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(54) **REINFORCED MASONRY AND METHOD FOR CARRYING OUT SUCH MASONRY**

VERSTÄRKTES MAUERWERK UND VERFAHREN ZUR HERSTELLUNG EINES SOLCHEN MAUERWERKS

MAÇONNERIE RENFORCÉE ET PROCÉDÉ POUR RÉALISER UNE TELLE MAÇONNERIE

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Description

[0001] The present invention relates to the field of construction concerning the improvement of earthquake resistance and/or the reinforcement of buildings with a load-bearing structure made of bricks or of reinforced concrete with bricks infill walls, and in particular it relates to a reinforced masonry and a method for carrying out such masonry.

[0002] The invention relates to a technical solution for improving the resistance to horizontal strain (e.g., seismic type) of existing brick buildings, such as those made of load-bearing bricks, and of reinforced concrete buildings with brick masonry panels, residential or industrial buildings, said improvement being obtained by operating mainly from the outside and with low-impact operations that allow the building to be kept usable during the work. In fact, it is well known that masonry buildings constructed in the past without provisions with respect to seismic actions are highly vulnerable, and that the known traditional techniques have the disadvantage of being highly invasive on the use of the building, while the known techniques considered innovative and non-invasive have the disadvantage of only partially solving the problems of vulnerability of such buildings to external stresses such as those due to seismic or flood or landslides events.

[0003] Prior art documents US 2020/362558 A1; US 2002/157344 A1 and KR 2009 0064830 refer to a reinforced masonry comprising a wall panel having an accessible face vertical and adjacent to a set of respective horizontal curb elements each one associated with the wall panel. Said reinforced masonry comprises a plurality of rod elements fixed within respective seats carried out in the accessible face of the wall panel. Prior art document KR 102 107 066 B1 refers to a reinforcing element.

[0004] One object of the present invention is to propose a reinforced masonry in order to improve its resistance to horizontal stresses, particularly those due to seismic events. Another purpose is to propose a reinforced masonry whose architectural and aesthetic characteristics generally do not differ significantly from those of the masonry itself prior to its reinforcement.

[0005] Further object is to propose a reinforced masonry whose final strength characteristics can be predetermined and obtained in a way that can be modulated according to needs and contingencies, within an overall seismic improvement project.

[0006] Another object is to propose a method for carrying out the reinforcement of the masonry which allow the use of the building even during the implementation of such method.

[0007] Further object is to propose a method that can be implemented in pre-existing buildings and masonries made of brick, or other kind of building materials, load-bearing or in buildings and masonries with reinforced concrete structure and with infill made of brick walls, such as hollow or solid bricks.

[0008] Other objects are to propose a method by which reinforcements of predetermined strength can be made as required, in single or multi-storey buildings and in specific portions or in the whole of buildings and masonries.

[0009] Another object of the present invention is to improve, compared with known techniques, by as much as 2-3 times the resistance to horizontal actions of masonry panels without increasing the thickness of the masonry itself.

[0010] Further object is to propose a method that can be implemented in a simple way to carry out the reinforced masonry even by typical workers such as those engaged in construction, moving limited weights that allow intervention with no more than two workers operating on a scaffold. This and other objects are achieved by a masonry according to claim 1 and a method according to claim 5.

[0011] It is noted that despite the simplicity of installation, the invention allows the reinforced masonry to reach the theoretical limit strength of the panels, which is that corresponding to diagonal compression failure.

[0012] The invention also includes specific techniques for anchoring to slab, curbs or building foundations.

[0013] The present invention can be the only intervention technique to be used in the case of buildings made entirely of load-bearing masonry, or it can be used to reinforce specific portions of a reinforced concrete building, even in conjunction with other intervention techniques.

[0014] In particular, three types of interventions are possible, similar from a technological point of view but very different from a structural point of view:

reinforcement of solid or perforated load-bearing masonry elements, with a minimum thickness of about 15 cm, forming part of the load-bearing structure of the building or some of its parts (e.g., the stairwell);

reinforcement of brick infill masonry panels, typically 8-15 cm thick, made outside the building and in the light between beams and pillars of a reinforced concrete structure, and making them integral with the reinforced concrete structure itself, so as to make the panels to all intents and purposes elements that cooperate in resisting horizontal strain (e.g., caused by an earthquake);

reinforcement of large masonry panels against transverse actions, e.g., with respect to overturning verifications.

[0015] Reinforcement can be placed over the entire height of the building, modulating the number of bars for each floor according to the design and using the accessory systems listed below.

[0016] The reinforcement can also allow an improvement in the seismic performance of the building by operating only from the outside of the building and/or in the

common parts, with obvious advantages from the point of view of reduced invasiveness of the interventions.

[0017] The intervention allows to improve the strength and ductility of the panels, as well as to avoid problems of out-of-plane tilting of the panels (both load-bearing and infill), without changing the stiffness of the structure in the case of load-bearing masonry, thus allowing, if necessary, to classify the intervention as "reinforcement intervention or local intervention" under the current Standards.

[0018] The characteristics of the invention are highlighted below with particular reference to the accompanying drawings in which:

- Figure 1 illustrates a schematic, partial, frontal view of the reinforced masonry object of the present invention in which two horizontal reinforcing elements are shown transparently to allow views of rearward portions of three first vertical reinforcing elements and in which any coatings, plastering or the like have been removed;
- Figure 2 illustrates a schematic, axonometric, partial view of a portion of Figure 1 of which two cross sections, top and side, made from horizontal and vertical planes, respectively, are visible;
- Figure 3 illustrates a schematic and partial view of a horizontal cross-section of a portion of the reinforced masonry of Figure 1 in which a coating or plaster is only partially visible;
- Figure 4 illustrates an alternative realization to that in Figure 3, including a holding element.

[0019] With reference to Figures 1-3, numeral 1 indicates the reinforced masonry of the present invention comprising at least one masonry panel M, for example, consisting of a wall or portion of a wall made of solid or hollow bricks or other bricks of a building used for dwelling or industrial purposes or a retaining wall or consisting of an infill wall of a frame structure with reinforced concrete columns and beams, where such wall panel has at least one accessible face F, e.g. and preferably an exterior face of the masonry and an interior face thereof.

