Aug. 13, 1935. R. DORN ET AL 2,011,440

PROCESS FOR MAKING CEMENTITIOUS SHEETS

Original Filed April 28, 1932 2 Sheets-Sheet 1

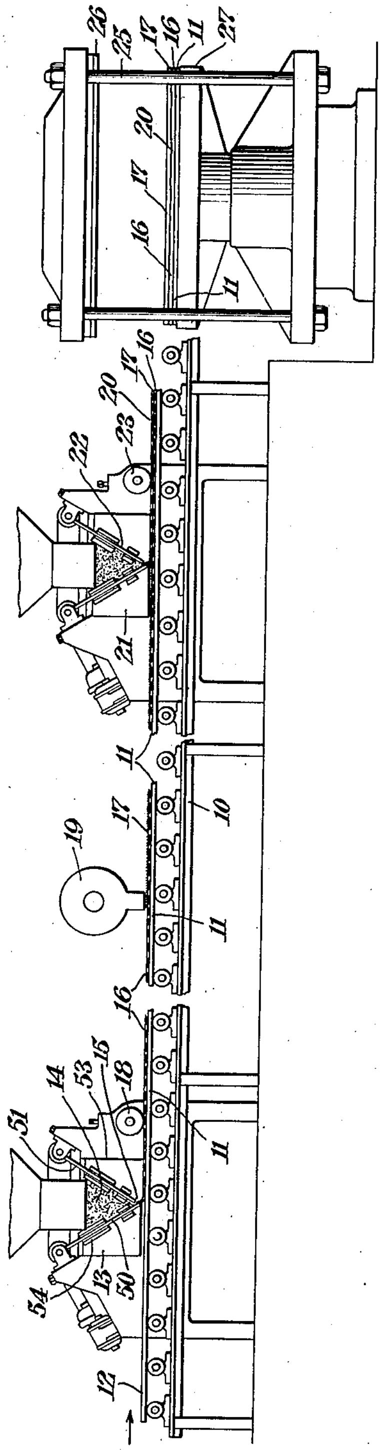

Fig. 1.

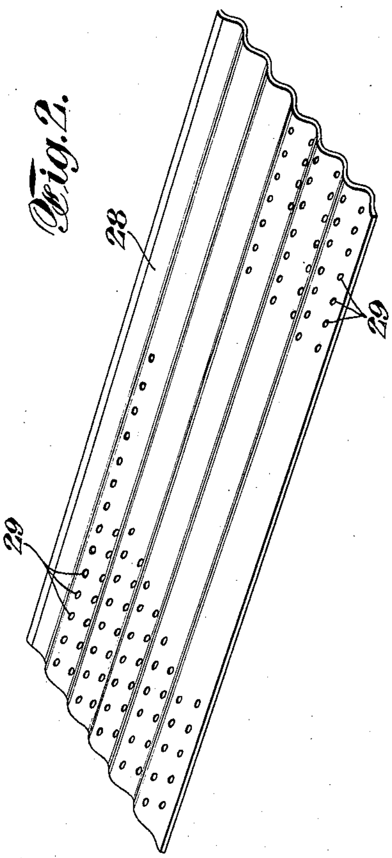

Fig. 2.

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PROCESS FOR MAKING CEMENTITIOUS SHEETS

Original Filed April 28, 1932 2 Sheets-Sheet 2

Fig. 3.

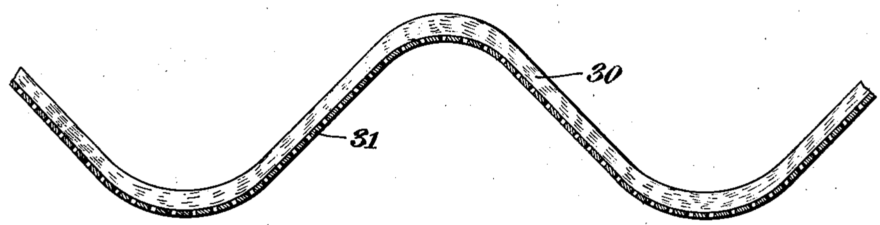

Fig. 4.

