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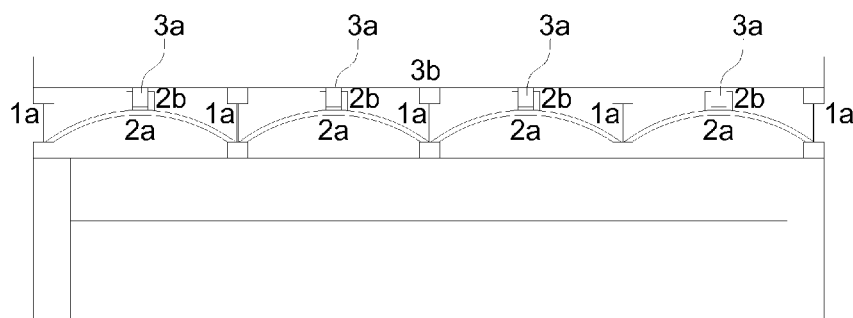


Figure 8

(57) Abstract: A collaborating joist and suspended ceiling system for a suspended ceiling is provided. The system comprises: profiled lightweight beams (1a) elongated in a first direction, each of the profiled lightweight beams having flange ends (1c) at distal ends thereof; a first edge beam (4a), having recesses (4b) corresponding to the footprint and depth of the flange ends (1c) of the lightweight beams (1a), said first edge beam (4a) being in contact with flange ends (1c) such that mechanical contact between the lightweight beams (1a) and the first edge beam (4a) is obtained; bent panels (2a) mounted between pairs of profiled lightweight beams (1a) and resting on a lower flange of the respective profiled lightweight beam (1a), wherein each of the respective bent panels (2a) is provided with a pair of crown beams (2b) arranged on an upper side of the bent panel (2a) for linear distribution of a pressure exerted from below on the bent panel (2a), the crown beams (2b) extending along the first direction; and secondary beams (3b) having vertical spacers (3a), wherein the vertical spacers (3a) are arranged between adjacent pairs of parallel secondary beams (3b), and wherein the secondary beams (3b) are arranged on the crown beams (2b) and on the profiled lightweight beams (1a) such that the secondary beams (3b) are extending in a second direction, the second direction being perpendicular to the first direction thereby forming the suspended ceiling supported by a rectangular grid structure.

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A collaborating joist and suspended ceiling system and a method for assembling the systemTechnical field

The present disclosure relates to suspended ceilings in general. More specifically, the disclosure relates to a collaborating joist and suspended ceiling system, and a method for assembling the system.

The current state of technology

In general, joists in buildings can consist of wooden beams or lightweight beams or a combination of both and also of steel beams and cement-based elements. In addition to the requirements for permanency and stability, the joists shall meet function-specific fire protection and sound absorption requirements according to the required building standards and regulations where the construction is carried out. By way of example, in Sweden, such regulations may be the Plan and the Building Ordinance ("Plan- och byggförrdningen"), the Planning and Building Act ("Plan- och bygglagen"), and the Housing Agency's building regulations ("Boverkets byggregler") and the European Building Standards.

In order to meet these requirements, most systems used today are supplemented with gypsum boards that are screwed on or nailed to the systems from below, either directly to the floor joists or to special profiles made either of aluminum or wood, which may be called "sparse panel" or "nail-batten". The result is a suspended ceiling that protects against fire and noise which can arise in the room from spreading upwards. The higher the fire and sound absorption requirements, the more gypsum boards, also referred to as plasterboards, and other elements are needed to achieve these requirements.

Such methods have so far made it possible to fireproof both wooden and steel buildings, which has meant that the fire risk in buildings has decreased and that noise does not have to propagate and for instance disturb different activities between different floors or between buildings.

A disadvantage of the used methods is that the gypsum boards consist of the raw material "gypsum" (calcium sulfate hydrate: $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) which originates from energy-intensive and particle-creating mining. Throughout the process from the extraction to finished plasterboard and also after the process problems associated with the generation of particles and/or energy consumption are present. Tearing down plasterboards gives rise to new

particles being generated. One could argue that the material plasterboard creates various environmental problems during its life cycle except when it is mounted, and after its life as well.

The installation of the plasterboards today takes place from below. The method requires many lifting situations and it is therefore both physically demanding and labor intensive but in particular it is a method that causes well-known wear and tear injuries in those who work with it. The method's well-known problems have already led to new technology and aids have been introduced to reduce such wear and tear injuries on the workers, for example the size and thickness of plasterboards have been reduced and there are plasterboards that are "reinforced" with others material to improve its performance and reduce the proportion of gypsum in the boards (ex: "Fermacell"). After installation the suspended ceiling has to be plastered and polished before it can be painted. These moments also happen from below and these are also very physically demanding for the workers and therefore also labor intensive.

Summary

It is an object of the present disclosure to mitigate, alleviate or eliminate one or more of the above-identified deficiencies and disadvantages in the prior art and solve at least the above-mentioned problem.

This invention solves the problems of the existing art by providing:

a. A system that makes it unnecessary to use plasterboard for fire protection of this type of joists.

b. A system without the need of further processing of the suspended ceiling from below.

c. A specially designed assembly method of prefabricated parts, both product specific and such that already are available on the market.

d. That the cooperating simultaneous suspended ceiling and joist system can be built from above and from adjacent scaffolding in its entirety. Put differently, a collaborating joist and suspended ceiling system is provided.

e. An innovative physical collaboration method that reduces the number of work steps.

f. That it contributes to reducing workers' wear and tear injuries.

g. The described system and its assembly method contribute to reaching the Global Goals expressed according to the UN in Agenda 2030.

These features are to be found in the subsequent patent claims.

According to a first aspect there is provided a collaborating joist and suspended ceiling system. The system comprises:

profiled lightweight beams elongated in a first direction, each of the profiled lightweight beams having flange ends at distal ends thereof;

a first edge beam, having recesses corresponding to the footprint and depth of the flange ends of the profiled lightweight beams, said first edge beam being in contact with the flange ends such that mechanical contact between the profiled lightweight beams and the first edge beam is obtained;

bent panels mounted between pairs of profiled lightweight beams and resting on a lower flange of the respective profiled lightweight beam, wherein each of the respective bent panels is provided with a pair of crown beams arranged on an upper side of the bent panel for linear distribution of a pressure exerted from below on the bent panel, the crown beams extending along the first direction; and

secondary beams having vertical spacers, wherein the vertical spacers are arranged between adjacent pairs of parallel secondary beams, and wherein the secondary beams are arranged on the crown beams and on the profiled lightweight beams such that the secondary beams are extending in a second direction, the second direction being perpendicular to the first direction, thereby forming the suspended ceiling supported by a rectangular grid structure.

An advantage of the provided system is that a versatile and cost-effective collaborating joist and suspended ceiling system is provided. A more lightweight joist and suspended ceiling is further provided. A further advantage is that the system is less complex to assemble. Heavy lifting may for example be reduced when assembling the system. A safer system is moreover provided. The provided collaborating joist and suspended ceiling system reduces or circumvent the need of using plasterboard. A more environmentally friendly collaborating joist and suspended ceiling system is thereby provided.

The collaborating joist and suspended ceiling system may be referred to as an interrelated joist and suspended ceiling system. The system is arranged to collaborate in distributing loads and stresses between the parts thereof.

5 The parts of the system may be made of wood. A reduced environmental footprint may thereby be provided.

The mechanical contact between the first edge beam and the flange ends of the profiled lightweight beams, may be understood to be between distal ends of profiled lightweight beams and the first edge beam. Each of the profiled lightweight beams may thereby be in contact with the first edge beam.

10 Less finishing work may moreover be needed in the form of painting and filling of the provided ceiling.

The joists may, moreover, without the need of plasterboards, transfer fire pressure efficiently from below and above.

15 To this end, further advantages of the system may comprise: The bent panels, that may be plywood sheets, may be understood as to form a robust and durable ceiling. The pair of crown beams mounted on the upper part of the bent panels may be arranged to transfer a fire pressure in that it distributes point like pressure loads exerted towards the suspended ceiling from below into linear loads. The vertical spacers are further arranged to transfer the pressure load further upwards via the secondary beams. The edge beams may be arranged to hold the
20 profiled lightweight beams in place to enable installation from above and may also resist pressure from below and/or from above. The secondary beams may be arranged to absorb and transfer the linear loads up to a floor surface arranged on the secondary beams as will be discussed. The profiled lightweight beams may be of wood.

25 According to some embodiments, the crown beams are connected with the secondary beams through the vertical spacers.

According to some embodiments, the profiled lightweight beam may have an I-profile, the I-profile comprising two flanges separated by a web. A stabile lightweight beam is thereby provided. The flange ends may protrude a larger portion than the web. The flange ends may be understood to project.

30 According to some embodiments, the first edge beam may be made of glulam.

According to some embodiments the first edge beam may be of wood or Plywood.

According to some embodiments, the system may also comprise a second edge beam, the second edge beam having recesses corresponding to the footprint and depth of the flange ends of the profiled lightweight beams, wherein the second edge beam is arranged in
5 mechanical contact with the flange ends of the profiled lightweight beams at distal ends thereof being opposite to the distal ends attached to the first edge beam.

