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

(11) EP 0 857 551 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.08.1998 Bulletin 1998/33

(51) Int. Cl.[6]: **B28B 1/52**, B28B 23/02

(21) Application number: **97830482.2**

(22) Date of filing: **30.09.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **07.02.1997 IT RE970007**

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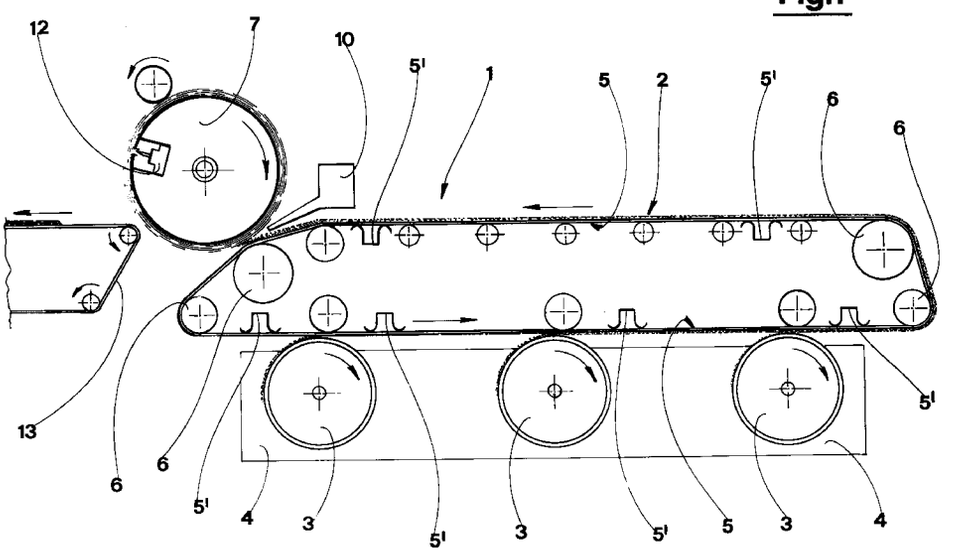
(54) Method for manufacturing corrugated sheets made of fibrous cement.

(57) Method for manufacturing corrugated sheets made of cement material, for example fibrous cement, used for the roofing of buildings. A pick-up felt (5) receives the thin layers of fibrous cement from a plurality of creating cylinders (3) partially immersed in tanks (4) containing the fibrous cement. The desired thickness of fibrous cement is thus achieved by means of the superposition of small layers. After which the fibrous cement is wound onto a forming drum (7) until a cylindrical layer of the desired thickness is obtained.

A device (10), operating in synchronism with rotation of the drum (7) and with forward movement of the felt (5), inserts longitudinal reinforcing elements into the cement binder of the cylindrical sheet. The latter is then cut along a generatrix and extended in a plane.

The flat sheet is then corrugated, pressed and finally conveyed to an oven for curing. The method enables the undesirable phenomena of delamination of the sheets to be reduced during use.

Fig.1



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Description

The present invention relates to a method for manufacturing corrugated sheets made of cement material.

In particular it relates to a method for manufacturing corrugated sheets provided with reinforcing elements of elongated shape, generally consisting of bands or strips, which are inserted into the cement binder of the sheet and arranged along the length of the sheet.

The invention is advantageously used in the case where the cement binder consists of fibrous cement.

In a specific, but not exclusive manner, these corrugated sheets are used for the roofing of civil or industrial buildings. The reinforcing elements (strips, bands and the like) serve to improve the safety of the roofing in the event of breakage of the cement binder, since they retain the parts of the binder itself which would tend to break off, preventing falling of a person who may be standing on the roofing.

Various type of corrugated sheets, generally made of fibrous cement and reinforced with longitudinal elements (for example bands), are already known, as are the associated methods and machinery for manufacturing thereof.

