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3,170,192

DEVICE FOR CORRUGATING SHEETS OF FIBROUS CEMENT

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2 Sheets-Sheet 1

FIG. 1

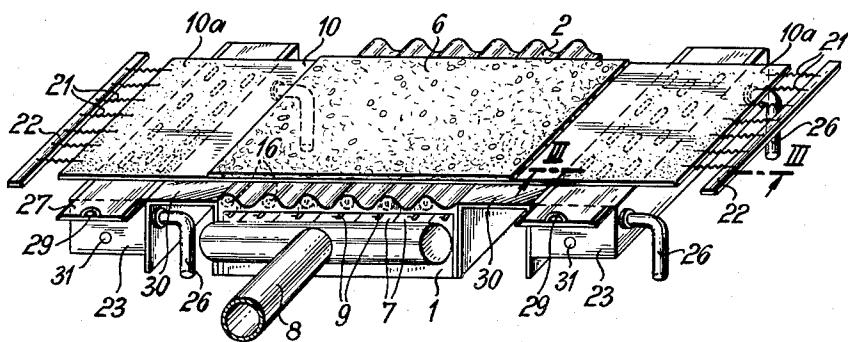


FIG. 2

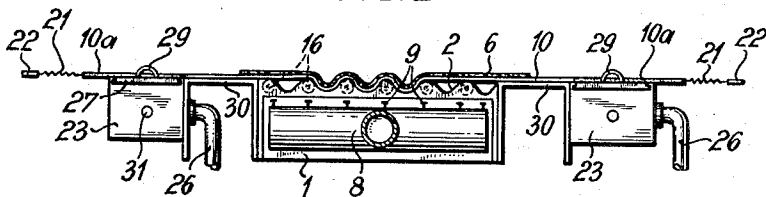
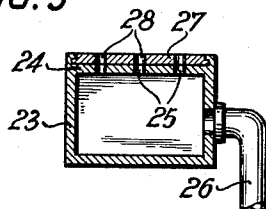


FIG. 3



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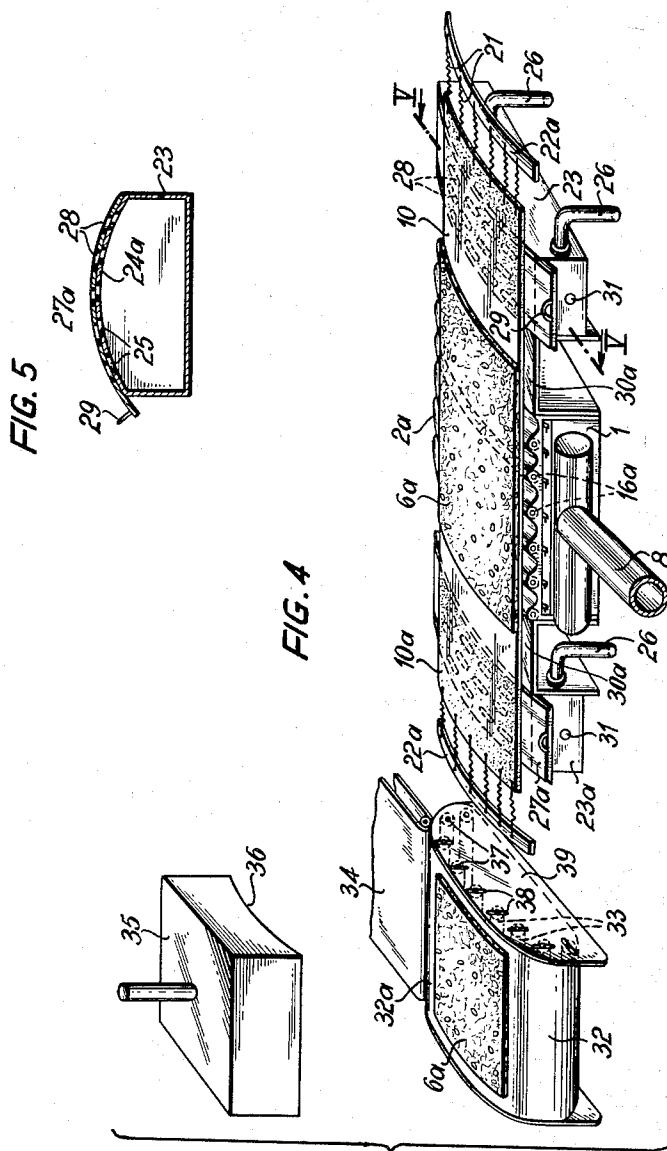
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DEVICE FOR CORRUGATING SHEETS OF FIBROUS CEMENT

