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(71) Applicant: **Sangiorgio, Luciano, Via Federico Galeotti, 62, I-00167 Roma (IT)**

(72) Inventor: **Sangiorgio, Luciano, Via Federico Galeotti, 62, I-00167 Roma (IT)**

(74) Representative: **Cavattoni, Fabio et al, Cavattoni & Raimondi Via Giuseppe Mangili, 16, I-00197 Roma (IT)**

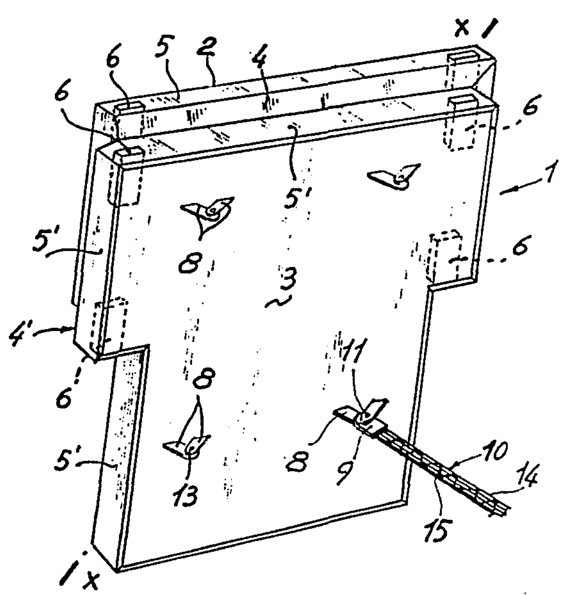
(54) **Concrete panels and relative means for their anchoring to earth, for forming a facing wall of variable planimetric course and allowing settlement of the panels in the facing wall surface, and the facing wall thus obtained.**

(57) The panels are constituted by two T-shaped integrally formed flat elements (2, 3), superposed in mutually translated relationship along one of the diagonal geometrical axes (X-X) of the ideal quadrangular perimeter which circumscribes them, in such a manner as to form perimetral support zones (4, 4', 5, 5') for other panels.

The upper part of each element comprises, in proximity to the upper and lower side ends, oblong seats (6) for housing pins for connecting the panels (1) together.

By suitably increasing the height of the stem of the T relative to the height of its transverse bar, a facing wall is obtained which can assume a variable planimetric course, while at the same time providing considerable facility for the settling of the panels in the surface of the facing wall itself.

The earth anchoring means comprise anchoring elements (10) constituted by pluralities of threads of glass filaments which form a warp (14) on which there is woven and resin-bonded a weft (15) of glass and/or polyester filaments, and connection elements on the panels for their fixing to the anchoring elements (10).



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Concrete panels and relative means for their anchoring to earth, for forming a facing wall of variable planimetric course and allowing settlement of the panels in the facing wall surface, and the facing wall thus obtained

The present invention relates to concrete panels and the relative means for their anchoring to earth, for forming a facing wall of variable planimetric course and allowing settlement of the panels in the facing wall surface, and the facing wall thus obtained.

The retaining of incoherent or non-incoherent earth masses was formerly effected using masonry structures. In its most simple conception, the masonry facing wall is of the "gravity" type, and withstands the overturning thrusts of the earth mass by virtue of its own weight, resulting in rather massive structures. In contrast, resistance to translatory movement is provided by friction between the foundation and the ground on which it lies. This type of structure generally requires excavation work, which can be costly, in seeking a resistant substrate for forming the foundation, and is generally unable to withstand subsidence which differs from point to point.

Reinforced concrete technology subsequently enabled the problem to be confronted differently by means of ledge-type walls in which a relatively thin base platform acts as the foundation surface for the masonry work. This type of structure enables the weight of the pressing earth mass acting on the upstream part of said base platform to be utilised, in order that the resultant of the overturning mass forces acts within the interior of the foundation, thus giving it stability. Resistance to sliding is again provided by friction between the base platform and its supporting ground.

The search for new constructional methods in the field under examination has been directed towards the following objects:

- obtaining facing walls in which the volume of the materials used increases only linearly with the height of the facing wall itself;

- obtaining facing walls requiring minimum bulk in the foundation zone, if only during the constructional stage, and requiring the minimum quantity of excavation work, which is always costly and sometimes dangerous;

- obtaining facing walls which adapt to non-uniform settling without the loss of structural and aesthetic characteristics;

- obtaining facing walls which require an increasingly lesser use of formwork and/or falsework for their construction, so as to reduce their construction time.

Within this viewpoint, it is normal to form structures (generally bank retaining walls) constituted by facing walls connected to anchoring elements buried in the rear earth. These anchoring elements are formed in accordance with two different systems.

In the case of earth masses which already exist on site and form the banking, ties are conveniently disposed in bores drilled in the mass to be retained.

In the case of artificial embankments or deposits generally, either the aforesaid method is used, or reinforcements of various kinds are more or less regularly intercalated into the earth as it is deposited and compacted, to utilise the friction forces exerted by the overlying earth mass. Finally, ties can be used connected to a passive anchoring terminal which opposes any attempt at its extraction by mobilising the passive resistance of the earth.

Examples of methods for securing a facing wall by friction means buried in the earth include the sometimes used method of connecting the facing wall to horizontal concrete elements embedded in the rear earth. In this respect, another widespread method is to form the retaining facing wall by means of prefabricated panels of various shapes anchored to the rear earth in one of the aforesaid ways, as for example described in the publication "La meccanica del terreno applicata alle costruzioni stradali", by Giuseppe Tesoriere, published by Denaro, Palermo, 1959, Figure 236, page 334. This publication shows a facing wall of modular prefabricated concrete panels anchored to the earth mass to be retained.

A further constructional method is to retain earth masses, such as those under discussion, by means of metal or concrete panels anchored to artificially laid rear earth by means of smooth or non-smooth metal bands of galvanised steel or other metals, suitably fixed to said panels.

Although such a method is currently widespread, it has drawbacks and deficiencies attributable both to the panels and to the anchoring elements used.

The geometrical configurations of currently known panels used in the construction of facing walls of the described type are many and varied. Some of these panels have specific characteristics for obtaining determined results and/or effects, whereas others have specific characteristics for obtaining results and/or effects which are different from the preceding, but of which some can be common. However, no known panel combines in itself without distinction the characteristics required for obtaining all the aforesaid results and/or effects by virtue particularly of a shape and configuration which without using special devices enables a facing wall to be constructed with a variable planimetric course which is not limited in terms of radius of curvature, which can be constructed either in successive horizontal rows or in only one row, with the facility for erecting the panels either from above or from the side without the need for falsework, and finally with the ability to absorb possible differential settling of a facing wall without the need to cut the facing wall over its entire height and insert suitable joints into the structure, and to absorb substantial and/or variable subsidence of the supporting ground along the facing wall.

In particular, in the known art, for forming accentuated angles, a suitable vertical connection element is inserted between the two facing wall parts, which are cut over their entire height. This device accentuates the drawback of having to renounce many panel characteristics (abutting surfaces, geometrical shape etc.) when the points of planimetric variation in the facing wall, which necessitate said device, are close together. In this respect, where a planimetric variation with 90° angles in close succession is required, for example a panel followed by the absence of a panel, the advantages of the shaped panels might in fact not be utilised.