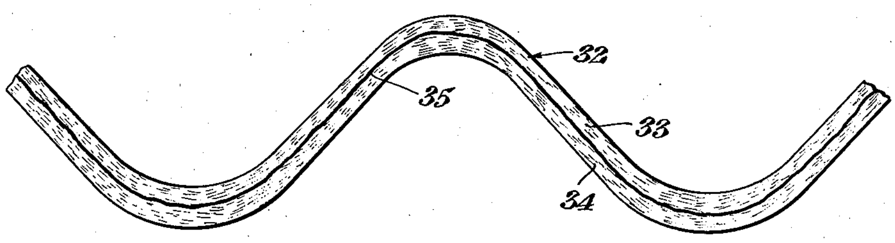

Fig. 5.

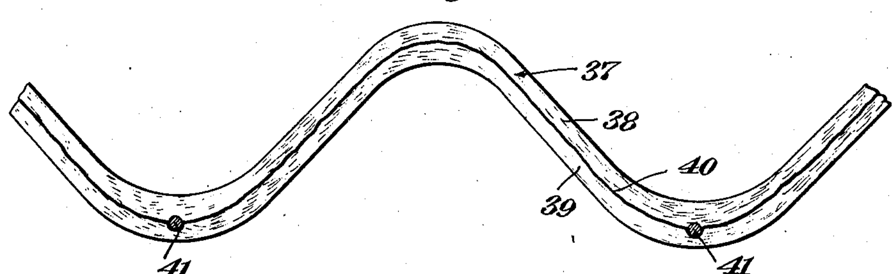

Fig. 6.

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PROCESS FOR MAKING CEMENTITIOUS SHEETS

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Original application April 28, 1932, Serial No. 607,970. Divided and this application March 1, 1933, Serial No. 659,133

16 Claims. (Cl. 154—33)

This invention pertains generally to the class of cementitious materials and particularly to the class of cementitious materials which are adapted to be formed for structural purposes. The invention pertains more particularly to sheets made from a pulp comprising a fibrous material and a suitable binder and to the process of manufacturing such sheets.

For the purposes of illustration, this invention will be described in connection with a pulp made from hydraulic cement, asbestos fibre and water. However, it is to be strictly understood that the invention is in no way limited thereto. It is adapted for use in connection with the manufacture of sheets with a pulp of any character, and particularly pulps containing fibrous fillers.

Sheets manufactured with a composition comprising cement, asbestos fibre and water are quite common in the art. Many of such sheets of the prior art, however, are objectionable, among other things because they are not of uniform density and strength, have high compression areas developed at irregular intervals during manufacture, do not properly incorporate reinforcing members and do not have a strength sufficiently commensurate with the amount of fibrous filler employed. These objections obtain particularly when the sheet has a form other than flat, that is, such as corrugated, etc.

Furthermore, many of the processes of the prior art involve an inordinate number of steps.

To overcome these difficulties we have provided a process whereby the fibrous material in the finished sheet affords a substantially increased aid to structural strength. This is accomplished, first, by forming the sheet in a manner such that at least a large part of the fibrous material is oriented into planes more or less parallel to the surface as opposed to a vertical heterogeneous arrangement, and second, by depositing the pulp in a manner so that it immediately takes the general form of the finished sheet, thus avoiding the stresses of molding and corrugating which tend to bend and disturb the relationship of the fibres at various points, and tend to develop high compression areas at irregular intervals resulting in variation in density. Furthermore, when reinforcing members such as rods, mesh, expanded metal, etc., are incorporated, this is done at a time and in a manner so that the pulp can entirely surround and impound all of the surfaces of the reinforcing member or members without any substantial disturbance of the structural relationship of the fibres, the reinforcing member having the form which it will assume in the finished sheet at the time of its incorporation. A complete union is thus afforded between the pulp and the reinforcing materials.

Moreover, by building up a sheet by way of laminations, it is possible to orient the fibres throughout the section, thus very substantially increasing the structural strength of the sheet per unit of fibrous material employed. This also makes it possible to vary the amount of fibrous material across a section in accordance with the nature and distribution of stresses across said section when the sheet is in use.

Inasmuch as the novel product has very definite characteristics which result from the novel steps of the process, we often prefer to incorporate with the laminations means for identifying our product from those of the prior art by a mere examination of a section thereof. This means comprises a deposit between laminations of a thin sheet, stripe, or stripes, of a coloring material. This coloring material very definitely demonstrates the position of each lamination in the finished sheet and will definitely show whether or not there has been a substantial disturbance in the structural relationship of the materials comprising the laminations in the process of manufacture.

Furthermore, the steps in our process are simple and few in number.

