Feb. 13, 1962 F. D. HELVERSEN ETAL 3,021,254

METHOD AND APPARATUS FOR DEWATERING PULP AND THE RESULTING PRODUCT

Filed Sept. 25, 1959

2 Sheets-Sheet 1

Fig. 1.

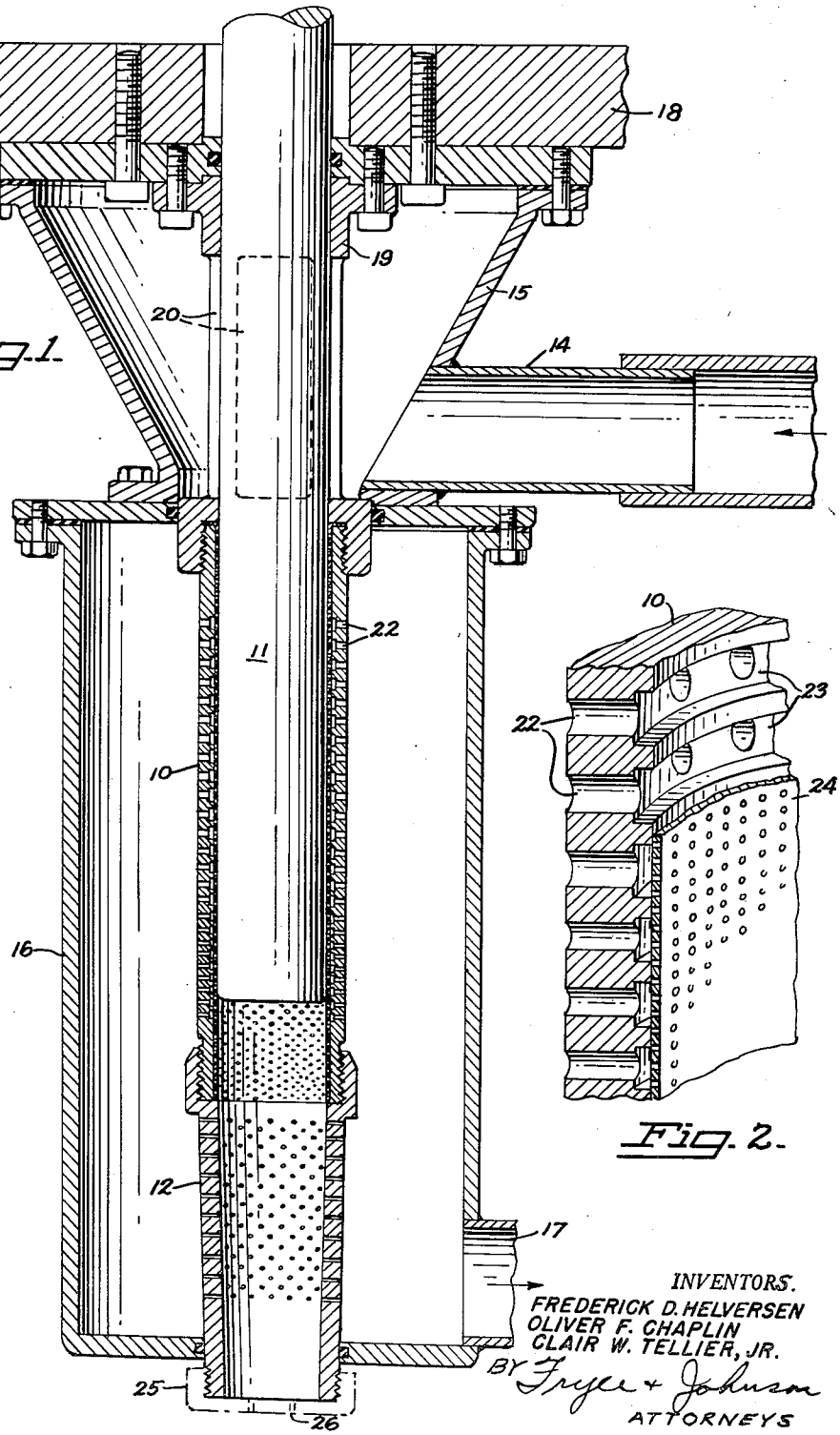


Fig. 2.

