

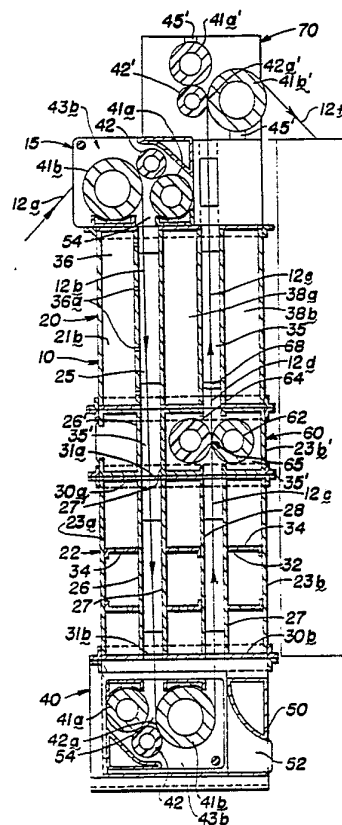


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>4</sup> :</b> <b>B05D 3/00, 3/12, B05C 3/12</b> <b>B05C 11/115</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 86/ 02291</b> <b>(43) International Publication Date:</b> 24 April 1986 (24.04.86)
<p><b>(21) International Application Number:</b>      PCT/US85/02006</p> <p><b>(22) International Filing Date:</b>      11 October 1985 (11.10.85)</p> <p><b>(31) Priority Application Number:</b>      660,026</p> <p><b>(32) Priority Date:</b>      12 October 1984 (12.10.84)</p> <p><b>(33) Priority Country:</b>      US</p> <p><b>(71) Applicant:</b> R &amp; R RESEARCH &amp; DEVELOPMENT, INC. [US/US]; 670 Huron, Memphis, TN 38107 (US).</p> <p><b>(72) Inventor:</b> REITH, Richard, A. ; 6142 Gray Oak, Memphis, TN 38115 (US).</p> <p><b>(74) Agents:</b> CRUTSINGER, Gerald, G. et al.; Crutsinger, Booth &amp; Ross, 1000 Thanksgiving Tower, 1601 Elm Street, Dallas, TX 75201 (US).</p>		<p><b>(81) Designated States:</b> AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), FI, FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent).</p> <p><b>Published</b>  <i>With international search report.</i></p>

**(54) Title:** PAPER SATURATOR**(57) Abstract**

An apparatus and method to saturate a web (12) of paper. The apparatus (10) comprises a sealed chamber divided to form a low pressure preparation or vacuum zone (25) and a high pressure treatment zone (35). Air is evacuated from the open area between the fibers in the web portion (12b) in the vacuum zone (25) and liquid in the treatment zone is forced into the evacuated open area between the fibers in the web portion (12c). A pair of nip rollers (62, 64) are submerged in liquid in the treatment zone (35) for squeezing residual air and liquid from the open area between the fibers in the web portion (12c) to cause liquid to be drawn into the open area between the fibers in the web portion (12d) upon exiting the nip (65) between the rollers.



***FOR THE PURPOSES OF INFORMATION ONLY***

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GA	Gabon	MR	Mauritania
AU	Australia	GB	United Kingdom	MW	Malawi
BB	Barbados	HU	Hungary	NL	Netherlands
BE	Belgium	IT	Italy	NO	Norway
BG	Bulgaria	JP	Japan	RO	Romania
BR	Brazil	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	LI	Liechtenstein	SN	Senegal
CH	Switzerland	LK	Sri Lanka	SU	Soviet Union
CM	Cameroon	LU	Luxembourg	TD	Chad
DE	Germany, Federal Republic of	MC	Monaco	TG	Togo
DK	Denmark	MG	Madagascar	US	United States of America
FI	Finland	ML	Mali		
FR	France				

## PAPER SATURATOR

BACKGROUND OF INVENTION

The paper saturator described herein relates to improvements in apparatus of the type disclosed in United States Patent No. 1,595,474; U.S. Patent  
5 No. 3,881,445; U.S. Patent No. 3,644,131; U.S. Patent No. 2,125,364; and U.S. Patent No. 1,683,254 which generally disclose apparatus for vacuum treatment of web material. The web is moved through a vacuum chamber to remove air which is held on the surface of  
10 the material or occluded in pores formed in the web of material. After passing from the vacuum chamber, the web is immersed in liquid in an effort to saturate the web.

