June 18, 1935. R. DORN ET AL 2,004,936

APPARATUS FOR THE MANUFACTURE OF CEMENTITIOUS SHEETS

Filed Jan. 16, 1934 3 Sheets-Sheet 1

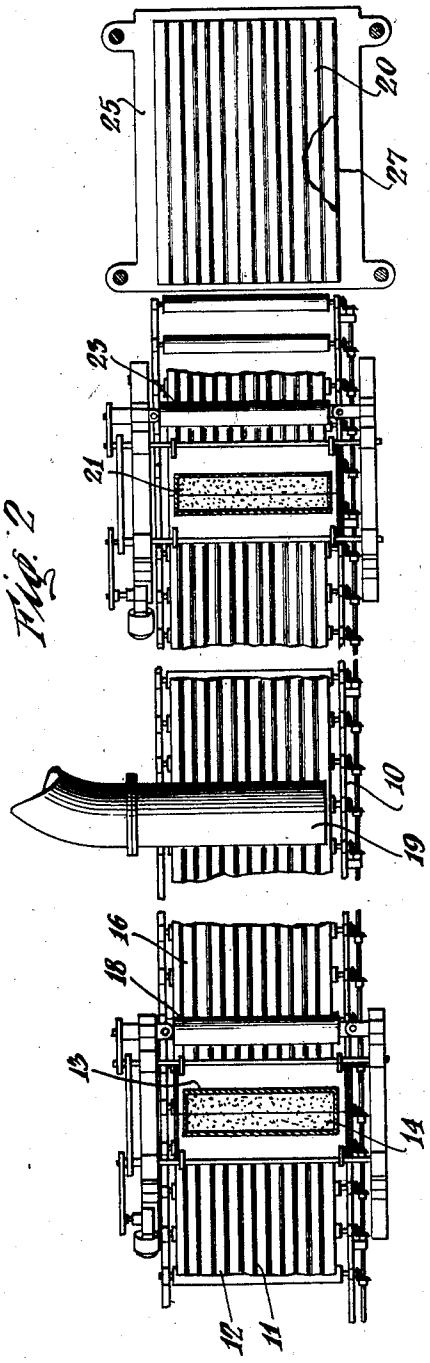



Fig. 2

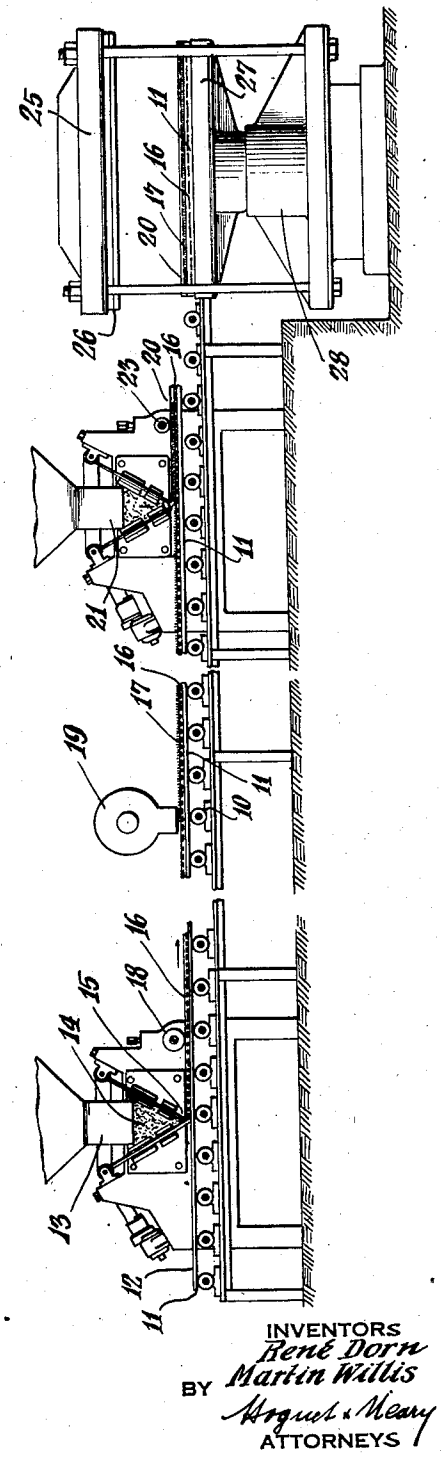



Fig. 1

INVENTORS
René Dorn
Martin Willis