According to some embodiments, the bent panels may be Plywood sheets.

According to some embodiments, a floor may be installed on top of the secondary beams. An advantage being that the joist and ceiling provided may be understood as a
10 collaborative joist and simultaneous ceiling supporting a floor. The provided elements cooperate such that the crown beams mounted on the upper part of the bending panels may transform point like loads exerted from below into linear loads. These linear loads may further be conveyed via the vertical spacers upwards towards the secondary beams and through these such that the load is balanced by the floor surface above. To this end, the provided system may
15 transfer loads from above down through the floor to the load-bearing elements of the system.

According to some embodiments, the vertical distances may be screwed to the adjacent pairs of parallel secondary beams.

According to some embodiments, the vertical distances may be screwed on the crown beams.

20 According to some embodiments, one or more of the following may comprise fire protective paint: the profiled lightweight beams; and the bent panels.

According to some embodiments, a vibration damping element may be arranged on each of the crown beams, the vibration damping elements being arranged between the secondary beams and the crown beams such that transfer of vibrations is reduced between the bent panels
25 and the secondary beams.

According to some embodiments, the system may comprise two adjacent bent panels arranged juxtaposed between a pair of profiled lightweight beams and a cover panel arranged on and overlapping with the two adjacent bent panels.

The cover panel may cover the interface formed between the pair of adjacent panels.

According to some embodiments, the system may comprise an acoustic insulating panel or an acoustic insulating sheet arranged in between the bent panels and upper flanges of the profiled lightweight beams, wherein the acoustic insulating panel or sheet extends in width
5 between the adjacent pair of profiled lightweight beams such that acoustic sound transfer from one side of the acoustic insulating panel or sheet to the other side thereof is reduced.

The acoustic insulating panel may comprise mineral wool. The acoustic insulating panel may be a mineral wool panel. The acoustic panel may comprise hemp.

According to some embodiments, the system may comprise a vibration damping sheet,
10 the vibration damping sheet being arranged on a convex surface of the bent panels such that vibrations of the bent panels are dampened.

According to a second aspect there is provided a method for assembling the collaborating joist and suspended ceiling system is provided. Put differently, a method for providing a cooperative joist and simultaneous ceiling is provided. The method comprises:

15 arranging the profiled lightweight beams on a supporting structure, each of the profiled lightweight beams having flange ends at distal ends thereof, the profiled lightweight beams being elongated in a first direction;

arranging the first edge beam in mechanical contact with a flange end of the profiled lightweight beams;

20 inserting between pairs of profiled lightweight beams the bent panels provided with a pair of crown beams such that the bent panels rest on a lower flange of the respective profiled lightweight beams;

arranging pairs of parallel secondary beams having vertical spacers arranged in between the adjacent secondary beams, on the crown beams and on the profiled lightweight
25 beams such that the secondary beams are extending in a second direction, the second direction being perpendicular to the first direction thereby forming the supported ceiling supported by a rectangular grid structure.

Effects and features of the second aspect are to a large extent analogous to those described above in connection with the first aspect. Embodiments mentioned in relation to the first aspect are largely compatible with the second aspect.

According to some embodiments, the inserting may comprise inserting the bent panels
5 at the flange end of the pair of profiled lightweight beams and sliding the bent panels along the lower flanges of the respective profiled lightweight beams.

According to some embodiments, the system may further comprise a second edge beam, wherein the method further comprises arranging the second edge beam in mechanical contact with the flange ends of the profiled lightweight beams at distal ends thereof being
10 opposite to the distal ends attached to the first edge beam.

According to some embodiments, the second edge beam may be made of glulam.

According to some embodiments the second edge beam may be made of wood or Plywood.

According to some embodiments, the collaborating joist and suspended ceiling system
15 may further comprise insulation material in the form of gravel, sand, mineral-soil or mixtures thereof, the insulation material being arranged at a border region formed by distal portions of the convex surfaces of the bent panels and the adjacent the profiled lightweight beams to which the bent panels are connected.

According to some embodiments, the method may further comprise providing a
20 vibration damping element at a distal end of the respective crown beams, the distal ends being on an opposite side of that of the bent panels such that when the parallel secondary beams are mounted against the crown beams the parallel secondary beams are mounted on and in contact with the vibration damping elements.

According to some embodiments, the method may further comprise arranging a cover
25 panel on and overlapping with two adjacent bent panels.

According to some embodiments, the method may further comprise providing a fireproof sealing at an interface between adjacent bent panels.

The present disclosure will become apparent from the detailed description given below. The detailed description and specific examples disclose preferred embodiments of the disclosure by way of illustration only. Those skilled in the art understand from guidance in the detailed description that changes and modifications may be made within the scope of the disclosure.

Hence, it is to be understood that the herein disclosed disclosure is not limited to the particular component parts of the device described or steps of the methods described since such device and method may vary. It is also to be understood that the terminology used herein is for purpose of describing particular embodiments only, and is not intended to be limiting. It should be noted that, as used in the specification and the appended claim, the articles "a", "an", "the", and "said" are intended to mean that there are one or more of the elements unless the context explicitly dictates otherwise. Thus, for example, reference to "a unit" or "the unit" may include several devices, and the like. Furthermore, the words "comprising", "including", "containing" and similar wordings does not exclude other elements or steps.

List of drawings

The above objects, as well as additional objects, features and advantages of the present disclosure, will be more fully appreciated by reference to the following illustrative and non-limiting detailed description of example embodiments of the present disclosure, when taken in conjunction with the accompanying drawings.

Figures 1 to 11 illustrate generally perspective views of different parts of a collaborating joist and suspended ceiling system according to some embodiments.

Figures 12 to 13 illustrate generally perspective views of the fully assembled collaborating joist and suspended ceiling system according to some embodiments.

Figures 14 to 21 illustrate generally perspective views of an assembly sequence for assembling a collaborating joist and suspended ceiling system according to some embodiments.

More specifically the drawings generally illustrate:

Figure 1 illustrates generally a perspective side view of a profiled lightweight beam according to some embodiments.

Figure 2 illustrates generally a perspective side view of a bent panel.

Figure 3 illustrates generally a perspective cross-sectional view of a pair of crown beams according to some embodiments.

5 Figure 4 illustrates generally a perspective side view of a bent panel provided with a pair of crown beams according to some embodiments.

Figure 5 illustrates generally a perspective side view of a secondary beam having vertical spacers according to some embodiments.

Figure 6 illustrates generally a perspective cross-sectional view of an edge beam according to some embodiments.

10 Figure 7 illustrates generally a perspective side view of an edge beam according to some embodiments.

Figure 8 illustrates generally a side view of an assembled collaborating joist and suspended ceiling system according to some embodiments.

15 Figure 9 illustrates generally a perspective top view of work floor arranged to be attached to the collaborating joist and suspended ceiling system according to some embodiments.

Figure 10 illustrates generally a perspective view from below of a cover panel provided between a pair of bent panels according to some embodiments.

Figure 11 illustrates generally a perspective view from above of a fireproof sealing of the interface between two adjacent bent panels according to some embodiments.

20 Figure 12 illustrates generally a perspective view from above of a collaborating joist and suspended ceiling system arranged on top of a support according to some embodiments.

Figure 13 illustrates generally a perspective view from below of a collaborating joist and suspended ceiling system arranged on top of a support according to some embodiments.

25 Figures 14 to 21 illustrate generally perspective views of an assembly sequence for a collaborating joist and suspended ceiling system according to some embodiments.

Figure 22 illustrates schematically a block diagram of the method for assembling a collaborating joist and suspended ceiling system according to some embodiments.

Figure 23 illustrates generally a cross-sectional side view of a collaborating joist and suspended ceiling system comprising vibrational and acoustical insulation according to some embodiments.

5 Detailed description

The present disclosure will now be described with reference to the accompanying drawings, in which preferred example embodiments of the disclosure are shown. The disclosure may, however, be embodied in other forms and should not be construed as limited to the herein disclosed embodiments. The disclosed embodiments are provided to fully
10 convey the scope of the disclosure to the skilled person.

Advantages of the system for a suspended ceiling and the method for assembling the collaborating joist and suspended ceiling system are here discussed, with reference to Figures 1 to 13. An advantage being that the cooperative principle of the parts of the collaborating joist and suspended ceiling system may distribute (possible) fire pressure that
15 can arise from below towards the formed ceiling (may be understood as the “false ceiling”) consisting of a sequence of vaults. The vaults being formed by the bent panels. The bent panels may be understood to form arches. Through the crown beams, the pressure is distributed along the long axis of the arches (formed by the bent panels) and from the crown beams to the spacers which in turn transmit the pressure to the secondary beams. The
20 pressure may finally be distributed to a floor. That is, the pressure arising from below may gradually be absorbed by surfaces as well as linear-shaped elements of the collaborating joist and suspended ceiling system and may finally be distributed over the entire floor surface. Simultaneously, the loads may be transferred from the floor to the primary beams, i.e. the profiled lightweight beams, through the secondary beams.