[0020] Such a face is usually flat and vertical but may be curved or slightly inclined.

[0021] The masonry may be without, or comprise one or more, floor curb elements C located at the height of the floors, and/or roofing and/or foundation. For example, the masonry may be without curb elements when it consists of enclosure or retaining walls.

[0022] Where present, such curb elements C are nearly horizontal and each is associated with at least one wall panel M that is closed, i.e., solid and continuous, or has a set of openings A, such as windows, doors, and the like. The masonry 1 comprises a plurality of rod elements 3 attached to the masonry individually or, if appropriate or if required by specific contingencies and/or characteristics of the masonry, in parallel bundles. Such rod elements 3 are clamped and secured within

respective hollow seats 7 by means of a fixing material 5 that thereby accomplishes the so-called "grouting" of the rod elements 3 in their respective hollow seats 7. Such hollow seats 7 are carried out nearly vertically and mutually spaced apart on the accessible face F of the wall panel M.

[0023] In addition, for each hollow seat or group of hollow seats 7, the masonry 1 includes a first reinforcing element 9, elongated in shape, thin, with nearly parallel edges, and reproducing the shape of the portion of the accessible face F of the wall panel M adjacent to the longitudinal development of the hollow seat or group of hollow seats 7. In other words, the first reinforcing element 9 is firmly attached to the portions of the accessible face F located laterally to a hollow seat 7 by rejoining, that is bonding, such portions separated by the hollow seat.

[0024] The tests and trials conducted have shown excellent behaviour and strength of the work described above, which, to achieve further improvement, may additionally include at least a second reinforcing element 11, each attached to a respective curb element C and to the portions of the wall panel M or wall panels M adjacent to said curb element C, e.g., the upper and lower panels to the curb itself. An intermediate horizontal portion or lower edge of the wall panel M may also include a corresponding second reinforcing element 11 attached to the respective visible face F.

[0025] The second reinforcing element 11 mutually ties the curb element C and the respective wall panels M together making the latter capable of contributing to the reinforcement of the masonry and possibly allows the intermediate and lower portions of the wall panels M to be strengthened as well.

[0026] The portions of the accessible faces of the wall panels M carrying the hollow seats 7 and the first 9 and second 11 reinforcing elements and adjacent thereto shall be either bare or devoid or deprived of any coatings, such as plaster, panels, slabs, or the like, so that the reinforcing elements first 9 and second 11 can adhere directly to the brick, cement, or concrete. If the masonry is obtained from a construction having some claddings or clothing, this will be removed in the portions indicated above for the application of the first 9 and second 11 reinforcing elements and then restored where appropriate.

[0027] The vertical development of the rod elements 3, fixed by means of the fixing material 5 in their respective hollow seats 7, generally starts from the base or foundation of the wall panel M and their respective upper ends reach to heights less than or equal to the height of the respective wall panel M or reach the upper portion of the masonry by passing through, and being fixed to, all vertically overlapping wall panels M of the masonry 1.

[0028] Each rod element 3 may have to be developed for a length even much greater than that which can be stored, transported, and easily handled, for said reason each rod element 3 may consist of one or more segments whose adjacent end portions are mutually connected

and locked or secured by means of rings and/or sleeves and/or steel ties or resin-bonded banding. It is also provided that the ends of the rod elements may be provided with bonded sleeve, bonded and possibly taped "spigot" or a male and female screw connection.

[0029] As shown in the variant in Figure 4, the masonry may also include one or more optional holding element 13 made of fabric or glass fabric or mat or the like and having a tubular, sock or tape form.

[0030] Such holding element 13 is placed between the walls of a hollow seat 7 and respective rod elements 3, wherein such at least one holding element 13 is at least partially encased in the fixing material 5. The holding element 13 viewed in cross-section may be "U-shaped" with sides interposed between the walls of hollow seat 7 and rod element 3 or "O-shaped" in that it is wrapped around the rod element or shod around it; in either case, the fixing material 5 totally, or nearly so, impregnates or encompasses both holding elements 13 and rod element 3 and adheres to, and/or penetrates into the interstices of the walls of the hollow seat 7. The holding elements 13 are particularly useful in hollow seats 7 made in wall panels M made of perforated or hollow bricks because they improve the attachment of the rod element and prevent leakage of the fixing material 5 into the cavities of the bricks by improving the adhesion of the rod elements 3.

[0031] The invention provides that each rod element 3 can be fixed to the floor and/or roofing and/or foundation curbs by means of clamps, collars, pins, bandages, and the like secured to the curbs by means of screwed or secured with resins masonry pins.

[0032] Each rod element 3, or respective segment, is made of composite material comprising carbon and/or glass and/or aramid and/or boron and/or basalt and/or high-density polyethylene or Dineema® fibres embedded in an epoxy or polyurethane resin matrix or embedded in adhesive mortars or grout or the like. Alternatively, the rod elements, or some of them, may consist of steel bars or pipes or cables. The surface of each rod element 3 may be provided with optional gripping means, assigned to improve coupling with the fixing material 5, consisting of at least one of: adherent coating of sand or other rough material, cavities, transverse grooves or protrusions, or the like.

[0033] Each of the first 9 and second 11 reinforcing elements is fabric made of carbon and/or glass and/or other mineral or organic fibres such as aramid and/or boron and/or basalt and/or high-density polyethylene or Dineema® and the like or steel. Alternatively, the second reinforcing element 11 may be nonwoven fabric or mat of said fibres.

[0034] The fabric of the first reinforcing element 9 is preferably of a quadriaxial type and the fabric of the second reinforcing element 11 is preferably of a unidirectional, bidirectional or mat type wherein said fabrics are embedded in an epoxy or polyurethane resin matrix of the respective first 9 and second 11 reinforcing elements and

adhered to the masonry 1, securing said first 9 and second 11 reinforcing elements to the masonry itself; the fixing material 5 consisting of at least one of: high-strength mortar, epoxy resin, construction adhesives also incorporating aggregates and/or reinforcing fibres.

[0035] The invention provides that the wall panels M and, if any, curb elements C together with other building elements, are of a pre-existing construction and to be reinforced, and that the other constituents of the masonry (easily identifiable as they are marked by Arabic numerals) constitute the cooperating reinforcement with panels and curbs to give the masonry the desired resistance, for example to seismic events.

