical lift platforms the sectional office modules are being transported to their respective place, according to the needs of the tenant/owner; these lift platforms can also transport green gardens**,** etc;

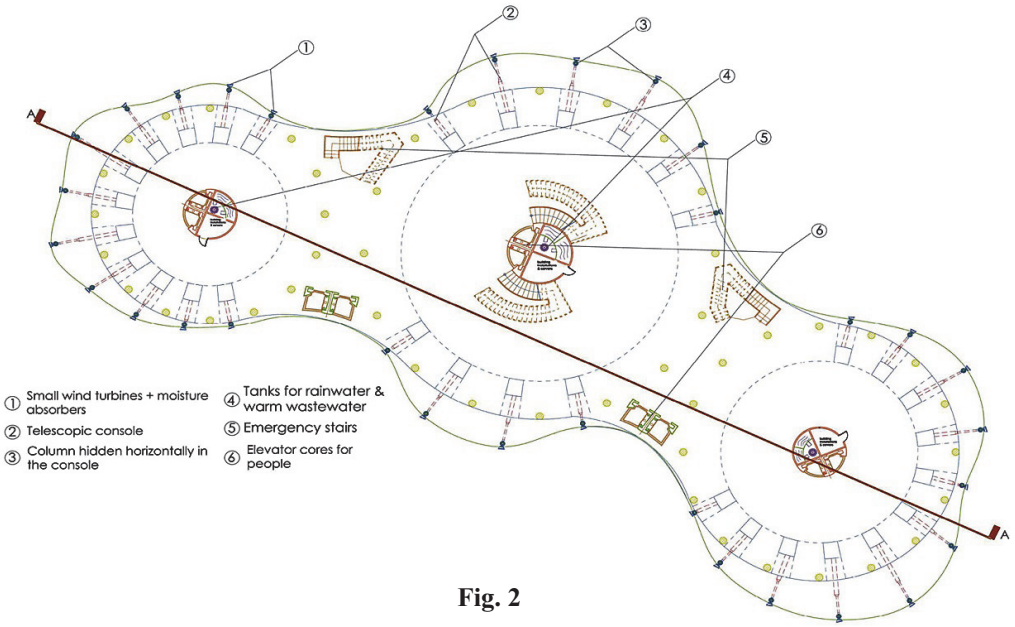

Fig. 2

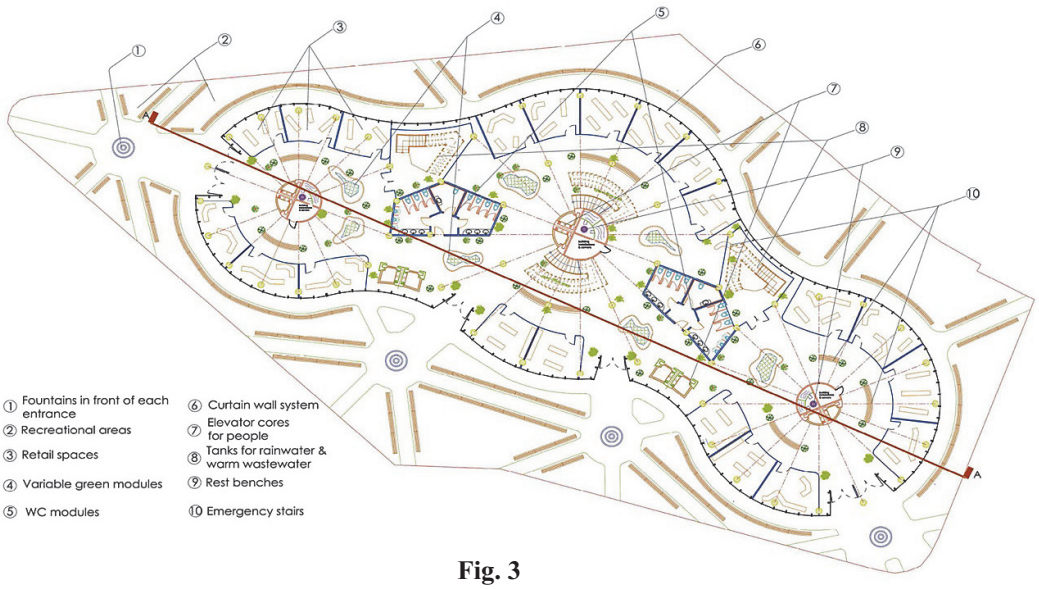

Fig. 3

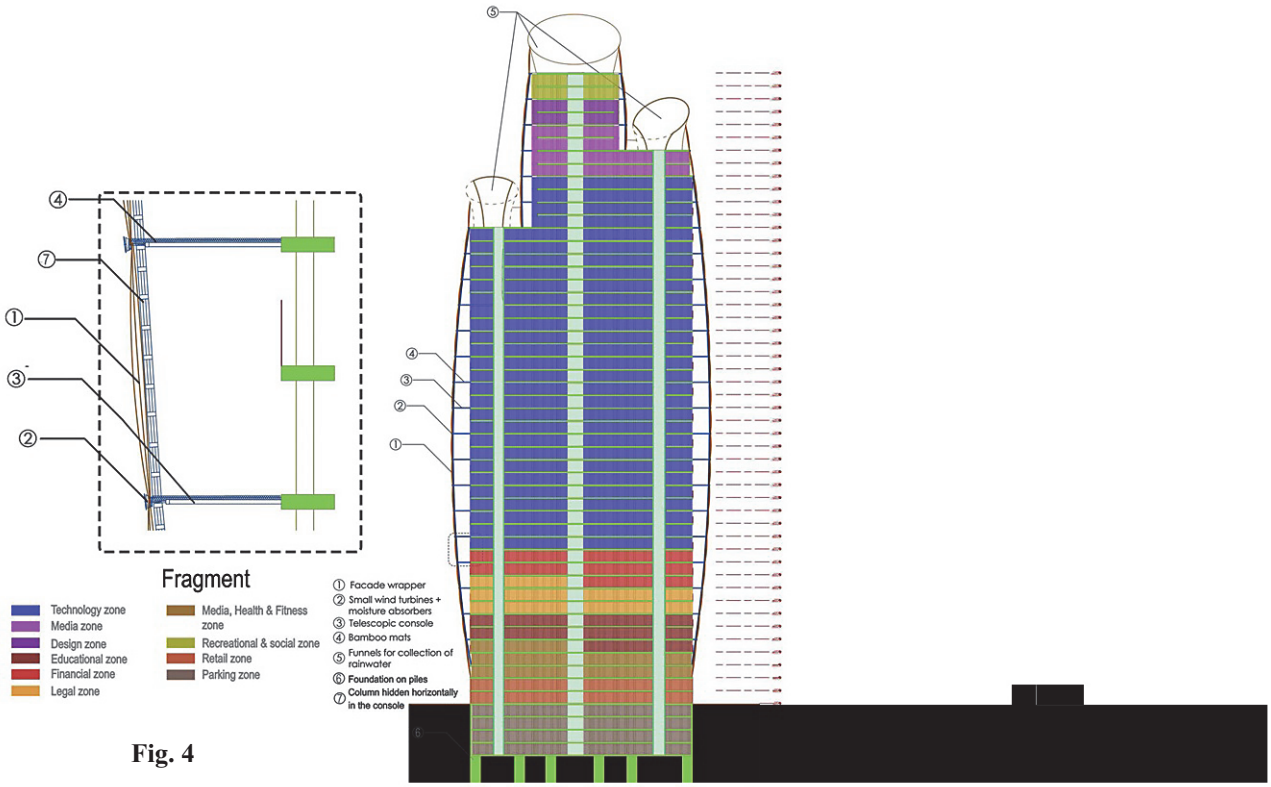

Fig. 4

• the change in design is realized by dismounting a given module and its transportation to the factory where these modules are refurbished or improved and returned back to the building for installation;

• the change in design has its impact on the shape, number of elements used, their connections, etc.; shapes and colors are available for purchase form the catalogue of the manufacturing factory.

Design of the modules (Figures 5, 6)

The modules used for specific activities are situated on the respective floor levels. For instance, the modules where a kindergarten is supposed to be situated are adapted to the needs and scale of children, etc. These modules represent boxes with their own system for operation – for moving them to the right or left, for rotation, etc.