Devices heretofore devised for vacuum treatment  
15 of a web moving through a vacuum chamber have encountered difficulties in sealing the chamber to permit reduction of pressure to a level sufficiently low to remove substantially all of the air from the pores in the web and to completely fill the pores with coating  
20 material to saturate the web.

Apparatus similar to that disclosed in U.S. Patent No. 3,881,445 has been used heretofore for applying an aqueous solution of various materials such as sodium silicate and starch to a paper web.  
.5 The system, however, did not provide optimum saturation of the web at maximum web speeds.

SUMMARY OF INVENTION

The paper saturator described herein generally comprises a chamber provided with seals to permit  
5 movement of a web of paper or other material through the chamber. The chamber is divided into at least two zones to form a low pressure preparation zone and a pressurized treatment zone.

Pressure in the preparation zone is reduced to  
10 form a partial vacuum to evacuate a substantial portion, for example, approximately 3/4 of air from the open area between the fibers in the web. The web passes from the preparation zone through a seal into a pressurized treatment zone which is at least par-  
15 tially filled with liquid so that liquid will be forced into void areas in the web.

A pair of squeeze rollers are submersed in liquid in the pressurized treatment zone to form a nip through which the web is routed. As the web enters the nip  
20 between the rollers, further roll line pressure is exerted on the liquid and any residue of air remaining in the open area between the fibers in the web.

This "kneading" action of the nip rolls in the pressurized liquid area forces the liquid which has  
25 already penetrated the surface and any residual air bubbles to move in a wave like motion causing additional wetting of internal fibers deep in the web. Occluded air bubbles which have been reduced in size due to being subjected to elevated pressure in the open areas  
30 between the fibers of the web are broken up, further reduced in size and disbursed throughout the fibers. This action is very desirous when dealing with hard to wet dense fibered papers. As pressure on the web is released when the web leaves the nip between the  
35 squeeze rollers, more liquid is again drawn into the

the open area between the fibers in the web to saturate the web with the liquid.

5       Rollers at the exit from the treatment zone of the chamber perform a dual function of a metering apparatus for removing excess liquid from the surface of the web and form an air lock or seal to assure that a pressure differential is maintained between the treatment zone and the atmosphere outside of the chamber. As the saturated web moves from the high  
10       pressure treatment zone to atmospheric pressure outside the chamber and after passing through the metering nip the saturated web is allowed to expand at atmospheric pressure.

15       It will become readily apparent that the web is squeezed between rollers at four separate stages as it moves into, through and out of a chamber in the saturator. The web is first squeezed between a pair of rollers at the entrance into the chamber to initially evacuate some of the air from the open area  
20       between the fibers in the web. The web then passes into a vacuum chamber to further evacuate air from the the open area between the fibers and subsequently between rollers forming a seal between the vacuum chamber and a pressure chamber. After removal of a  
25       significant portion of the air as the web moves into, through and out of the vacuum zone in the chamber, the web is moved through pressurized liquid in the treatment zone. Squeezing the web between squeeze rollers in the treatment zone flushes liquid and  
30       substantially all of the residue of air from the the open area between the fibers in the web and results in the web becoming almost completely saturated with liquid in the treatment zone.

DESCRIPTION OF DRAWING

Drawings of a preferred embodiment of the invention are annexed hereto so that the invention may be better and more fully understood, in which:

5        Figure 1 is a perspective view of the paper saturator;

Figure 2 is a cross sectional view taken along line 2-2 of Figure 1;

10       Figure 3 is an enlarged cross sectional view illustrating an arrangement of rollers to provide a seal between the preparation zone and the treatment zone;

Figure 4 is a cross sectional view taken along line 4-4 of Figure 3; and

15       Figure 5 is a schematic view diagrammatically illustrating steps of a method of saturating a web.

Numerical references are employed to designate like parts throughout the various figures of the drawing.

20       DESCRIPTION OF A PREFERRED EMBODIMENT

A preferred embodiment of the paper saturator is generally designated by the numeral 10 in Figures 1 and 2 of the drawing. A web 12 is routed through saturator 10 for removing air from the surface of the web and saturating the web with liquid as will be hereinafter more fully explained.

25       The paper saturator 10 comprises an infeed vacuum seal roll unit generally designed by the numeral 15, a pair of modular sections 20 and 22, a vacuum outfeed seal roll unit 40, a squeeze roll unit 60 and an out-  
30       feed metering seal roll unit 70.

Modular units 20 and 22 are of identical construction and each is partitioned to form a vacuum zone 25 and a treatment zone 35.