The metal anchor elements employed in the method heretofore described cannot always be used. In this respect, there are chemical and physical earth conditions or ranges of chemical and physical parameters such as resistivity, pH, content of Cl^-, SO_4^{--}, NO_3^-, NO_2^- and other ions, which make their use impossible. Metal elements can in fact be subjected to various types of corrosion, and it should be noted that in the present case "stress" corrosion occurs, this being an extremely insidious type of localised corrosion, which develops with the formation of cracks in the metal and occurs by the combined action of mechanical stress and a specific corrosive medium of mild corrosive action and such that, in the absence of the state of stress, would have been able to give rise to slight action of attack with different morphology. Stress corrosion is an extremely widespread phenomenon which affects a wide range of metal materials such as ferrite steels, stainless steels, light alloys, copper alloys and titanium alloys etc., under the action of environments of various kinds such as halides, nitrates, sulphides, caustic or slightly acid solutions and organic solvents, at various temperatures and including in the vapour state. Considering the variety of conditions under which cases of stress corrosion have been observed, it is not possible in the present state of research to formulate general rules which predict the degree of susceptibility of the material to stress corrosion or the aggressive power of a solution, because this type of corrosion intervenes only when strictly specific conditions occur. Thus an even slight variation in one of the system parameters would sometimes be sufficient to completely change the morphology of the attack towards less insidious forms. The result is that it is not possible to speak of metals which are immune from stress corrosion or of promoter environments. It is only possible to formulate a certain number of rules of general character which can assume merely the significance of orientating towards the choice of materials and their use ("Corrosione e Protezione dei Metalli", G. Bianchi - F. Mazza, published by Masson Italia, 1980).

From the aforegoing, it is apparent that the physical and chemical characteristics of earth can suffer considerable variation in time, which can prejudice the reliability of anchoring elements constructed in accordance with the said art. A further consequence is that the use of such metal anchoring elements is firstly limited in that from a study of the chemical and physical characteristics of the earth, their life must be related to corrosion (which reduces the useful cross-section of the anchoring element). It is also further limited (and because of this such anchoring elements must be subjected to periodic check) in that it is necessary to verify that the actual corrosion continues to correspond in time to the assumed corrosion.

The problem both of knowing whether the chemical and physical earth conditions vary with time and of how to remedy this remains in all cases unsolved. Furthermore, the currently used metal strip anchoring elements cannot be easily adapted to the earth particle size, and offer a coefficient of friction between the anchoring element and the earth which, although increased over smooth strips by means of suitable projections, acts only in the direction (monodirection) orthogonal to the projections provided on said strips.

An object of the invention is therefore to provide an earth retaining structure, or facing wall, which can take a variable planimetric course such as to be able to construct configurations which are not limited in terms of radius of curvature; which can be constructed either in the form of successive horizontal rows or in a single row, by changing the dimensions but not the shape of the panels, and with the facility for erecting them either from above or from the side, without the need for falsework for the concrete panels; and such as to be able to absorb both any differential settling of one part of the facing wall with respect to an adjacent part without the need for cutting the facing wall over its entire height and inserting suitable joints into the structure, and substantial and/or variable subsidence in the support ground along the facing wall by virtue of the panels themselves being able to adjust horizontally, vertically and rotatably in the surface of said facing wall; and again such as to be secured by an anchoring element which is not affected by quantitative or qualitative variations in the physical and chemical characteristics of the earth with time; and finally such as to be formable within a wide range of earth particle size and with a high multi-directional coefficient of friction.

A further object of the invention is consequently to provide concrete panels, the shape and configuration of which enable the vertical joints of the erected panels to permit rotation both about a vertical axis and about an inclined axis lying within the surface of the facing wall.

A further object of the invention is to provide anchoring elements which are not subject to corrosion, have a considerable life and therefore do not require periodic checking, are able to tolerate a considerable range of particle size of the earth in which they are embedded, and finally provide a high multi-directional coefficient of friction between the anchoring element and the earth.

These objects are attained according to the invention by a reinforced or non-reinforced concrete panel constituted by two T-shaped, integrally formed superposed flat elements which are in translated relationship to each other along one of the diagonal geometrical axes of the ideal quadrangular perimeter which circumscribes them, and which at each side of the panel comprise support zones which constitute the abutting surface for an overlying or underlying adjacent panel, said panel being secured to the earth by anchoring elements each formed in the manner of woven fabric of which the warp is constituted by a plurality of threads of extended length orthogonal or non-orthogonal to the panel, and of which the weft is constituted by at least one thread disposed orthogonally to the warp, said warp threads being constructed of glass filaments bonded together by resin and on which a weft of glass or mixed glass-polyester filaments is woven and then resin-bonded in such a manner as to form compact units.

The subject matter of the invention is described in greater detail hereinafter with reference to preferred embodiments shown by way of non-limiting example on the accompanying drawings, in which:

Figure 1 is a perspective diagrammatic view of some panels of the invention erected;

Figure 2 is a front view of a facing wall obtained from the panels of the invention;

Figure 3 is a cross-section on the line I-I of the facing wall of Figure 2;

Figure 4 is a detail of two pinned panels disposed at 90°;

Figure 5 is a diagrammatic view from below of a portion of facing wall of varying planimetric course in which the panels are rotated through an angle of up to 90°;

Figure 6 is a front view of a facing wall obtained from a single row of T-shaped panels of the invention having different but complementary proportions;

Figure 7 is a perspective view of the front surface of a further embodiment of a panel according to the invention;

Figure 8 shows an embodiment of a connection element for connecting the panels to the earth anchoring elements according to the invention, and which is partly embedded in the panel;

Figures 9 and 10 show further embodiments of the elements for connecting the panels to the anchoring elements;

Figure 11 is a perspective rear view of a panel according to the invention provided with the connection elements of Figures 8, 9 or 10;

Figure 12 is a detailed view of the terminal parts of a connection element in accordance with Figures 8, 9 or 10, with the reinforced head of an anchoring element inserted and locked therebetween;

Figure 13 shows some embodiments of the weave of the weft on the warp, and of the reinforced heads of the anchoring and/or connection elements according to the invention;

Figures 14 and 15 are views of particular embodiments of the anchoring elements according to the invention;

Figure 16 is a vertical sectional diagrammatic view of a facing wall constructed with the panels according to the invention, and of the earth which is retained thereby and in which anchoring elements according to the invention for said panels are embedded.

Figure 1 shows T-shaped panels according to the invention, suitably erected. More particularly, the reinforced or non-reinforced concrete panel 1 of the invention is constituted by two T-shaped integrally formed flat elements 2 and 3 which are superposed in mutually translated relationship along the diagonal geometrical axis X-X of the ideal quadrangular perimeter which circumscribes them, and have their projecting perimetral edges 4, 4' outwardly bevelled in such a manner as to form perimetral support zones for other panels, said zones being shaped substantially as a step formed by two parallel surfaces 5, 5' and by an intermediate inclined surface constituted by said outwardly bevelled projecting perimetral edges 4, 4'. The corners of the outer surfaces are suitably chamfered in order to facilitate rotation between adjacent panels.

The upper part of each element 2 and 3 which forms the transverse bar of the T comprises, in proximity to its upper and lower side ends, blind seats for housing with substantial play pins 6', for example of galvanised steel, for connecting the panels together.

This substantial play gives the facing wall a certain degree of horizontal deformability. The geometrical T shape of the panel according to the invention enables the relative facing wall to adapt to curved courses, in that the panel "lips" form at a constant spacing an "articulation" over the entire height of the facing wall, whereas the support zones, determined by the staggered configuration of the two flat elements of the panel, allow both erection without falsework, and mutual collaboration between panels, the positioning of which is also facilitated by the joint provided by the vertical pins.

Figures 2 and 3 show a front view of a facing wall constructed with panels according to the invention, and a section therethrough respectively.

The panels of the invention can also adapt to extremely accentuated curvatures, and indeed a facing wall can be formed with a limiting configuration forming a broken line with 90° angles, while still providing continuity of the facing wall itself.

The rotation which enables this is facilitated by the play between the pins and seats and by the inclination of the surfaces 4, 4' which join together the parallel surfaces 5, 5' of the support zone.

