Oct. 6, 1959 S. E. SEAMAN 2,907,388

APPARATUS FOR FORMING A FIBROUS WEB FROM A LIQUID SUSPENSION

Filed June 26, 1957 4 Sheets-Sheet 1

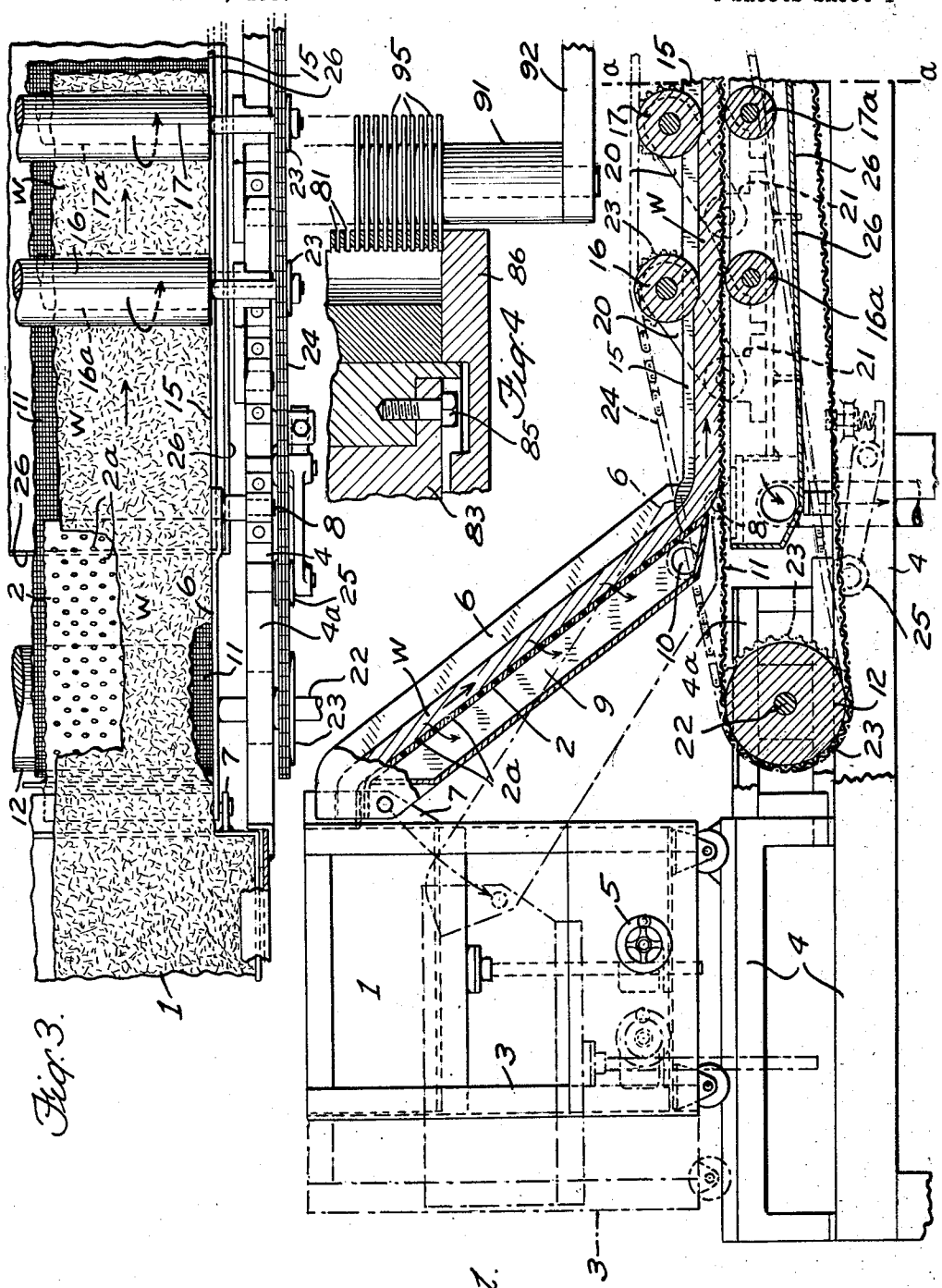


Fig. 3.

Fig. 4

Fig. 1.