Characteristics of the floor spaces (shown in different colors on the vertical section)

In such a dynamic design concept where all inhabitants are free to make decisions on design, i.e. finishes, colors and the relation of all elements in the space, it would be better to adapt a certain type of modules for each zone with the specific infrastructure, e.g.:

• 1 module type for the Technology Zone (IT and telecommunications) – 60% of area

• 1 module type for the Media Zone (PR, Social Media, Events) – 10% of area

• 1 module type for the Design Zone (Graphic and Product design) – 5% of area

• 1 module type for the Education Zone (Theatre, Lectures, Seminars, etc.) – 5% of area

• 1 module type for the Finance Zone (Investors, Insurance, Banking, Finance) – 5% of area

• 1 module type for the Law Zone (Law, Contracts, Trademarks, etc.) – 5% of area

• 1 module type for the Recreational Zone (Bar, Restaurant, Café, etc.) – 5% of area

• 1 module type for the Medical, Healthcare and Fitness zone – 5% of area.

• 1 module type for Parking of light vehicles (Bikes, motorcycles, etc.)

Parking

The total left area of 3510 m² of the lot could be used for parking.

Irrigation by using the condensed mist moisture

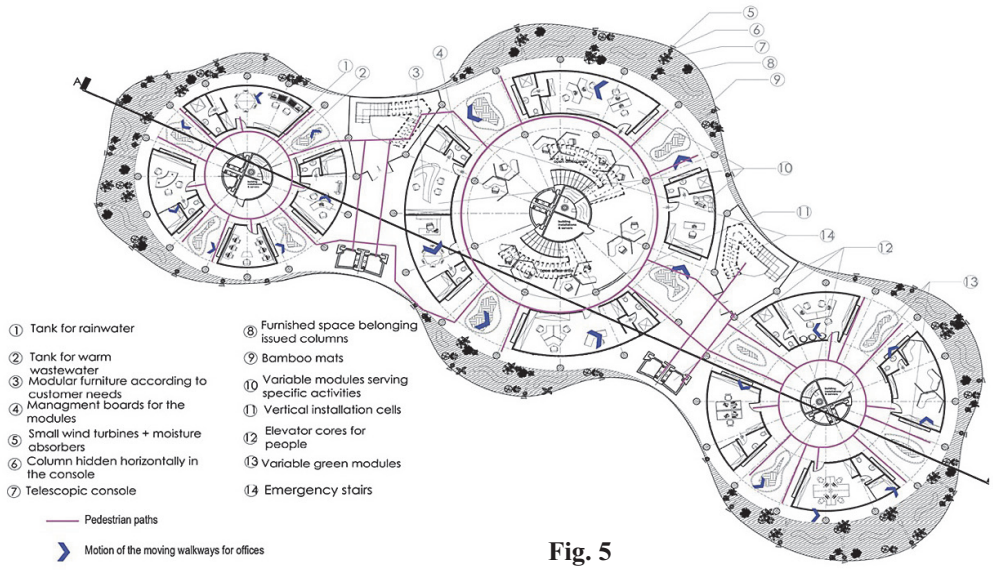

Fig. 5

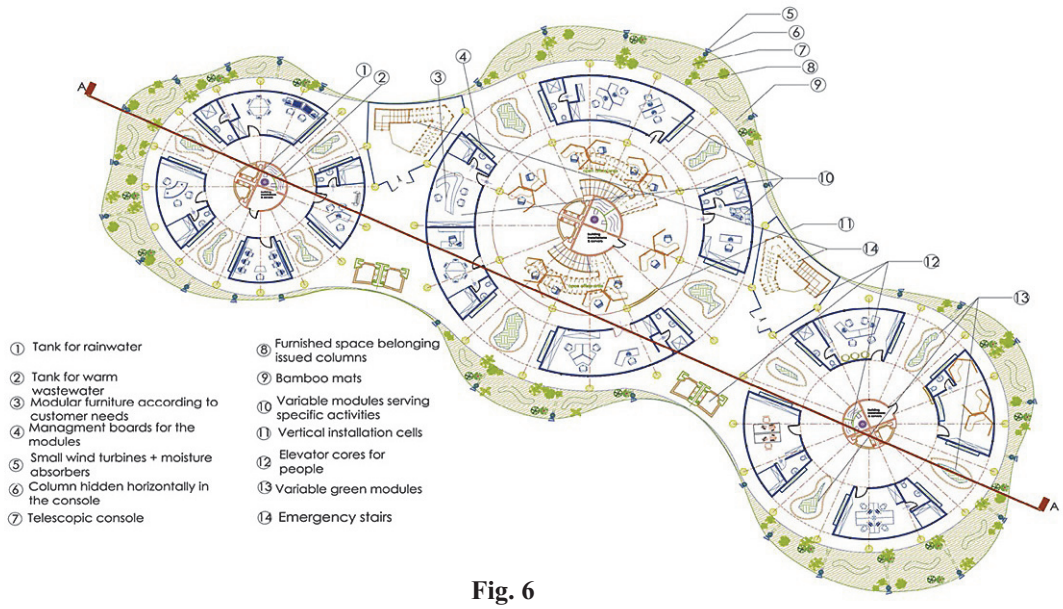

Fig. 6

In the zone where the facade envelope is concave supercharging ventilators are mounted which transfer the mist moisture to condensation tanks. After filtration, the drops are dispersed through nozzles in order to irrigate the greenery on every level.

Energy supply

The funnel-like shape of the roof helps collect rainwater, which is then stored in tanks. The natural downward fall of rainwater sets in motion water turbines. As well, wind turbines could be mounted in order to complement the process of energy production. Part of the changeable envelopes has a photo-voltaic covering, which enhances the options for autonomous energy supply of the building, independently from the city energy grid.

Function of design during night-time

The sustainable development is also ensured during

night-time by saving energy used for advertising purposes. This type of lighting is replaced by a fluorescent covering, situated in the separating plane between two transparent coverings of the facade envelope.

Dynamic design of office premises

Another variant of the dynamic design includes the use of flexible interconnected transparent separating walls. These "walls" are made by using stands and transparent fabric between those stands, the fabric being reinforced by transparent elastic fibers for spatial stability. Thus, the office space could be separated into independent comfortable working areas.