Moreover, in order for the panels to properly adjoin each other (allowing for tolerances) along the entire hinging axis when in positions between 0° and 90°, the panel lip must be dimensioned as a function of the depth of the zone of rotation, as shown by way of non-limiting example in Figure 4, in which the lips of each flat element 2 and 3 have a depth less than or equal to one half the panel thickness.

The arrangement of the seats 6 in each flat element 2, 3 enables the pins to be disposed for rotating the panels in one or other of said flat elements so as to obtain optimum adaptation of the facing wall to its planimetric course.

Figure 5 is a diagrammatic view from below of a portion of facing wall obtained from the panels of the invention, which takes a variable planimetric course with the panels being rotated through angles of up to 90°.

Suitable rubber joints can be inserted either vertically or horizontally in order, inter alia, to improve the retention of the earth to the rear of said panels. The panel thickness and its possible reinforcement vary as a function of the height of the facing wall to be constructed and/or of the loads acting on the embankment. The other geometrical dimensions, namely height and width, can vary to give architectural value to the facing wall, based on the panel/facing wall dimensional ratio. The outer face of the panel is normally smooth, but different forms can be easily obtained where required, by modifying the base of the moulds. Finally, each panel is provided with hooks for its transportation and erection. In addition, panels without lower support zones for forming the first row, panels cut to different heights for the top of the facing walls, for edges or other requirements of the geometrical configuration of the facing wall to be constructed, and T-shaped panels with different but complementary dimensions for forming a facing wall constituted by a single row of panels, as shown in Figure 6, can also be provided.

Figures 7 and 11 show a further embodiment of the reinforced or non-reinforced concrete panel 1' according to the invention, constituted by two T-shaped flat elements 2 and 3, of which the transverse bar is of smaller height than the stem, measured from the lower limit of the bar, they being superposed in mutually translated relationship along the diagonal geometrical axis X-X of the ideal quadrangular perimeter which circumscribes them, their projecting perimetral edges 4, 4' being outwardly bevelled so as to form perimetral support zones for other panels, these zones being shaped substantially as a step formed from two parallel surfaces 5, 5' and an intermediate inclined surface constituted by the outwardly bevelled projecting perimetral edges 4, 4'. The corners of the outer surfaces are suitably chamfered to facilitate rotation between adjacent panels about the connection pin.

The upper part of each flat element 2 and 3 forming the transverse bar of the T comprises, in proximity to its upper and lower side ends, blind seats 6 of rectangular or slot shape disposed with their larger dimension parallel to the plane of the panel 1', and designed to house pins for connecting the panels together.

The increase in height of the stem of the T with respect to the height of its transverse bar allows a panel to undergo its vertical translatory adjustment movement with respect to the adjacent panels, whereas the elongated shape of the seats 6 for the pins allows the horizontal translatory movement for the corresponding adjustment of the panels in this direction. Taken overall, these two movements also allow a panel to rotate with respect to its adjacent panels in the plane of the facing wall.

Moreover, the rectangular or slot shape of the pin seats 6 and their arrangement limit the movement of the pins in a direction orthogonal to the panels, so that any offsetting of a panel relative to its adjacent panels is prevented or limited, so providing the facility for mutual collaboration between said panels.

Finally, the fact that the flat element 2 lies in diagonally translated relationship to the flat element 3 enables the projecting perimetral edges 4, 4' of the panels of the invention to always lie superposed against those of the adjacent panels.

On that panel side which faces the embankment, the panels 1, 1' of the invention comprise connection elements for connecting said panels to the earth anchoring elements, said connection elements projecting from the rear surface of the panel. In specific cases, for example in the case of facing walls lying below the water table (especially in the case of sea water), the connection elements instead of projecting can be disposed in a cavity provided in the thickness of said panel, which is then sealed with cement mortar after the anchoring elements have been inserted.

With reference to Figure 8, according to the present invention the connection element 7 for connecting the panel 1, 1' to the anchoring elements is constituted by a strip of corrosion-resistant metal, for example galvanised steel, or preferably by a ribbon-like element in the form of threads of resin-bonded, pretensioned, parallel continous glass filaments, which form a warp on which a weft of mixed glass-polyester filaments is woven and resin-bonded, as described in greater detail hereinafter with reference to the anchoring elements.

This ribbon-like element is substantially collar-shaped, its horizontal ends 8, possibly reinforced, being superposed and suitably spaced apart for the insertion of the head 9 of the anchoring element 10, and comprising aligned holes for receiving a pin 11, screw or the like for fixing said head 9 to the connection element 7 by way of a hole provided in said head 9.

As shown in the figure, the central vertical part of the connection element 7 is embedded in the concrete of the panel 1, 1' so as to present the greatest possible surface perpendicular to the direction of the tensile stresses and thus the greatest possible resistance to withdrawal.

The arrangement of the connection element 7 thus enables the anchoring element 10 to be positioned not only perpendicularly to the panel 1, 1', but also in other positions in the substantially horizontal plane perpendicular to said panel, without any torsional and shearing stresses arising in the anchoring element 10 and/or stress concentrations which urge the concrete to separate in the zone in which the connection element 7 is embedded.

Thus, the result is firstly the absence of stress concentrations in the concrete in proximity to the connection element 7, and which are always damaging in that they are concentrated in small areas and in important zones such as the zones of contact between the connection element 7 and panel 1, 1'.

Secondly, the connection element 7 is stressed in such a manner as to obtain maximum profit from its strength characteristics without the drawback of undesirable stresses such as shearing and torsional stresses arising.

Finally, by virtue of being formed in a single shaped piece, said connection element 7 enables the holes in its horizontal ends 8 to be aligned, so ensuring stress uniformity between the connection element 7 and anchoring element 10.

Figure 9 shows a different embodiment of the connection element according to the invention, constituted by two C-shaped ribbon-like elements of the type heretofore described, their central parts being embedded vertically in the concrete to form an angle with each other and with the panel surface, such that the horizontal ends 8 projecting from said panel form triangles, and the holes 13 provided in said ends are aligned and suitably spaced apart.

A further embodiment of the connection element is shown in Figure 10, in which it can be seen that the ribbon-like element is given a triangular shape by being folded about a shaped round metal bar. Its free superimposed and suitably spaced-apart ends, which are possibly reinforced, project from the panel, whereas its remaining part is designed to be embedded in the concrete.

Both the connection element of Figure 9 and the connection element of Figure 10 enable the anchoring element 10 to be positioned not only perpendicular to the panel 1, 1', but also in other positions in the substantially horizontal plane perpendicular to said panel.

Figure 11 shows a panel 1, 1' provided with the connection elements of Figures 8, 9 or 10, whereas Figure 12 shows a detail of said connection elements with the reinforced head of an anchoring element 10 inserted.

In Figures 9 and 11, the connection points are shown as four in number by way of example only, and it is apparent that this number can vary in relation to the fixing requirements and the tensile stress which the panel transfers to the fixing elements.

Figure 13 shows some embodiments of the anchoring element 10 and relative reinforced head 9, indicated by a, b, c and d.

Each anchoring element 10 is formed in the manner of a woven fabric, of which the warp 14 is constituted by a plurality of threads formed from assemblies of glass filaments of extended length either orthogonal or non-orthogonal to the panel, and of which the weft 15 is constituted by threads formed from assemblies of glass filaments and disposed transversely to the warp 14. Thus both the warp 14 and weft 15 are formed from glass filaments and bonded together with resin so as to form compact units. Each anchoring element 10 is provided at one end with a hole 13 to enable it to be coupled to the panel 1, 1'.

The anchoring element 10 formed in this manner has, as its basic characteristic, a high multi-directional coefficient of friction between earth and earth within the mesh apertures, and a high coefficient of friction between the anchoring element and the earth together with mobilisation of the passive resistance of the earth at the weft, without presenting the phenomenon which arises in the so-called "reinforced plastics", ie the sliding of one strip layer relative to the other. The weft, rigid with the warp by friction, performs a parallel function to the bonding function of the resins, so that any decay of these latter in the long term, when the earth granules have settled into a stable configuration, does not change the tensile strength of the anchoring element.

