Aug. 1, 1933. D. M. SUTHERLAND, JR 1,920,481

MANUFACTURE OF FIBER SHEETS AND APPARATUS THEREFOR

Filed April 8, 1931 4 Sheets-Sheet 1

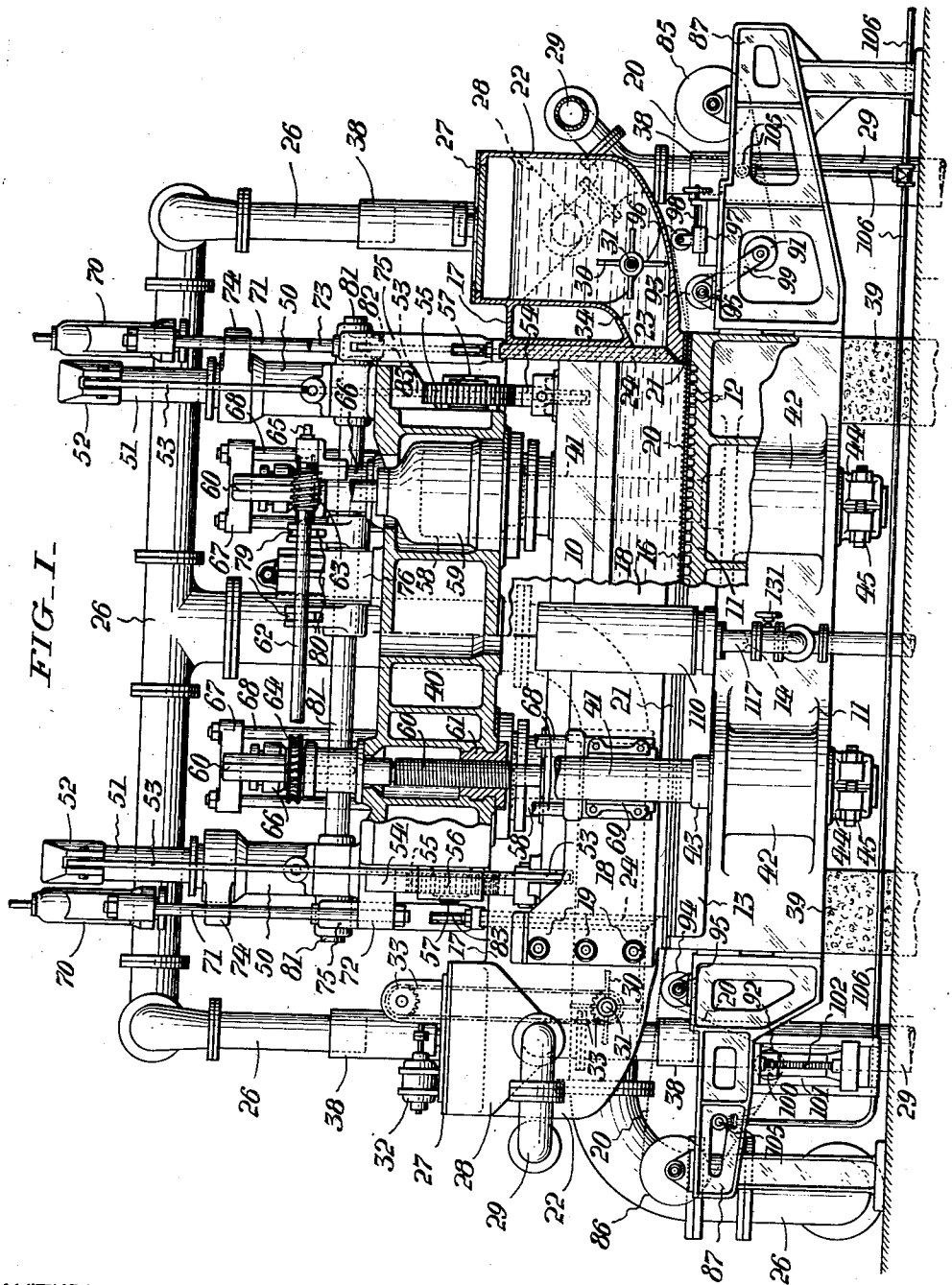


FIG. 1.