BY Arguet & Neary
ATTORNEYS


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APPARATUS FOR THE MANUFACTURE OF CEMENTITIOUS SHEETS

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Fig. 4

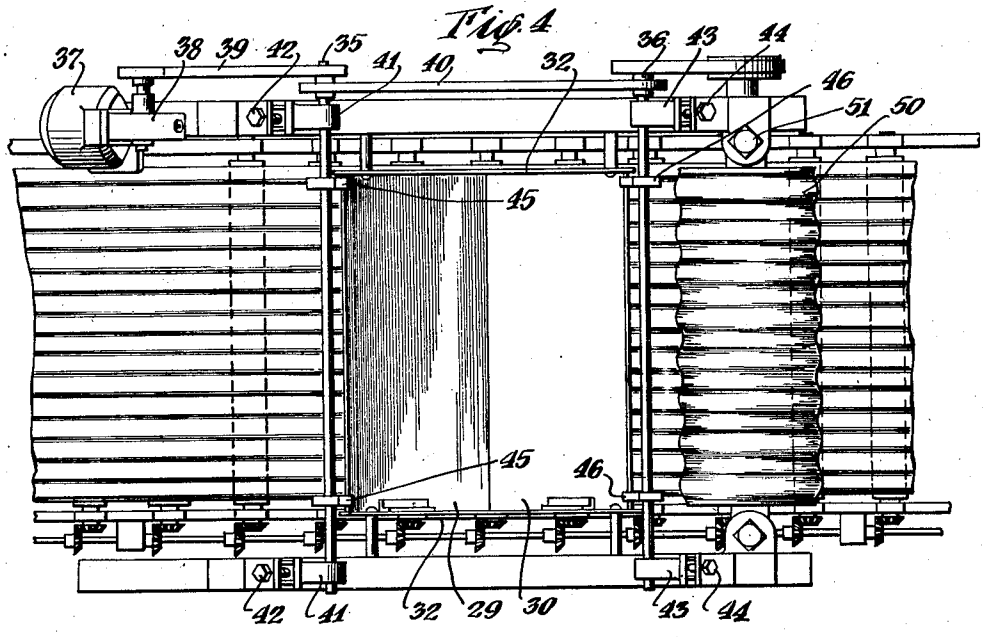
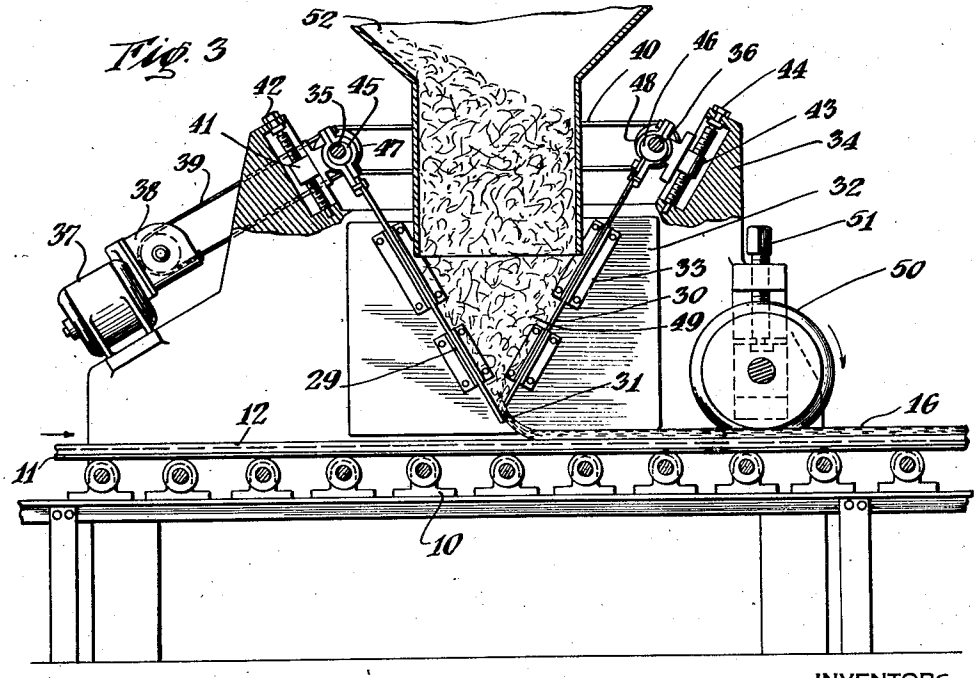