A certain number of rolls with this fabric are ordered at the factory, whereas every functional zone also has its own type of roll that is the most suitable for its requirements. Practically, the periphery of each module could be expanded by using additional transparent fabric and supporting stands. This expansion is realized within the boundaries of the rotating rings – external and internal, whereas this is possible for all module types.

INNOVATIVE SOLUTIONS WITH INVENTIVE STEP TO BE USED IN THE PRODUCTION OF REFRIGERATORS FOR FRUITS AND VEGETABLES WITH TRANSPARENT ELEMENTS

The triangular panels situated on the walls and the ceilings are transparent; the connections are gas-impermeable. The chambers and the containers with transparent walls and ceilings are situated over a base of channels, formed under them, whereas this base is situated directly on a rotating ring. The channels allow the air conditioning of the bottom of the chambers and the containers, in the case when they are used for refrigeration of fruits and vegetables (Aleksandrov, 2002).

Built-up refrigeration chamber, BG63644 (B1)

The chamber is used in the construction of industrial refrigerators, as well as in building of removable refrigeration tunnels (Fig. 7, 8). It achieves greater stability of the built-in volume. The four walls (1) of the chamber (2) are formed by beamed-walls (3) which have double T-section with trapeze-shaped belts. Panels (5), forming the ceiling and the floor of the chamber, have triangular shapes with chamfered peaks (6), and are fitted to each beamed-wall (3), by means of horizontal pivotal connections (4), fitted at the inner angle to the upper and to the lower trapeze-like belt of the beamed-walls (3) by their base, or by a triangular panel (5), respectively. The triangular panels (5) are fixed to each other at their chamfered peaks (6) by a clamp (7), and on the fronts of the triangular panels (5) sealing strips (13) are fitted, and the joints between the panels (5) at the floor and the ceiling are covered by gas impermeable layer (8).

The angular two-plane elements used in the floor and the ceiling are transparent. The chambers and the containers can have one or two volumes. When they have only one volume, every first volume is used for cultivation and every second volume is used for storage of fruits and vegetables (Aleksandrov, 2013a).