25 A certain degree of sound absorption may further be achieved by regulating the vault height and the degree of concavity of the vaults, i.e. of the bent panels. This is, however, a limited function because the concavity of the vaults is dependent on the center distance of the profiled lightweight beams and also because the project has certain height requirements that are not only dimensioned according to the need for sound absorption.

30 The system is also characterized by the fact that 2 out of 4 facades may have arched openings for windows or ducts and of that the vault sequence of the suspended ceiling.

According to some embodiments, the system may be seen as an internal structure that must be supplemented with an external climate shell with an air gap between both layers.

According to some embodiments, the anchoring of both the profiled lightweight beams and the secondary beams may be provided according to the respective construction document
5 and respective strength dimensioning.

According to some embodiments, the different components of the system may be produced by manufacturing and assembling components as follows:

Regarding items 1abc: Profiled lightweight beams such as Hunton or Masonite which may have been “life-profiled”, i.e. having a I-profile comprising two opposite flanges separated
10 by a web, in the workshop to leave flange ends free 1c, i.e. the flange ends being arranging to be connected to other objects, such as an end beam. Put differently, the profiled lightweight beams may be made out of Hunton or Masonite. The joist system may be of wood. The collaborating joist and suspended ceiling system may be of wood-based system.

According to some embodiments, the lightweight beams may be fitted with a
15 triangular-shaped sealing wedges 1b. The sealing wedges may be made of wood and may be glued firmly against both upper sides of the lower flange. The sealings may in other embodiments have a different shape, such as rectangular or cylindrical shape.

According to some embodiments, the wedge-equipped and life-profiled, i.e. the I-profiled lightweight beam may be fire-painted by dipping the bottom flange and half the life
20 (in height) into a container containing fire paint.

Regarding items 2ab: The vault, consisting of bent panels 2a may be fire-painted on the side that will be the exposed part of a ceiling surface. The ceiling surface may be referred to as a “false ceiling surface”. The edges of the bent panels may also be painted. After drying, the panels may be fitted with the crown beams 2b, glued against the upper side of the bent
25 panels. The crown beams may be fastened by other means, such as by nails, screws or similar fastening means.

Regarding items 3ab: The vertical spacers 3a may be screwed to the secondary beams (3b). According to other embodiments the vertical spacers may be attached by other means such as by gluing or nailing.

30 Regarding items 4ab: The edge beams 4a, may be provided with milled impressions 4b, i.e. recesses, corresponding to the depth of the flange ends of the profiled lightweight beams,

according to construction documents and strength dimensioning. According to some embodiments the recesses may be stretching in depth through the edge beams such that through-holes are formed.

Regarding items 5ab: According to some examples, a temporary work floor (5ab) may
5 be arranged on the profiled lightweight beams. The temporary work floor may comprise spacers, e.g. in the form of bars.

The temporary work floor may be made by reinforced structural plywood. The temporary work floor may, by way of example, comprise at least two 1.2m*2.4m*0.021m sheets of structural plywood. The work floor may have parallel rails spaced at a distance
10 corresponding to the distance in between underlying adjacent pairs of profiled lightweight beams. The rails may, by way of example, be 45 or 60 mm. The distance may, by way of example be 45 or 60mm (according the flange dimensions of the profiled lightweight beam) distance between each other and with the same center distance as of the lightweight beams 1a. The temporary work floor may be able to be moved back and forth along the upper flanges
15 of the lightweight beams as if these would be rails. Its function is to provide a certain statute that makes it possible to mount all additional elements. These work floor may thus be used as a temporary work floor.

Regarding items 6ab: According to some examples, the system may further comprise two adjacent bent panels 2a arranged juxtaposed between a pair of profiled lightweight
20 beams 1a and a cover panel 6a arranged on and overlapping with the two adjacent bent panels 2a. In other words, according to some examples, and if the vaults, or put differently arches formed by the bent panels, are longer than the module of the bent panel, adjacent bent panels may be connected by placing a cover panel 6a of the same material on the underside of the vault, such that it becomes visible from inside the room. On the opposite side
25 of the bent panels, i.e. on top of the bent panels, the joint formed between the panels may comprise a fireproof sealing 6b.

Regarding items 7: According to some embodiments, a floor 7a may be installed on top of the secondary

beams 3b. The floor 7a may consists of a wooden board according to the respective building
30 document, and may be attached, e.g. by screwing, to both edge beams 4ab and the secondary beams 3b.

Regarding items 8: For assembly, the system may require that the workplace is provided with scaffolding around the system to be built. Alternatively, a lifting device may be used with a connected safe workplace.

Advantages of the method for assembling the system are here discussed with reference to Figure 14 to 21.

According to some examples, the lightweight beams 1a may be placed on the supporting structure 8 (e.g. wall or beam) using a lifting device and anchored to the supporting structure temporarily from the surrounding workplace.

According to some examples, one edge beam 4ab is first fitted against one side of the profiled lightweight beams. Put differently, the edge beam may be arranged against a buttress such as a wall to give stability. The first row of flange ends 1c may then be glued and anchored against the recesses of the edge beam. The edge beams may be anchored to the supporting structure also in accordance with the respective construction regulation. The other end of the profiled lightweight beams may be free until further notice and may be terminated after all the vaults, i.e. the bent panels, are put in place. In other words, the method may comprise mounting the second edge beam 4a on an opposite side of the profiled lightweight beams 1a to the side being in contact with the first edge beam 4a.

According to some examples, the work floors 5ab may be placed against the profiled lightweight beams. The purpose is to provide a temporary stability for maneuvering of upcoming elements in the assembly of the joist.

According to some examples, the bent panels 2ab may be equipped with crown beams are lifted up and in between the profiled lightweight beams. The workers' main task may here be to retract the bent profiles, (forming vaults), such that they are lifted to the correct height using a lifting device, for example a lifting table or sky lift. Put differently, the bent panels are inserted in between two adjacent profiled lightweight beams.

According to some examples, the suspended ceiling is finished when all the bent panels are in place and it has been completed with the second one the edge beam, i.e. the second end beam has been attached to the profiled lightweight beams. In this way, a box-shaped structure is created and the joist gets greater stability. Put differently, rectangular grid structure and a suspended ceiling is provided.

According to some examples, the temporary work floors may be moved to give space for the secondary beams with vertical spacers which are attached to the crown beams. The secondary beams 3b and the vertical spacers may be lifted up using a lifting device, for example a lifting table or sky lift to then be placed in the correct position according to
5 respective building document and then attached, for example by screws, to the crown beams.

According to some examples and depending on the size of the joists, the work floors may be successively moved to continue the same maneuver. By way of example, when the distance to the inner side of each edge beam is approx. 1.3m, these must be lifted up and the rest of the maneuvering may take place from the surrounding workplace or from yet another
10 temporary work surface which may be created by placing the work floors on the secondary beams.

According to some examples, the assembly may result at this stage in spaces between the profile lightweight beams and the above the bent panels that may be supplemented with insulation.

15 According to some examples, the top side of the collaborating joist and suspended ceiling system may be covered with a Plywood board and used directly as floor covering.

According to some examples, and if the arches need to have a length that exceeds the bendable panels, these must be placed consecutively after each other. The intersections formed in between adjacent bent panels may have fireproof sealing. The vaults formed by the
20 bent panels may be covered from below with a sealing panel. The sealing panel may be of the same material as the bent panels.

With reference to Figure 22 illustrates the method for assembling a collaborating joist and suspended ceiling system according to some embodiments is described. The method 10 comprises: arranging 10a the profiled lightweight beams 1a on a supporting structure, each of
25 the profiled lightweight beams 1a having flange ends 1c at distal ends thereof, the profiled lightweight beams 1a being elongated in a first direction;

arranging 10b the first edge beam 4a in mechanical contact with a flange end 1c of the profiled lightweight beams 1a;

inserting 10c between pairs of profiled lightweight beams 1a the bent panels 2a fitted with a pair of crown beams 2b such that the bent panels 2a rest on a lower flange of the respective profiled lightweight beams 1a;

5 arranging 10d pairs of parallel secondary beams 3b having vertical spacers 3a arranged in between the adjacent secondary beams 3b, on the crown beams 2b and on the profiled lightweight beams 1a such that the secondary beams 3b are extending in a second direction, the second direction being perpendicular to the first direction thereby forming the supported ceiling supported by a rectangular grid structure.

10 According to some embodiments, the inserting 10c may comprise inserting the bent panels 2a at the flange end 1c of the pair of profiled lightweight beams 1c and sliding the bent panels 2a along the lower flanges of the respective profiled lightweight beams 1a.

According to some embodiments, the system may further comprise a second edge beam 4a, wherein the method 10 further comprises arranging the second edge beam 4a in mechanical contact with the flange ends 1c of the profiled lightweight beams 1a at a side thereof being
15 opposite to the side attached to the first edge beam 4a.

According to some embodiments, the method may further comprise providing a vibration damping element 11 at a distal end of the respective crown beams 2b, the distal ends being on an opposite side of that of the bent panels 2a such that when the parallel secondary beams 3b are mounted against the crown beams 2b the parallel secondary beams 3b are
20 mounted on and in contact with the vibration damping elements 11.