[0036] The method for carrying out the masonry, which is the object of the present invention, provides the following steps:

- making, at least in a predetermined position of the at least one accessible face F of one or more wall panels M of the masonry 1, at least one vertical hollow seat 7, each having transverse dimensions equal to or slightly greater than the transverse dimensions of at least one rod element 3 of one-piece type or of multiple interconnected segment type;
- fixing the at least one rod element 3 into its respective hollow seat 7, fixing it therein by applying into the hollow seat 7 fixing material 5 in the fluid or semi-fluid state and assigned to consolidate for realizing the block or anchoring or "grouting" of the at least one rod element 3 into its respective hollow seat 7;
- fixing a first reinforcing element 9 to a portion of the at least one accessible face F of the wall panel M adjacent to both sides of the longitudinal development of the hollow seat or a group of mutually adjacent hollow seats 7.

[0037] The method further provides securing at least one second reinforcing member 11 to portions of the at least one wall panel M or wall panels M adjacent to at least one curb member C and to such at least one curb member C and/or securing at least one second reinforcing member 11 to at least one horizontal portion of the at least one wall panel M.

[0038] The method further provides securing each first reinforcing element 9 of the masonry 1 to the respective portion of the accessible face F of the wall panel M by securing a four-axial fabric thereof 9, either having a different weft or weave or lacking the latter, by application to such respective portion of a resin in a fluid state assigned to imbibe the fabric and consolidate to embed or to encase the fabric and accomplish said fixing; and it provides the fixing of each second reinforcing element 11 of the masonry 1 to its respective surface portion by blocking a unidirectional, bidirectional, or differently textured fabric or fabric without any specific texture, of said second reinforcing element 11, by application to such respective portion of a resin in a fluid state assigned to imbibe the fabric and consolidate to embed or to encase

the fabric and to carry out said securing or fixing.

[0039] The method also provides removing, prior to the fixing of the first 9 and second 11 reinforcing elements, any plaster or other coatings of the portions of wall panels M assigned for said fixing. The coatings, whether of plaster, tiles, slabs, panels, or the like may eventually be applied or restored upon completion of the other steps of the method.

[0040] The method may further provide placing at least one optional holding element 13 made of fiberglass fabric or mat or the like in the form of a sock or tube or ribbon folded into place, against at least one wall of a hollow seat 7 carried out in a wall panel M made of perforated or solid brick, prior to the positioning and fixing of the respective rod element 3 into that seat by means of the fixing material 5.

[0041] The method provides making hollow seats 7 at fixed or variable mutual distances depending on the peculiarities and characteristics of the masonry and the type and magnitude of stresses to which it might be subjected by foreseeable events. It is also contemplated to make hollow seats 7 at the sides of the openings A of the masonry panels of the construction and, if necessary, to fix the second reinforcing elements to the masonry panels, not only at the curbs but also at base or intermediate areas of the masonry panels, such as above and below the openings A.

[0042] The invention provides that the hollow seats 7 with their respective rod elements 3 and the first reinforcing elements 9 can be made and fixed vertically in one or more stacked wall panels.

Claims

1. Reinforced masonry comprising at least one wall panel (M) having at least one accessible face (F) almost vertical and adjacent to a set of respective almost horizontal curb elements (C) each one associated with the at least one wall panel (M); said reinforced masonry (1) comprises a plurality of rod elements (3) fixed, individually or in bundles and by means of fixing material (5), within respective hollow seats (7) carried out, almost vertically and mutually spaced, at least in the accessible face (F) of the at least one wall panel (M), wherein each rod element (3) or respective segment is made of composite material comprising carbon and/or glass fibers or other mineral or organic fibres, embedded into an epoxy or polyurethane resin matrix or into adhesive mortar or the like, where the surface of each rod element (3) is provided with gripping means consisting of at least one of adherent sand coating or other rough material, cavities, transverse engravings or protrusions or similar, or it lacks them, **characterized in that** said reinforced masonry (1) comprises, for each hollow seat or group of hollow seats (7), a first reinforcing element (9) fixed to portions of the at

least one accessible face (F) of the wall panel (M) which are adjacent to the longitudinal development of the hollow seat or group of hollow seats (7), and rejoining such portions separated by the hollow seat; and **in that** said reinforced masonry (1) further comprises, for at least one curb element (C), a second reinforcing element (11) fixed to said curb element (C) and/or to the portions of the wall panel (M) or of the wall panels (M) adjacent to it (C), and/or **in that** it comprises at least a second reinforcing element (11) fixed to at least a horizontal portion of the edge of the wall panel (M); each first reinforcing element (9) is made of fabric, as the quadriaxial type, and each second reinforcing element (11) is of fabric, as unidirectional or bidirectional, or is mat, where such fabrics or mat are in carbon and/or glass fibres and/or other mineral or organic fibres and are embedded into a resinous matrix of the respective first (9) and second (11) reinforcing element, and they adhere to the masonry (1) fixing these reinforcing elements (9, 11) to the masonry itself; the fixing material (5) consisting of at least one of high-strength mortar and building adhesives, also incorporating inerts and/or reinforcing fibres.

2. Masonry according to claim 1 **characterized in that** the rod elements (3) fixed by means of the fixing material (5) in their respective hollow seats (7) extend starting from the base or foundation of the at least one wall panel (M) up to one or more respective heights lower than the height of their respective wall panel (M), or at least a subset of these rod elements (3) extends for the entire height of its respective wall panel (M) or of the entire masonry (1).

3. Masonry according to claim 1 or 2 **characterized in that** each rod element (3) can be constituted by one or more portions whose ends are mutually connected and blocked or fixed by means of rings and/or sleeves and/or steel bands or resin-soaked bands.

4. Masonry according to any one of claims 1 - 3 **characterized in that** it comprises at least one holding element (13) made of fabric or mat of glass fibre or similar in the shape of a sock or ribbon, between the walls of a hollow seat (7) and its respective rod elements (3), where said at least one holding element (13) is at least partially incorporated into the fixing material (5).