The behaviour constancy (life) of the glass filaments means that there are no problematical variables in predicting the strength fall-off with time, as for example in the case of metals, due to possibly irregular or concentrated corrosion phenomena (pitting, stress corrosion). This merit, together with the constant mechanical characteristics (tensile strength) of the glass, allows exact quantifying of the safety coefficients on which the design calculations are based.

An undoubted advantage of the anchoring element according to the invention formed in the manner of a weave of resin-bonded glass filaments is also the non-corrosion thereof even when the chemical and physical characteristics of the earth vary, thus making periodic checks unnecessary.

According to a further preferred embodiment of the invention, said anchoring elements 10 are constituted by pluralities of threads of resin-bonded, pretensioned, parallel, continuous glass filaments forming the warp 14, on which the weft 15 of mixed glass-polyester filaments is woven and then resin-bonded.

The pretensioning operation fixes the parallelism of the continuous glass filaments, so that the tensile stresses to which the anchoring element is subjected are distributed uniformly over the individual glass filaments constituting each thread of the warp 14, this uniform stress distribution enabling not only an obviously optimum material yield to be obtained, but also a certain definition of the total strength, and thus of the design safety coefficients.

Another arrangement of the threads forming the warp 14 is obtained by longitudinally winding one or more threads of glass and/or polyester filaments in any patten, for example helically, over the threads formed from resin-bonded, pretensioned, parallel continuous filaments. The weft 15 in the form of threads of glass and/or polyester filaments is then woven on the threads thus obtained, and the entire assembly is resin-bonded.

The weaving is carried out such that the weft 15 connects together the various threads of the warp 14, while at the same time leaving voids which allow copenetration of the earth granules, to result in a high coefficient of friction between the anchoring element and the earth.

Moreover, the particular weave of the weft 15 on the warp 14, as shown in Figure 13, with the weft 15 wound helically continuously or in portions or in some other manner thereon, gives the anchoring element 10 thus obtained a further increase in adherence.

The mixed use of glass and polyester filaments for the weft 15 gives the anchoring elements a transverse flexibility, with the consequent facility for better adaptation to the earth.

Said anchoring elements 10 also enable the friction of the individual threads of the warp 14 to be utilised, and provide a considerable contribution to the weft/warp strength by transferring stresses, and which can in no way be done by the resins.

Again with reference to Figure 13, the head 9 of the anchoring element 10 is provided with a hole 13 about which the threads of the warp 14 of the anchoring element 10 pass without interruption. Several levels of superposed and/or criss-crossed and resin-bonded filaments are also provided, so as to be able to absorb the stresses concentrated about said connection hole 13. These resins, which also allow stress distribution, can possibly be mixed with sand or inert material.

The ends 8 of the elements 7 for connecting the panels to the anchoring elements 10 can comprise heads substantially equal to the head 9 of said anchoring elements 10.

The anchoring element according to the invention is generally of elongated plane form, but it is apparent that it can assume any other suitable form. By way of example, Figures 14 and 15 show further configurations of the anchoring element according to the invention.

In particular, Figure 14 shows an anchoring element 10 in which a first elongated part 16, carrying at its free end a holed and reinforced head 9, terminates in a pseudocircular part 17, whereas Figure 15 shows an anchoring element 10 substantially of V shape comprising holed and reinforced heads 9 at its two free ends.

Figure 16 is a diagrammatic side sectional view showing the panels 1, 1' according to the invention when they have been erected and anchored to the earth T by means of the anchoring elements 10 according to the invention. The panels are fitted together along the support zones 4,4', 5, 5', which, as shown in the figure, are formed by parallel surfaces 5, 5' joined together by intermediate inclined surfaces 4, 4'. The figure also shows the ends 8 of the connection elements 7, into which the heads 9 of the anchoring elements 10 have been inserted and locked.

The procedure for constructing a facing wall according to the invention is as follows:

- the surface on which the facing wall and rear embankment are to lie is prepared by removing a layer of earth;

- a kerb C of small dimensions is formed in order to obtain a level laying surface for forming the first row of panels;

- the first row of panels is laid with temporary means, and a first layer of selected material suitable for embankment formation is spread;

- said layer is compacted and the necessary anchoring elements 10 are laid;

- a compacted layer of earth T is formed on top of said anchoring elements 10;

- a second row of panels is laid by fitting them on to the preceding;

- the necessary anchoring elements 10 are laid at this level and a layer of earth T is spread and compacted.

This procedure is repeated until the required height is reached.

Patent Claims:

1. A concrete panel for constituting a facing wall of variable planimetric course, characterised by being constituted by two T-shaped integrally formed flat elements (2, 3) which are superposed in translated relationship to each other along the diagonal geometrical axis (X-X) of the ideal quadrangular perimeter which circumscribes them, in such a manner as to form perimetral support zones (4, 4', 5, 5') for other panels, said zones being shaped substantially as a step comprising two parallel surfaces (5, 5') and an inclined intermediate surface constituted by said projecting perimetral edges (4, 4'), which are outwardly bevelled, the upper part of each flat element (2, 3) which forms the transverse bar of the T comprising, in proximity to the upper and lower side edges, blind seats designed to house pins (6') for connecting the panels together in an articulated manner, the outer surfaces of said flat elements (2, 3) having chamfered edges.

2. A panel as claimed in claim 1, characterised in that said flat elements (2, 3) are shaped in the form of a T with its transverse bar having a height less than that of the stem measured from the lower limit of the bar, and said blind seats (6) designed to house pins (6') for connecting the panels together in an articulated manner are of rectangular, slot or similar shape, and are disposed with their major dimension parallel to the plane of the panel so as to allow vertical, horizontal and, in particular, rotational adjustment of adjacent panels forming a facing wall, in the plane of the facing wall itself.

3. A panel as claimed in claim 1 or 2, characterised by comprising connection elements (7) for its connection to anchoring elements (10), said connection elements (7) being each constituted by a strip of corrosion-resistant metal or, preferably, a ribbon-like element of threads of resin-bonded pretensioned, parallel continuous glass filaments forming a warp (14) on which there is woven and resin-bonded a weft (15) of mixed glass and polyester filaments, said

connection elements (7) being substantially collar-shaped with their vertical central part embedded horizontally in the concrete so as to obtain the greatest possible resistance to withdrawal, and having possibly reinforced horizontal ends (8) projecting from the panel surface and superposed and suitably spaced apart for the insertion of a head (9) of anchoring elements (10), and provided with aligned holes (13) for receiving pins (11), screws or the like for locking said head (9), said connection elements (7) also allowing anchoring elements (10) to be positioned not only perpendicular to the panel (1, 1'), but also in other positions in the substantially horizontal plane perpendicular to said panel (1, 1') to prevent stress concentrations in the concrete in proximity to said connection element (7).

4. A panel as claimed in claim 1 or 2, characterised by comprising connection elements (7') for its connection to anchoring elements (10), constituted by two ribbon-like elements of resin-bonded, pretensioned, parallel continuous glass filaments forming a warp (14) on which there is woven and resin-bonded a weft (15) of mixed glass and polyester filaments, and being C-shaped with their central parts vertically embedded in the concrete to form an angle with each other and with the surface of the panel (1, 1') such that the ends (8) projecting horizontally from said panel (1, 1') and provided with holes (13) for their connection and locking to heads (9) of anchoring elements (10) by means of pins (11) screws or the like, are superposed such that the holes (13) are aligned so as to allow the anchoring elements (10) to be positioned not only perpendicular to the panel (1, 1'), but also in other positions in the substantially horizontal plane perpendicular to sai panel (1, 1').