Each modular unit 20 and 22 comprises spaced end walls 21a and 21b, front and rear walls 23a and 23b, and partitions 26, 27, 28 and 29 which extend generally parallel to front and rear walls 23a and 23b. Top plate 30a and bottom plate 30b having slots 31a and 31b, respectively formed therein, are welded or otherwise secured to the walls 23a and 23b and to partitions 26, 27, 28 and 29 to form a strong rigid construction. Perforated plates 32 having spaced apertures 34 extending therethrough are welded or otherwise secured as illustrated in Figure 2 of the drawing to provide structural reinforcing between the front and rear walls and the partitions as will hereinafter be more fully explained.

A vacuum separator tank 36 is formed between front wall 23a and partition 26 while a vacuum zone is formed between partitions 26 and 27. Partitions 28 and 29 form treatment zone 35 between holding tanks 38a and 38b which are between partition 27 and back wall 23b as best illustrated in Figure 2 of the drawing.

As diagrammatically illustrated in Figure 1, a gear pump 25a draws liquid through a line 25b communicating with separator tank 36 and delivers the liquid through a line 25c into holding tank 38a. A pair of air lines 39a and 39b communicate with treatment zone 35 and holding tank 38b, respectively. Each of the lines 39a and 39b is connected through a control valve and line 39c to an air compressor or other suitable source of pressurized fluid. Each of the lines 39a and 39b is preferably provided with a check valve to prevent back flow of air or fluid from treatment zone 35 or holding tank 35b.

A vacuum pump 24 is connected through conduit 24a and valve 24b to the vacuum separator tank 36 for

evacuating air from separator tank 36 and vacuum zone 25. As best illustrated in Figure 2, the partition 26 between separator tank 36 and vacuum zone 25 has openings 36a through which vacuum zone 25 and separator tank 36 are placed in fluid communication.

#### SEAL ROLL UNIT

Seal roll units 15 and 40 are of substantially identical construction and as illustrated in Figure 2 of the drawing one of the units is positioned adjacent opposite ends of vacuum zone 25 formed through one or more modular units 20 and 22.

As best illustrated in Figure 3 of the drawing, each seal roll unit 15 and 40 comprises a pair of hard rollers 41a and 41b and a resilient roller 42 urged into pressure indented relation with each of the rollers 41a and 41b to form a pair of nips 42a and 42b. Rollers 41a, 41b and 42 are rotatably secured between spaced end plates 43a and 43b.

Seal supports 44a and 44b extend generally parallel to rollers 41a and 41b, as illustrated in Figure 3 of the drawing, and support seal holders 45 having slots formed therein in which seal member 46 and inflatable tube 47 are movably secured. Tube 47 is connected through a suitable air line (not shown) to a source of pressurized fluid. Pressure in tubes 47 urge seal members 46 in a direction generally radial toward the surfaces of rollers 41a and 41b for forming an airtight seal therebetween. Seals 46 and seals (not shown) between the ends of rollers 41a, 41b and 42 and end plates 43a and 43b, respectively, are similar to structure disclosed in Minton Patent No. 1,633,121, the disclosure of which is incorporated herein by reference.

Each of the end plates 43a and 43b has a groove 48 formed in the periphery thereof and an inflatable



tube 49 is positioned in the groove for providing a seal between end plates 43a and 43b and the housing in which the unit is installed.

5 As diagrammatically illustrated in Figure 1 of the drawing, rollers 41a and 41b are driven by sprockets 41c and 41d, respectively, which are connected by a chain 41e. Rollers 41a and 41b thus rotate in unison and are preferably driven by an electric motor (not shown).

10 The outfeed metering seal roll unit 70 is similar to seal units 15 and 40 except that rollers 41a', 41b' and 42' are located in slightly different positions and seal holders 45' have been relocated to accommodate the geometry of the system.

15 As best illustrated in Figure 2 of the drawing, seal unit 40 is mounted in a housing 50 having a bottom and side walls arranged to form a reservoir 52 for liquid. The vacuum zone 25 through modular units 20 and 22 is divided from treatment zone 35, as diagrammatically illustrated in Figure 5 by roller seal unit 20 40. Thus, when air is evacuated from vacuum zone 25, zone 54 in housing 50 will be in communication with vacuum chamber 25 while the reservoir 52 is in communication with treatment zone 35. As best illustrated in Figure 1 of the drawing, a pump 56 is mounted 25 for drawing liquid through line 58 and valve 56a from holding tanks 38a and 38b and depositing the liquid in reservoir 52 until the lower treatment zone 35 is completely filled with liquid and the liquid level 68 30 arises above the rollers 62 and 64 in squeeze unit 60 as will be hereinafter more fully explained.

