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(54) CONNECTION SYSTEM FOR PRECAST REINFORCED CONCRETE PANELS

(57) The present invention is in the field of reinforced concrete structures, more particularly prefabricated indoor and outdoor structures comprising precast reinforced concrete panels, which may comprise also layers of thermal and/or acoustic insulation. The present invention discloses an innovative connection system of the panel layers through main and secondary interacting connections, to obtain precast reinforced concrete panels with insulating elements.

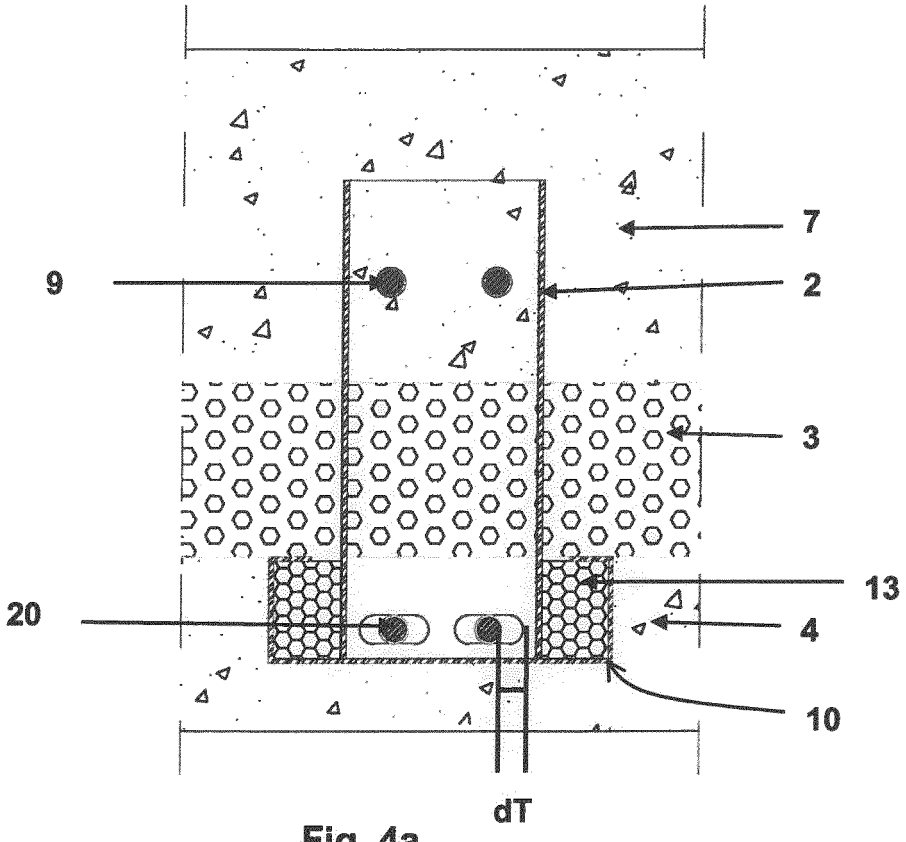

Fig. 4a

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Description

[0001] The present invention relates to the field of reinforced concrete constructions, more particularly precast indoor and outdoor structures comprising precast reinforced concrete panels. These structures, more particularly the most recent ones, may comprise layers of thermal and/or acoustic insulation.

[0002] Several manufacturing systems of said precast reinforced concrete panels are known, as well as a number of connection systems allowing the correct integration of all the elements of said precast structures in an effective, stable and durable way. A typical structure of these elements may for instance comprise at least two layers of reinforced concrete, possibly with interposed insulating material. In most occurrences the concrete layer of the inner side of the structure is load bearing, while the outer side, generally referred to as born layer, has a reduced thickness and merely architectural features. An example of common and cheap insulating material consists of polystyrene plates. The inner load bearing layer generally has a considerable thickness since, in addition to bearing the weight of the outer layer through the connections, it has to be anchored to the building structure and stand up to the actions caused by its own weight as well as wind, earthquake and other external factors. The load bearing layer may be entirely made of reinforced concrete or comprise other insulating materials used as lightening components.

[0003] These layers are connected each other by a number of connections passing through the insulating layer so as to keep the layers united. These connection elements are generally also adapted to take up loads and expansions that are differently developed between the panel layers, since they undergo thermal sudden changes on the outer side according to the seasons of the year and on the inner side according to the temperature inside the building. Therefore these connections are very important to warrant the general solidity of the panel as well as to avoid cracking and/or warping due to thermal gradients mainly acting on the outer layer of the panel.

[0004] In this technical field of the manufacture of precast reinforced concrete panels, there are several connection systems for said structures; for instance the persons skilled in this art know systems (hereinafter defined as type 1) comprising a limited number of load bearing connections subject to flexure, adapted to operate said main connections when the panel is vertically standing, while the stress following the operation of dismantling the panels from the formwork into which the concrete panels are cast, is taken up by secondary connections working only under traction. The load due to the weight of the external layer is almost entirely concentrated at the load bearing connections, which are generally of considerable size, thus being also the main heat bridge of the structure, with all the relevant drawbacks due to these heat bridges, well known to the persons skilled in this art. On the contrary the heat bridge due by the secondary connections is practically negligible.

[0005] Then there are systems, hereinafter defined as type 2 for simplicity, comprising use of one type only of connection undergoing both traction and flexure; this kind of systems allows distribution of all the stress to a plurality of connections, all being identical and arranged on the entire panel. Therefore each connection must support a portion of the load and acts as a heat bridge, that may be negligible if the connections are made of plastics or other synthetic material. However, the wrong arrangement even of only one connection with the corresponding loss of load bearing capacity, may jeopardize the holding capacity of the other connections in a critical way as they would be undersized for the additional load they are compelled to hold.

[0006] At last, for completeness of this illustration, there are systems (defined as type 3) comprising peripheral and transversal connections uniting continuously the concrete layers. Systems of this kind are generally comprising C-shaped plates or iron trestles, for instance made by welding longitudinal elements and connections binding the two concrete layers. The latter kind of connection is often mainly useful for structures where there is no load bearing layer separate from a born layer, but the panel is considered to be load bearing on its entire thickness. One of the main problems of these systems is that the thermal expansions are not taken up by any element and for this reason in such assembled products cracking and warping are more frequent, and they develop much higher heat bridges in comparison with those that may be developed in the two previously described types of systems.

[0007] In any case, each of said connection systems used in the manufacturing plants if said products, has generally the same function, that is to unite the various layers of the reinforced concrete panel in order to achieve a correct dismantling at the plant and then the best operation when installed. The manufacture of said panels takes place by layers in horizontal formworks, where the concrete is cast and the insulation is applied, the panels are removed from the forms after about 16-20 hours from casting and then stored in vertical curing racks where the process of concrete solidification of the panels is finished. Once the final strength is attained, said panels are carried to the yard and installed always in the vertical position relative to the ground. The rotation of 90 degrees from the lying position in the formwork to the standing storage position is the most critical phase for the panels, because at this stage their curing is not yet completed. Therefore it is apparent that the role played by the connections is crucial and fundamental for the correct curing and the best achievement of all the mechanical features required to obtain panels of good quality.

[0008] The connection elements are generally made, according to the system type, of raw, stainless, galvanized, mixed steel or other suitable materials, even of synthetic nature. The connections of the systems included in the above mentioned three main types mostly rep-

resentative of the state of art, may generally operate under traction, compression or flexure or operate under any kind of stress, so that it is clear that the production of connection systems is particularly important to achieve a good finished product.