With reference to Figure 23, the system may further according to some embodiments comprise a vibration damping element 11 that is arranged on each of the crown beams 2b, the vibration damping elements 11 being arranged between the secondary beams 3b and the crown beams 2b such that transfer of vibrations is reduced between the bent panels 2a and the
25 secondary beams 3b.

According to some embodiments, wherein the system may further comprise an acoustic insulating panel 12 arranged in between the bent panels 2a and the corresponding crown beams 2b. The insulating panel may extend in width between the adjacent pair of profiled lightweight

beams 1a such that acoustic sound transfer from one side of a plane formed by the system to the other side of the plane is reduced.

According to some embodiments, the system comprises an acoustic insulating panel or an acoustic insulating sheet 12 arranged in between the bent panels 2a and upper flanges of the profiled lightweight beams 1a, wherein the acoustic insulating panel or sheet extends in width between the adjacent pair of profiled lightweight beams 1a such that acoustic sound transfer from one side of the acoustic insulating panel or sheet to the other side thereof is reduced.

According to some embodiments, wherein the system further comprises a vibration damping sheet 13. The vibration damping sheet 13 may be arranged on a convex surface of the bent panels 2a such that vibrations of the bent panels 2a are dampened.

According to some embodiments, the system may further comprise insulation material 14 in the form of gravel, sand, soil or mixtures thereof. The insulation material may be arranged at a border region 15 formed by distal portions of the convex surfaces of the bent panels 2a and the adjacent the profiled lightweight beams 1c to which the bent panels 2a are connected.

According to some embodiments the second edge beam is made of glulam.

According to some embodiments is provided a special simultaneous cooperation system that results in a suspended ceiling that is ready for installation without the need for either filling or plastering and which is mounted from above.

According to some embodiments is provided a profiled lightweight beam whose flanges cooperate mechanically with an edge beam.

According to some embodiments is provided an edge beam of glulam with recesses corresponding to the footprint and depth of the free flange ends of the profiled lightweight beam, which constitutes a load-bearing building part that cooperates mechanically with the lightweight beams that are part of the system.

According to some embodiments is provided an element produced by completing a bent Plywood board on its highest convex part with two crown beams intended for linear distribution of pressure from below the Plywood board (against its concavity)

According to some embodiments is provided an element consisting of vertical spacers screwed together against two parallel beams as together and simultaneously distributes the pressure from the floor down to the light beams and the pressure from the linearly distributed pressure against the crown beams and upwards towards the floor.

- 5 According to some embodiments is provide an ergonomic mounting system that can be built from above using scaffolding and/or sky lift and also with support from the spacers/work floors.

According to some embodiments is provided a fire-proof and sound-absorbing simultaneous cooperation joists and false ceiling of light wooden elements

- 10 According to some embodiments is provided a fire-proof and sound-absorbing joist floor as during assembly results in a simultaneous ceiling characterized by its shape as being vaulted. The invention also relates to an ergonomic mounting method for its construction. The collaboration beam achieves fire protection through a mechanical interaction that distributes the pressure that arises from below at fire upwards through various structural connections.

- 15 Put differently, according to some embodiment the cover panel is of the same material as the bent panels and the method may further comprise providing a fireproof sealing of the interface in between the cover panel and the respective bent panels.

The desired level of sound absorption may be achieved by adjusting the vault height.

- 20 The collaborating joist and suspended ceiling system can be used for horizontal division of rooms in, for example, a two-story house or as a ceiling in e.g. halls and building entrances. It can be advantageously used in larger buildings to save working time.

- 25 The person skilled in the art realizes that the present disclosure is not limited to the preferred embodiments described above. The person skilled in the art further realizes that modifications and variations are possible within the scope of the appended claims. For example. Additionally, variations to the disclosed embodiments can be understood and effected by the skilled person in practicing the claimed disclosure, from a study of the drawings, the disclosure, and the appended claims.

CLAIMS

1. A collaborating joist and suspended ceiling system, said system comprises:

profiled lightweight beams (1a) elongated in a first direction, each of the profiled lightweight beams having flange ends (1c) at distal ends thereof;

- 5 a first edge beam (4a), having recesses (4b) corresponding to the footprint and depth of the flange ends (1c) of the profiled lightweight beams (1a), said first edge beam (4a) being in contact with the flange ends (1c) such that mechanical contact between the profiled lightweight beams (1a) and the first edge beam (4a) is obtained;

- 10 bent panels (2a) mounted between pairs of profiled lightweight beams (1a) and resting on a lower flange of the respective profiled lightweight beam (1a), wherein each of the respective bent panels (2a) is provided with a pair of crown beams (2b) arranged on an upper side of the bent panel (2a) for linear distribution of a pressure exerted from below on the bent panel (2a), the crown beams (2b) extending along the first direction; and

- 15 secondary beams (3b) having vertical spacers (3a), wherein the vertical spacers (3a) are arranged between adjacent pairs of parallel secondary beams (3b), and wherein the secondary beams (3b) are arranged on the crown beams (2b) and on the profiled lightweight beams (1a) such that the secondary beams (3b) are extending in a second direction, the second direction being perpendicular to the first direction, thereby
20 forming the suspended ceiling supported by a rectangular grid structure.

2. The system according to claim 1, wherein the profiled lightweight beam (1a) has an I-profile, the I-profile comprising two flanges separated by a web.

- 25 3. The system according to claim 1 or 2, wherein the first edge beam (4a) is made of glulam.

4. The system according to any one of the preceding claims, wherein the system also comprises a second edge beam (4a), the second edge beam (4a) having recesses (4b) corresponding to the footprint and depth of the flange ends (1c) of the profiled
30 lightweight beams (1a), wherein the second edge beam (4a) is arranged in mechanical contact with the flange ends (1c) of the profiled lightweight beams (1a) at distal ends thereof being opposite to the distal ends being attached to the first edge beam (4a).

5. The system according to any one of the preceding claims, wherein the bent panels (2a) are Plywood sheets.

5 6. The system according to any one of the preceding claims, wherein a floor (7a) is installed on top of the secondary beams (3b).

7. The system according to any one of the preceding claims, wherein the vertical distances (3a) are screwed to the adjacent pairs of parallel secondary beams (3b).

10 8. The system according to any one of the above claims, wherein one or more of the following comprises fire protective paint:

the profiled lightweight beams (1a); and

the bent panels (2a).

15 9. The system according to any one of the above claims, wherein a vibration damping element (11) is arranged on each of the crown beams (2b), the vibration damping elements (11) being arranged between the secondary beams (3b) and the crown beams (2b) such that transfer of vibrations is reduced between the bent panels (2a) and the
20 secondary beams (3b).

10. The system according to any one of the above claims, wherein the system comprises two adjacent bent panels (2a) arranged juxtaposed between a pair of profiled lightweight beams (1a) and a cover panel (6b) arranged on and overlapping with the two adjacent
25 bent panels (2a).

11. The system according to any one of the preceding claims, wherein the system comprises an acoustic insulating panel or an acoustic insulating sheet (12) arranged in between the bent panels (2a) and upper flanges of the profiled lightweight beams (1a), wherein the
30 acoustic insulating panel or sheet extends in width between the adjacent pair of profiled lightweight beams (1a) such that acoustic sound transfer from one side of the acoustic insulating panel or sheet to the other side thereof is reduced.

12. The system according to any one of the preceding claims, wherein the system comprises a vibration damping sheet (13), the vibration damping sheet (13) being arranged on a convex surface of the bent panels (2a) such that vibrations of the bent panels (2a) are dampened.

13. A method for assembling the collaborating joist and suspended ceiling system according to any one of the preceding claims, wherein the method (10) comprises:

arranging (10a) the profiled lightweight beams (1a) on a supporting structure, each of the profiled lightweight beams (1a) having flange ends (1c) at distal ends thereof, the profiled lightweight beams (1a) being elongated in a first direction;

arranging (10b) the first edge beam (4a) in mechanical contact with flange ends (1c) of the profiled lightweight beams (1a);

inserting (10c) between pairs of profiled lightweight beams (1a) the bent panels (2a) provided with a pair of crown beams (2b) such that the bent panels (2a) rest on a lower flange of the respective profiled lightweight beams (1a);

arranging (10d) pairs of parallel secondary beams (3b) having vertical spacers (3a) arranged in between the adjacent secondary beams (3b), on the crown beams (2b) and on the profiled lightweight beams (1a) such that the secondary beams (3b) are extending in a second direction, the second direction being perpendicular to the first direction thereby forming the supported ceiling supported by a rectangular grid structure.

14. The method for assembling the system according to claim 10, wherein the inserting (10c) comprises inserting the bent panels (2a) at the flange end (1c) of the pair of profiled lightweight beams (1c) and sliding the bent panels (2a) along the lower flanges of the respective profiled lightweight beams (1a).

15. The method for assembling the system according to claim 9 or 10, the system further comprises a second edge beam (4a), wherein the method (10) further comprises arranging the second edge beam (4a) in mechanical contact with the flange ends (1c) of the profiled lightweight beams (1a) at distal ends thereof being opposite to the distal ends attached to the first edge beam (4a).