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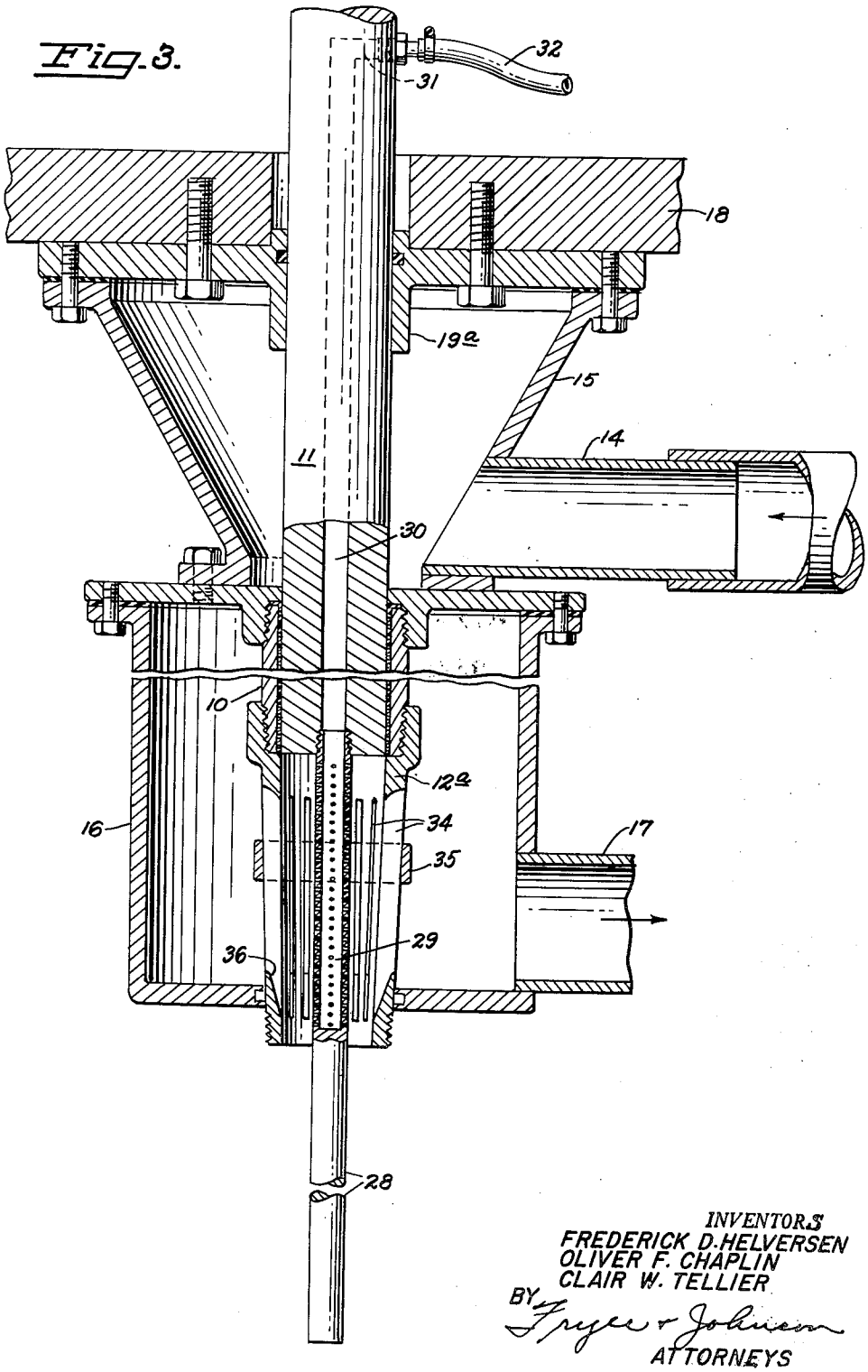
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Fig. 3.



