(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 117 019 B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
07.05.2014 Bulletin 2014/19

(51) Int Cl.:
H01F 27/30 *(2006.01)*

(21) Application number: **08425162.8**

(22) Date of filing: **17.03.2008**

(54) **Modular device for clamping and positioning power transformer windings, particularly for a dry-type transformer with resin-encapsulated windings**

Modulare Vorrichtung zum Festklemmen und Positionieren der Wicklungen von Leistungstransformatoren, insbesondere für einen Trockentransformator mit in Giessharz eingebetteten Wicklungen

Dispositif modulaire pour le serrage et le positionnement des enroulements des transformateurs de puissance, notamment pour un transformateur de type sec avec enroulements encapsulés en résine

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR

(43) Date of publication of application:
11.11.2009 Bulletin 2009/46

(73) Proprietor: **Bticino S.p.A.**
21100 Varese (IT)

(72) Inventors:
- **Bucci, Italo**
  64024 Notaresco (TE) (IT)
- **Cori, Gaetano**
  64026 Roseto degli Abruzzi (TE) (IT)
- **De Lauretis, Lino**
  64032 S. Giacomo di Atri (TE) (IT)

(74) Representative: **Perani, Aurelio et al**
Perani & Partners
Piazza San Babila, 5
20122 Milano (IT)

(56) References cited:
EP-A- 1 298 681
DE-B3-102005 030 014
DE-U1- 20 105 608
DE-U1- 20 210 882
GB-A- 1 115 025

EP 2 117 019 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a modular device for clamping and positioning power transformer windings, particularly for dry-type transformers with resin-encapsulated windings.

[0002] Power transformers are known to be generally formed of a sheet pack (magnet core) with two yokes clamped by yoke pressing plates and two or three columns.

[0003] Low and high voltage windings are concentrically arranged around the columns, the low voltage windings being interposed between the columns and the high voltage windings.

[0004] Accurate and stable positioning of low and high voltage windings, spaced from each other and the magnet core (yokes and columns) as prescribed in the design specifications are required to meet a number of needs: on the one hand, the windings should be mechanically clamped to avoid excessive vibrations thereupon during operation of the transformer or, even worse, displacements caused by electrodynamic stresses generated in load conditions, particularly at full load or in case of a short circuit; on the other hand, electric insulation of the windings from each other, the core and any other part of the transformer at ground potential should be ensured, while allowing proper aeration in the ventilation passages formed between or within the windings (particularly the low voltage winding, having high currents therein).

[0005] Furthermore, the clamping devices shall have a certain controlled elasticity to absorb the different thermal expansion of the windings during operation and to damp vibrations, which will thence not be transferred to the whole structure.

[0006] In view of fulfilling the above requirements, clamping devices are generally employed which are specially designed to fit the size of the transformer and its windings, which size can be varied over wide ranges and involves highly variable insulation spacings and sizes of the clamping devices.

[0007] This implies high costs for manufacturing and stock management.

[0008] In an attempt to at least partially obviate the above drawbacks, DE 20105608U, which is regarded as the closest prior art, and DE 20210882U disclose modular clamping devices, composed of a combination of different elements of insulating material.

[0009] Nonetheless, no provision is made therein to stacked coupling of elements of the same type.

[0010] Also, the adaptability of these modular devices to various needs is limited and requires the provision of elements of different thicknesses.

[0011] In view of obviating this limitation, compound clamping devices have been proposed, as disclosed in EP1298681, in which two of the multiple elements that compose the device may be interlocked together to obtain different combined thicknesses.

[0012] These devices have a particularly complex structure and provide little mechanical strength and adaptability to the required wide range of thicknesses.

[0013] Another approach is proposed by GB1,115,025 where winding trunks spacers have complementary profiles of their opposite faces, so that two or more of them con be interlocked together in stacked relationship, without any stagger.

[0014] Such spacers may also be used as transformer windings clamping devices, but are unsuitable to cope with the requirements imposed by the overall diameter of the concentric windings, which varies in a relatively wide range.

[0015] The present invention solves this problem and provides a modular sturdy system to form clamping devices that use, possibly multiple times, distinct elements that can be stacked and assembled like the bricks of the well-known LEGO (registered trademark) toy.

[0016] The system substantially comprises an elongate base block or support, a second substantially square element, that can be defined as a bolt holder, but also acts as a rubber pad holding element and as a support shim for a winding and a third element, similar to the second, that can be defined as a winding guide or centering element, which also acts as a rubber pad-holder and support shim for a winding.

[0017] The invention, as characterized by the claims, addresses the issue of providing clamping devices with a minimized number of different parts and the required rubber pads, that can fit transformers in which the diameter of the concentric windings varies in a relatively wide range and, by repeated use of the same part type, provide all the thicknesses required to ensure the required voltage-related insulation spacing and to allow the device to accommodate windings having different axial dimensions.

[0018] Furthermore, the particular conformation of the elements ensures a high surface electric resistance and does not affect the efficiency of the ventilation passages typically interposed between the primary and secondary windings, thanks to the provision of air flow passageways in the base block.