WITNESSES

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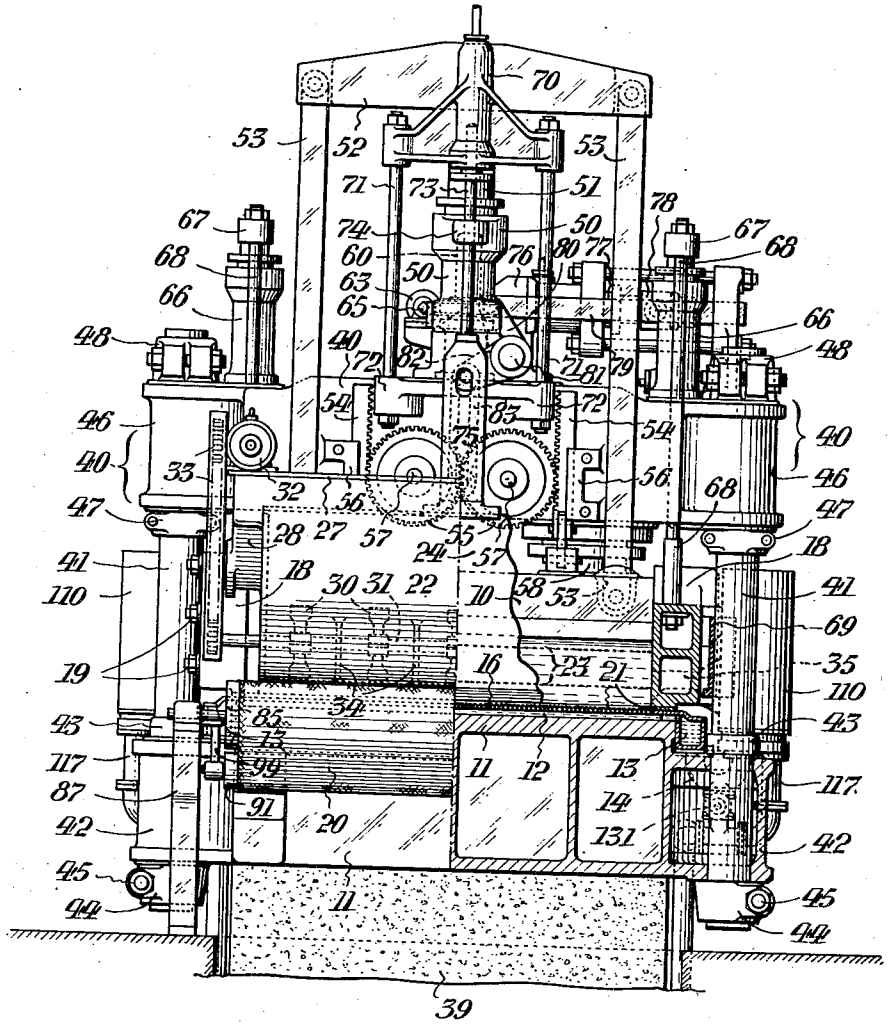
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MANUFACTURE OF FIBER SHEETS AND APPARATUS THEREFOR

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FIG. II.