Moveable cold storage chamber for positive temperature, BG111651 (A)

The invention relates to a cold storage chamber having a natural lighting along the edges of the chamber to create

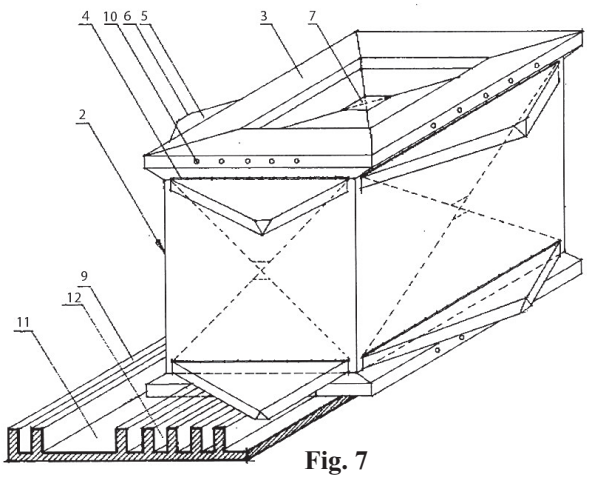

Fig. 7

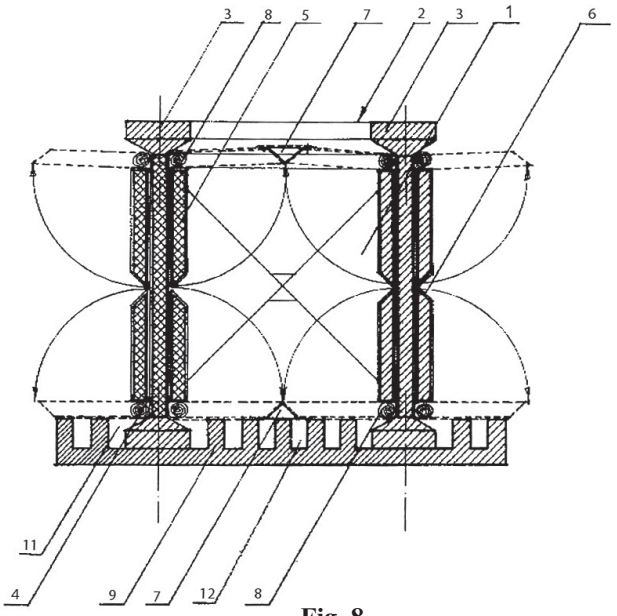

Fig. 8

a greenhouse effect (Fig. 9, 10). There is a possibility for artificial lighting and heating of the storage by converting solar energy into electricity through photovoltaic coatings. The cold storage chamber has a supporting structure of longitudinal transparent frames (12) and transverse transparent frames (12a), as to the columns of the frames are installed inside transparent guides (11, 13) for securing the walls of the chamber. Along the edges of the chamber are situated transparent elements – three angular planar elements (1, 8) horizontal angular of two planar elements (2, 7), a T-shaped angular member (3, 6) and the vertical angular of two planar elements (4). The walls are covered by not transparent wall panels (10) secured to the inner side of the guides (11, 13) and the ceiling is made of not transparent ceiling panels (9) secured to the inner side of the transverse frames (12a). On the wall panels (10) and the ceiling panel (9) is arranged a photovoltaic coating.