#### SQUEEZE UNIT

35 The squeeze unit 60 preferably comprises a hard roller 62 and a resilient roller 64 urged into pressure indented relation to form a nip 65 therebetween.

Rollers 62 and 64 are mounted in a generally rectangular shaped housing having front walls and end walls similar to those of modular units 20 and 22. Partitions 26' and 27' form a sealed vacuum zone 35' communicating with the ends of vacuum zones 35 in modular units 20 and 22. A treatment zone 35' is formed between partition 27' and the back wall 23b' of the squeeze unit 60 and communicates with treatment chambers 35 in modular units 20 and 22. Pressure adjustment mechanism (not shown) is provided for moving one or both of the rollers 62 and 64 for separating the surfaces thereof at nip 65 for positioning web 12 through nip 65 and for adjusting pressure exerted by rollers 62 and 64 on the web as the web is moved through nip 65.

#### OPERATION

The operation of the apparatus hereinbefore described permits sequential treatment of a web 12 as diagrammatically illustrated in Figure 5, as it is moved through a chamber in the housing divided into a vacuum zone 25 and a treatment zone 35.

From the foregoing, it should be readily apparent that web 12 passes around roller 41b of the infeed vacuum seal roll unit 15 and is squeezed between hard roller 41b and resilient roller 42 for squeezing some of the air from the open area between the fibers in the web. Portion 12b of the web in the vacuum zone 25 of a chamber in the saturator is subjected to reduced pressure to draw additional air from the open area between the fibers in the web. As portion 12b of the web moves through the nip 42a between rollers 41b and 42 of outfeed seal roll unit 40, additional air is squeezed from the web. As the web leaves nip 42a it is moved through liquid in reservoir 52 which is pressurized to a predetermined pressure by deliver-

ing air through air lines 39a and 39b above the surface 68 of a column of liquid extending from reservoir 52 through squeeze unit 60.

5 The pressure in vacuum chamber 25 is preferably reduced about 15 pounds per square inch less than atmospheric pressure and the pressure in treatment zone 35 is preferably approximately 15 pounds per square inch greater than atmospheric pressure. Thus, the pressure differential between vacuum zone 25 and 10 treatment zone 35 is approximately 30 pounds per square inch such that liquid in reservoir 52 and the lower portion of treatment zone 35 is forced into the open area between the fibers in portion 12c of the web, the the open area between the fibers in the web having 15 been evacuated at nip 42a of seal unit 15, in vacuum zone 25 and at nip 42a of outfeed seal unit 40.

As portion 12c of web 12 moves through nip 65, between rollers 62 and 64 of the squeeze unit 60, liquid is squeezed from the the open area between the 20 fibers in the web carrying out any residual air which may have been occluded in the open area between the fibers and around fibers in the paper. Since squeeze rollers 62 and 64 are submerged in liquid, the portion 12e of the web readily absorbs liquid as it moves out 25 of nip 65 in the pressurized treatment zone 35.

As shown in Figure 5, a surface layer 112 of fibers in portion 12c of the web initially absorbs liquid. However, a boundary 113 is formed leaving a dry core 114 of fibers. Rollers 62 and 64 break up 30 and disburse bubbles in the core 114 and move the air and liquid in the core 114. Only very small disbursed bubbles 115 remain in the web which is impregnated and saturated with the liquid.

Resilient roller 42' of the outfeed metering 35 seal roll unit 70 squeezes excess coating material

from the surface of the web while forming a seal between the pressurized treatment zone 35 of the chamber in the paper saturator and atmospheric pressure outside of the chamber.

5           From the foregoing, it should be readily apparent that the paper saturator 10 hereinbefore described may be employed separately or in line with a variety of equipment such as paper making machines or printing presses. Portion 12f of web may be routed through a  
10           dryer before delivery to a rewind stand or to additional equipment for performing additional functions on the web.