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DEVICE FOR CORRUGATING SHEETS OF FIBROUS CEMENT

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O 9,245

9 Claims. (Cl. 18—19)

This invention relates to a device for corrugating sheets of fibrous cement which comprises a corrugating suction box subdivided into a plurality of longitudinally extending separate suction chambers, a rigid cover disposed on said corrugating suction box and provided with suction holes and with corrugations corresponding to the corrugations to be formed in said sheets of fibrous cement, an auxiliary suction box arranged at either end of said corrugating suction box and in spaced relationship thereto, a plain surface cover disposed on either of said auxiliary suction boxes and provided with suction holes, a flexible layer with an air permeable middle portion and air impermeable end portions, which for supporting said sheets of fibrous cement to be corrugated is stretched over said corrugating suction box and said auxiliary suction boxes in such a manner that said air permeable middle portion is situated on said corrugated cover of said corrugating suction box, whereas said air impermeable end portions are situated on said plain surface covers of said auxiliary suction boxes with parts of said impermeable end portions projecting beyond said auxiliary suction boxes, and tension members secured to said air impermeable end portions of said flexible layer and exerting a predetermined amount of pull thereon.

For keeping the flexible air permeable layer during the corrugating process in a stretched condition on the corrugating suction box and for restretching the flexible layer after completion of the corrugating process, weights are provided in a known device, which act with constant force on the ends of the flexible layer. Stretching the flexible layer by means of weights has the disadvantage that when normal atmospheric conditions are restored to the chambers of the corrugating suction box the flexible layer is stretched with a jerk by the dropping weights and thus heavily stressed by continuously recurrent elongation forces. To avoid this disadvantage and to preclude structural changes in the soft fresh sheet of fibrous cement, which will occur when the flexible layer and the sheet of fibrous cement supported thereon are abruptly sucked into the individual corrugations of the suction box cover, it has already been suggested that the suction type corrugating device be associated with a brake gear motor operated control device which lifts the loading weights at a low hoisting speed in accordance with the operation of each individual suction chamber of the corrugating suction box and also permits the loading weights to return smoothly into their initial positions upon completion of the corrugating process.

In this case, accurate synchronism between the mode of operation of the control device and the mode of operation of the suction type corrugating device is required to obtain that the corrugating process takes place in the desired manner so that the flexible layer will slide slowly into the corrugations of the cover of the suction box.

In the device proposed by the present invention such difficulties of adjustment are eliminated by the use of the auxiliary suction boxes which are considerably simpler in design than the known device for controlling the stepwise lifting and the slow return of the weights and which in a simple manner and without complicated adjustment can be easily set for proper co-operation

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between the corrugating suction box and the tension members stretching the flexible layer. Owing to the suction applied through the auxiliary suction boxes to the air impermeable end portions of the flexible layer the yielding movement of this latter is retarded when suction is applied by the corrugating suction box straight through the air permeable middle portion of the flexible layer to the sheet of fibrous cement placed thereon, thereby to suck this sheet together with the flexible layer into the corrugations of the cover of the corrugating suction box, the forces exerted by the tension members to the ends of the flexible layer being only of a degree ensuring that the flexible layer is restretched after normal atmospheric conditions have been restored to the corrugating suction box and to the auxiliary suction boxes.

