

March 19, 1946.

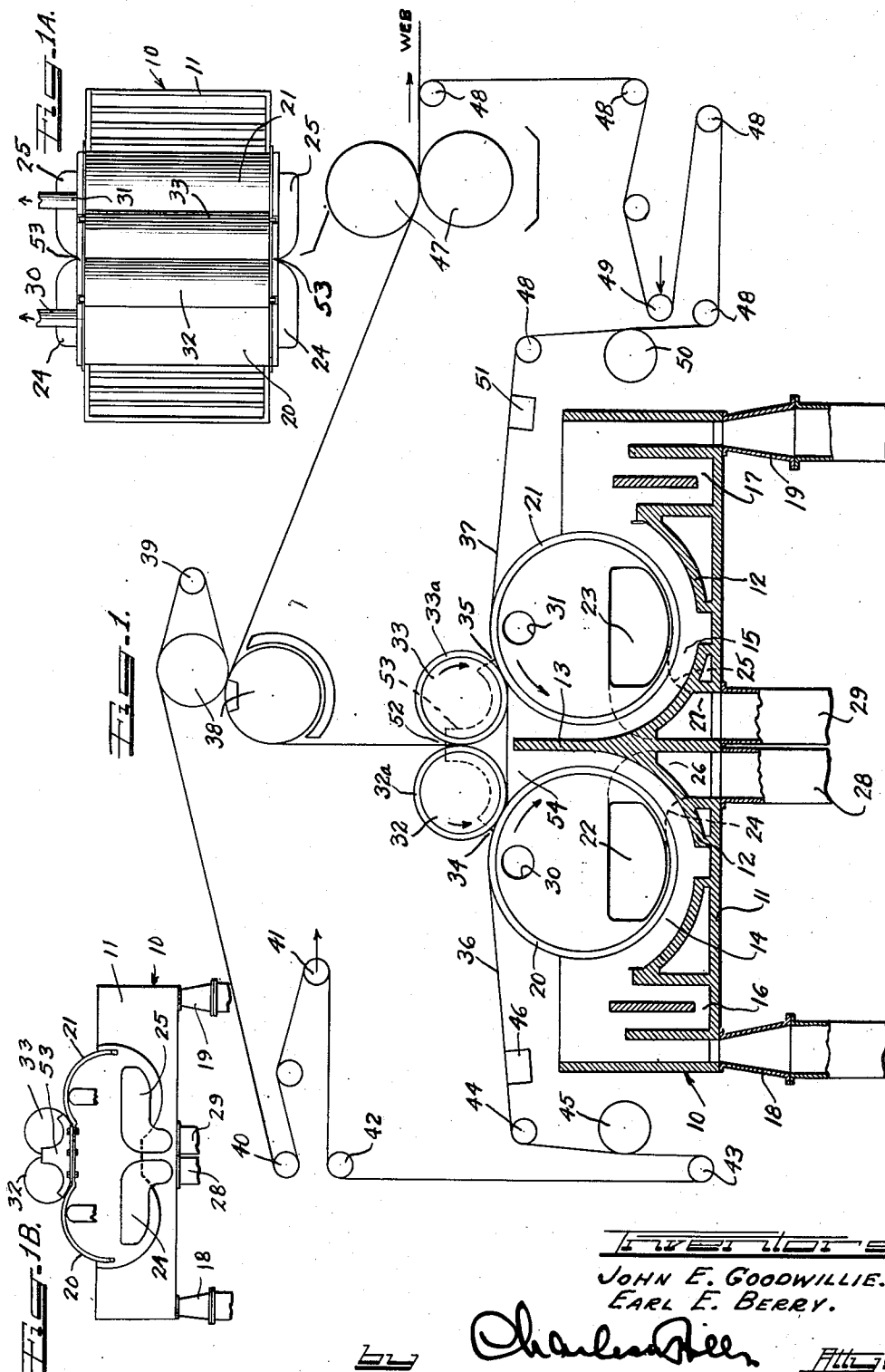
J. E. GOODWILLIE ET AL

2,396,694

CYLINDER TYPE PAPER MAKING MACHINE AND METHOD

Filed May 31, 1941

9 Sheets-Sheet 1



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Charles Beer

Att. 1

March 19, 1946.

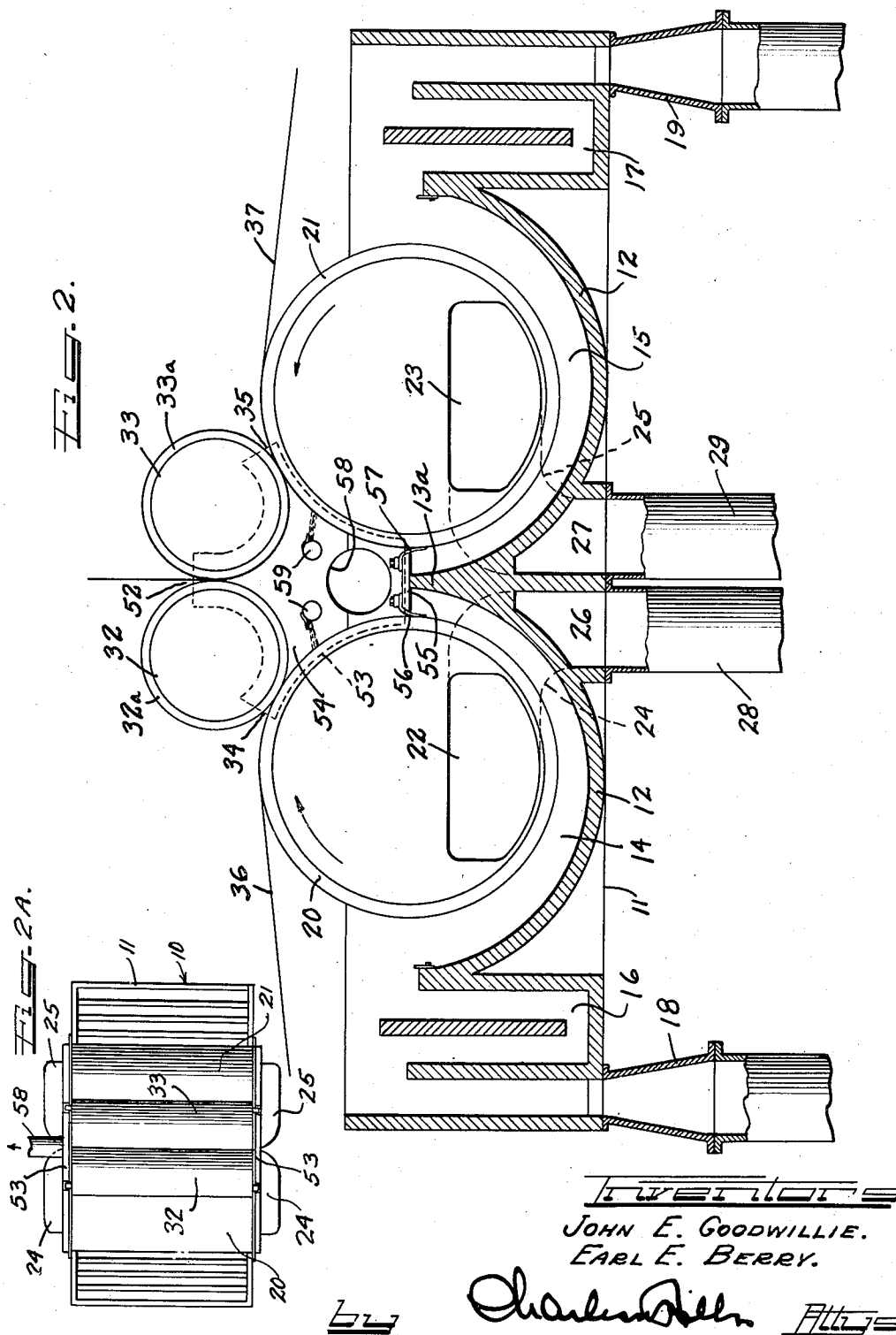
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CYLINDER TYPE PAPER MAKING MACHINE AND METHOD

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9 Sheets-Sheet 2



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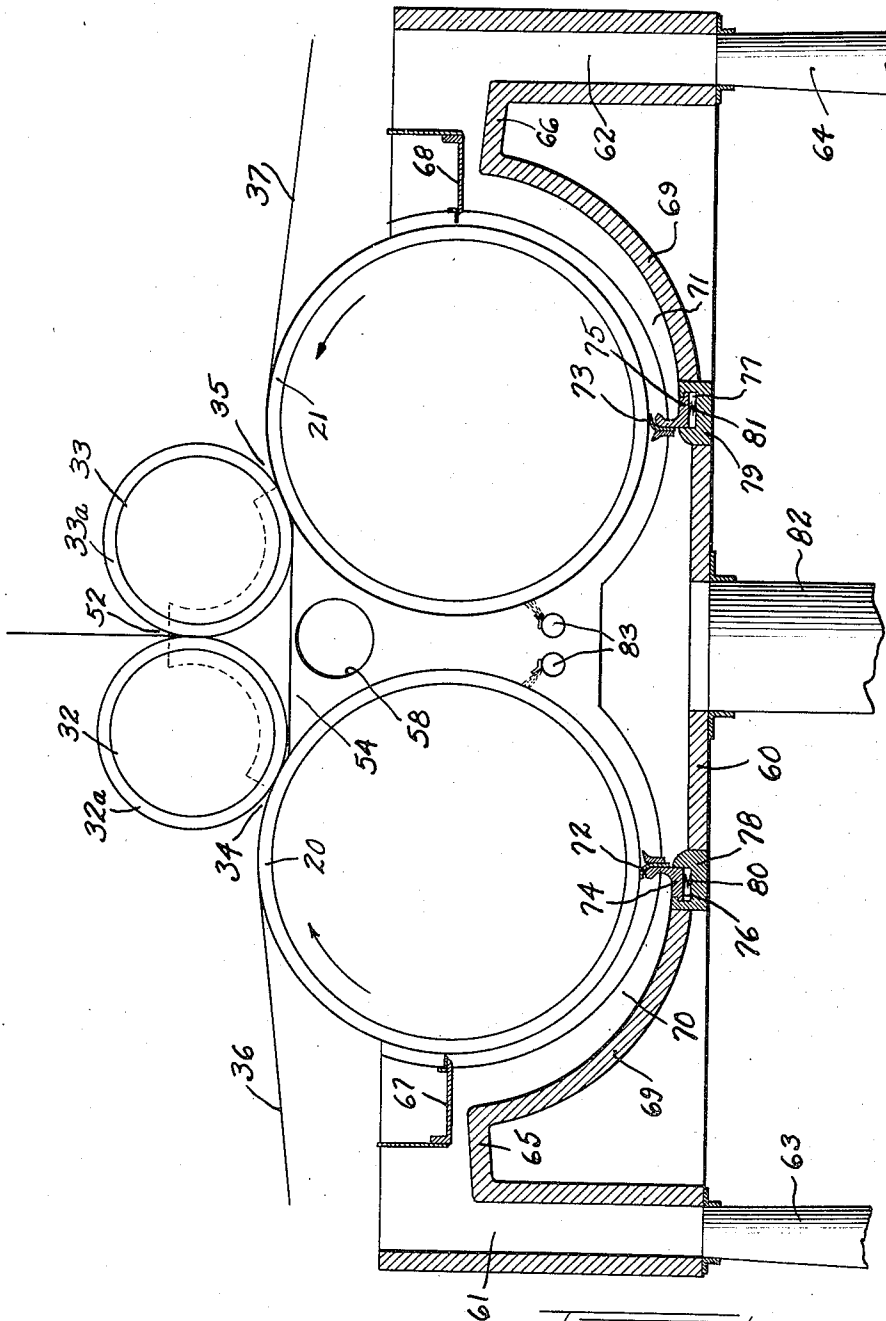
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CYLINDER TYPE PAPER MAKING MACHINE AND METHOD