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United States Patent Office 3,021,254 Patented Feb. 13, 1962

3,021,254

METHOD AND APPARATUS FOR DEWATERING PULP AND THE RESULTING PRODUCT

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Filed Sept. 25, 1959, Ser. No. 842,269
11 Claims. (Cl. 162—100)

This invention relates to the partial drying or dewatering and compressing of wood or similar pulps such as used in the manufacture of paper particularly for the purpose of reducing its bulk and weight and converting it into pellet-like pieces of convenient size and shape for handling and shipping.

In the manufacture of paper, timber harvested in forests is delivered to a pulp mill where it is reduced by any one of several methods to pulp or the separated cellulose fibers of which paper is made. In many instances a paper mill is located at or adjacent the site of the pulp mill and a slurry of pulp and water is readily conveyed as in conduits or the like to a paper making machine. It is economically desirable in some cases to locate paper mills in industrial areas closer to the market for the paper and various products to which it is converted. This requires the shipment of pulp for long distances as by boat or rail. Reduction of the bulk and weight of the pulp temporarily for shipment and handling is, therefore, desirable but is economically feasible only if the reduction or dewatering of the pulp can be accomplished at a cost which is lower than the saving effected by shipping the lighter weight and less bulky material.

It is also desirable that the reduced product be in pellets or chunks of relatively small size and uniform shape to facilitate moving it to and from vessels and mills by rapid methods such as hydraulic pumping, aerovating and conveying on endless belts and the like.

It is necessary, too, to be able to repulp the reduced material, by adding water and agitating it, rapidly and inexpensively.

Various materials have been dewatered and compacted by placing them in moist form in a cylinder or a chamber and then subjecting them to pressure. Efforts to produce dewatered pulp acceptable for the purposes of the present invention by this method have proven entirely unsatisfactory principally because water becomes entrapped in a mass of wood pulp fibers to the extent that extremely high pressures are required for long periods of time to produce the desired dryness and compaction.

It is the object of the present invention to provide a method and apparatus for dewatering pulp of the kind used in the manufacture of paper and to produce economically a dry product of light weight, low bulk and of uniform cross-sectional shape, easily handled and transported and readily repulped by the addition of water thereto.

Further objects and advantages of the invention are made apparent in the following specification wherein the method and apparatus of the invention are described in detail by reference to the accompanying drawings.

In the drawings:

FIG. 1 is a central vertical sectional view through the apparatus of the present invention;

FIG. 2 is an enlarged fragmentary perspective view of the cylinder wall of the apparatus shown in FIG. 1 illustrating the manner in which it is perforated and screened to permit the escape of water from the cylinder while retaining pulp fibers therein; and

FIG. 3 is a view similar to FIG. 1 with a portion broken away and with certain modifications which represent a preferred structure.