These features of our invention will become more obvious upon reference to the drawings, in which

Figure 1 is a diagrammatic illustration of apparatus for carrying out our process;

Figure 2 is a perspective view of a matrix;

Figure 3 is a broken section of a matrix with a layer of pulp thereon;

Figure 4 is a broken section of a finished laminated sheet;

Figure 5 is a broken section of a finished laminated sheet illustrating the identifying means as well as one type of reinforcing member; and

Figure 6 is a broken section of a finished laminated sheet illustrating another type of reinforcing member.

Referring more particularly to the drawings, at 10 is shown a conveyor which may be of any approved construction and type and is shown as of the driven roller type merely for the purposes of illustration. Resting upon the conveyor 10 is shown a matrix 11. Matrix 11 has an upper surface 12 conforming to that of the finished sheet whether of flat or of corrugated or of any other sectional configuration. Matrix 11 is illustrated as passing under a hopper 13 containing pulp illustrated at 14. Hopper 13 may be of any desired construction, for instance such as particularly described in our copending application Serial No. 607,971 filed April 28, 1932.

The function of hopper 13 is that of forming a layer 16 of pulp of desired thickness, and advantageously having the cross-sectional contour desired in the finished sheet, and depositing it on the matrix 11. In the hopper shown this is accomplished by means of a slot 15. This hopper comprises oppositely arranged reciprocating side walls 50 and 51 shown arranged in the form of a V with the opening or slot 15 at the vertex As described and shown more fully on our copending application Serial No. 607,971, above mentioned, and in our co-pending application Serial No. 716,814, filed January 16, 1934, now Patent No. 2,004,936, dated June 18, 1935, the contour of the slot 15 may conform to the contour which it is desired to give to the layer 16 of pulp. Side walls 50 and 51 are arranged between stationary end walls 53, the side walls 50 and 51 being supported in guides 54 secured to the end walls 53. Side wall 50 is illustrated as being somewhat longer than the side wall 51 at the slot 15. The side wall 50 thus acts somewhat as a base toward which the side wall 51 may operate in the formation of a layer. Any means may be provided for reciprocating side walls 50 and 51 such as eccentrics, etc. This construction is more particularly described in our aforementioned copending applications. The layer 16 may be of uniform sectional thickness or, if desired, may vary in sectional thickness transversely of the sheet. For instance, the latter might be desired when surface 12 is corrugated to obtain an increased thickness at either the crests or the vales, or both, and might be accomplished by varying the contour of slot 15 to give to the layer 16 the cross-sectional form desired.

Preferably the pulp 14 is made up with a minimum water content so that it will be unnecessary to drain or expel any water from the layer or layers prior to the final pressing step. For instance, the mass may be of such a viscous, pasty consistency as to require some special means to cause the desired flow through the slot 15, such as a vibrating hopper, a particular form of which is disclosed in our copending applications above referred to, or such as a positive pressure on the pulp 14 to extrude it through the slot 15, etc.

The layer 16 by virtue of its flow through slot 15 will have at least a large part of its fibrous material oriented so that the individual fibres will become more or less substantially parallel to the surfaces of the layer 16. That is, in the case of a corrugated sheet, a large part of the fibre will be orientated into planes more or less horizontal or parallel to the axes of the corrugations as opposed to a vertical or a heterogeneous arrangement. In other words, at least a large part of the fibrous material is arranged in directions longitudinally and transversely of the layer 16 instead of in the direction of the thickness of the sheet. This orientation is not disturbed as the layer 16 conforms itself to the surface 12 of the matrix 11.

The applying of the layer 16 to the matrix 11 is a continuous process, the matrix moving to the right in Figure 1 as indicated by the arrow.

The thickness of the layer 16 fed from the hopper 13 through the slot 15 can be varied, for instance, by varying the speed of vibration of the hopper or varying the pressure on the pulp as the case may be, by varying the opening at the slot 15, by varying the water ratio of the pulp composition, or by varying the speed of the matrix 11, etc.

Adjacent to the hopper 13 we have illustrated a smoothing roller 18 which performs the function of smoothing out any minute undulations which might occur on the upper surface of the layer 16. It is, of course, understood that the roller 18 conforms to the surface which layer 16 has assumed after its deposit on the matrix 11, be this flat, corrugated or otherwise. Roller 18 preferably travels oppositely to the layer 16 at an increased peripheral speed, and only lightly touches layer 16. A shoe might be substituted for the roller 18, or the roller 18 or its equivalent might be entirely eliminated as desired.

