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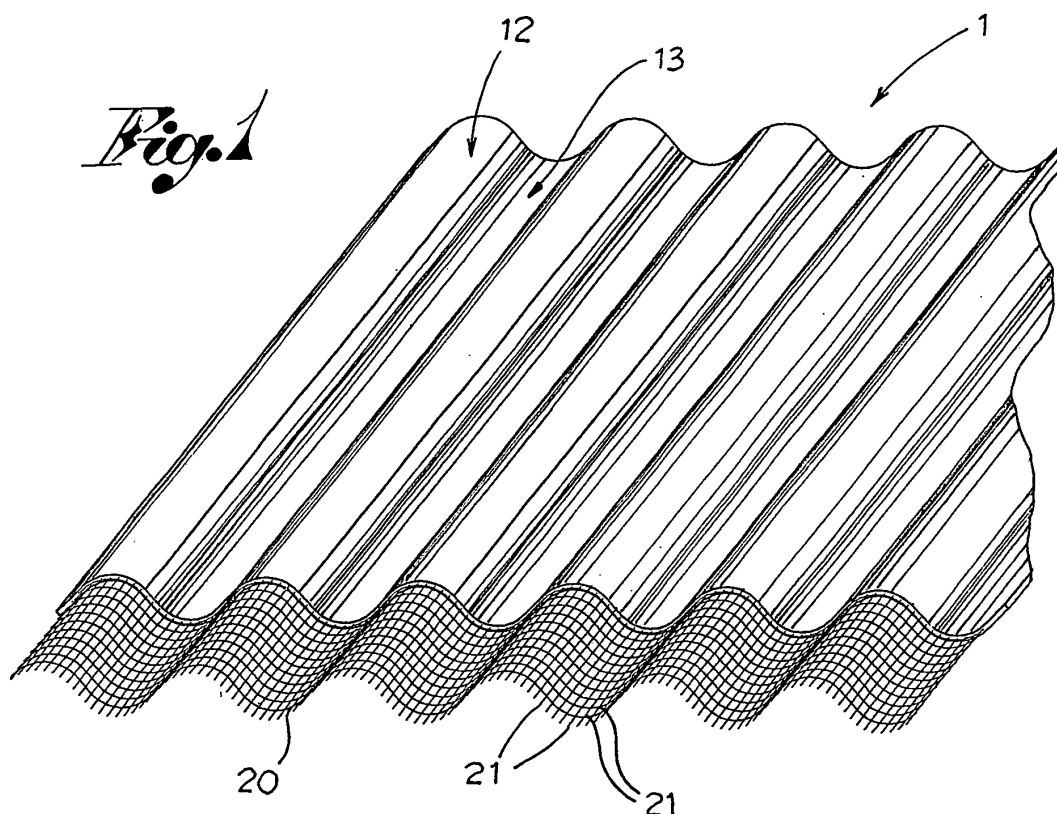
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(54) **Reinforced slab of concrete material and method for manufacturing such slab**

(57) Reinforced slab of concrete material, suitable in particular for making building roofs and comprising a base concrete matrix 10 wherein reinforcing elements 20 are buried. The latter are suitable for keeping matrix 10

adhering in the event of breakage. Slab 1 is characterised in that the reinforcing elements 20 comprise at least one net 20 that substantially extends by the entire surface development of slab 1.



Description

[0001] The present invention relates to a reinforced slab of concrete material and to a method for manufacturing such slab.

[0002] The subject reinforced slab falls within the field of concrete prefabricated buildings for the building industry and can be advantageously used in the making of treadable building roofs, in particular industrial warehouses.

[0003] Prior art

[0004] In the fielding of prefabricated buildings for the building industry, slabs having different profiles have long been known, consisting of a concrete matrix charge with short dispersed fibres, of inorganic or organic nature.

[0005] Until the 80's - 90's, the concrete matrix was charged with asbestos fibres for obtaining an end product known as "concrete asbestos slab" on the market. At present, once asbestos has become illegal, the concrete matrix is charged with cellulose fibres and plastic polymers (for example polyvinylalcohol) for obtaining an end product known as asbestos cement on the market.

[0006] These slabs are formed by overlapping sheets of a mixture of concrete material and fibres. The sheets are formed and overlapped to one another in a special forming machine, in the field known as Hatscheck machine.