5. A panel as claimed in claim 1 or 2, characterised by comprising connection elements (7") for its connection to anchoring elements (10), said connection elements (7") being each constituted by a strip of corrosion-resistant metal or, preferably, a ribbon-like element of threads of resin-bonded, pretensioned, parallel continuous glass filaments forming a warp (14) on which there is woven and resin-

bonded a weft (15) of mixed glass and polyester filaments, said connection elements (7") being of triangular shape obtained by being folded about a shaped metal rod, the possibly reinforced horizontal free ends of the ribbon-like element being designed to project from the panel suitably spaced apart for the insertion of a head (9) of anchoring elements (10) and being provided with aligned holes (13) for receiving pins (11), screws or the like for locking said head (9), said connection elements (7") allowing the anchoring elements (10) to be positioned not only perpendicular to the panel (1, 1') but also in other positions in the substantially horizontal plane perpendicular to said panel (1, 1').

6. An anchoring element for the panels claimed in the preceding claims, characterised by being formed in the manner of a woven fabric, of which the warp (14) is constituted by a plurality of threads formed from assemblies of glass filaments of extended length, and of which the weft (15) is constituted by threads formed from assemblies of glass filaments, disposed transversely to the weft (14), and treated with resin in order to form a compact unit.

7. An anchoring element for the panels claimed in claims 1 to 5, characterised by being constituted by a plurality of resin-bonded, pretensioned, parallel continuous glass filaments forming a warp (14), on which there is woven and resin-bonded a weft (15) of mixed glass and polyester filaments for connecting together the threads of the warp (14).

8. An anchoring element as claimed in claim 7, characterised by being obtained by longitudinally winding in any pattern, for example helical, over the predisposed threads formed from resin-bonded, pretensioned, parallel continuous glass filaments, one or more threads of glass and/or polyester filaments, on which there is woven and resin-bonded a weft (15) of threads of glass and/or polyester filaments.

9. An anchoring element as claimed in claims 6 to 8, characte-

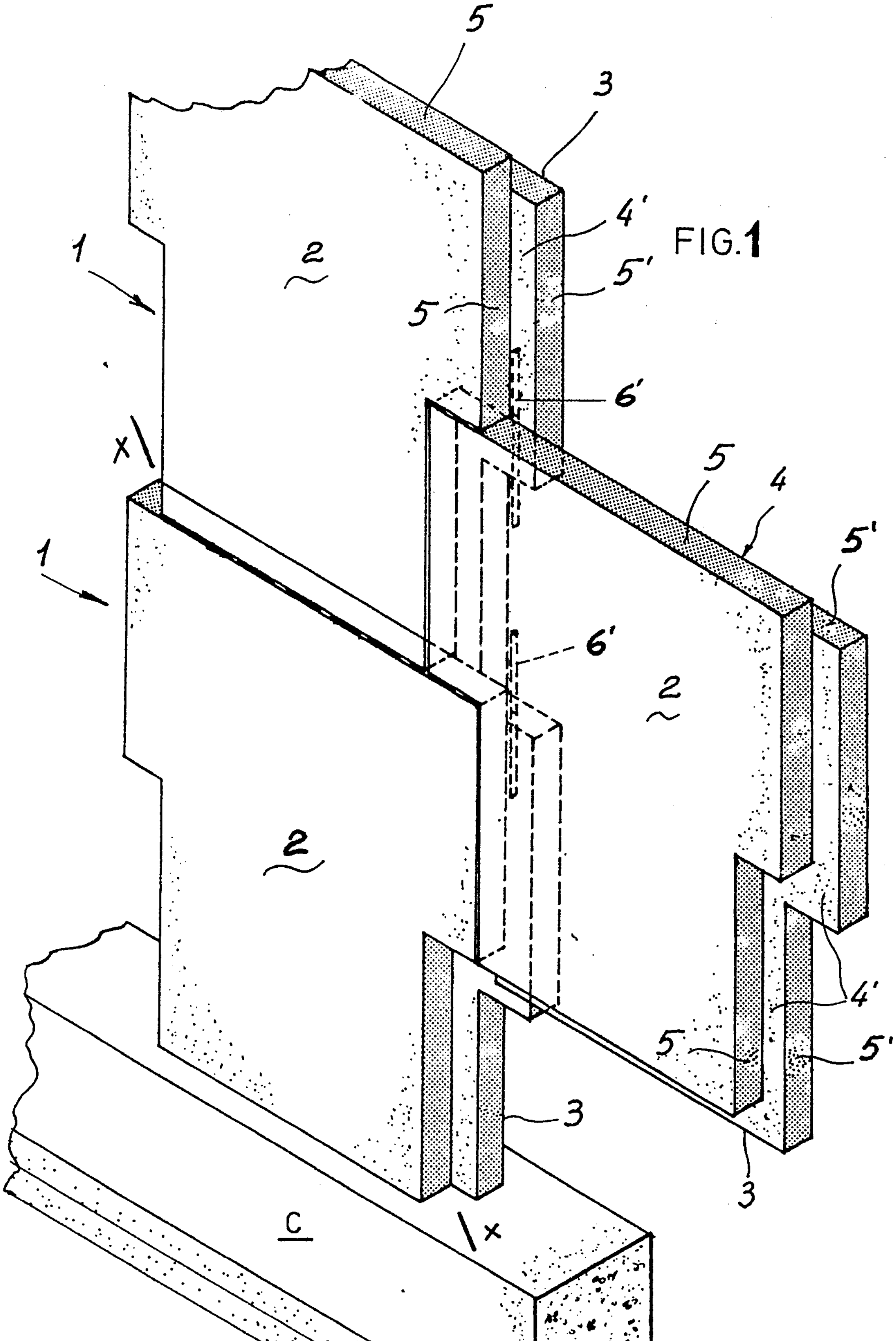
rised by comprising a first elongated part (16) terminating in a pseudocircular part (17).

10. An anchoring element as claimed in claims 6 to 8, characterised by being of substantially V-shape comprising holed, reinforced heads (9) at its two free ends.

11. A head (9) for the anchoring element (10) claimed in claims 6 to 11 or for the connection element claimed in claims 3 to 5, characterised by being provided with a hole (13) about which there pass without interruption the threads of the warp (14) of the anchoring element (10) or of the connection element (7, 7', 7"), and by being formed from several levels of superposed and/or criss-crossed glass filaments, resin-bonded with the possible addition of sand or inert materials, so as to absorb the concentrated stresses about said hole (13).

12. A facing wall of variable planimetric course and with the facility for the settling of the panels (1, 1') in the surface of said facing wall, characterised by being constituted by the panels (1, 1') as claimed in claim 1 or 2, which are provided with the connection elements (7, 7', 7") as claimed in any one of claims 3 to 5 and as claimed in claim 11, and are anchored to the earth by means of the anchoring elements (10) as claimed in any one of claims 6 to 10 and as claimed in claim 11.