As the matrix 11 with its layer 16 passes under the color depositing device shown generally at 19, a thin layer 17 of any suitable coloring medium might be deposited on layer 16 such as a mixture of 90% hydraulic cement and 10% red iron oxide. This film may be either in sheet or stripe form, and in any event is preferably very fine, its purpose being merely to define the border line between laminations as above set forth. The device 19 may be of any approved construction.

If the sheet is to be made up of laminations, a second layer 20 is deposited upon the layer 16 by hopper 21 as illustrated in dotted lines. The layer 20 will conform to the surface of the layer 16 and may be of like thickness or otherwise as desired.

The consistency and/or composition of the pulp 22 in hopper 21 may be similar to that of the pulp 14 or may be varied. Variation of fibre content is particularly beneficial in the formation of a laminated sheet which is to be used for roofing and similar purposes wherein the load is carried by one surface of the sheet only or where the load on one surface is greater than that on the other. In view of the fact that the material adjacent the surface bearing the load is under compression and the material adjacent the surface opposite that carrying the load is under tension and that this condition of compression and tension through the section divides along a plane substantially midway of the section, it is possible to choose the compositions of the laminations so that they will more nearly equally withstand these stresses. For instance, the layer under tension may have a higher fibre content to add strength under tension, because the tensile strength of materials of this type is generally considerably lower than the compressive strength. In this instance the layer under compression may have a considerably less fibre content, not only because it is placed under compression and, therefore, does not need the same amount of added fibre to have the same strength as the layer under tension, but also so that it may have a more highly compacted and impervious surface exposed to the weather.

For instance, in a two-layer laminated sheet we find that the upper layer which is exposed to the weather may have 20% less fibre content without impairing the strength of the sheet. This at the same time greatly improves the resistance of the sheet to the elements.

It is, of course, understood that a sheet may be made up of any number of laminations and the fibre content may be varied across the section as desired or may be held constant.

A smoothing roller 23 in all respects similar to roller 18 may be added adjacent hopper 21 if desired.

The layer or layers eventually reach the press 25 comprising an upper matrix 26 and a lower matrix 27 for compacting the sheet. The function of the press 25 is that of expelling the small amount of water present and that of substantially uniform section reduction, thereby bringing about intimate contact of the particles. This is accomplished without a substantial disturbance of the relationship of the particles, without substantial displacement of material laterally and without setting up high pressure zones at irregular places throughout the area. The surface of matrix 26, of course, conforms more or less closely to the upper surface of the sheet. Provision is made in or about matrix 27 for the removal of water expelled from the sheet. Matrix 11 may be perforated for this purpose if desired or may comprise any other form of filter bed to permit escape of water during pressing.

A corrugated matrix 28, having perforations 29, is shown in perspective in Figure 2.

After the water has been expelled as above set forth, the matrix and sheet are removed from the press and the sheet may be stripped immediately from the matrix or may be allowed to cure thereon. The process is now substantially completed and the finished sheet after curing may be further processed as desired and as is usual in the art.

In Figure 3 is illustrated a sheet 30 comprising a single lamination resting upon a perforated corrugated matrix 31. It should be noted that sheet 30 has thickened crests and vales, a configuration described in copending application Serial No. 447,150 of Martin Willis and Frederick Schroder.

In Figure 4 is illustrated a finished sheet 32 comprising laminations 33 and 34. At 35 is shown a thin film of coloring material illustrating the dividing line between the laminations.

Incidentally, the slight irregularity in the cross sectional contour of the film 35 resulted during the laying of the layer 33 on the layer 34 and is not the result of the pressing step. The film 35 not only clearly demonstrates that there is not a substantial disturbance of the relationship of the fibres in applicants' process but also affords a ready means of identification of materials resulting from said process in view of the substantial non-disturbance of the contour of the film 35.

In Figure 5 is shown a broken section of a finished sheet 37 comprising upper lamination 38 and lower lamination 39 with an intermediate film 40. The sheet 37 has reinforced vales, said vales being reinforced by longtiudinally arranged rods 41 positioned in the vales between layers 38 and 39.

To thus incorporate the rods 41 between layers 38 and 39, rods 41 are placed in the vales upon layer 39 between hoppers 13 and 21, that is, before the application of layer 38. It should be noted that the rods 41 have not been changed in contour, bent or reshaped in any way by the press 25.

In Figure 6 is shown a broken section of a corrugated sheet 43 comprising upper layer 44 and lower layer 45. Sheet 43 is reinforced by a sheet of mesh 46 such as wire cloth, expanded metal, etc. The corrugated mesh 46 was incorporated in the sheet 43 between hoppers 13 and 21, the mesh having been preformed to the shape which it assumes in Figure 6, said mesh 46 not having been changed in contour by the press 25.

