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Passive Solar Heating and Hot Water Supply for Medical Purposes in Extreme Situations

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Abstract: ***In the paper are shown several ways for passive solar heating and hot water supply by using rainwater for medical purposes, demonstrated in patent BG66192 (B1) – „Solar energy application for hot water residential supply and air heating in a modular medical unit (operation theatre) in extreme situations” . Here are also explained the applications of stretched membranes as well as the use of tensegrity structures as a way of execution of protective screens for the chambers and volumes.***

Keywords: ***passive, solar heating, hot water supply, medical purposes, extreme situations.***

I. INTRODUCTION

In extreme situations infrastructure is usually destroyed. The technical maintenance of the operating rooms and the operating block requires the development of new sources of energy. The use of solar energy for air heating (passive) requires the construction of transparent surfaces – walls or ceilings, where are situated aerial spaces, which are being heated by sunrays; the warm air passes to the operating rooms (i.e. direct thermal exchange). Hot water supply requires the presence of solar water collectors, situated on the roof, where the water is heated in serpentines. These serpentines make part of a tubular circle, passing through the water tanks which accumulate hot water. This hot water is used to cover the needs of the operating rooms. Lighting is another aspect, which is ensured by photo-voltaic elements, situated on the roof. Solar energy transforms into electricity. Rainwater and the water from existing water wells covers the need for water to be used for medical purposes.

II. TYPES OF TECHNICAL SOLUTIONS

2.1. Bibliographic data: BG66192 (B1)— 2011-12-30. Solar energy application for hot water residential supply and air heating in a modular medical unit (operation theatre) in extreme situations.

Abstract of BG66192 (B1)

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. The water collectors (18) have collector coil (28) and are connected from below with a lower horizontal tube (29), and in its upper end û to an upper horizontal tube (27), one of the ends of which is connected to a vertical tube with lower circulation pump (5).

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The latter is further connected to a lower horizontal accumulation tube (36), connected to accumulation coils (2), connected to an upper horizontal accumulation tube (37), connected to the upper circulation pump (1), and it, on its turn, - to the other end of the lower tube (29).; Coils (2) are fitted in first hot water vessels (4) the walls of which are resting to second vessels (3) for rain water, and a blast fan (32) is fitted in the heat-insulation wall (11) to the first angular installation space (8) at a level over the suspended ceiling (38). On the same level, but at the second angular installation space (12), in the other perpendicular heat insulation wall (11) an exhaust fan (33) is found, connected by means of a short duct (39) with the environment.

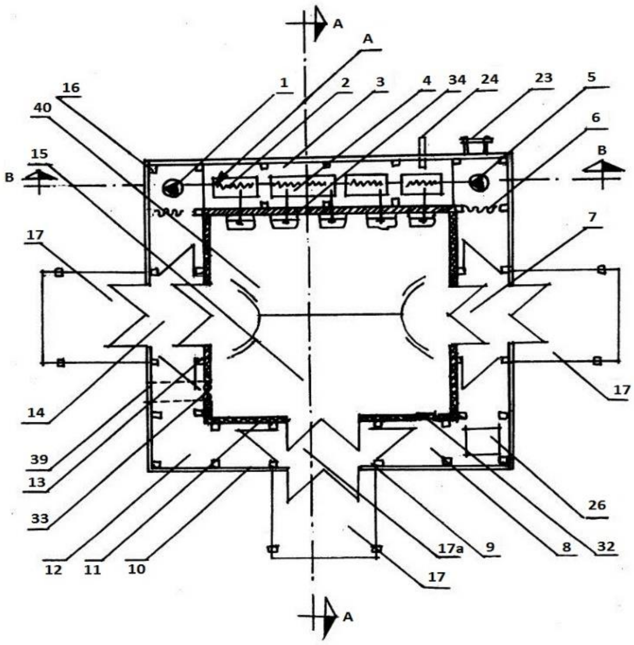

Fig.1 . PLAN. Patent BG66192 (B1) - Solar energy application for hot water residential supply and air heating in a modular medical unit (operation theatre) in extreme situations. [4]

A- tube system; (1) - upper circulation pump; (2) - accumulation coils; (3) - second vessels; (4) - first hot water vessels; (5) - lower circulation pump; 6 - thermo-insulating curtain; 7 - second exit to the emergency room; (8) - first angular installation space; 9 - columns; 10 - transparent wall; (11) - heat-insulation wall; (11) - other perpendicular heat insulation wall; (12) - second angular installation space; 13 – other columns; 14 - entrance; 15 - operating room; 16 - bearing angular columns; 17 - loading platform; 17a - exit to the hospital; (18) - water collectors; 19 - other photo-voltaic elements; 20 - inclined plate; 21 - second floor; 22 - ballast bed; 23 - outside stairs; 24 –

overflow drain; 25 - photo-voltaic elements; 26 - electricity accumulator; (27) - upper horizontal tube; (28) - collector coil; (29) - lower horizontal tube; (29) - lower tube; 30 - horizontal roof plate; 31 - shelter; (32) - blast fan; (33) - exhaust fan; 34 - energy-radiating wall; (36) - lower horizontal accumulation tube; (37) - upper horizontal accumulation tube; (38) - suspended ceiling; (39) - short duct; 40 - premises for the preparation room and the narcosis room.

