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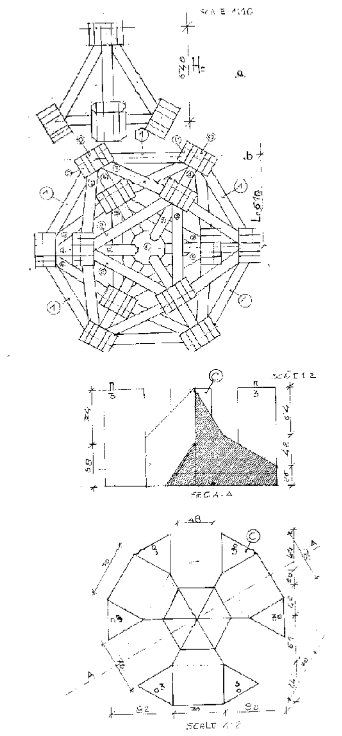
(54) Title: RETICULAR STRUCTURE



(57) Abstract: The Tetric Module is made up of wooden rods and knots. The appropriate shaping of the rods at the head and tail, with cuts at 30 ° and 60 °, makes it possible to create load-bearing structures of any shape (flat walls, however inclined, curves, frame / bridge structures, multiline structures with curved and straight sections, etc..) composing rods of a single shape and size. The versatility of this new structural tool is concentrated in the shape and function of the wooden knot, where up to (12) rods can be connected: it works in morza, then adds wood around the rods that it tightens without the need for bolting and / or nailing them, preserving its integrity and resistance. The wooden knot consists of two overlapping parts, suitably shaped with suitable bevels to fit the aforementioned rods, while the tightening effect is entrusted to steel "Barilotto and Tie" joints placed in its perimeter (18) per knot up to (12) rods and (12) per node up to (6) rods) with vertical and horizontal movement to the axis of the node. The structures thus created: are completely demountable, therefore they benefit from the possibility of using the temporary and mobile structures; they are perfectly anti-seismic; fully recoverable; offer the possibility (when buffered in the external perimeters) to use the confined air for energy uses and for the air conditioning of the delimited areas. The constructions made in this way are effective in all cases of emergency - even in extreme places - and not, for housing, congress, sporting, educational-cultural, exhibition, recreational and tourist purposes. For this "Tetric Module" is in accordance with points 3,7,9,10,11 and (13) of the 2030 Agenda.

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RETICULAR STRUCTURE

1.3 DESCRIPTION of the invention with TITLE: "Tetric module: holistic way of overcoming the emergencies (and not) induced by climate change", in the name of Anna Poggiani resident in Chiusi (SI) Via Montegrappa n 152, of Italian nationality. presented on 29/10/2019 with the number 102019000020014 ".

Field of technique:

Structural. Space reticular structures. Temporary and mobile architecture and buildings. Material: wood.

Purpose:

Manage housing emergencies (also within prison communities or similar) with innovative self-built structures. Overcoming the time limits, in civil emergencies (floods, earthquakes and other disasters), induced by the need to prepare adequate urban works for the supply of water, electricity and gas and for the disposal of waste water, offering comfortable housing solutions already in the first 24 hours from the manifestation of the emergency-necessity. Offer reception capacity to integrate the agricultural income of agricultural entrepreneurs or direct growers, even in areas with environmental restrictions, ensuring the perfect removal of the structures placed in place for short or very short periods (for some areas - less delicate - up to 2 years; for over 6 months and for some, with particular naturalistic emergencies, even 20 - 30 days only), without leaving any residual works in the area. These structures can also be used in campsites already set up for this accommodation by diversifying their reception, always on a temporary and / or transitory basis. But also for the temporary construction of sports infrastructures or secondary accommodation, as for any other use that involves rapidity of implementation, self-sufficiency and the ability to remove without any territorial and urban change. Offer hygienic and comfortable housing possibilities in extreme areas such as high mountain areas, deserts, steppes and areas of war.

The state of the art:

Lattice structures for buildings have been known since ancient times. In brief, reference should be made to the wooden buildings buffered in masonry of the ancient medieval cities.

In the modern era (second half of the nineteenth century) we have all the experiences, including calculation, of steel trusses for railway construction of bridges and shelters, without neglecting the Eiffel Tower. In fact, the triangle is geometrically defined to be a non-deformable shape.

The oldest wooden reticular structure is the truss, already used in basilicas in Roman times.

In recent times (20-30 years) there has been greater attention to the development of wooden structures, including reticular beams (previously unjustly considered useful only for industrial and production structures), including for civil construction, in especially for covering large areas (gyms, covered squares, etc.).

In self-construction there are geodesic domes, in wood, but which make up a spherical surface, with important restrictions of use (see height at the kidneys) and in any case little practical use in the creation of comfortable living areas due to the limitations in the external coating.

In reality, the tetric module was born precisely in trying to overcome these usage constraints.

The modern "VESTRUT System" in steel, could probably resemble the tetric module, but the differences are substantial (for material, shape, functioning of the node and consequent static model of calculation / structural verification) for which the tetric module is an innovative invention .

Description:

TAB.N.1 - Orthogonal projection of composition of the elements of the tetric module (wooden rods and knots): elevation of the tetrahedron; plan of the icosahedron. Claimed

TAV.N.2 - Auction with detail of the cuts at the ends. Claimed

TAB.N.3 - Orthogonal projection of element C for structural node: section and upper plan

TAB.N.4 - Orthogonal projection of element C for structural node: elevation and lower planimetry

TAB.N.5 - Isometric axonometry of element C for structural node: view from above

TAV.N.6 - Isometric axonometry of element C and A for structural node: detail of the central notch B of element C

TAB.N.7 - Isometric axonometry of the composition of 6 rods in element C of the structural node

TAB.N.8 - Isometric axonometry of the composition of 12 rods in double element C for structural node

TAV.N.9 - Orthogonal projection in composition section with 6 rods, for terminal node, with union of elements C and D; lower plan of element D with arrangement of bushes to anchor PI, PE, SI and SE panels

TAB.N.10 - Planimetry example of structural use of the tetric module, for the construction of a 5.112 m wide portal, 15.00 m span, 3.75 m internal useful height. Hypothesis of intended use of the example: gyms, exhibitions, fairs, school canteens, field hospital, dormitories, conference rooms.

TAV.N.11 - Example section of structural use of the tetric module, for the construction of a 5.112 m wide portal, 15.00 meters span, 3.75 m internal useful height as per the plan of TAV.N.10

TAB.N.12 - Details of the PI and PE panels, transparent and translucent, for the confinement of the cavity in the example of assembly of TAV.N.10 and TAV.N.11

TAV.N.13 - Detail of the wooden foundation for the assembly example of TAV.N.10 and TAV.N. 11

Modulo Tetric is a structural system for temporary and removable constructions. This consists of rods and knots, entirely of wood. The rods are made up of spruce wood strips, 7 cm x 7 cm x 70 cm, suitably shaped at both ends (TAV.N.2) to allow a single possibility of coupling / interlocking (reducing the need for specialization and / or practical skills of the assembler) in the node, represented in TAB.N.3-4-5-6-7-8 and 9. The cuts at the ends of the rods and the notches (to be made with a computerized pantograph cutter) of the node, allow the construction of equilateral triangles, then tetrahedra (TAV.N.1. a), icosahedron (TAV.N.1.b) and compositions of these, up to the creation of complex spatial structures to be used as roofs and closed places of great impact emotional (TAV.N.10, representing the plan and TAV.N. 11, representing the elevation).

In the tetric module, the application involves the use of the wooden spatial reticular structure for the construction of continuous cavities (i.e. constituting a single body between vertical and horizontal walls, letter I in TAV.N. 10) with a large thickness of air confined (the basic module foresees one of 150 cm, see

TABs. 10 and 11, representation of assembly of the upper precautionary limit) within flat sheets of shiny and transparent material, placed on both surfaces of the interspace as indicated in TAV.N. 10 and TAV.N. 11 with the abbreviations: PE (external wall), PI (internal wall), SI (internal ceiling) and SE (external ceiling).

The aforementioned plates belong to the construction category of wood and wood and glass frames. Of these there can be different sizes and designs, suitable for achieving particular decorative architectural effects of the elevations, where required. In the TAV.N. 12 represent standard panels, useful for many of the possible compositions, which can be made with the tetric module, starting from the one indicated in TAB.N. 10 and TAV.N. 11. These panels consist of a wooden frame (standard profile 50 mm x 65 mm, for 4 mm single glass) and glass (TAV.N 12.a) or pre-assembled panel 22mm +30 mm + 22, i.e. plywood + cork + plywood (TAB.N 12.b).

The panels are fixed to the terminal nodes represented in TAV.N. 9, specially equipped with 3 (highlighted by n.4 in TABLE N.9) threaded bushes (diameter 15 mm, length 30mm, for M10 screws).

To this end, the dimensions of the panels (TAB.N.12), in both cases, are 1220 mm in width, differing in height between PI and PE in, respectively, 3750 mm and 5225 mm (see the elevations of the TAV .N.11).

These dimensions can be deduced from the positions of the nodes in the assembly of the tetric module: width of the panel, double of Lc = 610 mm, measurement shown in the figure TAV.N.1.b of the assembly of the icosahedron; height of the panel, deduced from 3 times for PI and 4 times for PE, of the height of the tetric module, i.e. of the icosahedron, as double the height Hc (640 mm), measurement shown in the figure TAV.N.1.a , of the assembly of the tetrahedron.