Some examples of sheets of this type are illustrated, for example, by the patents IT No. 172579 (utility model), EP No. 293301, IT No. 1254637, and the applications IT No. MI93U 200, IT No. 183917 (utility model) and IT No. MI92U 498.

A problem of the known corrugated sheets consists in the fact that the cement binder of the sheets reinforced with longitudinal elements may be subject to delamination, cracking and similar phenomena. These phenomena occur more in corrugated sheets provided with longitudinal reinforcing elements than in sheets without these elements. This may be due to the fact that, in the region of the longitudinal reinforcing elements, the cement binder sometimes has microscopic discontinuities, which trigger the formation of cracks, delaminations, breakages and the like in the binder itself, with consequent deterioration in the mechanical characteristics of the sheet.

Another problem is that of ensuring efficient gripping and adhesion of the cement binder on the longitudinal reinforcing elements. In order to improve the bonding between the cement binder and the longitudinal reinforcing elements it is known, for example, from Italian Patent Application No. MI93 U 200 to use reinforcing elements provided with a corrugated or rough external surface. In this case, however, the bond between the cement binder and the reinforcing elements embedded therein may not be sufficient to avoid separation phenomena.

The object of the present invention is to solve the aforementioned problems of the known art, by providing a method for manufacturing corrugated sheets provided with longitudinal reinforcements, as a result of which the risk of formation of structural problems such as cracks, delaminations, breakages, various defects, separation, etc., is reduced considerably.

Another object is that of providing a method for manufacturing corrugated sheets provided with longitudinal reinforcements, which allows the adhesion of the cement binder to the reinforcing elements to be improved.

These objects are achieved by the method in question, as characterized by the claims indicated below.

The invention is described below in a detailed manner with reference to the accompanying drawings which illustrate a preferred embodiment thereof.

Figure 1 shows a schematic side view, in vertical elevation, of a part of a plant for implementing the method in question;

Figure 2 shows, on a larger scale, a detail of Figure 1;

Figure 3 shows a schematic plan view of a part of the plant mentioned above.

Figure 4 shows a schematic side view, in vertical elevation, of a press forming part of the aforementioned plant;

Figure 5 shows a cross-section through a sheet obtained with the method.

The method in question involves an initial step of preparing a mix of fibrous cement, namely a mixture of cement and short synthetic fibres (for example made of polyvinyl alcohol) in predetermined proportions. This step is substantially known and does not require particular explanations.

Figure 1 illustrates a step of the method during which a continuous layer of fibrous cement is prepared. This step involves the use of a machine, indicated in its entirety by 1, in which a layer 2 - often thick - of fibrous cement is formed. The layer 2 is made by means of superposition of single relatively thin layers, resulting from the contribution of each of the cylinders 3. The machine 1 comprises a series of collecting cylinders 3, operating in succession, each of which has a part of its diameter immersed in a tank 4 containing the mix of fibrous cement. The example shows three collecting cylinders 3, although a different number may be used. Each collecting cylinder 3 is able, in response to a command, to rotate in the direction indicated by arrows in Figure 1. The fibrous cement mix forms a more or less thick film on the external surface of the cylinders 3. The film of fibrous cement which, in a paste-like state, is deposited on each cylinder 3 is conveyed, by means of rotation of the latter, into the upper part where it is taken up by a special pick-up felt 5 in the form of endless belt which is wound on pulleys 6 and capable of travelling in the direction indicated by arrows. The bottom section of the pick-up felt 5 is substantially tangential with respect to the exterior of the various collecting cylinders 3. The rotation of the cylinders 3 is synchronised with the forward movement of the felt 5. In the zone of tangential

contact between the cylinders 3 and the felt 5, the various thins layers of fibrous cement are removed and transferred using a known technique from the cylinders to the felt, being superposed on one another and forming the layer with the desired thickness. The pick-up felt 5 thus performs the function of picking up the various films or thin layers formed on the cylinders 3. In other words, by means of the successive superposition of very thin layers, a thicker layer 2 of fibrous cement in the plastic state is formed on the pick-up felt 5. This layer 2 of fibrous cement is then subjected to a known treatment of partial dehydration, travelling over vacuum boxes 5' which suck in the excess water impregnating the felt 5 and the layer 2.