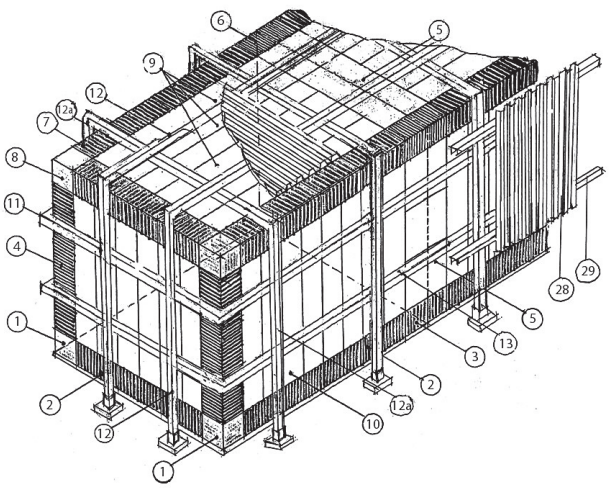

Fig. 9

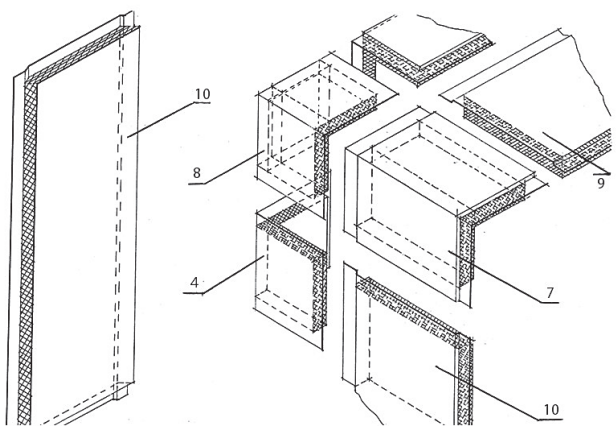

Fig. 10

The transparent angular elements are combined with solar water collectors situated on the roof of the refrigerator. When the chambers and the containers have two volumes, the first volume situated on the ring, near the facade is used for cultivation of soft fruits and vegetables, and the other volume situated near the core of the skyscraper is used for their storage. The solar collectors are situated near the facade, whereas their back surface is heated by the sun rays, which are reflected by the horizontal reflective surface (Aleksandrov, 2013b).

A system for solar heating of cooling chamber with positive temperatures, BG111658 (A)

The invention finds application in extreme situations and features with solar heating to achieve the positive temperature, with naturally absentmindedly solar lighting in the area of vertical joints between the panels, as well as with combined thermal insulation of walls and the roof of transparent thermal insulation, at least half-filled with energy accumulation composition (Fig. 11, 12). Three flat corner is filled with the external transparent layer (1a), an inner dense layer (7), as in layers (7) shaped the first vertical zigzag channel (7a) and the second horizontal zigzag channel (7b), as in the channel (7a) is a heirloom layer (6), and the zigzag shaped element (6) is fixed to the thick layer (7) with the connector (4), (7) and behind this layer (6) are located in the thin heating coils (3b) and between the outer transparent layer (1a) and the inner dense layer (7) is a transparent thermal insulation (2), with its transparent walls (2) are shaped confined spaces, as at least half of these spaces are filled with energy accumulation composition, and a T-shaped three-flat corner is filled with external vertical transparent layer (5), and the other two layers (1a), and (7) are dense, such as in the layer (7) shaped the first vertical zigzag channel (7a); and the second horizontal zigzag channel (7b), as in the channel (7a) is a heirloom layer (6), and zigzag shaped element (6) is fixed to the thick layer (7) with the connector (4) as in the sewers (7a) and behind this layer (6) are located in the thin heating coils (3b), and to the same layer (6) are located on the thicker heating coils (23), such as to the left of the layer (1a) are located other vertical curved channels (7b), and the two flat corner (on the external walls of the enclosure) is filled with outdoor transparent layer (1a), the inner dense layer (7) as in layers (7) shaped the first vertical zigzag channel (7a) and the second horizontal zigzag channel (7b), as in the channel (7a) is situated here.

SECONDARY USE OF THE ROTATING RINGS FOR MEDICAL PURPOSES

The volumes, which can are assembled on the rings can be intended for the construction of operation rooms (Fig.