5. Method for carrying out the masonry of any one of the previous claims comprising the following steps:

- making, at least in a predetermined position of the at least one accessible face (F) of a wall panel (M) of the masonry (1), at least one vertical hollow seat (7), each having transverse dimensions equal to or slightly greater than the trans-

verse dimensions of at least one rod element (3) of the single kind or of the kind made of several interconnected segments;

- placing the at least one rod element (3) into its respective hollow seat (7) fixing it therein by applying into the hollow seat (7) fixing material (5) in the fluid or semi-fluid state and assigned to consolidate for realizing the block or anchoring of the at least one rod element (3) in its respective hollow seat (7);

said method being **characterized in that** it comprises the following steps

- fixing one first reinforcement element (9) to a portion of the at least one accessible face (F) of the wall panel (M) adjacent to the sides of the longitudinal development of the hollow seat or of a group of side by side hollow seats (7) and rejoining such portions separated by the hollow seat;

- fixing at least a second reinforcement element (11) to the portions of the wall panel (M) or of the wall panels (M) adjacent to at least one curb element (C) and to this at least one curb element (C), and/or fixing at least a second reinforcing element (11) to at least a horizontal portion of the wall panel (M);

- fixing each first reinforcing element (9) of the masonry (1) to the respective portion of the accessible face (F) of the wall panel (M) by blocking a fabric of the first reinforcing element (9), quadriaxial or with different weave or without it, by applying to this respective portion a resin in the fluid state assigned to soak the fabric and to reticulate to incorporate the fabric and to make said fixing thereof;

- fixing each second reinforcing element (11) of the masonry (1) to the respective surface portion by blocking a fabric of the second reinforcing element (11), of the unidirectional, bidirectional kind or with a different weave or without it, by applying to this respective portion a resin in the fluid state assigned to soak the fabric and to reticulate to incorporate the fabric and to make said fixing thereof.

6. Method according to claim 5 **characterized by** removing plasters or other coatings of the portions of the wall panels (M) before fixing to such portions their respective first (9) or second (11) reinforcing elements.

7. Method according to claim 5 or 6 **characterized by** placing at least one holding element (13), made of fabric or mat of glass fiber or similar in the shape of a sock or ribbon, against at least one wall of a hollow seat (7) made in a hollow or solid bricks wall panel

(M), before fixing in such seat the respective rod element (3) by means of the fixing material (5).

5 Patentansprüche

1. Verstärktes Mauerwerk umfassend mindestens ein Wandpaneel (M) mit mindestens einer zugänglichen Fläche (F) fast vertikal und angrenzend an einen Satz entsprechender fast horizontaler Einfasselemente (C), wobei jede davon dem mindestens einen Wandpaneel (M) zugeordnet ist; wobei das verstärkte Mauerwerk (1) eine Vielzahl von Stangenelementen (3) umfasst, die einzeln oder in Bündeln und mittels Befestigungsmaterial (5) in entsprechenden hohlen Aufnahmen (7) befestigt sind, die fast vertikal und voneinander beabstandet zumindest in der zugänglichen Fläche (F) des mindestens einen Wandpaneels (M) vorgenommen sind, wobei jedes Stangenelement (3) oder entsprechende Segment aus einem Verbundmaterial hergestellt ist, das Kohlenstoff- und/oder Glasfasern oder andere mineralische oder organische Fasern umfasst, die in einer Epoxy- oder Polyurethanharzmatrix oder in Haftmörtel oder dergleichen eingebettet sind, wobei die Oberfläche jedes Stangenelements (3) versehen ist mit Greifmitteln, die aus mindestens einer haftenden Sandbeschichtung oder einem anderen rauen Material bestehen, mit Hohlräumen, mit querlaufenden Einkerbungen oder Vorsprüngen oder dergleichen, oder es ist nicht damit versehen, **dadurch gekennzeichnet, dass** das verstärkte Mauerwerk (1) für jede hohle Aufnahme oder Gruppe hohler Aufnahmen (7) ein erstes Verstärkungselement (9) umfasst, das an Bereiche der mindestens einen zugänglichen Fläche (F) des Wandpaneels (M) befestigt ist, die sich angrenzend an den länglichen Verlauf der hohlen Aufnahme oder Gruppe hohler Aufnahmen (7) befinden, und die Bereiche wieder miteinander verbindet, die durch die hohle Aufnahme separiert sind; und dadurch, dass das verstärkte Mauerwerk (1) weiterhin zumindest für ein Einfasselement (C) ein zweites Verstärkungselement (11) aufweist, das mit dem Einfasselement (C) und/oder mit den Bereichen des Wandpaneels (M) oder den daran (C) angrenzenden Wandpaneelen (M) befestigt ist, und/oder dadurch, dass es mindestens ein zweites Verstärkungselement (11) umfasst, das an mindestens einem horizontalen Bereich des Rands des Wandpaneels (M) befestigt ist; wobei jedes erste Verstärkungselement (9) aus einem Gewebe der quadriaxialen Art hergestellt ist und jedes zweite Verstärkungselement (11) ist aus einem Gewebe der unidirektionalen oder bidirektionalen Art hergestellt oder ist eine Platte, wobei derartige Gewebe oder Platte aus Kohlenstoff- und/oder Glasfasern und/oder anderen mineralischen oder organischen Fasern sind und in eine harzartige Matrix des ent-

sprechenden ersten (9) und zweiten (11) Verstärkungselement eingebettet sind, und an dem Mauerwerk (1) haften, das diese Verstärkungselemente (9, 11) an dem Mauerwerk selbst befestigt; wobei das Befestigungsmaterial (5) aus mindestens einem

2. Mauerwerk gemäß Anspruch 1, **dadurch gekennzeichnet, dass** sich die Stangenelemente (3), die mittels des Befestigungsmaterials (5) in ihren entsprechenden hohlen Aufnahmen (7) befestigt sind, sich beginnend bei der Basis oder dem Fundament des mindestens einen Wandpaneels (M) bis zu einem oder mehr entsprechender Höhen erstrecken, die niedriger sind als die Höhe ihrer entsprechenden Wandpaneele (M), oder mindestens eine Teilmenge dieser Stangenelemente (3) erstreckt sich über die gesamte Höhe ihrer entsprechenden Wandpaneele (M) oder des gesamten Mauerwerks (1).