[0019] The characteristics and advantage of the invention will be more apparent from the following description of a preferred embodiment, when taken with reference to the accompanying drawings, in which

- Figure 1 is a perspective top view of a preferred embodiment of a base block for the modular clamping device of the present invention;
- Figure 2 is a perspective bottom view of the base block of Figure 1;
- Figure 3 is a perspective top view of a bolt holding element for the modular clamping device of the present invention;
- Figure 4 is a perspective bottom view of the bolt-holding element of Figure 3;
- Figure 5 is a perspective top view of a preferred embodiment of a centering element for the modular

clamping device of the present invention;

- Figure 6 is a perspective bottom view of the guide element of Figure 5;
- Figure 7 is a perspective view of a resilient pad for the modular clamping device of the present invention;
- Figure 8 is a longitudinal sectional view of the base block of Figure 1, as taken along the line A-A of Figure 1;
- Figure 9 is a longitudinal sectional view of a variant embodiment of the base block of Figure 1, as taken along the line A-A of Figure 1;
- Figure 10 is a front view of the base block of Figures 1, 2, 8 and 9;
- Figure 11 is a front view of the bolt-holding element of Figures 3 and 4;
- Figure 12 is a front view of the guide or centering element of Figures 5 and 6;
- Figure 13 is a partial perspective view of a transformer incorporating an embodiment of the clamping device of the present invention.

[0020] Referring to Figures 1, 2, 8, 9 and 10 the base block 1 is a hollow rectangular parallelepiped element having a length K (e.g. 140 mm), a width W1 (e.g. 55 mm) and a thickness H1 (e.g. 18 mm), conveniently beveled at one end

[0021] The block 1 is formed by injection molding of a plastic material having high mechanical and dielectric strength, such as PBT (polybutilen terephthalate) and has two sides 2, 3 interconnected by a plurality of transverse ribs, such as the rib 4, which have either a vertical extension as shown in the sectional view of Figure 8 or are inclined to the vertical at least in the central part of the block, for reasons to be explained hereafter, as shown in Figure 9.

[0022] The block structure is further reinforced by a pair of ribs 5, 6 extending parallel to the sides 2, 3.

[0023] The sides 2, 3 have a continuous upper toothing 7, 8, conveniently recessed (e.g. by 2.5 mm) relative to the lower part, which preferably has a triangular shape, tapered at its top, with a pitch of the order of 2 ÷ 3 mm and a height H3 of the order of 3 mm.

[0024] The distance between the toothing crests of the two opposed toothings 7, 8 is W2 (approximately equal to W1 - 7 mm, i.e. in this example 48 mm).

[0025] As clearly shown in Figures 2 and 10, the sides 2, 3 extend downwards further than the connecting and reinforcing ribs, to form a continuous housing, open at its ends, with a depth H3 equal to the height of the toothings 7, 8.

[0026] As clearly shown in Figure 2 and in Figure 8, the sides of this housing also have toothings 9, 10 identical to the toothings 7, 8.

[0027] The distances between the troughs of the two opposed toothings 9, 10 is equal to W2.

[0028] In other words, the base block has identical upper and lower transverse interlocking profiles.

[0029] These profiles allow stable interlock of multiple base blocks in stacked relationship, possibly with a longitudinal stagger that is equal to or a multiple of the tooth pitch (2 ÷ 3 mm).

[0030] Thus, different thicknesses may be obtained, equal to H1 + N.(H1 - H3) where N is zero or a positive integer, by way of example with a 15 mm resolution.

[0031] Referring to Figures 3, 4, the bolt holding element 11 is also a parallelepipedal block, having substantially square top and bottom faces and a width exactly equal to the width W1 of the base block.

[0032] The height H2 of the parallelepiped may be equal (18 mm) to or conveniently lower (e.g. 15 mm) than that of the base block.

[0033] The bolt holding block also has identical upper and lower transverse profiles, which are also identical to those of the base element, with two sides 12, 13 having an upper external toothing 14, 15, which is also identical to that of the sides of the base element.

[0034] Also the sides 12, 13 extend downwards to form a housing open at its ends, with toothed sides, having the same transverse dimension W2 and depth H3 as the upper profile of the base block and of the bolt holding element itself.

[0035] This allows stable interlocking of multiple blocks in stacked relationship to each other or to one or more base blocks to obtain different combined thicknesses with a resolution depending on the combined thicknesses of the base block and the bolt holding block, if different.

[0036] Concerning the specific use of the bolt holding block, the latter has a closed bottom 16 and stiffening ribs 17 that form a hexagonal prismatic housing 18, open at its top face, for accommodating the head of a clamping bolt commonly used in transformers for exerting an adequate and controlled pressure on the windings.

[0037] The closed bottom 16 not only provides a support for the clamping bolt head but also helps in stiffening the element.

[0038] By its lateral interlocking toothings, the bolt holder may be coupled to the base block in the most appropriate position for clamping.

[0039] The structure and the size of the guide or centering element 19 as shown in the perspective views of Figures 5, 6 and in the front view of Figure 12 are similar, when not even identical to those of the bolt holding block.