If desired, rods 41 shown in Figure 5 may be added to the vales of sheet 43 or to the crests or to both.

It is, of course, understood that in sheet 37 rods 41 might be moved to the crests or may be placed in both the crests and the vales.

It will be seen from the above description that the material forming the sheet immediately assumes the general shape which it is to have in its finished form upon application of the pulp to the matrix 11.

While we prefer to apply the pulp to the matrix 11 in sheet form and/or with the fibres oriented, it is, of course, understood that the invention is not limited thereto inasmuch as substantial other advantages accrue by way of simplicity of formation of a sheet and by way of avoiding undue disturbance of the structural relationship of the filler and binder such as absence of bending, etc. during the formation of the sheet.

While we have described a single matrix 11 on the conveyor 10, it is, of course, understood that any number of matrices 11 may succeed each other, for instance in abutting relation, and may be connected together if desired to make a continuous sectional apron, the layers from hoppers 13 and/or 21, etc. being applied continuously and being severed at the end of each matrix 11 when the matrix is disconnected from the apron for placing in the press 25. Means might be provided for continuously expelling water from the sheets.

It will be seen that by varying the fibre content across the section of a sheet, the fibre content may be materially reduced without a sacrifice of strength and the product will have a substantially increased resistance to the elements.

It will also be seen that a substantial saving in fibre is effected without sacrifice in strength by orientation of the fibre.

The preforming of the reinforcing members and the time of their incorporation in the sheet insure a complete impounding of all of the surfaces of the reinforcement members and a firm union between the reinforcement members and the remaining materials.

It is, of course, obvious that the reinforcement members may be smooth or have any other surface contour.

The term "sheet" is used herein in its broad sense to cover not only the structural members that are sold as sheets but also to cover other members that are generally of sheetlike form, such as tiles, shingles, etc.

Having described our invention, it is obvious that many modifications may be made within the scope of the claims without departing from the spirit thereof.

This application is a division of our copending application Ser. No. 607,970 filed April 28, 1932, now Patent No. 2,004,935, dated June 18, 1935.

We claim:

1. In a process for making structural sheets from a cementitious pulp, the steps which comprise forming a mass of said pulp into a layer of the desired thickness and, directly as formed, depositing said layer upon successive portions of a matrix having substantially the surface contour of the finished sheet, and compacting said layer upon said matrix.

2. In a process for making structural sheets of undulating surface contour from a cementitious pulp, the steps which comprise forming a mass of said pulp into a layer of desired thickness and, directly as formed, depositing said layer upon successive portions of an undulating sur-

face of a matrix having substantially the surface contour of the finished sheet, and compacting said layer upon said matrix.

3. In a process for making corrugated structural sheets from a cementitious pulp, the steps which comprise forming a mass of said pulp into a layer of the desired thickness and, directly as formed, depositing said layer upon successive portions of a corrugated matrix, said pulp as deposited being of a substantially non-flowing consistency, and compacting said layer upon said matrix.

4. In a process for making structural sheets, the steps which comprise forming a mass of a pulp containing cementitious and fibrous materials into a layer of the desired thickness and, directly as formed, depositing said layer upon successive portions of a matrix having substantially the surface contour of the finished sheet, said pulp as deposited being of a substantially non-flowing consistency and compacting said layers upon said matrix.

5. In a process for making laminated structural sheets, the steps which comprise forming and, directly as formed, depositing successive layers of a pulp containing cementitious and fibrous materials upon successive portions of the surface of a matrix having substantially the surface contour of the finished sheet, said pulp as deposited being of a substantially non-flowing consistency, and said layers as deposited being caused to assume substantially the desired contour of the finished sheet, regulating the fibre content of the pulp so that one of said layers will have a substantially greater fibre content than another of said layers, and subsequently compacting said associated layers upon said matrix.

6. In a process for making laminated structural sheets, the steps which comprise forming and, directly as formed, depositing successive layers of a pulp containing cementitious and fibrous materials upon successive portions of the surface of a matrix having substantially the surface contour of the finished sheet, said pulp as deposited being of a substantially non-flowing consistency, and said layers as deposited being caused to assume substantially the desired contour of the finished sheet, and subsequently compacting said associated layers upon said matrix.