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Fig. 3.



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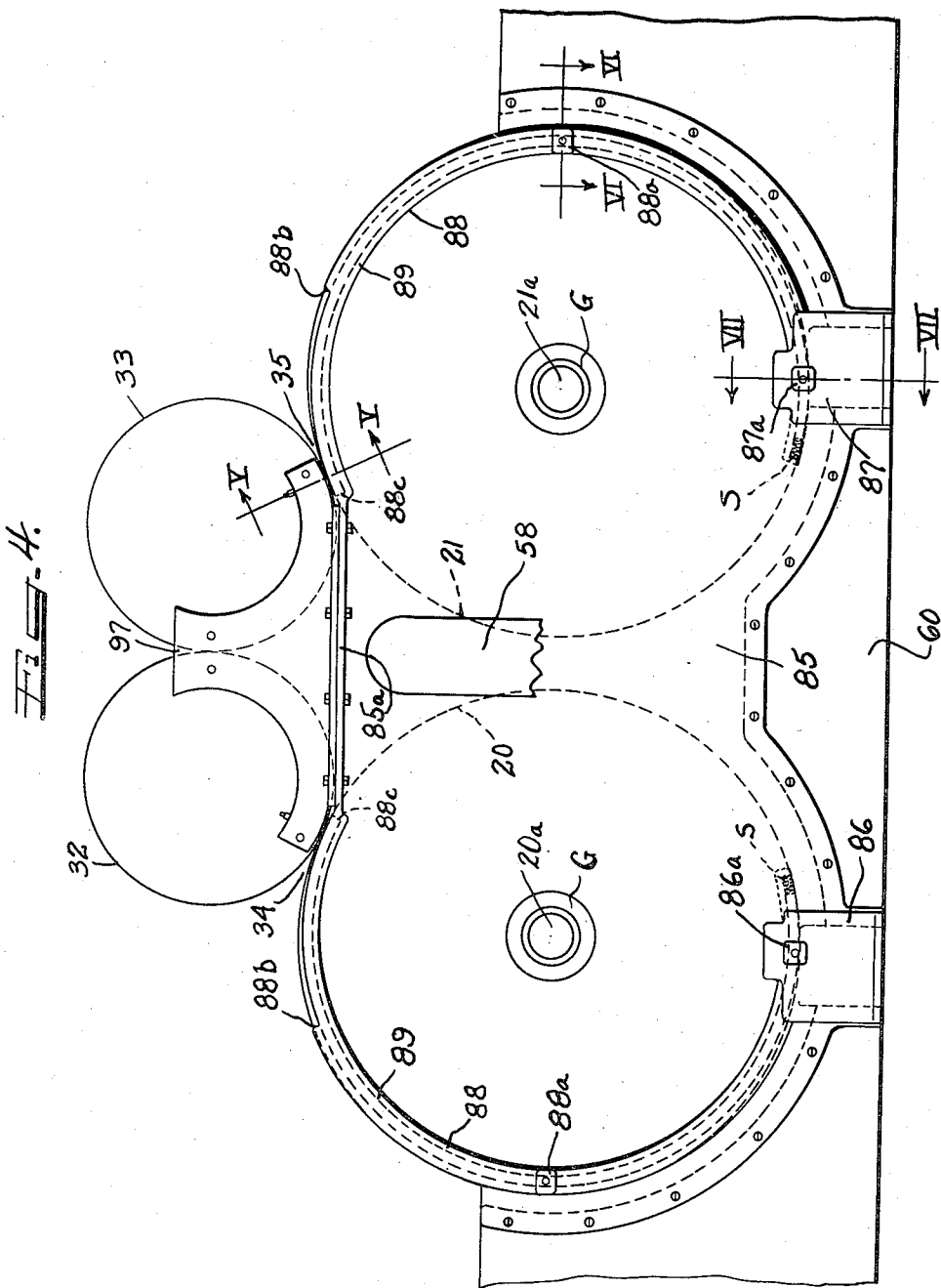
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CYLINDER TYPE PAPER MAKING MACHINE AND METHOD

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9 Sheets-Sheet 4



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2,396,694

CYLINDER TYPE PAPER MAKING MACHINE AND METHOD

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9 Sheets-Sheet 5

Fig. 5.

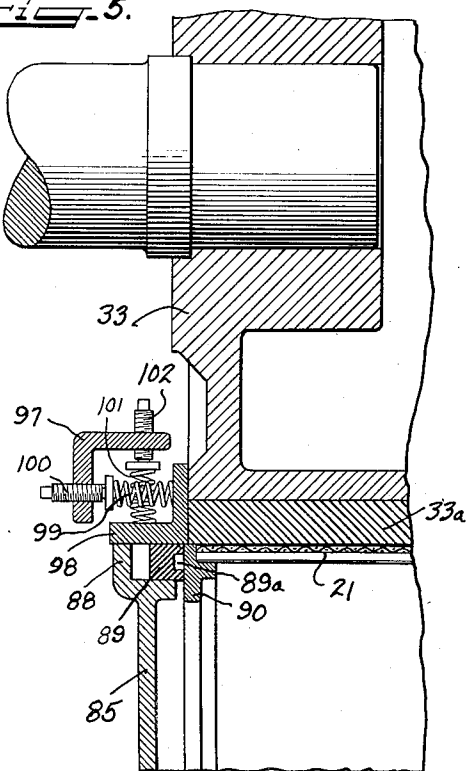


Fig. 6.

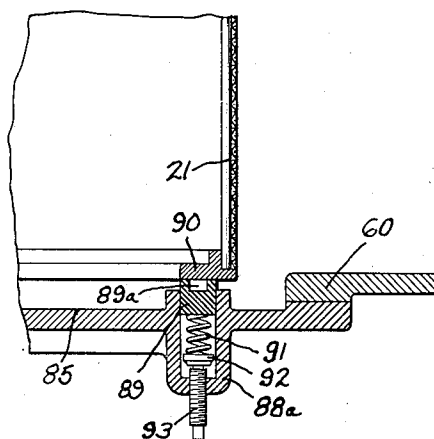
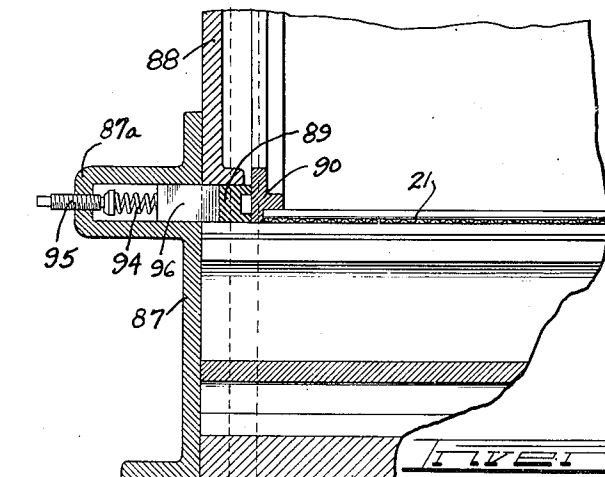


Fig. 7.



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Fig. 5.