[0007] More in detail, the forming machine comprises a series of picking cylinders operating in a succession, each picking into a basin containing the mixture of concrete material and fibres. The mixture lays on the cylinder surface forming an even film, while part of the excess water falls back into the basin. The films that progressively form on the picking cylinders are pulled away continuously by a first conveyor belt that transfers them to a revolving forming roll. During the transport, the films meet suction cases that act below the belt compacting the film and reducing the water contents. The films leave the first conveyor belt and adhere to the outer surface of the forming roll overlapping to each other. In this way a multilayer is formed on the revolving forming roll with progressively increasing thickness. The roll rotation is continued until a multilayer of fixed thickness is obtained, which undergoes compression by the effect of the contrast between forming cylinder and control roll. At this point, the multilayer is cut along a generatrix of the roll and then transferred to a second conveyor belt where it takes a plane configuration. The multilayer sheet is then laid inside a shaped die where it takes the final shape of the slab and is finally left to dry.

[0008] To improve the mechanical properties of these asbestos cement slabs it has long been known to bury elongated reinforcing elements, such as metal tapes or bands, into the concrete matrix. These elements are inserted into the multilayer during the forming thereof by special placing means arranged in the forming machined in the proximity of the forming roll.

[0009] In particular, asbestos cement slabs with cor-

rugated profile are made with this technique, intended for making building roofs. The reinforcing elements are in the form of tapes, straps or plaited threads, of metal or plastic material, and are buried in the concrete matrix along the longitudinal development of the multilayer. Normally after the slab forming the reinforcing elements are arranged at the depressions of the corrugated profile.

[0010] The function of these longitudinal reinforcing elements is not much that of increasing the mechanical resistance of the slabs but that of guaranteeing a minimum of structural integrity to the slabs in the event of yields or breakage. In these situations the reinforcing elements support the concrete matrix at the damaged zone and thus prevent the forming of tears through which people present on the slabs could fall.

[0011] It has been noted that the mechanical behaviour of these slabs is strongly influenced by ambient humidity, with considerable consequences on the functionality of the longitudinal reinforcing elements in the case of breakage of the slabs themselves.

[0012] With humidity values of more than 10% the concrete matrix maintains a sufficient cohesion level for ensuring adhesion between the matrix and the reinforcing elements. In the event of breakage of the slab, the damaged matrix keeps its consistency. This allows the reinforcing elements to hold the broken parts avoiding the forming of tears.

[0013] With humidity values of less than 10% on the other hands, it has been noted that the concrete matrix loses cohesion becoming more fragile. In the event of collision, the concrete matrix tends to crumble, detaching from the reinforcing elements. Even quite extended tears could therefore form at which the longitudinal reinforcing elements are exposed. Under the weight of the body of the reinforcing elements, not connected to each other by the concrete matrix anymore, they tend to get deformed departing from each other. It could therefore happen that the reinforcing elements cannot support the body anymore and let it fall down.

[0014] Disclosure of the invention

[0015] In this situation, therefore, the object of the present invention is to eliminate the disadvantages of the mentioned prior art by providing a reinforced slab of concrete material which should be safe in the event of damages also with ambient humidity values below 10%.

[0016] Another object of the present invention is to provide a reinforced slab of concrete material which should be simple and inexpensive to manufacture.

[0017] These and other objects are all achieved by a reinforced slab of concrete material and by a method for manufacturing such slab according to the annexed claims.

[0018] Brief description of the drawings

[0019] The technical features of the invention, according to the above objects, are clearly found in the contents of the claims below and the advantages of the same will appear more clearly from the following detailed description, made with reference to the annexed drawings, which

show a purely exemplifying and non-limiting embodiment thereof, wherein:

[0020] - Figure 1 shows a perspective view of a reinforced slab according to the invention, with some parts removed for highlighting the presence of a reinforcing net,

[0021] - Figure 2 shows a section view of a reinforced slab shown in Figure 1;

[0022] - Figure 3 shows a detail of the reinforcing net shown in Figure 1;

[0023] - Figure 4 shows a side view of a machine for forming reinforced slabs according to the invention; and

[0024] - Figure 5 shows a schematic view of a detail of the machined of Figure 4 relating to the means for introducing the net shown in Figure 1.

[0025] Detailed description

[0026] With reference to the annexed drawings, reference numeral 1 globally denotes the reinforced slab of concrete material object of the present invention. The above slab 1 can advantageously be used for making treadable building roofs, in particular industrial warehouses.

[0027] Slab 1 according to the invention comprises a base concrete matrix 10 obtained by overlapping multiple layers 11 of a concrete material mixture.

[0028] By concrete material it is herein understood in general a mixture of inert particles and hydraulic binders. The latter in particular may comprise hydraulic cement of the Portland type.