Having described my invention, I claim:

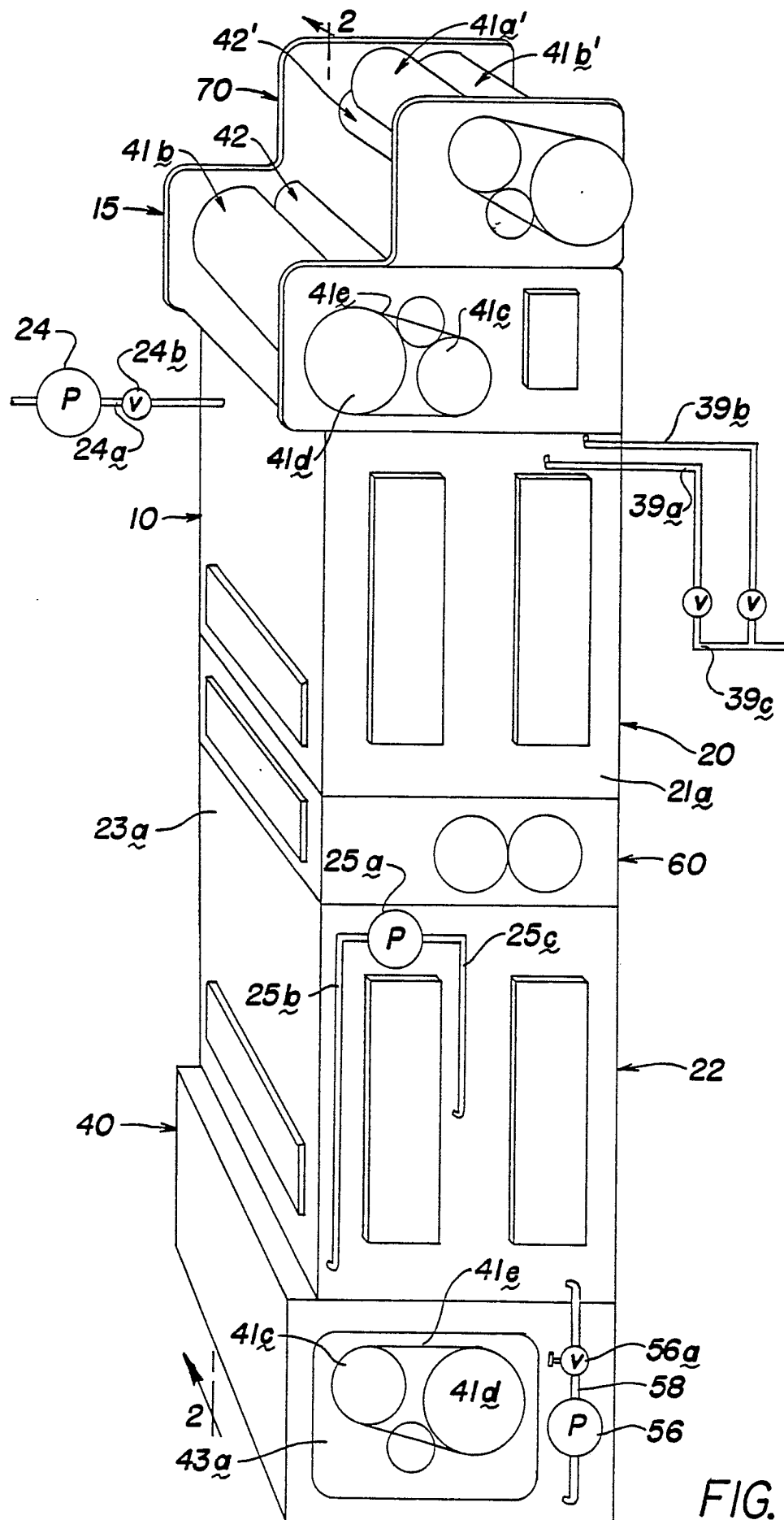
1. Apparatus to saturate a web with coating material comprising: a chamber having an inlet and an outlet; seal means adjacent said inlet and outlet,  
5 said seal means being adapted to permit passage of a web into and out of the chamber; seal means in said chamber dividing the chamber into a zone and a treatment zone; and the improvement comprising: means associated with said preparation zone for evacuating  
10 air from the open area between the fibers in the web; pressure control means to maintain pressure in the treatment chamber greater than atmospheric pressure; and means submerged in pressurized liquid in said treatment zone forming a nip to compress said web to  
15 squeeze liquid from the open area between the fibers in the web adjacent the entrance into the nip and to cause liquid to be drawn into the open area between the fibers in the web upon exiting said nip.

2. Apparatus to saturate a web according to Claim 1, said seal means adjacent the inlet comprising means forming a nip to squeeze air out of the open area between the fibers in a web passing through the  
5 nip and prior to entry of the web into the preparation zone.

3. Apparatus to saturate a web according to Claim 2, said means associated with the preparation zone to remove air from the open area between the fibers in the web comprising means for forming a  
5 partial vacuum in said preparation zone.