During a subsequent step of the method, a cylindrical sheet 8 of fibrous cement with a thickness of a few millimetres is formed. In order to perform this step of the process it is known to use a rotating drum 7, of relatively large diameter, around which the layer 2 of fibrous cement collected previously by the pick-up felt 5 is wound several times (for example 7 to 8 turns).

The cylindrical sheet 8 is obtained by means of the superposition of many layers until the desired thickness is obtained. During this step, longitudinal reinforcing elements 9, consisting for example of bands, are also inserted in the cement binder of the sheet. An insertion device 10, of the known type, introduces the reinforcing elements 9 above the layer 2 to be wound onto the drum 7 so that, during the step of superposition of the layers on the drum, the reinforcing elements 9 are located between two intermediate adjacent layers (for example between the third and fourth layers). This device 10 operates in synchronism with rotation of the drum 7 so as to arrange the elements 9 in predetermined positions, as will explained more clearly below.

The cylindrical sheet 8 thus obtained is then cut along a generatrix and extended in a plane, by means of a cutting and extending device 12 of a known type and shown only schematically, so as to obtain a flat sheet 11. Cutting of the cylindrical sheet 8 is performed along a generatrix 12' located between the two opposite ends of the reinforcing elements 9. In other words this generatrix does not intersect the reinforcing elements 9. Cutting and extension of the cylindrical sheet 8 is performed with the cement material still in the plastic state. The flat sheet 11, with the reinforcing elements 9 incorporated, is deposited on a conveyor belt 13. The edges of the flat sheet 11 are generally cut and trimmed, reducing the sheet to the desired dimensions.

Figure 3 shows in broken lines the cutting lines along the edges of the sheet 11. The reinforcing elements 9 are arranged sufficiently far from the edges so as not be intersected by the cutting lines of the edges themselves.

Then the flat sheet 11 is corrugated, for example by means of a mould consisting of a suitably shaped suction table to which the sheet adheres. In this way the sheet is deformed plastically, assuming the shape of the table in reverse.

Then the corrugated sheet, together with the reinforcing elements embedded in the cement binder, is conveyed to a press 14, shown schematically in Figure 4, which may be of the type already used for pressing corrugated sheets without the longitudinal reinforcing elements. The press 14 has a lower half-mould 15 and an upper half-mould 16, which are suitably shaped and between which the sheet is compressed, maintaining substantially its corrugated shape.

The lower half-mould 15 and upper half-mould 16, which are able to perform a rectilinear movement towards and away from one another, have active profiles which are corrugated and match the respective lower and upper corrugated surfaces of the sheet.

With this pressing step it is possible to eliminate, during use, problems of delamination, flaking, formation of cracks and microfissures, etc., in particular in the zone of the cement binder adjacent to the reinforcing elements 9. The value of the pressure preferably applied onto the sheet may vary from a minimum of 50 kg/cm^2 to a maximum of 350 kg/cm^2, depending on the type of mix, and the type and use of the sheet.

Figure 5 shows the cross-section of a corrugated sheet 17 thus obtained and intended for use as the roofing for buildings. This sheet 17 comprises a lower surface 18 which, when laid, is intended to face downwards, an upper surface 19 directed upwards and a series of troughs 20 and peaks 21, and also has a reinforcement consisting of a plurality of reinforcing elements 9 embedded in the cement binder, arranged parallel alongside one another and extending in the direction of the length of the sheet 17, parallel to the troughs 20 and peaks 21 of the sheet itself.

The step involving insertion of the reinforcing elements 9 in the cement binder must be performed in such a way that, after the step involving corrugation of the sheet, each reinforcing element 9 is arranged in the vicinity of a respective trough 20. In the example shown, the elements 9 are situated along the middle plane of the respective trough 20, substantially in the bottom zone thereof. It is possible, however, for the elements 9 to be located at a certain distance from the middle plane of the trough 20.

