

Nov. 1, 1932.

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1,885,334

PROCESS AND EQUIPMENT FOR FORMING SHEETS

Filed Sept. 9, 1929

3 Sheets-Sheet 1

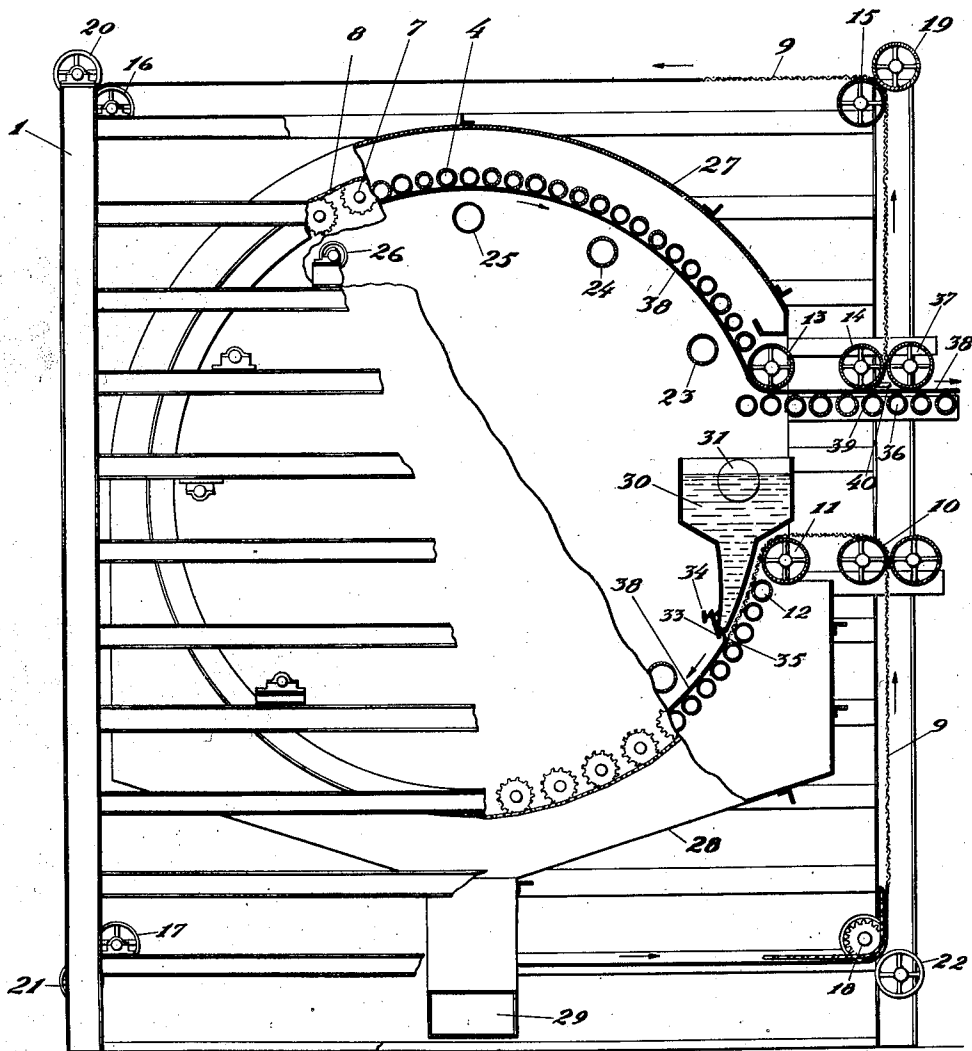


Figure 1.