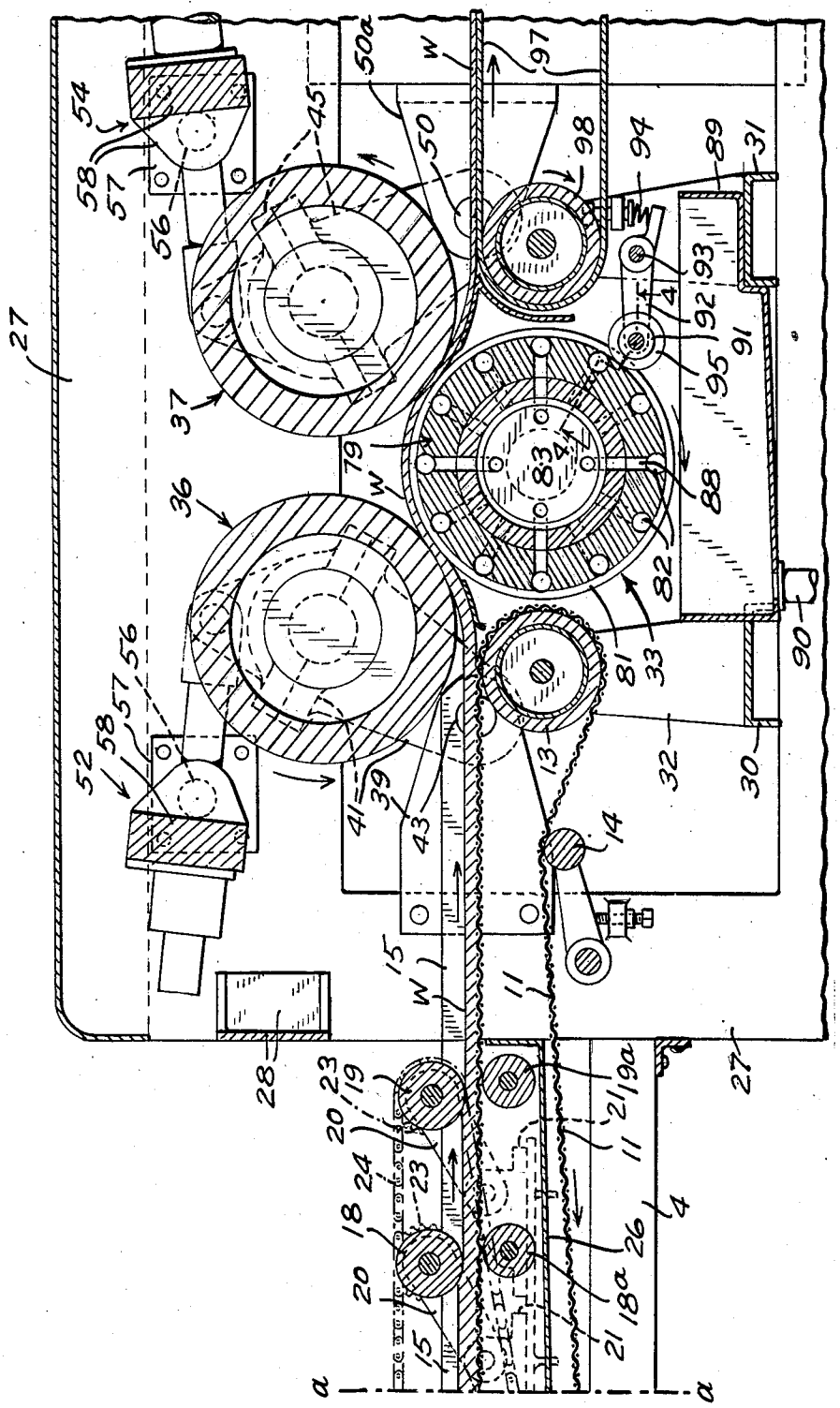
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APPARATUS FOR FORMING A FIBROUS WEB FROM A LIQUID SUSPENSION

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Fig. 2.

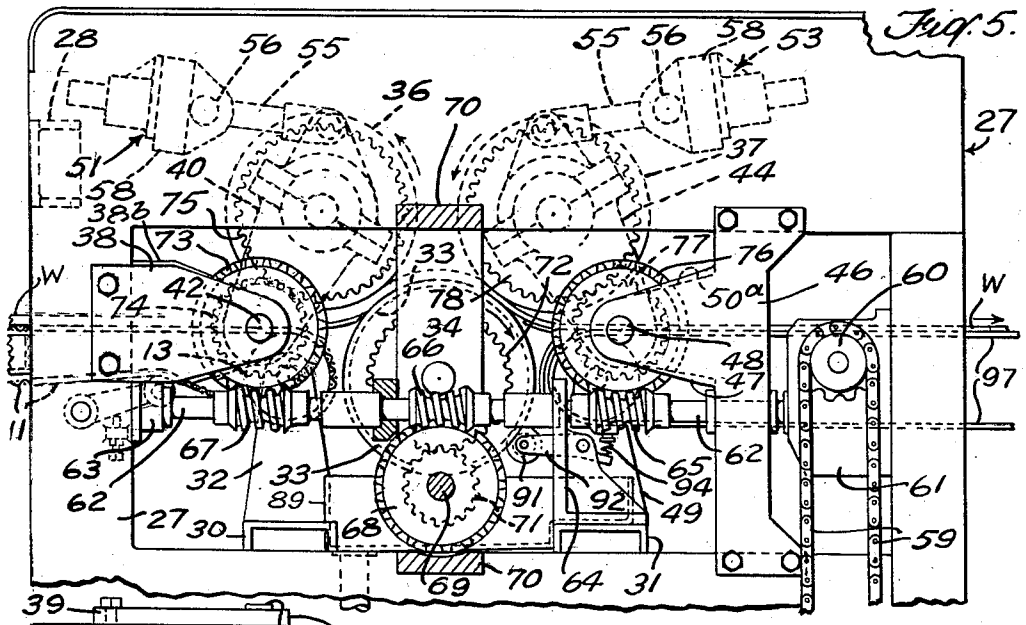


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Fig. 5.