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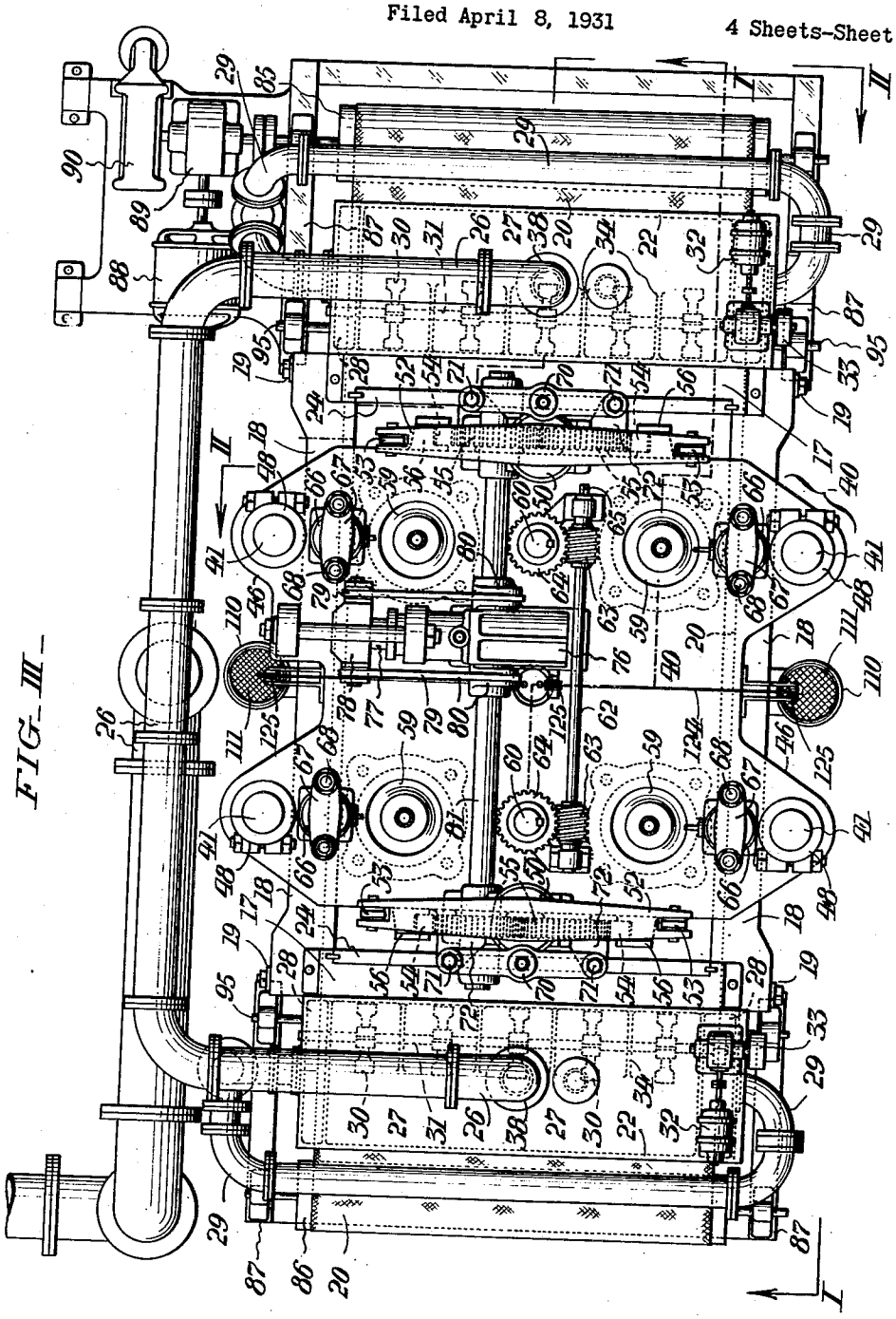
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MANUFACTURE OF FIBER SHEETS AND APPARATUS THEREFOR

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FIG. III.



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MANUFACTURE OF FIBER SHEETS AND APPARATUS THEREFOR

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FIG. V.