[0040] The only difference is that the guide element has a ribbed flap 20 at one end, which extends from the bottom 21 of the lower housing, perpendicular to the latter.

[0041] It shall be noted that, as used herein, the terms upper and lower, top and bottom are related to the viewing directions of the figures.

[0042] Indeed, the various elements may be used on either the upper or lower side of the windings and may be also mounted in the transformer in reverse or upturned positions.

[0043] The difference involved in these applications is that a use on the lower side of the windings does not generally require a bolt-holding block with this specific function, although it doesn't exclude it, because the base block can simply lie on the support structure, with its top face (see Fig. 1) facing towards the support structure.

[0044] This aspect will be further explained below.

[0045] First a further feature of both the guide element 19 and the bolt holding block has to be considered.

[0046] Clamping of windings requires the provision of resilient members for damping vibrations (generated by alternate excitation of windings) and absorbing the thermal expansions that occur during operation.

[0047] As a rule, these resilient members are rubber pads glued to the clamping devices and interposed between the latter and the windings.

[0048] With a modular device as disclosed above no gluing is required: the housings formed in the lower side of the bolt holding block and the guide element act as receptacles for positioning and stable retention of resilient pads having a transverse dimension L1 slightly larger than the width W2 of the housings.

[0049] One of these pads, substantially having the shape of a rectangular parallelepiped, and a thickness related to the requested elastic constant is shown in Figure 7 and designated by numeral 22.

[0050] The dashed arrow 23 indicates the direction of insertion of the pad 22 into the guide element 19 of Figure 6, although it will be understood that the same pad may be inserted in the lower housing of the bolt holding block (see Fig. 4), which is used in this case as a simple rubber pad holding block or, if needed, may be also inserted in the lower housing of the base block 1.

[0051] It shall be further noted that the continuous and uniform section of the pad allows it to be obtained from a cut-to-size extruded strip, thereby simplifying the manufacturing process.

[0052] For better clarity, Figure 13 shows a partial perspective view of an embodiment of the above elements that are used for forming compound devices for clamping the windings of a transformer, with the windings being arranged coaxial with the columns of the magnet core.

[0053] Figure 13 shows that the upper and lower yokes of the transformer are respectively clamped by a magnet keeper that is formed, as is known, of a pair of yoke-pressing plates consisting of beams or C-sections 24, 25 and 26, 27 connected together by tie rods.

[0054] The angle bars 28, 29 of the lower yoke-pressing plates act as supports for a plurality of (generally four per column) clamping devices (only two of them 30, 31 being shown herein) evenly distributed around the columns and radially oriented relative to the axis of the columns.

[0055] Likewise, the angle bars 32, 33 of the upper yoke-pressing plates act as retainers for a plurality of (generally four per column) pressing bolts (only two of them 34, 35 being shown herein) which exert a convenient force upon corresponding clamping devices 36, 37 placed above the windings.

[0056] As an example, Figure 13 shows an external medium/high voltage primary winding 38 in the transformer and an internal low voltage secondary winding formed of two coaxial windings 39, 40.

[0057] It shall be noted that the low voltage windings 39, 40 have a larger axial size than the medium/high voltage winding.

[0058] In order that the windings can be properly positioned and retained the upper clamping device 37 (and the device 36) is composed of the following elements, from top to bottom:

- a bolt holding block 41,
- a series of three base blocks 42, 43, 44 in stacked relationship,
- a resilient pad 45 held under the base block 44 in such position as to press against the upper end of the windings 39, 40,
- a guide centering element 46 placed under the base block 44, having a flap 20 (see Figs. 5, 6, 12) that ensures proper axial arrangement of the winding 38,
- a resilient pad 47 held under the guide element 46 and pressing against the top of the winding 38.

[0059] The lower clamping device 31 (and the device 30) is composed (from bottom to top) of the following elements, disposed in a reverse direction with respect to those used in the previous figures:

- a series of four base blocks 48, 49, 50, 51 in stacked relationship, the first lying directly on the angle bar 29,
- a resilient pad 52 held on the base block 52 in such position as to support the two low voltage windings 39, 40,
- a guide element 53 stacked above the base block 51 in such position as to guide the medium/high voltage winding 38;
- a resilient pad 54 stacked above the guide element 53 to elastically support the winding 38.

[0060] Figure 13 highlights other important aspects:

I) the insulation spacing ensured by the upper and lower clamping devices relative to the support magnet keepers 33 and 29 is substantially the same and corresponds to the thickness obtained by stacking five of the above elements and the thickness of the resilient pad.

[0061] If the bolt holder and the guide element are thinner than the base element, then the difference will be very small (such as 3 mm) and may be eliminated, if needed, by replacing, in the lower clamping device, the base block 51 with two bolt holding blocks interposed between the base block 50 and the pad 52 on the one hand and between the base block 50 and the guide element 53 on the other.

[0062] Otherwise, the base block 48 may be replaced by a bolt holder to be laid on the angle bar 28.

[0063] The first alternative is preferable for stability reasons.

[0064] II) For stable clamping, with an even distribution of the force exerted by the bolt 35 on both the primary and secondary windings, the bolt holder 41 should be placed in a radially intermediate position between the two windings.