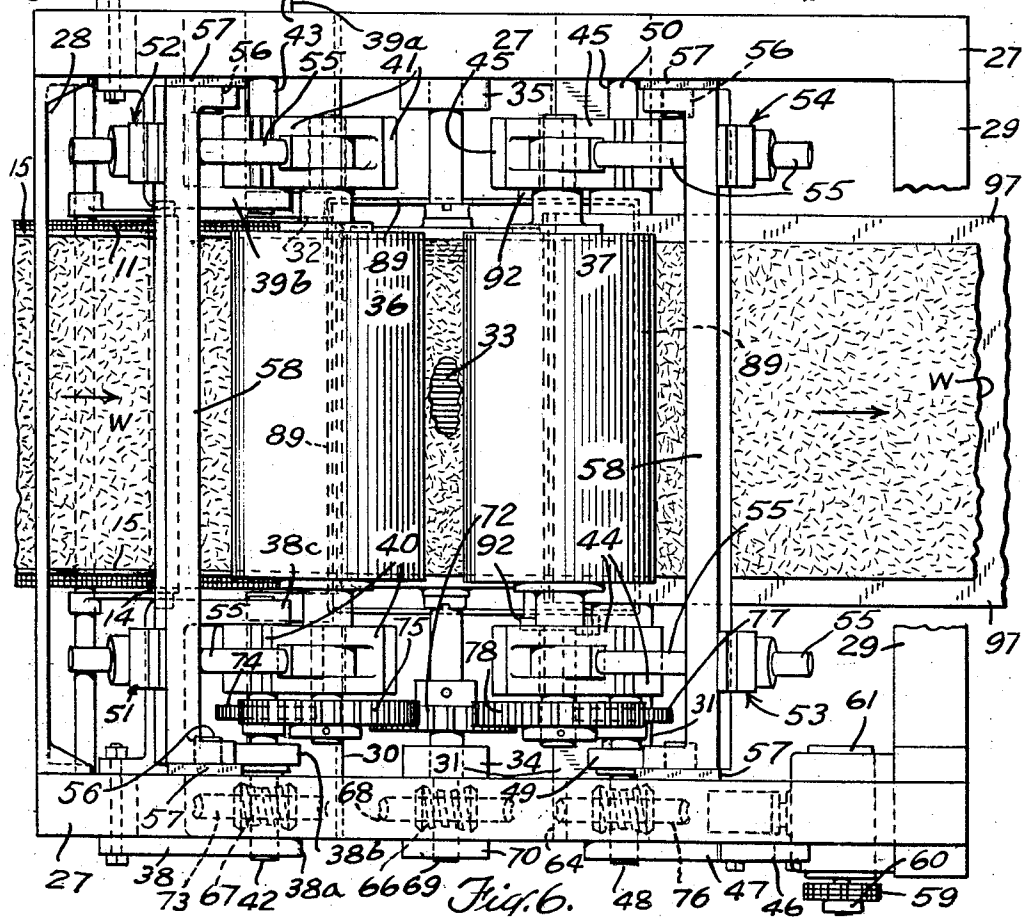


Fig. 6.

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APPARATUS FOR FORMING A FIBROUS WEB FROM A LIQUID SUSPENSION

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Fig. 7.