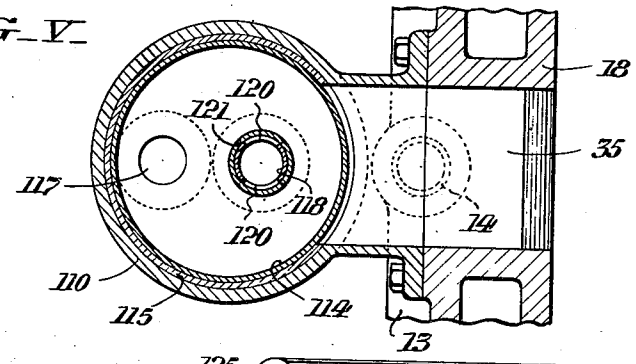
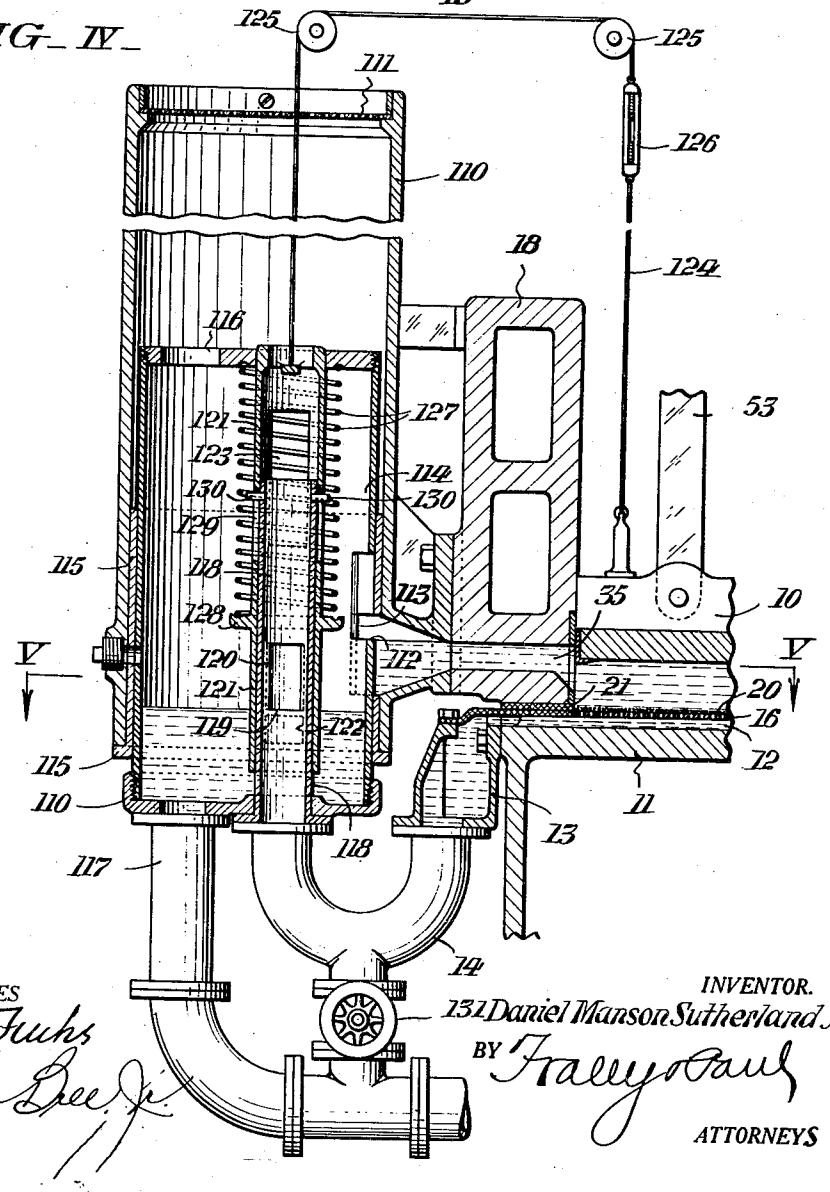


FIG. IV.



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Patented Aug. 1, 1933 1,920,481

UNITED STATES PATENT OFFICE

1,920,481

MANUFACTURE OF FIBER SHEETS AND APPARATUS THEREFOR

Daniel Manson Sutherland, Jr., Morrisville, Lower Makefield Township, Bucks County, Pa.

Application April 8, 1931. Serial No. 528,478

7 Claims. (Cl. 92—61)

My invention relates to the manufacture of fiber sheets and the like, and to a wet machine for this purpose. By my invention, large sheets of any desired thickness and composition can be produced rapidly and economically, and of uniform good quality. Sheets so produced can be made into fiber board of any desired density and quality for which the materials employed are suitable. Furthermore, practically any additional material desired can be homogeneously distributed through the formed pulp sheet, and in the final board ultimately produced. Various advantages that can be realized through the invention will be apparent to those skilled in the art from the following description.

In the drawings, Fig. I is a side view of a wet machine conveniently adapted for and embodying my present invention, with certain parts in vertical section as indicated by the line and arrows I—I in Fig. III.

Fig. II is an end view of the machine from the right of Figs. I and III, with certain parts in vertical section as indicated by the line and arrows II—II in Fig. III.

Fig. III is a plan view of the machine.

Fig. IV shows a vertical mid section through a portion of the mold and associated parts, illustrating the provisions for venting it and controlling the draining away of the water from the pulp.

Fig. V shows a horizontal section taken as indicated by the line and arrows V—V in Fig. IV.