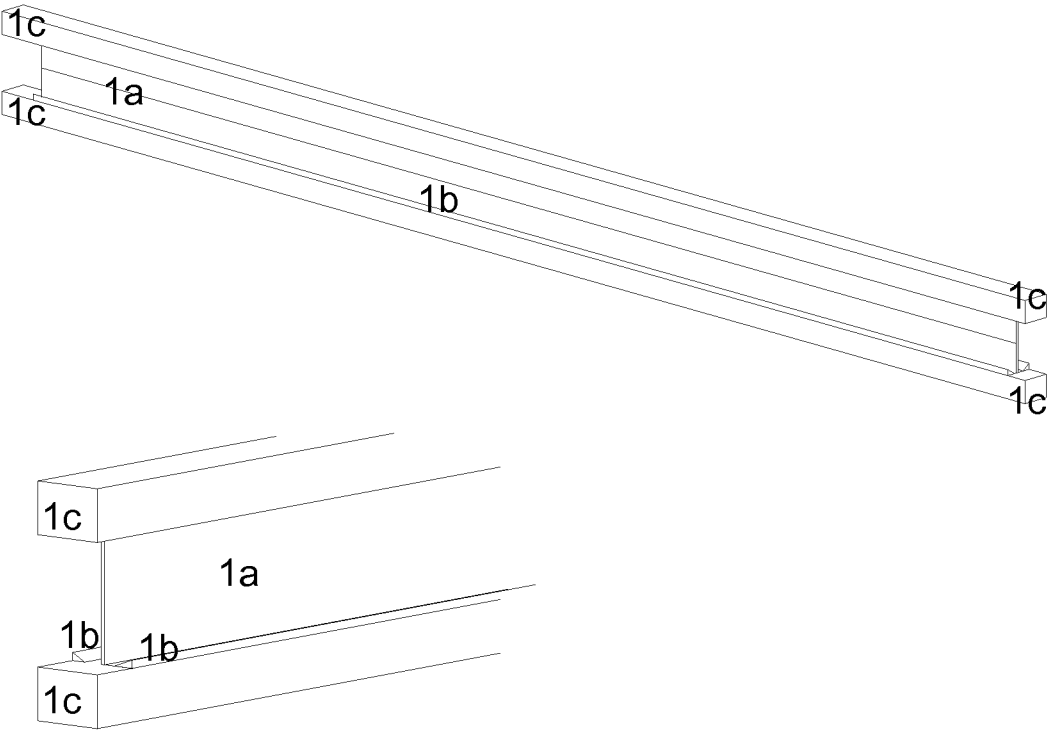


Figure 1

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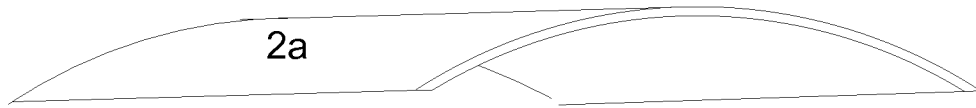


Figure 2

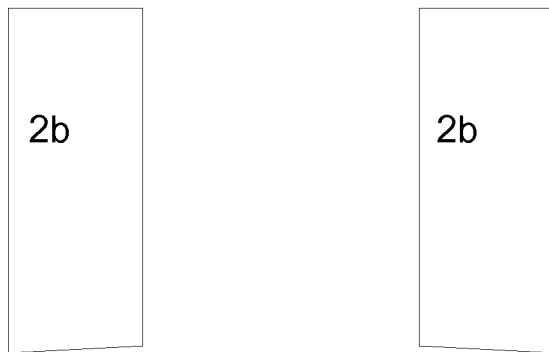


Figure 3

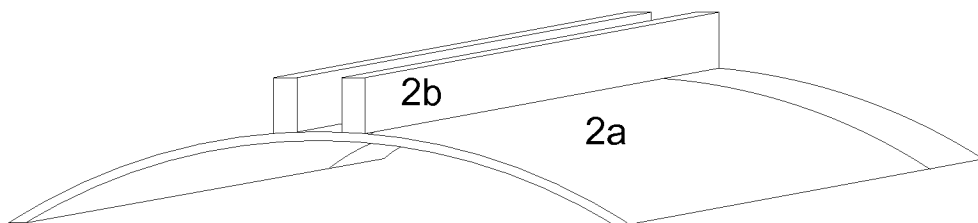


Figure 4

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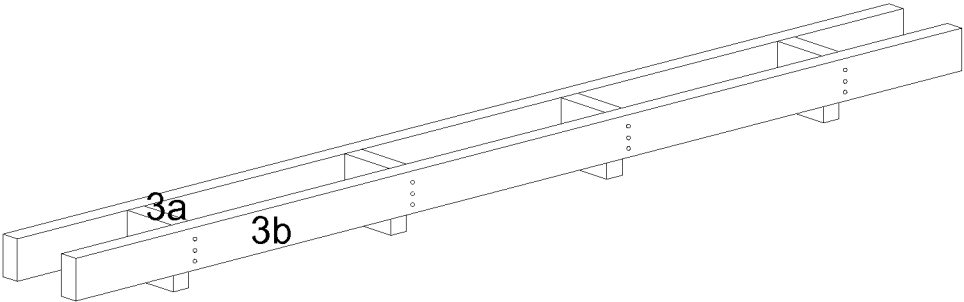


Figure 5

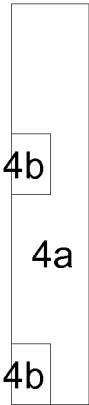


Figure 6

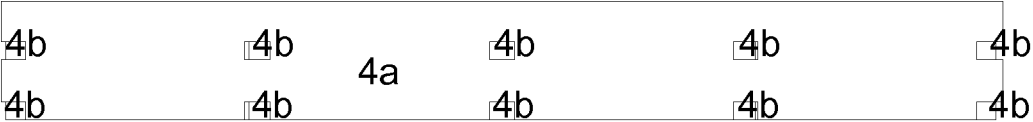


Figure 7

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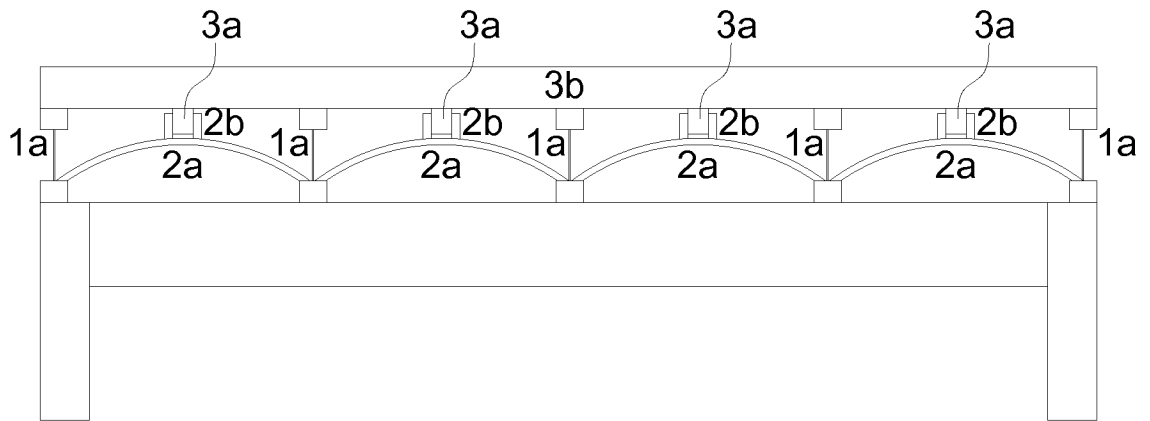


Figure 8

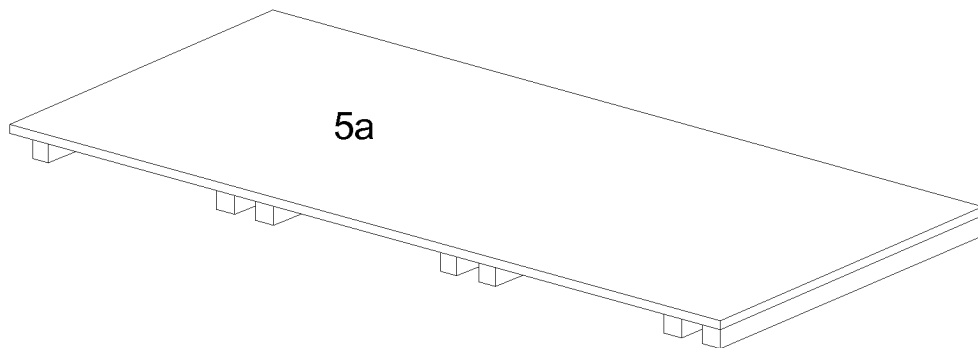


Figure 9

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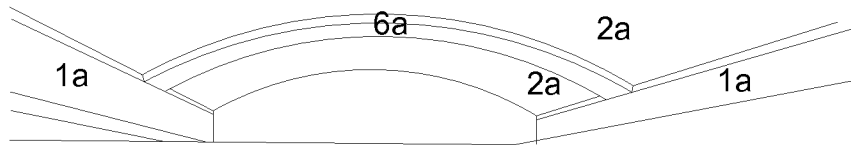