[0065] Since the bolt holder and the resilient pads are impervious, this arrangement partially obstructs the ventilation passage between the two windings.

[0066] The same applies for the lower clamping device, where air flow is obstructed by the angle bar 29.

[0067] Nonetheless, by providing base blocks with slanted ribs, as shown in the sectional view of Figure 9, oblique passageways may be created in the stacked base blocks, allowing air flows through the paths designated by the dashed arrows 56, 56, which improve ventilation efficiency.

[0068] III) The slant of the ribs provides an additional advantage in terms of the surface electric resistance of the clamping devices.

[0069] Considering the front views of Figures 10, 11, 12 and the sectional view of Figure 8, it is evident that the stacked elements create a corrugated outer surface with a square wave profile.

[0070] This inherently involves an increase of the surface resistance of the device, because it increases the length of the path to be followed by any surface discharges, at least on the outer surface of the device.

[0071] This does not apply to the ribs 4 of the base blocks as shown in the sectional view of Figure 8, which, when stacked, are in contact and continuation with each other.

[0072] However, an inclined arrangement like the one of Figure 9 stops this continuity and ensures a more effective insulation in terms of surface resistance.

[0073] It will be appreciated that the same concept applies to the longitudinal ribs 5, 6 (see Figs. 1 and 2), whereas a step may be provided on the sides 2 and 3, such that their inner profile corresponds to the outer profile.

[0074] IV) In Figure 13, the radial dimension of the windings is substantially equal to the length of the base blocks.

[0075] Nonetheless, it shall be understood that nothing prevents the use of the above described device with windings of smaller radial size, in which case the base blocks project out of the outer cylindrical surface of the outermost winding.

[0076] Likewise, the present device may be used with windings whose radial dimension is larger than the length of the base blocks.

[0077] For this purpose, the base block/s can simply have a pair of bolt holding elements coupled thereto, partially stacked above the base block and projecting out of its ends, as allowed by the interlocking toothing, with the only condition that the stress center is contained in the base block.

[0078] Furthermore, if the various elements have the same thickness and two or more blocks are used in stacked relationship, a bolt holding block may be seamlessly coupled to a bolt holding block, the pair being retained by a base block in stacked relationship to both (like in the shift joints technique used in masonry).

[0079] In practice, if the length of the base block is 140 mm, and the bolt holding element is as long as 55, the device may be used in transformers in which the radial dimension of the windings falls in a range from $140 / \sqrt{2} \approx 100$ mm and $140 + 2 \,.\, 27.5 = 195$ mm.

[0080] Nonetheless, for mechanical safety reasons, its use is preferably limited to windings having a radial dimension not larger or slightly larger than the width L of the base block, longer base blocks, e.g. as long as 170 to 200 mm, being provided for use in larger transformers.

[0081] In this case, a series may be provided in which the three elements as described above all have an enlarged size.

Claims

1. A modular device for clamping the windings of a transformer, of the type in which an elongate base block (1), with two parallel sides (2, 3) is combined with other stacked elements and these sides extend downwards to form an elongate lower housing open at its ends, **characterized in that**
said sides have upper external toothings and lower internal toothings (7, 8, 9, 10) in mating interlocking relationship, the distance W2 between the two opposite upper toothings (7, 8) of the sides being equal to the distance W2 between the two facing lower internal toothings (9, 10) of the sides, so that the upper and lower transverse profiles of the base blocks mate with each other and a plurality of identical base blocks can be interlocked together in stacked relationship with a longitudinal stagger in the direction of their length.

2. A modular device as claimed in claim 1, wherein said sides (2, 3) are interconnected by transverse stiffening ribs (4) which leave apertures between the top face and the lower face of the base block for allowing air flow therethrough.

3. A modular device as claimed in claim 2, wherein said transverse ribs (4) are inclined to a plane perpendicular to the top and bottom faces of said base block.

4. A modular device as claimed in claim 1, 2 or 3, wherein said sides (2, 3) have a step such that the stacking together of said base blocks creates a corrugated outer surface with a square wave profile that increases the surface electric resistance of said device.

5. A modular device as claimed in the preceding claims, comprising a winding guide element (19), said element having upper and lower transverse profiles in mating relationship, and identical to each other and to those of said base block, such that said guide element can be coupled by interlocking to said base block, said guide element having a winding guide flap (20).

6. A modular device as claimed in the preceding claims, comprising a bolt holding block (11), said block having upper and lower transverse profiles in mating relationship, and identical to each other and to those of said base block, such that said bolt holding block can be coupled by interlocking to said base block, said bolt holding block having a housing (18) for receiving a bolt head.

7. A modular device as claimed in claim 5 or 6, wherein the sides of said guide element (19) and/or said bolt holding block (11) have a step such that the stacking together of said guide element (19) and/or said bolt holding block (11) with said base block (1)creates a corrugated outer surface with a square wave profile that increases the surface electric resistance of said device.

8. A modular device as claimed in the preceding claims, wherein said lower housing of said base block (1) and/or a corresponding lower housing of said guide element (19) or bolt holding block (11) accommodate a resilient pad (22) in interlocking relationship.