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3 Sheets-Sheet 2

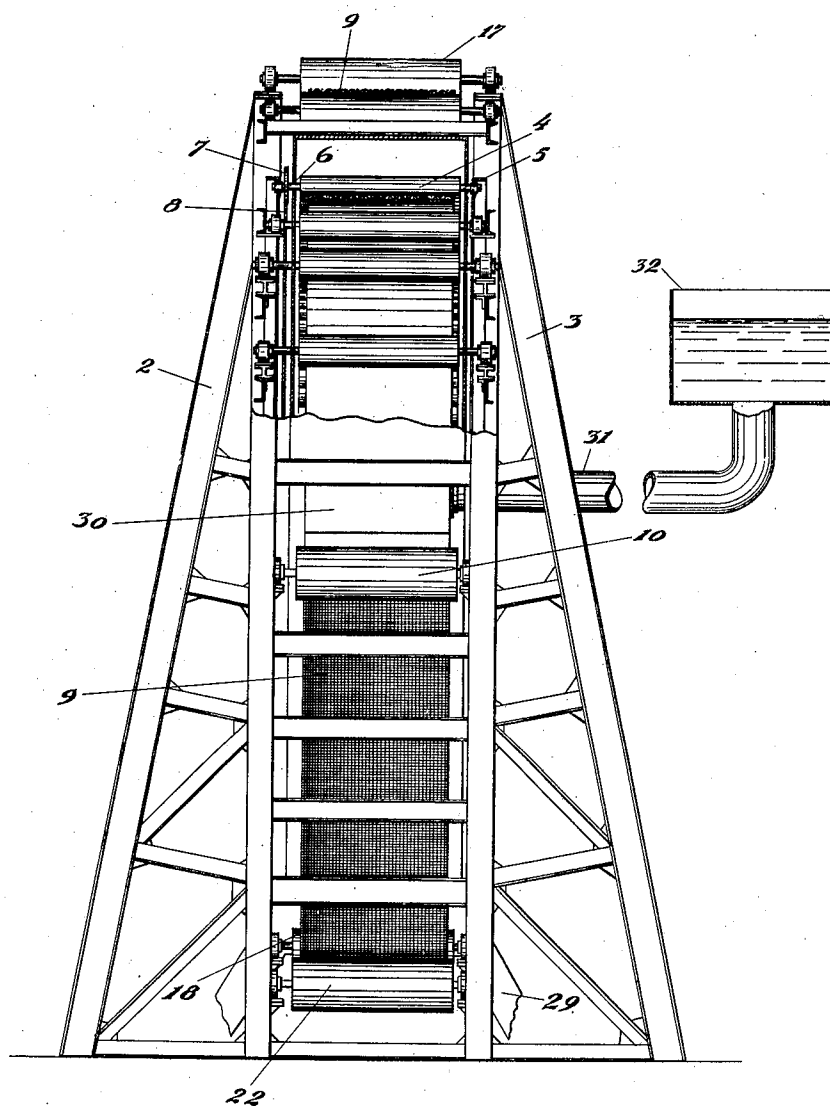


Figure 2.