[0029] Preferably the concrete material mixture is of the type used for producing the so-called asbestos cement, or charged with short dispersed fibres, organic and/or inorganic, in particular a mixture of cellulose fibres and polyvinylalcohol.

[0030] According to the invention, reinforcing elements 20 are buried into the concrete matrix 10 arranged between two layers 11. Such reinforcing elements 20 comprise at least one net 20, which substantially extends to the entire the surface development of slab 1, as can be seen in Figure 1.

[0031] In accordance with alternative solutions of the invention not shown in the annexed Figures, slab 1 may be provided with multiple nets 20 arranged between different pairs of layers of the concrete matrix 10.

[0032] Advantageously, a slab 1 according to the invention in the event of damage ensures the safety of people thereon in any ambient humidity condition.

[0033] In normal ambient conditions (humidity higher than 10%), net 20 substantially serves for keeping slab 1 adhering in the event of breakage or partial yields, holding the portions of concrete matrix that may have detached from the rest of slab 1.

[0034] In abnormal ambient conditions (humidity below 10%), on the other hand, when the crumbling of the concrete matrix 10 and therefore the forming of wide tears in the matrix itself are highly likely in the event of collision, net 20 acts as "safety net" preventing at least the fall of any people present on slab 1 and of the heavy body that

has caused the breakage of slab 1.

[0035] Preferably, net 20 is made of polypropylene, suitably treated with antialkali compounds so that net 20 is not chemically deteriorated by the concrete mixture. However, other polymers suitable for the use may be used, such as polyvinylalcohol, polyethylene, polypropylene, kevlar, carbon fibres, glass fibres.

[0036] Advantageously, the meshes of net 20 have sides of length L comprised within the range between 6 and 35 mm, preferably between 8 and 12 mm. These dimensions of the mesh allow the concrete mixture to evenly cross net 20 during the slab manufacturing steps, allowing the top layers of slab 1 to closely adhere to the bottom ones.

[0037] More in detail, net 20 is formed by weaving of thread-like elements 21 having a thickness s comprised within the range between 0.5 and 1.2 mm. Titre T of these elements 21 is comprised within the range between 1700/2 and 1100/4 dtex. The titre is an indirect measure of the thickness (or diameter) of a thread-like element and is expressed as weight of the thread-like element in grams by 1,000 linear metres (Tex) or by 10,000 linear metres (dTex).

[0038] Advantageously the presence of net 20 does not considerably increase the slab weight. In fact, net 20 in se has a weight comprised within the range between 60 and 110 g/m².

[0039] From a point of view of the mechanical behaviour, net 20 offers a resistance to tensile stress comprised within the range between 80 and 200 daN/5cm and an elongation comprised within the range between 15 and 25 %. These values apply both in the warp and in the weft direction. These values are sufficient for supporting at the same time the weight of a damaged portion of concrete matrix and the weight of a person. In particular, the ultimate elongation value of the warp is very important, since such reinforcement intervenes after the breakage of the slab matrix and can absorb the kinetic energy of the body upon the impact on the slab itself.

[0040] As already mentioned before, net 20 is buried into the concrete matrix 10, arranged between two layers 11.

[0041] Preferably, net 20 is arranged so as to be closer to one of the two surface layers that define the two faces of slab 1. In particular it is arranged so as to be in contact with one of the two surface layers. Net 20 is therefore decentralised relative to the median plane M of slab 1, as can be seen in Figure 2.

[0042] Therefore, based on the position taken by net 20, the two faces of slab 1 can be distinguished from one another. The face closer to net 20 shall be identified hereinafter as reinforced face 10', whereas the other face shall be identified as non-reinforced face 10".

[0043] Operatively, in the laying slab 1 is preferably arranged with the reinforced face 10' facing downwards, thus defining an upside down orientation for slab 1. With this arrangement of slab 1, net 20 is right in the zone of slab 1 which is most subject to tensile stress. In this way

net 20 can carry out a safety function as well as a more structural function.

[0044] To this end, several mechanical resistance tests have been carried out on slabs 1 according to the invention, whose results have fully confirmed the effective structural action of net 20. According to the EN 10960 standard in particular, a corrugated slab of asbestos cement in normal ambient conditions (humidity of more than 10%) should withstand the collision with a bag weighing 50 kg falling from a height of 1.20 m. Slabs 1 according to the invention have withstood the collision of a bag weighing 50 kg fallen from a height of even more than 2 m in conditions of limited humidity of the slabs equal to 4 - 5%, without damages.