The wet machine here shown comprises a substantially horizontal mold in which aqueous fiber pulp is largely freed of its water and pressed into a compact, moist, frail sheet of interlaced fibers that can afterward be consolidated into coherent fiber board,—as by pressure and heat in a plate drier. The top and bottom mold walls 10 and 11 (Figs. I and II) are relatively movable, so that they can be brought together to squeeze out the water, and provision is made for drawing or draining the water away without allowing the fibers to escape. As here shown, the mold bottom 11 has a multitude of transverse drainage ducts or grooves 12 communicating with discharge headers 13 connected to suitable outlet or discharge means 14 (Figs. II and IV), controlled by any suitable means, such as that hereinafter described. Over the ducts 12 is a perforated or foraminous plate or screen 16 to retain the fibers of the pulp in the mold, while allowing the water to pass through into the ducts. The edge walls of the mold cavity are formed by end and side deckels 17 and 18 shown in Figs. I and II as bolted together at 19 to form a unitary frame around the top mold 10, which frame engages at its edges with the bottom mold 11. The deckel structure 17, 18 and the mold top 10 and bottom 11 are relatively movable, to permit the mold to be opened for removal of the pulp sheet formed therein. For this purpose, there is a wire or screen conveyor 20 extending through the bottom of the mold on the foraminous plate 16, under the lower edges of the deckels 17, 18. When the mold is closed, as in Fig. I, suitable packing 21 on the lower edges of the deckels 17, 18 is pressed into the screen 20, making a reasonably tight joint against the unperforated margins of the plate 16,—and, of course, rendering the conveyor 20 immovable. When the deckel structure 17, 18 is raised and the mold opened for removal of the formed sheet, the conveyor 20 is freed from engagement with the deckel packing 21, and can be operated to carry the sheet out of the mold, as hereinafter described.

Provision is made for introducing aqueous fiber pulp into the edge of the mold cavity and for allowing the air to escape from in front of the inflowing pulp, as hereinafter described. As here shown, hopper-like reservoirs 22, 22 are arranged to deliver directly into opposite edges (ends) of the mold cavity, through openings 23, 23 in the end deckels 17, 17. These hoppers 22 are shown in Figs. I and III as attached to the end deckels 17 and forming part of them. For the best results, it is important that the inlet openings 23, 23 extend substantially the full width of the mold cavity, as indicated in Fig. II; since if they be narrower, the rate of operation and output may have to be reduced to secure proper filling of the mold, and even then imperfect fiber sheets may be produced. Vertically sliding inlet gates 24, 24 (Figs. I and III) can be closed, as shown in Fig. I, to shut off the mold cavity, when charged, from the supply reservoirs 22, 22, so that the pulp is then confined under the pressure exerted thereon,—save for the water drainage outlet through the ducts 12 and header 13 that is afforded as hereinafter described. The lower edges of the gates 24 make contact with the subjacent mold sills (forming part of the deckels 17, 17) on a bevel, so that the internal pressure in the mold is effectually resisted and merely makes the joint tighter against leakage.

The reservoirs 22, 22 extend substantially the full width of the mold, and may be supplied with pulp by any suitable means, such as a system of piping 26 opening and discharging into

each reservoir hopper 22 through its cover 27. At the ends of each hopper 22 are pockets 28, 28 with return pipe connections 29, 29 back to the pulp supply source or tank, so that any excess of pulp delivered to the reservoirs 22, 22 may overflow and return to the supply. In the bottom of each hopper 22, at the side toward the mold, is a series of rotary paddles 30, for agitating and thoroughly mixing the pulp on its way to the mold outlet 23. These paddles 30 are mounted on a common shaft 31 extending into the pockets 28, and are driven by an electric motor 32 mounted on the mold cover 27, through connections including a chain and sprocket drive 33. Vertical webs 34 extend across the bottom of the hopper 22 adjacent the gate 24 between the paddles 30 and below the shaft 31. Their vertical edges lie directly behind and practically touching the gate 24, so as to sustain it against the internal pressure in the mold when the water is being squeezed out and the pulp compacted.

Provision may be made for venting the air from the mid region of the mold, from between the inflowing pulp streams, by any suitable means, such as the outlets 35 in Figs. II, IV, and V, further described hereinafter.

As shown in Fig. I, the pipe connections 26, 26 and 29, 29 to the pulp hoppers 22, 22 have sliding or slip-joints 38 to permit up and down movement of the hoppers with the deckel structure 17, 18.