[0009] Document US 3996713 discloses a connection device for prior art prefabricated panels comprising a tubular body 4 (shown in its figure 6) which is anchored to the inner and outer concrete layer of the panel by means of anchoring bars 11. However this device cannot support dimensional variations of said outer and inner layers due to thermal expansions, because the main function of the bars 11 is the concrete anchoring feature. Moreover this document discloses a system of secondary connections consisting of plates 8 (also anchored to concrete by proper bars) difficult to be installed during the panel manufacturing stage, because for a correct installation and in order not to damage their function, these bars must be held in a perfectly vertical position also for correctly piercing the overlying insulating layer, said condition being difficult to be obtained during the concrete casting operative stage.

[0010] A further prior art example for the identification of the object of the present invention is the system of connections for concrete panels disclosed in document EP 0905330 B1 comprising an insulating layer including also main connections and secondary connections. In this case the main connections are solid steel cylinders, dimensioned and configured to be self-anchoring in the two concrete layers; these cylinders are strong, but the drawback is that they require that the insulating layer at the place where said cylinder is disposed has a maximum thickness of 4 cm, so that it is necessary to provide for specific insulating layers for the subsequent housing of said main connection (while to meet the present requirements of energy saving for these panels it is necessary to have a minimum thickness of insulating material in the range of 5 - 6 cm); moreover one can easily recognize that at these points, very important heat bridges are generated, affecting the total thermal transmittance of the product. Moreover in order to distribute the stress in the inner layer for avoiding that it becomes critical, a frettage spring should always be coupled to the system.

[0011] Such an illustrative system provides for the insertion of support elements for said main connections only when the panel has considerable dimensions (generally more than 6 m long), thus requiring that the connections can withstand the thermal expansions of the outer layer; in this case said main connections are combined with guides comprising a C-bent plate filled with a suitable polyurethane foam, in order to make the support theoretically "slidable" relative to the outer layer of the product. However it was found that this guide often does not succeed to achieve this function, and having also several defects and problems of installation. Moreover pairing the guide to the cylinder involves loss of the loading capacity, because said cylinder is no more anchored in concrete at the panel outer side, and more particularly does not offer resistance against traction forces, like those generated during the dismantling operations, or once installed against the horizontal actions caused by wind or earthquake. Moreover, the secondary connections completing said systems are very complex, but this aspect will be discussed in detail in connection with the illustration of the drawings. In the light of what discussed an object of the present invention is to implement and describe a system of connections for prefabricated reinforced concrete panels, allowing to simplify the operations of manufacturing and installing said products, as it will be described more in detail hereinafter.

[0012] The system described in the present invention, with regard to its typology, may be compared to a system of the type identified in the foregoing as type 1 or a system of the discussed prior art, which in the opinion of men skilled in this art, would have better performances when applying the connection system of the present invention, in comparison with other general systems.

[0013] Thus an object of the present invention is a system of connection for prefabricated concrete panels, reducing the heat bridges as much as possible.

[0014] Another object of the present invention is a connection system increasing durability and structural strength with time of said connection and consequently of said panels, more particularly allowing the main connections to keep their full load bearing capacity, even when paired to devices for absorbing thermal expansions.

[0015] A further object of the present invention is the provision of a system allowing to reduce the manufacturing costs of the connections, and versatile to be assembled, thus being suitable for a number of constructional conditions.

[0016] Still another object of the present invention is the provision of a system of reliable and safe connections limiting installation failures and/or defects.

[0017] Therefore an additional object of the present invention is an innovative connection system provided with a relevant quick and easy assembling mode for said connections of the system to said panels.

[0018] The connection system of the present invention more particularly comprises main connections and secondary connections disposed along the periphery of said panel including reinforced concrete layers and layers of insulating material.

[0019] The connections have predetermined mutual distances projected to optimize mechanical strength to flexure and traction and reduce heat bridges to a minimum.

[0020] More particularly it was assessed that the materials used for said connections be very suitable for the best stress distribution, durability and reduction of heat bridges. Therefore the present invention will combine the known advantages of these materials with an innovative system of optimized connections solving the above mentioned technical problems. The development of the best form jointly with the most suitable material as well as the

method of manufacturing the finished panels provided with said connection system, is a part of the innovative nature of the present invention.

[0021] These and other objects are accomplished by the connection system of the present invention comprising said main connections which are advantageously carried out in a hollow form so as not to modify or undermine thickness and shape of the insulating layer and to reduce heat bridges to a minimum. Said connection system also comprises a device to take up expansions for example in the form of a sheet box to avoid a contact between concrete of the outer layer and the portion of the load bearing hollow body embedded in the outer layer, in order to accomplish the function of innovative absorber and preserve said hollow body from any stress due to external expansions, still keeping its load bearing capacity under traction and flexure.

[0022] In addition said absorber device comprises holes for the insertion of bars, preferably made of steel, generally used for reinforced concrete and suitable for the arrangement in the formwork and required to be constrained to the main connection. Said absorber advantageously includes also holes aligned with preferably hollow slots of said main connections, to allow a mutual motion due to concrete contraction/expansion between said absorber and the main connection, in order to avoid creation of further additional tensions in said main connection, due to thermal expansion of the reinforced concrete. This device has also other advantageous aspects that will be described hereinafter with reference to the accompanying drawings.

[0023] Moreover said connection system comprises also secondary connections, that are preferably smooth bar with a diameter chosen according to the need, bent and shaped to develop a sufficient bond to be anchored in the concrete layers. These secondary connections are made so as to be suitable for a quick and functional installation, said secondary connections being also advantageously carried out in such a way to be versatile for the best installation and structural yield according to the kind of panel, without needing any substitution or modification of the connections.

[0024] These and other advantages of the connection system for prefabricated concrete panels will be examined closely and better specified in the following description of some preferred embodiments of the invention, together with corresponding assembling and installation variations. These details and advantages are illustrated in the accompanying drawings, in which:

Figures 1 a and 1 b are sectional views of an example of prior art main connection;

Figure 2 is a sectional view of a preferred embodiment of the system of main connections according to the present invention;

Figure 3a shows an embodiment of the innovative absorber according to the present invention;

Figures 3b, 3c, 3d are different views of the assembly of main connection and absorber according to a preferred embodiment of the present invention;

Figures 4a and 4b are sectional views of the assembly of main connection and absorber in different operative stages;

Figures 5a and 5b show a prior art secondary connection;

Figure 6 shows an embodiment of the secondary connection according to the present invention, provided with innovative support elements for the installation in the stage of manufacturing the panel;

Figure 7 is a plan view of the final product assembly comprising the connection system according to the present invention.

[0025] With reference now to figures 1 a and 1 b, illustrating the most relevant prior art to be compared with the technical problems solved by the present invention, the system 1' of connection for structures of reinforced concrete with at least one insulating layer 3' comprises main connections 2', that in this case are solid steel cylinders 2', particularly with shaped base, for distributing the weight of the outer layer 4' of reinforced concrete and comprise a tapered head for anchorage in the load bearing inner layer 7' of reinforced concrete. These main connections 2', in order to be housed and disposed for the production, require a reduced maximum thickness R (variable in the range 1 - 4 cm) of the insulating layer 3', in comparison with the preceding thickness S of insulating layer (for the present requirements as an average greater than 5 cm). This requirement results to be very unfavorable because in the zone of reduced thickness R, a considerable heat bridge is generated between outer layer 4' and inner layer 7', as it is clear for a person skilled in the art, and this heat bridge obviously affects in still higher terms the total thermal transmittance of the product. It has further to be pointed out that the capacity load of the connection 2' depends on the reduced thickness R and decreases when such a reduced thickness R is greater, just in view of the self-anchoring nature of said connection 2'. A kind of main connection 2' of this type works under flexure and transfers the weight of the outer layer 4' to the inner loading layer 7'. The main connection 2' requires also the aid of a frettage spring 6' to warrant a distribution of the stress acting on the product, so as not to become critical for the strength of concrete in contact with said solid steel cylinders 2'. It is also to be noted that additional treatments are required to reduce the thickness of the insulating layer 3' from S to R, with consequent increase of cost and time and high precision required for making these zones with variable thickness R and for the following installation of the main connection element 2'.