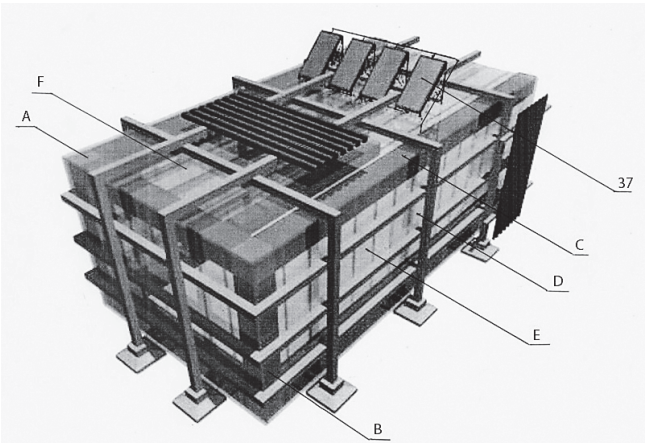

Fig. 11

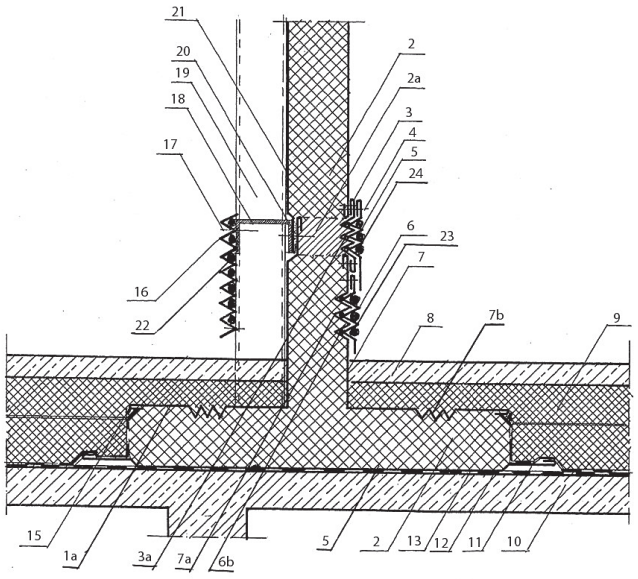

Fig. 12

13). Patent BG66192 (B1) offers a suitable solution for such cases (Aleksandrova, 2011). The hothouse effect is of particular importance in the construction of built-up exploitation volumes in extreme situations. The invention of Aleksandrova (2011) BG66192 (B1) "Solar energy application for hot water residential supply and air heating in a modular medical unit (operation theatre) in extreme situations" reveals that „The invention shall find application in the construction of temporary medical modules (operation theatres) in extreme situations with facilities for longer maintenance of constant temperatures in the hot water vessels, as well as for air heating due to the hothouse effect formed at the angular installation spaces." Thus, hothouse effect could be created in the

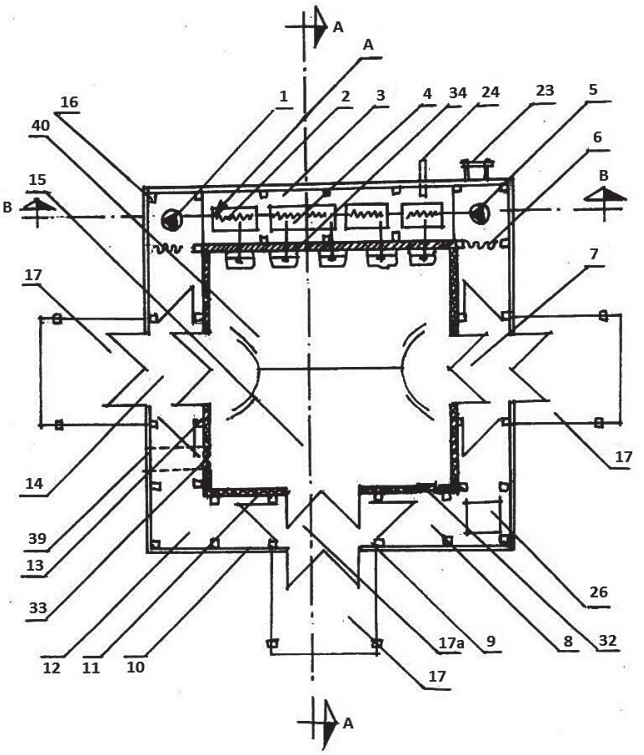

Fig. 13

aerial space, situated between transparent external walls and dense internal walls of an operating room.

Conclusions

The combination of innovative solutions with inventive step with such without inventive step is highly suitable for the design of skyscrapers and super skyscrapers (Aleksandrov, 2017a, 2017b). The rotating rings used in them represent an important technical indicator of the design of the reviewed skyscraper. Besides their typical use for residential and office purposes, the premises of skyscrapers can be used for cultivation and storage of soft fruits and vegetables. In extreme situations, the rotating rings can be adapted for medical purposes (Aleksandrova, 2011). The rotation of the rings ensures the balanced access of sun rays to the chambers and the containers situated in them, whereas the use of solar energy leads to a positive technical effect of the solution. The sun rays, passing through the transparent elements which are situated in the walls and the ceilings maintain the positive temperature which is required for the cultivation and storage of soft fruits and vegetables (Aleksandrov, 2013a). In case that the need for a higher temperature in the container arises,

a system for solar water heating is used, whereas the solar collectors are situated on the roof (Aleksandrov, 2013b). The transformation of mist moisture and its use for irrigation in megacities like London is a considerable advantage in terms of the preservation of environment (Aleksandrov et al., 2014). The soft facade envelopes, hanged over console bars, whereas the wind pressure is partially reduced by the channels, situated inside the structure of the floor plates allows the creation of a dynamic geometry of the facade (Aleksandrov et al., 2014).

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