FIG.1



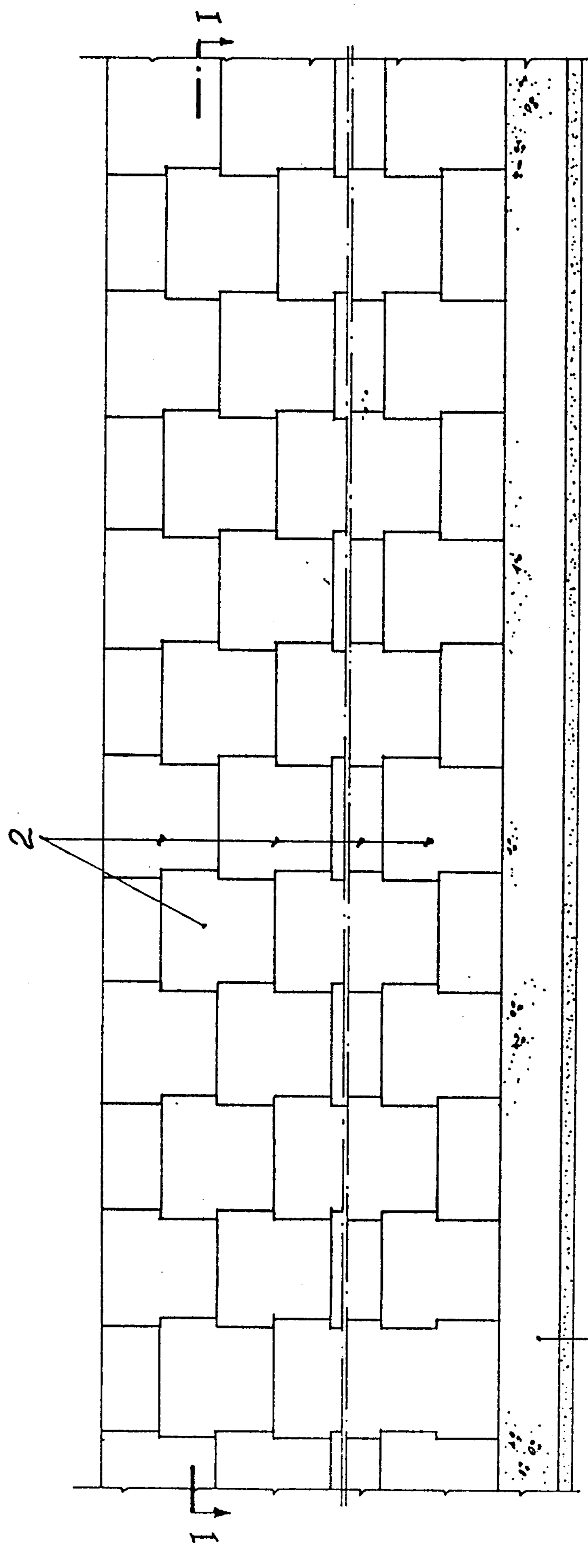


FIG.2

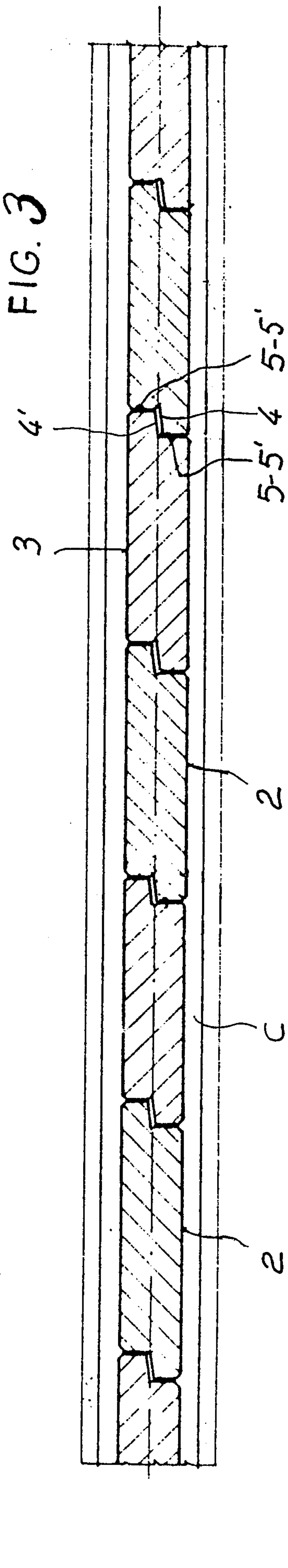


FIG. 3

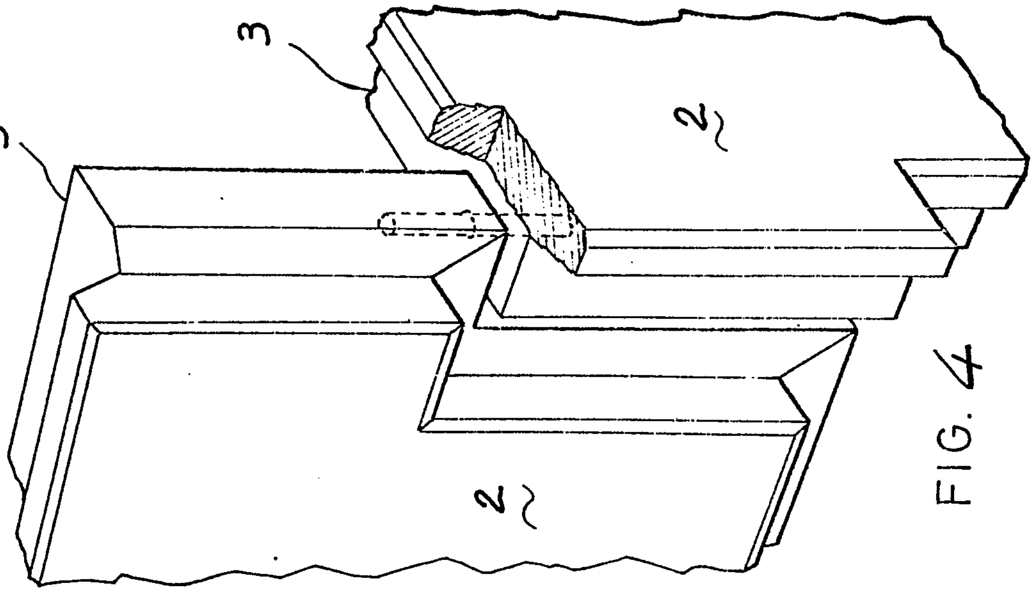


FIG. 4

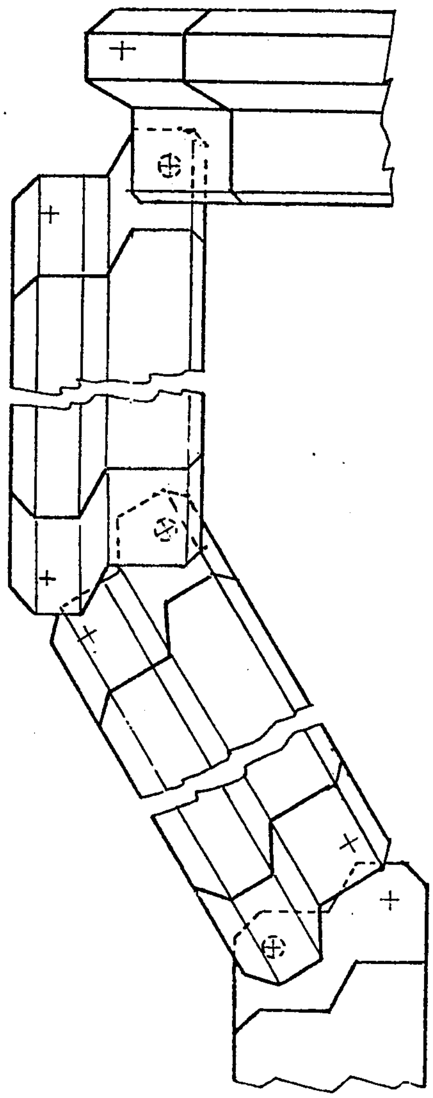


FIG. 5

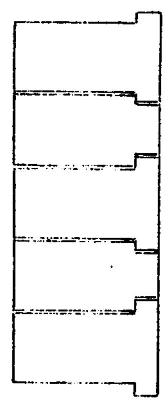