The apparatus of the present invention comprises a tube in the form of a cylinder illustrated at 10 which must be vertically or substantially vertically disposed as shown in FIG. 1 of the drawing and having its wall perforated for the escape therethrough of moisture as presently will be described in greater detail. A plunger 11 is reciprocable throughout the length of the cylinder by means of any desired source of power. Hydraulic fluid under pressure and a double acting hydraulic jack with suitable controls to produce a reciprocal action such as employed in commercially available presses have been found suitable for this purpose. At its lower end, the cylinder has an extension 12 which forms a tubular terminal end portion inwardly tapered toward its bottom end to provide a restricted open end for extrusion of pulp, and which is also perforated adjacent said restricted open end to permit the escape of moisture. With the construction disclosed, a continuous supply of slurry is fed to the cylinder 10 from a suitable source, not shown, through an inlet conduit 14 and a hopper 15 which serves as an accumulator chamber for the continuously supplied slurry. Upon retraction of the plunger 11 to a position where its upper end is well above the top of the cylinder 10, slurry enters the cylinder and is compressed therein upon downward movement of the plunger so that the moisture is pressed out of the slurry through the perforations in the cylinder where it is received in a chamber 16 and carried off through an outlet 17. Because of the taper of the extension 12 on the lower portion of the cylinder greater force is required to cause extrusion of the dewatered pulp from its lower end and greater compaction occurs further reducing the water content and causing the extrusion through the lower end of the extension 12 of a relatively dry product in the form of a uniformly cylindrical rod which, for reasons that will presently appear, will be inclined to break into short pieces or pellets of random length which are easily handled and transported.

Apparatus comprising a perforated tube or cylinder for drainage of liquid therefrom and a piston or plunger movable therein is in a general way old and has been employed for the purpose of expressing moisture and compacting various types of products. However, the use of this general type of apparatus under ordinary methods has failed to produce a satisfactory dewatering of wood fiber pulp as it has been found that in the application of initial pressure to such pulp the matted or inter-tangled relationship of the fibers thereof form structures which upon compression entrap and hold pockets of water to such an extent that extremely high pressure for example 50 tons or more per square inch is required to reduce the pulp to a 50% moisture content which is considered dry for the purposes of the present invention.

The present invention utilizes the natural tendency of the fibers in a slurry to distribute themselves in horizontal positions and to deposit themselves upon withdrawal of water from the slurry in horizontal positions thus producing a felt-like structure which has what is in effect a grain in which the greatest percentage of voids are horizontally extending spaces through which water may flow more readily than it flows against the grain. The use of the term "slurry" throughout this specification is to be taken as meaning a mixture of fibers and liquid in which the percentage of liquid is sufficient to enable free movement of the fibers within the mixture.

The apparatus disclosed in FIG. 1 is adapted to be supported from the bottom of a table, a portion of which is illustrated at 18, and the hopper 15 which depends from the table acts as a support for the cylinder 10 and the chamber 16. A tubular member 19 disposed centrally of the hopper serves as a guide for the plunger 11 upon its retraction from the cylinder and has large openings 20

to enable free flow of slurry from the inlet **14** into the cylinder **10** with a minimum of turbulence. If a sufficiently rigid support for the cylinder is provided, the tubular member **19** may be omitted entirely. The wall of the cylinder **11** is provided with holes **22** in horizontally aligned groups and the sizes of the holes may be smaller toward the bottom of the cylinder. The inside wall of the cylinder is grooved as illustrated at **23** in FIG. 2 and a screen in the form of a piece of perforate sheet metal **24** provides a liner for the tube. Perforations in this liner are considerably smaller than those in the cylinder so that the grooves **23** form a communication between a number of small holes in the liner and each of the larger holes in the cylinder. The liner should have small holes particularly adjacent its upper end because it functions to screen the fibers out of the water flowing through them. The tapered extension **12** is also provided with small perforations and the taper of this extension is slight. For example in practice, an inwardly tapered tube six inches long with an inside diameter of 2½ inches at its upper end and an inside diameter of 2⅜ inches at its lower end has been successfully employed.

To start the operation of the apparatus, a cap, as indicated in broken lines at **25**, is employed to close the bottom of the tapered extension **12** and is provided with a few small perforations **26** to prevent entrapment of water in the bottom portion of the extension. A thin slurry is then introduced through the inlet **14** to the cylinder where a large percentage of the water from the slurry drains off through the perforations **22** and the perforations in the tapered extension. The plunger **11** is then brought down upon the contents of the cylinder and this may be repeated a few times until sufficient compacted fibers from the slurry have been built up to be retained by friction within the tapered extension. The slurry must be sufficiently thin to permit free flow and free movement of the fibers in the water so that they settle upon each other in horizontal positions to produce the desired horizontal or transverse grain in the product as it is being compacted. After the plug has been removed the plunger is reciprocated constantly alternately to admit slurry from the inlet **14** and compress it in the cylinder while the water exudes through the perforations in the cylinder and the fibers become compacted and relatively dry.