Fig. 3




INVENTORS
René Dorn
Martin Willis
BY Hoguet & Neary
ATTORNEYS


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Fig. 5

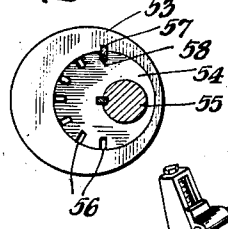



Fig. 6




Fig. 7

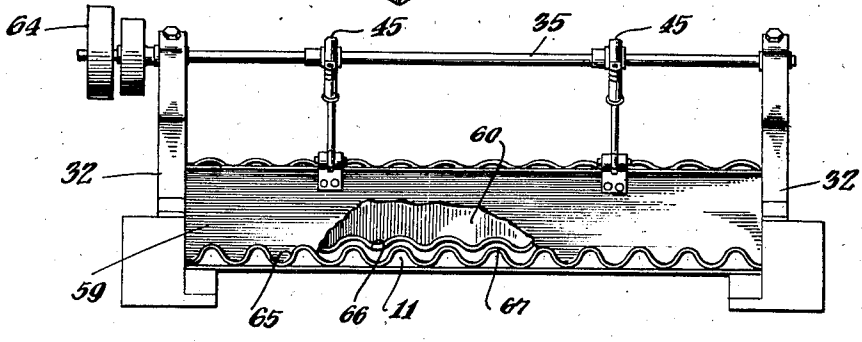



Fig. 9

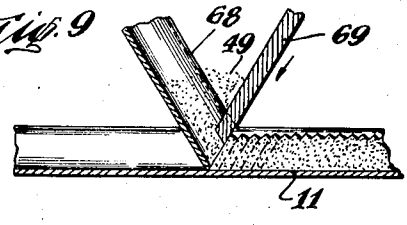



Fig. 10

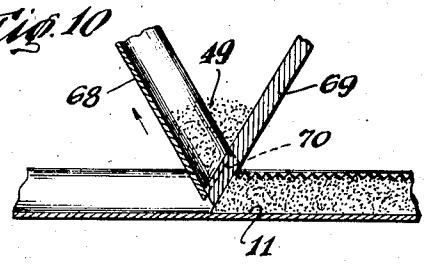
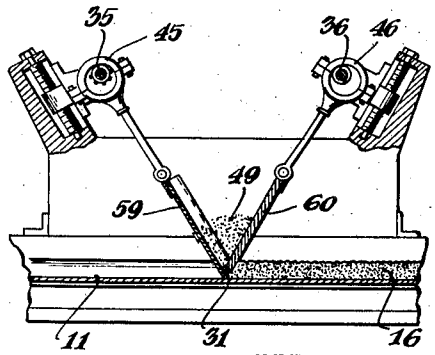



Fig. 8




INVENTORS
René Dorn
Marlin Willis
BY Hoguet & Neary
ATTORNEYS


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# UNITED STATES PATENT OFFICE

2,004,936

## APPARATUS FOR THE MANUFACTURE OF CEMENTITIOUS SHEETS

René Dorn and Martin Willis, New Orleans, La.

Application January 16, 1934, Serial No. 706,814

17 Claims. (Cl. 25—42)

This invention pertains generally to apparatus for the formation of cementitious sheets and more particularly to that part of the apparatus, commonly known as a hopper, for deploying the sheet material upon a pre-formed matrix.

In our co-pending parent application, Serial No. 607,971, filed April 28, 1932, of which the present application is in part a continuation, is described the entire apparatus for forming a novel cementitious sheet. The invention herein relates to the hopper and cooperating apparatus used in making the above mentioned sheets.