In the present instance, the mold bottom 11 is stationary, consisting of a rigid casting resting on the foundations 39, while the mold top 10 and the deckel structures 17, 18 are vertically movable. Overlying the mold top 10, there is a rigid superstructure 40 on which are mounted the various parts and mechanisms for moving and controlling the mold top 10, the deckel structure 17, 18, the gates 24, 24, etc. This structure 40 is supported from the mold bottom 11 and connected thereto by four columns 41, two at either side of the mold. As shown in Fig. II, the lower ends of the columns 41 extend through marginal ears 42 on the bottom 11 and have shoulders at 43 that rest on these ears, and are secured by split nuts 44 threaded on the columns and locked by bolts 45. The structure 40 has marginal ears 46 through which the upper ends of the columns 41 extend; these ears 46 rest on split nuts 47 suitably adjusted and clamped on the columns, and are secured by split nuts 48, threaded and locked on the columns. This construction not only allows the superstructure 40 to be accurately adjusted and leveled relative to the mold bottom 11, by adjusting the collars 47 and 48, but also allows the machine to be easily taken apart when desired.

On the ends of the superstructure 40 are mounted hydraulic motor or ram cylinders 50 whose plungers 51 carry yokes 52 from whose ends the mold top 10 is suspended by link rods 53. By admitting fluid under pressure to the cylinders 50, the mold top 10 is raised; by allowing the fluid to escape, it is lowered. To insure perfectly uniform up and down movement of the mold top 10, without tilting or cocking, equalizers are provided, consisting of pairs of rack bars 54 universally connected to the corners of the mold top and held in mesh with pairs of meshing pinions 55, 55 at opposite ends of the structure 40 by fixed guides 56, 56. The pinions 55, 55 are fast on the opposite ends of shafts 57, 57 extending through the structure 40. Provision is made for applying downward pressure to the mold top 10, to squeeze the water out of the pulp and compact its interlaced fibers together, by means of four hydraulic motors or rams, consisting of plungers 58 on the mold top working in cylinders 59 mounted in openings in the structure 40. To limit the upward movement of the mold top 10, adjustable stop screws 60, 60 are shown, one near each end of the mold top 10 at its center line, working in nuts 61 suitably fixed in the structure 40. These stop screws 60, 60 may be operated in unison by means of a horizontal shaft 62, through worms 63 on said shaft meshing with worm gears 64 splined to the screw shafts 60, 60 so as to turn the latter while at the same time permitting vertical movement of the screw shafts relative to the gears. The shaft 62 is shown with one end squared at 65 for operation by a hand crank (not shown), or by any other suitable means. By adjusting the stop screws 60, 60, the vertical depth of the mold cavity is adjusted, and thus the capacity of the mold and the thickness of the pulp sheet produced may be controlled and varied as desired.

On the sides of the superstructure 40, just inside the columns 41, are mounted four hydraulic motor or ram cylinders 66 whose plungers carry yokes 67 to which the deckel structure 17, 18 is connected, by operating rods 68 extending down through the structure 40, with their lower ends secured to the side deckels 18, 18. By admitting fluid under pressure to the cylinders 66, the deckel structure 17, 18 is raised; while by allowing the fluid to escape, it is lowered. As shown in Figs. I and II, the side deckels 18, 18 have lateral guides 69 for engaging the columns 41,—shaped to conform to the column surfaces. Thus the deckel structure 17, 18 and the mold top 10 that slides within it are kept in proper relation to the mold bottom 11.

On the structure 40 is a hydraulic actuating motor for each of the gates 24, 24, comprising a cylinder 70 mounted on rods 71, 71 connected to yoke arms on the cylinder and to lugs 72, 72 on the structure 40. The plunger of each cylinder 70 has an operating rod connection to its gate 24, whose upper portion 73 extends through a guide 74 on the adjacent cylinder 50, and whose lower portion 75 is hollow. Admission of fluid to the cylinders 70, 70 depresses and closes the gates 24, 24. The gates 24, 24 may be opened by a common hydraulic motor 76 (of differential double acting type) mounted on the structure 40 and having on its plunger 77 a yoke head 78 connected by link rods 79, 79 to crank arms 80, 80 on a shaft 81 mounted in suitable bearings on the structure 40. On the ends of the shaft 81 are crank arms 82, 82 with link rod connections 83, 83 to the gates 24, 24, inside the hollow gate operating rod portions 75, 75. The gates 24, 24 are raised by admitting fluid to the large area of the plunger 77.