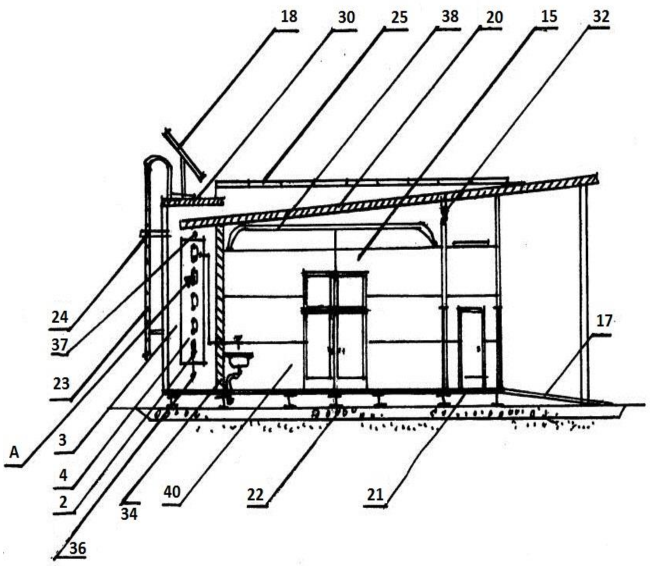

Fig. 2. SECTION A-A. Patent BG66192 (B1) - Solar energy application for hot water residential supply and air heating in a modular medical unit (operation theatre) in extreme situations.[4]

A- tube system; (2) - accumulation coils; (3) - second vessels; (4) - first hot water vessels; 15 - operating room; 17 - loading platform; (18) - water collectors; 20 - inclined plate; 21 - second floor; 22 - ballast bed; 23 - outside stairs; 24 - overflow drain; 25 - photo-voltaic elements; 30 - horizontal roof plate; (32) - blast fan; 34 - energy-radiating wall; (36) - lower horizontal accumulation tube; (37) - upper horizontal accumulation tube; (38) - suspended ceiling; 40 - premises for the preparation room and the narcosis room.

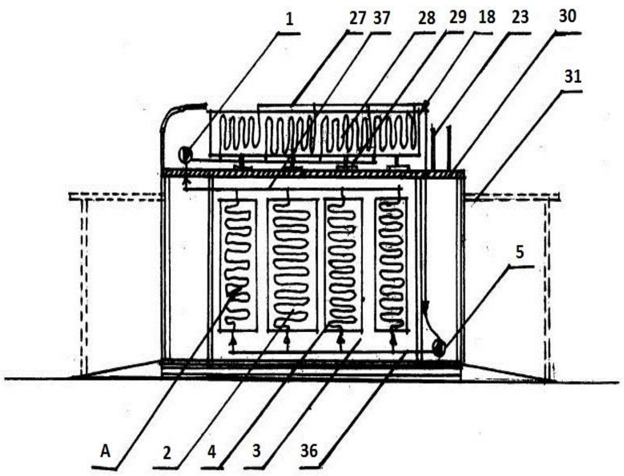

Fig. 3 . SECTION B-B. BG66192 (B1) - Solar energy application for hot water residential supply and air heating in a modular medical unit (operation theatre) in extreme situations. [4]

A- tube system; (1) - upper circulation pump; (2) - accumulation coils; (3) - second vessels; (4) - first hot water vessels; (5) - lower circulation pump; (18) - water collectors; 23 - outside stairs; (27) - upper horizontal tube; (28) - collector coil; (29) - lower horizontal tube; (29) - lower tube; 30 - horizontal roof plate; 31 - shelter; (36) - lower horizontal accumulation tube; (37) - upper horizontal accumulation tube.

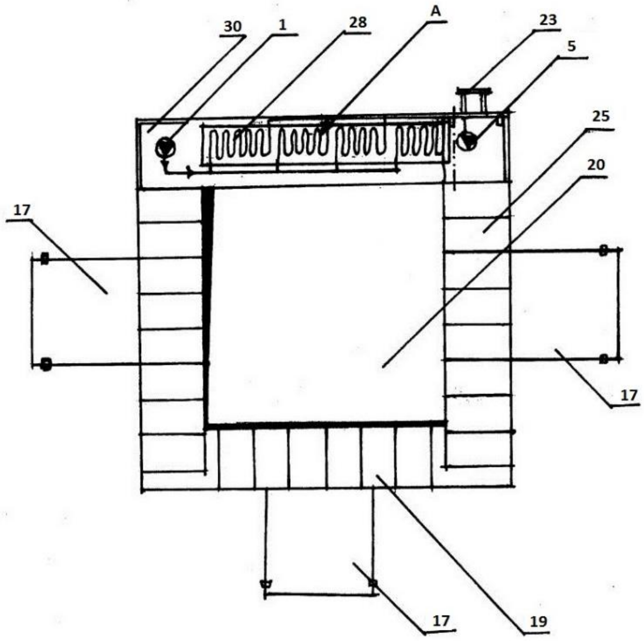

Fig. 4 . ROOF PLAN. BG66192 (B1) - Solar energy application for hot water residential supply and air heating in a modular medical unit (operation theatre) in extreme situations. [4]

A- tube system; (1) - upper circulation pump; (5) - lower circulation pump; 17 - loading platform; 19 - other photo-voltaic elements; 20 - inclined plate; 23 - outside stairs; 25 - photo-voltaic elements; (28) - collector coil;; 30 - horizontal roof plate.