To give a full and clear understanding of the invention, a description of the general apparatus associated with the hopper for producing the novel cementitious sheet is given also in addition to the description of the hopper itself. However, the invention claimed in this application is directed mainly to the hopper and its immediate cooperating apparatus.

Referring to the drawings in which like reference characters are appended to like parts in the various figures,

Fig. 1 is an elevation of apparatus for making the above mentioned cementitious sheets;

Fig. 2 is a plan view thereof;

Fig. 3 is an elevation partly in section of a hopper and of parts adjacent thereto;

Fig. 4 is a plan view of the hopper;

Fig. 5 is a detail of an adjustable eccentric;

Fig. 6 is a perspective view partly in section of a modification of the hopper shown in Figs. 3 and 4;

Fig. 7 is a side view partly in section of the hopper shown in Fig. 6;

Fig. 8 is an elevation partly in section of the reciprocating side walls of the hopper and its associated matrix;

Fig. 9 is a diagrammatic representation of the reciprocating side walls when the left hand wall has reached its lowest downward position; and

Fig. 10 is a diagrammatic representation of the reciprocating side walls when the right hand wall has reached its lowest downward position.

Referring more particularly to the drawings, at 10 in Figs. 1 and 2 is shown a conveyor illustrated as being of the driven roller type. However, any other suitable type of conveyor, whether endless or not, may be substituted therefor.

Resting on the conveyor 10 is a matrix 11 having an upper surface 12 with a shape substantially indentical with that of the sheet to be manufactured.

At 13 is shown a hopper containing pulp 14. Hopper 13 has an opening 15 transversely thereof of a length equal to the desired width of the layer 16 of pulp which is formed by pulp 14 passing through the opening 15.

Pulp 14 may be of a consistency such as to flow by gravity through the opening 15 but is preferably of lesser water content. This will require some special means to cause the pulp to flow through the opening 15 because of the stiffer and viscous consistency. Such means may comprise a vibrating hopper, a form of which will be more particularly described hereinafter, or any other device such as one adapted to extrude the layer 16 through a die conforming to the desired opening 15 by means of pressure on the pulp 14 with or without heat.

If the pulp contains a fibre, such as pulp made from hydraulic cement, asbestos fibre and water, the fibre upon passing through the narrow opening 15 will become substantially oriented into planes substantially parallel with the surface of the layer 16 formed by the opening 15. We find substantial orientation is obtained with layers up to three quarters inch in thickness.

The matrix 11 is positioned and moved relative to the layer 16 so that the end of layer 16 contacts the right end of matrix 11 as seen in Fig. 1, the matrix 11 preferably moving to the right on conveyor 10 at a speed conforming more or less closely to the speed at which the layer 16 issues from the opening 15 so that the layer 16 will be laid out on the matrix 11 without undue stretching or buckling.

By proper design of the converging side walls of the vibrating hopper 13, explained in detail hereinafter, the layer 16 issuing from the opening 15 will be preformed by these side walls in such a manner that it will conform to the contour of matrix 11. Thus, the walls of hopper 13 may be designed to deploy a sheet layer of substantially uniform thickness upon the matrix 11 regardless of whether this matrix is flat, corrugated, or of any other configuration.

Depending upon the type of means employed for depositing layer 16, this layer may have a certain slight surface unevenness or waviness. To remove any such irregularity, we may provide a roller 18 adapted to lightly touch the upper surface of the layer 16 throughout its width, the roller 18 having a contour conforming to that of the layer 16. The roller 18 preferably is driven so that its surface moves oppositely to that of the layer 16 and at a substantially greater speed. The roller 18 is essentially a smoothing roller and its contact with the layer 16 should


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not be such as to cause pulp to accumulate on the front side of the roller 18.

Any other means might be substituted for the roller 18 such as a shoe adapted to lightly contact the upper surface of the layer 16.

It may be pointed out here that it is not necessary to expel any water from the layer 16 at this point. Expelling of water is accomplished by means of a press 25 having an upper matrix 26 conforming to the upper surface of the layer 16 and a lower matrix 27 for holding the matrix 11. To expel water, matrix 27 together with the matrix 11 and the layer thereon are raised by means of the piston and cylinder arrangement shown at 28, the upper surface of the layer 16 coming in contact with the matrix 26 and being substantially uniformly compacted thereby throughout its surface so that the water is expelled without substantially disturbing the previous structural relationship of the layer 16 or substantially displacing the particles of the layer 16 in a lateral sense and without setting up high pressure zones at irregular places throughout the area. The reduction in section will be small and uniform throughout the layer 16. For purposes of disposing of the water which is expelled from the layer 16 the matrices 11 and 26 may be perforated in some well known manner.