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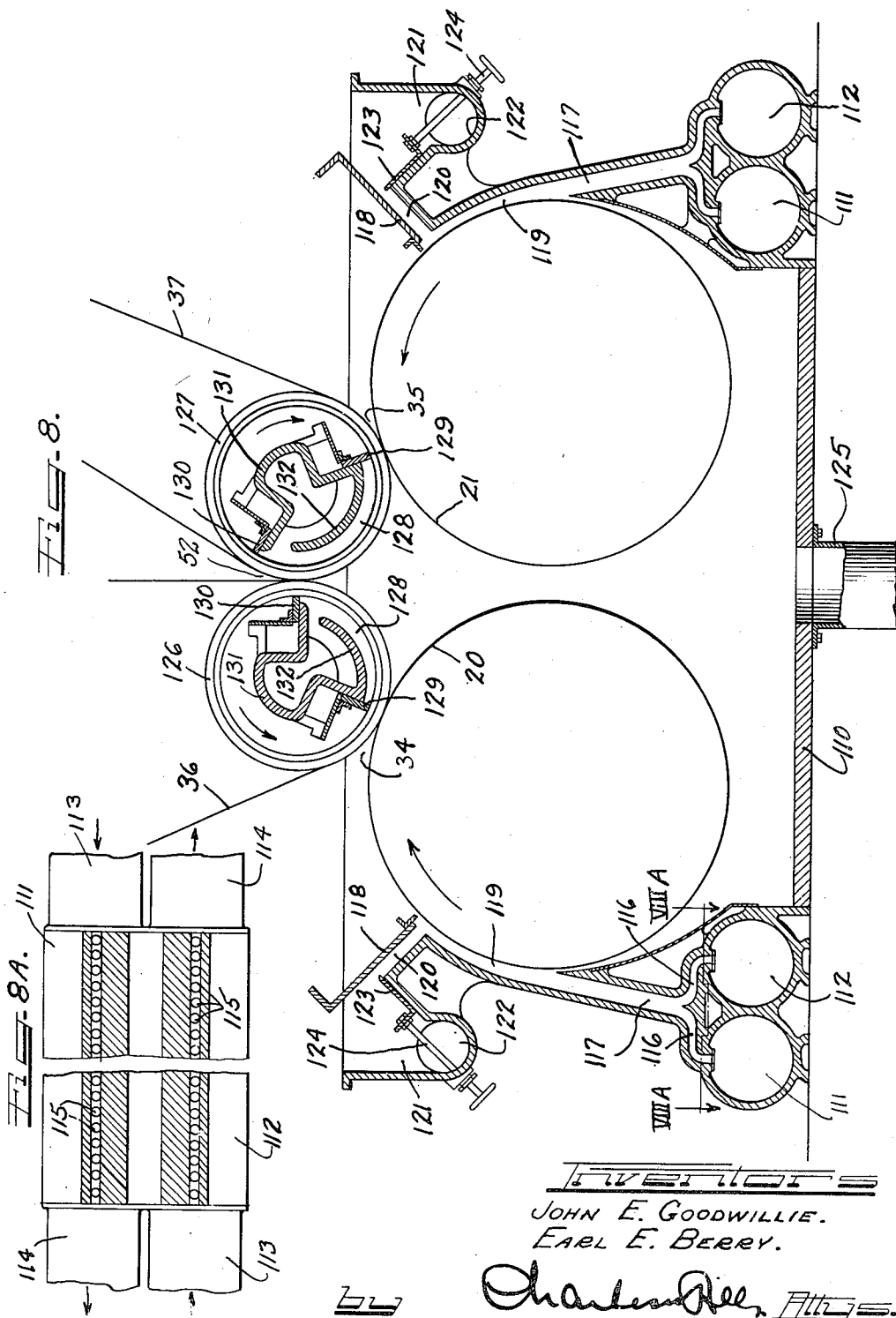
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Filed May 31, 1941

9 Sheets-Sheet 6



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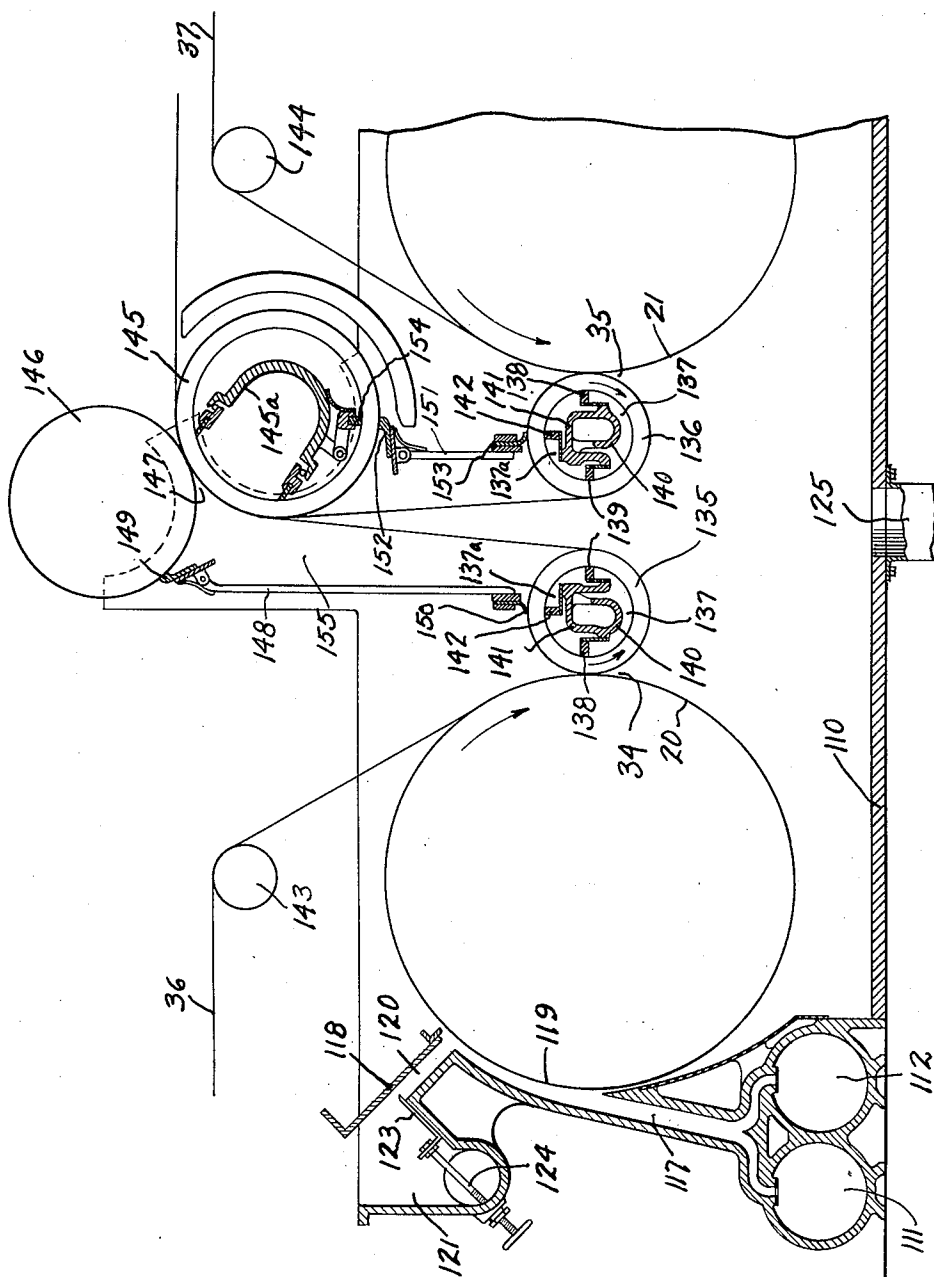
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9 Sheets-Sheet 7

Fig. 9.