3. Mauerwerk gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** jedes Stangenelement (3) aus einem oder mehr Bereichen bestehen kann, deren Enden miteinander verbunden sind und mittels Ringen und/oder Hüllen und/oder Stahlbändern oder harzgetränkten Bändern blockiert oder befestigt sind.

4. Mauerwerk gemäß einem der Ansprüche 1-3, **dadurch gekennzeichnet, dass** es mindestens ein Halteelement (13) umfasst, das aus einem Gewebe oder einer Matte aus Glasfaser oder ähnlichem in der Form einer Socke oder Schleife hergestellt ist, zwischen den Wänden einer hohlen Aufnahme (7) und ihrer entsprechenden Stangenelemente (3), wobei das mindestens eine Halteelement (13) mindestens teilweise in das Befestigungsmaterial (5) aufgenommen ist.

5. Verfahren zum Ausführen des Mauerwerks gemäß einem der vorhergehenden Ansprüche, umfassend die folgenden Schritte:

- Herstellen, zumindest in einer vorbestimmten Position der mindestens einen zugänglichen Fläche (F) eines Wandpaneels (M) des Mauerwerks (1), von mindestens einer vertikalen hohlen Aufnahme (7), die jeweils Querabmessungen aufweist, die gleich oder geringfügig größer sind als die Querabmessungen von mindestens einem Stangenelement (3) der einzelnen Art oder der Art bestehend aus mehreren miteinander verbundenen Segmenten;
- Platzieren des mindestens einen Stangenelements (3) in seine entsprechende hohle Aufnahme (7), darin Befestigen durch Anbringen von

Befestigungsmaterial (5) im fluiden oder halbfluiden Zustand in die hohle Aufnahme (7) und welches vorgehen ist, sich zu verfestigen um das Blockieren oder Verankern des mindestens einen Stangenelements (3) in seiner entsprechenden hohlen Aufnahme (7) zu realisieren;

und das Verfahren ist **dadurch gekennzeichnet, dass** es die folgenden Schritte umfasst

- Befestigen eines ersten Verstärkungselements (9) an einen Bereich der mindestens einen zugänglichen Fläche (F) des Wandpaneels (M) angrenzend an die Seiten des Längsverlaufs der hohlen Aufnahme oder einer Gruppe von Seite an Seite angeordneten hohlen Aufnahmen (7) und erneutes Verbinden der Bereiche, die durch die hohle Aufnahme separiert wurden;

- Befestigen von mindestens einem zweiten Verstärkungselement (11) an die Bereiche des Wandpaneels (M) oder der Wandpaneele (M) angrenzend an mindestens ein Einfasselement (C) und an dieses mindestens eine Einfasselement (C), und/oder Befestigen von mindestens einem zweiten Verstärkungselement (11) an mindestens einen horizontalen Bereich des Wandpaneels (M);

- Befestigen jedes ersten Verstärkungselements (9) des Mauerwerks (1) an den entsprechenden Bereich der zugänglichen Fläche (F) des Wandpaneels (M) durch Blockieren eines Gewebes aus dem ersten Verstärkungselement (9), quadraxial oder mit unterschiedlicher Webart oder ohne Webart, durch Aufbringen eines Harzes in fluidem Zustand auf diesen entsprechenden Bereich, das vorgesehen ist, das Gewebe zu tränken und sich netzförmig anzulegen, um das Gewebe aufzunehmen und dessen Befestigung herzustellen;
- Befestigen jedes zweiten Verstärkungselements (11) des Mauerwerks (1) an die entsprechenden Oberflächenbereiche durch Blockieren eines Gewebes des zweiten Verstärkungselements (11), der unidirektionalen, bidirektionalen Art oder mit einer anderen Webart oder ohne Webart, durch Aufbringen eines Harzes in fluidem Zustand auf diesen entsprechenden Bereich, das vorgesehen ist, das Gewebe zu tränken und sich netzförmig anzulegen, um das Gewebe aufzunehmen und dessen Befestigung herzustellen.

6. Verfahren gemäß Anspruch 5, **dadurch gekennzeichnet, dass** Putz oder andere Beschichtungen der Bereiche des Wandpaneels entfernt werden, bevor an diese Bereiche deren entsprechendes erstes (9) oder zweites (11) Verstärkungselement be-

festigt wird.

7. Verfahren gemäß Anspruch 5 oder 6, **dadurch gekennzeichnet, dass** mindestens ein Halteelement (13), das hergestellt ist aus Gewebe oder einer Platte aus Glasfaser oder ähnlichem in der Form einer Socke oder Schleife, gegen mindestens eine Wand einer hohlen Aufnahme (7) platziert ist, die in einem Wandpaneel aus hohlen oder festen Steinen vorgenommen ist, bevor in einer solchen Aufnahme das entsprechende Stangenelement (3) mittels des Befestigungsmaterials (5) befestigt wird.

Revendications

1. - Maçonnerie armée comprenant au moins un panneau mural (M) ayant au moins une face accessible (F) presque verticale et adjacente à un ensemble d'éléments bordures (C) presque horizontaux respectifs, associés chacun à l'au moins un panneau mural (M) ; ladite maçonnerie armée (1) comprend une pluralité d'éléments tiges (3) fixés, individuellement ou en faisceaux et au moyen d'un matériau de fixation (5), à l'intérieur de sièges creux (7) respectifs réalisés, presque verticalement et mutuellement espacés, au moins dans la face accessible (F) de l'au moins un panneau mural (M), chaque élément tige (3) ou segment respectif étant fait de matériau composite comprenant des fibres de carbone et/ou de verre ou d'autres fibres minérales ou organiques, intégrées dans une matrice de résine époxy ou polyuréthane ou dans un mortier adhésif ou analogue, la surface de chaque élément tige (3) comportant des moyens de prise constitués d'au moins un parmi un revêtement de sable adhérent ou un autre matériau rugueux, des cavités, des gravures ou saillies transversales ou analogues, ou en étant dépourvue, **caractérisée par le fait que** ladite maçonnerie armée (1) comprend, pour chaque siège creux ou groupe de sièges creux (7), un premier élément de renforcement (9) fixé à des parties de l'au moins une face accessible (F) du panneau mural (M) qui sont adjacentes au développement longitudinal du siège creux ou du groupe de sièges creux (7), et rejoignant ces parties séparées par le siège creux ; et **par le fait que** ladite maçonnerie armée (1) comprend en outre, pour au moins un élément bordure (C), un second élément de renforcement (11) fixé audit élément bordure (C) et/ou aux parties du panneau mural (M) ou des panneaux muraux (M) adjacentes à celui-ci (C), et/ou **par le fait qu'**elle comprend au moins un second élément de renforcement (11) fixé à au moins une partie horizontale du bord du panneau mural (M) ; chaque premier élément de renforcement (9) est fait de tissu, par exemple du type quadriaxial, et chaque second élément de renforcement (11) est fait de tissu, par exemple