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3 Sheets-Sheet 3

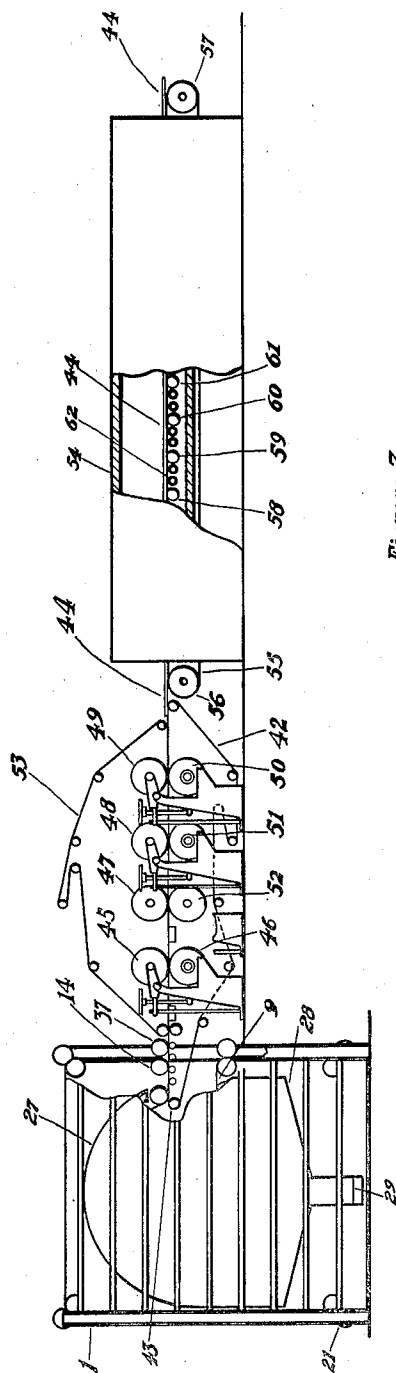


Figure 3.

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PROCESS AND EQUIPMENT FOR FORMING SHEETS

Application filed September 9, 1929. Serial No. 391,235.

This invention relates to methods, apparatus and processes for forming sheets in a manner which may be continuous or discontinuous as desired. The process and equipment may be used to produce continuous uniform sheets such as paper, board, insulation, etc., or the equipment may be employed to remove water from powder or loose materials.

Some of the objects of this invention are to provide economical, rapid and uniform means and processes for separating liquids from solids. Other objects of this invention are to provide processes and means for producing sheets from pulp, fibers or other materials. Another object of this invention is to reduce the content of water or other liquid in a sheet or board or discontinuous material to a lower percentage than can be readily obtained in a continuous manner by present commercial means.

Further objects of this invention will appear from the drawings, description, specifications and claims appended hereto.

Referring to the drawings:

Figure 1 shows a side elevation partly broken away which illustrates somewhat diagrammatically one form of my invention,

Figure 2 shows an end elevation also partly broken away illustrating further details of a form of my invention.

Figure 3 shows diagrammatically an arrangement of my invention assembled with pressing and drying equipment.

Referring to the drawings, a frame 1 composed of structural members and braced by end pieces 2 and 3 supports a series of live or rotating rollers one of which is indicated by 4 and the others being substantially similar. The rollers 4 are carried on shafts indicated by 5 and 6 on which is supported a sprocket 7 which is caused to revolve by chain 8.

Each of the live rollers is driven in the manner indicated by chain 8 through a series of sprockets arranged so that they all revolve at substantially the same speed and in the same direction.

A felt or foraminous structure 9 is arranged to pass over the series of live rollers

4 in a closed loop and in the direction shown by the arrows. Tracing the travel of the felt it will be noted that it begins to travel upward from the lower right hand corner of the structure shown in Figure 1 passing over driven pulley 10 and then traveling horizontally to driven pulley 11 after which it turns downward in the direction shown by the arrows and passes over a series of live rolls similar to those described by 4 and indicated by reference number 12. The felt completes the circle returning over the upper portion of live rollers 4 and finally leaving the loop by passing over live pulley 13 and traveling horizontally to live pulley 14 after which it travels upward over pulley 15 and horizontally to pulley 16 returning by the corners of the frame to live pulleys 17 and 18, thus making a complete loop. The felt is reinforced at the points of turning by pulleys 19, 20, 21 and 22 which serve to assist maintaining it into place and relieve some of the strains upon the felt.

A series of idler pulleys 23, 24, 25, 26, etc., are supported inside of the loop and serve to retain the felt in position during the period in which it is shut down.

The loop formed of live pulleys and felt is enclosed in a metal housing 27 provided with a drain 28 connected with discharge duct 29. The housing, drain and discharge duct serves to recover the liquid removed during the process of operation.

The material to be treated is delivered to feed box 30 by feed pipe 31 which is connected to storage tank 32 in a manner to permit maintaining a constant level in feed box 30.

The discharge of material from feed box 30 is controlled by means of slice 33 which for purposes of illustration is shown as adjusted by means of screw 34. The degree of opening 35 between slice and box 30 controls the rate at which liquid leaves feed box assuming the head is maintained constant. By varying the head in feed box 30 a rate of control of feed is also obtainable.