Patentansprüche

1. Modulare Vorrichtung zum Festklemmen der Wicklungen eines Transformators, bei der ein länglicher Grundblock (1) mit zwei parallelen Seiten (2, 3) mit anderen gestapelten Elementen verbunden ist und sich diese Seiten nach unten erstrecken, um ein an seinen Enden offenes längliches unteres Gehäuse zu bilden, **dadurch gekennzeichnet, dass** diese Seiten obere Außenverzahnungen und untere Innenverzahnungen (7, 8, 9, 10) in passender ineinandergreifender Beziehung aufweisen, wobei der Abstand W2 zwischen den zwei entgegengesetzten oberen Verzahnungen (7, 8) der Seiten gleich dem Abstand W2 zwischen den zwei gegenüberliegenden unteren Innenverzahnungen (9, 10) der Seiten ist, so dass die oberen und unteren Querprofile der Grundblöcke zusammenpassen und eine Vielzahl von identischen Grundblöcken miteinander in einer gestapelten Beziehung mit einer Längsstaffelung in Richtung ihrer Länge in Eingriff gebracht werden kann.

2. Modulare Vorrichtung nach Anspruch 1, wobei die Seiten (2, 3) durch querlaufende Versteifungsrippen (4) miteinander verbunden sind, die Öffnungen zwischen der Oberseite und der Unterseite des Grundblocks lassen, um das Strömen von Luft dadurch zu ermöglichen.

3. Modulare Vorrichtung nach Anspruch 2, wobei die Querrippen (4) zu einer Ebene hin geneigt sind, die perpendikulär zur Ober- und Unterseite des Grundblocks ist.

4. Modulare Vorrichtung nach Anspruch 1, 2 oder 3, wobei die Seiten (2, 3) eine Stufe derart aufweisen, dass das Zusammenstapeln der Grundblöcke eine gewellte Außenfläche mit einem Rechteckwellenprofil erzeugt, das den elektrischen Oberflächenwiderstand dieser Vorrichtung erhöht.

5. Modulare Vorrichtung nach den vorhergehenden Ansprüchen, die ein Wicklungs führungselement (19) umfasst, wobei dieses Element obere und untere Querprofile aufweist, die in passender Beziehung stehen und untereinander und mit denen des Grundblocks identisch sind, so dass das Führungselement durch Ineinandergreifen mit dem Grundblock verbunden werden kann, wobei das Führungselement eine Führungslasche (20) aufweist.

6. Modulare Vorrichtung nach den vorhergehenden Ansprüchen, die einen Schraubenhalteblock (11) umfasst, wobei dieser Block obere und untere Querprofile aufweist, die in passender Beziehung stehen und untereinander und mit denen des Grundblocks identisch sind, so dass der Schraubenhalteblock durch Ineinandergreifen mit dem Grundblock verbunden werden kann, wobei der Schraubenhalteblock einen Sitz (18) zum Aufnehmen eines Schraubenkopfes aufweist.

7. Modulare Vorrichtung nach Anspruch 5 oder 6, wobei die Seiten des Führungselements (19) und/oder des Schraubenhalteblocks (11) eine Stufe derart aufweisen, dass das Zusammenstapeln des Führungselements (19) und/oder des Schraubenhalteblocks (11) mit dem Grundblock (1) eine gewellte Außenfläche mit einem Rechteckwellenprofil erzeugt, das den elektrischen Oberflächenwiderstand dieser Vorrichtung erhöht.

8. Modulare Vorrichtung nach den vorhergehenden Ansprüchen, wobei das untere Gehäuse des Grundblocks (1) und/oder ein entsprechendes unteres Gehäuse des Führungselements (19) oder Schraubenhalteblocks (11) eine nachgiebige Platte (22) in ineinandergreifender Beziehung beherbergen.

Revendications

1. Dispositif modulaire pour le serrage des enroulements d'un transformateur, du type dans lequel un bloc de base allongé (1) avec deux côtés parallèles (2, 3) est combiné à d'autres éléments empilés et ces côtés s'étendent vers le bas pour former un logement inférieur allongé ouvert à ses extrémités, **caractérisé en ce que**
lesdits côtés ont des dentures externes supérieures et des dentures internes inférieures (7, 8, 9, 10) en relation de verrouillage réciproque d'accouplement, la distance W2 entre les deux dentures internes supérieures opposées (7, 8) des côtés étant égale à la distance W2 entre les deux dentures inférieures face à face (9, 10) des côtés, de manière que les profilés transversaux supérieurs et inférieurs des blocs de base s'accouplent entre eux et qu'une pluralité de blocs de base identiques puissent être verrouillés réciproquement en relation empilée avec un échelonnement longitudinal dans la direction de leur longueur.

2. Dispositif modulaire selon la revendication 1, dans lequel lesdits côtés (2, 3) sont interconnectés par des nervures de renforcement transversales (4) qui laissent des ouvertures entre la face supérieure et la face inférieure du bloc de base pour permettre à l'air de circuler entre celles-ci.