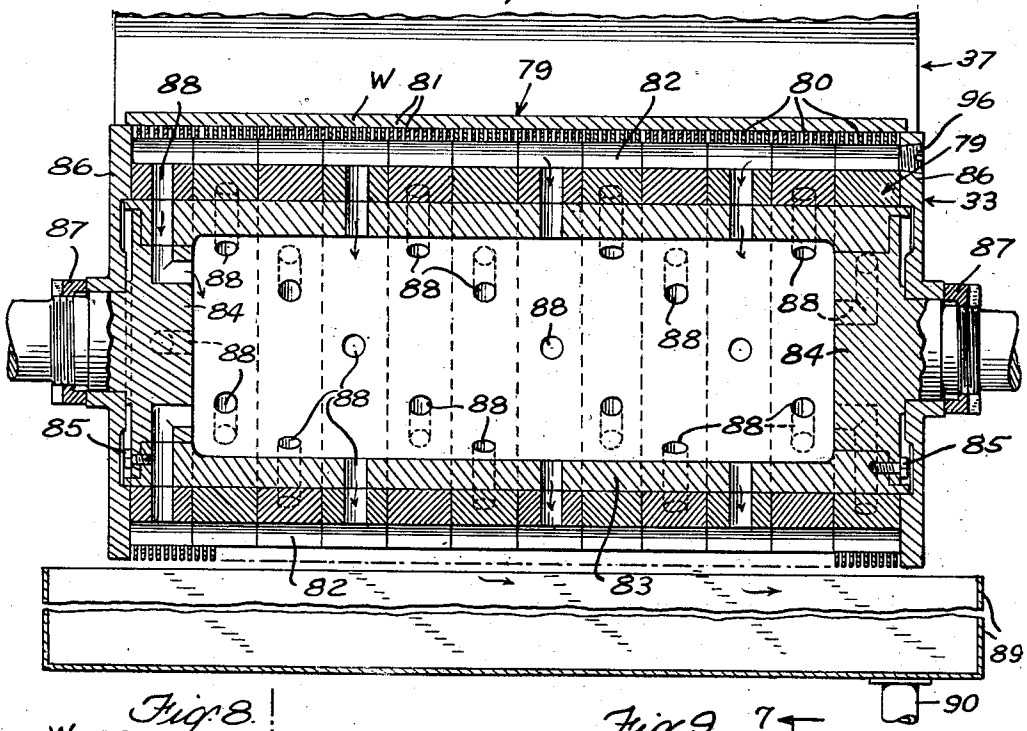


Fig. 8.

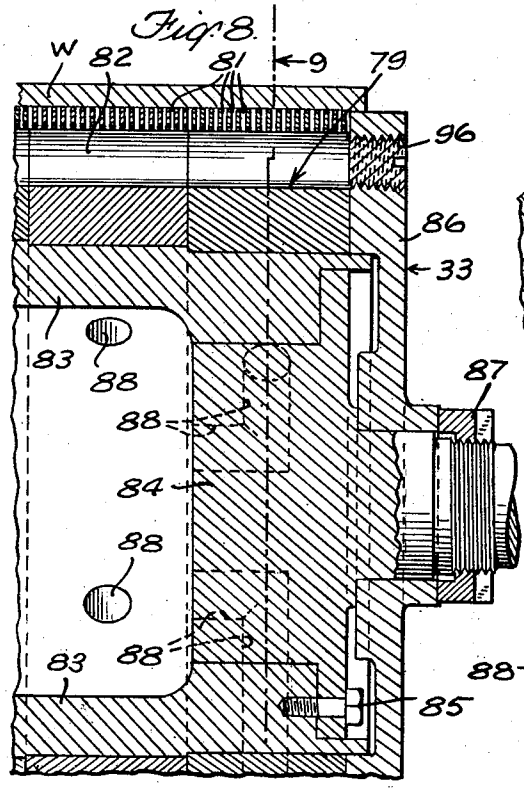
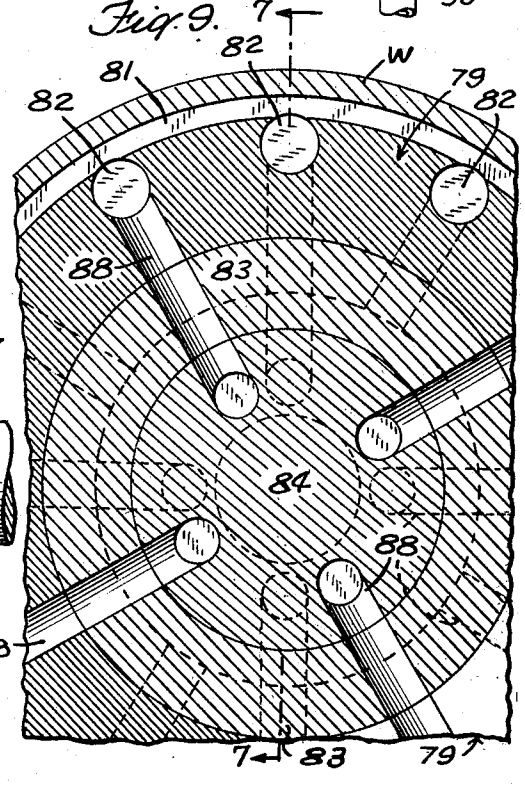


Fig. 9.



United States Patent Office 2,907,388 Patented Oct. 6, 1959

2,907,388

APPARATUS FOR FORMING A FIBROUS WEB FROM A LIQUID SUSPENSION

Stewart E. Seaman, Osprey, Fla.

Application June 26, 1957, Serial No. 668,140

2 Claims. (Cl. 162—305)

This invention relates to improvements of the press section of web forming apparatus useful in the formation of various types of mats or webs from fiber stock in suspension, as in the manufacture of board from various fibrous raw materials, in the manufacture of chemical pulp and in the formation of sheets of alkali cellulose.

Such apparatus consists of a preliminary web forming section, which may be of the conventional wet end construction of paper forming machines, including a Fourdrinier wire with its suction boxes and couch rolls, but preferably consists of the wet end construction shown in my copending application for patent Serial No. 566,844, filed February 21, 1956, now U.S. Patent 2,828,675 dated April 1, 1958, which dispenses with the costly Fourdrinier wire and felt, and which is illustrated in the accompanying drawings and will be hereinafter described; together with a press section which receives the preliminarily formed web and expresses its contained liquor to the proper consistency for drying. In the apparatus of the application, the free liquor is largely removed in a preliminary web forming section which has a smooth perforated inclined plate upon which the stock is delivered from a head chest and from which sufficient liquor is drained as it moves down the inclined plate to permit the fibers to mat into a tenuous web. Before delivery of the web into the press section where the mechanical dehydration is completed, it is contemplated that the firmness of the web will be increased by removal of more of the free liquor until a consistency of approximately 17% is obtained. In the apparatus of the said application, this is accomplished by delivering the tenuous web to a relatively short wire conveyor from which it is delivered to the press section and upon which it may be caused to pass between rollers which will exert a moderate pressure upon the web and thus accelerate the drainage of the free liquor.