4. Apparatus to saturate a web according to Claim 3, said means in the treatment zone forming a nip comprising a pair of rollers, one of said rollers having a hard surface and the other a resilient surface for squeezing liquid and air from the web.
- 5

5. A method of saturating a web with coating material comprising the steps of: squeezing a web between a pair of rollers; subjecting the web which has been squeezed to a partial vacuum to draw air  
5 from the open area between the fibers in the web; squeezing the web between a second pair of rollers to form a seal to maintain the partial vacuum; moving the web through a reservoir of pressurized liquid to cause liquid to be drawn into the open area between  
10 the fibers in the web; moving the web between a third pair of rollers submerged in liquid to squeeze liquid and residual air from the open area between the fibers in the web to condition the web to become saturated with liquid in which the third pair of rollers is  
15 submerged.





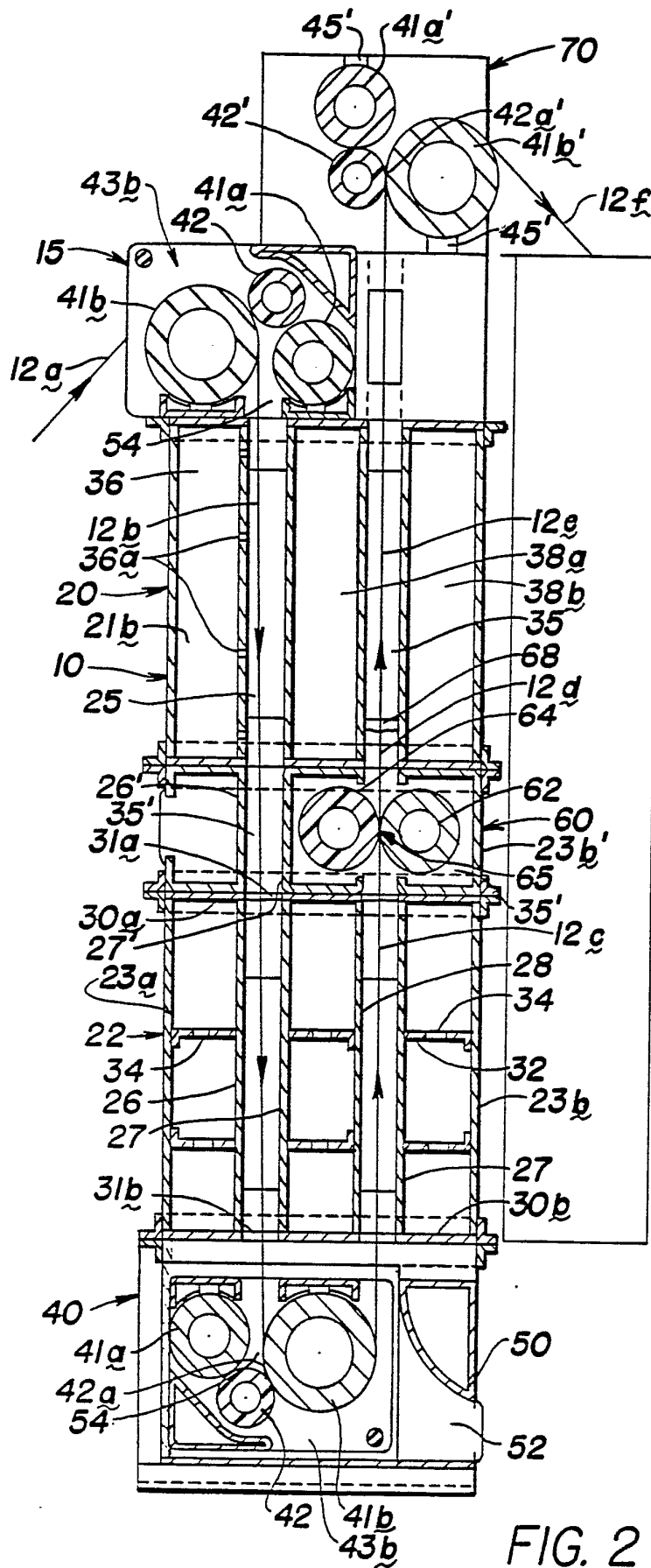
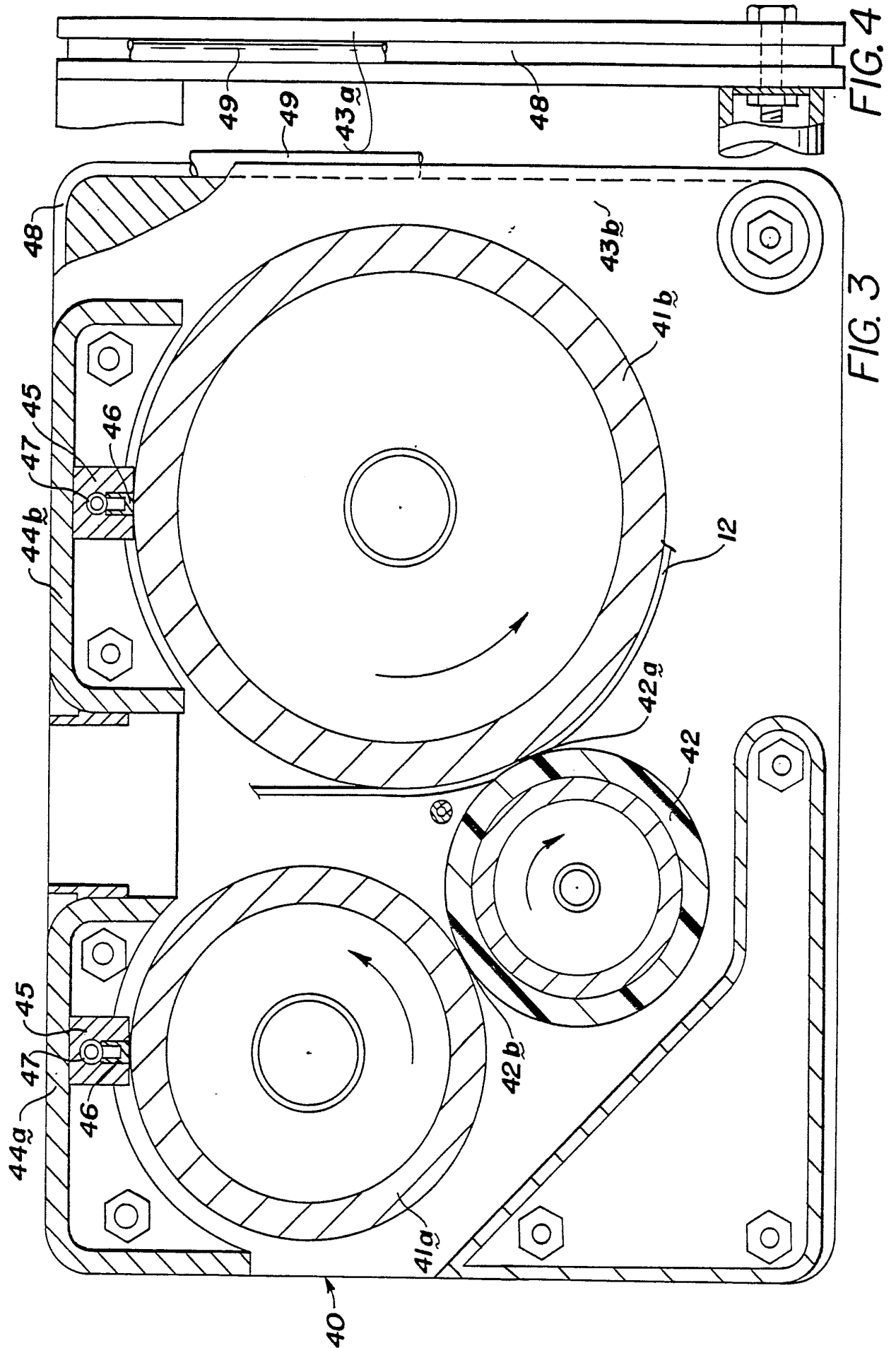