The apparatus adapts itself very readily to the manufacture of laminated sheets, it being merely necessary to duplicate the hopper 13, as illustrated at 21, or to add any additional number of hoppers depending upon the number of laminations desired. As shown, the roller 18 has been duplicated at 23.

Any additional layers such as the layer 20 deposited upon layers 16 will conform to the configuration of the layer 16 in all respects similarly to the manner in which the layer 16 has conformed to the matrix 11. Depending upon the fluidity of the layers of pulp and the care with which the second layer is deposited upon the first, there may be a slight and inconsequential shift of material so that one layer might be very slightly thicker at one point than at another. However, such slight shift in material is wholly incidental and in no way departs from the spirit of the invention.

Orientation of the fibres greatly increases the tensile strength of the layer per unit of fibre content.

By variation of fibre content in each layer the tensile strength across a section of a sheet may be varied in accordance with demands. For instance, if the load is on one face of the sheet the layer adjacent the load will be under compression and the layer opposite the load will be under tension. The layer under compression may, therefore, have less fibre in view of the higher compressive strength of materials of this type. This will increase its resistance to the elements.

It is very simple to provide means for studying the division line between the adhering laminations by merely providing any suitable device such as illustrated at 19 for depositing a thin film or stripes of coloring matter 17 on the layer 16 before application of the layer 20 thereto. We find that a very suitable coloring substance can be made by mixing 90% dry hydraulic cement and 10% red iron oxide. It is, of course, understood that any other substance might be substituted therefor inasmuch as the function of this coloring matter is merely to show the division line between the adhering laminations to identify the process by means of which the sheet has been manufactured. If more than two laminations comprise the sheet, it is, of course, understood that, if desired, any additional number of color depositing devices may be added.

The manufacture of sheets by means of combining laminations affords an opportunity to efficiently incorporate reinforcement members during the steps of superimposing the layers.

For instance, in the manufacture of corrugated sheets, particularly those used for roofing purposes wherein the vales are placed under tension and the crests under compression, inasmuch as the compressive strength of this type of material is substantially greater than the tensile strength it is desirable to reinforce the vales. This may be done by laying longitudinal rods in the vales between the hoppers 13 and 21. These longitudinal rods, of course, are not reshaped in the press 25 but already have the shape which they will have in the finished product. It is, of course, possible also to insert rods in the crests if desired or to insert rods in the crests only. It is also possible to employ any other form of reinforcement alone or in addition to the rods such as mesh of which wire cloth and expanded metal are samples. Such mesh would be pre-formed to conform to the upper surface of the layer 16 so that no reshaping would be necessary in the press 25 or otherwise. For instance, if the sheet be corrugated, the mesh would also be corrugated.

After the desired number of laminations have been superimposed with or without coloring matter and/or reinforcements, the composite mass is placed within the press 25 and the water expelled in the same manner as above set forth.

The matrix 11 is then withdrawn and the sheet is stripped therefrom or permitted to cure on the matrix as desired.

While the invention has been described in connection with a single matrix, it is, of course, understood that the matrices 11 will succeed each other on the conveyor 10. In fact, the matrices 11 may be arranged on the conveyor 10 with abutting ends so that the layers of pulp may be deposited continuously, the cutting of the layers between the matrices 11 taking place just before introduction of each matrix into the press 25.

Other means may be substituted for the press 25 for expelling water from the sheets.

In Figs. 3 and 4 we have shown a vibrating hopper. This hopper comprises oppositely arranged reciprocating side walls 29 and 30, shown arranged in the form of a V with an opening 31 at the vertex. Side walls 29 and 30 are shown arranged between stationary end walls 32, the side walls 29 and 30 being supported in guides 33 secured to the end walls 32.