Upon leaving the press 14 the corrugated and compressed sheets 17 are positioned on corrugated tables and stacked on top of one another, with corrugated metal sheets being arranged in between. The stacks thus formed are then conveyed to an oven, for example of the tunnel type, for curing.

The reinforcing 9 elements used may consist of bands or strips and may be made of a plastic material (for example polypropylene or polyvinyl alcohol), metal (for example steel), carbon fibres or other material. The external surface of the reinforcing elements 9 may be corrugated in order to improve the gripping of the cement binder. The cross-section of the reinforcing elements 9 may be rectangular, circular or of another type.

A single reinforcing element 9 may in fact be replaced by one or more wires arranged close to one another.

In the example shown in Figure 5 the position of the reinforcing elements 9 is located in the bottom part 20 of each trough, it being possible moreover for this position to be located elsewhere, depending on the particular requirements and characteristics of the product.

The cement binder preferably consists of fibrous cement comprising, for example, polyvinyl alcohol fibres or other types of fibres, or having mixtures of different fibres such as, for example, cellulose fibres, in known percentages and using known methods.

It has been determined that the compression of the sheets, already corrugated and reinforced with the elongated elements, significantly improves the compactness of the sheets themselves. In particular, it favours the bonding of the binder with the longitudinal reinforcing elements. A positive effect observed is the reduction in the phenomena of delamination, crumbling, cracking, etc. of the cement binder. It should be noted that compression of the sheets 17 is performed prior to curing thereof, i.e. when the cement binder has not hardened, but is still in the plastic state.

The example described envisages the use of machine 1 with several collecting cylinders 3 for forming a layer 2 of cement material. The latter, however, may be formed using other known methods, such as, for example, by means of successive spraying of the material onto a single carrier belt.

Claims

1. Method for manufacturing corrugated sheets of cement material, in which a plurality of reinforcing elements (9) of elongated shape are inserted into the cement binder of the sheet, the sheet being then corrugated, characterized in that, after insertion of the reinforcing elements (9) and after corrugation, the corrugated sheet is pressed.

2. Method according to Claim 1, characterized in that the corrugated sheet is pressed between a lower half-mould (15) and an upper half-mould (16) of a press (14), the said lower half-mould (15) and upper half-mould (16) having active profiles which are corrugated and match the upper and lower corrugated surfaces of the sheet to be pressed.

3. Method according to any one of the preceding claims, characterized in that the pressure applied to the sheet is comprised in the range between 50 kg/cm^2 and 350 kg/cm^2.

4. Method according to any one of the preceding claims, characterized in that the cement binder of the sheet is in the form of a mix consisting of a hydraulic binder and a mixture of fibres.