Figure 10

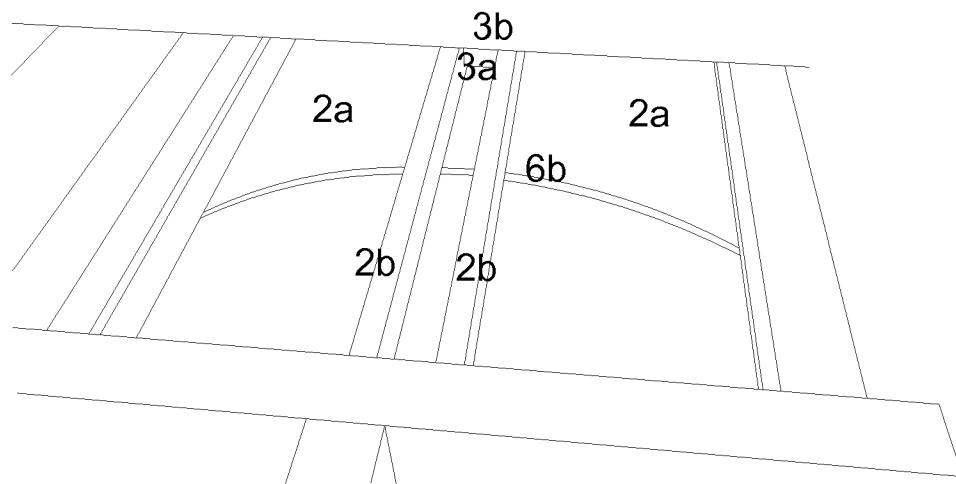


Figure 11

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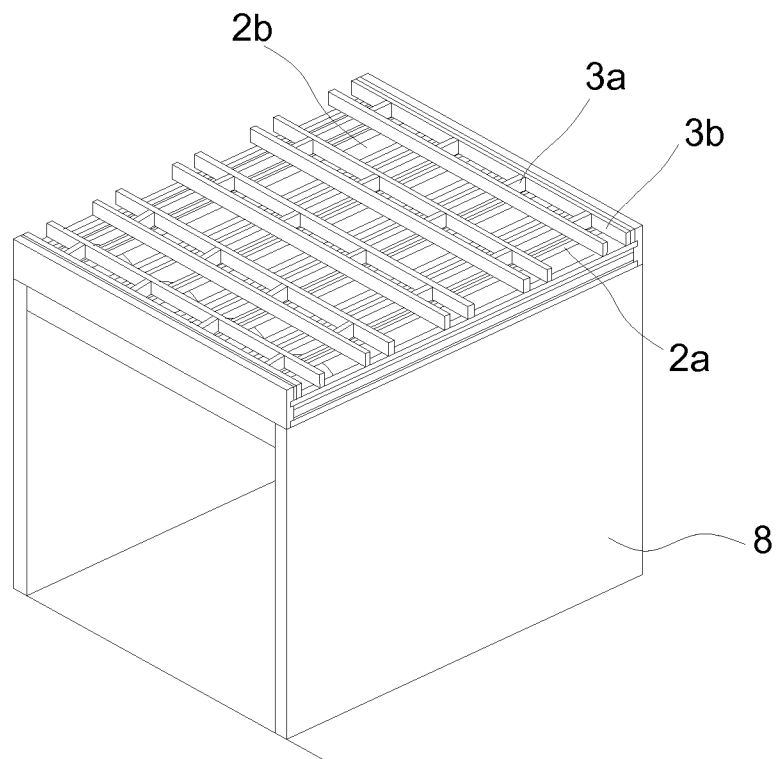


Figure 12

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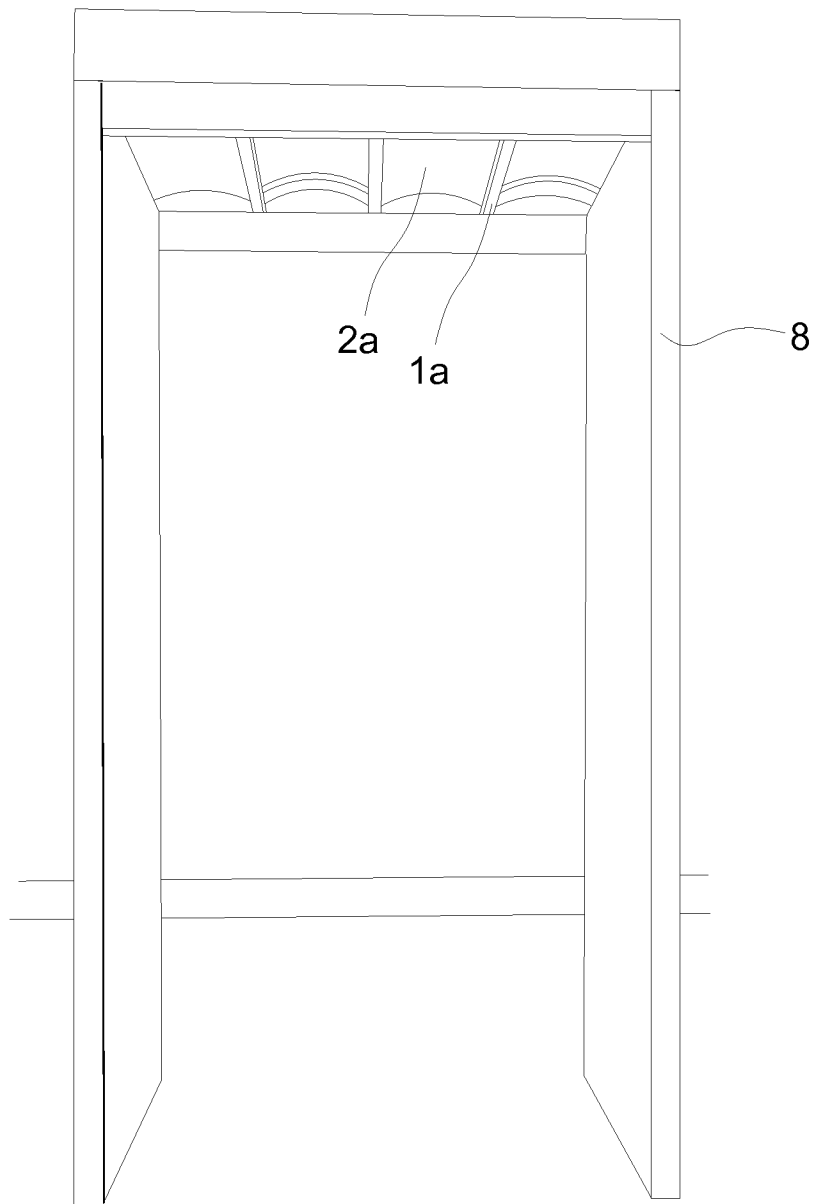


Figure 13

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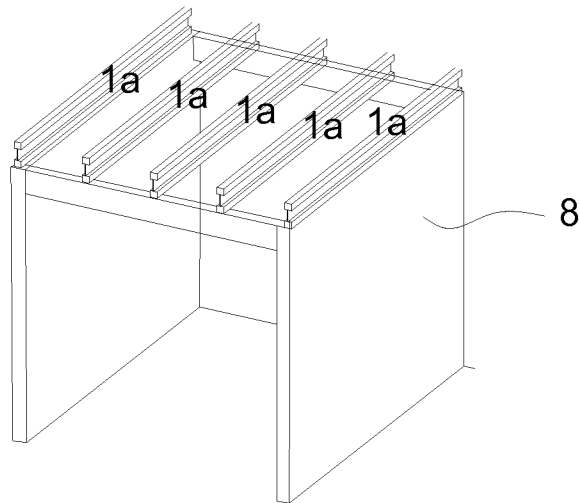