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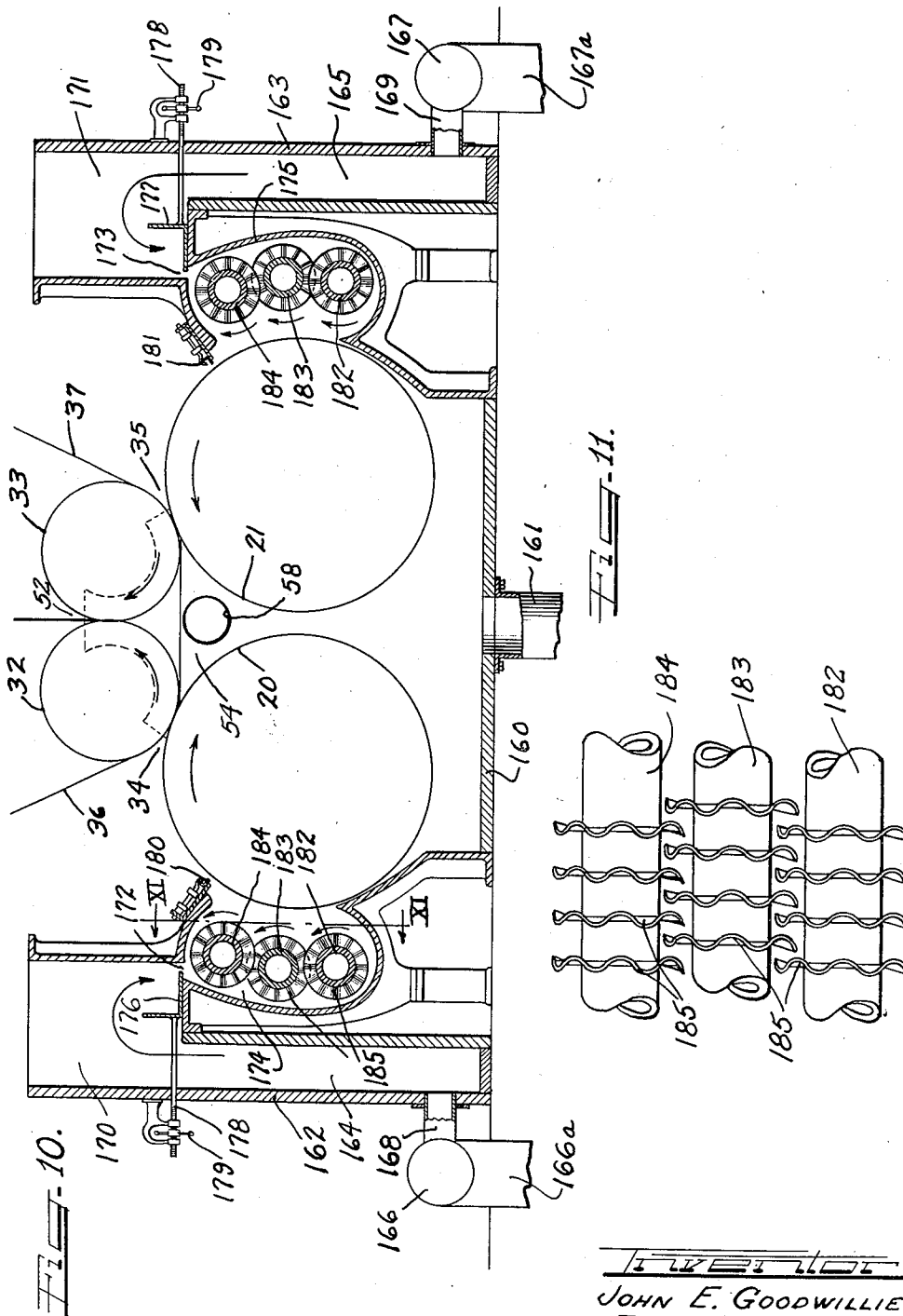
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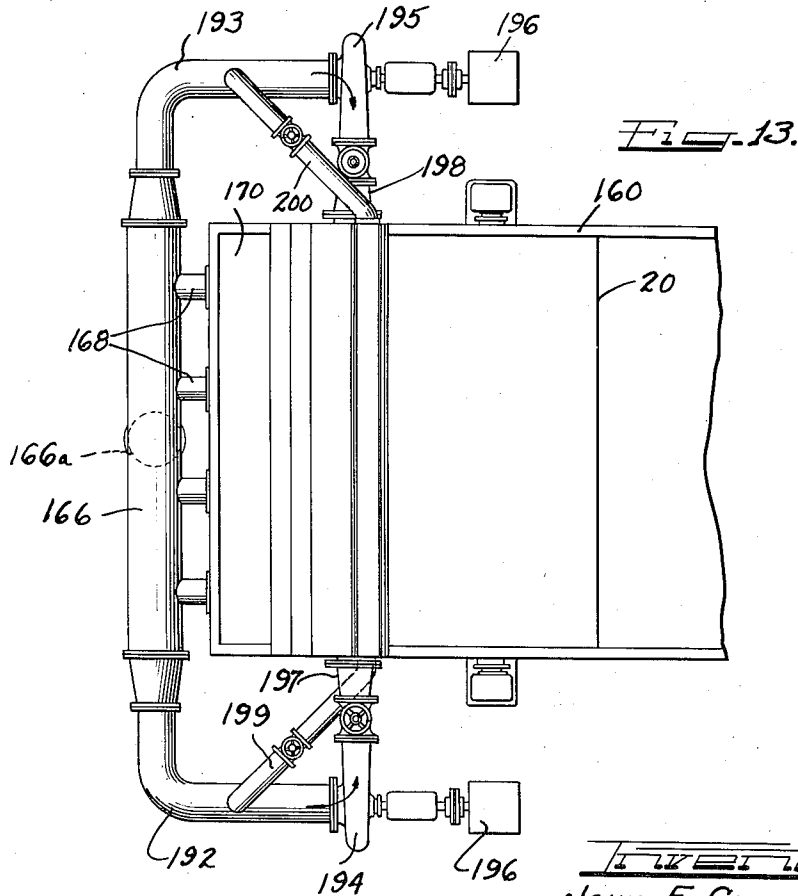
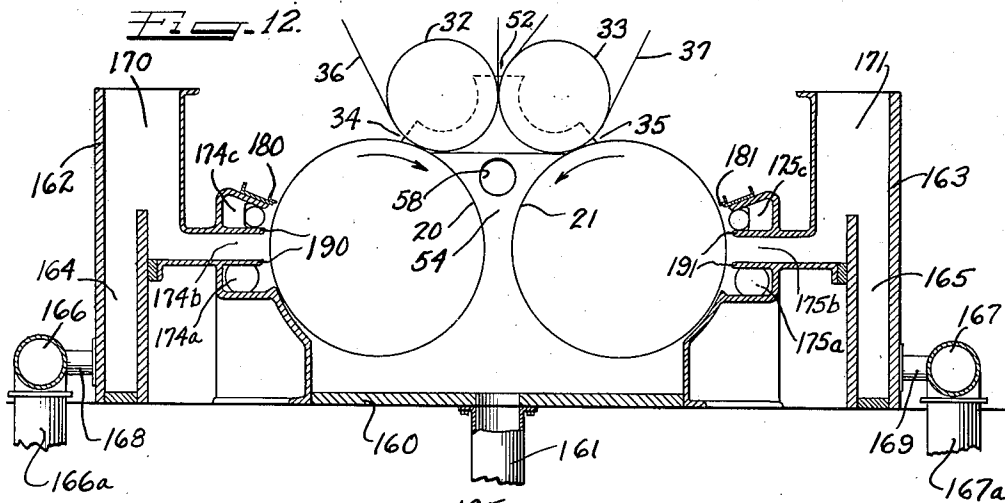
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CYLINDER TYPE PAPER MAKING MACHINE AND METHOD

Filed May 31, 1941

9 Sheets-Sheet 9



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UNITED STATES PATENT OFFICE

2,396,694

CYLINDER TYPE PAPERMAKING MACHINE
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Application May 31, 1941, Serial No. 396,066

24 Claims. (Cl. 92—43)

This invention relates to the rapid formation of laminated paper and board sheets by a combination of atmospheric or superatmospheric pressures on the paper stock on one side of the cylinder molds and vacuum or subatmospheric pressures of various degrees on the insides of the cylinder molds.

More specifically this invention relates to cylinder type paper making machines including opposed cylinder molds having web forming areas covering various degrees of the mold faces, together with plain or suction couch rolls that are positioned to direct pick-up felts for bringing together the wire sides of the webs from each mold, to combine the webs into one laminated sheet, and to seal vacuum or subatmospheric pressure areas at the points where the webs are removed from the molds.

In the usual cylinder type paper making machines, the webs from the molds are successively picked up on a felt to produce a laminated sheet or board always having at least one exposed wire or forming side face. This wire side face is always coarser than the non-wire side face and has, due to drainage of fine fibers through the wire, imperfections or wire marks not found in the non-wire side or top side of the web. It is referred to by papermakers as a "galvanized" surface and can be described as a streaked surface simulating "watered silk" and having irregular wavy lines running in the direction of the length of the forming wire. The "galvanized" surface may also be defined as an imperfection in the fiber arrangement on the wire side of the sheet formed by the action of the stock and water as it first contacts the wire.

The machines of this invention produce superior laminated sheets or boards since the wire side of each web or lamination is inside of the laminated sheet or board. The "galvanized" surface of the web is hidden by bringing together two wire sides of newly formed webs and joining the same to produce the laminated sheet. As a result only the non-wire sides of the webs will be exposed and both surfaces of the finished sheet will have well-filled and well-formed characteristics. In this way the sheets produced by machines of this invention are always symmetrical and will not curl due to differences in fiber formation on opposite sides thereof.

In accordance with this invention a plurality of cylinder molds are arranged with a pair of transfer rolls or couch rolls defining a nip receiving the webs from each mold therebetween to

consolidate the webs into a single laminated sheet or board.

In preferred embodiments of the invention a pair of opposed oppositely rotating cylinder molds are mounted in the same vat or in adjacent vats to deliver their webs to separate felts trained through the nips provided by couch rolls cooperating with the top of each cylinder mold. These couch rolls in turn cooperate with each other to define a common nip for both felts and webs. The felts are directed around their respective couch rolls to bring the wire sides of the webs together, and as the webs pass through this common nip they are pressed together to form the laminated sheet or board.

The nips between the cylinder molds and the couch rolls together with the common nip between the couch rolls seal off the space between the cylinder molds through which the exposed forming surfaces must pass after delivering their webs to the felts. This facilitates the maintenance of vacuum within the molds.

In the first illustrated form of the invention the pair of opposed cylinder molds rotate into and out of separate adjoining ponds of stock maintained by separate feed boxes. White water is removed from the interior of each cylinder mold through suitable drain connections and suction lines communicate with each interior above the pond levels. The couch rolls bridge the space between the molds. Since the webs cover the molds between the points where they emerge from the ponds to the points where they are removed from the molds, and since the couch rolls bridge the space through which the exposed mold surfaces must travel before reentering the ponds, the vacuum within the molds can be maintained without difficulty by the mere provision of suitable end seals.

In the second illustrated form of the invention a similar arrangement is provided except that the ponds are sealed off from the space between the cylinder molds bridged by the couch rolls. This space is evacuated by means of a suction line. With this arrangement it is possible to maintain higher degrees of vacuum inside of the cylinder molds, because the pond levels are not raised into the evacuated space.

In the third illustrated form of the invention, stock is flowed from feed boxes against the surfaces of the pair of cylinder molds, but the white water from the stock is drained back through the faces of the molds so that the molds will run substantially empty. Seals extend across the faces of the molds at the bottoms thereof and

divide the vacuum space from the space containing the paper stock.

In the fourth illustrated form of the invention the paper stock is brought to the formation areas on the cylinder molds by means of double pipe distributors or flow eveners. Suction couch rolls are provided to bridge the space between the cylinder molds.

In the fifth illustrated form of the invention the suction couch rolls are maintained in spaced opposed relation but effectively transfer the webs from the cylinder molds to the pick-up felts. These felts are then directed with the webs therebetween through a suction press which laminates the webs into a single sheet or board. Seals maintain the vacuum existing in the cylinder molds throughout the space above the couch rolls and below the suction press. In this arrangement the couch rolls, suction press and seals bridge the space between the cylinder molds.

In the sixth illustrated form of the invention the formation zones for the cylinder molds are equipped with a series of corrugated disks which are rotated in timed relation to the speed of the machine for creating an entirely random formation of fibers.

In the seventh illustrated embodiment of the invention the formation zones for the cylinder molds are divided into three parts. The lower part of each zone receives stock flowing across the length of the cylinder mold in one direction. The top part receives stock flowing in the opposite direction. The middle part receives stock directly from the head box to flow radially onto the cylinder molds.

It is then an object of this invention to provide cylinder type paper making machines for rapid production of laminated sheets free from exposed galvanized surfaces.

Another object of the invention is to provide arrangements of cylinder molds and couch rolls for effectively sealing off the vacuum areas in the cylinder molds.

Another object of the invention is to provide cylinder type paper making machines having opposed oppositely rotating cylinder molds in co-operating relation with couch rolls bridging the space between the cylinder molds.

A further object of the invention is to provide cylinder type paper making machines with the cylinder molds and couch rolls thereof arranged for bringing together the wire sides of the separate webs.

A still further object of the invention is to provide a pair of cylinder molds in adjacent ponds of stock with couch rolls which define transfer nips to remove the webs from the molds together with a common web consolidating nip to join together the webs from the molds.

A specific object of the invention is to isolate the web forming zones of cylinder type paper making machines from the web transfer zones of the cylinder molds.