The suction forces by which the air impermeable end portions of the flexible layer are retained on the auxiliary suction boxes are adjustable to actual requirements by varying the degree of the vacuums prevailing in the auxiliary suction boxes.

To obtain an additional possibility of controlling the forces retarding the yielding movement of the flexible layer a slide may be associated with either auxiliary suction box, which slides are provided with openings, which correspond to the suction holes in the covers of the auxiliary suction boxes, and arranged to be displaceable in relation to these covers thereby to vary the total clear cross section of the suction holes in the cover of each of the two auxiliary suction boxes.

The suction forces acting on the air permeable end portions of the flexible layer and retarding the yielding movement thereof primarily keep the flexible layer stretched. Restretching of the flexible layer after completion of the corrugating process will be effected by the elastic tension member attached to either end of the flexible layer.

Moreover, the invention affords a further considerable technical progress in so far as for the first time it opens up the advantageous possibility of producing convex or concave (curved) corrugated sheets without it being necessary to incorporate special structure in the device and without any necessity of carrying out an additional operation.

So far, curved corrugated sheets have been manufactured in that the fresh sheets of fibrous cement are first corrugated and then stacked in numbers of 50 to 60 between corrugated sheet steel plates. This stack is removed from the sheet producing plant and fed to a second plant in which the plane structural steel plates are removed one by one and from which they are transported back again to the sheet producing plant after having been cleaned and oiled. The corrugated sheets are taken off by a suction die which, for example, consists of a plurality of hingeably interconnected suction elements. The corrugated sheets of fibrous cement, which still are in a state of plasticity just sufficient to allow their deformation—although a period of about an hour has already passed since the lowermost sheets of the stack have been manufactured and thus these sheets are already in their first setting process—are placed by the suction die in flat condition on to a pedestal-like support which has a surface corresponding to the curved corrugated sheet to be formed. The suction elements of the suction die form a polygonal continuous series of lines and consequently also the curved sheets do not have a continuously curved but a polygonal shape. After a certain number of corrugated sheets have been stacked with an intermediate layer being interpositioned between any two successive sheets, the stack is moved out of the plant and the fresh curved corrugated sheets are left to the setting process. This hitherto customary way of curving previously corrugated sheets of fibrous cement involves con-

siderable expenditure with regard to mechanical equipment and additional operations. The subsequent curving of the corrugated sheets causes structural changes in the corrugation troughs and crests of the corrugated sheets, which may have a detrimental effect upon the quality of the finished product.

By the further development of the basic idea of the invention, i.e. to retain the flexible air permeable layer by suction forces in its stretched position on the corrugating suction box, these difficulties, which arise in the manufacture of curved corrugated sheets and are notorious to the asbestos-cement industry may be eliminated in that the corrugated cover of the corrugating suction box as well as the plain surface covers of the auxiliary suction boxes and if required the bridging surfaces arranged therebetween are provided with a convex or concave curvature in the transverse direction so that the device can be used for corrugating correspondingly curved fresh sheets of fibrous cement.

Contrary to the method of manufacturing curved corrugated sheets that has been hitherto customary in practice, the fresh sheets of fibrous cement now may be corrugated by the proposed device after previously having been curved. Curving a flat fresh sheet of fibrous cement and subsequent corrugating can be effected in an easier manner than curving a previously corrugated sheet which has acquired a certain rigidity through the corrugation process and thus offers a high resistance to the corrugating action, which may be the cause for changes in structure. The final forming of the fresh curved corrugated sheets of fibrous cement is effected in a continuous operation the individual steps of which are substantially the same as in the manufacture of plane corrugated sheets. The equipment proposed by the invention for producing curved corrugated sheets is extremely simple and is characterized by high reliability in operation. By replacing or adjusting a few parts it can be easily set for the manufacture of differently curved corrugated sheets.