Figure 14

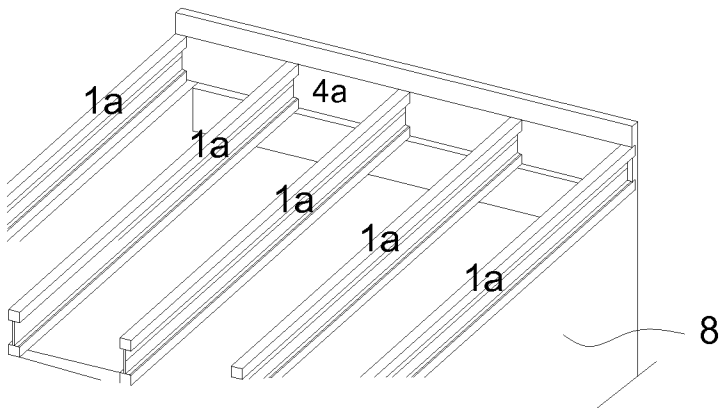


Figure 15

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Figure 16

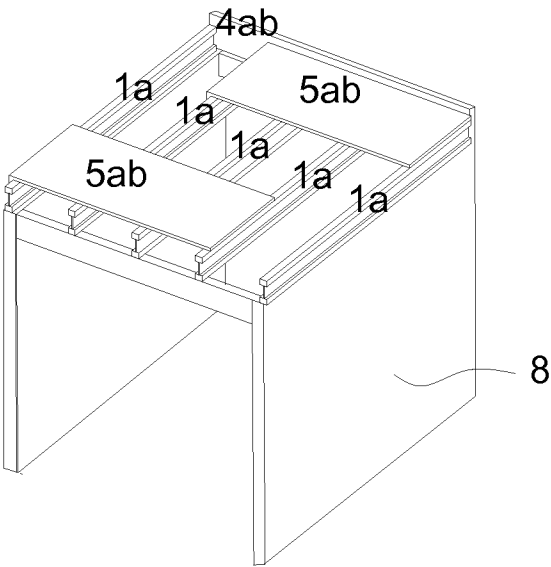
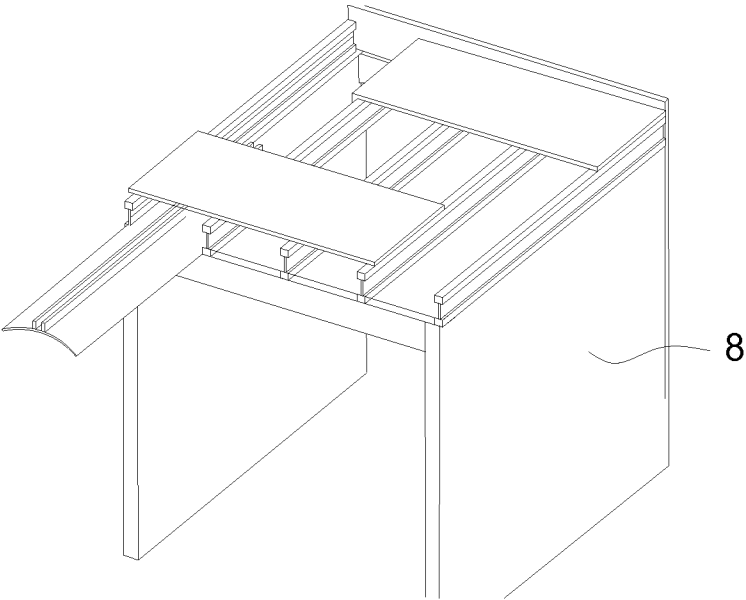


Figure 17



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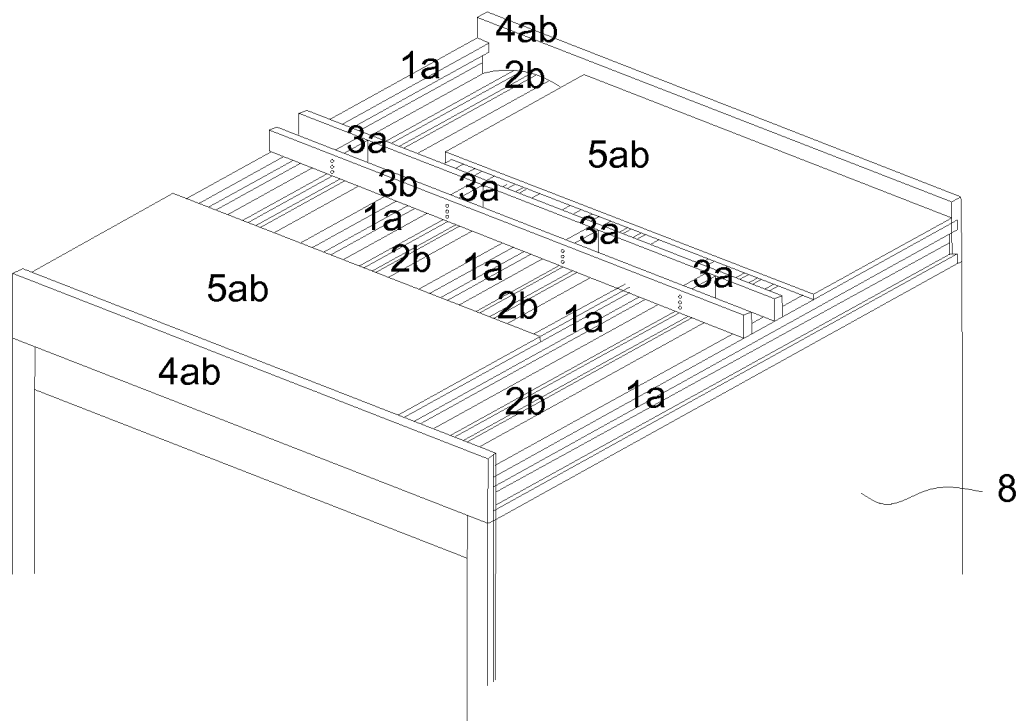


Figure 18

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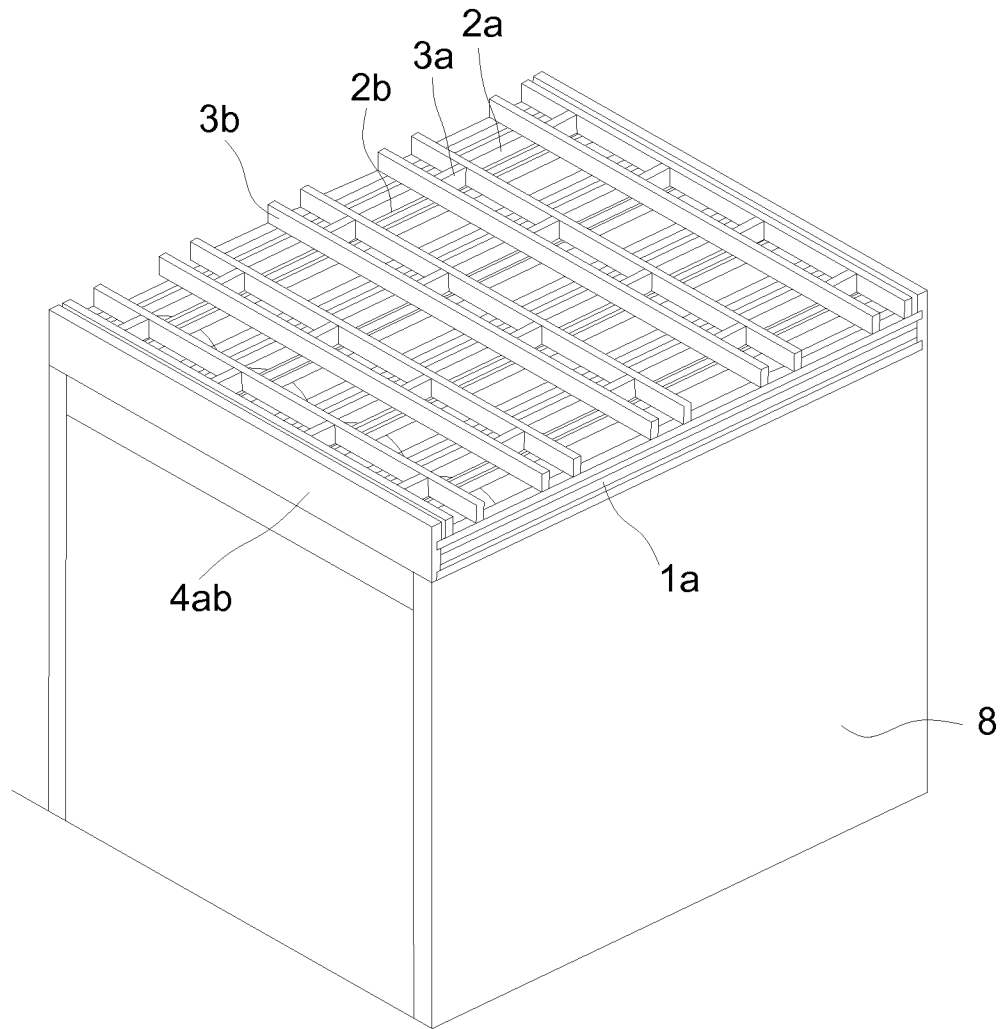