Another specific object of the invention is to provide forming areas for cylinder type paper making machines which insure the application onto the cylinder molds of a random mixture of fibers free from fiber bundles.

A further specific object of the invention is to provide cylinder type paper making machines with web forming zones having different stock areas.

Other and further objects of the invention will be apparent to those skilled in the art from the following detailed descriptions of the annexed

sheets of drawings which by way of example disclose the preferred seven embodiments of the invention.

On the drawings:

Figure 1 is a somewhat diagrammatic side elevational view, with parts shown in vertical cross section, of the first preferred embodiment of the invention wherein the cylinder molds rotate into and out of adjoining ponds of stock.

Figure 1A is a diagrammatic top plan view of the couch rolls, cylinder molds and vat illustrated in Figure 1.

Figure 1B is a diagrammatic side elevational view of the machine shown in Figures 1 and 1A.

Figure 2 is a vertical cross sectional view of the second preferred form of the invention wherein the ponds of stock are sealed off from the space between the cylinder molds bridged by the couch rolls.

Figure 2A is a top plan view of the machine shown in Figure 2.

Figure 3 is a vertical cross sectional view of the third preferred form of the invention wherein the white water drained from the paper stock is allowed to flow back through the faces of the cylinder molds.

Figure 4 is a side elevational view of the machine shown in Figure 3 illustrating the end seals for the cylinder molds and couch rolls.

Figure 5 is a fragmentary cross sectional view, with parts in elevation, taken along the line V—V of Figure 4.

Figure 6 is a fragmentary cross sectional view, with parts in elevation, taken along the line VI—VI of Figure 4.

Figure 7 is a fragmentary cross sectional view, with parts in elevation taken along the line VII—VII of Figure 4.

Figure 8 is a vertical cross sectional view of the fourth preferred form of the invention wherein the cylinder molds receive stock from opposite flowing streams and wherein suction couch rolls are provided.

Figure 8A is a horizontal cross sectional view taken along the line VIIIa—VIIIa of Figure 8.

Figure 9 is a fragmentary vertical cross sectional view, with parts in elevation, of the fifth preferred form of the invention wherein suction couch rolls cooperate with a suction press and with seals to bridge the space between the cylinder molds.

Figure 10 is a vertical sectional view, with parts in elevation, of the sixth preferred form of the invention wherein the forming zones for the cylinder molds are equipped with corrugated disks to effect a random distribution of fibers.

Figure 11 is a fragmentary elevational view taken along the line XI—XI of Figure 10.

Figure 12 is a vertical cross sectional view of the seventh preferred form of the invention wherein the forming zones for the cylinder molds are divided into a plurality of parts receiving stock flowing in different directions.

Figure 13 is a fragmentary top plan view of the machine shown in Figure 12.

As shown on the drawings:

In Figure 1 the reference numeral 10 designates generally a cylinder type paper making machine including a vat 11 having two vat circles 12 with a dividing wall 13 therebetween to provide a pair of adjacent pond areas 14 and 15 which are supplied with stock from head boxes 16 and 17. The stock is supplied to the head boxes 16 and 17 through stock conduits 18 and 19.

A cylinder mold 20 is rotatably mounted in the

pond area 14. A second cylinder mold 21 is rotatably mounted in the pond area 15. The side walls of the vat 11 have openings 22 and 23 there-through communicating with the interiors of the cylinder molds 20 and 21. These side walls carry drain boxes 24 and 25 for conveying white water from the interiors of the cylinder molds to passageways 26 and 27 under the vat circles 12. These passageways communicate with drain conduits 28 and 29.

Suction conduits 30 and 31 communicate with the interiors of the cylinder molds 20 and 21 at the tops thereof.

Couch rolls 32 and 33 cooperate with the cylinder molds 20 and 21 respectively to define transfer nips 34 and 35 at the top portions of the molds for effecting transfer of the webs on the molds to pick-up felts 36 and 37 respectively. As shown, the pick-up felt 36 is directed over the top of the mold 20 around the couch roll 32 and thence through either a suction press roll assembly 38 as shown, or around a guide roll and thence through a plain press roll assembly (not shown). The felt after passage through the press roll assembly 38 is directed around a guide roll 39 back over the press 38 to a guide roll 40. After passage around the guide roll 40 it is trained around a tensioning roll 41, thence back around another guide roll 42 and downwardly to a guide roll 43. The felt next passes upwardly to a guide roll 44. The draw of the felt between the guide rolls 43 and 44 can be acted on by a beater 45. After passage over the guide roll 44 the felt is directed over a suction box 46, and thence again to the top of the cylinder mold.

The felt 37 has a similar path and travels over the cylinder mold 21 around the couch roll 33, through the press 38 and next to a second press 47. After passage through the second press 47 the felt is then directed around guide rolls 48 to a tensioning roll 49 and in front of a beater 50, thence around another guide roll 48 and over a suction box 51.

The couch rolls 32 and 33 preferably have relatively soft rubber covers 32a and 33a respectively. These couch rolls cooperate to define a common nip 52 therebetween. End seal plates 53 carried by the side walls of the vat 11 cooperate with the ends of the cylinder molds 20 and 21 and the ends of the couch rolls 32 and 33 to seal off a space 54 between the cylinder molds. As will be hereinafter described the ends of the cylinder molds between the points where the same emerge from the ponds of stock 14 and 15 to the nips 34 and 35 are also sealed.

In operation, stock is supplied to the head boxes 16 and 17 from the conduits 18 and 19. These head boxes maintain ponds of stock in the pond areas 14 and 15. The cylinder molds 20 and 21 rotate in opposite directions through these ponds of stock. Thus the cylinder mold 20 rotates in a clockwise direction through the pond area 14 while the cylinder mold 21 rotates in a counter-clockwise direction through the pond area 15. White water is drained from the interiors of the cylinder molds through the drain conduits 24 and 25. The fibers in the stock are thus deposited on the cylinder molds to form webs thereon. As the molds emerge from the ponds the webs cover the peripheral forming surfaces thereof. The pick-up felts 36 and 37 then contact these webs and the webs are transferred to the felts as the same pass through the nips 34 and 35. The felts with the webs thereon are then directed around the couch rolls 32 and 33 into the common nip 52 thereby

bringing together the wire sides of the webs. The felts with the laminated web therebetween are next directed through the press 38 where the web is pressed to express water therefrom. The web then follows the felt 37 through the press 47 for further extraction of water.

The interiors of the cylinder molds 20 and 21 are maintained under reduced pressure by the suction conduits 30 and 31 for speeding up the web formation on the molds. Since the cylinder mold forming surfaces are exposed from the points where the webs are removed therefrom to the points where they reenter the stock ponds, this partial vacuum would be destroyed unless the exposed surfaces of the molds were sealed from the atmosphere. The bridging arrangement of the couch rolls together with the pressure nips provided therebetween and the end seals efficiently protect these otherwise exposed areas of the cylinder molds in an easy manner.

In Figures 2 and 2A parts substantially identical with parts described in Figure 1 have been designated by the same reference numerals. The dividing wall 13a between the pond areas 14 and 15 does not extend to the top of the vat 11 as does the wall 13 in Figure 1. The wall 13a terminates below the top of the vat 11 and supports a horizontal partition 55 carrying flexible seals 56 and 57 which rub against the cylinder molds 20 and 21 to separate the pond areas 14 and 15 from the space 54. A suction conduit 58 communicates with the space 54 to evacuate this space, and at the same time to evacuate the interiors of the cylinder molds 20 and 21 since the same communicate through their exposed forming surfaces with this space 54. The space 54 can be maintained under higher vacuum when the seals 56 and 57 are used, since the level of stock in the ponds 14 and 15 will not be drawn up into this space. As a result the interiors of the suction molds can be maintained under a very high vacuum without difficulty.

A pair of shower pipes 59 can be mounted in the space 54 to eject sprays of water against the exposed forming surfaces of the molds 20 and 21 as they pass through this space.

The webs formed on the molds are transferred to the felts 36 and 37 at the nips 34 and 35 and have their wire sides brought together at the common nip 52 in the same manner described in Figure 1.

In the third form of the invention illustrated in Figures 3 and 4 the cylinder molds 20 and 21 are rotatably mounted in a common vat 60. This vat has stock inlets 61 and 62 in the opposite ends thereof supplied from conduits 63 and 64. The stock flows upwardly through the inlets, over walls 65 and 66 and under slices 67 and 68 mounted in the vats in cooperating relation with the molds 20 and 21 respectively. The vat has a pair of circles 69 formed therein defining pond areas 70 and 71 for the cylinder molds 20 and 21 respectively. These pond areas receive the stock from the inlets 61 and 62.

The slices 67 and 68 define the upper limits of the pond areas 70 and 71.

In accordance with this invention, seals 72 and 73 extend across the faces of the molds 20 and 21 at the bottoms thereof to form the lower limits of the pond areas 70 and 71. These seals 72 and 73 are mounted on carriers 74 and 75 slidably engaged in grooves 76 and 77 of track members 78 and 79 mounted in the bottom of the vat 60. Springs 80 and 81 urge the carriers 74 and 75

upwardly towards the cylinder molds 20 and 21 to provide a flexible mounting for the seals.

The stock flows downwardly through the pond areas 70 and 71 against the oppositely rotating cylinder molds 20 and 21. The white water drains into the interiors of the cylinder molds, and thence flows back through the faces of the molds at points between the seals 72 and 73, and back into the vat 60 at the central portion thereof. The white water is drained from the central portion of the vat through a drain conduit 82. The rubber covered couch rolls 32 and 33 cooperate with the cylinder molds in the same manner described in connection with Figure 1 to provide the nips 34 and 35 together with the common nip 52.

The space 54 between the cylinder molds is bridged by the couch rolls but communicates with the bottom portion of the vat between the seals 72 and 73. A suction conduit 58 similar to that described in Figure 2 is provided for evacuating the space 54, and since this space 54 communicates with the interiors of the suction molds 20 and 21 throughout the entire exposed forming surface areas thereof between the nips 34 and 35 and the seals 72 and 73, the interiors of these suction molds are readily evacuated. Since the white water drains into the interiors of the cylinder molds at the pond areas 70 and 71, and then drains back through the faces of the cylinder molds just beyond the seals 72 and 73, the molds are kept substantially empty. A very high speed web formation is thus obtained.