If the radius of curvature of the curved covers of the corrugating suction box, the auxiliary suction boxes and of the bridging surfaces is relatively large, the fresh sheet of fibrous cement, owing to its dead weight, will conform of itself in a satisfactory manner to the curved box cover of the corrugating suction box when the sheet is transferred by means of a suction die having a plane suction underside from the last belt conveyor of the sheet producing plant on to the flexible layer stretched over the cover of the corrugating suction box. In the case of a small radius of curvature it may be convenient to apply the sheet of fibrous cement in the as curved shape to the cover of the corrugating suction box. For this purpose, the upper run of the last belt conveyor in the plant for producing fresh true to size sheets of fibrous cement may be guided over cylinders or sliding surfaces having a curvature corresponding to the curved covers of the corrugating suction box and the auxiliary suction boxes as well as the bridging surfaces, while the underside of the suction die, which takes the curved sheet of fibrous cement off this run of the belt, may conveniently be realized with a corresponding curvature.

Two preferred embodiments of the invention will now be described by way of example and with reference to the accompanying drawing, in which:

FIG. 1 is a perspective view of a device for corrugating plane sheets of fibrous cement;

FIG. 2 is a front elevational view showing the device after having produced the first corrugations in the sheet of fibrous cement;

FIG. 3 is a cross section taken on line III—III of FIG. 1;

FIG. 4 is a perspective view of a modified embodiment of the device, which is adapted to be used for corrugating curved sheets of fibrous cement, as well as of associated equipment such as belt conveyors and of a

suction die for transferring the curved sheet of fibrous cement from the adjacent belt conveyor on to the corrugating suction box, and

FIG. 5 is a vertical cross section taken on line V—V of FIG. 4.

Identical parts will be designated by the same reference numerals in the description of the two embodiments of the invention.

FIGS. 1 to 3 show a device for corrugating plane sheets of fibrous cement, which comprises a corrugating suction box 1 subdivided into separate suction chambers and provided with a corrugated cover 2 in which the corrugation crests in their apex regions may be formed by rotatably mounted rolls 16. The separate chambers of the corrugating suction box 1 are connected to a common T-shaped suction conduit 3 through the intermediary of connecting pieces 7 each including a shutoff device 9. The suction conduit 3 for its part communicates with a vacuum generator, not shown, such as a suction fan of a known type.

Laterally adjacent the corrugating suction box 1 and at a distance apart from the latter there are arranged two auxiliary suction boxes 23 including plain surface covers 24 provided with a plurality of suction holes 25, e.g. elongated holes.

A flexible layer 10, which includes an air permeable middle portion and air impermeable end portions 10a, is stretched across the corrugated cover 2. To make the end portions 10a air impermeable these may either be impregnated or made of an air impermeable material. On the transverse edges of the air impermeable end portions 10a, several soft-elastically expandible tension members 21, for example rubber members or long soft helical springs, are distributed over the length thereof and secured thereto, the other ends of which members are fixed to stationary strips 22. The elastically expandible tension members 21 do not offer much resistance to the yielding movement of the flexible layer 10 when a vacuum is produced in each of the separate suction chambers of the corrugating suction box 1 and a sheet of fibrous cement 6 placed on the air permeable middle portion of the flexible layer 10 is sucked zone by zone successively into the corrugations of the cover 2 of the corrugating suction box 1, the total force of all tension members 21 acting on the two end portions 10a of the layer 10 being just sufficient to restretch the flexible layer across the corrugated cover 2 upon completion of the corrugating operation as soon as the corrugated sheet of fibrous cement 6 has been lifted off the cover 2 of the corrugating suction box 1 and normal atmospheric conditions have been restored to the individual chambers of the corrugating suction box 1.