3. Dispositif modulaire selon la revendication 2, dans lequel lesdites nervures transversales (4) sont inclinées par rapport à un plan perpendiculaire aux faces supérieure et inférieure dudit bloc de base.

4. Dispositif modulaire selon la revendication 1, 2 ou 3, dans lequel lesdits côtés (2, 3) ont un échelon tel que l'empilement desdits blocs de base crée une surface extérieure ondulée avec un profil d'onde carrée qui augmente la résistance électrique de surface dudit dispositif.

5. Dispositif modulaire selon les revendications précédentes, comprenant un élément de guidage d'enroulement (19), ledit élément ayant des profilés transversaux supérieur et inférieur en relation d'accouplement, et identiques entre eux et à ceux dudit bloc de base, de manière que ledit élément de guidage puisse être accouplé par verrouillage réciproque audit bloc de base, ledit élément de guidage ayant un volet de guidage d'enroulement (20).

6. Dispositif modulaire selon les revendications précédentes, comprenant un bloc de maintien de boulon (11), ledit bloc ayant des profilés transversaux supérieur et inférieur en relation d'accouplement, et identiques entre eux et à ceux dudit bloc de base, de manière que ledit bloc de maintien de boulon puisse être accouplé par verrouillage réciproque audit bloc de base, ledit bloc de maintien de boulon ayant un logement (18) pour recevoir une tête de boulon.

7. Dispositif modulaire selon la revendication 5 ou 6, dans lequel les côtés dudit élément de guidage (19) et/ou dudit bloc de maintien de boulon (11) ont un échelon tel que l'empilement dudit élément de guidage (19) et/ou dudit bloc de maintien de boulon (11) avec ledit bloc de base (1) crée une surface extérieure ondulée avec un profil d'onde carrée qui augmente la résistance électrique de surface dudit dispositif.

8. Dispositif modulaire selon les revendications précédentes, dans lequel ledit logement inférieur dudit bloc de base (1) et/ou un logement inférieur correspondant dudit élément de guidage (19) ou bloc de maintien de boulon (11) logent un coussinet élastique (22) en relation de verrouillage réciproque.

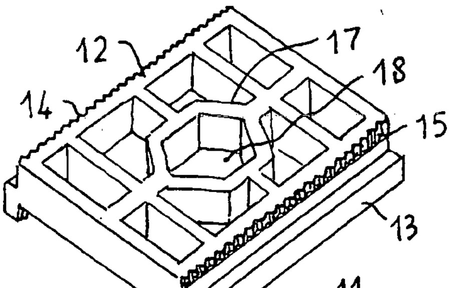
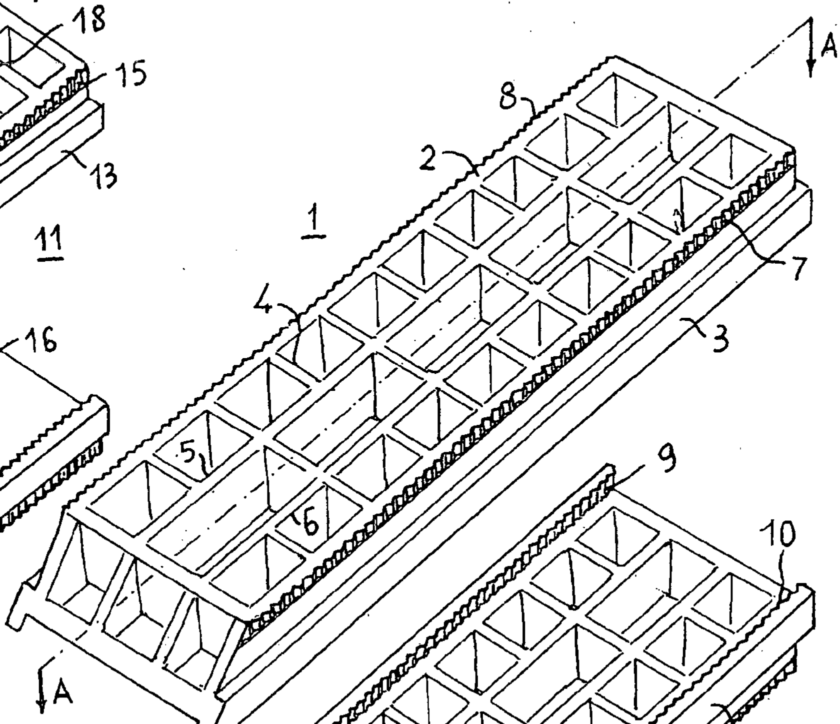