Tables N 10 and 11 represent the tetric module composed of a portal, capable of creating a covered surface of about 5 meters in length by 15 meters of light (TAB.N.10.b). This portal can be extended beyond the current length of 5.112 meters to form tunnel structure of the desired length. In particular, the drawing by TAV.N. 10.a, also represents the final solution of the tunnel structure, with the assembly of the tetric modules in the back wall. In the same TAV.N.10 and TAV.N.11, the 300 mm x 50 mm x 4000 mm planking of the flooring is highlighted with the letter L, resting on a chestnut beam grid (highlighted by the letter TL, in TABLE N. 11), designed to create raised and ventilated flooring. The wooden foundations and the grid of the ventilated floor are described in TAV.N.13.

The TAV.N. 11, highlights with the letter C the aluminum supports, fixed to the aforementioned terminal nodes, adjustable in height, designed to guarantee a slope of 1% to the SE covering panels, to facilitate the drainage of rainwater towards the on-board channels Cb. Furthermore, the SE panels are waterproofed with an 8/10 mm copper sheet.

The loads of the structures made with the assembly of the Tetric Modules, are distributed on the ground with a continuous foundation (highlighted with the letter Fnd, in TAB.N.11), removable, consisting of chestnut beams 200 mm x 200 mm x 1700 mm , resting on the ground without requiring any preventive excavation (possibly only resting on a waterproofing tape, removable and reusable when the structure is removed). This foundation is also entirely removable and reusable in another context.

The structures made with the tetric module are connected to the foundation with wooden screw bolts.

According to the conditions of use, translucent material could be used on the internal side of the PI interspace, in contact with the habitable / usable area, for suitable solar shielding and / or privacy, as well as to block the sun's rays inside the cavity for energy purposes.

For particular architectural effects, the structures created by assembling the tetrical modules can be left open (ie without the PI and / or PE infill panels) to form sunshades and arcades.

When the walls made with the tetric module are confined within the (transparent and translucent) PI and PE infill plates, the interspace can be energetically used to create the cooling and heating system of the rooms delimited by the structures made with the assembly of the Tetric module. This is achieved by using the movement of the air confined inside and heated by the sun; special valves electronically managed (also remotely), placed at the top and at the bottom of the PE, PI, SI and SE infill plates (possibly in other strategic positions for achieving comfort in the specific use), regulate the optimum air speed within the habitable / usable area (*) and the optimal internal temperature (as well as controlling the humidity rate in the cavity and in the usable / habitable area). The quantity and size of these differs according to the climatic zone of installation of the structure made with the tetric module and will favor the exchange of air between the passenger compartment and the cavity, between the cavity and exterior, between the passenger compartment and the exterior. The algorithm that will regulate the opening-closing function of the individual valves will be developed during the prototyping and testing of the Modulo tetric system, and will therefore be the subject of a further, possibly, patent.

The tetric module is easily assembled on the ground. Composed of 42 rods in the composition of the icosahedron (TAV.N. 1.b) weighing 1.28 kg (Italian conifers) in the dimensions shown in TAV.N2, for the weight of 53.76 kg to which the weight of wooden notes. Regarding the nodes, the icosahedron composition of the drawing TAV.N.1.b, represents a node with 12 concurrent rods (central in the drawing), composed of two pieces of type C (in detail in TAV.N. 3, section and internal; TAB.N.4, upper exterior and elevation; TAV.N.5, isometric axonometry of the piece C only; TAN.N.6.C, isometric axonometry of the detail of the diamond cut, centered in the piece C; TAV .N.7, isometric axonometry of the type C piece with 6 rods mounted). This node with 12 rods, central to the icosahedron, is represented in isometric axonometry in TAV.N.8, with inclination rod 1, facing the observer, sectioned on the perimeter of the node only in order to make the drawing meaningful, showing this which would otherwise be hidden by the sectioned rod. The knot is structurally effective and composed as shown in TAV.N.8, if you add 6 (3 upper and 3 lower) wedges of the size and shape of the design TAV.N.6.A. The knot thus formed has a weight of about 5.19 kg (excluding the tall ones), in hardwood.

The components of the nodes are bound together, to tighten, forming a vice around the competing rods in the node. The elements that operate the junction are barrel and tie rod joints, named with the number 3 in TAV.N.3, TAV.N.4, TAV.N. 5, TABLE N. 7 and TAV.N. 8. This type of hardware for wood is now approved only for furniture, during the prototyping phase it will be necessary to ask one of the numerous manufacturing companies to approve a model for structural use. This type of screwing makes assembly easier. Each piece of shape C and D contains 6 vertical joints of barrel and tie rod; each piece A referred to in TAV.N.6, contains 2. The node with 12 rods, therefore has 18 barrel and tie rod junctions, divided into 6 with vertical and 12 with horizontal. The terminal node with 6 rods instead has 12 barrel and tie rod junctions, divided into 6 vertical and 6 horizontal.

The assembly of the icosahedron of TAV.N. 1.b, also shows 12 terminal nodes (i.e. arranged for anchoring the panels (TAB.N.12) for the creation of the confinement of the air, referred to in the letters PI, PE, SI, SE of TAB.N 10 and TAB.N.11). These nodes are composed of piece C (described in the previous paragraph) and piece D, described in TAV.N.9, in section A'-A 'and in the upper exterior (where the bushings distinguished with the number 4 are also visible). This node has 6 rods (three with inclination 1 and three with inclination 2), so it also needs 3 wedges represented by the drawing TAV.N.6.A. The weight of this node is, again excluding the rods, slightly lower than that described in the previous paragraph, in fact it is estimated (with coniferous wood) at 4.10 kg.

The weight, therefore, complete with the single icosahedron composition (perfectly assembled, in reality theoretical, in fact a single module will not be assembled, if not for demonstration purposes) is 108.15 kg, while the external dimensions are (simple envelope in prismatic area) 1.5 mx 1.22 m at the base and 1.28 m in height, for a volume of 2.3424 mc. The theoretical structural density of the structure is therefore 46.17 kg / m3, extremely low due to the important technical quality at accidental loads. This is achieved by having filed all the material in excess of the normal lines of force.

When assembling the architectural structures with the composition of the rods and nodes of the tetric module (for example, as shown in TAB.N.10 and TAV.N 11), for two icosahedron modules side by side and joined, no 2 nodes are mounted and a rod, for which there is an important saving in the complete structure in terms of material, transport, structural weight and assembly time.

Particular attention is paid to the junction of the external / internal panels (TAV.N.12) which must guarantee watertight integrity, but also support thermal expansion.

The structures derived from the assembly are in effect spatial reticular structures, verifiable with the theory of equilibrium of nodes or funicular diagrams. The rods have a compressive breaking load (NTC 2018) fc, 0, k, for wood class C14, of 16 N / mm2, and tensile strength ft, 0, k of 7.2 N / mm2. Considering the structure in operation over Long Duration (from 6 months to 10 years), Solid Wood in Service Class 1, Kmod will be 0.70 while the partial safety factor is 1.5. Furthermore, it is appropriate to make the coefficient Kh for structures with a height h <150 mm, which in the specific case (with h = 70 mm) is calculated as 0.89589.

In this way we would have Xd (Design Resistance) equal to:

6.688 N / mm2 for compression tension parallel to the fibers

3.01 N / mm2 for tensile stress parallel to the fibers.

The rod section measures 7 cm x 7 cm, therefore 4900 mm2, from which the maximum stress of the rod is inferred in:

32,771 KN in compression parallel to the fibers (3341 Kg)

14,749 KN with parallel tension to the fibers (1504 kg).

In the analysis of loads, in our case, the structural own weight is absolutely modest, as highlighted in the previous paragraphs, while accidental loads play an important role:

Cover assembly and maintenance Qk Cat H1 (Roofs and attics accessible for maintenance only) 1.2 KN located in an area of 50 cm x 50 cm;

Wind, zone 3, as = 360 m, vb = vb, 0 = 27 m / sec, reference kinetic pressure qb = 455.625 kg / m2, pressure (ground roughness C; exposure category III, Kr = 0.2 z0 (m) = 0.10; zmin (m) = 5; Cez = 0.5311 Cpe = + 0.8) p = 96.79 kg / m2 for the pitch in depression and ep = 193.59 kg / m2 for the vertical leeward wall ;

Snow (zone 3, characteristic reference value 1.326 KN / m2, shape coefficient = 0.8, exposure coefficient 0.9), qs = 0.955 KN / m2;

The SI, SE panels are hooked on 3 nodes, at the vertices of the equilateral triangle formed by the 70 cm long rods. Each node therefore weighs 1/3 of the surface of the hexagon with a side of 70 cm, equal to 0.448 m2. This implies that in each node will arrive, to be distributed in the auctions:

Mounting the 1.2 KN cover

Vento 43.36 Kg per pitch in depression, and 86.72 Kg for vertical leeward wall

Snow 0,428 KN (43,64Kg)

These calculations (boundary condition, central Italy elevation 360 m asl, roughness of the countryside with hills and widespread trees) reassure us amply about the pre-dimensioning of the wooden rods.

The tightness of the knot is absolutely relevant for the functionality of the tetric module, and this is ensured by the shear check of the barrel and tie rod joints, in particular of the latter. In this case, however, there are limits imposed by not having published reference data, as this system, at the moment, is only approved for furniture and not for structural use.

The wood has a fire retardant treatment, it can be colored at the user's request, defining a welcoming space even for the youngest users. The structural wood is equipped with appropriate certification.

Industrial interest:

The tetric module introduces many innovations with respect to the assembled components currently on the market, now making certified self-construction a business product.

The wooden rods and knots can be made by wood companies (the knot is modeled with a computerized pantograph cutter) and distributed individually or in pre-set assembly boxes for specific technical performances (for example, a glamping chamber of specific dimensions standard, will have an equal number of rods, nodes, transparent and translucent panels, as well as valves and water purification / potabilization system - not described in this report because systems patented by specific companies to which we intend to request collaboration for the development of this project -, only the algorithm for managing the air valves for the different climatic zones will vary).