A feature of the press section of the apparatus of the application is the fact that at least the lower press roll at each nip is formed of spaced rings that provide circumferential slots that open into the hollow interior of the roll and allow the liquor expressed from the web to run into the slots and through the hollow roll and out from the bottom of the roll. In this way, the need for felt is dispensed with.

One of the principal objects of the present invention is to improve upon the press section of the apparatus of the copending application by providing a construction of slotted press roll which will readily dispose of the expressed liquor by furnishing free access to the interior of the roll and freedom to flow by gravity and escape through the bottom area of the roll, and which at the same time will be simpler and cheaper to manufacture and maintain than the construction of ring roll disclosed in the said application.

Another object is to provide for maximum efficiency in the press section with a minimum number of rollers. Still other objects and advantages of the invention will appear from the following description.

The invention contemplates a hollow press roll which has closely spaced circumferential slots and a series of axial passages that intersect the bottoms of the slots so that the expressed liquor will pass through the slots into the passages. These axial passages are equally spaced circumferentially of the cylindrical wall. Radial bores provide passages partially through the wall which tap the axial passages and provide communication between the axial passages and the interior of the roll. The ends of the axial passages and of the hollow interior of the roll are closed so that the expressed liquor is constrained to run radially through the roll where it may be collected in a pan supported underneath the roll.

Structurally it has been found advantageous to form the roll of abutting circumferentially slotted ring sections mounted upon an inner shell, each provided with corresponding axial bores and the rings being angularly adjusted upon the shell with the axial bores in alinement so as to provide continuous axial passages in communication with the slots for the full length of the roll. In such case, the radial bores extend through the shell as well as into the cylindrical wall of the roll.

Preferably, a single slotted roll may cooperate with two other rolls which may be solid press rolls disposed above the slotted roll with their axes in the same horizontal plane, and they may be adjustable to vary their proximity and hence their pressure relation to the slotted roll. In this way, a single slotted roll has two pressure nips, the force of which may vary, the pressure of the second roll being greater than that of the first.

The invention will be more clearly understood from the following description of the embodiment of the invention illustrated in the accompanying drawings.

Fig. 1 is a partial side elevation and a partial longitudinal sectional elevation of the first portion of the preliminary web forming section of an apparatus embodying the invention.

Fig. 2 is a continuation of Fig. 1 from the common broken line *a*—*a* and is a longitudinal sectional elevation of the remaining portion of the preliminary web forming section and of the press section.

Fig. 3 is a plan with parts sectioned of a portion of the apparatus shown in Fig. 1.

Fig. 4 is a fragmentary section on enlarged scale on the line 4—4 of Fig. 2, showing a partial plan view of the slot cleaning means.

Fig. 5 is a side elevation of the press section, with parts in section.

Fig. 6 is a plan of the press section.

Fig. 7 is a longitudinal section of the ring section roll of the press section, and of the pan associated therewith, taken on line 7—7 of Fig. 9 and viewed in the direction of the arrows.

Fig. 8 is a view similar to Fig. 7 of an end portion of the roll on an enlarged scale.

Fig. 9 is a fragmentary transverse section of the same on line 9—9 of Fig. 8.

The preliminary web forming section is in principle and general construction similar to that shown in the said copending application. A flow box or head box 1 receives the prepared stock which is a fiber suspension having a consistency for alkali cellulose, for example, of approximately 1½%. From the head box, the stock is delivered on to an inclined perforate plate 2. This is a metallic plate having a smooth surface and provided with drain holes 2*a* the size and number of which will depend upon the nature of the stock.

The angle of inclination of the perforate plate is variable and will be varied according to the requirements of different stocks. The head box is carried by a frame 3 supported on flanged wheels which run on rails on top of the side frames 4 of the machine. To decrease the

inclination of the perforate plate, the head box is lowered by operation of a hand wheel **5** which controls the height of the head box through a rack and pinion. As the head box is lowered, it rolls back ultimately to the position shown in broken lines in Fig. 1.

This retreat of the head box lowers the upper end of the perforate plate. To permit of this, the plate is pivoted at its two ends. As shown, the inclined perforate plate has two side plates **6**. At their upper ends, the side plates are pivoted to brackets **7** on the head box. At their lower ends, they are pivoed at **8** to the machine side frames **4**.

The liquor which drains from the stock as it slides down the inclined plate is received in a catch chamber **9** shown integral with the plate and having a discharge opening **10** at its lower end from which a conduit (not shown) leads the drainage back to the stock chest or other place of disposal.