Fig.1

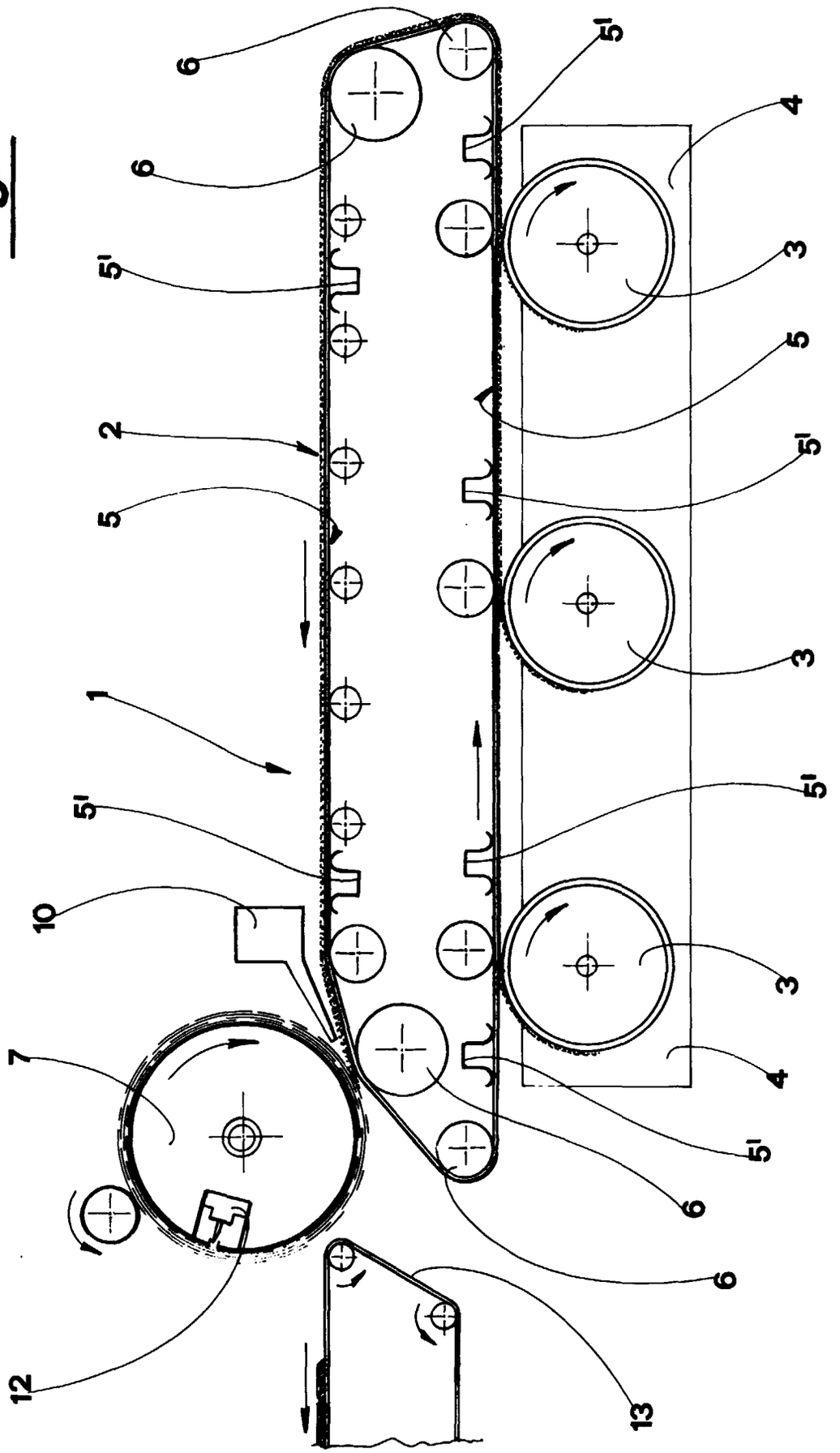