[0026] As further illustrated in figure 1b, when the dimensions of the product are considerable, that is for instance they exceed a length of 6 m, it is additionally necessary that said main connections 2' are able to respond to the thermal expansions of the outer layer 4' of the

panel; to this purpose a sliding support or guide 10' is coupled, consisting of a suitably C-shaped plate including a filling of polyurethane foam which, according to the prior art statement, should make said connection 2' in a sense "sliding" relative to the guide 10' and the outer layer 4' which is notoriously subject to a temperature gradient (delta). It is to be verified that this indeed does not occur, because said guide 10' is open on three sides namely, with reference to the horizontal plane of lying formwork for casting the panel, the upper side (in contact with the insulating material) and the two side shorter ends, and a technician skilled in this field may deduce that, more particularly when casting the concrete of the outer layer 4' occurring in a vertical direction (relative to the horizontal plane of the lying formwork), it is very likely and it was verified that the foam contained therein is undermined laterally and comes out from the two side shorter ends of the guide 10', or in any case a portion of concrete slips between foam and connection 2' already when casting the panel, thus requiring additional measures to solve the problem such as for instance taping of guide 10' to close the upper open side, in order not to frustrate the operation of the sliding connection 2'.

[0027] In the same way the guide 10' and the base of cylinder 2' are not integral, and indeed guide 10' is positioned with the aid of two reinforcement bars (not shown) passing through dedicated holes made in the vertical sides of said guide 10'. Then warranting anchorage of guide 10' in the outer layer 4'. On the contrary the main connection 2' is disposed free inside said guide 10'; it was verified that the component of the traction load is distributed on the guide 10', which is made of metal sheet, a structurally weak material. This technical gap affects also the turnover of 90 degrees of the formwork during the panel dismantling stage, as it might involve removal of the main connection 2' from said guide 10' if said guide would undergo an excessive stress of traction load.

[0028] The connection system according to the present invention comprises one or more main connections 1 and a plurality of secondary connections 30.

[0029] The one or more main connections 1 in turn comprise a hollow body 2 preferably made of steel. The hollow body 2 of the main connection 1, in a preferred embodiment of the connection system of the present invention, has a square cross-section and is provided with holes 12 and slots 11 for insertion of the anchorage bars 9 and 20 (shown in the following figures of the drawings).

[0030] The hollow section of said hollow body 2 allows to cause said main connections 1 to work without needing variations of thickness in the insulating layer 3; in this way it is at once clear that the heat bridges are reduced, to the advantage of the thermal transmittance of the product.

[0031] Moreover, these panels do not require special treatments and consequently additional cost and time for their adjustments, and positioning of said innovative main connections 1 does not require dedicated zones especially prepared for their insertion, but they can be freely positioned according to the requirements, to the advantage of convenience and practicality of machining and manufacturing the product.

[0032] The hollow body 2 is also designed to be sufficient for distributing the pressure of contact between iron and concrete, in both the inner layer 7 and the outer layer 4 as illustrated in the drawings.

[0033] As better illustrated in figure 3a and more particularly in the projection of figure 3b, side view of figure 3c and plan view of figure 3d, the main connection 1 advantageously comprises an innovative expansion absorber 10. This innovative expansion absorber 10 is preferably carried out, like in the here described preferred embodiment, in the form of a box for instance of sheet, closed on all sides excepting the upper side 10a, where the hollow body 2 is inserted. The expansion absorber 10 is provided with holes 10b on the two vertical long sides for inserting anchorage bars 20, to be used for positioning the connection in the formwork and the subsequent anchorage in the outer layer 4. Said expansion absorber 10 avoids that the thermal expansions of the concrete outer layer 4 cause the formation of cracking and warping in the panel once installed. Indeed said expansion absorber 10 is totally positioned (as clearly seen in the assembled view of figure 3b) between the hollow body 2 and the concrete outer layer 4 which is the most subject to expansions, thus warranting that there is no contact between hollow body 2 and outer layer 4 and allowing a free expansion of the latter. Said holes 10b of the absorber are aligned with the slots 11 of hollow body 2, in order to allow a mutual motion between the hollow body 2 and the expansion absorber 10, thus avoiding formation of additional tensions on said hollow body 2, without impairing its load bearing capacity. At last in the cavities 10c generated between the inner surfaces of said expansion absorber 10 and the hollow body 2, a filling 13 for instance of low density polystyrene is previously inserted. Such a material produces advantageously a double positive effect, that is firstly the presence and the size of the two polystyrene elements 13 warrants the alignment between holes 10b and slots 11 after insertion of hollow body 2 in the expansion absorber 10, and secondly since such a material is compressible, in case of expansions the polystyrene elements 13 will be compressed on the side of the hollow body 2, so that this body will not undergo any additional stress. Moreover, the inner sides of said expansion absorber 10 in contact with the sides of the hollow body 2, in a preferred variation may be coated with Teflon® or other similar material, so as to reduce to a minimum the friction between two steel members (when both hollow body and expansion absorber are made of steel), thus making still easier the free expansion of the outer layer 4. In this way, with the free expansion of the outer layer 4, cracking of the layer and panel warping are avoided.

[0034] From the operative point of view, in a preferred embodiment, said expansion absorber 10 may be supplied already provided with the polystyrene filling 13, so

that on installation said hollow body 2 is inserted in said expansion absorber 10 and anchorage bars 20 are inserted in the holes of the expansion absorber 10 and consequently in the slots of said hollow body 2.

[0035] The anchorage bars 20 consist for example of two iron rods of diameter 8 mm and length 40 cm passing through holed 10b and slots 11 and keep united the hollow body and the expansion absorber, because once the bars 20 are inserted it is no more possible to pull the hollow body 2 out from the expansion absorber10, and there will be only a horizontal play between the two elements, useful in case of expansions.

[0036] In this way an assembly comprising hollow body 2 and expansion absorber 10 is created, having also a good tensile strength, avoiding any possible problem of removal of hollow body 2 from absorber 10.

[0037] Said bars 20, which may be for instance iron rods with improved bond, initially used for positioning the hollow body 2, once the concrete has been cast, allow anchorage of the hollow body 2 in the outer layer 4 of reinforced concrete even in absence of the expansion absorber 10 (this is the case for panels of little size). More particularly, for a correct positioning of said hollow body 2 in the concrete outer layer 4, said bars 20 are inserted into slots 11. Then in a subsequent stage of production, bars 9 are then inserted into holes 21 of hollow body 2, to obtain anchorage of said hollow body 2 in the concrete inner layer 7.

[0038] Figure 3d is a plan view of said assembly, with the hollow body 2 disposed in said expansion absorber 10 comprising said filling for instance of polystyrene foam 13.

[0039] Figures 4a and 4b are sectional views of said main connection 1 comprising said hollow body 2 and said expansion absorber 10 in the installation stage. In figure 4a one can see the maximum dT admissible in case of expansions of the concrete outer layer 4, between one of the bars 20 passing through holes 10b of the expansion absorber 10 and the relevant slot 11 of hollow body.

[0040] In figure 4b one can see the same system comprising the same members shown in figure 4a, but the detailed sectional view shows said expansion absorber 10 in the position of maximum expansion (residual dT = 0), since the outer layer 4 in this case has been expanded.