Compared to the products on the market, the tetric module brings the following innovations:

- Construction material for knot and rod in wood, while the most common systems are in steel;
- Characteristics of the wooden knot, which in the VESTRUT System is mobile and in steel, while in the Thermal Module it is made of wood and fixed, characterized by a perfect defined interlocking cut (composition of 60 ° and complementary angles), clamped around the competing auctions;
- The characteristic of the node adds woody material and places the hardware (reduced only to the tie rod joint and bush) outside the rod, so the rod is not weakened by the bolt holes;
- Ease of use and assembly, although it can vary in the section (defining suitable models for situations of use), the tetric module arranges the rods only on compositions of tetrahedron and icosahedron repeatedly, so the rods are of a single type for structures and anyone is endowed with a medium-high manual skill can prepare his own structure without having specific knowledge (self-construction), following the assembly instructions
- The assembly is also facilitated by the lightness of the module that can be pre-assembled on the ground, with a minimum number of 6 rods, and then fixed on those already in place, even using simple painter's scaffolding (furniture, 2 meters high) .
- Even large structures can be built with the use of a modest amount of wood, a material perfectly suited to the contrast of the increase in greenhouse gases and aligned with the objectives of the 2030 Agenda;
- At the end of its life, the material is perfectly usable for thermo-compound (reduced to wood chips);
- Wood is a CO2 tank, the tetric module keeps the wood material in operation for 15-20 years in addition to the cutting time, extending the storage time (currently 20 years) operated with the reforestation forest works.

Note

From salute.gov.it the following data:

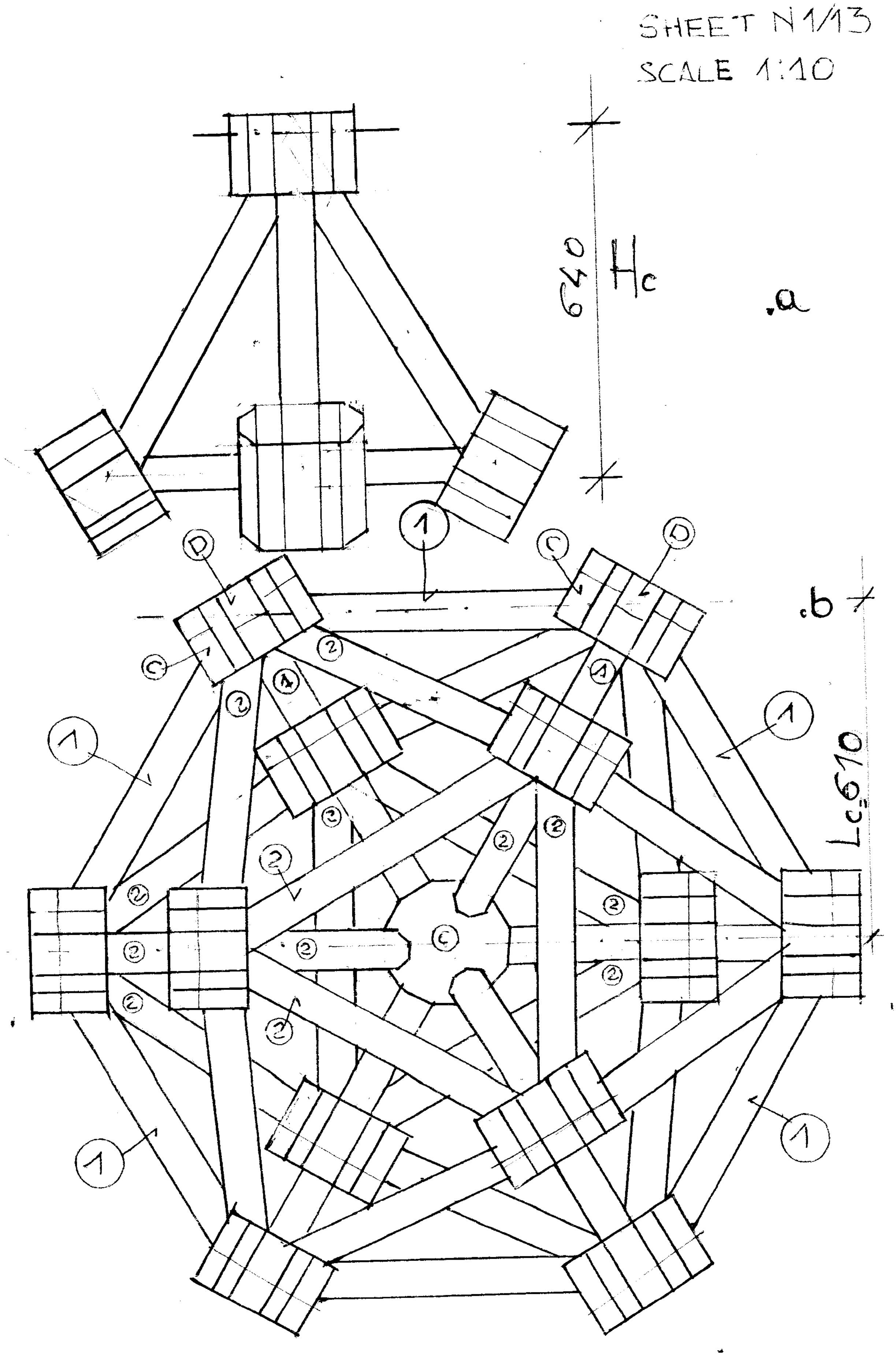
Condizioni microclimatiche ottimali		
Stagione	**Temperatura dell'aria (T)**	**Umidità Relativa(UR)**
Inverno*	19-22°C	40-50%
Estate*	24-26°C	50-60%

1.4 CLAIMS of the invention having the TITLE: "Tetric module: holistic way of overcoming the emergencies (and not) induced by climatic changes", in the name of Anna Poggiani resident in Chiusi (SI) via Montegrappa 152, of Italian nationality. Presented on 29/10/2019 with the n. 102019000020014

1) Essential structural system - Tetric module - (TAB.N.1) for the construction of light, vertical, horizontal or otherwise oriented hollow walls (spatial reticular structures), removable and reassembled, consisting of wooden rods with cuts at the ends at 30 ° (TAB.N.2) to fit into the knot (TAB.N.3-4-5-6-7-8-9), carved with bevels of 30 ° -60 ° for clamping max 12 competing rods, equipped with 3 threaded bushes to anchor the vertical and horizontal infill panels (TAV.N.9), tightened by a total of 18 barrel and perimeter, horizontal and vertical tie rod joints.

2) Bottom system for satial reticular structures built with the essential structural system - Tetric Module - as per claim 1, consisting of continuous foundations and grid of the raised ventilated floor, with wooden beams (TAV.N.13) clamped by bolted collaborative interlocking joint.