unidirectionnel ou bidirectionnel, ou est un mat, ces tissus ou ce mat étant en fibres de carbone et/ou de verre et/ou d'autres fibres minérales ou organiques et étant intégrés dans une matrice résineuse des premier (9) et second (11) éléments de renforcement respectifs, et ils adhèrent à la maçonnerie (1), fixant ces éléments de renforcement (9, 11) à la maçonnerie elle-même ; le matériau de fixation (5) étant constitué d'au moins un parmi un mortier à haute résistance et des adhésifs de construction, incorporant également des matières inertes et/ou des fibres de renforcement.

2. - Maçonnerie selon la revendication 1, **caractérisée par le fait que** les éléments tiges (3) fixés au moyen du matériau de fixation (5) dans leurs sièges creux (7) respectifs s'étendent à partir de la base ou fondation de l'au moins un panneau mural (M) jusqu'à une ou plusieurs hauteurs respectives inférieures à la hauteur de leur panneau mural (M) respectif, ou au moins un sous-ensemble de ces éléments tiges (3) s'étend sur toute la hauteur de son panneau mural (M) respectif ou de l'ensemble de la maçonnerie (1).
3. - Maçonnerie selon la revendication 1 ou 2, **caractérisée par le fait que** chaque élément tige (3) peut être constitué d'une ou plusieurs parties dont les extrémités sont mutuellement reliées et bloquées ou fixées au moyen d'anneaux et/ou de manchons et/ou de bandes d'acier ou de bandes imbibées de résine.
4. - Maçonnerie selon l'une quelconque des revendications 1 à 3, **caractérisée par le fait qu'**elle comprend au moins un élément de maintien (13) fait de tissu ou de mat de fibre de verre ou analogue en forme de chaussette ou de ruban, entre les parois d'un siège creux (7) et ses éléments tiges (3) respectifs, ledit au moins un élément de maintien (13) étant au moins partiellement incorporé dans le matériau de fixation (5).
5. - Procédé de réalisation de la maçonnerie selon l'une quelconque des revendications précédentes, comprenant les étapes suivantes :
- réaliser, au moins dans une position prédéterminée de l'au moins une face accessible (F) d'un panneau mural (M) de la maçonnerie (1), au moins un siège creux vertical (7), chacun ayant des dimensions transversales égales ou légèrement supérieures aux dimensions transversales d'au moins un élément tige (3) du type unique ou du type fait de plusieurs segments interconnectés ;
 - placer l'au moins un élément tige (3) dans son siège creux (7) respectif, le fixant à l'intérieur de celui-ci par application dans le siège creux (7) du

matériau de fixation (5) à l'état fluide ou semi-fluide et destiné à se consolider pour réaliser le blocage ou l'ancrage de l'au moins un élément tige (3) dans son siège creux (7) respectif ; (5).

5

ledit procédé étant **caractérisé par le fait qu'il** comprend les étapes suivantes :

- fixer un premier élément de renforcement (9) à une partie de l'au moins une face accessible (F) du panneau mural (M) adjacente aux côtés du développement longitudinal du siège creux ou d'un groupe de sièges creux (7) côte à côte, et rejoignant ces parties séparées par le siège creux ; 10 15

- fixer au moins un second élément de renforcement (11) aux parties du panneau mural (M) ou des panneaux muraux (M) adjacentes à l'au moins un élément bordure (C) et à cet au moins un élément de bordure (C), et/ou fixer au moins un second élément de renforcement (11) à au moins une partie horizontale du panneau mural (M) ; 20

- fixer chaque premier élément de renforcement (9) de la maçonnerie (1) à la partie respective de la face accessible (F) du panneau mural (M) par blocage d'un tissu du premier élément de renforcement (9), quadriaixial ou avec une armure différente ou sans celle-ci, par application à cette partie respective d'une résine à l'état fluide destinée à imbiber le tissu et à se réticuler pour incorporer le tissu et pour réaliser ladite fixation de celui-ci ; 25 30

- fixer chaque second élément de renforcement (11) de la maçonnerie (1) à la partie de surface respective par blocage d'un tissu du second élément de renforcement (11), du type unidirectionnel bidirectionnel ou avec une armure différente ou sans celle-ci, par application à cette partie respective d'une résine à l'état fluide destinée à imbiber le tissu et à se réticuler pour incorporer le tissu et réaliser ladite fixation de celui-ci. 35 40

6. - Procédé selon la revendication 5, **caractérisé par** le retrait d'enduits ou autres revêtements des parties des panneaux muraux (M) avant de fixer à ces parties leurs premiers (9) ou seconds (11) éléments de renforcement respectifs. 45 50

7. - Procédé selon la revendication 5 ou 6, **caractérisé par** la mise en place d'au moins un élément de maintien (13), fait de tissu ou de mat de fibre de verre ou analogue en forme de chaussette ou de ruban, contre au moins une paroi d'un siège creux (7) réalisé dans un panneau mural en briques creuses ou pleines (M), avant de fixer dans ce siège l'élément tige (3) respectif au moyen du matériau de fixation 55