FIG. 2

3/4



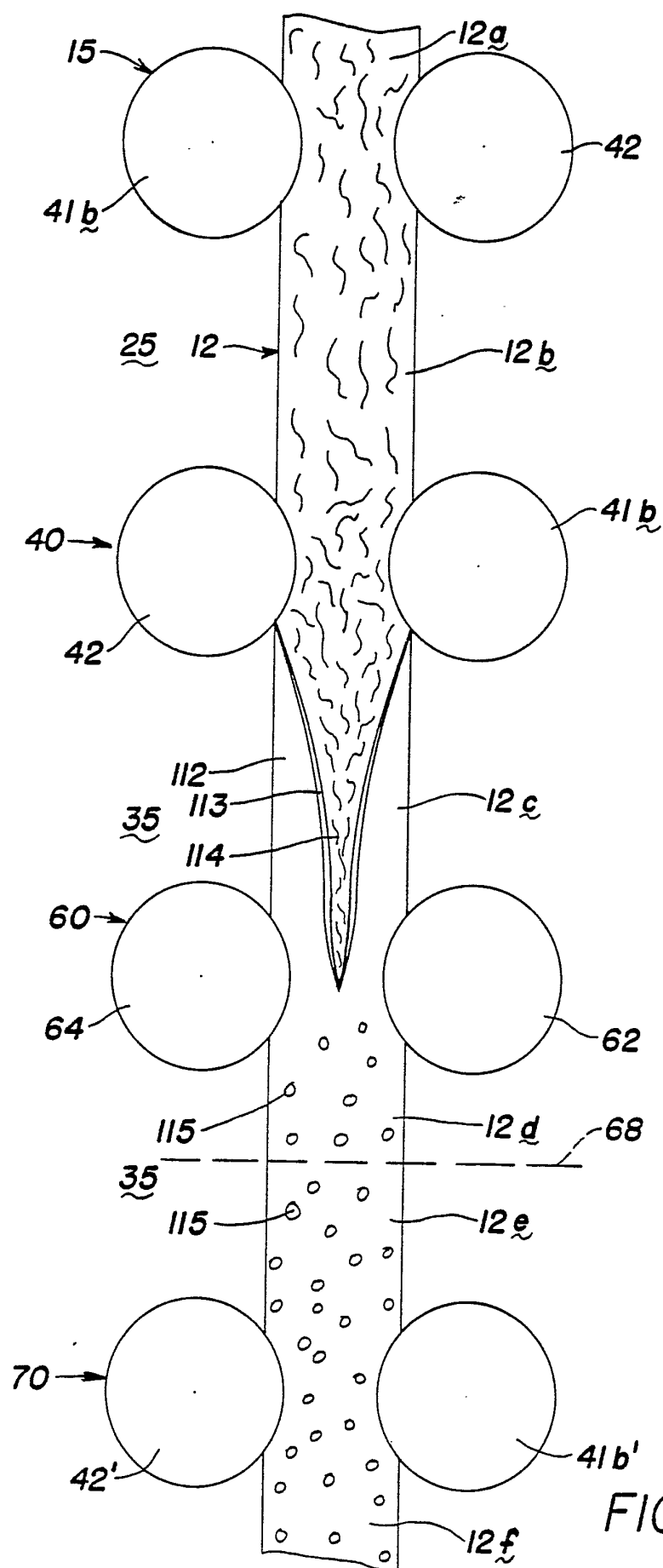
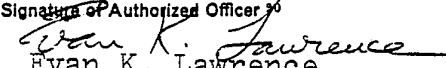


FIG. 5

# INTERNATIONAL SEARCH REPORT

International Application No PCT/US85/02006

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>3</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC INT. CL. 4 B05D 3/00, 3/12; B05C 3/12, 11/115 U.S. CL. 427/296, 326, 434.4; 118/50, 405, 424, 427		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>4</sup>		
Classification System	Classification Symbols	
U.S.	118/50, 405, 424, 427 427/294, 296, 326, 434.4	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>5</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>		
Category *	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
A	US, A, 1,322,327 PUBLISHED 18 NOVEMBER 1919 MINTON	
A	US, A, 1,595,491 PUBLISHED 10 AUGUST 1926 MINTON	
A	US, A, 1,633,121 PUBLISHED 21 JUNE 1927 MINTON	
A	US, A, 2,125,364 PUBLISHED 02 AUGUST 1938 WALDRON	
A	US, A, 2,193,861 PUBLISHED 19 MARCH 1940 CROWLEY	
A	US, A, 3,360,415 PUBLISHED 26 DECEMBER 1967 HELLMAN ET AL	
A	US, A, 3,533,834 PUBLISHED 13 OCTOBER 1970 MARZOCCHI	
A	US, A, 3,644,137 PUBLISHED 22 FEBRUARY 1972 FOX ET AL	
A	US, A, 3,826,703 PUBLISHED 30 JULY 1974 RUSSELL	
<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p>* Special categories of cited documents: <sup>15</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 48%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <sup>2</sup>		Date of Mailing of this International Search Report <sup>2</sup>
18 NOVEMBER 1985		03 DEC 1985
International Searching Authority <sup>1</sup>		Signature of Authorized Officer <sup>10</sup>
ISA/US		 Evan K. Lawrence

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No <sup>18</sup>
A	US, A, 3,848,439 PUBLISHED 19 NOVEMBER 1974 LOPATA	
A	US, A, 3,881,445 PUBLISHED 06 MAY 1975 NOTHIGER	