[0041] Furthermore, said innovative connection system for reinforced concrete panels comprises, in addition to the main connections 1, the afore mentioned secondary connections; for sake of completeness, figures 5a and 5b show the corresponding example of prior art applied to the system 1' described in figure 1. In Figure 5a one can see the prior art secondary connection 30' comprising a braid of steel wires bent back with a splice forming an eyelet to obtain the anchorage in the concrete inner layer 7', see figure 5b. This secondary connection is introduced into the insulating layer 3' through a small plastic tube 31' provided with a cut end to make an easy insertion while the other end has a round retainer to adjust the embedding depth in the outer concrete layer 4'. This kind of secondary connection 30' should be inserted only after the insulating layer 3' was disposed on the outer concrete layer 4' and at the same time should be prepared by cutting to size a cylindrical polystyrene spacer 32' that will partially cover the small tube 31' as a function of the thickness of the insulating layer 3'; these connections 30' for instance always require that a specific condition is met, like insulating thickness 3' + spacer thickness 32' = 10 cm. Said secondary connection 30' therefore can be disposed in a vertical position, after the preparation stage comprising the following steps: manual fraying the two braids outgoing from the small tube, then acting on the eyelet, withdrawing the steel rope so as to cause the small tube 31' to pierce the insulating material, and after piercing it the rope is squeezed so that the eyelet splice hits the upper end of small tube 31' and the previously frayed wires of said secondary connection 30' can come out and be anchored in the previously cast outer concrete layer 4'. It is clear for a man skilled in this art that said secondary connection 30', besides being expensive and very laborious to be prepared, is not at all easy to be installed. Moreover, there is no warranty of the correct positioning as to alignment suitable for the best performance of said secondary connections 30', since in this case the process is extremely operator dependent.

[0042] In order to make the process of installing said secondary connections more immediate, simpler and performing, and to provide a more reasonable product which is also more versatile and easier to be used, in figures 6 and 7 a preferred embodiment of innovative secondary connections 30 included in the connection system according to the present invention is described. Figure 6 shows said secondary connection 30, which in this preferred embodiment consists of a stainless steel bar of reduced diameter d, e.g. of 4 mm, preferably L-bent, having a vertical end of length X, knurled to increase adhesion to concrete of the inner layer 7, warranting anchorage of the secondary connection 30 in the concrete layer. Said secondary or peripheral connections 30 are partially embedded in said outer layer 4, and indeed they are generally bound individually to the reinforcement of the outer layer 4 of the panel; in order to make this operation easier and faster, an innovative plastic spacer 34 was designed, molded and provided with at least two fasteners 25 also referred to as clips, just to fix said secondary connections 30 on said innovative spacer 34,which is suitable to keep said connections 30,which will be fixed in pairs on said spacer through said clips 35, at a pitch b required by the installation. Moreover in this way said secondary connections 30 are resting on the reinforcement in a stable way. This assembly of spacer 34 and clips 35, especially designed for the innovative secondary connections 30 of the present invention, allows to install simultaneously more secondary connections 30, avoiding any welding step, holding each secondary connection precisely at the desired pitch and in

a perfect vertical position, thus allowing also an easier laying of the insulating layer 3. Clearly materials, length and diameter of clips, spacers and secondary connections as well, will be decided and implemented according to the technical requirement of each specific occurrence. This system comprising said secondary connections, spacers and clips is very advantageous, also in view of the fact that it may be installed before laying the insulating layer and/or even before casting the outer concrete layer, thus with a great simplicity and versatility of installation, as well as with warranty of a correct anchorage and of a correct work when the connection is completed. This makes a great difference from the prior art secondary connections 30', which can be installed only after casting the outer concrete layer and laying the insulating material, thus being dependent from the setting time of the outer concrete layer 4'.

[0043] Moreover, the insertion of the secondary connection 30 in the clip 35 occurs quickly, for instance by the insertion of the short side of connection 30 in the special eyelet 36 having a suitable shape, and rotation with clamping of the long side of the connection 30 in said clip 35. At last, the absence of welding steps (which are common particularly in the afore described systems of type 3) besides a considerable time saving, ensures the absence of possible consequences on the intrinsic characteristics of steel and improves durability of the secondary connections 30 in respect of corrosion.

[0044] It is to be noted that said secondary connections 30 with an advantageous L-shape, are anchored in the concrete inner layer 7 and outer layer 4, and each connection passes through the insulating layer 3 at one point only, thus making positioning of said secondary connections very easy, performing and quick, more particularly with regard to laying the insulating material, and moreover the heat bridge of each single connection 30 is negligible.

[0045] Finally figure 7 shows a sectioned plan view of a reinforced concrete panel with insulating material, which is provided with the innovative connection system described in the present invention. It has to be pointed out that a very advantageous aspect of the system according to the present invention is also the manufacturing method which, together with the innovative devices comprised in the connection system according to the present invention, make the assembly of this product versatile as well as quicker and more accurate achieving a better final result.

[0046] This system, unlike all the other systems of type 1, as above classified for a better description, is also suitable for its installation at a stage immediately following casting of the outer concrete layer 4 and its compaction by vibration. Indeed when casting is ended, one may take the hollow bodies 2 provided with the proper bars 20 and possibly assembled with the expansion absorber 10 and spacers 34 with relevant prearranged secondary connections 30, and embed the whole in the vertical position, being ensured that the embedded condition will be sufficient for a correct and sure positioning, because the still green outer concrete layer does not hinder insertion and anchorage of the hollow bodies 2, also because the embedding operation is a standard routine, as it stops at the position of a reinforcement net already prearranged at half the thickness of the outer concrete layer 4.

[0047] This double timing possibility for the insertion of the main and secondary connections is also definitely advantageous both as to flexibility and versatility of use and as a function of operative freedom for production requirements and preferences.

[0048] In a particularly preferred embodiment of the connection system according to the present invention, insertion of the secondary connections 30 occurs only close to the periphery of the panel, as shown in figure 7, and possible openings for instance for doors and windows. This makes the entire manufacturing process still easier, with relevant reduction of time and cost. Again for completeness of description, figure 7 shows an embodiment of prefabricated panel comprising also lightening portions 25 in the inner concrete layer 7, just provided for lightening the entire prefabricated panel.

[0049] The foregoing illustrates only some possible embodiments of the connection system for precast reinforced concrete panels provided with insulating material described in the present invention, and it has to be noted that any variation concerning materials, material alloys useful for this purpose, variations of shape, dimensions or diameter of the main connection, as well as like variations of the absorbers, or the insulating material contained therein, may be modified or altered for the object of the present invention, as well as embodiments of said secondary connections and related spacers and clips, while these two last mentioned elements may even be omitted in some embodiments of said connection systems, or made integral, and finally even the assembling methods may be changed, still falling however in the protection scope as defined in the present invention and in the appended claims.

Claims

1. A connection system (1,30), for precast reinforced concrete panels having at least an inner layer (7), and intermediate insulation layer (3) and an outer layer (4), comprising at least one main connection (1), and a plurality of secondary connections (30) for manufacturing and assembling said panels, **characterized in that** said main connections (1) comprise a hollow body (2) provided with slots (11) and holes (21) for housing anchorage bars (9, 20) for positioning and anchoring said hollow body (2) in the concrete inner layer (7) and outer layer (4) in the panel production stage, further comprising an expansion absorber (10) open only at one upper side (10a) and configured to partially house one of the two ends of said hollow body (2), so as to allow take up of the

additional stress on said hollow body (2) caused by thermal expansion of the outer concrete layer (4) once the panel is installed, said secondary connections (30) being shaped as bars of diameter (d) with at least a knurled end (x) for anchorage in the inner layer (7) of said precast concrete panel.

2. The connection system (1, 30) according to claim 1, wherein said hollow body (2) is substantially rectangular, and said expansion absorber (10) comprises holes (10b) aligned with slots (11) of said hollow body (2) for the insertion of bars (20) passing from said hollow body (2) to said outer layer (4) and anchorage bars (9) passing between said inner layer (7) and said hollow body (2), for anchoring the hollow body (2) to said inner layer (7) and outer layer (4) in the panel production stage.