As shown in Fig. I, the wire screen conveyor 20 is a continuous belt looped around two main rolls 85, 86 with its upper and lower runs extending in contact with one another through the bottom of the mold, over the screen plate 16. The axes or shafts of the rolls 85, 86 are mounted in bearings on brackets 87, projecting from the ends of the mold bottom 11, and the (right hand) roll 85 is driven by an electric motor 88 through gearing 89 (Fig. III). A spring-actuated friction brake device 90 may be connected to the shaft of roll 85 beyond the gearing 89, to control the conveyor belt 20 and prevent the motor 88 from racing when its load is suddenly reduced

as the formed sheet leaves the conveyor. While the mid portion of the loop formed by the conveyor screen 20 is flattened in the mold, its ends are held open or expanded, as by passing around the main rolls 85, 86 and beneath tension and adjusting rolls 91, 92. Between the mold ends and the rolls 91, 92, the lower (return) run of the conveyor 20 bends downward around guide rolls 93, 94, whose axes 95 are mounted in bearings on the brackets 87. Between the mold and the roll 85, the upper (active) run of the conveyor 20 passes over a supporting roll 96, whose bearing brackets 97 are adjustable along ways on the brackets 87 by means of screws 98.

The tension roll 91 has its axes mounted in links 99 pivoted on the axes 95 of the adjacent guide roll 93. Thus the roll 91 rests and "floats" against the "bight" or loop of the belt 20 between the rolls 85 and 93, exerting a pull that maintains a proper tension on the belt, while yielding to accommodate temperature changes, etc. The adjusting roll 92 has each of its axes mounted in a bearing block 100 which is adjustable up or down in ways 101 by means of a screw 102. By adjusting the roll 92 in this way, the effective length of the conveyor belt 20 can be varied beyond the range taken care of by the tension roll device 90, 99.

Spray pipes 105, 105 may be arranged over the return run of the screen conveyor belt 20, between rolls 85, 90 and 86, 91 in the belt loops, for washing them clean of adherent fibers from the pulp, so that the two thicknesses of screen shall always afford free passage for the water from the pulp through the foraminous plate 16 to the ducts 12. These spray pipes 105, 105 may be supplied with wash water under pressure through a pipe system 106. The spray strikes what has been the reverse or under side of the screen 20, so as to pass through and push off particles that have adhered to the upper side in the mold.

As shown in Figs. I, II and IV, the air outlet 35 leads to a cylindrical chamber 110 mounted on the deckel 18. This chamber 110 is freely vented to the atmosphere through a grating 111 across its otherwise open top. The vertical dimension of the outlet 35 where it opens through the deckel 18 is such as to cover the full range of vertical adjustments of the mold top 10, so as always to afford an air outlet from the upper region of the mold cavity. A barrier 112 affords an overflow for liquid from the outlet 35 at a height slightly above the highest adjusted position of the mold top 10, so that no pulp can escape through the outlet 35 until the mold cavity is completely filled. As here shown, the barrier 112 is defined by the lower edge of a port 113 in a drainage connection cylinder 114 extending up into the chamber 110. A packing 115 in the lower part of the chamber 110 assures tight joints. An opening 116 in the top of the cylinder 114 allows free discharge of air into the open-topped chamber 110, and a pipe 117 connected into the bottom of the cylinder affords a discharge for liquid (pulp or water) to any convenient point.

As here shown, there is a curved pipe connection 14 from the water discharge ducts 12 and header 13, leading downward and then up through the bottom of the cylinder 114, with an upright extension 118 within the cylinder. From the pipe 118 there is a port 119 leading into the interior of the cylinder 114, defined by the lower edge of a port 120 in the upstanding pipe 118. The bottom edge of the port 119 is just below the level of the lower side of the perforated plate 16. Port 120 and the overflow at 119 are controlled by a valve sleeve 121 around the pipe 118, provided with ports 122 and 123. The valve 121 is connected to the top mold 10 by a cable 124, extending over pulleys 125 and provided with a turnbuckle 126 as a means of adjustment. A helical compression spring 127 may be provided between the top of the cylinder 30 and a flange 128 on the valve 121, to reinforce gravity in depressing the valve. The valve 121 has guide slots 129 for pins 130 on the pipe 118, to insure proper correspondence of the ports 120, 122. The upper ends of pipe 118 and valve sleeve 121 are open, to permit free venting of air,—or even overflow of liquid, in case of need. As shown, there is a connection between the pipes 14 and 117, controlled by a valve 131, so that the water from the header 13 can be drained off directly.