[0045] Functionally, thanks to the decentralised arrangement of net 20 most of the concrete matrix is arranged above net 20 itself. Only the surface layer corresponding to the reinforced face 10' (or optionally in addition also the layer adjacent thereto) is arranged under net 20. In the event of breakage of slab 1 and of concurrent detachment between layers 11, net 20 is therefore capable of mechanically supporting the entire matrix 10, with the exception of the bottom surface layer. Therefore, the portion of concrete matrix that in the event of damage of slab 1 could optionally fall is limited to the bottom surface layer only (less than one millimetre thick).

[0046] In accordance with a preferred embodiment of the invention, slab 1 has a typical corrugated profile defined by a succession of longitudinal bumps 12 and depressions 13. Advantageously, net 20 is oriented inside the concrete matrix 10 so that at the end of the forming of the corrugated slab the thread-like elements that form the net are arranged substantially parallel and perpendicular to the longitudinal development direction of bumps 12 and depressions 13. In this way net 20 can more easily adapt to the corrugated shape of the slab, preventing the onset of internal tensions that could weaken slab 1 itself.

[0047] From a production point of view, slab 1 according to the invention is made using a Hatscheck forming machine on in se known type.

[0048] The method for manufacturing the reinforced slab 1 according to the invention envisages an initial step of preparation (a) of a concrete mixture, charged with a mixture of short fibres, organic and/or inorganic.

[0049] Preferably the solid substances that make up the concrete mixture are the following ones, with the relevant percentages by weight: polyvinylalcohol fibres (PVA) between 1.5 and 3%; cellulose fibres between 2 and 5 %; microsilica between 2 and 7%; Portland cement 3.25 between 65 and 85%; inert additives between 20 and 30%. These substances are mixed with water up to forming a mixture having a percentage by weight of dry solids equal to about 10%.

[0050] The method then provides a step (b) of making a multilayer for subsequent overlapping of layers of the above mixture. This step provides the use of a Hatscheck forming machine, schematically illustrated in Figure 4.

[0051] More in detail, the machine comprises: one more basins 111 for containing the concrete mixture arranged in a succession; a picking cylinder 112 for each basin 111; a first conveyor belt 113 that slides by a first branch in contact with the picking cylinders 112; a revolving forming roll 114 with annexed control cylinder 116; one or more suction cases 115 arranged at the first conveyor belt 113; and a second conveyor belt 119.

[0052] Operatively, the concrete mixture lays on the surface of the revolving picking cylinders 112 forming an even and thin film, whereas part of the excess water falls into basins 11. The films that progressively form on cylinders 112 are removed by the first conveyor belt 113, where they overlap to those coming from the other picking cylinders 112 up to forming a sheet (corresponding to a layer). The sheet thus formed, travelling on the first conveyor belt, meets the suction cases 115 and is compacted, losing part of its water content. Before returning to the picking cylinders 112 the sheet leaves the first conveyor belt 113 and adheres to the outer surface of the forming roll 114 overlapping to the sheets already wound on the roll. In this way a multilayer is formed on the revolving forming roll 114 with progressively increasing thickness. The roll rotation is continued until a multilayer of predetermined thickness is obtained. Said thickness, moreover, is determined by a compression generated by the contrast of the forming cylinder 114 on the control roll 116. Preferably, slab 1 is given by the overlapping of six - seven layers each having a thickness of about 0.8-1.2 mm.

[0053] At this point the method provides a step (c) of cutting the multilayer at a generatrix of the forming roll 114. The multilayer is pulled away by the second conveyor belt 119 where it takes a plane shape. A forming step (d) of the multilayer into a shaped die follows, for impressing the desired profile to the slab. Finally, a drying and seasoning step (e) of the slab thus formed takes place.

[0054] According to the invention, the method for manufacturing a reinforced slab 1 provides a step of insertion (f) of at least one reinforcing element shaped as a net 20 between two layers of the multilayer being formed. The insertion of net 20 takes place in the point of contact between the forming roll 114 and the first conveyor belt 113. Net 20 is then wound on the forming roll 114 along with a layer of mixture and then cut when it has been wound by a length substantially equal to the roll circumference.

[0055] To carry out this insertion step, the forming machine is provided with: means for supporting a net coil 120; motor driven rolls 121 for approaching net 20 to the forming roll 114; motor driven rolls 122 for inserting the net; and means 123 for cutting net 20. Figure 5 shows the introduction zone of net 20 in detail.