3) Use of the essential structural system - Tetric Module -, composed of light bearing hollow walls, for the construction of removable vertical and horizontal structures (TAV.N.10-11) and interspaces for energy use (TAV.N.10 -11).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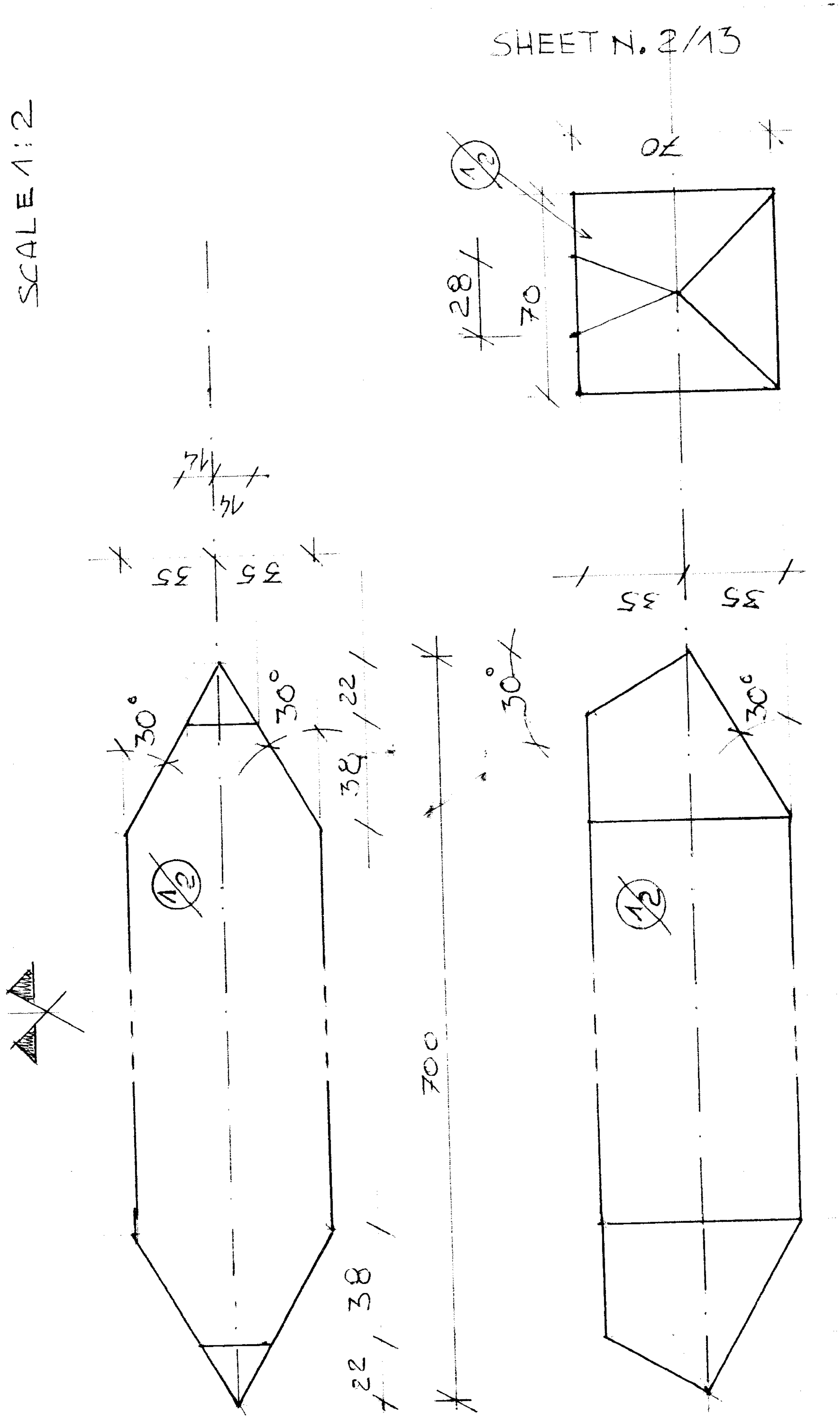
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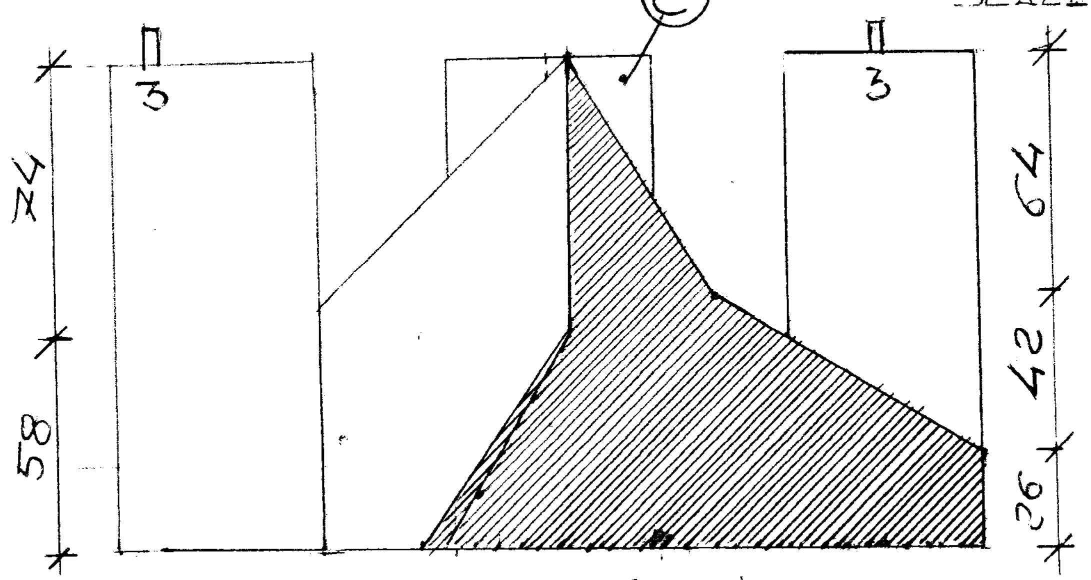

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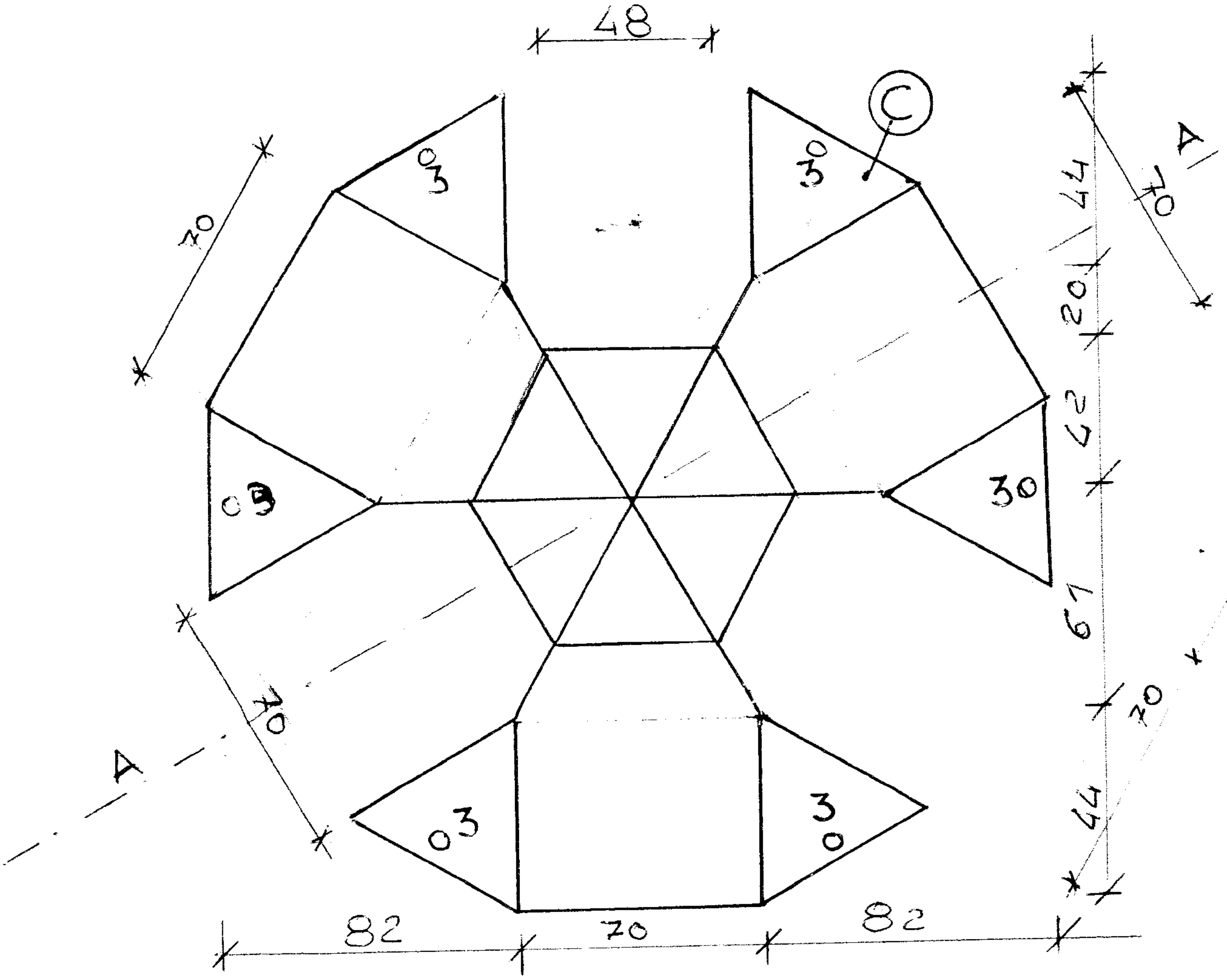