Mounted on the frame 34 are two transverse shafts 35 and 36. Shaft 35 is shown driven by a motor 37 through reduction gearing 38 and belt or chain 39. Shaft 36 is illustrated as driven from shaft 35 by means of a chain 40.

Shaft 35 is journaled in slidable blocks 41, blocks 41 being adjustable by means of screws 42 to move the side wall 29 with respect to the side wall 30 to adjust the opening 31.

Shaft 36 is journaled in blocks 43 being adjustable by means of screws 44 for the purpose of moving side wall 30 with respect to side wall 29 to adjust the opening 31.

Side wall 29 is mounted on spaced eccentrics 45 in a manner so that the eccentrics 45 reciprocate side wall 29 upon revolution of the shaft 35.


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Side wall 30 is mounted on eccentrics 46 on shaft 36 in a manner so that side wall 30 is reciprocated upon revolution of the shaft 36.

The reciprocation of the side wall 29 may be timed with respect to the reciprocation of side wall 30 by means of adjusting chain 40 on sprocket 47 on shaft 35 and on sprocket 48 on shaft 36. The adjustment is preferably one in which side walls 29 and 30 reciprocate in unison, that is, synchronously. It is, of course, understood that the length of chain 40 will vary according to the adjustment at 42 and 44.

The variation in size of the opening 31 and the movement of the side walls 29 and 30 about the opening 31, due to the reciprocation of side walls 29 and 30 not only causes the pulp 49 to flow through the opening 31 in layer form but also tends to cause any fibre in the pulp to become orienated into planes substantially parallel to the surfaces of the layer of pulp formed at the opening 31.

As shown, the opening 31 has a longitudinal dimension more or less equal to the width of the matrix 11.

The cross sectional contour of the layer of pulp may be varied by variation in the lower edge of side wall 30 and/or side wall 29, and also by variation of the inner surface of these side walls as is explained in detail below. This will prove of advantage in forming corrugated sheets with thickened crests and vales.

Side wall 29 in Figure 3 is illustrated as being somewhat longer than the side wall 30 at the opening 31. The side wall 29 thus acts somewhat as a base toward which the side wall 30 may operate in the formation of a layer, both side walls acting to advance the layers through the opening 31. However, any other arrangement of the ends of side walls 29 and 30 may be made.

The layer 16, issuing from the opening 31, may be more or less undulatory in character. If desired, a roller 50 may be provided for smoothing the layer 16. The action of roller 50 is merely smoothing in character and roller 50 ordinarily will no more than lightly touch the surface of the layer 16. Roller 50 preferably rotates in a direction opposite to the movement of the layer 16 on matrix 11 and should preferably have a somewhat increased peripheral speed. Roller 50 may be made adjustable vertically by means of screws 51.

The chute, shown at 52, pertains to a device for keeping the pulp 49 at a uniform height in the hopper and otherwise does not pertain to this invention.

Another means for timing the reciprocation of side wall 29 with respect to the reciprocation of side wall 30 is by use of an adjustable cam. Such a cam, however, is more useful for varying the length of the stroke of the reciprocating side walls. One form of adjustable cam is disclosed in Figure 5 in which an eccentric rim portion 53 is made adjustable with respect to an eccentric hub portion 54 mounted on a shaft 55. The adjustment may be accomplished by providing the hub portion 54 with a plurality of spaced grooves 56 which are adapted to cooperate with a complementary groove 57 in the rim portion 53 to form a key-way for a key 58. It is, of course, understood that any other form of adjustable cam may be employed. By moving rim portion 53 with respect to hub portion 54 the length of the stroke of the side wall may be varied as will be understood by persons skilled in the art. Any necessary adjustment as to synchronization may then be made by adjusting chain 40 shown in Fig. 4.

It is, of course, understood that any other means may be employed for driving shafts 35 and 36 and for connecting the shafts together so as to synchronize the movements of side walls 29 and 30.