The taper in the extension **12** is such as to prevent the product from being forced out of the lower end of the extension until it is capable of forming a self-sustaining shape and has the appearance of a piece of relatively hard dry wood. The compaction is sufficiently great to produce a solid cylindrical form but, due to the transverse grain produced by floating the fibers into place, the form is easily fractured and will break in relatively short pieces as it falls upon a conveyor or the like. It is also contemplated that some means (not shown) for breaking the extruded rod may be employed if it is desired that the pieces be of relatively uniform length.

The tapered extension **12** used in combination with the straight cylinder in which the fibers have been transversely deposited has been found to be of utmost importance in producing a pulp of the desired dryness because the advancing of the cylindrical partially dried pulp from the bottom of the cylinder **10** causes an inward compression or force which disrupts the horizontal laminae of which the rod is composed temporarily opening spaces which extend in a horizontal direction to permit the outward flow of a considerable quantity of water as the rod passes through the extension **12**. It has been found in practice that without the extension **12** with its tapered conformation and its perforations a pressure of 50 tons per square inch is required to produce the same dryness of the pulp that is produced in the apparatus of the present invention with the pressure not exceeding 5 tons per square inch.

The laminate structure of the product not only facilitates the removal of water from it under pressure but materially aids in the repulping which is necessary before making paper because it hastens the wetting of the product when it is immersed in water. It is also less destructive to the fibers to compress them in uniform arrangement and prevents the accumulation of swirls or knots of fibers which will not readily repulp and are capable of producing flaws in paper made from the pulp.

FIG. 3 illustrates some modifications to the apparatus as shown in FIG. 1 and particularly the addition to the bottom of the plunger **11** of a concentrically disposed and axially aligned rod **28** which extends donwardly through the tapered extension herein shown at **12***a*. The upper end of the rod **28** is threaded into the lower end of the plunger **11** and has a hollow portion with perforated walls shown at **29** which extends downwardly to a position just short of the lower end of the tapered member **12***a*. The hollow portion of the rod communicates with a passage way **30** extending upwardly through the plunger **11** to a point where it intersects with a radial passage **31** for communication with a flexible hose **32**. The plunger **11** in FIG. 3 is illustrated in its lower-most position and the flexibility of the hose **32** permits its vertical reciprocation in the manner hereinbefore described. Because of the presence of the rod **28** extending axially through the chamber in which compression and dewatering takes place, the resulting product will be of tubular shape and the compressed tube or mass will slide downwardly on the extending end of the rod **28** which is sufficiently long that it will not be retracted from the member **12***a* when the plunger moves to its upper limit. One advantage provided by the rod **28** is that it permits escape of water radially inwardly from the mass under compression thus increasing the area through which the escaping water may flow and also decreasing the area of the mass and the distance that the water must travel to find its way out of the body of pulp under compression. The water which enters the hollow portion of the rod **28** gradually rises in the passage **30** and is discharged through the flexible tubing **32**.

Another modification illustrated in FIG. 3 is the use of elongated slots **34** in the member **12***a* in place of the perforations illustrated in the member **12** in FIG. 1. Slots **34** which extend longitudinally of the tapered member and are spaced circumferentially are less likely to become clogged with pulp fibers as the pulp is under compression and moving downwardly through the member **12***a*. They do tend to reduce the strength of the member and its ability to withstand distortion during compression of pulp within it and instead of making the member of considerably heavier construction, a constricting band may be placed around it as illustrated at **35** to prevent its side walls from bulging. The lowermost end of the slots **34** are tapered or formed on an incline as illustrated at **36** to further reduce the tendency of fibers to become lodged in them.