[0056] Operatively, net 20 is first pinched by the approach rolls 121; said rolls 121 then unwind the net from coil 120 so that it passes between the insertion rolls 122, which remain open until the net has arrived in the prox-

imity of the forming roll 114. At that point, the insertion rolls 122 close, pinching the net. The motor driven rolls 121 continue to unwind coil 120 up to accumulating the length set by the operator, required for covering the entire extension of the slab. The length is measured by an encoder mounted for example on the approach rolls 121. The cutting means 123 then cut the net. At the suitable time, the insertion rolls 122 insert the net between the slab layers.

[0057] Preferably, the method according to the invention provides the insertion of a single net 20 in the concrete matrix 10 that is associated to the multilayer during the winding of the last layer of mixture on the forming roll 114. Advantageously, it is still possible to provide the insertion of multiple nets arranging them between different pairs of layers.

[0058] As already mentioned before, net 20 is inserted in a guided manner by the insertion rolls 122 in the multilayer being formed so that the weft or warp are parallel to the longitudinal development direction of the slab. In particular, if slab 1 in the forming step takes a corrugated profile, the weft or warp of net 20 must be preferably parallel to the longitudinal bumps 12 and depressions 13 of slab 1.

[0059] The invention thus conceived thus achieves the intended purposes.

[0060] Of course, in the practical embodiment thereof, it may take shapes and configurations differing from that illustrated above without departing from the present scope of protection.

[0061] Moreover, all the parts may be replaced by technically equivalent ones and the sizes, shapes and materials used may be whatever according to the requirements.

Claims

1. Reinforced slab of concrete material, in particular suitable for making building roofs, comprising a base concrete matrix (10) wherein reinforcing elements (20) are buried, intended for keeping said matrix (10) adherent in the event of breakage, **characterised in that** said reinforcing elements (20) comprise at least one net (20) that extends substantially by the entire surface development of said slab (1).
2. Slab according to claim 1, wherein said base concrete matrix (10) comprises multiple overlapped layers (11), said net (20) being arranged between two of said layers (11), which adhere closely to each other at the empty spaces between one mesh and the other of said net (20).
3. Slab according to claim 2, wherein said net (20) is buried into said concrete matrix (10) in contact with one of the two surface layers.
4. Slab according to any one of the previous claims, wherein said net (20) is made of a plastic material, preferably polypropylene, treated with antialkali compounds.
5. Slab according to any one of the previous claims, wherein the meshes of said net (20) have sides of length L comprised within the range between 6 and 35 mm, preferably between 8 and 12 mm.
6. Slab according to any one of the previous claims, wherein said net (20) is formed by thread-like elements (21) having a thickness (s) comprised within the range between 0.5 and 1.2 mm.
7. Slab according to claim 5, wherein said thread-like elements (21) have a titre (T) comprised within the range between 1700/2 and 1100/4 dtex.
8. Slab according to any one of the previous claims, wherein said net (20) offers a resistance to tensile stress comprised within the range between 80 and 200 daN/5cm in the weft direction and/or in the warp direction.
9. Slab according to any one of the previous claims, wherein said net (20) has an elongation comprised within the range between 15 and 25% in the weft direction and/or in the warp direction.
10. Slab according to any one of the previous claims, wherein said net (20) has a weight comprised within the range between 60 and 110 g/m².
11. Slab according to any one of the previous claims, having a corrugated profile defined by a succession of longitudinal bumps (12) and depressions (12), said net (20) being arranged with the thread-like elements (21) substantially parallel and perpendicular to the direction of longitudinal development of said bumps (12) and said depressions (13).
12. Slab according to any one of the previous claims, wherein said concrete matrix (10) is charged with short dispersed fibres, organic and/or inorganic, preferably a mixture of cellulose fibres and polyvinylalcohol.
13. Method for manufacturing reinforced slabs of concrete material according to the previous claims, comprising the following operating steps:
 - (a) an initial step of preparation of a concrete mixture, preferably charged with a mixture of short fibres, organic and/or inorganic;
 - (b) a step of making a multilayer for subsequent overlapping of layers of the above concrete mixture about a forming roll (114);

- (c) a step of cutting (c) said multilayer at a generatrix of said forming roll (114), said multilayer taking a substantially plane shape;
- (d) a forming step (d) of said multilayer into a pressing die for impressing the desired profile to said slab (1) ; and 5
- (e) a drying and seasoning step (e) of said slab (1) ;

characterised in that it comprises an insertion step (f) of at least one reinforcing element shaped as a net 20 between two layers of said multilayer being formed, said insertion step (f) being carried out during said making step (b). 10

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- 14.** Method for manufacturing reinforced slabs according to claim 13, wherein said at least one reinforcing element shaped as a net (20) is wound on said forming roll (114) along with the last layer of said mixture. 20