The perspective view in Fig. 6 shows a modification of the hopper shown in Figs. 3 and 4 described hereinabove. The modification consists principally in the changed structure of the reciprocating side walls 59 and 60, shown in Fig. 6, as compared with the reciprocating side walls 29 and 30 shown in Figs. 3 and 4 above. The reciprocating wall 59 has its inner surface 61 as well as its lower edge 62 corrugated in such a manner that the hills and vales match those of the matrix 11. This structure is conductive to pre-forming the pulp or other material 49 in the hopper, before it reaches the pre-formed matrix 11, into the form which it will finally assume after deposition on the matrix 11. The result is that the pulp 49 or any other material used will deposit on the corrugated matrix 11 more evenly and will conform to the shape of the matrix 11 more easily than it will if the entire inner surface and lower edge of the reciprocating wall 59 were plain instead of corrugated. The other reciprocating wall 60 has also been modified as compared with its corresponding wall 30 in the previous figures by corrugating its bottom edge 63 at an appropriate angle and in such a manner that the hills and vales will coincide with those of the corrugated wall 59 and matrix 11. The purpose of this structure is to provide a more efficient deposition of the pulp 49 or other material on the matrix 11 and more particularly to scavenge or clean off the corrugated surface 61 and corrugated edge 62 of the reciprocating wall 59. This latter action will be described more in detail hereinafter in connection with Figs. 9 and 10.

During operation, the walls 59 and 60 are given their reciprocating motion in their respective slots 33 formed in the end walls 32, as described above, by means of a connecting belt 40 and transverse shafts 35 and 36 and eccentrics 45 and 46. The driving wheel 64 is connected by a belt or chain to a motor, (not shown) such as motor 37 in Figs. 3 and 4.

The grooves or corrugations which are formed along the bottom edges of corrugated wall 59 and plane wall 60 are shown clearly in Fig. 7 by the curved lines 65 and 66 respectively. These lines 65 and 66 represent the bottom edges of the walls 59 and 60 respectively and the curved line 67 represents the top of the corrugated surface of matrix 11.

The operation of the reciprocating walls 59 and 60 will be clearly understood from an examination of Fig. 8. When the shafts 35 and 36 are rotated in the manner explained above, the walls 59 and 60 are reciprocated with an up and down motion. When the shafts 35 and 36 and consequently the eccentrics 45 and 46 are rotated approximately 180° from the position shown in Fig. 8, the walls 59 and 60 are consequently drawn in a substantially straight line the full stroke of the eccentrics 45 and 46 away from the matrix 11. This action opens a considerable gap at point 31. Since the materials 49 have been brought to a predetermined state of plasticity they have a tendency to flow through the opening 31 and deposit as a layer 16 on the matrix 11 as the shafts 35 and 36 continue to

rotate in the same direction and the walls 59 and 60 begin to converge at the point 31.

In one modification, the hopper shown in Fig. 8 is operated in a manner described below. The details of the movements of walls 59 and 60 being shown in Figs. 9 and 10. In this type of operation, the eccentrics 45 and 46 are not set so that the walls 59 and 60 reach dead center at the same instant but eccentric 45 is given a lead over eccentric 46 by a substantial amount, for example, 12°. When wall 59 has reached its maximum downward stroke as represented in Fig. 9 by the member 68, the wall 60 represented in Fig. 9 by the member 69 still has to travel in a downward direction the distance involved in the rotation of eccentric 46 through 12° of its revolution. Consequently as wall 59 represented in Fig. 10 by the member 68 starts upward in its stroke, wall 60, or member 69, still has to travel a slight distance downward and pass its dead center point before it starts back in its upward motion. Now, since the member 68, or wall 59, is a female corrugation over its entire inner surface and member 69, or wall 60, is a male corrugation along its bottom edge, preferably through a section on an inclination of about 60° from its plane, as indicated by the dotted line 70 in Fig. 10, when the members 68 and 69 or, in other words, the walls 59 and 60 fully converge the member 69 will mesh into the member 68 due to their complementary corrugations and to the lag in the eccentric 46. The result of this meshing action between members 68 and 69 or walls 59 and 60, is that the pulp or other material 49 is scavenged or wiped from the lower point of wall 59, or member 68, and caused to deposit on the matrix 11.

The particular description given herein has been merely for the purpose of illustration and many modifications and/or substitutions may be made in the parts particularly described without departing from the spirit of the invention. The appended claims are intended to be limited only by the prior art.

We claim:

1. A hopper comprising opposite side walls, each adapted to reciprocate, one end of each of said walls being arranged with respect to the adjacent end of the other of said walls so as to define an opening therebetween through which to issue material from said hopper.