3. The connection system (1,30) according to claim 1, wherein said expansion absorber (10) comprises insulating material (13) inserted in said expansion absorber (10) until it rests on the opposite sides of an end of said hollow body (2), to prevent the formation of cavities between said expansion absorber (10) and said hollow body (2), for preventing any contact between the outer layer (4) and said hollow body (2).

4. The connection system (1,30) according to claim 3, wherein said expansion absorber (10) after insertion of bars (20) is integrally connected with said hollow body (2) and surrounds said hollow body on all sides except the upper side (10a) for the insertion of said hollow body (2) in said expansion absorber (10).

5. The connection system (1,30) according to claim 1, wherein said secondary connections (30) comprise one or more knurled parts for the anchorage of said connections (30) in said reinforced concrete inner layer (7).

6. The connection system (1,30) according to claim 1, wherein said secondary connections (30) in the manufacturing stage are disposed through spacers (34) adapted to be coupled to at least one pair of secondary connections (30) to keep said secondary connections (30) at a given predetermined distance (b) from each other.

7. The connection system (1,30) according to claim 6, wherein said secondary connections (30) are connected to said spacers (34) by means of clips (35) for the insertion of more secondary connections on one same spacer device (34).

8. The connection system (1,30) according to claim 3, wherein said secondary connections (30) are partially embedded in said outer concrete layer (4), having been fixed individually.

9. The connection system (1, 30) according to any preceding claim, wherein said secondary connections (30) are inserted in said outer layer (4) at any stage of the panel production, indifferently either before or after laying the insulation layer (3).

10. The connection system (1, 30) according to any preceding claim, wherein each of said secondary connections (30) passes through the insulation layer (3) at one single point, generating a single thermal bridge through a single circular surface of reduced size.