The air impermeable end portions 10a of the flexible layer 10 flatly rest on the covers 24 of the auxiliary suction boxes 23. Prior to placing the sheet of fibrous cement 6 to be corrugated, on to the air permeable middle portion of the flexible layer 10, a vacuum is produced in either auxiliary suction box 23. For rapidly obtaining a vacuum, each of the two boxes 23 is provided with two suction pipe connections 26 from which conduits lead to a suction conduit not shown which conveniently is connected to the same vacuum generator that serves to produce the vacuum in the corrugating suction box 1. With the aid of a control device incorporated in the suction conduit leading to the auxiliary suction boxes 23, the degree of vacuum produced in either auxiliary suction box 23 can be controlled as required.

For individually fine-controlling the suction of the two auxiliary suction boxes 23, a slide 27 is disposed on each cover 24 so as to be displaceable in relation thereto and provided with openings 28 corresponding with the suction holes 25 in the respective cover 24. By adjusting the slides 27, which for easy manipulation are each equipped with a handle 29 at one of their ends, the total clear cross section of the suction holes 25 in the covers 24 of the auxili-

any suction boxes 23 can be varied as desired, thereby to adapt the suction force of each of the two suction boxes 23 accurately to actual requirements.

The force retaining the air impermeable end portions 10a of the flexible layer 10 though suction on the covers 24 of the auxiliary suction boxes 23 must be so great as to maintain the flexible layer 10 with the sheet of fibrous cement 6 resting thereon tightly stretched and, moreover as to retard the yielding movement of the flexible layer 10 when the vacuum of the individual chambers of the corrugating suction box 1 is successively applied to the sheet of fibrous cement 6 straight through the air permeable middle portion 10a of the flexible layer 10, in such a manner that the middle portion 10a of the flexible layer 10 together with the sheet of fibrous cement 6 supported thereby slowly enters the corrugations of the cover 2 of the corrugating suction box 1 at approximately uniform speed and zone by zone. The force with which the air impermeable end portions 10a of the flexible layer 10 are retained on the auxiliary suction boxes 23, plus the relatively weak tension exerted by the tension members 21, must however not exceed the suction force of the corrugating suction box 1.

The distance between the auxiliary suction boxes 23 and the corrugating suction box 1 is so determined that the air impermeable end portions 10a of the flexible layer 10 do not get into the region of the corrugations of the cover 2 of the corrugating suction box 1 in consequence of the yielding movement of the flexible layer 10 during the corrugating process. In the initial position, the air impermeable end portions 10a of the flexible layer 10 project outwards beyond the auxiliary suction boxes 23 by strips corresponding in width to the distance by which the end portions 10a are drawn towards the corrugating suction box 1. The free spaces between the auxiliary suction boxes 23 and the corrugating suction box 1 are bridged by incorporated surfaces 30 which extend in a common plane with the plain surfaces of the covers 24 and with the corrugating crests of the corrugated cover 2 of the corrugating suction box 1, as can be seen from FIG. 1.

The corrugating of the sheet of fibrous cement 6 freshly supplied from the production plant is effected in a known manner viz. in that, starting in the middle of the sheet, a first corrugation is formed and subsequently the other corrugations are produced, proceeding towards the ends of the sheet of fibrous cement 6. FIG. 2 shows the corrugating device in an operating condition in which the corrugations in the middle part of the sheet of fibrous cement 6 have already been formed.

After completion of all corrugations, the corrugated sheet of fibrous cement 6 will, as usual, be removed from the corrugating suction box 1 by means of a suction die, the suction surface of which is shaped in conformity with the shape of the corrugated sheet of fibrous cement, and subsequently the suction chambers of the corrugating suction box 1 and the auxiliary suction boxes 23 are brought into communication with the outside air. To permit normal atmospheric conditions to be restored as fast as possible to the auxiliary suction boxes 23, a ventilating valve 31 is incorporated in a wall of each suction box 23 and so controlled in dependence on the operation of the corrugating device that it is automatically opened at the right instant. At the same moment at which the air impermeable end portions 10a of the flexible layer 10 are completely released by the auxiliary suction boxes 23, the elastically expanded tension members 21 re-stretch the flexible layer 10, and the next corrugating process can be initiated immediately thereafter.