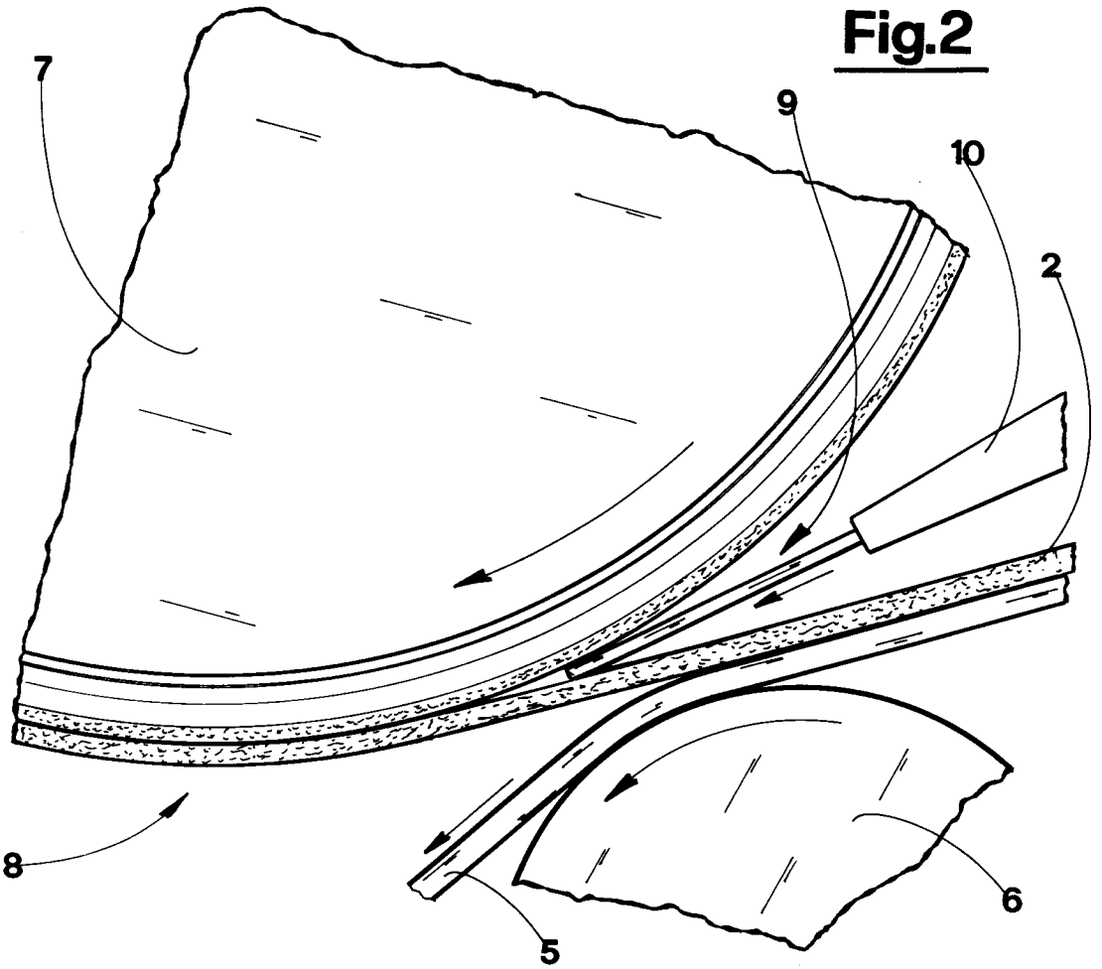