It will be noted that the flow of liquid from feed box 30 is in a general downward direction substantially parallel to the direc-

tion of travel of the moving felt. An additional series of live rollers 36 are located adjacent to the point at which the felt after passing from the loop in a horizontal position changes direction and travels upward. A guide roll 37 is placed at this point also. The sheet or board formed on the felt or screen 9 is indicated by 38 and is shown beginning to form adjacent to slice 33. The sheet passes around the loop following the felt or screen but separates at approximately the point indicated by 39 where the felt or screen changes direction rapidly, the sheet continuing in a substantially horizontal direction as indicated by 38 passing under roll 37 and over live rolls 36.

While the device shown and described consists of one loop only it will of course be obvious that I may obtain more marked results by my process by utilizing a series of loops, by making the loop much larger in size or by increasing the speed of travel.

If desired a scraper member 40 may be placed adjacent to pulley 14 to assist in thoroughly removing the sheet or other material from the felt or screen.

The felt or screen may consist of a Fourdrinier wire, a porous canvass belt or any equivalent structure which will support the fibers and allow the liquid to penetrate.

In operation the mixture of water and solid which may for example, be considered to represent wood pulp, is delivered to the felt or Fourdrinier wire from box 30 controlled by slice 33 and forms a uniform smooth layer. The felt or Fourdrinier wire which is traveling rapidly around the loop serves as a single pass centrifugal in that centrifugal force due to the continuous change of direction of the moving felt causes the water to pass into the felt and leave its outer surface while the fiber or solid material is retained on the inner surface of the felt.

The operating speeds utilized may be as found most suitable for the particular material being treated. Speeds from 2000 to 3000 feet per minute are ample for most materials although with higher speeds the results are more marked.

The separation of liquid from solid material begins immediately after the solution strikes the felt and progresses continuously until the felt passes around pulley 13. Under these conditions of course centrifugal force also forces the felt outward against the live pulleys 4, 12, etc., and these rolls as well as the pulleys described above all combine to maintain the felt in rapid motion.

As the felt quickly changes direction by passing around pulley 14 the effect of centrifugal force is now in the reversed direction from that existing within the loop and the sheet or partially dried material at this point tends to be thrown away from the felt. Pulley 14, therefore, serves as a convenient

separation point and the sheet preferably therefore leaves the felt 9 adjacent pulley 14 and travels over rolls 36 and under rolls 37 to suitable equipment for storing, drying, finishing or otherwise completing of the sheet.

It will be understood that live rolls 36 merely represent diagrammatically a form of conveyor which serves to direct or convey the material from felt 9 adjacent to pulley 14. While this equipment and process has been described as relating to the formation of a continuous sheet, as for example from wood pulp, it will be apparent that the equipment and process may be employed as a continuous filtering device or a continuous de-watering device. It may, therefore, be employed to remove liquids from solids continuously and may handle powders such as salt, sugar or other chemicals, ore or in fact any suspensions from which it is desired to partially remove the liquid.

The amount of liquid which may readily be removed depends on the size of the equipment, the linear speed of travel of the felt and, of course, the nature of the solid and the liquids employed. With equipment of this kind it is entirely feasible to reduce a wood pulp containing four or five percent of solid to a mass containing from thirty to fifty percent of solid.

One desirable application of this equipment is in the preliminary drying of wood pulp as for example prior to transportation. Another application is the formation of a sheet or board from fibers such as wood pulp, straw, corn, peat, asbestos and similar materials.

A board formed by the use of my equipment is produced with great rapidity, much faster than is normally possible under present commercial conditions, as for example, by the use of a horizontal Fourdrinier wire. In using present methods the speed at which it is practical to operate the Fourdrinier wire is closely controlled by the so-called freeness factor of the pulp. In order to obtain a rapid rate of travel of Fourdrinier wires under present commercial conditions, it is necessary to carefully process the pulp so that the resultant felt or mat will allow the water to travel through it rapidly without clogging the pores.