A pair of shower pipes 83 are mounted in the central portion of the vat 60 to direct streams of water against the exposed forming surfaces of the molds for washing the same before they enter the pond areas 70 and 71.

The webs from the cylinder molds are transferred to the felts 36 and 37 at the nips 34 and 35 and the wire sides of the webs are brought together at the common nip 52 as described in Figure 1.

As shown in Figure 4 the side wall of the vat 60 is built up with a plate 85 bolted on the vat. This plate covers the ends of the cylinder molds 20 and 21 and carries removable doors 86 and 87 in alignment with the seal carriers and mountings for the seals 72 and 73. The removal of the doors provides access to the seals so that the seal mountings 74 and 75 can be slid out of the vat for adjustment and replacement of the seals 72 and 73.

The plate 85 has arcuate flanges 88 around the outer ends thereof which, as shown in Figure 5, house seals such as 89 in sealing engagement with end rings 90 of the cylinder molds such as 21. The flanges 88 have localized built up housing portions 88a as best shown in Figure 6. A spring 91 is mounted in each housing portion 88a and is backed by a block 92 carried on an adjusting bolt 93 threaded through the housing 88a. The spring 91 can thus be compressed to urge the seal 89 in proper sealing engagement with the end ring 90 of the cylinder mold 21. The seal 89 can be formed of any suitable sealing material such as rubber, leather or the like, and preferably has a recess 89a in the face thereof contacting the ring 90 to convey a lubricating fluid such as water around the end ring 90 for lubricating the rubbing surfaces.

The doors 86 and 87 also have built up housing portions 86a and 87a thereon. As shown in Figure 7 the housing portion 87a of the door 87 receives a spring 84 urged by an adjusting bolt 85

against a filler block 96 slidably mounted through the flange 88 of the plate 85 for urging the seal 89 against the end ring 90. In this manner the seals 89 in each flange 88 of the plate 85 are urged at several points against the end rings of the cylinder molds 20 and 21.

The filler block 96, in addition to holding the seal 89 against the end ring 90, also serves as a stopper or seal for the space in the flange 88 back of the seal 89. If such a stopper were not used, air could be sucked through the space in flange 88 from the point 88b at the top of the cylinder around the circumference of the flange and into the vacuum space between the molds.

As shown in Figure 4, a spring S in the lower end of each flange 88 urges the seals 89 circumferentially into abutment with the top ends 88c of the flanges to prevent air from flowing through the spaces in the flanges back of the seals into the vacuum space at the top ends of the seals.

The cylinder molds may have the supporting shafts 20a and 21a thereof mounted in packing glands G where they pass through the end plates 85 as indicated in Figure 4, or the entire bearing assembly support for the molds can be housed over and subjected to vacuum.

It will be noted from Figure 4 that the seals 89 are in eccentric relation to the cylinder molds 20 and 21 so that grooves will not be worn in the end rings of the molds. It will also be noted from Figures 4 and 5 that the top portions of the flanges 88 are cut off as at 88b to expose the tops of the seals 89.

The plate 85 has an outturned top flange 85a between the flanges 88 to which is secured a seal plate 97 extending above the plate 85 and having arcuate sides conforming with the peripheries of the couch rolls 32 and 33. Seals 98, as best shown in Figure 5, are mounted between the plate 97 and the ends of the couch rolls. A horizontal spring 99 urged by an adjusting bolt 100 threaded through the plate 97 holds the seal 98 against the end of the couch roll 33 as illustrated in Figure 5. A vertical spring 101 urged by an adjusting bolt 102 also threaded through the plate 97 holds the seal 98 against the seal 89. In this manner the transfer point at the nip 35 is efficiently sealed at the ends thereof. It will be understood that identical seal structure exists at the nip 34. It will also be understood that the vat 60 has plates and seals at the opposite side thereof identical with the structure just described and cooperating with end rings on the opposite ends of the cylinder molds as well as with the opposite ends of the couch rolls.

The plate 54 described in Figures 1 to 3 is provided with a similar seal arrangement and the ends of the cylinder molds described in Figures 1 to 3 are also sealed with a seal arrangement similar to the just described plate 85 and seals 89.

In the fourth embodiment of the invention illustrated in Figure 8 the cylinder molds 20 and 21 are rotatably mounted in a vat 110. A pair of adjacent parallel conduits 111 and 112 are mounted at each end of the vat 110 and receive stock from inlets 113 communicating with a non-adjacent end of each conduit. Return stock conduits 114, as shown in Figure 8A communicate with the other nonadjacent ends of the conduits 111 and 112 so that stock will flow through the conduits in opposite directions. The tops of the conduits are perforated along the lengths thereof as at 115 to discharge stock from the con-

duits into passageways 116 communicating with an inlet passageway 117. Each inlet passageway 117 discharges against a cylinder mold 20 or 21 to deposit the stock on the forming surfaces thereof. Slices 118 are adjustably mounted in the vat 110 to cooperate with the cylinder molds 20 and 21 and form the top wall of the forming areas 119 for the cylinder molds. Excess stock can overflow under the slices 118 through passageways 120 communicating with overflow boxes 121 which are drained through drain outlets 122. The passageways 120 can be dammed off by means of gates 123 which are slidable toward and away from the slices 118 and are controlled by adjusting rods 124. In this manner an excess of stock can be flowed to the forming areas 119 and the excess can be recirculated. Alternatively the forming areas 119 can be maintained under pressure by damming off the overflow passageways 120.

White water flows from forming areas 119 to the interiors of the cylinder molds 20 and 21, and can then flow back through the faces of the molds to the vat 110. The white water is removed from the vat through a drain outlet 125.

Suction couch rolls 126 and 127 cooperate with the cylinder molds 20 and 21 to define the transfer nips 34 and 35. These couch rolls also cooperate with each other to define the common nip 52. The felts 36 and 37 are trained around the couch rolls 126 and 127 to pick up the webs from the cylinder molds at the nip areas 34 and 35 and to convey these webs away from the molds where their wire sides are brought together at the common nip 52.

The suction couch rolls 126 and 127 have downwardly opening suction areas 128 bounded by seals 129 at the nips 34 and 35 and by seals 130 adjacent to the common nip 52. The seal 130 in roll 126 terminates the vacuum area in the roll 126 at the nip 52 while the seal 130 in the roll 127 terminates the vacuum area in that roll at a point slightly beyond the nip 52. Thus the action of the continuing vacuum from roll 127 on the laminated sheet serves to strip the sheet from the felt 36 and insure its being carried away on felt 37.

The suction box 131 within each suction couch roll carries a flange 132 which extends substantially across the suction area 128 from the bottom end thereof into spaced relation from the top end thereof. This flange forms a collecting trough which prevents water entering the suction area from draining by gravity back through the rotating shell of the suction couch roll.

End seals (not shown) can be used to seal the ends of the cylinders and suction couch rolls so that the interiors of the cylinder molds 20 and 21 can be maintained under vacuum.

The suction couch rolls enhance the transfer of the webs from the cylinder molds to the felts 36 and 37.

In this embodiment of the invention, therefore, the plain rubber covered couch rolls are replaced with suction couch rolls and the forming areas for the cylinder molds are supplied with stock from oppositely flowing streams which prevent any unevenness in stock deposition along the length of the molds.

In the fifth embodiment shown in Figure 9, parts substantially identical with parts described in the fourth embodiment shown in Figure 8

have been designated by the same reference numerals.

In Figure 9 only the forming area 119 for the cylinder mold 20 has been illustrated. It will be understood, however, that an identical forming area together with an identical stock flow evener device is provided for the cylinder mold 21 as shown in Figure 8.

Suction couch rolls 135 and 136 somewhat smaller than the suction couch rolls 126 and 127 described in Figure 8 are rotatably mounted in the vat 110 at levels beneath the tops of the cylinder molds 20 and 21. These suction couch rolls 135 and 136 each have a suction area 137 bounded by seals 138 adjacent the cylinder molds 20 and 21 and by diametrically opposite seals 139. The suction areas 137 thus extend around the bottom portion of each couch roll 135 and 136 from the nips 34 and 35 between the couch rolls and the cylinder molds to the space between the couch rolls. A flange or wall 140 carried by the head 141 of each suction couch roll prevents gravity drainage of water back through the roll as described in Figure 8. An area 137a is also provided in each suction couch roll and extends from a seal 139 to a top seal 142. This area is under the same vacuum prevailing in the main casing. In-leakage of air to the areas 137a is prevented by the inside seals 142 cooperating with other outside seals hereinafter described.

The pick-up felts 36 and 37 are trained over guide rolls 143 and 144 respectively disposed over the cylinder molds 120 and 121 and thence travel downwardly against the cylinder molds and through the nips 34 and 35. The webs are thus transferred at the nip areas to the felts and travel with the felts around the suction areas 137 of the couch rolls.

A suction press composed of a suction roll 145 and a cooperating press roll 146 is mounted above the couch rolls 135 and 136. The felts with the webs therebetween are directed around the suction roll 145 through the nip 147 of the suction press.

A plate 148 has a seal 149 at the top end thereof in sealing engagement with the roll 146 of the suction press. This plate 148 also has a seal 150 at the bottom end thereof in sealing engagement with the suction couch roll 135 above the seal 142.

A second plate 151 has a seal 152 at the top end thereof in sealing engagement with the suction roll 145 and has a seal 153 at the bottom end thereof in sealing engagement with the suction couch roll 136 above the seal 142.

It will be noted that the rolls 145 and 146 of the suction press bridge the space between the spaced couch rolls 135 and 136, and that this space is closed by the plates 148 and 151. Since the shell of the suction roll 145 is perforated the suction box 145a of the suction roll carries another seal 154 rubbing against the interior of the shell to prevent leakage from the outside atmosphere into the space 155 provided between the plates.

It will be understood that the ends of this space 155 are closed by end seals described hereinabove in connection with other embodiments of the invention.