For alkali cellulose, the inclination and orifice size will be such as to produce a consistency of approximately 7% at the bottom of the inclined drainage plate. It is desirable that the consistency be further increased before the web is introduced into the press section. For this purpose, the web, which throughout the figures of the drawings is designated W, is delivered from the inclined perforate plate on to a short length of endless conveyor wire screening **11** which runs over rollers **12** and **13**, the former bearing in the side frame members **4** and the latter in bearings provided in the press section frame as will be described. The conveyor wire **11** is kept under proper tension by a tension and alinement roller **14** the supporting arm of which pivotally bears on the upright of the press section frame, as shown in Fig. 2.

Side or deckle plates **15** are alined with the side plates **6** of the perforate inclined plate member and, as shown in Fig. 1, their meeting edges are arcuate concentric with the pivot **8** so that the side delimitations to the web remain continuous as the inclination of the inclined plate is altered.

Resting on top of the web W as it is conveyed on the wire **11** are four rollers **16, 17, 18** and **19** arranged in tandem. These rollers are mounted in bearings on the free ends of arms **20** which at their opposite ends pivotally bear in their respective blocks **21** supported on the side frames **4**. These rolls on top of the web therefore rest by gravity on the moving web and they are weighted so as to exert progressively increasingly greater pressure on the web.

These top or gravity rollers are each opposed by a lower roller which bears in fixed bearings in the side frames, these lower rolls serving as supporting rolls for the wire and being numbered **16***a*, **17***a*, **18***a* and **19***a*, respectively.

The top rolls **16, 17, 18** and **19** are driven. For this purpose in the construction shown, the roller **12** for the endless wire is driven by power applied to shaft **22** (Fig. 3) on each end of which is a sprocket wheel **23**. Chains **24** run over sprockets **23** and over sprockets on the same sides of the machine on the shafts of rolls **16, 17, 18** and **19**. The top rolls are thus positively driven at a peripheral speed equal to the rate of movement of the web. A pair of chain take-ups **25** keep the chains taut.

The liquor removed from the web on the wire **11** by reason of the drainage and the successive pressures of the gravity rolls is caught in a tank **26** supported underneath the wire from which it is conducted away through a conduit for treatment for reuse.

After passage through the rollers **19, 19***a*, the web of alkali cellulose which has been taken for an example will have a consistency of approximately 17%.

From the preliminary web forming section, the web is conducted into the press section, as shown in Fig. 2, where it is further dehydrated to a consistency of approximately 50%. From there it goes to the drier if it is to be stored or to shredders if it is to be used at once.

To obviate the need for felt, the press section has at least one roll at each nip which is hollow and has openings in its surface communicating with the hollow interior so that the liquor expressed at the nip, which in the absence of felt cannot be absorbed, may enter the openings in the roll and run through the roll by gravity into a catch pan.

In Fig. 2 which shows the preferred construction, the press section consists of three rolls, an intermediate open surface (i.e., a surface having openings therein), hollow roll and two solid surface (i.e., a surface without openings therein) pressure rolls in successive pressure relation with the open surface roll, thereby providing two successive nips with three rolls. Preferably, as shown, the two solid surface rolls are above their cooperative roll so that the expressed liquor runs down from the nip lines. The lower intermediate roll has fixed bearings while the two solid upper rolls have floating bearings and are urged through independently adjustable pressure means toward the intermediate roll. In other words, the pressures at the two nips are independently adjustable, and in practice the second pressure is substantially greater than the first pressure.

The press section as shown in Figs. 2, 5 and 6 has a frame consisting of two open rectangular side frames **27** joined near the top at the entrance end by channel frame member **28** and at the other end by cross member **29** and at intermediate points by two inverted channel members **30** and **31** which span the two side frames at the bottom of the opening. Upstanding from inverted channel **30** are two brackets **32**, one on each side of the web, which provide bearings for roller **13**.

The intermediate roll **33** of the three press rolls has its bearings in two uprights **34** and **35** which span the openings in the respective side frames **27**. The two solid rolls **36** and **37** have floating bearings. These floating bearings are in pressure loaded pivoted plates as will now be described.

Secured to the side frame **27** at the entrance end of the press section are two forwardly extending brackets **38** and **39** to the free ends of which within the frame opening are pivoted bearing plates **40** and **41**, respectively, which support the bearings for the trunnions of solid roll **36**. These brackets **38** and **39** are of complex shape, each having two rearwardly extending arms which receive between them the inner edges of the respective side frame uprights to which they are secured by bolts. Bracket **38** has three forwardly extending arms **38***a*, **38***b* and **38***c*, while bracket **39** has two forwardly extending arms **39***a* and **39***b*.

A shaft **42** bears in the three arms **38***a*, **38***b* and **38***c* and in the space between arms **38***b* and **38***c* the bearing plate **40** is loosely pivoted on the shaft **42**. Also in the same space and in the space between arms **38***a* and **38***b* are gears fixed to the shaft **42** which constitute part of the drive train to rotate roll **36** as will later be described.

On the other side is the pivot **43** for the bearing plate **41**. This pivot is a shaft or pin supported at its ends in the arms **39***a* and **39***b* and pivotally supporting the bearing plate **41**.