The necessary treatment to obtain a high speed in the Fourdrinier is expensive and tedious and requires accurate control. This treatment also involves large investment for equipment and large expenditures for power.

It has not proven practical or desirable to increase the head or pressure of the liquid on the present commercial Fourdrinier wires as this results merely in clogging the pores of the felt and does not proportionately increase the speed of formation of the sheet. In my device, however, I am utilizing an additional force not available in present Fourdrinier, namely, the so-called centrif-

ugal force, due to the change in direction of travel of the pulp on the wire. This force may readily be ten to fifty times greater than the head now available on ordinary Fourdriniers. This greater force makes it possible to materially increase the rate of speed of formation of the sheets and furthermore materially reduces the importance of the freeness factor of the pulp. I am therefore able to produce sheets rapidly and commercially with pulp solutions which it would be very costly or impractical to handle by present commercial methods. My device permits the formation of a continuous sheet which is highly desirable in the manufacture of paper, board and similar products.

The equipment is automatically and substantially foolproof. Since the speed of rotation and the head of liquid in the feed box may readily be held constant, the resultant product will be constant in thickness and quality. Further by varying the speed of rotation of the rate of feed of material to the felt I may easily control the thickness and quality of the finished product.

As the screen or Fourdrinier wire 9 returns on the outside of the loop the centrifugal forces act upon it each time that it passes around the outer pulleys. This serves to automatically clean the Fourdrinier by throwing off any particles which adhere to it. As a result of this construction the equipment is self cleaning and continually ready for operation.

It will be evident that many modifications may be made in the general arrangement of the equipment shown without departing from the spirit of my invention.

While I have shown the loop in the form of a circle which is under most conditions the most desirable arrangement it is obvious that the loop may be constructed as an ellipse or as a figure having a multiple of substantially straight or curved sides. The loop may, therefore, be modified in shape to accommodate the available building space. I prefer to utilize a substantially circular construction for the reason that it gives a continuous and substantially equal force tending to remove the liquid and compress the resultant felt. An irregular figure naturally results in variations in the centrifugal force which is likely to cause unequal portions in the resultant material.

I do not wish to be restricted to any particular driving method. Furthermore the details of the structure shown on the drawings are merely diagrammatic and may be modified to suit working conditions.

The position and shape of the feed box may be modified as desired, although I prefer to apply pulp at some portion of the inner loop rather than on the tangent portions.

The amount of water removed by my device is largely within the control of the de-

signer and operator. Normally my equipment removes materially more water than present commercial methods with a corresponding reduction in steam consumption in the subsequent drying process.

I prefer to apply the pulp or solution to the felt 9 in a smooth uniform manner designed to eliminate eddies. This is ordinarily included in the term "stream line flow". The production of eddies or rapid changes in direction or velocity at the time that the liquid is applied to the pulp or immediately following this period, causes undesirable groupings of the fibers which normally result in an inferior product. I, therefore, consider the stream line application of the solution in a direction substantially parallel to the travel of the felt and at approximately the same speed, of great importance where a continuous uniform sheet is required. On the other hand, in the operation of the equipment as a dewatering device the adherence to stream line flow is of lesser importance.

It is desirable to obtain a uniform distribution of pulp across the entire width of the felt or Fourdrinier and this may be obtained by the proper adjustment of set screws 34 acting on slice 33. In using the term "pulp" it should be understood that I am referring to any suspension of insoluble materials in a liquid. In the case of forming a sheet or board the pulp would normally consist of fibers probably cellulose fibers suspended in a water solution and under usual commercial conditions the amount of solid matter in the water would range from three to six percent.

I do not, however, wish to be limited to the single illustration which I have chosen for purposes of clearness as it will be obvious that my process and device may be applied to any suspension.