In operation the cylinder molds 20 and 21 receive stock at the forming areas 119. White water drains through the cylinder molds into the vat 110. The webs on the cylinder molds are removed from the molds onto the felts 36 and 37 at the nips 34 and 35, and are then conveyed

through the space 155. Suction acting through the felts is effective to dewater the webs along the suction areas 137. As a result the interiors of the cylinder molds 20 and 21 are evacuated from the suction action of all three suction rolls 135, 136 and 145, and the webs are subjected to suction continuously until they pass through the nip of the suction press. The vacuums in the areas 137 and in the suction press box 145a are, of course, higher than that maintained in the interior of the casing proper to effect flow of water into the rolls from the sheet and felts. Vacuum in the box 145a can be regulated to suit press roll conditions.

The arrangement shown in Figure 9 thus provides for the removal of the formed sheet from each molding means separate from the laminating means.

In the sixth modification shown in Fig. 10, cylinder molds 20 and 21 together with cooperating couch rolls 32 and 33 are rotatably mounted in a vat-like structure 160 having a drain outlet 161 in the bottom thereof.

Feed boxes 162 and 163 are provided at each end of the vat 160 and define passages 164 and 165 respectively receiving stock from inlet headers 166 and 167. The stock is distributed across the full width of the passageways 164 and 165 by means of a plurality of branch pipes such as 168 and 169 connecting the headers with the bottom portions of the passageways 164 and 165 respectively.

Enlarged headboxes 170 and 171 are provided at the tops of the passageways 164 and 165 respectively and communicate through passageways 172 and 173 with formation chambers 174 and 175 which respectively open onto portions of the cylinder molds 20 and 21.

The passageways 172 and 173 are controlled by gates 176 and 177 which are conveniently operated by means of rods 178 and wheels 179. The gates will control the sizes of the passageways to regulate the flow of stock from the head boxes into the formation chambers.

Slices 180 and 181 are provided at the tops of the formation chambers and can be adjusted toward and away from the cylinder molds.

Three shafts 182, 183 and 184 extend through each formation chamber 174 and 175 in spaced superimposed relation. A plurality of corrugated disks 185 are mounted in spaced parallel relation on each shaft. The disks on adjacent shafts intermesh or overlap as shown in Figure 11, so that their peripheries just clear the surface of an adjacent shaft. The corrugations of the disks run radially outward from the centers thereof. The three shafts in each formation chamber are rotated in the same direction by driving means (not shown) timed with the speed of the machine to be operated as desired either above, at, or below machine speed. The speed reference is to the peripheral speed of the edges of the disks as compared with the peripheral speeds of the molds.

The disks as best shown in Figure 10 are spaced rather close to the confining sides of the formation chambers, and somewhat further from the faces of the molds. They are rotated upwardly as indicated by the arrows since the cylinder molds rotate upwardly at these points. With the formation chambers 174 and 175 filled with stock, the rotation of the shafts and disks will create a rotating envelope of the stock in the confined formation chambers. The flow will be

generally downward on the side remote from the mold and upward or in the mold direction on the side adjacent to the mold. When the shafts are rotated at peripheral speeds higher than that of the mold the speed of the rotating stock envelope at the face of the mold can, if desired, be arranged to coincide with the surface speed of the mold.

As white water drains through the faces of the molds 20 and 21 from the formation chambers 174 and 175, a corresponding amount of stock will be drawn from the head boxes 170 and 171 through the regulated passageways 172 and 173. Some of this stock will pass down beside all three shafts to come to the face of the mold at its start in the formation area. Another portion of the stock will pass between the lower and middle shaft to make up the amount passing from the face of the mold toward the center of the formation area and the remaining amount of stock will pass between the upper and middle shaft. Now all parts of this stock will be completely agitated by the action of the disks thus breaking up fiber bundles and causing the fibers to take entirely random arrangements in the rotating envelope of stock.

The pressures in the formation areas can be regulated by varying the height of the stock in the head boxes above the entering passageways as well as by regulating the sizes of these passageways.

The white water draining through the face of the cylinder molds at the formation chambers enters the interiors of the molds and can again drain back through the faces of the molds at the bottoms thereof into the vat chamber 160. This drained white water can be removed from the vat through the drain pipe 161. In this arrangement the molds will run substantially empty as described in Figure 3. Alternatively, of course, drain outlets for the cylinder molds such as are described in Figures 1 and 2 could be used.

The fibrous webs formed on the cylinder molds pass under the slices 180 and 181 into the nips 34 and 35 where they contact the felts 36 and 37. The webs and felts then pass through the nips and the webs follow the felts around the couch rolls 32 and 33 through the common nip 52.

End seals can be provided to close off the space 54 between the cylinder molds bridged by the couch rolls as described above, and this space can be evacuated as described in Figures 2 or 3 or the interiors of the cylinder molds can be evacuated as described in Figure 1. Alternatively, of course, the molds could be run at atmospheric pressures relying upon gravity drainage for web formation.

The corrugated disk arrangement shown in Figure 11 and included in the formation chambers of Figure 10 is claimed in the copending divisional application Serial No. 523,801, filed February 25, 1944, by John E. Goodwillie.

In the seventh embodiment of the invention shown in Figures 12 and 13, parts corresponding with parts described in the sixth embodiment of the invention shown in Figure 10 have been designated by the same reference numerals. In Figures 12 and 13, however, the formation chambers 174 and 175 are divided into three compartments including bottom compartments 174a and 175a, middle compartments 174b and 175b, and top compartments 174c and 175c. The head boxes 170 and 171 communicate directly with the middle compartments 174b and 175b, and the top

and bottom walls of these middle compartments carry slices 190 and 191 extending from the ends thereof toward the cylinder molds to better isolate the compartments.

The bottom compartments 174a and 175a taper in size across the width of the chamber being larger at one end than at the other end thereof. The top compartments 174c and 175c taper in the opposite direction as indicated in Figure 12.

The headers 166 and 167, as best shown at 166 in Figure 13 have the stock feed pipes 166a and 167a communicating with the mid-portions thereof, and end pipes 192 and 193 extend from the ends of the headers to pumps 194 and 195. The pumps are driven individually by means of motors such as 196. The pump 194 communicates through a valved pipe 197 with the top chamber 174c. The pump 195 communicates through a valve pipe 198 with the bottom chamber 174a. Thus the pumps discharge into the large ends of the top and bottom chambers respectively. The small end of the bottom chamber is connected through a valved pipe 199 with the pipe 192. The small end of the top chamber 174c is connected through a valved pipe 200 with the pipe 193. Thus stock is flowed in opposite directions through the chambers 174a and 174c from the large inlet ends thereof to the small outlet ends thereof and excess stock is removed from these outlet ends through the pipes 199 and 200 back to the pipes 192 and 193. Similar pumps and pipe connections are provided for the chambers 175a and 175c.

As a result the top and bottom compartments of each formation chamber have streams of stock flowing in opposite directions therethrough along the full length of the cylinder molds. The intermediate or middle compartments 174b and 175b, on the other hand, receive stock directly from the head boxes and this stock flows radially onto the cylinder molds 20 and 21. In this manner, crossing of the fiber structure in various parts of the webs being formed on the cylinder molds as the same advance through the formation chambers is insured. Pressures in the various chambers is controlled largely by the heads of stock carried in the head boxes 170 and 171 while the cross velocity in the top and bottom chambers is controlled by the speeds of the pumps and the setting of the valves in the valved pipes.

By this arrangement it is possible to obtain a sheet arrangement on each cylinder mold with the fibers lying at reversed angles to the lengthwise direction of the sheet in the upper and lower portions. The formation in the center will have the fibers lying substantially in the machine direction.

The conveyance of the webs and the transfer of the webs to the felts as well as the drainage of white water from the cylinder molds and the sealing of the space 54 between the cylinder molds is the same as described in connection with the sixth embodiment of the invention shown in Figure 10.

The three-compartment formation chamber arrangements of Figures 12 and 13 are claimed in the copending divisional application Serial No. 523,806, filed by Wilma E. Berry, executrix of the estate of Earl E. Berry, deceased, on February 25, 1944

From the above descriptions of the various illustrated forms of the machines, it will be understood that this invention now provides for the rapid formation of webs under positive pressures

if desired, together with rapid drainage of white water through the forming surfaces. The invention provides an efficient sealing arrangement for maintaining high vacuums in the cylinder molds and utilizes couch rolls as seals as well as transfer media. The invention also provides for controlled handling of the stock to insure thorough criss-crossed arrangement of fibers as the same are formed into webs. This eliminates one of the main objections of cylinder type paper making machines which generally produce sheets having the fibers mainly lying in the machine direction.

We claim as our invention:

1. In a paper making machine, a pair of forming parts in spaced relation, pick-up felts for removing webs from the forming parts, rolls bridging the space between the forming parts defining a common nip therebetween and cooperating with the forming parts to define pressure nips, means cooperating with said rolls and felts to seal the space between the forming parts, said common nip receiving the felts and webs therethrough to bring together the forming surface sides of the webs, and means for evacuating the sealed space between the forming parts.

2. In a cylinder type paper making machine, a pair of spaced opposed cylinder molds rotatable in opposite directions, couch rolls bridging the space between the cylinder molds defining a separate nip with each cylinder mold and a common nip therebetween, means including said couch rolls for sealing the space between the cylinder molds, felts movable toward each other around said couch rolls to pick up webs from the cylinder molds and bring together the mold sides of the webs at said common nip, and means creating a pressure differential between the sealed space and the atmosphere surrounding said paper making machine.

3. In a cylinder type paper making machine, means defining a pair of adjacent stock ponds, a separate cylinder mold rotatable into and out of each pond, a pair of couch rolls bridging the space between the cylinder molds and defining a common nip therebetween, means including said couch rolls sealing said space, means for evacuating the sealed space, and a pair of pick-up felts trained around said couch rolls for bringing together the mold sides of webs formed on the molds at said common nip.

4. In a cylinder type paper making machine including a pair of spaced opposed cylinder molds, a pair of couch rolls bridging the space between said molds in cooperating relation with the molds and with each other for defining nips to seal said space, end seals for said space, and means for evacuating the sealed space.