FIGS. 4 and 5 show a corrugating device of a modified form of construction which is intended for corrugating curved sheets of fibrous cement 6a. The corrugating suction box 1 and the auxiliary suction boxes 23 are provided in this case, with a curved corrugated cover 2a and curved plain surface covers 24a, respectively. The

covers 24a are fitted with correspondingly curved slides 27a. Moreover, the device includes curved bridging surfaces 30a as well as curved strips 22a, to which latter the elastic tension members 21 are secured. The degree of curvature is the same in all of these curved parts so that their surfaces are located on a common generated cylinder surface. In the apex regions of the corrugation crests of the cover 2a, accordingly curved rolls 16a are mounted for rotation, as shown by dash-line representation of one roll in FIG. 4. The curved rolls 16a are made of elastically flexible material such as rubber so that they can rotate—similarly to a flexible shaft—with their material being only slightly deformed. For maintaining the curved shape of the rolls 16a these can be supported on rollers arranged at small distances from one another.

This extension of the range of use of the proposed corrugation device is extraordinarily important for the practice and rendered possible in that by the provision of the suction boxes 23 the difficulties are overcome that consist in making the flexible layer 10, which must be stretched in a curved state over the curved cover 2a of the corrugating suction box 1, slowly yield and slip into the corrugations of the curved cover 2a at a controlled speed.

The sheet of fibrous cement to be curved and to be corrugated immediately thereafter can be taken off the last belt conveyor of the plant for producing true to size sheets of fibrous cement by means of a suction die, as described with reference to the device of FIGS. 1 to 3, and transferred on to the curved corrugated cover 2a of the corrugating suction box 1, i.e. on to the flexible layer 10 stretched thereover. By the action of its dead weight, the soft fresh sheet of fibrous cement will take the curvature of the box cover 2a. The corrugating of the already curved sheet 6a can be carried out in an unobjectionable manner without detrimental structural changes in the fibrous cement material at the same working speed at which plane sheets of fibrous cement are corrugated by the action of a vacuum.

To ensure in the case of corrugating heavily curved sheets of fibrous cement that the sheets 6 are resting snugly and uniformly on every spot of the curved flexible layer 10 it is proposed to curve the sheets of fibrous cement to be corrugated already prior to being placed on the flexible layer 10. For this purpose, a run 32a of a belt conveyor 32 of the sheet producing plant is guided over cylinders 33 which are so arranged as to impart the run 32a, which is the upper run of the belt, substantially the same curvature as that possessed by the cover 2a of the corrugating suction box 1 and by the covers 24a of the auxiliary suction boxes 23. The fresh sheet of fibrous cement supplied from a sizing roller by means of a belt conveyor 34 slides on to the upper run 32a of the belt conveyor 32 adjoining the corrugating device and thereby is given the desired curvature. A suction die 35 having a correspondingly curved suction bottom 36 is provided for transferring the curved sheet of fibrous cement 6a on to the air permeable middle portion of the flexible layer 10 stretched in curved condition. The corrugating of the curved sheet of fibrous cement 6a then can be performed in the same manner as in the case of the device shown in FIGS. 1 to 3. Upon completion of the corrugating process, the flexible layer 10 is restored to the curved stretched state by the tension members 21. The suction die to be provided for delivering the finished curved and corrugated sheet of fibrous cement 6a from the corrugating device must be provided, as a matter of course, with an appropriately curved and, moreover, also corrugated suction bottom.