After a sheet or board has been formed by dewatering the pulp on the foraminous belt I then proceed to dry or to press and dry the sheet in case I am producing a strong board for commercial purposes. If I am merely interested in producing a dewatered material such as a sludge, powder or lump substance the pressing if desired may be omitted and in some cases the drying is not necessary.

In Figure 3 a diagrammatic arrangement is shown for pressing and drying the dewatered product from my device. Similar numbers refer to similar parts on Figures 1 and 2.

A conveyor 42 in the form of a carrying belt or other device is provided to receive the dried material from foraminous structure 9. Conveyor 42 passes over roller 43 and extends to roller 44 returning by way of pulleys or rollers indicated. Conveyor 42 passes between press rolls 45, 46, 47, 48, 49, 50, 51 and 52. It will be understood that more or less of the rolls may be used if required

or other press devices may be employed, as the exact form of pressing equipment is not intended to be covered by this invention.

A protecting conveyor 53 is shown covering the material being pressed as it travels through the various pairs of rolls. Protecting conveyor 53 is also a diagrammatic indication as both felts 42 and 53 and the associated equipment may follow standard practice, which is well known in the art. I do not wish to be confined to roller presses as many other forms are applicable.

54 indicates a dryer and for purposes of convenience, I have shown an ordinary conveyor type of dryer in which a belt, felt, wire or other device indicated by 55 passes around rollers or pulleys 56 and 57. The material being dried indicated by 44 passes through dryer 54. For diagrammatical purposes, I have indicated a series of rollers 58, 59, 60 and 61 which serve to support the conveyor member 55 as it travels through dryer 54. I have also indicated a series of steam coils, one of which is shown as 62. These are designed to supply necessary heat for carrying out the drying operation.

I wish it to be clearly understood that many other types of dryers may be satisfactorily used in connection with my process and equipment. I am merely indicating one type which is practical in many cases.

Obviously, the dryer may be in the form of rolls as in paper practice or a roller conveyor such as is used in the manufacture of board, may be substituted. The exact type of dryer will depend upon the material being handled and the various modifications indicated and shown come within the scope of my invention.

In using the term "pulp" in the claims and elsewhere it is to be understood that I intend to indicate broadly suspensions of various materials in liquids, and while the term is intended to include wood pulp, it will be obvious that the process and apparatus may be applied to the removing of liquids from any mixture of solid materials and liquids.

In using the terms "de-watered" and "de-watering" it should be understood that I do not intend to confine my invention to the actual removal of water only as obviously the process and apparatus can be applied in the case of any liquid.

Having now fully described my invention what I claim as new and wish to secure by Letters Patent in the United States, is as follows:

1. The process of removing liquids from pulp which consists in applying the pulp to a foraminous belt, removing a portion of the liquid therefrom by centrifugal force and then continuously removing said material from said belt.

2. The process of forming sheets from pulp which consists in applying pulp uniformly

to a continuous belt, removing a portion of the liquid therefrom by centrifugal force and continuously removing said sheet from said belt.

3. The process of forming sheets from pulp which consists in flowing pulp uniformly onto a continuous belt in a band substantially the width of the sheet being formed, removing a portion of the liquid therefrom by centrifugal force and removing said sheet from said belt in a continuous strip.

4. The process of forming sheets from pulp which consists in flowing the pulp uniformly onto an endless foraminous belt, removing a portion of the liquid therefrom by centrifugal force while on said belt thereby forming a continuous sheet of interlocked particles, and continuously removing said sheet.

5. The process of forming sheets from pulp which consists in applying the pulp uniformly to an endless foraminous belt, removing a portion of the liquid therefrom by centrifugal force while on said belt thereby forming a continuous sheet of interlocked particles, continuously removing and subsequently drying said sheet.

6. The process of forming sheets from pulp which consists in applying the pulp uniformly to an endless foraminous belt, removing a portion of the liquid therefrom by centrifugal force while on said belt thereby forming a continuous sheet of interlocked particles and continuously removing, pressing and drying said sheet.