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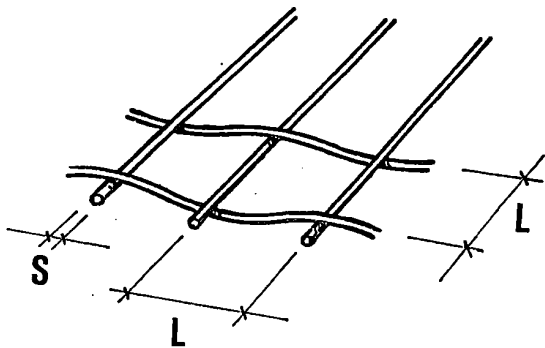
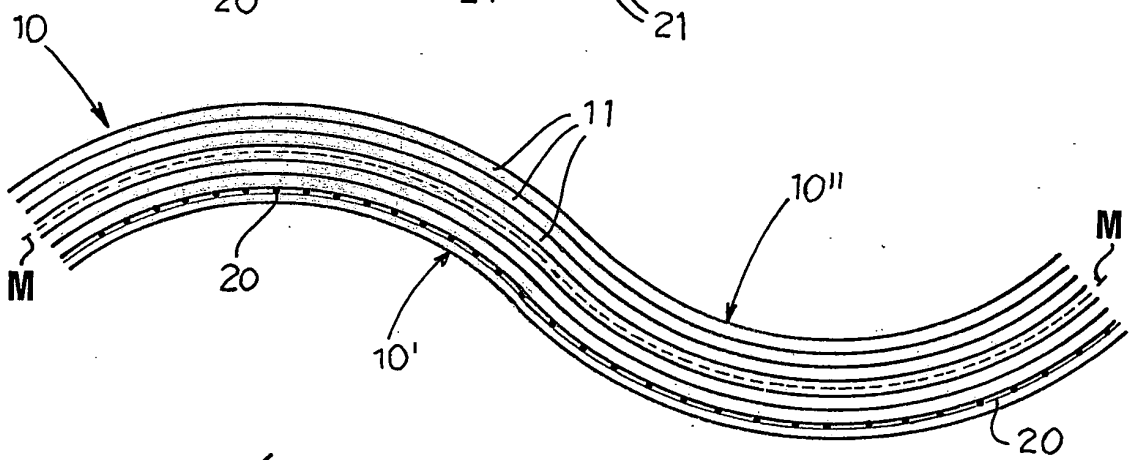