Figure 19

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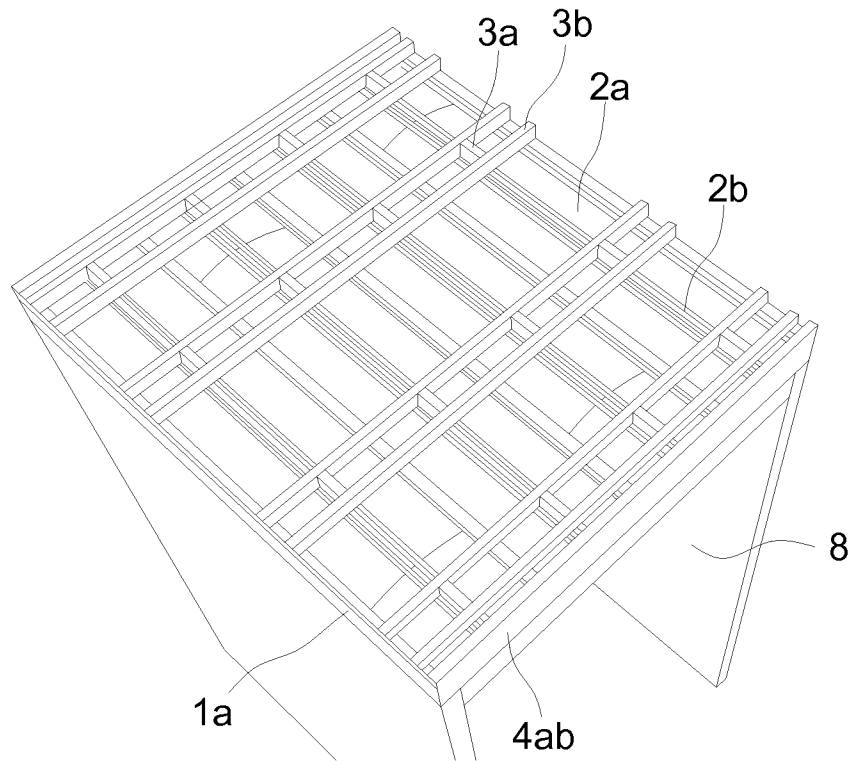


Figure 20

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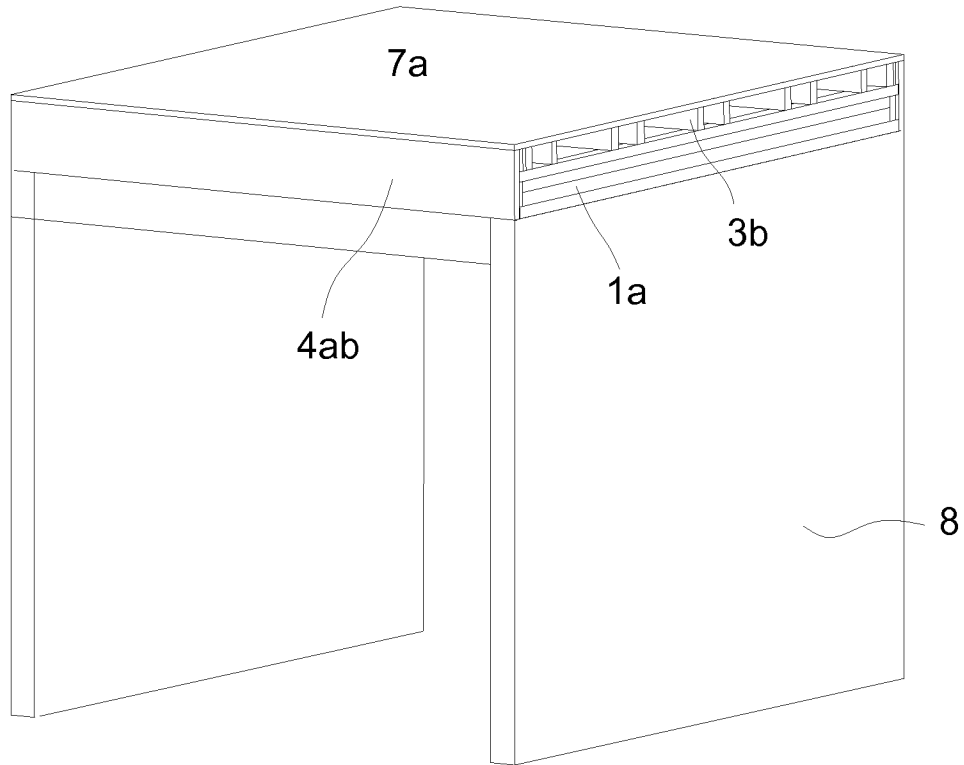


Figure 21

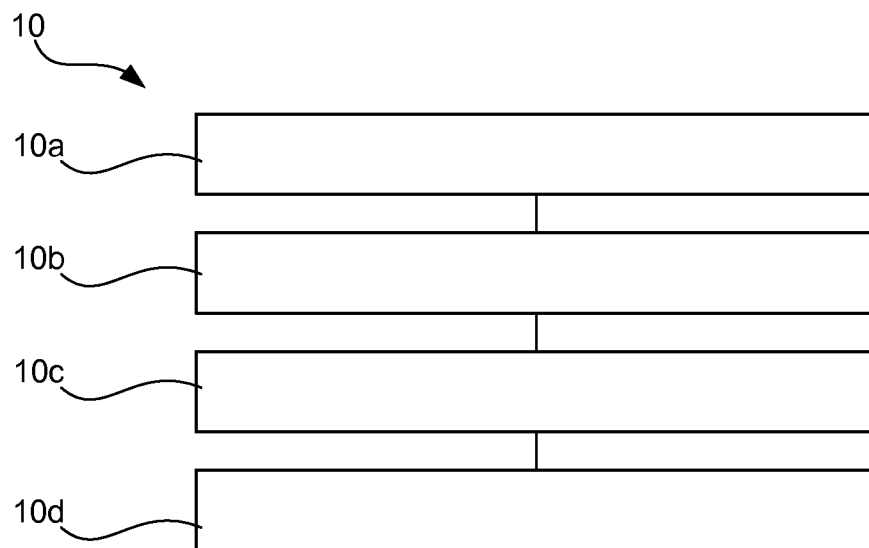


Figure 22

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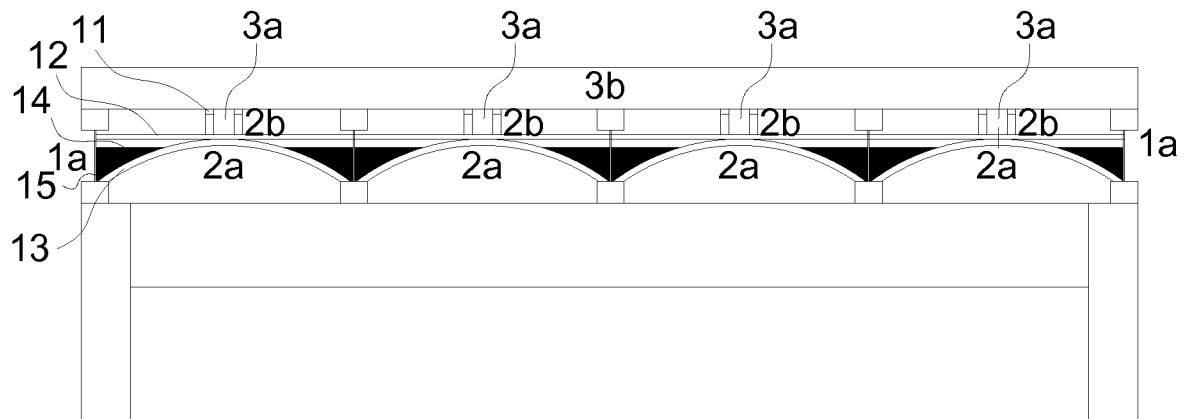


Figure 23

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2023/050055

A. CLASSIFICATION OF SUBJECT MATTER		
IPC: see extra sheet		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC: E04B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE, DK, FI, NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EPO-Internal, PAJ, WPI data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR 1199040 A (FABRICATION D ISOLANTS ET REVE), 10 December 1959 (1959-12-10); figures 1,2,4; machine translated description --	1-15
A	WO 03029574 A1 (DAMPA APS ET AL), 10 April 2003 (2003-04-10); abstract; all figures --	1-15
A	EP 0278448 A1 (GUTERMUTH PAUL SEN), 17 August 1988 (1988-08-17); abstract; all figures --	1-15
A	US 3080022 A (MOTE ROY F), 5 March 1963 (1963-03-05); figure 4 --	1-15
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents:		
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
"D" document cited by the applicant in the international application	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	
"E" earlier application or patent but published on or after the international filing date		
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed	"&" document member of the same patent family	
Date of the actual completion of the international search	Date of mailing of the international search report	
10-02-2023	10-02-2023	
Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Anders Toll Telephone No. + 46 8 782 28 00	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2023/050055

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4083153 A (SUMPTER GARY T), 11 April 1978 (1978-04-11); abstract; figure 1 --	1-15
A	US 2666233 A (KLEMM EDWIN O), 19 January 1954 (1954-01-19); figure 27 -- -----	1-15

Continuation of: second sheet

International Patent Classification (IPC)

E04B 9/06 (2006.01)

E04B 9/04 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2023/050055

FR	1199040 A	10/12/1959	NONE		
WO	03029574 A1	10/04/2003	CN	1561425 A	05/01/2005
			CN	100359112 C	02/01/2008
			EP	1438468 A1	21/07/2004
			GC	0000402 A	31/03/2007
			HK	1071411 A1	15/07/2005
			US	7428801 B2	30/09/2008
			US	20040244323 A1	09/12/2004
EP	0278448 A1	17/08/1988	AT	52824 T	15/06/1990
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US	4083153 A	11/04/1978	NONE		
US	2666233 A	19/01/1954	NONE		