Another modification is illustrated in FIG. 3 by means of which the entrance of slurry into the cylinder **10** is accomplished more rapidly and with less turbulence. To accomplish this, the tubular portion **19** surrounding the upper part of the plunger **11** is terminated as illustrated at **19***a* so that no obstruction exists between its lower end and the top of the chamber **16** as the slurry flows into the cylinder **10** when the plunger is in its retracted position.

The terms "wood fiber" and "water" are used herein as the elements of pulp generally employed in the manufacture of paper, they are not, however, to be taken as limiting the invention which is obviously applicable to the removal of any liquid from any of many types of fiber or fiber-like material and it is, therefore, intended that the appended claims be so construed.

We claim:

1. The method of dewatering wood pulp slurry and forming a compressed solid wood pulp mass therefrom for transportation which comprises providing a tubular perforated passageway open at one end and terminating

adjacent its opposite end in an inwardly tapered perforate restricted terminal portion, maintaining a continuous supply of said slurry in communication with said open end; and while the slurry supply is thus continuously maintained, constantly and alternately reciprocating a plunger in and retracting it from said passageway to allow slurry to flow through said open end into said passageway from said supply upon each retraction stroke of the plunger from said passageway, and upon each compression stroke of the plunger in said passageway to express liquid from the slurry through the perforations in the passageway and its terminal portion, and also to compress the slurry to form said solid pulp mass and extrude said mass from said restricted portion.

2. The method of claim 1 comprising initially closing said restricted portion, and initially reciprocating the plunger to build up compacted pulp fibers in said restricted portion.

3. The method of dewatering wood pulp slurry and forming a compressed solid wood pulp mass therefrom for transportation which comprises providing a tubular upright perforated passageway open at its top end and terminating adjacent its bottom end in an inwardly tapered perforate restricted terminal portion open at the bottom, providing a plunger carrying a rod extending from the bottom of the plunger and having a hollow perforate portion, maintaining a continuous supply of said slurry in communication with said open top end; and while the slurry supply is thus continuously maintained, constantly and alternately reciprocating said plunger in and retracting it from said passageway to allow slurry to flow through said open top end into said passageway from said supply upon each retraction stroke of the plunger from said passageway, and upon each compression stroke of the plunger in said passageway express liquid from the slurry through the perforations in the passageway and its terminal portion and express liquid inwardly through the perforations in the hollow rod, and also to compress the slurry to form said solid pulp mass and extrude said mass from said restricted portion.

4. Apparatus for preparing wood pulp for transportation comprising an upright tube having perforations in its wall and open at its top end, a tubular terminal portion at the bottom of the tube tapered inwardly and open at its bottom end, the side wall of said terminal portion being formed with circumferentially spaced apart slots extending longitudinally of the terminal portion, means for maintaining a continuous supply of slurry in communication with the open top end of said tube including a hopper communicating with said open top end; and a plunger constantly and alternately reciprocated in said tube to allow flow of slurry from said hopper into said tube upon each retraction stroke of the plunger therefrom, and to express liquid from the slurry and compact pulp and extrude the same from said bottom end of the terminal portion upon each compression stroke.

5. An apparatus for preparing wood pulp for transportation comprising an upright tube having perforations in its wall and open at its top end, a tubular terminal portion at the bottom of the tube tapered inwardly and open at its bottom end, the side wall of said terminal portion being formed with circumferentially spaced apart slots extending longitudinally of the terminal portion, means for maintaining a continuous supply of slurry in communication with the open top end of said tube including a hopper communicating with said open top end; a plunger constantly and alternately reciprocated in said tube to allow flow of slurry from said hopper into said tube upon each retraction stroke of the plunger therefrom, and to express liquid from the slurry and compact pulp and extrude the same from said bottom end of the terminal portion upon each compression stroke; and a rod carried by said plunger projecting from the lower end thereof and extending through the open bottom end of said terminal portion, said rod having a hollow perforate portion adjacent the lower end of the plunger.