The solid roll **37** has axially extending trunnions which bear in pivoted bearing plates **44** and **45** which are also pressure loaded and have a pivotal mounting similar to that of bearing plates **40** and **41**, as will now be described.

Near the other end of the side frame opening on the front or drive side of the press frame is an upright or vertical stretcher strip **46** extending across the frame opening and secured at its top and bottom ends. This stretcher strip has a rearward bearing extension **47** in which bears the outer end of a shaft **48** which also bears in an upright **49** from the inverted channel **31**. Loosely pivoted on the inner end of shaft **48** is the bearing plate

44, and fixed on the shaft 48 are gears forming part of the drive train for roll 37, as will be described.

On the other side, the bearing plate 45 is pivotally mounted on a fixed bearing pin 50 supported in the rear side frame by bearing arm 50*a*, as shown in Fig. 2.

The bearing plates 40, 41, 44 and 45 are pressure loaded by hydraulic or pneumatic jacks the function of which will now be described.

There are four jacks, one for each bearing plate, all alike and similarly coupled to their respective bearing plates 40, 41, 44 and 45. Each is independently controlled. They are connected in pairs by transverse bars. Since these power members are duplicates, the same reference numerals will be applied to similar parts, the jacks as a whole having separate designations.

The jacks for roll 36 are numbered 51 and 52 for the front and rear jacks, respectively. The jacks for roll 37 are numbered 53 and 54 for the front and rear jacks, respectively.

The bearing plates 40, 41, 44 and 45 are similar, being split to receive the bearings for their roll trunnions and being pivoted at their lower ends and bifurcated at their upper ends for pivotal attachment to the reciprocating piston rod 55. The jacks are pivoted on pivots 56 on plates 57 secured to the top members of frame 27, and the jacks of each pair are connected by a transverse spanning bar 58. The pivots for the bearing plates are so located and the radial distance of the roll bearings from the pivotal centers is such that the solid rolls are symmetrically disposed with their axes in the same horizontal plane above that of roll 33, and the solid rolls are urged toward roll 33 with the nip lines in vertical planes equidistant from the axis of roll 33.

The drive for the press rolls is illustrated in Figs. 5 and 6. A sprocket chain 59, driven by power means not shown, drives sprocket 60 which through gearing in gear box 61 drives longitudinally extending worm shaft 62 which bears in a frame supported bearing 63 and in a bearing in an upright 64 on the inverted channel 31. On shaft 62 are three worms 65, 66 and 67.

Worm 66 meshes with worm wheel 68 fixed on the shaft 69 that bears in plate 34 and also in plate 70 which opposes plate 34 on the outer side of the frame. On the inner end of shaft 69 is smaller pinion 71 which meshes with larger gear wheel 72 on the trunnion shaft of roll 33.

Worm 67 meshes with worm wheel 73 on shaft 42 on the inner end of which shaft is fixed pinion 74 which meshes with gear wheel 75 on the trunnion shaft of roll 36.

Worm 65 meshes with worm wheel 76 on shaft 48 on the inner end of which shaft is fixed pinion 77 which meshes with gear wheel 78 on the trunnion shaft of roll 37.

The ratio of the gearing is such that the peripheral speed of the three press rolls is the same and is that of the wire conveyor 11.

The two top rolls 36 and 37 have smooth continuous surfaces and may be hollow cylindrical members with end hub members forming end closures and having trunnions bearing in the bearing plates 40, 41, 44 and 45 as above explained.

The lower intermediate roll 33 is a hollow roll with openings in its surface to receive the expressed liquor and having communication with the hollow interior to receive the liquor and from which it is drained by gravity into a pan underneath the roll, the liquor being conducted from the pan to dialyzers or other place of disposal.

The roll 33 shown in Figs. 2, 7, 8 and 9 is illustrative of the principle and will now be described.

The illustrated roll 33 is composed of an outer hollow cylindrical member having closely spaced circumferential slots in its periphery which intersect a series of axial passages in the wall which passages are tapped by radial bores leading from the hollow interior of the roll.

For manufacturing advantages this outer slotted cylindrical member is made of a number of integral abutting ring sections which are fitted upon an inner sleeve, the radial bores extending through the sleeve and into the ring sections to the axial passages.

The ends of the hollow cylinder thus formed are closed by end plates having hub portions with driving connection to the cylinder and trunnion extensions to bear in the uprights 34 and 35.

The outer slotted cylindrical member is designated generally by the numeral 79. This is a sectional member made up of a number (shown as twelve) of ring sections 80. These ring sections are provided with closely spaced circumferential slots 81 and with a number (shown as twelve) equally spaced, circumferentially arranged axial bores 82. The rings are shrunken or otherwise secured upon an internal sleeve 83, thus constituting a double wall hollow cylindrical member.

The ends of this cylinder are closed by hub members 84 which fit tightly into the ends of the sleeve and are secured thereto by screws 85. Annular end plates 86 fit over the hub external projection which is continued to form the trunnion, lock nuts 87 engaging with screw threads in the hub projection to secure the end plate in place.