7. In a process for making laminated corrugated structural sheets, the steps which comprise forming and, directly as formed, depositing successive layers of a pulp containing cementitious and fibrous materials upon successive portions of the surface of a corrugated matrix having substantially the surface contour of the finished corrugated sheet, said pulp as deposited being of a substantially non-flowing consistency, and said layers as deposited being caused to assume substantially the desired contour of the finished sheet, regulating the fibre content of the pulp so that one of said layers will have a substantially greater fibre content than another of said layers, and subsequently compacting said associated layers upon said matrix.

8. In a process for making a reinforced laminated structural sheet, the steps which comprise forming a mass of cementitious pulp into a layer of the desired thickness and, directly as formed, depositing said layer upon successive portions of the surface of a matrix having substantially the surface contour of the finished sheet, placing reinforcing members on said layer in conforming relation to the surface contour of said layer, forming and depositing a second layer of cementitious pulp of desired thickness on said first layer and said reinforcing members, said pulp as deposited being of a substantially non-flowing consistency, and then compacting said associated layers upon said matrix.

9. In a process for making a reinforced laminated corrugated structural sheet, the steps which comprise forming a mass of a cementitious pulp into a layer of the desired thickness and, directly as formed, depositing said layer upon successive portions of a corrugated matrix of the surface contour desired in the finished sheet and causing said layer to assume substantially the contour of the finished sheet, placing reinforcing members on said layer in the vales of the corrugations thereof, forming and depositing a layer of cementitious pulp of desired thickness on said first layer and said members, said pulp as deposited being of substantially non-flowing consistency, and then compacting said associated layers upon said matrix.

10. In a process for making a reinforced laminated corrugated structural sheet from a cementitious pulp, the steps which comprise forming a mass of said pulp into a layer of the desired thickness and, directly as formed, depositing said sheet upon successive portions of a corrugated matrix of the surface contour desired in the finished sheet, placing a corrugated reinforcing member conforming to the corrugations of said matrix upon said layer, forming and depositing another layer of said pulp of desired thickness on said first layer and said reinforcing member, said pulp as deposited being of substantially non-flowing consistency, and then compacting said associated layers upon said matrix.

11. In a process for making corrugated structural sheets from a cementitious pulp, the steps which comprise forming a mass of said pulp into a layer of the desired thickness and, directly as formed, depositing said layer upon successive portions of a corrugated matrix, and substantially uniformly compacting said layer upon said matrix.

12. In a process for making laminated corrugated structural sheets, the steps which comprise forming and, directly as formed, depositing successive layers of a cementitious pulp upon successive portions of a surface of a corrugated matrix having substantially the surface contour of the finished corrugated sheet, said pulp as deposited being of a substantially non-flowing consistency, and said layers as formed and deposited being substantially of the desired thickness, and substantially uniformly compacting said associated layers on said matrix.

13. In a process of making structural sheets from a pulp containing cementitious and fibrous materials, the steps which comprise forming a mass of said pulp into a layer of the desired thickness with at least a large part of the contained fibres oriented into planes more or less parallel with the surface of the layer, and directly as formed, depositing said layer upon successive portions of the surface of a matrix having substantially the surface contour of the finished sheet, and compacting said layer upon said matrix.

14. In a process of making corrugated structural sheets from a pulp containing cementitious and fibrous materials, the steps which comprise forming a mass of said pulp into a layer of the desired thickness with at least a large part of the contained fibres oriented into planes more or less parallel with the surface of the layer, and directly

as formed, depositing said layer upon successive portions of the surface of a corrugated matrix having substantially the surface contour desired in the finished corrugated sheet, said pulp as deposited being of a substantially non-flowing consistency and said layer as deposited being caused to assume substantially the desired contour of said matrix, and compacting said layer upon said matrix.

15. In a process for making structural sheets from a cementitious pulp, the steps which comprise forming a mass of said pulp into a layer varying in thickness transversely thereof and, directly as formed, depositing said layer upon successive portions of a matrix having substantially the surface contour of the finished sheet, and compacting said layer upon said matrix.

16. In a process for making corrugated structural sheets from a cementitious pulp, the steps which comprise forming a mass of said pulp into a layer conforming substantially to the desired contour of the finished corrugated sheet and having thickened portions in the transverse section thereof corresponding to the crest and vale portions of the finished sheet, and, directly as formed, depositing said layer upon successive portions of a corrugated matrix, said pulp as deposited being of a substantially non-flowing consistency, and compacting said layer upon said matrix.

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