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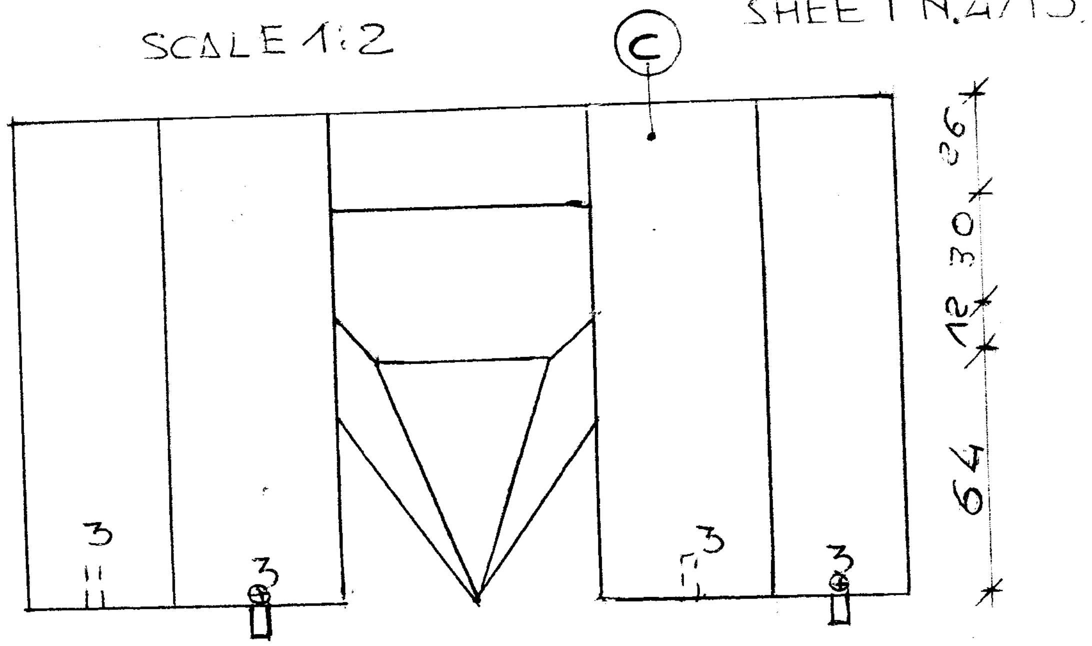
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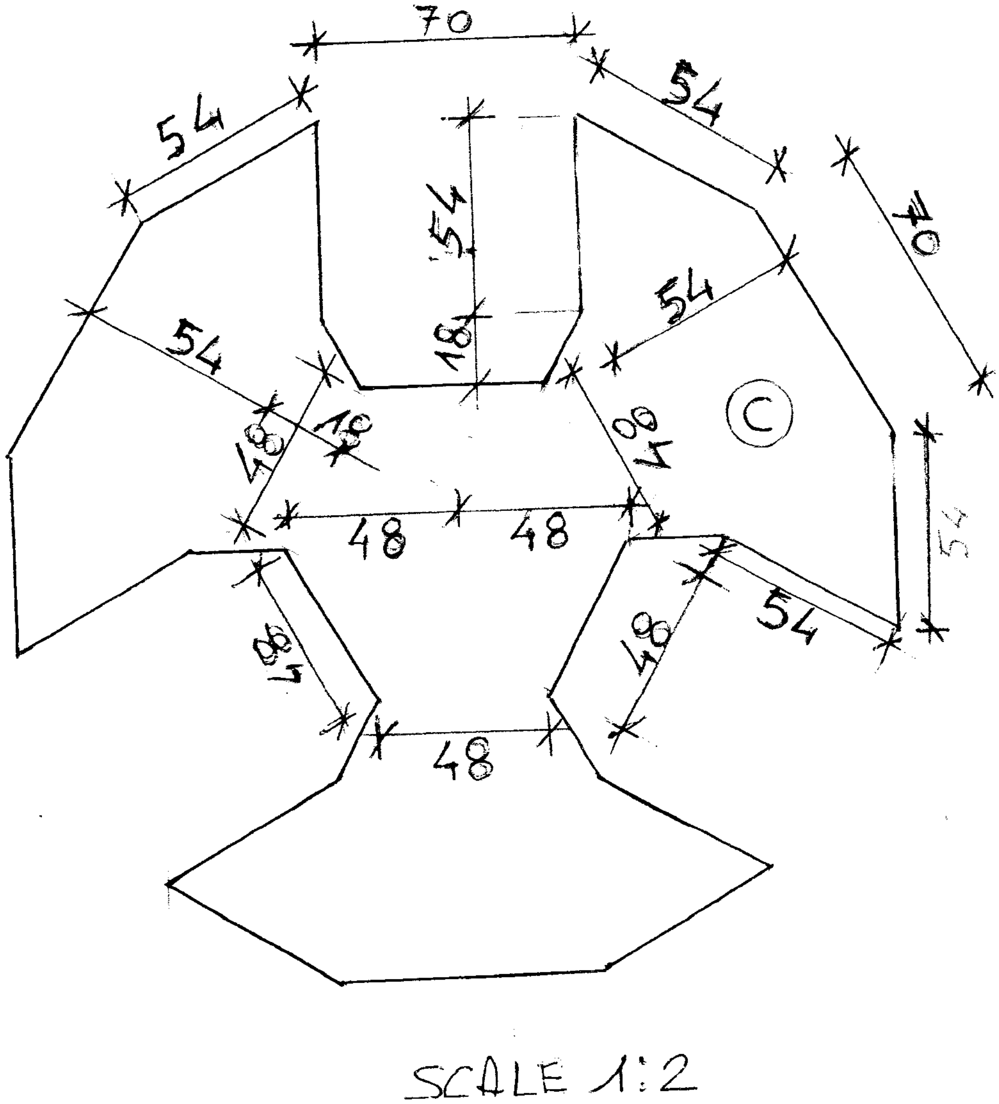
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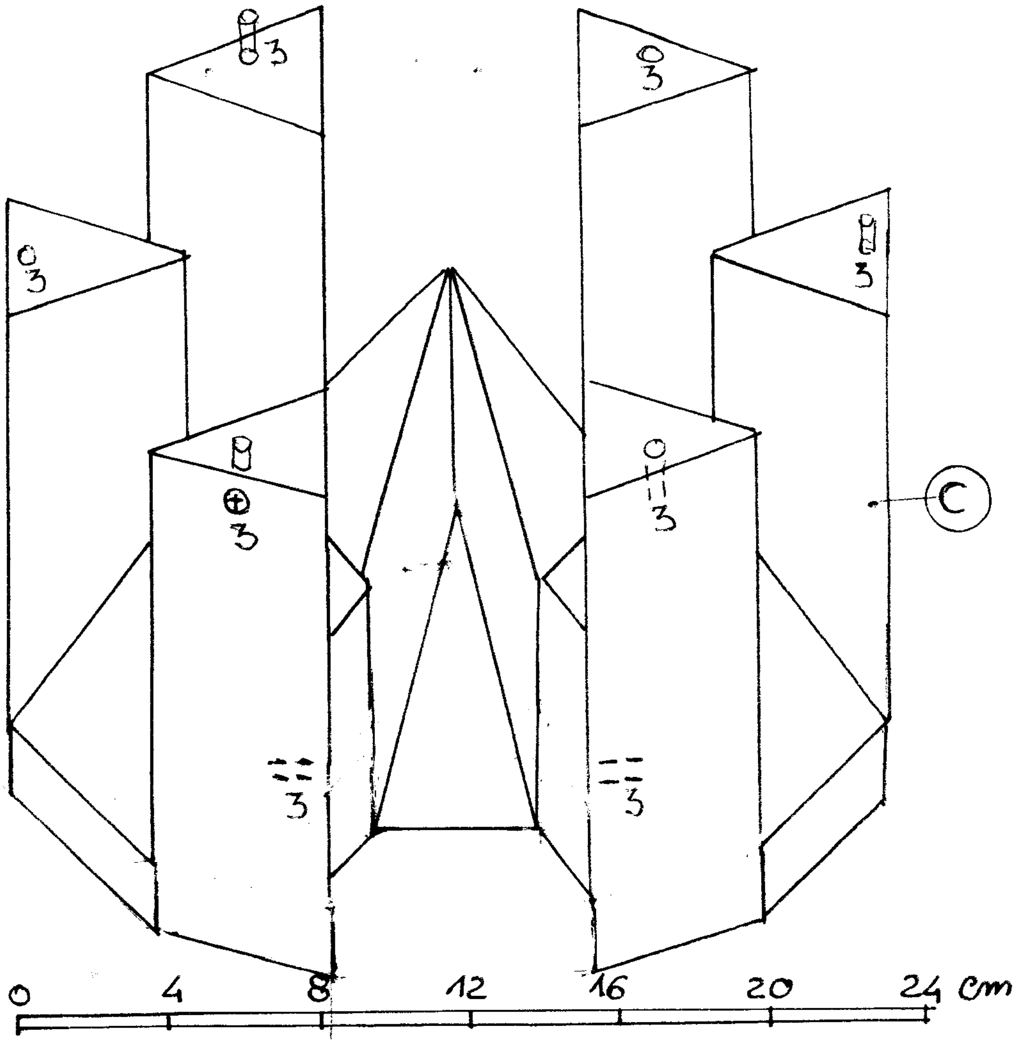

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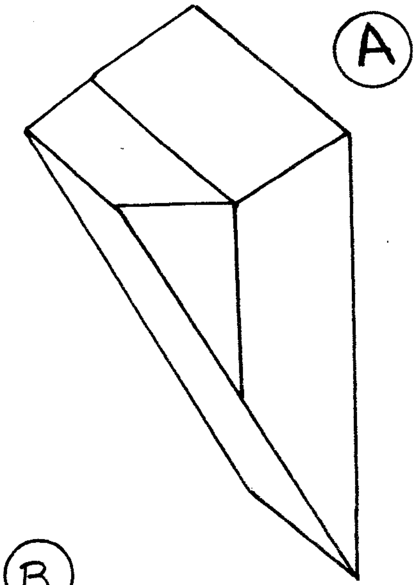