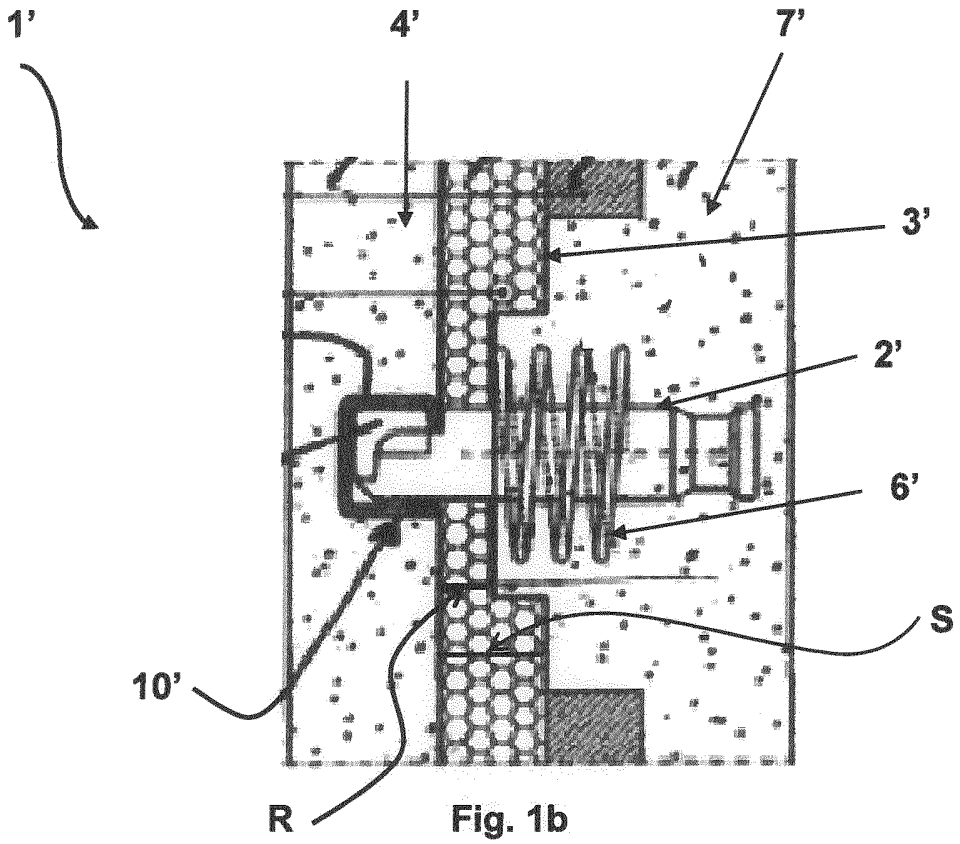

Fig. 1b

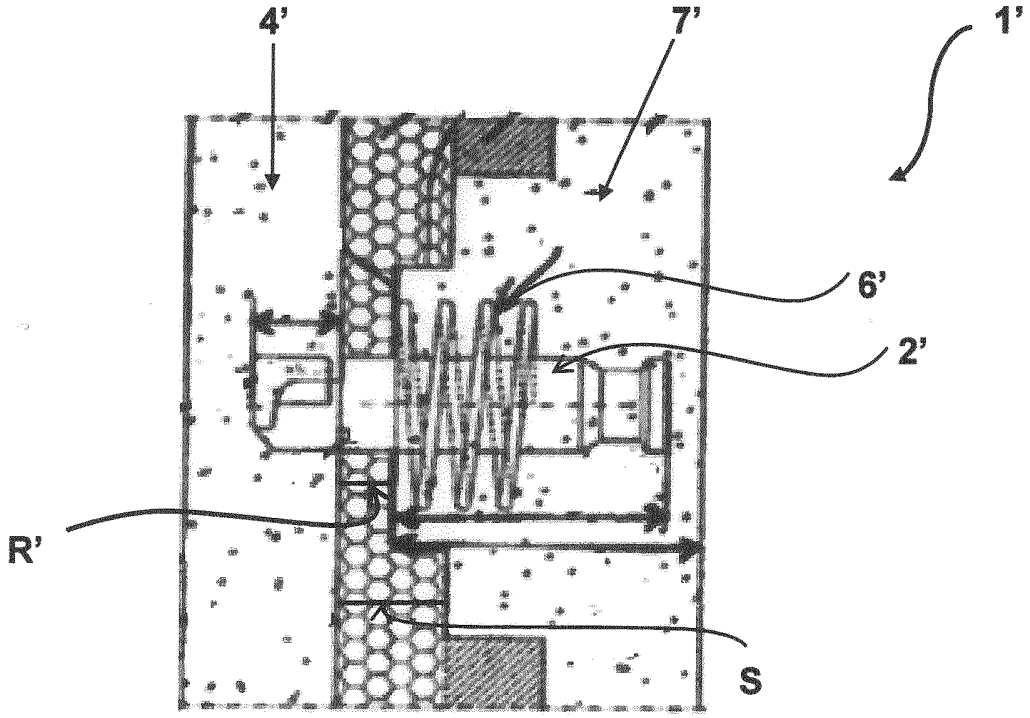

Fig. 1a

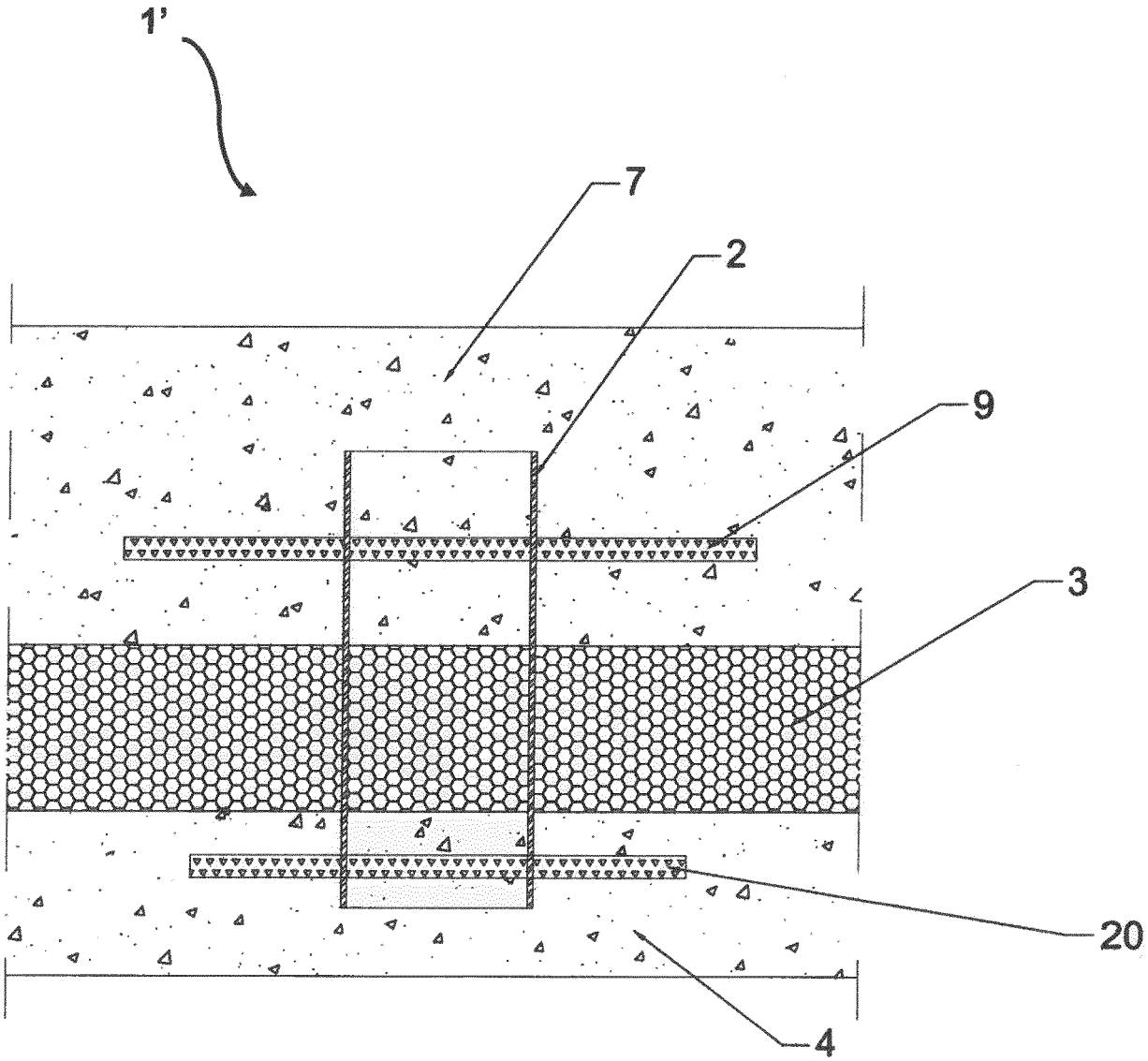

Fig. 2

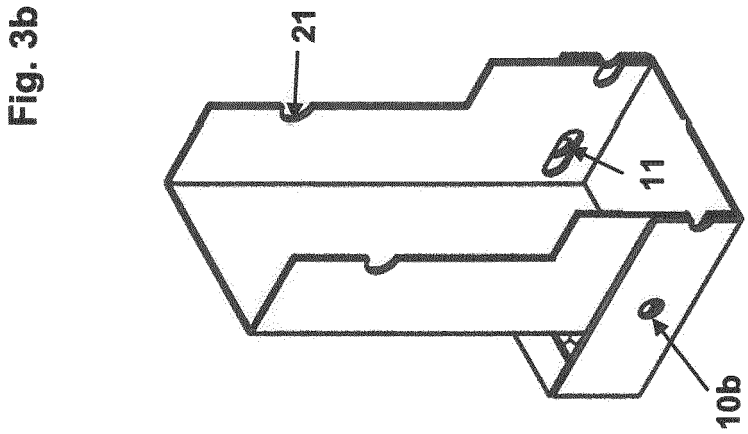

Fig. 3b

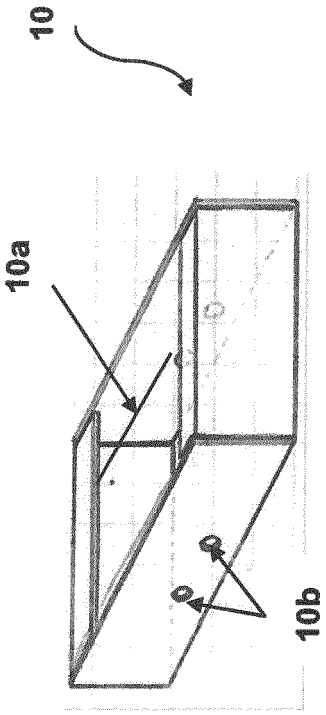

Fig. 3a

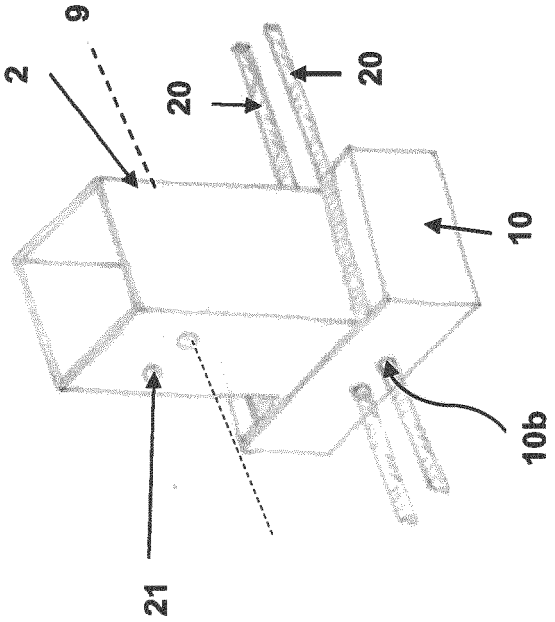

Fig. 3c

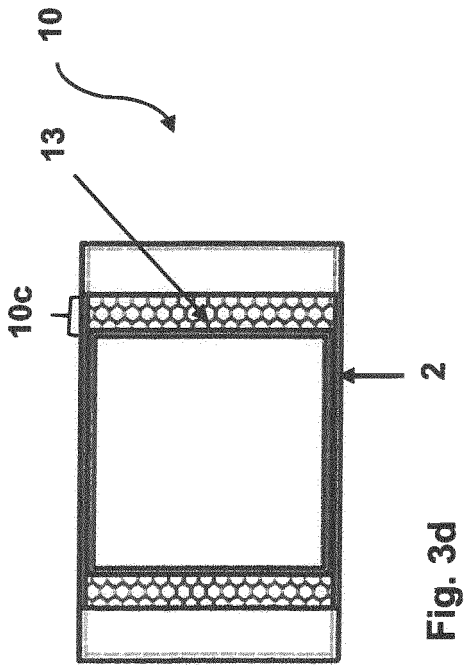

Fig. 3d

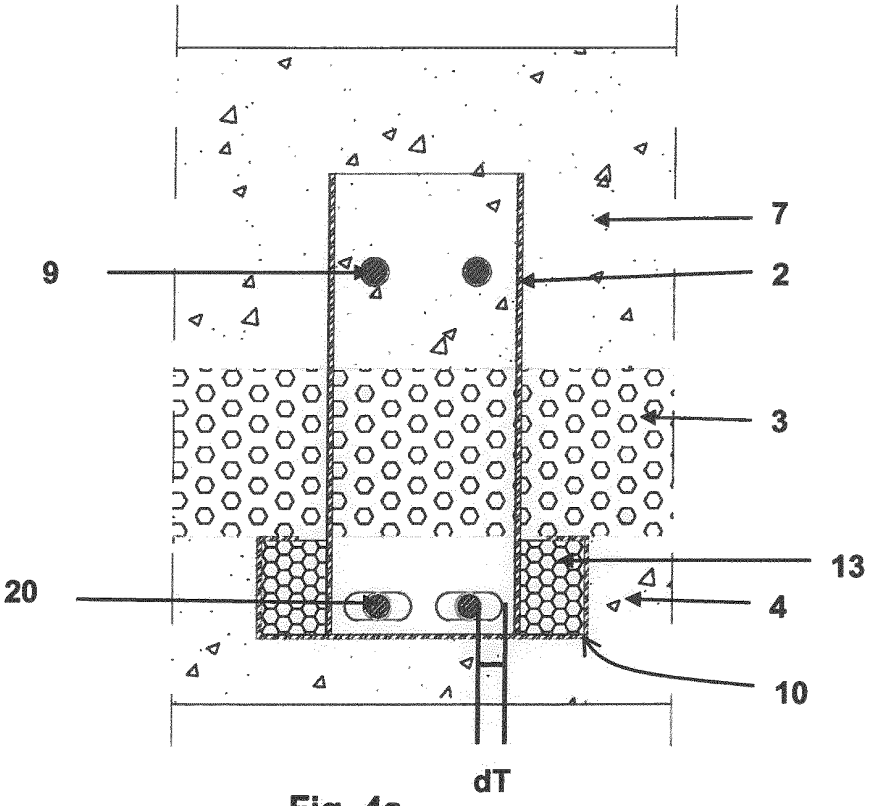

Fig. 4a

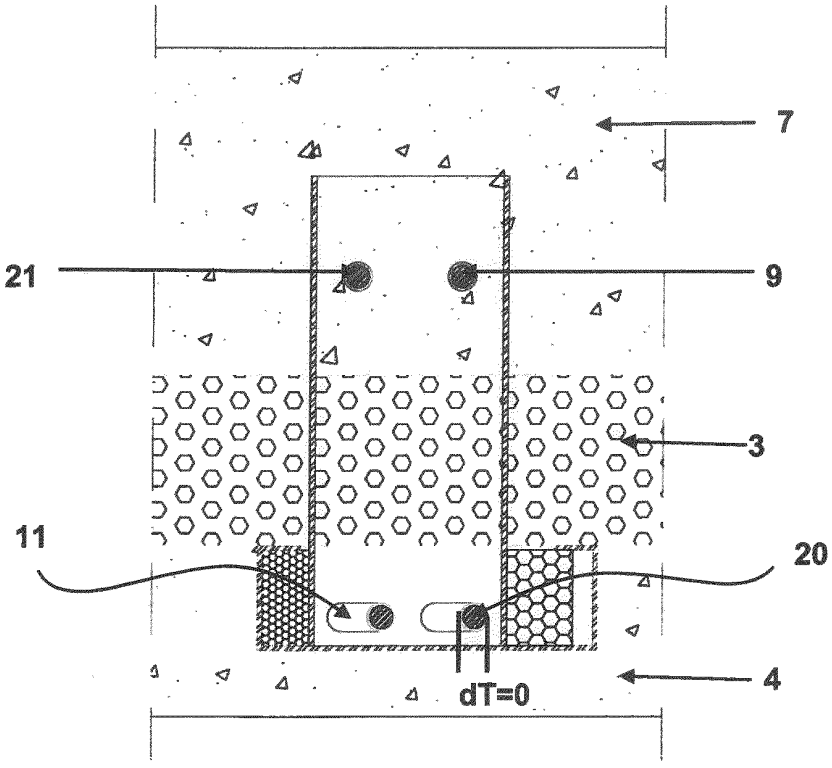

Fig. 4b