6. An apparatus for preparing wood pulp for transportation comprising a vertically disposed perforate cylinder, a pulp hopper communicating with the upper end of the cylinder, a plunger disposed in the cylinder and constantly and alternately reciprocated therein, means to introduce continuously a slurry of pulp into the hopper whereby slurry flows into the cylinder upon each retraction of the plunger therefrom, and a perforate inwardly tapered extension on the bottom of the cylinder providing a restricted open end for extrusion of pulp.

7. An apparatus for preparing wood pulp for transportation comprising a vertically disposed perforate cylinder, a pulp hopper communicating with the upper end of the cylinder, a plunger disposed in the cylinder and constantly and alternately reciprocated therein, means to introduce continuously a slurry of pulp into the hopper whereby slurry flows into the cylinder upon each retraction of the plunger therefrom, and a perforate tapered extension on the bottom of the cylinder providing an open end for extrusion of pulp, the taper of said extension being inwardly to provide a restriction retarding the extrusion of the pulp until its water content is reduced sufficiently to produce a self-sustaining relatively dry shape.

8. An apparatus for preparing wood pulp for transportation comprising a vertically disposed perforate cylinder, a pulp hopper communicating with the upper end of the cylinder, a plunger disposed in the cylinder and constantly and alternately reciprocated therein, means to introduce continuously a slurry of pulp into the hopper whereby slurry flows into the cylinder upon each retraction of the plunger therefrom, a perforate inwardly tapered extension on the bottom of the cylinder providing a restricted open end for extrusion of pulp, and a rod carried by and extending coaxially from the end of the plunger and through the open end of said tapered extension.

9. An apparatus for preparing wood pulp for transportation comprising a vertically disposed perforate cylinder, a pulp hopper communicating with the upper end of the cylinder, a plunger disposed in the cylinder and constantly and alternately reciprocated therein, means to introduce continuously a slurry of pulp into the hopper whereby slurry flows into the cylinder upon each retraction of the plunger therefrom, a perforate inwardly tapered extension on the bottom of the cylinder providing a restricted open end for extrusion of pulp, and a rod carried by and extending coaxially from the end of the plunger and through the open end of said tapered extension, said rod having a hollow portion with perforate walls adjacent the end of the plunger to receive liquid from the pulp under compression.

10. An apparatus for preparing wood pulp for transportation comprising a vertically disposed perforate cylinder, a pulp hopper communicating with the upper end of the cylinder, a plunger disposed in the cylinder and constantly and alternately reciprocated therein, means to introduce continuously a slurry of pulp into the hopper whereby slurry flows into the cylinder upon each retraction of the plunger therefrom, a perforate inwardly tapered extension on the bottom of the cylinder providing a restricted open end for extrusion of pulp, a rod carried by and extending coaxially from the end of the plunger and through the open end of said tapered extension, said rod having a hollow portion with perforate walls adjacent the end of the plunger to receive liquid from the pulp under compression, and means to discharge said liquid through the plunger.

11. An apparatus for preparing wood pulp for transportation comprising a vertically disposed perforate cylinder, a pulp hopper communicating with the upper end of the cylinder, a plunger disposed in the cylinder and constantly and alternately reciprocated therein, means to introduce continuously a slurry of pulp into the hopper

whereby slurry flows into the cylinder upon each retraction of the plunger therefrom, and a perforate tapered extension on the bottom of the cylinder providing an open end for extrusion of pulp, the taper of said extension being inwardly to provide a restriction retarding the extrusion of the pulp until its water content is reduced sufficiently to produce a self-sustaining relatively dry shape, and the perforations in said extension being in the form of narrow spaced slots extending longitudinally through its wall.

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