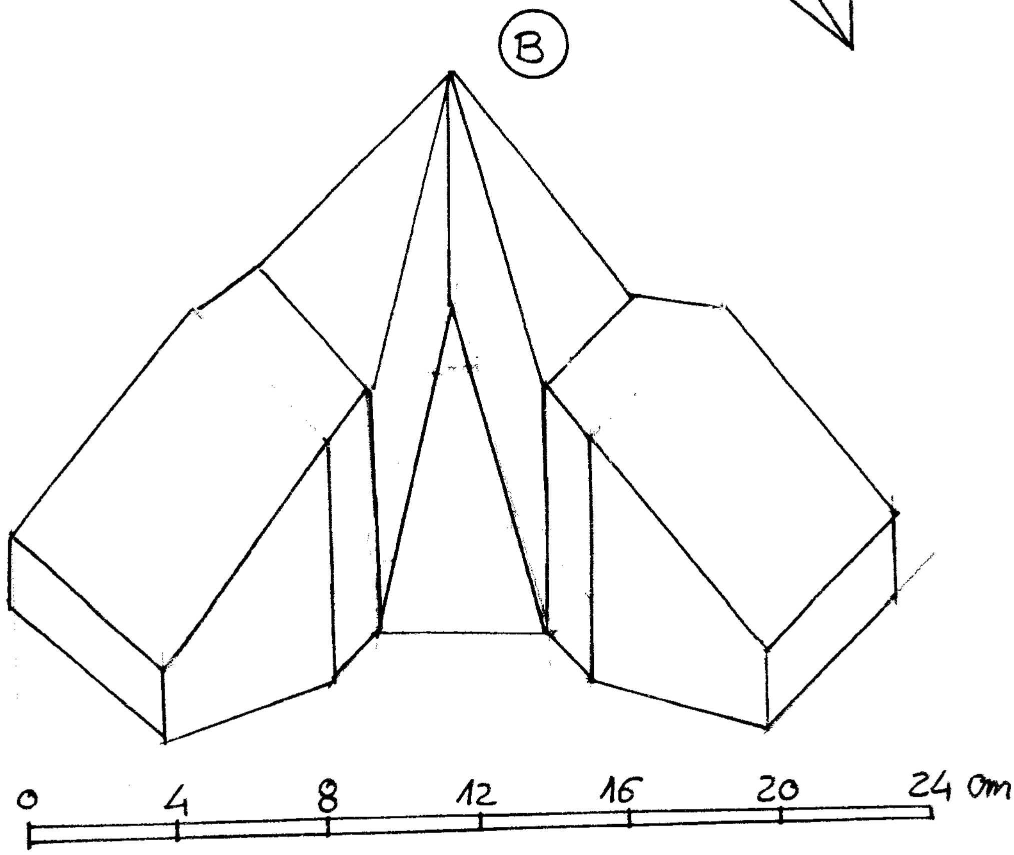

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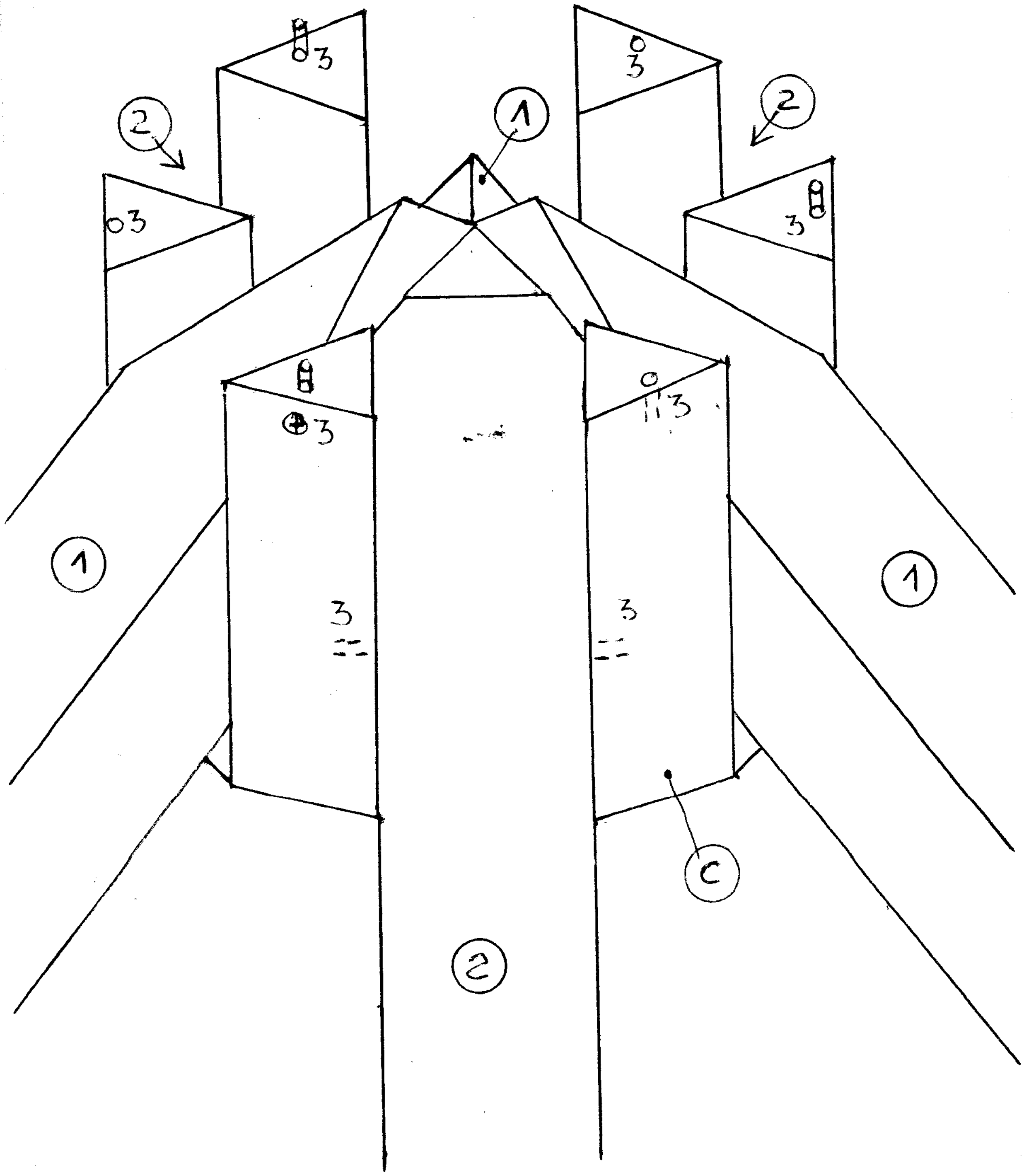