The cycle of operation of the apparatus will be apparent from the foregoing description, but may be summarized as follows:

Starting with the conditions shown in Figs. I, II, and IV, the water drainage port 119 is open. The top mold 10 is allowed to descend, and sufficient pressure is applied to it to squeeze out the water from the pulp and compact its fibers into a coherent raw sheet. As the mold top 10 descends, the valve 121 necessarily rises, and the port 122 in the valve comes over the port 120 in the pipe 118, so that the water in the pipe 118 overflows at 119 and escapes into the cylinder 114 and through the pipe 117. At the end of its movement, the mold top 10 overtravels the lower edge of the outlet 35, thus sealing off the latter from the mold cavity. Then the deckels 17, 17, 18, 18 (with the associated parts) are raised, carrying the chamber 110 and the gates 24, 24 with them,—without, however, causing the gates to open. The cylinder 114, being fixed to the base 11, remains stationary, and thus in effect slides out of the chamber 110, virtually lowering the barrier 112 so that the pulp trapped in the outlet 35 has a chance to overflow into the cylinder 114 and escape through the pipe 117. The top mold 10 is raised to the position of Figs. I and II, and the fiber sheet is detached therefrom (if necessary) and allowed to drop back on the conveyor 20. The conveyor 20 is then operated to carry the fiber sheet (in either direction) out of the mold, for further treatment elsewhere.

The deckels 17, 17, 18, 18 (and the associated parts) are now lowered again to their positions in Fig. I. The hoppers 22, 22 having been filled with pulp from the piping system 26, the gates 24, 24 are opened, and the mold thus recharged with pulp,—the air venting freely from between the inflowing pulp streams through the outlets 35, 35, and passing out through the port 113 and the opening 116 to the atmosphere. Some of the pulp enters the outlet 35, and may even overflow at 112 into the lower end of the cylinder 114. The gates 24, 24 are closed,—bringing the apparatus back to the condition of Figs. I and II, ready for another cycle of operation.

Having thus described my invention, I claim:

1. A method of charging with aqueous pulp a horizontal mold for forming pulp sheets by pressing and drawing off the water from the pulp in the mold; which method comprises admitting the pulp into the mold at opposite edges and concurrently allowing the air in the mold to escape from its mid region, separately from the water of the pulp.

2. A method of charging with aqueous pulp a horizontal mold for forming pulp sheets by pressing and drawing off the water from the pulp in the mold; which method comprises admitting the pulp into the mold through an edge opening extending substantially the full width of the mold, concurrently allowing the air to escape from in front of the inflowing pulp, while preventing escape of the water from the pulp until after the mold is fully charged.

3. A wet machine of the character described for forming pulp sheets, comprising a horizontal mold with relatively movable top and bottom walls, means for introducing aqueous pulp into the mold at opposite edges and for venting air from between the inflowing pulp streams, while preventing escape of water from the pulp until after the mold is fully charged, and means for thereafter drawing away the water from the pulp in the mold.

4. A wet machine of the character described for forming pulp sheets, comprising a horizontal mold with relatively movable top and bottom walls, means for introducing aqueous pulp into the mold at opposite edges and for venting air from between the inflowing pulp streams, and means for separately drawing away the water from the pulp in the mold.

5. A wet machine of the character described for forming pulp sheets, comprising a horizontal mold with relatively movable top and bottom walls comprising means for introducing aqueous pulp, pulp supply reservoirs at opposite ends of the mold having a combined capacity sufficient to fill the mold and opening directly thereinto through openings extending substantially the full width of the mold, with gates for said openings, means for venting air from the mid-region of the mold, and means for separately drawing away the water from the pulp in the mold.

6. A wet machine of the character described for forming pulp sheets, comprising a horizontal mold with relatively movable top and bottom walls, means for introducing aqueous pulp comprising pulp supply reservoirs at opposite ends of the mold having a combined capacity sufficient to fill the mold and opening directly thereinto through openings extending substantially the full width of the mold, with gates for said openings, means for agitating the pulp in said reservoirs, means for venting air from the mid-region of the mold, and means for separately drawing away the water from the pulp in the mold.

7. A wet machine of the character described for forming pulp sheets, comprising a horizontal mold with edge deckels and top and bottom walls; means for raising and lowering one of said walls; means for preventing unequal action of said raising and lowering means on different portions of said wall, and thus causing uniform rectilinear movement of said wall, without cocking; means for positively limiting the separation of said walls, adjustable to vary the mold capacity; and means for raising and lowering said deckels.

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