Fig.2



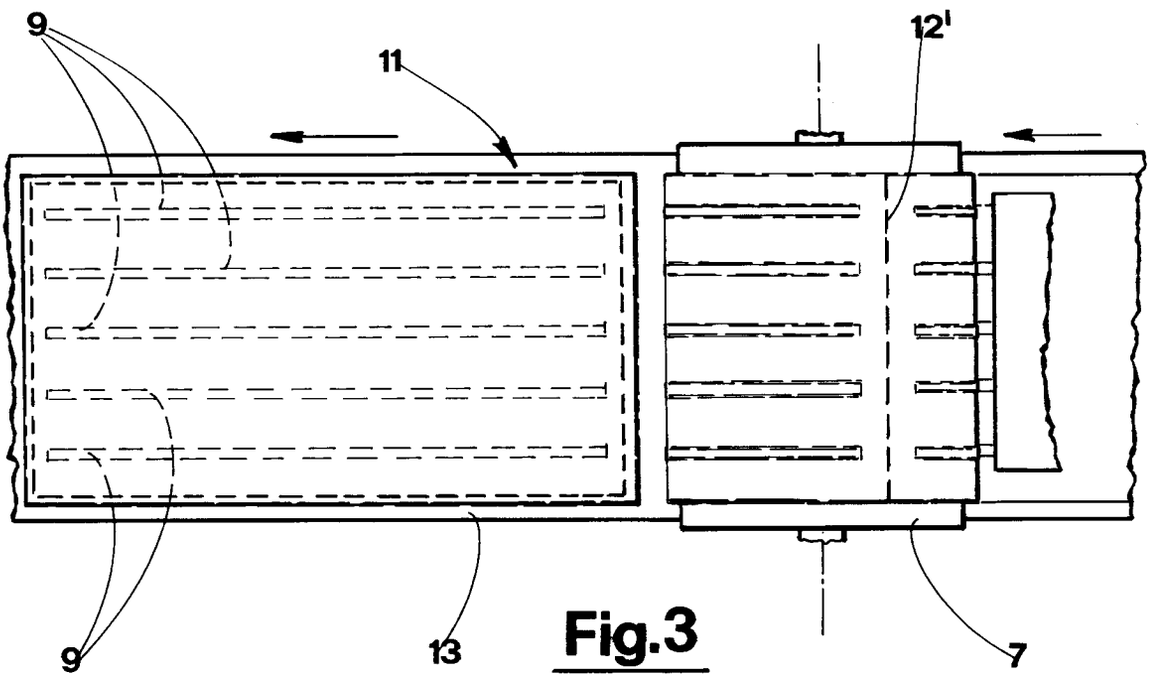


Fig.3

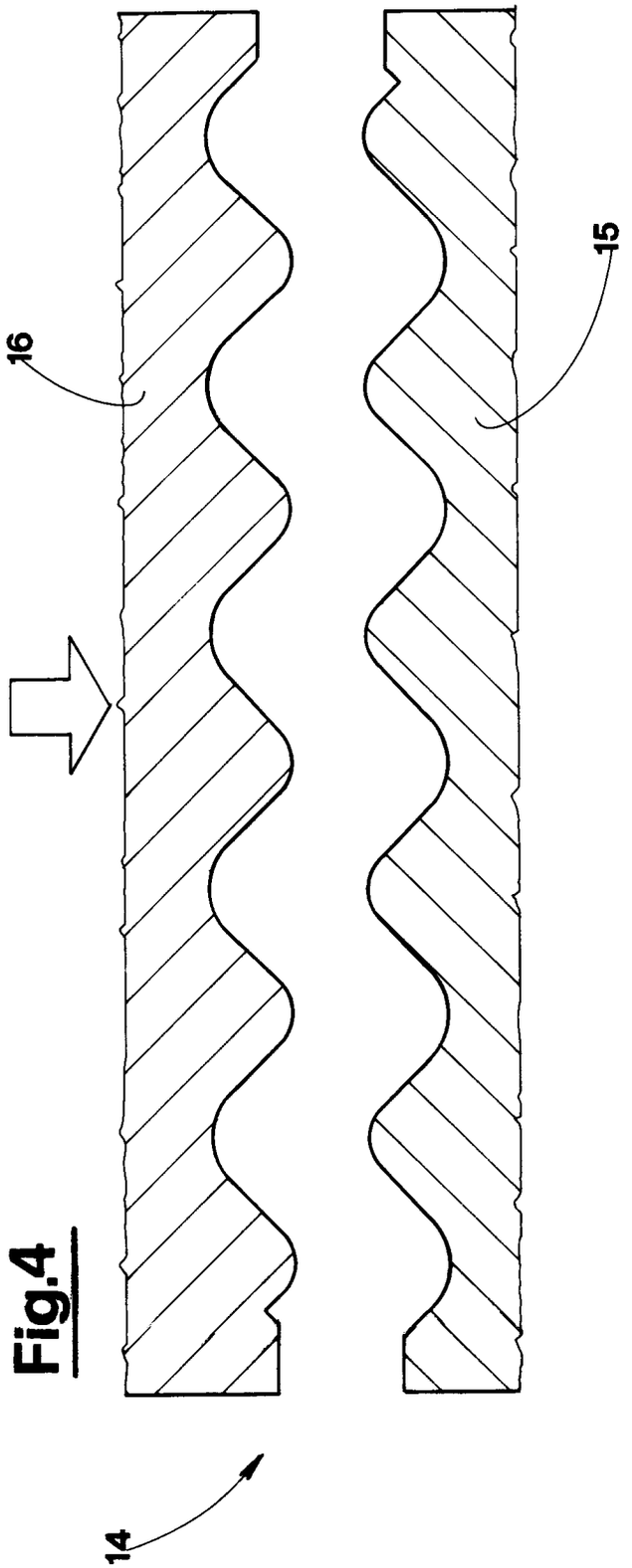


Fig.4

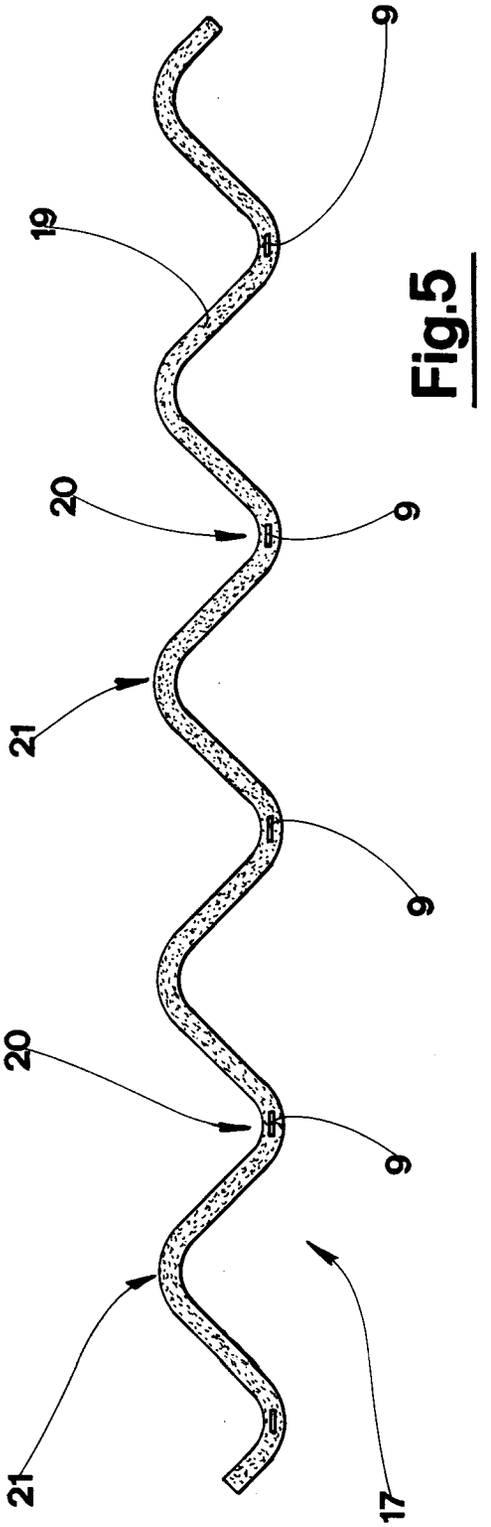


Fig.5

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EUROPEAN SEARCH REPORT

Application Number
EP 97 83 0482

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US 1 931 494 A (E. HURDEN) * the whole document * * page 2, line 72 - page 2, line 95 * * figure 7 *	1,2,4	B28B1/52 B28B23/02
A	US 2 004 935 A (R. DORN) * page 1, line 46 - page 3, line 20 * * page 3, line 42 - page 3, line 55 * * figure 5 *	1-4	
A	US 2 672 076 A (A. MAGNANI) * the whole document *	1,2,4	
A	FR 2 286 254 A (MARCHIOLI GIORGIO) * the whole document *	1-4	
A	GB 632 767 A (TURNERS ASBESTOS CEMENT COMPANY LIMITED) * the whole document *		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B28B
E04C
E04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 May 1998	Gourier, P

CATEGORY OF CITED DOCUMENTS

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