2. Apparatus for forming a thin layer of pulp and for orienting fibre in said pulp into planes substantially parallel to the surfaces of the layer, comprising a vibrating hopper, and an opening in said vibrating hopper conforming to the desired shape of said layer.

3. In an apparatus for forming a layer of pulpy material, means adapted to retain and issue a quantity of said material and including a movable element normally in retaining relation to pulpy material to be issued from said means, and means for moving said element to issue the material from the retaining and issuing means to form a layer from the issued material.

4. A vibrating hopper comprising an enclosure, said enclosure having opposite walls adapted to reciprocate, said walls at their lower edges defining a narrow opening of a desired length.

5. A vibrating hopper comprising an enclosure having oppositely arranged reciprocating side walls, the lower edges of said side walls defining an opening substantially of the character of the desired cross section of a layer of pulp to be formed at said opening, and means for synchronizing the reciprocation of said side walls.

6. A vibrating hopper comprising an enclosure, said enclosure having oppositely arranged downwardly converging side walls, said side walls having their lower edges spaced from each other to define an opening, and means for reciprocating said side walls.

7. A vibrating hopper comprising an enclosure, said enclosure having oppositely arranged downwardly converging side walls, said side walls having their lower edges spaced from each other to define an opening, means for adjusting the width of said opening, and means for reciprocating said side walls.

8. A vibrating hopper comprising an enclosure, said enclosure having oppositely arranged downwardly converging side walls, said side walls having their lower edges spaced from each other to define an opening, one of said lower edges overlapping the other, and means for reciprocating said side walls.

9. Apparatus for forming a thin layer of pulp and for orienting fibre in said pulp into planes substantially parallel to the surface of the layer, comprising a hopper, and an opening in said hopper of narrow width and conforming to the desired shape of said layer, and means for continually changing the width of said opening.

10. A hopper comprising an enclosure, said enclosure having opposite walls adapted to reciprocate, said walls at their lower edges defining a narrow opening of a desired length, and means for continually reciprocating said walls to change the width of said opening.

11. A vibrating hopper comprising a substantially V shaped enclosure, said enclosure having oppositely arranged downwardly converging side walls, a narrow opening between said side walls at the vertex of said enclosure, and means for reciprocating said side walls.

12. A vibrating hopper comprising an enclosure, said enclosure having oppositely arranged downwardly converging side walls, said side walls having their lower edges spaced from each other to define an opening, means for moving said side walls up and down along substantially straight lines to continually change the width of said opening.

13. A vibrating hopper comprising an enclosure, said enclosure having oppositely arranged downwardly converging side walls, said side walls having their lower edges spaced from each other to define an opening, means for moving said side walls upward and downward so that one of the walls reaches its lowest and highest positions at different times than the other wall reaches its lowest and highest positions.

14. A hopper comprising an enclosure, said enclosure having opposite walls adapted to reciprocate, said walls at their lower edges defining a narrow opening of a desired length, and one of said walls having corrugations over its entire inner surface.

15. A hopper comprising an enclosure, said enclosure having opposite walls adapted to reciprocate, said walls at their lower edges defining a narrow opening of a desired length, one of said walls having corrugations over its entire inner surface and the other of said walls having a plain inner surface and a corrugated bottom edge.

16. A vibrating hopper comprising an enclosure, said enclosure having opposite walls adapted to reciprocate, said walls at their lower edges defining a narrow opening of a desired length, one of

said walls having corrugations over its entire inner surface, and the other of said walls having only its lower section corrugated and in such manner that it will mesh with the opposite corrugated wall during a portion of the time that the walls are reciprocating.

17. A vibrating hopper comprising an enclosure containing a cementitious material, said enclosure having opposite walls adapted to reciprocate, said walls at their lower edges defining a narrow opening of a desired length, means for moving said walls upward and downward, one of said walls having corrugations over its entire inner surface and the other of said walls having corrugations cut at an angle through its bottom portion so that at its lowest downward position it meshes with the bottom portion of said entirely corrugated wall and thereby effects a scavenging action of the material deposited on said corrugated wall and causes such material to flow through said narrow opening.

RENÉ DORN.
MARTIN WILLIS.


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