FIG.3



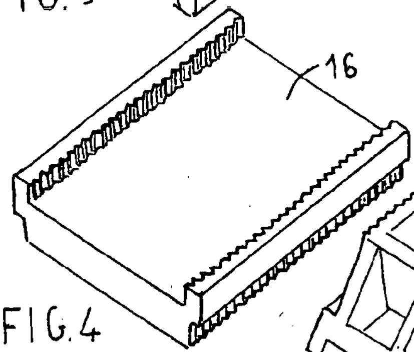


FIG.4

FIG.1

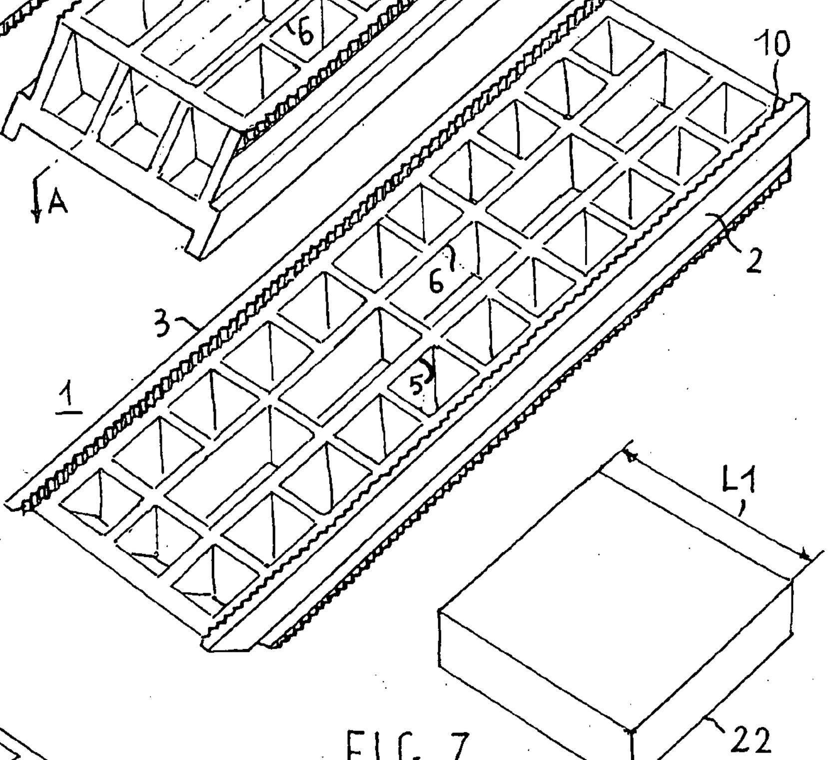


FIG. 2

FIG. 7

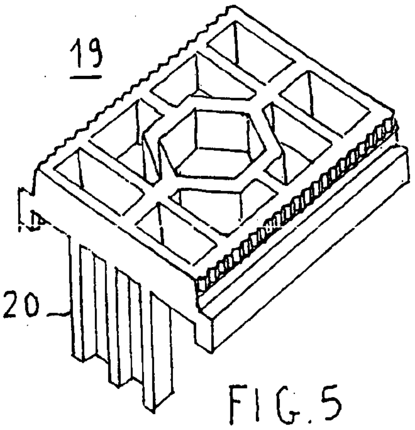


FIG.5

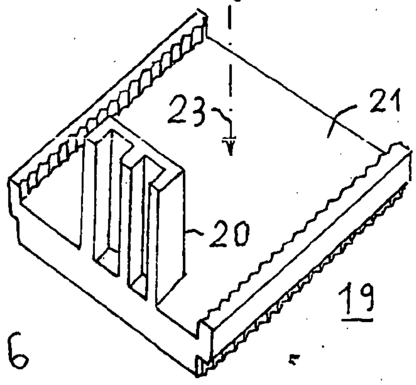


FIG. 6

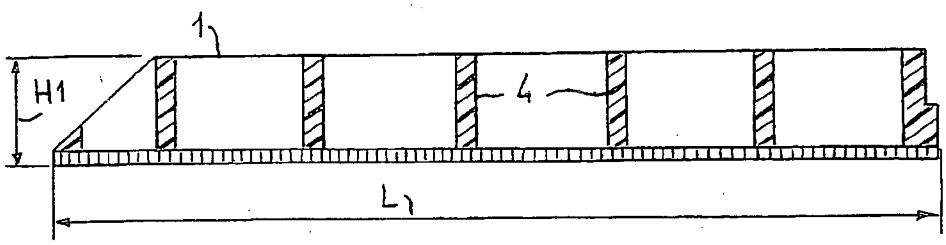


FIG. 8

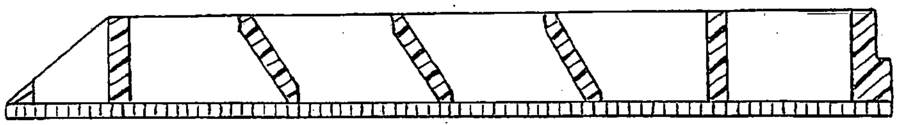


FIG. 9

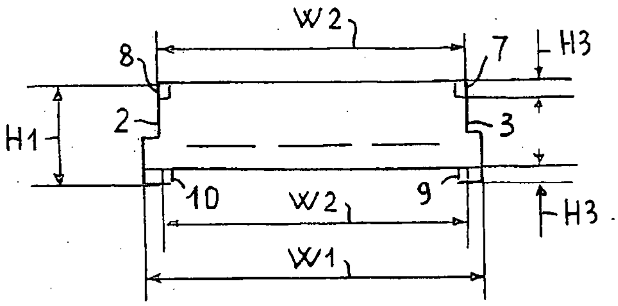


FIG. 10