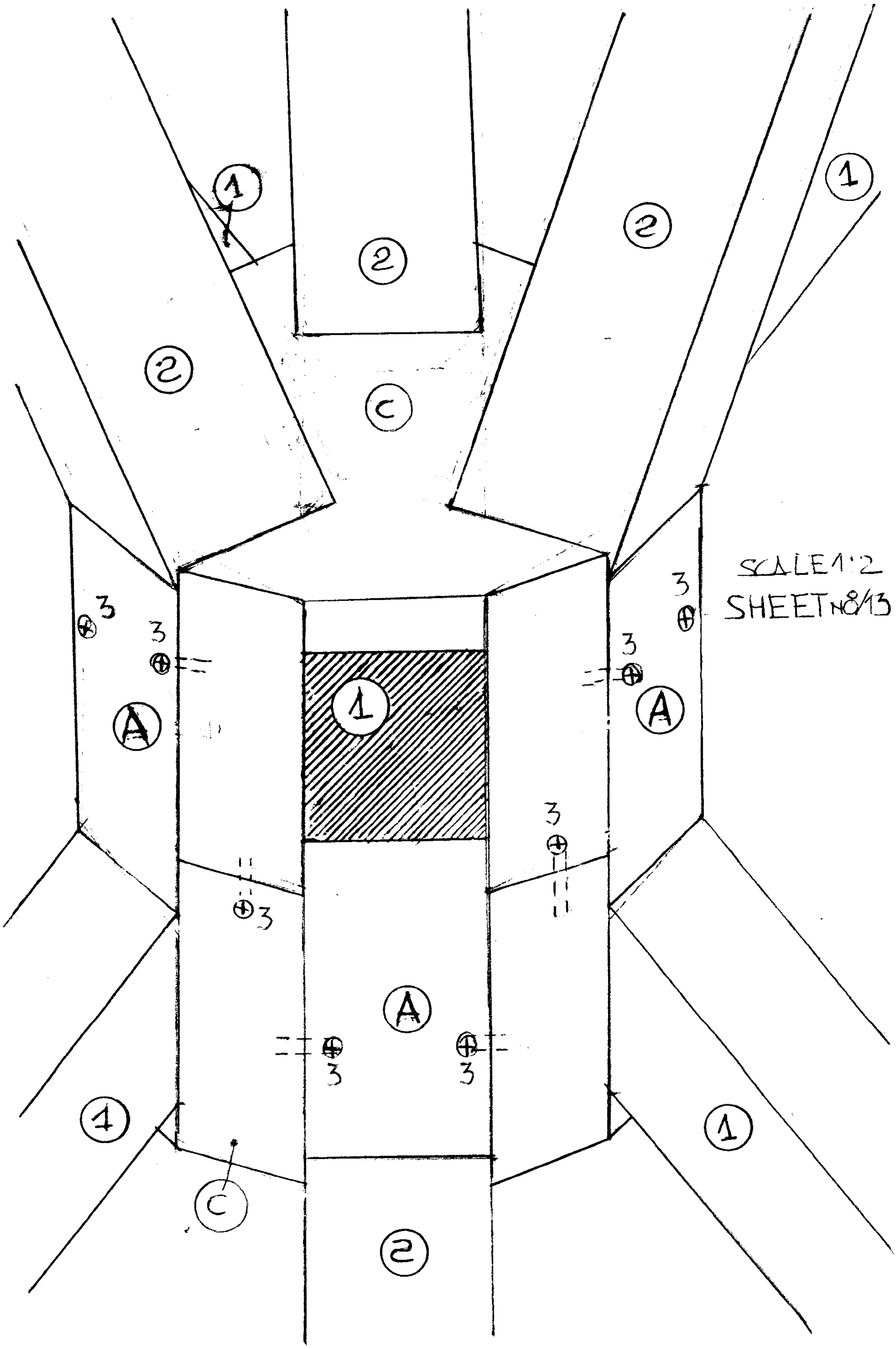
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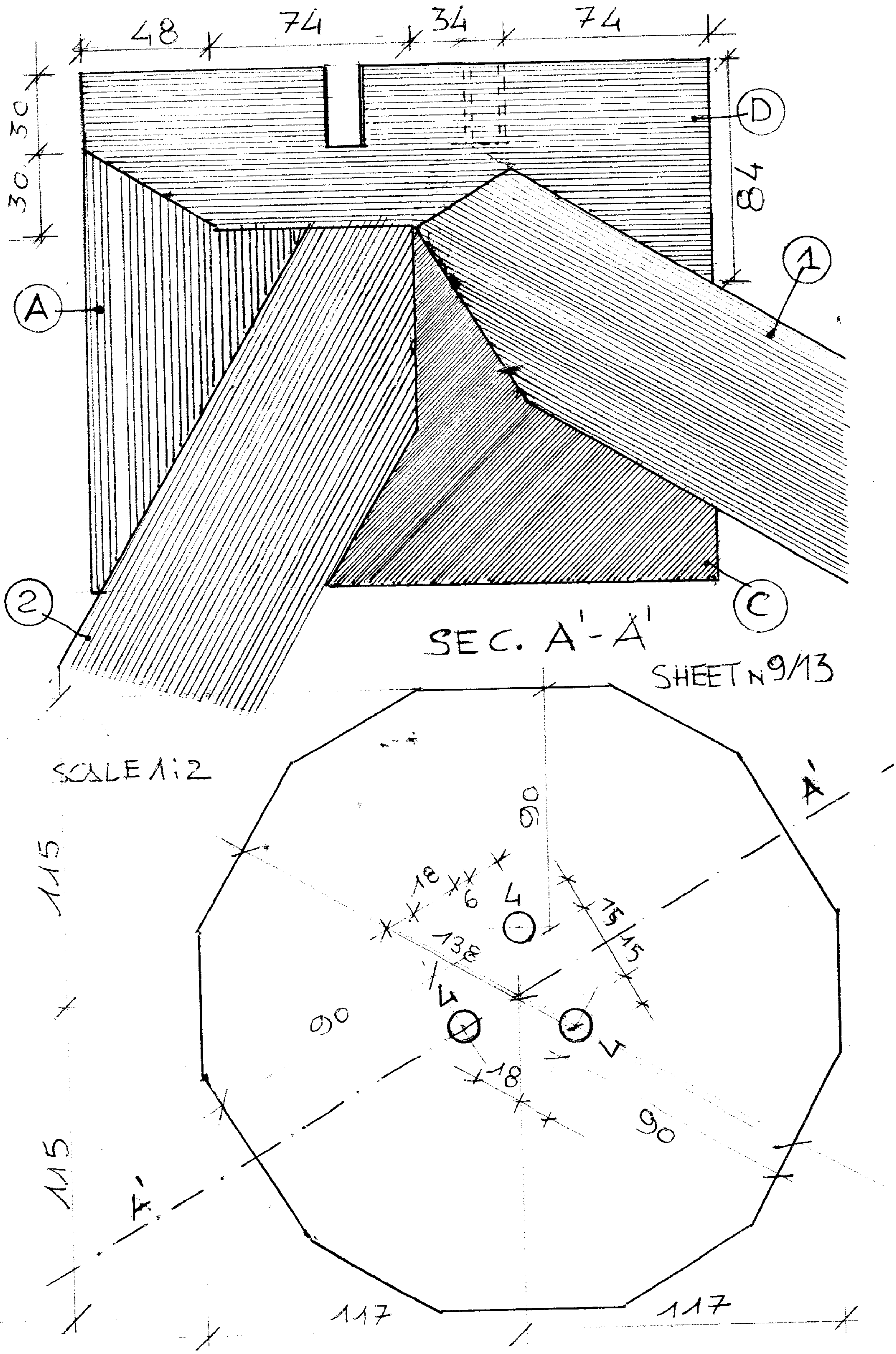
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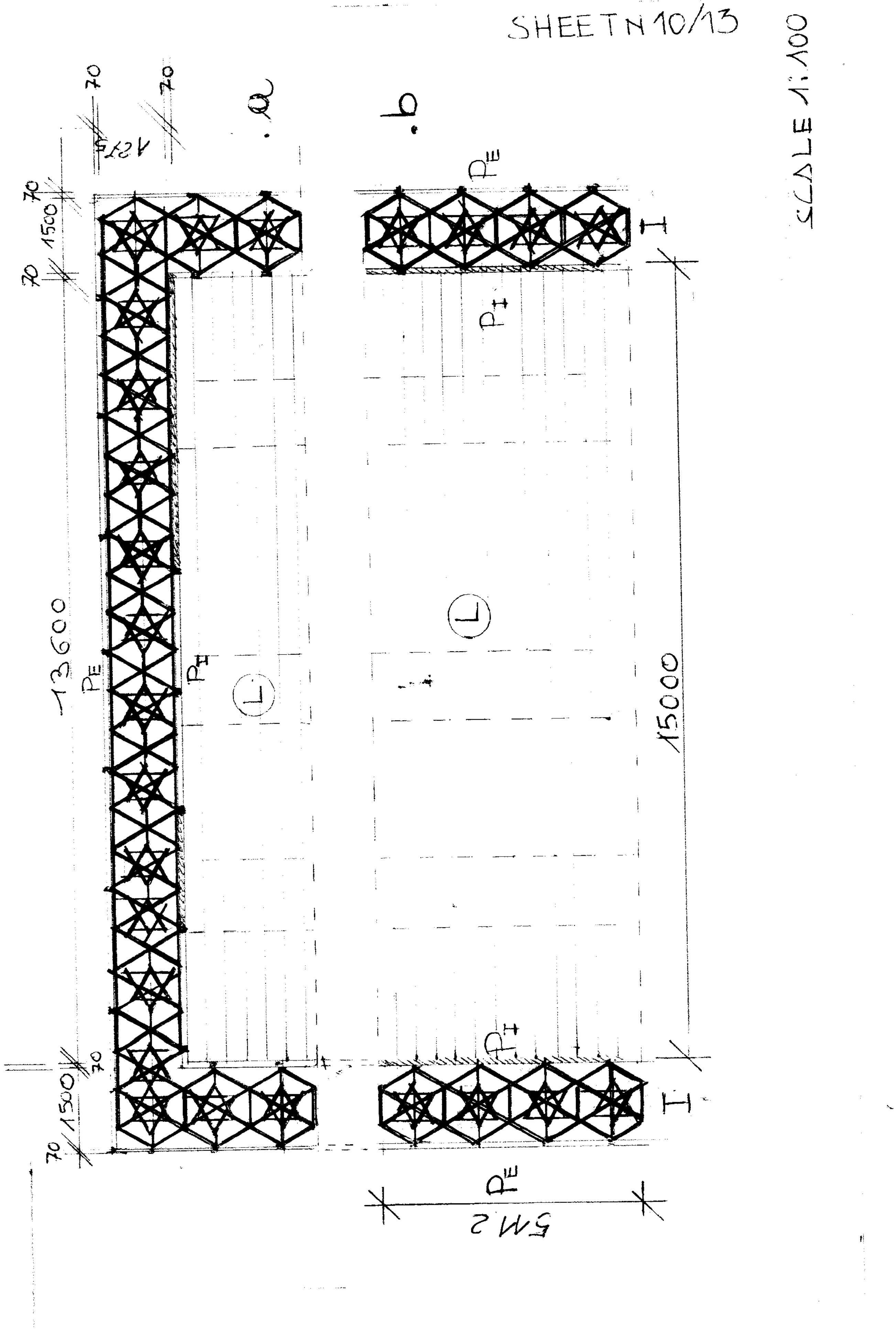
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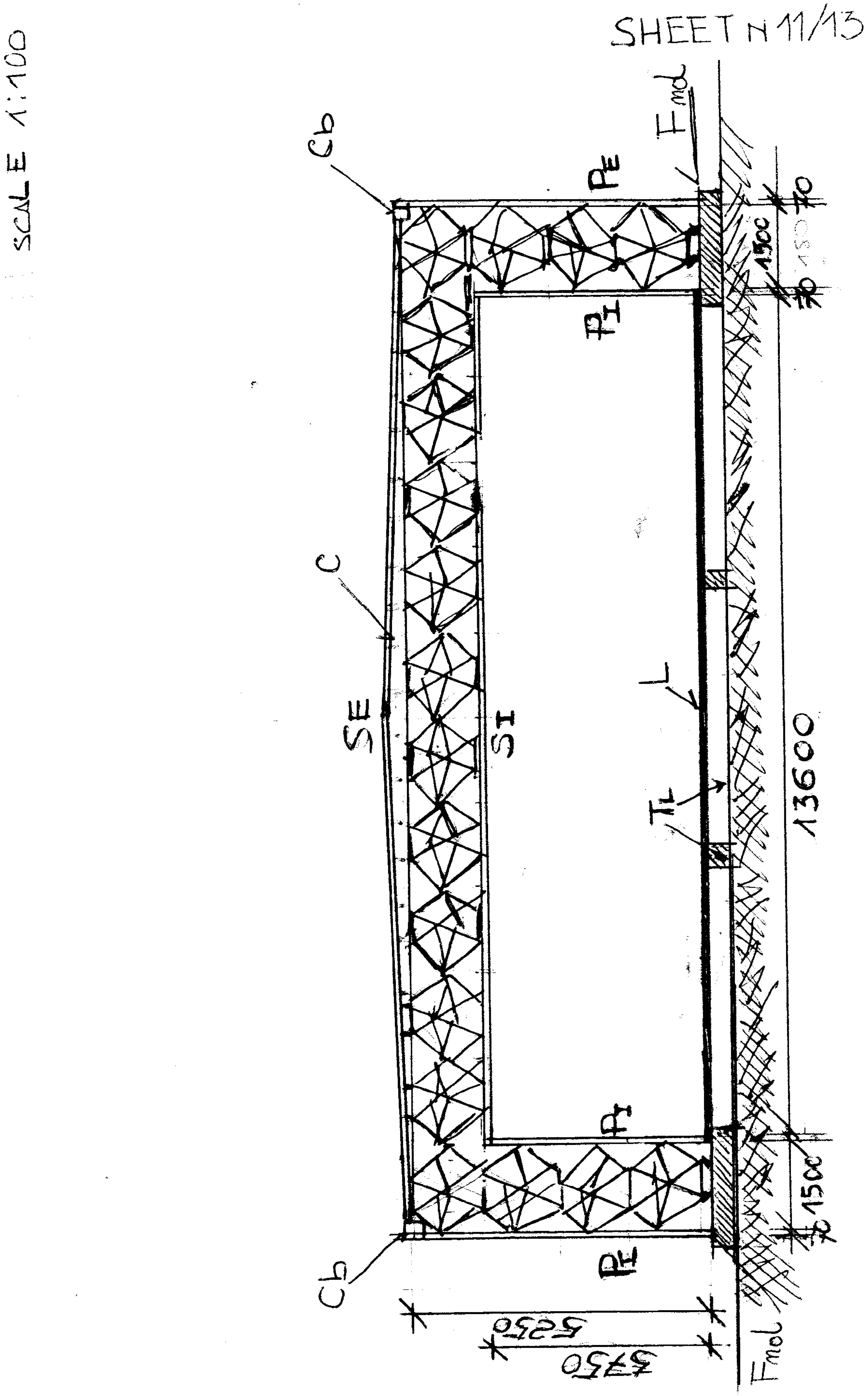
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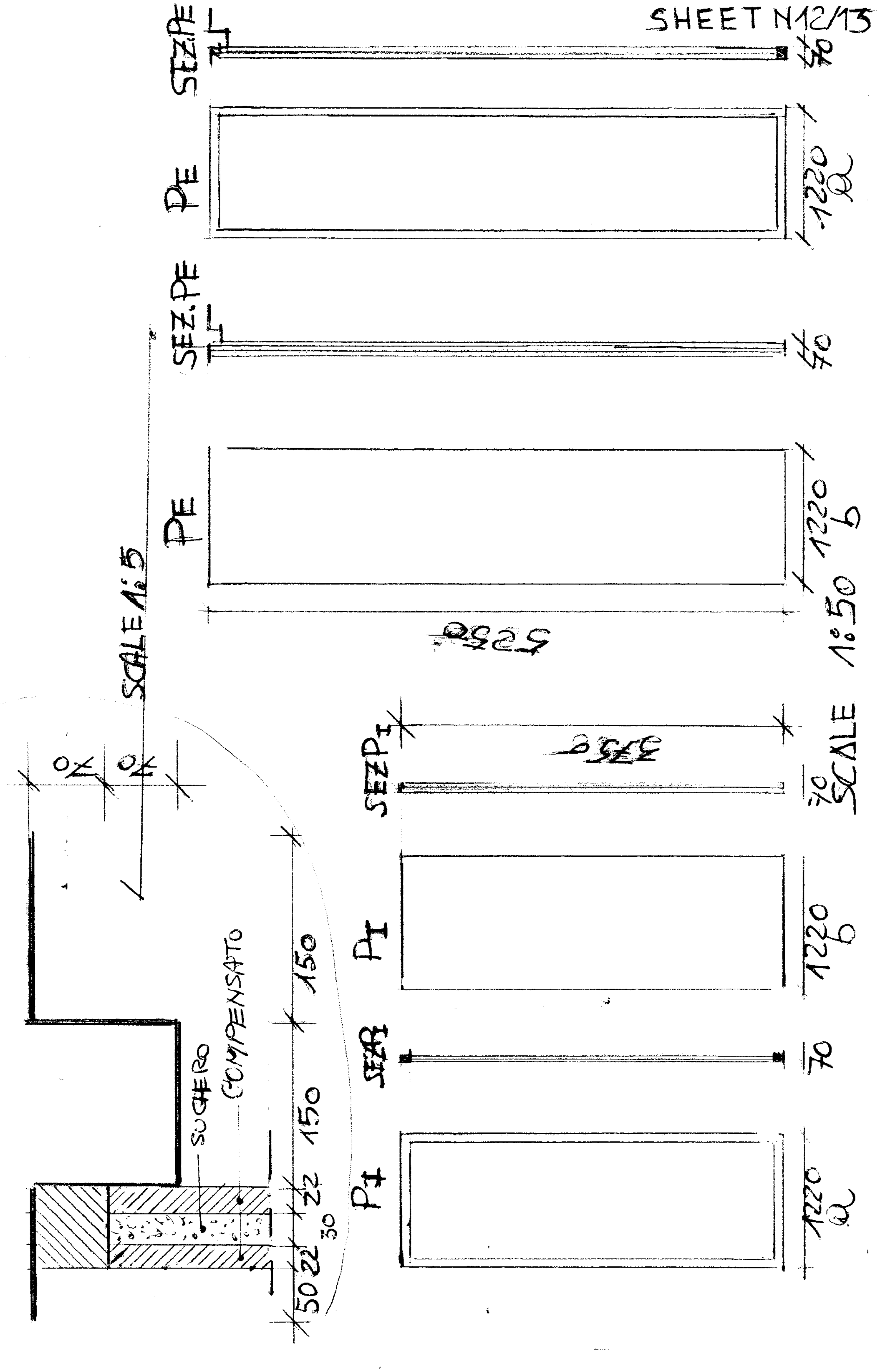
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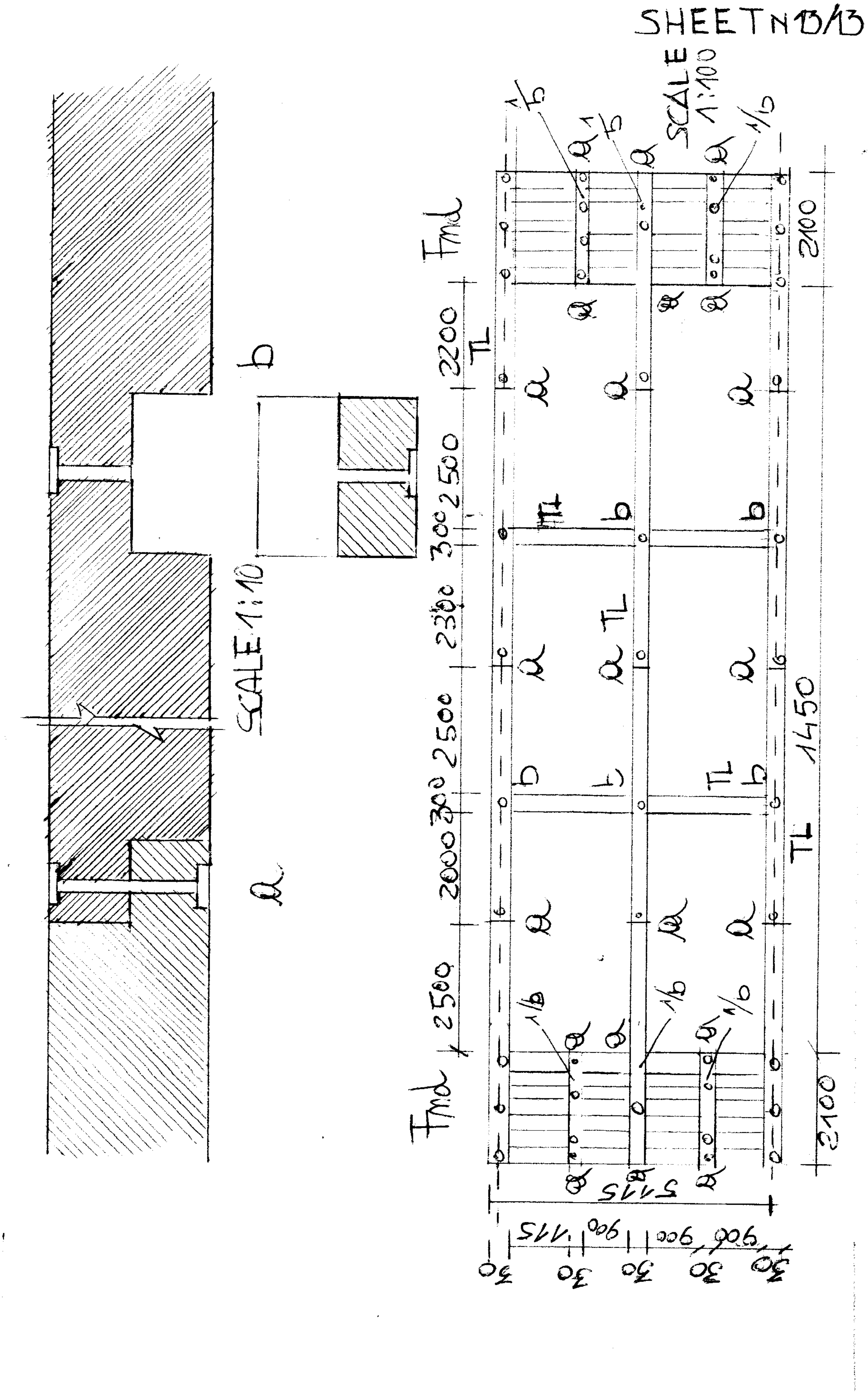
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INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2020/050258

A. CLASSIFICATION OF SUBJECT MATTER
INV. E04B1/19
ADD.

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)
E04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 369 074 A1 (MARCEL SPOERRI ARCHITEKT FH [CH]) 28 September 2011 (2011-09-28) paragraphs [0022], [0024], [0029]; figures 8,9,16,17 -----	1-3
A	US 4 357 118 A (MURRAY JOHN R) 2 November 1982 (1982-11-02) column 3, lines 2-16; figures 1,4 -----	1-3
A	FR 1 560 807 A (CHEMOPROJEKT) 21 March 1969 (1969-03-21) page 3, lines 33-45 -----	1-3
A	US 4 671 693 A (ROSSMAN WENDELL E [US]) 9 June 1987 (1987-06-09) column 2, lines 45-68 -----	1-3

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"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

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 February 2021	04/03/2021

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Dieterle, Sibille

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IT2020/050258

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 2369074	A1	28-09-2011	NONE	
US 4357118	A	02-11-1982	NONE	
FR 1560807	A	21-03-1969	NONE	
US 4671693	A	09-06-1987	NONE	