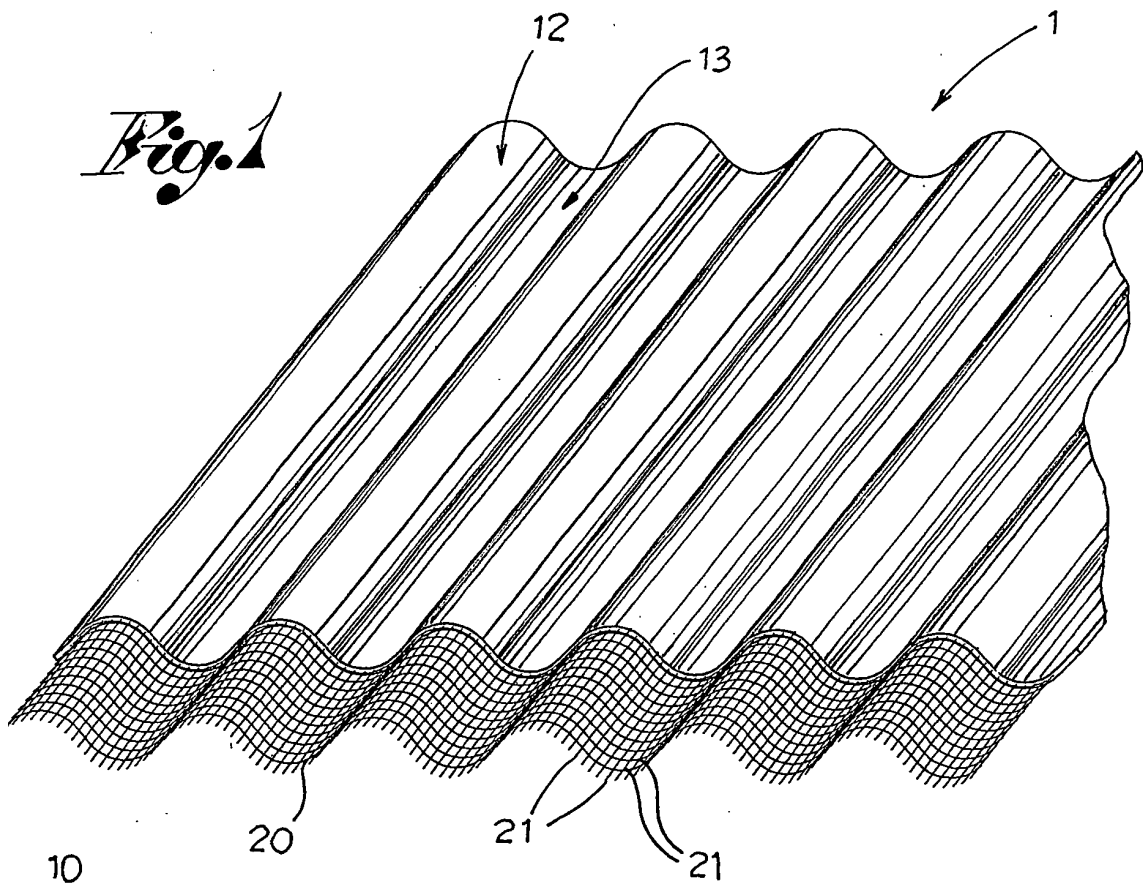
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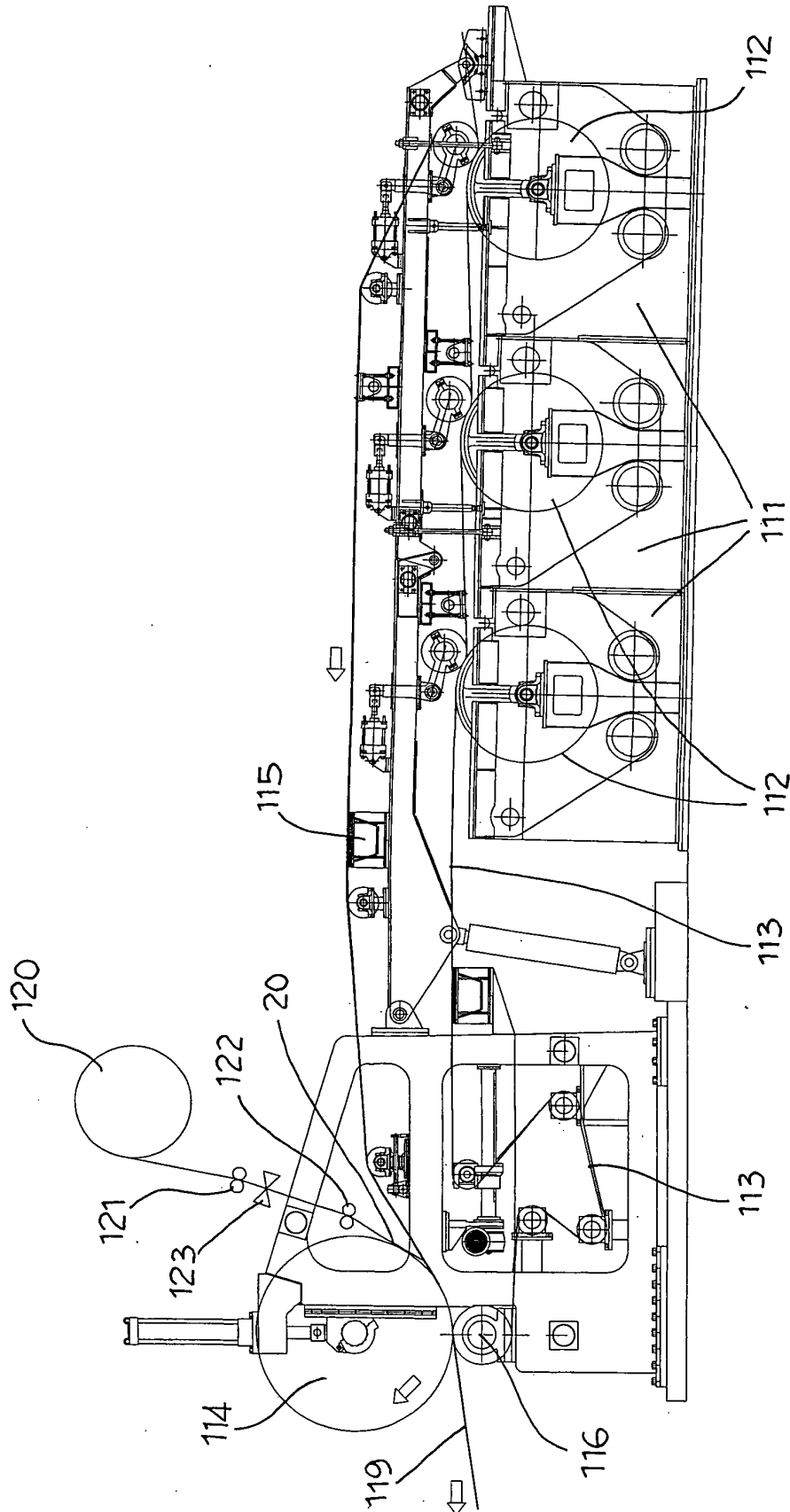