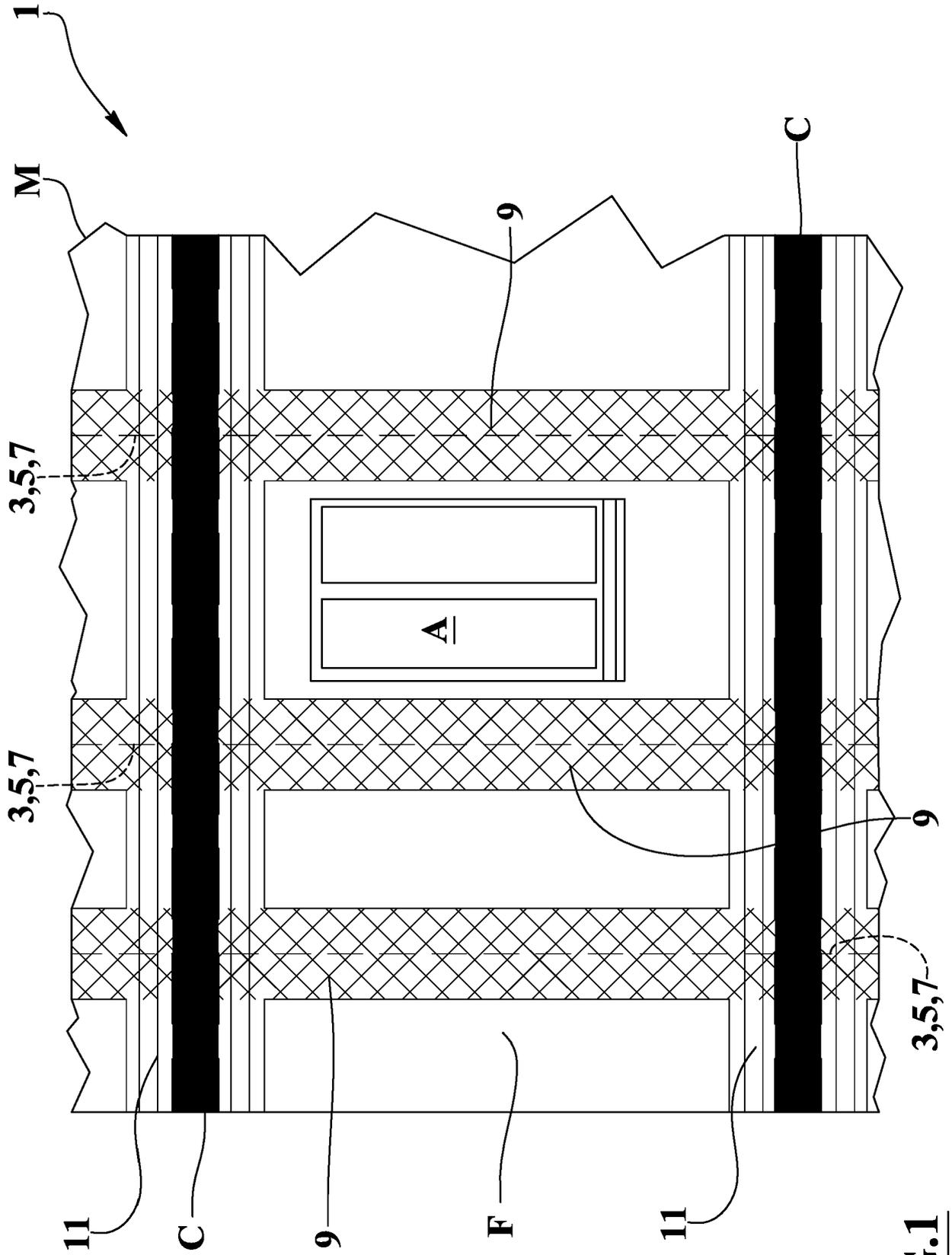


FIG.1

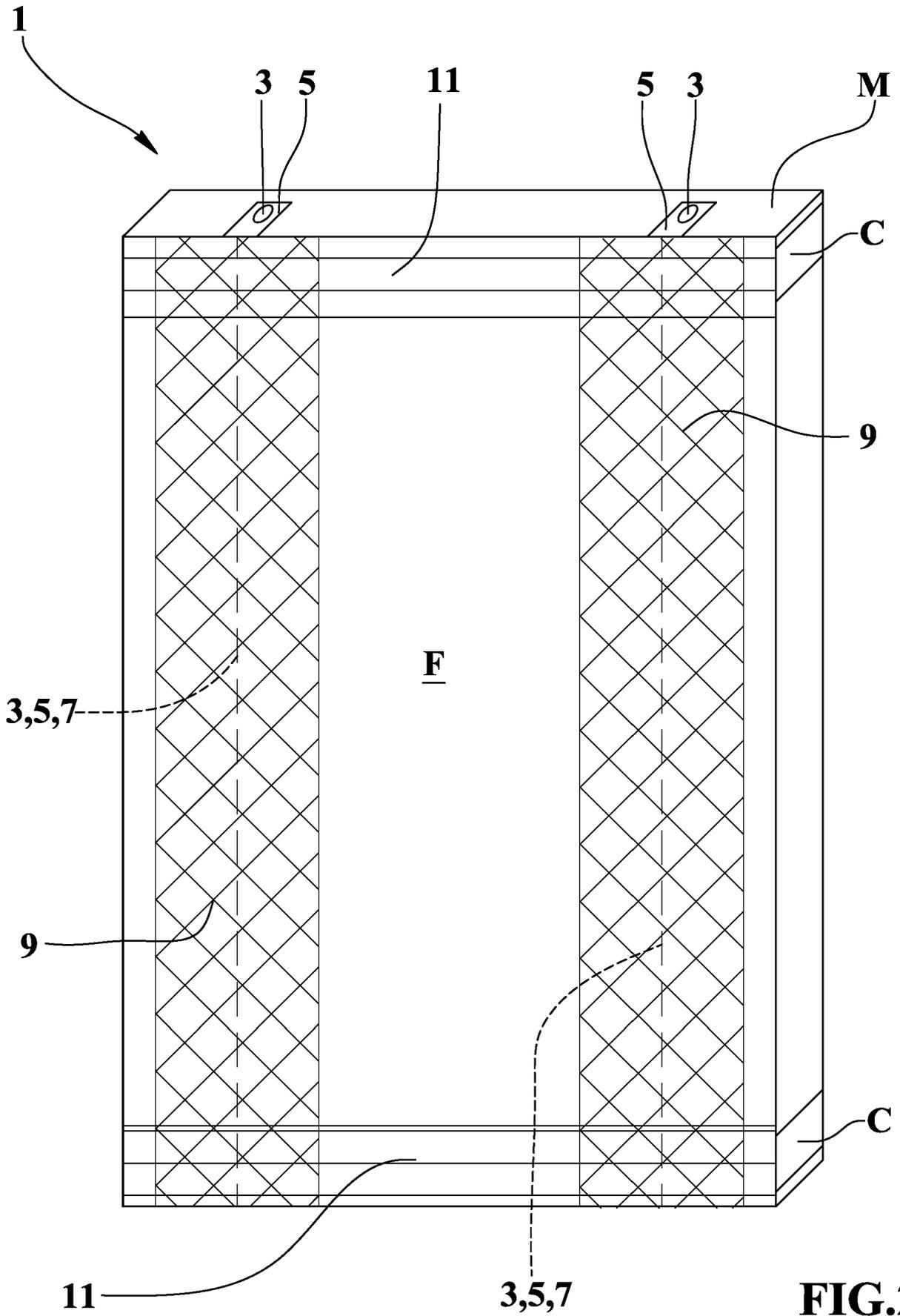


FIG.2

FIG.3

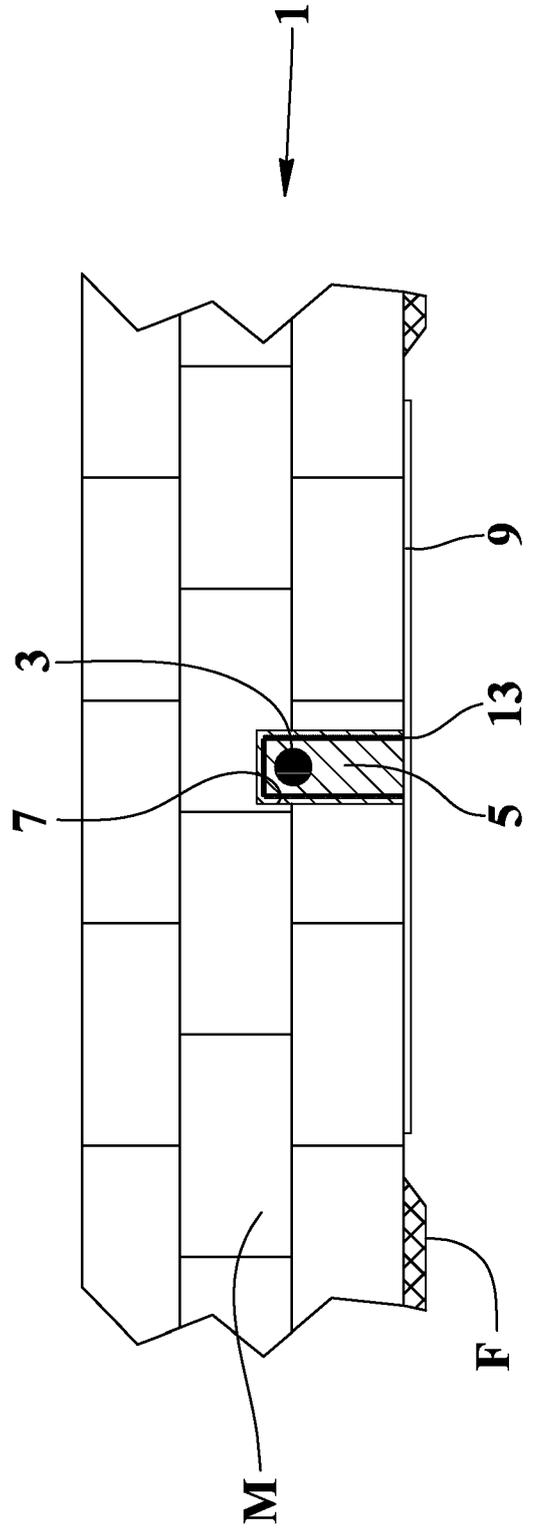