The cylinders 33 are carried by axles 37 arranged in elongated holes 38 in side parts 39 of the substructure of the belt conveyor 32 so as to be adjustable and fixable therein. This enables the curvature of the upper run 32a of the belt to be varied and the device to be reset

for the production of curved corrugated sheets of fibrous cement of any desired radius of curvature within a short period of time by replacing the corrugating suction box 1, the lateral suction boxes 23, the bridging surfaces 30a as well as the anchoring strips 22a for the tension members 21 by parts having the required surface curvature. The device may also be designed for the manufacture of concave sheets of fibrous cement.

I claim:

1. A device for corrugating sheets of fibrous cement comprising a corrugating suction box subdivided into a plurality of longitudinally extending separate suction chambers, a rigid cover disposed on said corrugating suction box and provided with suction holes and with corrugations corresponding to the corrugations to be formed in said sheets of fibrous cement, an auxiliary suction box arranged at either end of said corrugating suction box and in spaced relationship thereto, a plain surface cover disposed on either of said auxiliary suction boxes and provided with suction holes, a flexible layer with an air permeable middle portion and air impermeable end portions, which for supporting said sheets of fibrous cement to be corrugated is stretched over said corrugating suction box and said auxiliary suction boxes in such a manner that said air permeable middle portion is situated on said corrugated cover of said corrugating suction box, whereas said air impermeable end portions are situated on said plain surface covers of said auxiliary suction boxes with parts of said impermeable end portions and projecting beyond said auxiliary suction boxes, and tension members secured to said air impermeable end portions of said flexible layer and exerting a predetermined amount of pull thereon.

2. A device as claimed in claim 1, wherein bridging surfaces are incorporated between said corrugating suction box and said auxiliary suction boxes, said bridging surfaces extending in a common plane with said corrugated cover and said plain surface covers of said corrugating suction box and said auxiliary suction boxes respectively.

3. A device as claimed in claim 2, wherein said corrugated cover, said plain surface covers and said bridging surfaces extend in a horizontal plane.

4. A device as claimed in claim 2, wherein said corrugated cover, said plain surface covers and said bridging surfaces are curved in the direction of the longitudinal extension of said corrugations provided in said cover of said corrugating suction box.

5. A device as claimed in claim 1, wherein a slide is associated with each of said plain surface covers of said auxiliary suction boxes and openings are provided in each slide, said openings corresponding to said suction holes

in said covers of said auxiliary suction box, so that the total clear cross section of said suction holes is adjustable by displacing said slides in relation to said covers of said auxiliary suction boxes.

6. A device as claimed in claim 1, wherein said auxiliary suction boxes are adapted to act on said air impermeable end portions of said flexible layer in such a manner as to release said air impermeable end portions only with retardation when said air permeable middle portion of said flexible layer supporting a sheet of fibrous cement is carried along by said sheet of fibrous cement, owing to suction applied thereto by means of said corrugating suction box, and forced into said corrugations provided in said cover of said corrugating suction box thereby pulling said air impermeable end portions against the retarding forces of said auxiliary suction boxes, said tension members being adapted to yield to said retarded movement of said flexible layer and to restretch said flexible layer when normal atmospheric conditions have been restored in said corrugating suction box and in said auxiliary suction boxes.

7. A device as claimed in claim 1, wherein a belt conveyor is provided for conveying fresh sheets of fibrous cement from a sheet producing plant to said device and a suction die is provided for transferring said sheets of fibrous cement from said belt conveyor on to said air permeable middle portion of said stretched flexible layer.

8. A device as claimed in claim 3, wherein a belt conveyor is provided for conveying fresh sheets of fibrous cement from a sheet producing plant to said device and a suction die is provided for transferring said sheets of fibrous cement from said belt conveyor on to said air permeable middle portion of said stretched flexible layer, said belt conveyor including an upper run which is guided over cylinders 33 curved in conformity with the curvature of said corrugated cover, said plain surface covers and said bridging surfaces and said suction die having a suction surface provided with the same curvature.

9. A device as claimed in claim 7, wherein said cylinders are arranged so as to be adjustable.

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