7. The process of removing water from pulp which consists in applying said pulp to a continuous endless belt, subjecting said pulp while on said belt to the action of centrifugal force thereby removing a portion of the water from said pulp and continuously removing said partially dewatered pulp from said belt.

8. The process of continuously partially dewatering pulp which consists in applying said pulp, to a continuous belt, subjecting said pulp while on said belt to the action of centrifugal force and then continuously removing said pulp from said belt.

9. The process of forming sheets from pulp which consists in applying said pulp to an endless belt, removing a portion of the liquid therefrom by centrifugal force while on said belt thereby forming a continuous sheet of interlocked fibers.

10. The process of forming a sheet from cellulose fibers which consists in applying a pulp of cellulose fibers to an endless belt, subjecting said pulp while on said belt to the action of centrifugal force thereby removing a portion of the water in said pulp and forming a sheet having interlocked fibers, and continuously removing said sheet.

11. The process of forming a sheet from cellulose fibers which consists in applying a pulp of cellulose fibers to an endless belt, sub-

jecting said pulp while on said belt to the action of centrifugal force thereby removing a portion of the water in said pulp and forming a sheet having interlocked fibers, and continuously removing said sheet from said belt and subsequently drying it.

12. The process of removing liquid from pulp which consists of applying said pulp to an endless belt, continuously subjecting said pulp while on said belt to the action of centrifugal force thereby removing a portion of the liquid therefrom and then continuously removing said partially dewatered pulp from said belt by reversing the direction through which the centrifugal force acts on said pulp.

13. A machine for forming sheets from pulp which consists of a continuous belt supported on rollers, means for maintaining said belt in continuous motion, said belt being arranged with a re-entrant portion and a return portion, means for feeding pulp into said belt within the re-entrant portion causing said pulp to travel around said re-entrant portion thereby losing water and means for removing said partially de-watered sheet from said belt adjacent the leaving part of said re-entrant portion.

14. A machine for continuously removing liquid from pulp which consists of a continuous foraminous conveyor, means for supporting said foraminous conveyor, means for maintaining said conveyor in motion, said conveyor being arranged with a re-entrant portion and a return portion, means for delivering said pulp to the re-entrant portion, said delivering means being surrounded by said re-entrant portion of said foraminous conveyor thereby removing liquid from said pulp in said reentrant portion, and means for continuously removing said pulp, from said conveyor.

15. In a machine for dewatering pulp a continuous foraminous conveyor arranged with a re-entrant de-watering portion and a return portion, and a pulp feeding member entirely surrounded by said re-entrant portion.

16. In a machine for forming sheet from pulp a continuous foraminous conveyor having a re-entrant portion and a return portion, means for delivering said pulp on said conveyor by centrifugal action while on said re-entrant portion of said conveyor and means for continuously removing the sheet from said conveyor.

17. The process of continuously de-watering material which consists in applying such material to a continuous conveyor, subjecting said material while on said conveyor, to the action of centrifugal force, and then continuously pressing and drying said material.

18. The process of continuously de-watering material which consists in applying said material to a continuous conveyor subjecting

the material while on said conveyor to the action of centrifugal forces and then continuously drying and removing said material.

19. A machine for continuously removing liquid from material which consists of a continuous foraminous conveyor with a re-entrant portion, means for supporting said conveyor in said re-entrant portion from its outside surface only, means for maintaining said conveyor in motion, means for continuously pressing said material and means for continuously drying said material.

20. In a machine for de-watering material, a feeding member for pulp to be de-watered, a continuous foraminous conveyor arranged with a re-entrant de-watering portion surrounding said feeding member, a return portion of said conveyor, a pressing device and a dryer.

21. In a machine for de-watering material, a feeding member for pulp to be de-watered, a continuous foraminous conveyor arranged with a re-entrant de-watering portion surrounding said feeding member and a return portion and a drying device.

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