2.2. Application of hot-house effect with the help of building elements, which are entirely or partially transparent [1, 2, 3].

For the construction of the chambers and other volumes to be used in extreme situations are designed special modular elements – three-plane angular T-shaped elements and two-plane angular elements, combined with striped elements. The upper three-plane angular and the upper two-plane angular elements are entirely transparent and let the sunrays pass directly to the chamber, which is designed for use in case of positive temperatures. The lower three-plane and two-plane elements are partially transparent – only in their vertical planes. They are used for lighting the walkways, leading to the shelves where fruits and vegetables are stored [1]. Besides for storing of fruits and vegetables, these chambers are also suitable for a second use for medical purposes (operating rooms). Y.

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Aleksandrov proposes a solution using a **regulated hot-house effect** in chambers, achieved by implementing different percentage levels of glazing of the roof and the wall surfaces depending on the technological requirements of the different premises and the intensity of solar radiation. The effect of regulation is achieved with the help of the closing/opening of reflective curtains, regulated by a computer. The temperature is being controlled by sensors and can be regulated between +2 ^{0}C and +12 ^{0}C in fruit storehouses or between +22 ^{0}C and +24 ^{0}C in operating rooms and operating blocks. [2, 3.]

The regulated hot-house effect is characterised by:

- Low level of opening of the glazing leading to low degree of passing of solar radiation;
- Medium level of opening of the glazing leading to medium degree of passing of solar radiation;
- High level of opening of the glazing leading to high degree of passing of solar radiation
- Very high level of opening of the glazing leading to very high degree of passing of solar radiation.

Thus, the intensity of solar radiation is regulated by the level of opening of the glazing regulated by reflective curtains.

2.3. Tensegrity- Structures with Stretched Membranes.

The advantages of this solution are as follows:

- Depending on the dimensions of the membrane, any number of chambers and volumes can be situated under it, while protecting them from direct solar radiation;
- Depending on the materials used for the fabrication of the membranes, i.e. transparent, dense, partially transparent or combined, various functional requirements can be met;
- passive solar heating and hot water supply for medical purposes in extreme situations;

The space under the transparent membrane is suitable for placement of chambers and volumes to be used in extreme situations. (Fig. 5)

Fig. 5. Passive solar heating. A transparent membrane is stretched over a tensegrity-structure in a greenhouse for exotic plants. Hot water supply for medical purposes with the tubes of the tensegrity- structure.

III. CONCLUSIONS

1. In the use of medical modules in extreme situations the hot-house effect leads to electricity savings and helps support positive temperatures between +2 ^{0}C and + 12 ^{0}C in fruit storehouses or between +22 ^{0}C and + 24 ^{0}C in operating rooms and operating blocks.
2. The regulation of the surface of the upper and lower lighting achieved by implementing different percentage levels of glazing of the roof and the wall surfaces depending on the technological requirements of the different premises and the intensity of solar radiation ensures an additional comfort of exploitation.
3. The membranes play the role of protective screens for the refrigeration chambers, while their covering, transparent or dense, ensure the regulation of the temperature range, resulting in the so-called “regulated hothouse effect”.
4. A transparent membrane is stretched over a tensegrity-structure can use for formation passive solar heating and hot water supply for medical purposes with the tubes of these tensegrity- structure .

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   - cooperative: Y02E10/40
   Application number: BG20060109516 20060421
   Priority number(s): BG20060109516 20060421
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Associate Professor Lyudmila Aleksandrova is the author and co-author of more than 30 patents for inventions, whereas a significant part of them solve problems in the sphere of the energy efficiency of buildings, e.g. active-energy walls, energy-accumulating panel connections, systems for solar heating of buildings, sectional modules with autonomous energy supply for use in extreme situations, i.e. natural disasters, etc. Associate Professor Lyudmila Aleksandrova in co-authorship is winner of the “Genius Grand Prix” and a Gold medal from the International Invention Fair in Budapest. Her papers have roused high interest at numerous international conferences on architecture and sustainable development, e.g. in Tokyo, Seoul, Hong Kong, Kuala Lumpur, Cape Town, Florence, etc. She has been guest lecturer at the Faculty of Architecture of the Institute for Building Management in Belgrade, Serbia as well as “Erasmus” lecturer at the Riga Building College, Latvia in 2012, 2013, 2014 and 2015. The author teaches the course “Innovative design of buildings, constructions and details” at the Faculty of Architecture of the Civil Engineering Higher School “Liuben Karavelov” in Sofia, Bulgaria.

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