Fig. 4

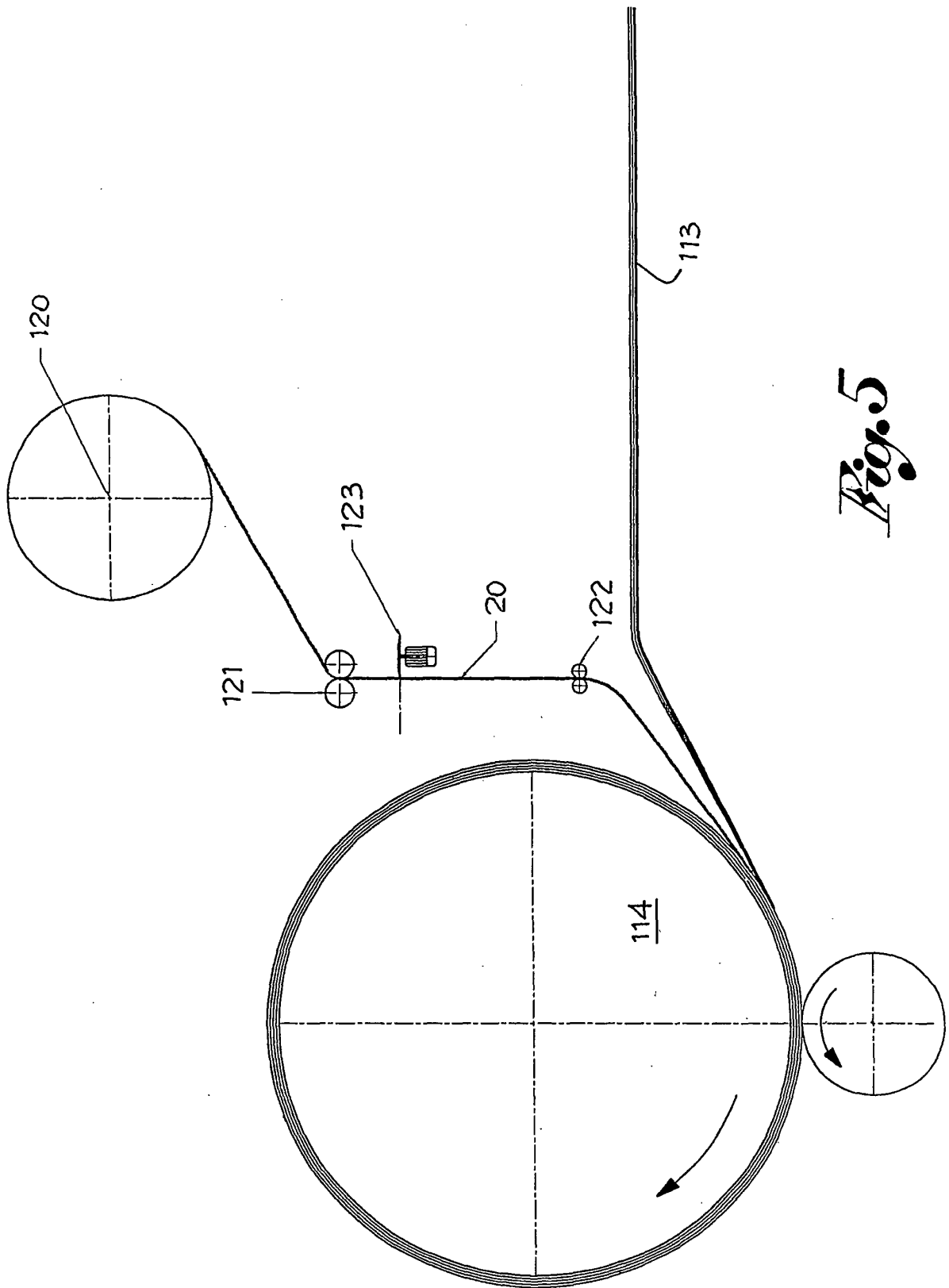


Fig. 5