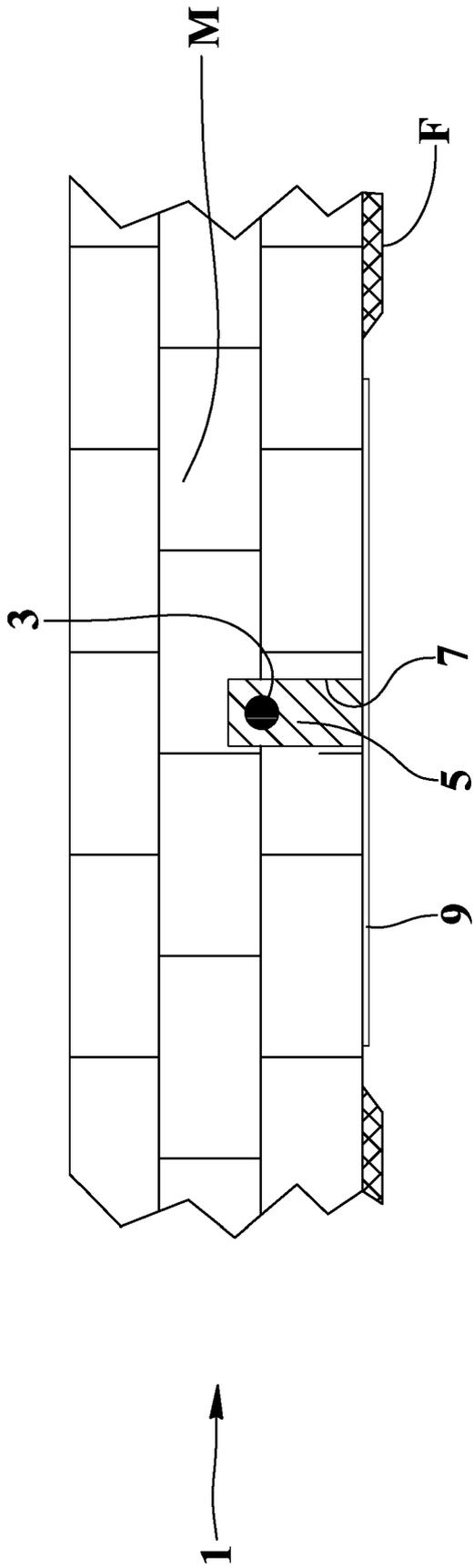


FIG.4

REFERENCES CITED IN THE DESCRIPTION

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