5. In a cylinder type paper making machine, a vat defining a pair of separated vat circles for ponds of stock, cylinder molds rotatably mounted in each of said vat circles, a couch roll cooperating with the top portion of each cylinder mold, said couch rolls defining a common nip therebetween, felts trained around said couch rolls and over the tops of said cylinder molds for bringing together the mold sides of webs formed on the molds at said common nip, end seals for the space between said cylinder molds and suction means evacuating said space to maintain the interiors of the cylinder molds at subatmospheric pressures.

6. In a cylinder type paper making machine, a vat defining a pair of adjoining vat circles, feed

boxes at the ends of said vat for maintaining ponds of stock in said vat circles, cylinder molds rotatably mounted in said vat circles for movement in opposite directions through said ponds, a couch roll cooperating with the top portion of each cylinder mold, said couch rolls defining a common nip therebetween, felts movable toward each other over the tops of said cylinder molds trained around said couch rolls and through said common nip to bring together the mold sides of webs formed on said molds, end plates mounted on said vat in sealing engagement with said cylinder molds and said couch rolls to cooperate therewith for sealing the space between the cylinder molds, and means for evacuating the interiors of said cylinder molds.

7. In a cylinder type paper making machine, a vat providing a pair of separate adjoining vat circles, feed boxes in the ends of said vat for maintaining separate ponds of stock in said vat circles, cylinder molds mounted in said vat circles and rotatable to enter the adjoining ends of said ponds, seals between the vat circles cooperating with said cylinder molds, couch rolls cooperating with the tops of said cylinder molds and bridging the space between the cylinder molds, end plates in sealing engagement with said cylinder molds, couch rolls cooperating with said seals to define an isolated space between the cylinder molds, and means for evacuating said space to maintain the interiors of said cylinder molds at subatmospheric pressure.

8. In a cylinder type paper making machine, a vat, a pair of spaced opposed cylinder molds rotatably mounted in said vat, couch rolls cooperating with the tops of said cylinder molds and with each other to bridge the space between the molds, said couch rolls also cooperating to define a common nip therebetween, felts trained around said couch rolls for bringing together in said common nip the mold sides of webs formed on the molds, means at the ends of said vat defining a separate formation chamber for each cylinder mold, means for supplying stock to said formation chambers whereby liquid from the stock will drain through the faces of the cylinder molds into the bottoms of the molds and back through the faces of the molds into the central portion of the vat, and a drain outlet communicating with said central portion of the vat.

9. In a cylinder type paper making machine, a vat, a pair of spaced opposed cylinder molds rotatably mounted in said vat, seals in the bottom of said vat cooperating with the bottoms of said cylinder molds to isolate the end portions of the vat from the central portion thereof, means for supplying stock to said isolated end portions for forming webs on said cylinder molds, said cylinder molds receiving liquid from said stock therethrough and discharging said liquid in the central portion of the vat, a drain in said central portion of the vat for said liquid, said cylinder molds rotatable in opposite directions upwardly through said isolated end portions of the vat, a pair of couch rolls cooperating with the top portions of said cylinder molds and with each other to bridge the space between the cylinder molds, said couch rolls also cooperating to define a common nip, and felts trained around said couch rolls to pick up webs from the cylinder molds for bringing together the mold sides of the webs in said common nip and thereby produce a laminated sheet free from exposed surfaces which contacted the molds.

10. A paper making machine comprising a

pair of spaced opposed forming parts, means defining web forming chambers on said forming parts, a pair of suction couch rolls cooperating with said forming parts and with each other to bridge the space therebetween, means sealing said space, means for evacuating the sealed space, and a pair of oppositely running felts trained around said suction couch rolls to pick up and bring together webs from the forming parts.

11. In a cylinder type paper making machine including a pair of spaced opposed cylinder molds, the improvements which comprise a pair of suction couch rolls bridging the space between said cylinder molds and evacuating said space, and end seals cooperating with the cylinder molds and couch rolls to seal the space for maintaining the evacuation thereof.

12. In a cylinder type paper making machine including a pair of spaced opposed cylinder molds, a pair of spaced couch rolls each cooperating with a cylinder mold to define a nip therewith, a suction press disposed above said couch rolls and bridging the space therebetween, seals between the rolls of said suction press and said couch rolls, means for evacuating the sealed space defined by the suction press, the couch rolls and the seals, and separate felts each trained through a nip between a couch roll and the cylinder mold and through the nip of said suction press.

13. A cylinder type paper making machine comprising a pair of spaced opposed cylinder molds, suction couch rolls rotatably mounted in the space between the cylinder molds, felts trained around the bottoms of said couch rolls, means in said couch rolls defining a suction area at the bottoms thereof, a suction press above said couch rolls receiving said felts therefrom, seals extending between the tops of said couch rolls and the rolls of said suction press for sealing off the space bounded by the suction press, the cylinder molds, and the couch rolls, means for evacuating said sealed off space, and means in said couch rolls defining additional suction areas between said felts and said seals.

14. In a cylinder type paper making machine including a pair of spaced opposed cylinder molds and couch rolls bridging the space between said cylinder molds to define a common nip therebetween together with transfer nips for removing webs from said cylinder molds, the improvements which comprise seal plates for the ends of said cylinder molds carrying arcuate seals for rubbing engagement with the ends of the cylinder molds, and additional arcuate seals for the ends of said couch rolls extending between said transfer nips and said common nip, whereby said seals will cooperate to seal off the space between the cylinder molds bridged by the couch rolls adapting said space for maintenance of reduced pressures.

15. In a paper making machine, a plurality of web forming parts in spaced relation, rolls bridging the space between the forming parts including couch rolls cooperating with the forming parts, said rolls defining nips, means including said rolls providing a sealed space between the web forming parts, means creating a pressure differential between said sealed space and the atmosphere surrounding the paper machine, and felts trained through said nips and around the couch rolls to convey webs away from the forming parts and into engagement with each other.

16. In a cylinder type paper making machine, a vat, a pair of spaced opposed cylinder molds rotatably mounted in said vat, couch rolls co-

operating with said cylinder molds and with each other to bridge the space between the molds, said couch rolls providing pickup nips with said cylinder molds and a common nip for receiving webs formed on said molds, means defining formation chambers for each cylinder mold each communicating with a localized area of the cylinder molds for supplying paper stock to the cylinder mold whereby liquid from the stock will drain through the faces of the cylinder mold into the vat, and a drain in said vat for receiving said liquid.

17. In a cylinder type paper making machine, a vat, a pair of spaced opposed cylinder molds rotatably mounted in said vat, couch rolls cooperating with said cylinder molds and with each other to bridge the space between the molds, said couch rolls also cooperating to define a common nip therebetween, felts trained around said couch rolls for bringing together in said common nips the mold sides of webs formed on the molds, means cooperating with each cylinder mold defining a stock chamber having an open end directly communicating with the cylinder mold for flowing stock fibers onto the molds and stock liquid through the molds into the vat and a drain outlet for said vat receiving said liquid.

18. A paper making machine comprising a cylinder, a forming wire around the cylinder, a stock feed device defining a chamber communicating with said cylinder to deposit stock on the forming wire, a couch roll for removing from said forming wire a web formed thereon from said stock, structure sealingly enclosing a space receiving the cylinder therethrough, and means creating a pressure differential between said sealed space and the atmosphere surrounding said paper making machine to speed up formation of the web on the forming wire up to the point of removal of the web from the forming wire by the couch roll.

19. A paper making machine comprising a vat, a cylinder therein, a forming wire around the cylinder, a feed device for supplying stock to the wire, a couch roll for removing a web formed on the wire from said stock, seal structure cooperating with said vat, cylinder, and couch roll enclosing a space communicating with the forming wire, and means creating a pressure differential between said enclosed space and the atmosphere surrounding the paper making machine to speed up formation of the web on the forming wire up to the point of removal of the web from the forming wire.

20. A paper making machine comprising a cylinder, a stock feed device communicating with said cylinder, a seal on said device acting on said cylinder to provide a lower terminal end for a pool of stock maintained on the cylinder by said device, a couch roll cooperating with the top of said cylinder to remove a web formed from stock deposited on the cylinder from said pool, and structure sealingly enclosing that portion of the

cylinder between the point of removal of the web therefrom by said couch roll to said seal at the lower end of the pool of stock, means for evacuating said space to force drainage of white water through the cylinder from said pool and to subject the web formed on the cylinder to vacuum up to the point of removal therefrom, and drainage means outside of said cylinder receiving said white water whereby white water from said pool will drain into the cylinder above said seal and thence back through the face of the cylinder to said drain means below said seal.

21. A cylinder type paper making machine comprising a vat, a pair of spaced parallel cylinders rotatably mounted in said vat, couch rolls cooperating with said cylinders bridging the space therebetween and defining a common nip to receive webs from both cylinders and form a laminated web therefrom, seal means between said cylinders and vat, and means for evacuating the sealed interior of the vat to speed up web formation on the cylinders up to the points of removal of the webs from the cylinders by said couch rolls.

22. A paper making machine comprising a cylinder, a vat supporting the cylinder for rotation, a stock feed device communicating with a localized portion of the cylinder to deposit stock thereon for forming a web, a couch roll for removing the web formed from said deposited stock, seal structure between the cylinder and feed device, seal structure between the vat and couch roll, and means creating a pressure differential between the space sealed off by said seal structures and the atmosphere surrounding the paper making machine to speed up paper formation on the cylinder up to the point of removal of the web from the cylinder.

23. The method of forming paper on spaced adjacent cylinder molds which comprises sealing the space between the molds, evacuating said space to evacuate the interiors of the molds, rotating the molds, depositing paper stock onto the evacuated molds to form paper webs on the molds, removing the webs from the molds to uncover the portions of said molds in said space, and pressing the mold contacted faces of the webs together to form a composite paper sheet.

24. The method of forming paper on spaced adjacent cylinder molds which comprises sealing the space between the molds, rotating the molds through paper stock, creating a pressure differential between said space and said paper stock to effect forced deposition of paper stock onto the molds to form paper webs thereon, removing the webs from the molds to uncover portions of said molds in said space, and maintaining said pressure differential up to the point of removal of the webs from the molds.

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