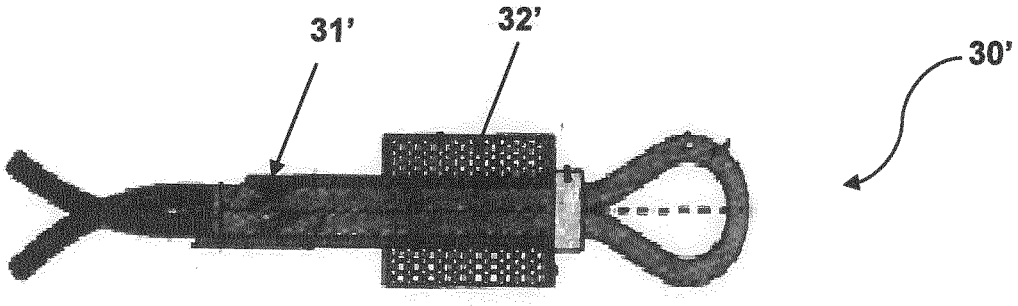

Fig. 5a

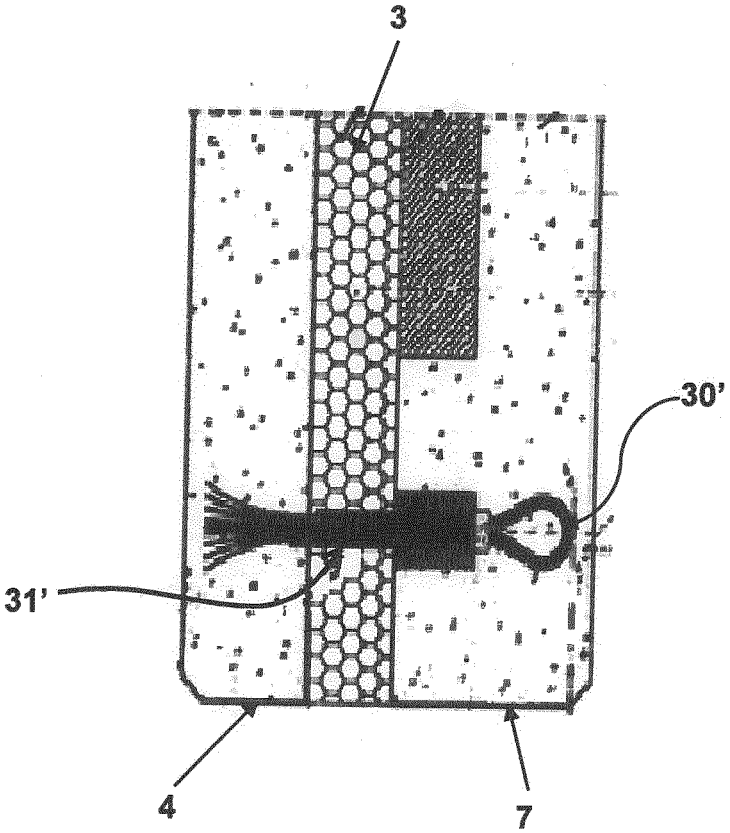

Fig. 5b

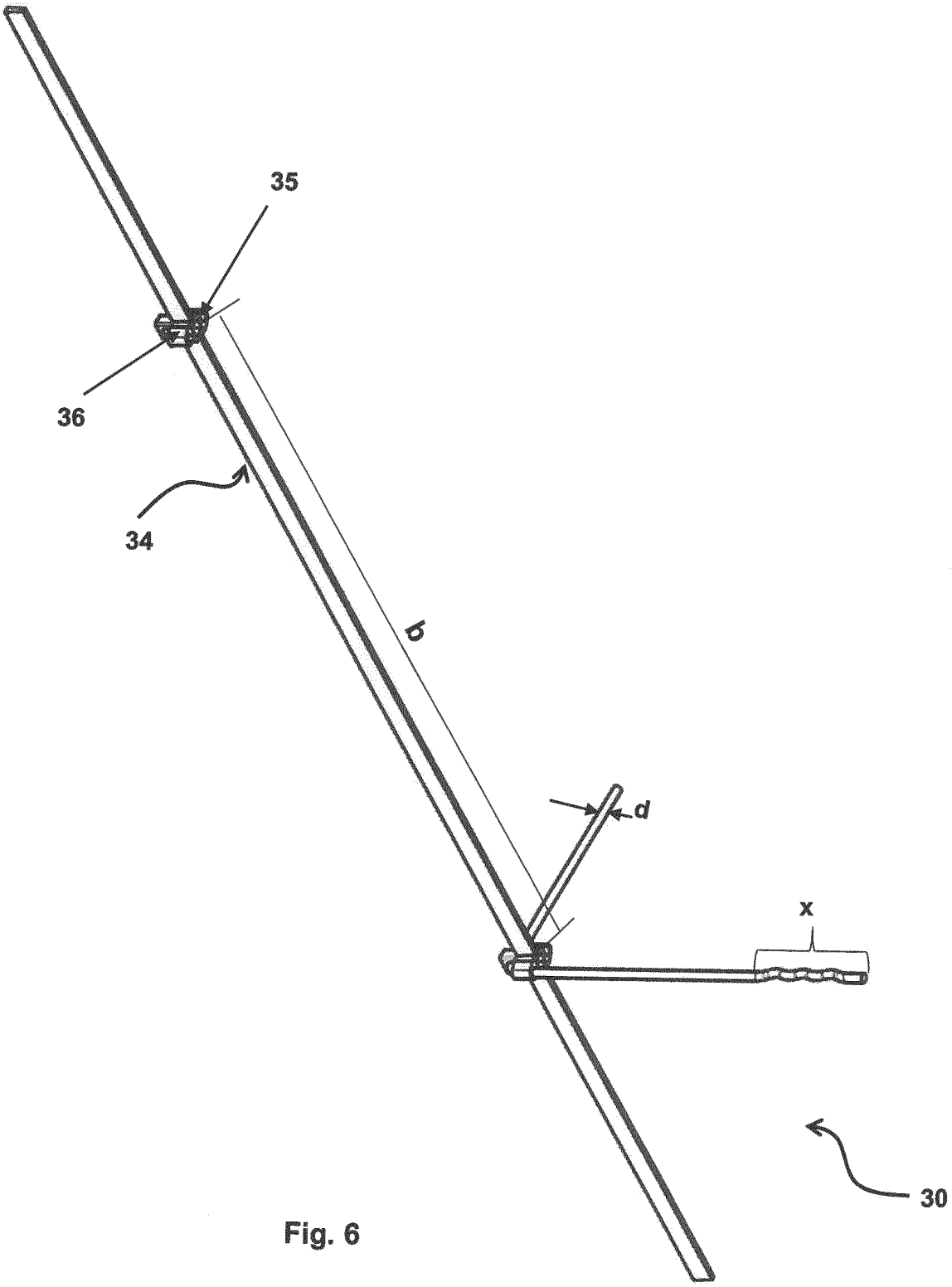

Fig. 6

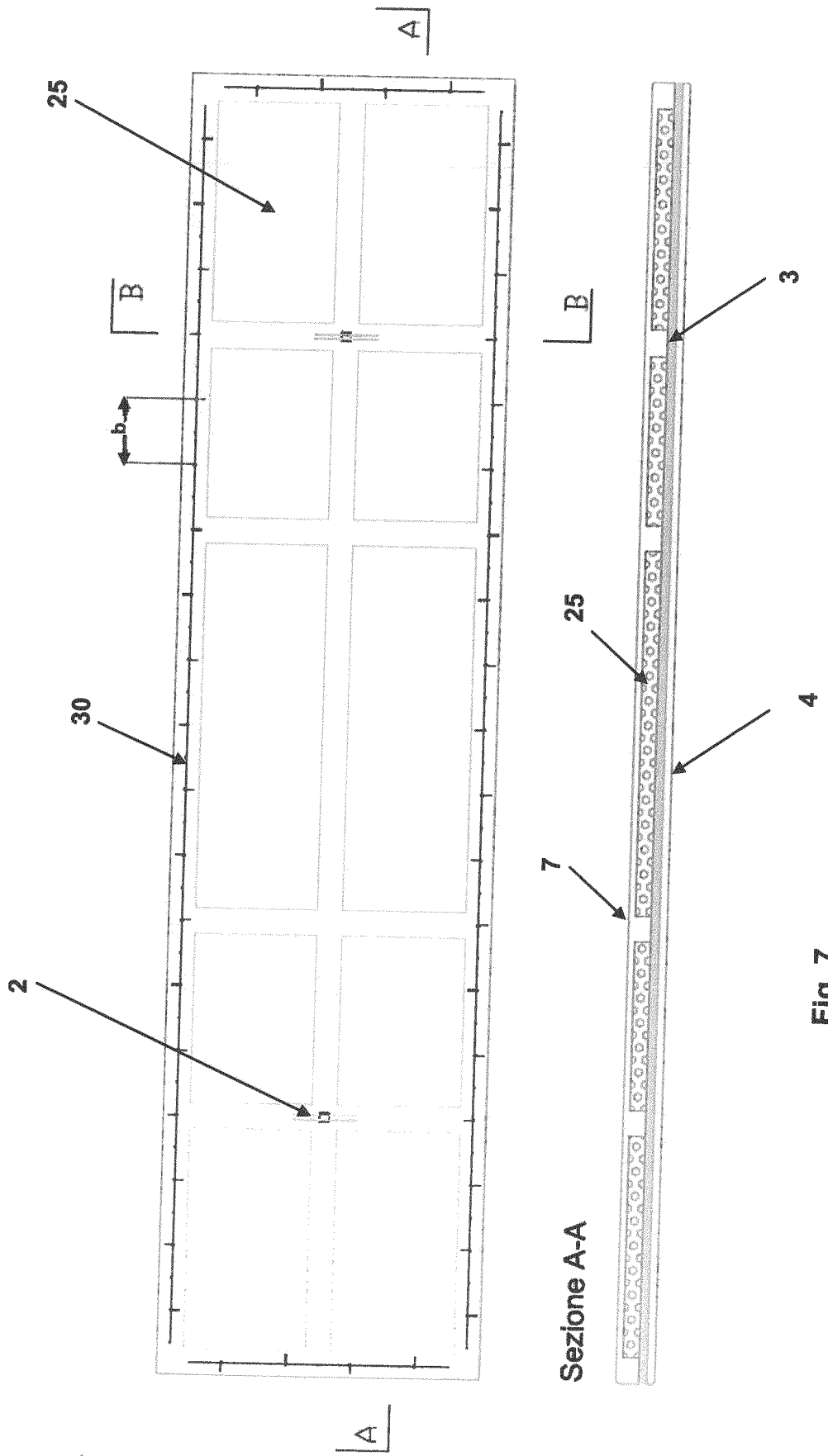

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 16 07 5010

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 3 996 713 A (HAEUSSLER ERNST) 14 December 1976 (1976-12-14) * figures 1,6 * * column 1, line 6 - line 10 * * column 1, line 52 - line 58 * -----	1-10	INV. E04C2/04
X	US 4 394 201 A (HAEUSSLER ERNST [DE]) 19 July 1983 (1983-07-19)	1	
A	* figures 1,3 * * column 1, line 9 - line 18 * * column 5, line 14 - line 19 * -----	2-10	

TECHNICAL FIELDS SEARCHED (IPC)
E04C E04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 August 2016	Petrinja, Etiel

CATEGORY OF CITED DOCUMENTS

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17-08-2016

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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