Radial taps or passages 88 connect the axial passages 82 with the hollow interior of the roll. These radial passages will be of a size and number to meet the requirements. As shown, each axial passage has four equally spaced radial taps, or one tap for every three rings 80. Since the end rings are internally occupied by the respective hub member 84, the hub member is angularly bored to provide the communication with the hollow interior of the roll. The taps, of course, lead through the wall of the shell 83 and the wall material of the ring sections inside the axial passages.

To avoid undue weakening of the walls of the roll, the radial taps are staggered, those for the successive axial passages being progressively angularly offset by an amount proportional to the number of axial passages with the result that the taps have a spiral helical arrangement as shown in Fig. 7. In other words, each ring including the hubs 84 has four taps which are angularly offset from those in each immediately adjacent ring by the angular distance between successive axial passages.

The liquor squeezed from the web W at the two press roll nips will therefore pass into the slots 81 and collect in the axial passages 82 and run by gravity through the radial taps 88 into the interior of the roll and run out from the bottom of the roll in the reverse order of the openings, and will be collected in a pan 89 and be led through conduit 90 to the dialyzers.

Fibers will be likely to accumulate in the slots 81 and while these may be periodically cleaned by forced washing, it is desirable and in some cases necessary to clear the slots continually by mechanical means. For this purpose, means are provided to enter into the slots and remove the fiber accumulation as the roll turns.

While a toothed device with fixed teeth will theoretically accomplish the purpose, the teeth of such a device are apt to be broken when encountering a packed mass of fiber in a slot, and the invention therefore contemplates discs which are rotatively mounted on a common axis and which are disposed within the slots and will be free to rotate as the roll turns and fiber in the slots frictionally engages the disc. In this way, breakage is avoided and the slots are effectively cleaned.

An end portion of the particular cleaning device for illustration is shown in plan in Fig. 4 and end views appear in Figs. 2 and 5. A shaft 91 is mounted for free rotation in the ends of a pair of arms 92, the arms piv-

oted at their opposite ends on a pivot **93** and urged by a spring **94** in a direction to raise the shaft **91**. On the shaft **91** are discs **95** which are of the same number and spacing as the slots **81**. This cleaning device is disposed proximate the roll **33** in position for the discs to enter the slots **81**. Thus on each rotation of the roll **33** the fiber which is caused to enter the slots at the nips of the rolls and remains there will be removed by the discs of the cleaning device.

Periodically water or other fluid under pressure will be used to remove any residual fiber in the passages. For the introduction of such cleaning fluid a removable screw plug **96** is provided in one of the end plates **86** in line with one of the axial passages **82**, as shown in Figs. 7 and 8. Cleaning fluid can thus be caused to flow through all of the passages.

From the second nip, the web is delivered on to a traveling belt **97** running over a power driven roller **98** and a companion roller (not shown) at the same speed as the peripheral speed of the press rolls. Its disposition thereafter depends upon its intended use.

The line pressures of the two upper press rolls will ordinarily be substantially different. For alkali cellulose, for example, the line pressure at the first nip might be one thousand pounds per linear inch and at the second nip double that pressure. Thus from approximately 17% consistency of the fiber content at the entrance to the press section, the consistency may be approximately 40% after the first nip and approximately 50% after the second nip.

While the press section is illustrated and above described as operating in tandem with a section for preliminarily forming a web from fibers in suspension, it will be understood that the press section as such is susceptible of a wide variety of uses, for example, the pressing of amorphous materials and the extraction of oil from seeds.

It is obvious that the principle of the invention may be otherwise embodied, and that various modifications in the embodiment illustrated in the drawings and above particularly described will occur to those skilled in the art within the principle and scope of the invention as defined in the following claims.

What is claimed is:

1. In an apparatus for forming a web of fibrous material having a preliminary web forming section, a press roll section comprising an intermediate lower roll and two upper rolls spaced less than the diameter of the lower roll and engaging the lower roll in two nip lines in a horizontal plane above that of the axis of the lower roll, the rolls being positioned to receive the web from the preliminary forming section into the first of the two nips, the upper rolls having imperforate surfaces, the lower roll being formed of an inner hollow cylindrical sleeve and a plurality of abutting ring members fitting and supported upon the sleeve and having closely spaced peripheral circumferential slots in their external face and a plurality of circumferentially disposed and equally spaced alined axial passages intersecting and communicating with the slots, closures for the ends of the axial passages, and radial passages in the ring members topping the axial passages and opening at the inner faces of the respective rings, each ring having at least one radial passage and the rings being rotatively related with the radial passage in each ring angularly offset from that in the next adjacent ring by the angular distance between adjacent axial passages, the sleeve having spirally disposed radial passages registering with the radial passages in the ring members, whereby each axial passage has communication with the hollow interior of the roll.

2. In an apparatus for forming a web of fibrous material having a preliminary web forming section, a press roll section as defined in claim 1 in which there are an even number of said axial passages and each ring member has two diametrically opposed radial passages each of which communicates with an axial passage.

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