FIG. 6

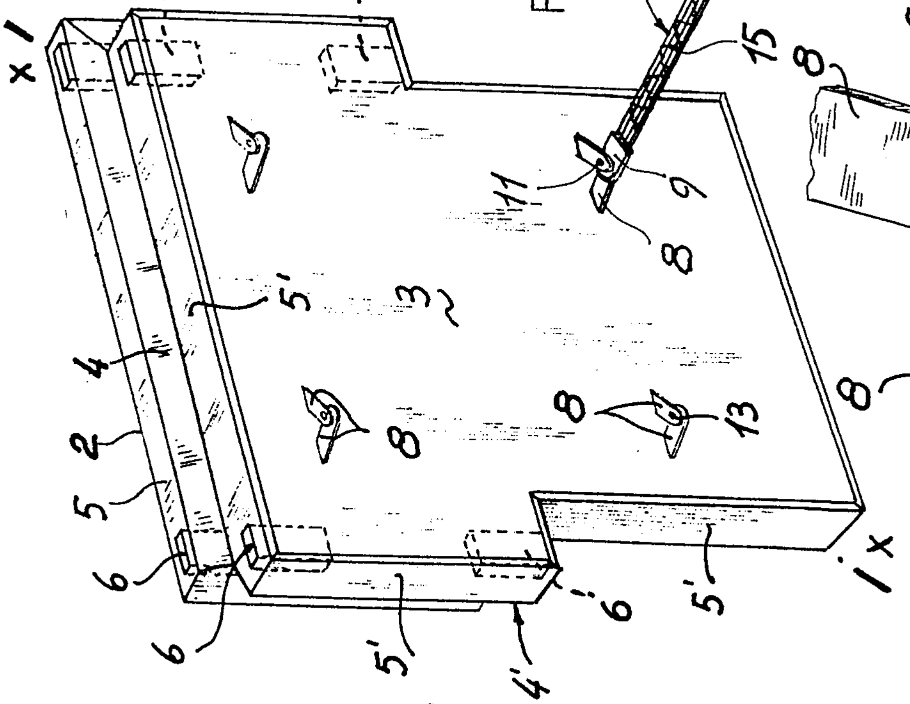


FIG. 11

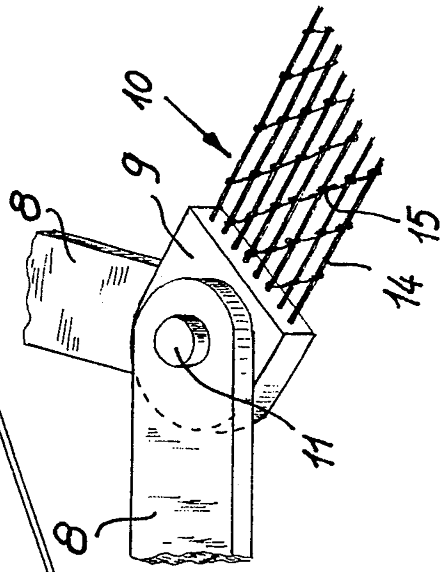


FIG. 12

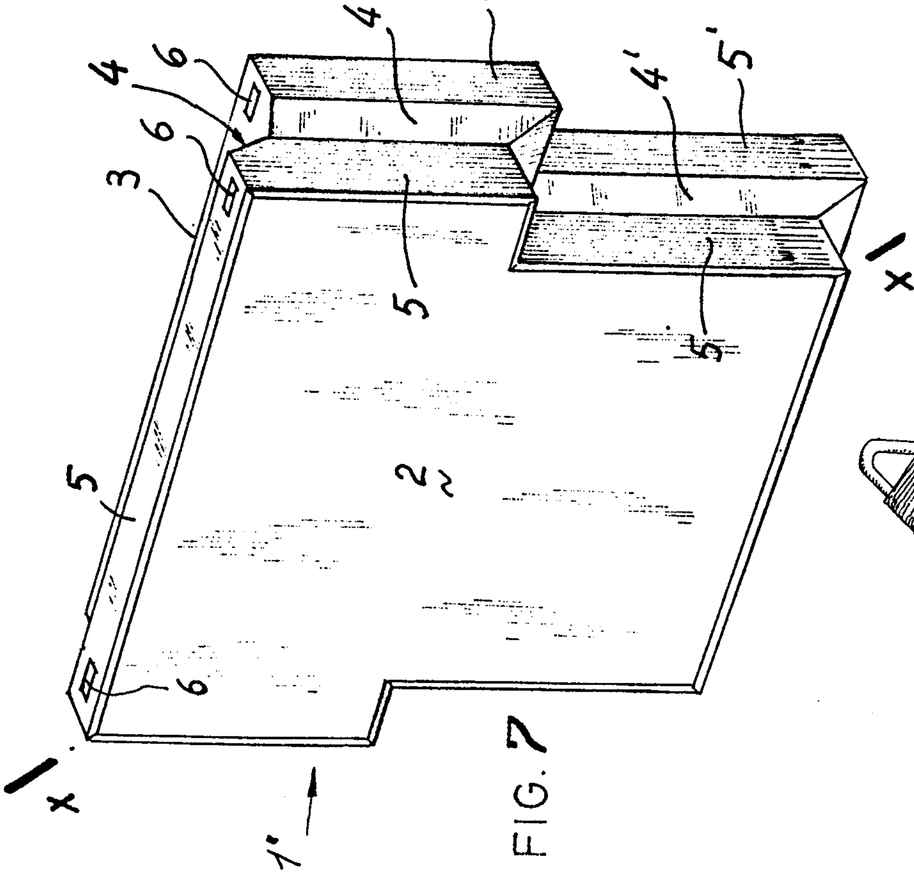


FIG. 7

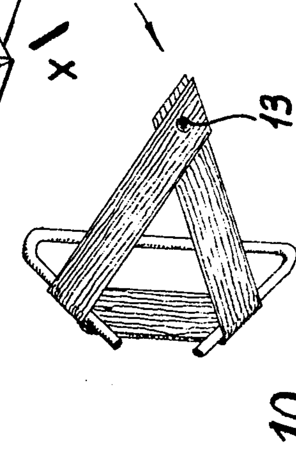


FIG. 10

FIG. 13

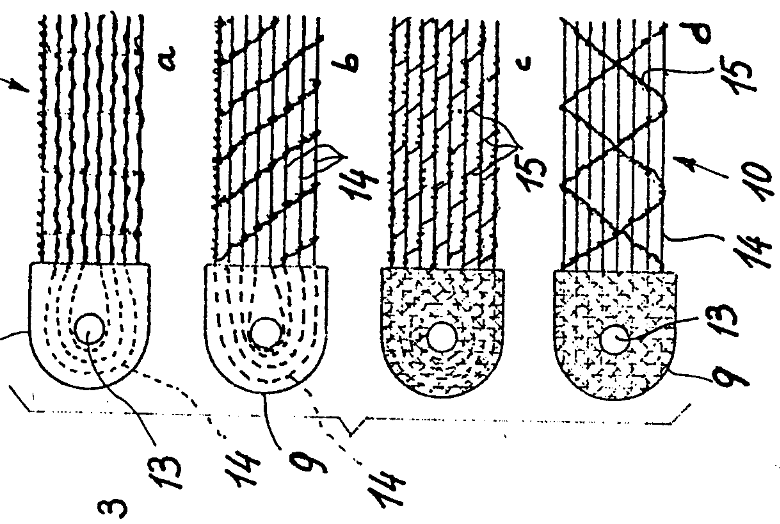