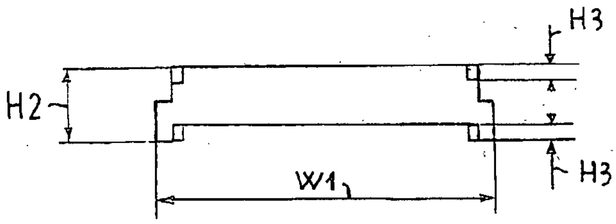


FIG. 11

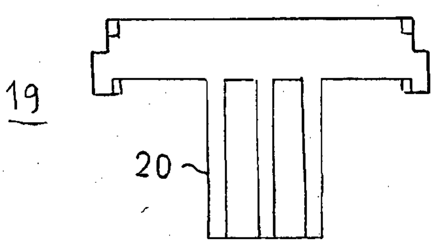


FIG. 12

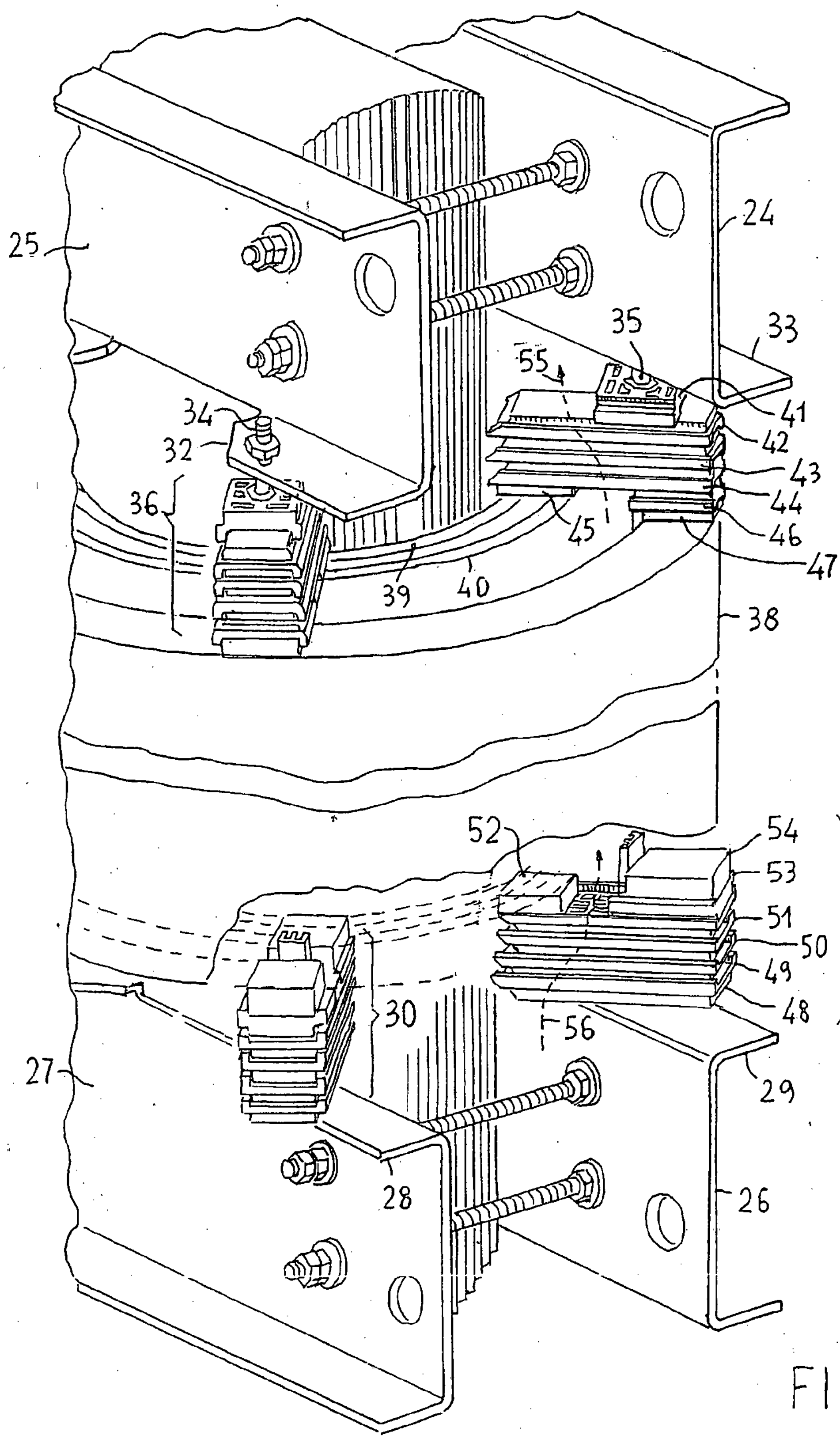

25
24
35
33
55
41
34
42
32
43
37
36
44
45
46
39
40
47
38
52
54
53
51
31
50
49
30
48
56
27
29
28
26

FIG. 13

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 20105608 U **[0008]**
- DE 20210882 U **[0008]**
- EP 1298681 A **[0011]**
- GB 1115025 A **[0013]**