FIG 9

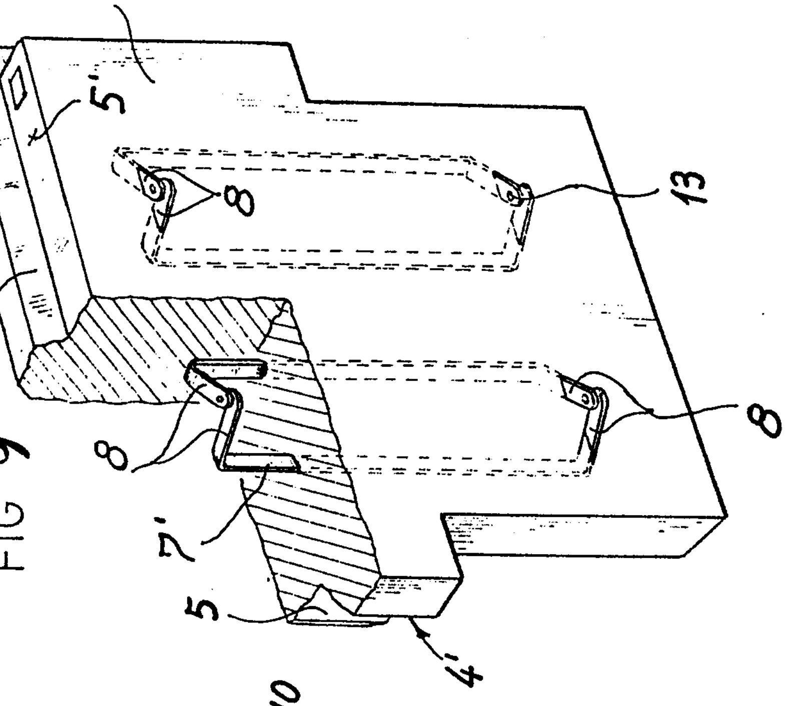


FIG. 15

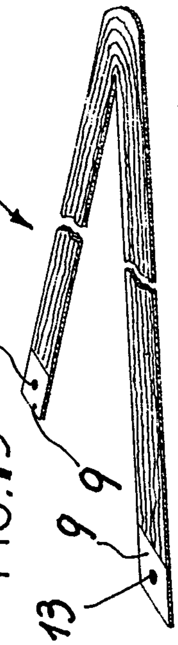


FIG. 8

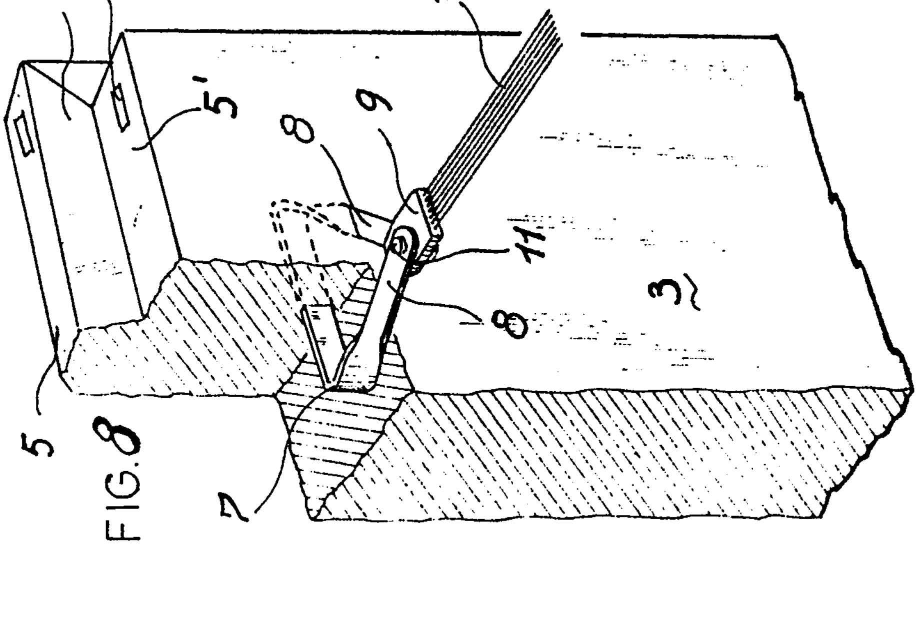
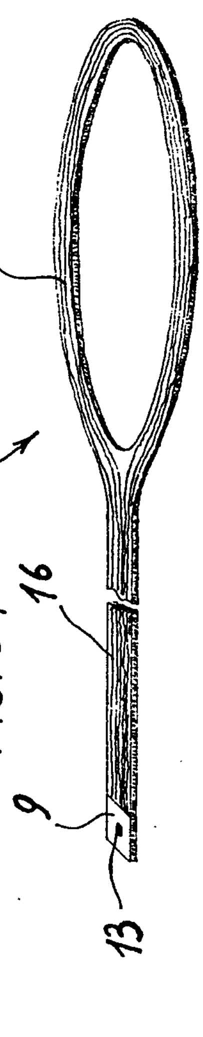


FIG. 14



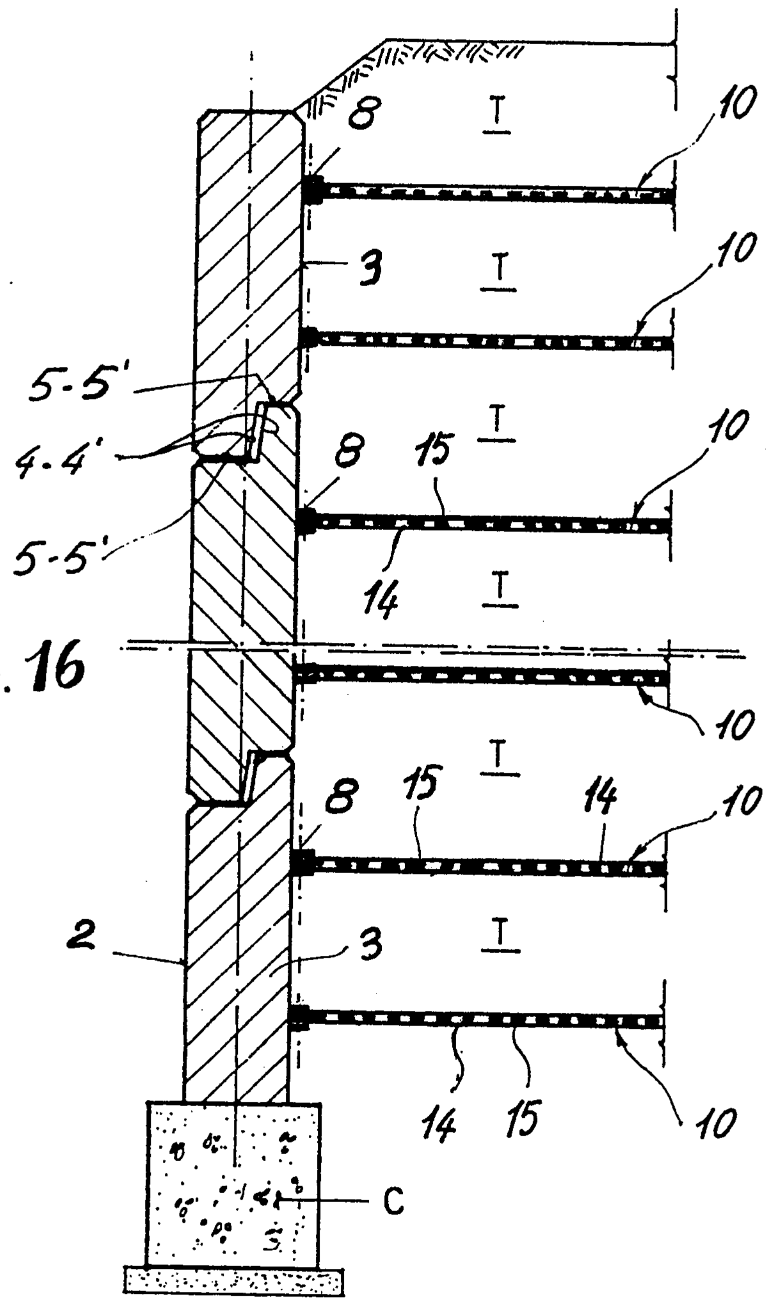


FIG. 16