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(71) Applicant: **MEDITE CORPORATION
Medford, Oregon 97501 (US)**

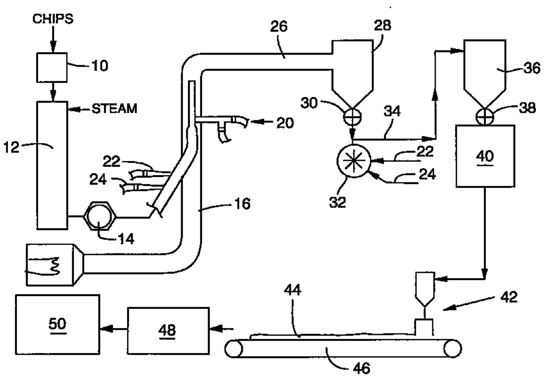
(72) Inventors:
- **Harmon, David M.
Phoenix, Oregon 97535 (US)**
- **Poitevint, Loy L.
Medford, Oregon 97501 (US)**
- **Allen, William M.
Medford, Oregon 97501 (US)**
- **Washburn, Donald L.
Medford, Oregon 97504 (US)**
- **Hutchison, Kenneth L.
White City, Oregon 97503 (US)**

(74) Representative: **Meddle, Alan Leonard
FORRESTER & BOEHMERT
Franz-Joseph-Strasse 38
80801 München (DE)**

(54) Method and apparatus for reducing blowline obstructions during production of cellulosic composites

(57) An apparatus and method are described that allow for the continuous production of cellulosic products produced using reactive binder compositions by significantly reducing or substantially eliminating obstructions of the blowline. A binder application assembly is used to apply binder compositions to the cellulosic materials in the blowline. The application assembly generally is plumbed to the blowline at an obtuse angle and at a position adjacent the blowline outlet. The application assembly includes an air sheath that defines a conduit through which a binder applicator passes. Preferred embodiments of the invention also include a binder-diluent mixer that is operatively coupled to the binder applicator. The binder-diluent mixer includes a binder inlet for receiving a first stream containing a binder, a diluent inlet for receiving a second stream containing a diluent, and an inline mixer that is fluidly connected to the binder inlet and the diluent inlet to produce a mixed stream. The mixed stream is conveyed to the binder applicator and is applied to the cellulosic material in the blowline. The mixer may include supplemental inlets for receiving supplemental materials that are useful for producing cellulosic products. The method comprises conveying cellulosic material in a blowline and through a blowline outlet that is positioned inside an inlet portion of a dryer. Binder is applied to the cellulosic material in the blowline using the binder application assembly.

FIG. 1



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Description

FIELD OF THE INVENTION

The present invention concerns an apparatus and method for manufacturing products from cellulosic or lignocellulosic materials.

BACKGROUND OF THE INVENTION

Refined cellulosic and/or lignocellulosic materials (referred to as furnish) may be fashioned into finished products. Examples of processes for forming such products are shown in Betzner's U.S. Patent No. 4,407,771 and Harmon's U.S. Patents, Nos. 5,093,058 and 5,188,785. The disclosures of Harmon's patents are incorporated herein by reference. Board products are formed from cellulosic furnish by first reducing cellulosic fibers to the desired size using a refiner. The refined cellulosic material is then mixed with a binder and possibly other chemicals, including fire retardants, release agents and sizing agents. The cellulosic material is then partially dewatered, formed into mats and compressed between heated platens in a hot press to form a consolidated board product.

Although a number of binders are used for forming consolidated board products, a particularly useful group of binders are the isocyanates or polyisocyanates, which are collectively referred to herein as isocyanate binders. These binders have advantages over other binders. For instance, isocyanate binders produce boards having greatly improved weather resistance and reduce processing times compared to standard phenolic binders. Moreover, using specially formulated binders, such as the phenolic binders, may be significantly more expensive.

Isocyanate binders are very reactive and generally are applied to furnish as aqueous emulsions or dispersions. Isocyanate binders often react within the binder dispensing apparatus before the binder can be applied to the furnish. Isocyanate binders also may adhere to other structures, such as the dryer wall, accumulating thereon and eventually forming obstructions. This prevents continuous operation of the processing system because the system must be shut down to clear the obstruction. This has been found to be a particularly egregious problem when isocyanate binder compositions are introduced into the blowline of the apparatus at elevated temperatures. The isocyanate binders are more reactive at elevated temperatures, and therefore quickly cure in the blowline or dryer. Current processes that utilize blowlines and introduce isocyanate binders into the blowlines can run continuously for less than about 48 hours. Shutting down the apparatus to clear obstructions is unavoidable and expensive.

Known processes and apparatuses utilizing fast-curing binders such as isocyanates and also utilizing a blowline for transporting the cellulosic fibers from the refiner to the dryer, have added the binder to the blowline close to the refiner and remote from the blowline outlet. This was done to provide adequate mixing time of the binder and cellulosic material before the fast-moving binder-fiber stream enters the dryer. However, this need for adequate mixing time has exacerbated the problem of binder buildup and obstruction of the blowline and dryer.

Water-cooled isocyanate-binder-application devices have been developed ostensibly for addressing problems associated with isocyanate reactivities. Water-cooling devices lower the temperature of the isocyanate binder compositions, thereby increasing the time required for binder precure. However, water-cooling alone has proven ineffective in solving the problem of binder precure and obstruction of the blowline.

Accordingly, there is a need for a method and apparatus for adequately mixing cellulosic fibers and a highly reactive binder in a binder-fiber stream while eliminating the buildup of obstruction in the apparatus caused by binder precure.

It is therefore an object of the present invention to provide an apparatus and method for producing products from cellulosic furnish using reactive binders, such as the isocyanate binders, in a manner which significantly reduces or substantially eliminates apparatus obstructions, particularly blowline obstructions, while also providing adequate mixing time for the binder and cellulosic fibers before the binder-fiber stream enters the dryer.

SUMMARY OF THE INVENTION

The present invention provides an apparatus and method that satisfies the object stated above, allowing for the continuous production of cellulosic products that are produced from reactive binder compositions adequately mixed with cellulosic fibers. According to the invention, it has been found, surprisingly, that obstruction of the blowline and equipment components downstream thereof, can be eliminated or significantly reduced, while still providing adequate mixing of binder and fibers, by introducing the binder to the fiber stream within the blowline, but close to the blowline outlet rather than near the blowline inlet at the refiner.

In a preferred embodiment, a blowline is used to transport cellulosic furnish to a dryer. A binder application assembly applies binder compositions to the furnish in the blowline. The application assembly, which is plumbed to the blowline at a position adjacent the blowline outlet, includes an air sheath that defines a conduit through which a binder applicator passes. Air is drawn or forced into the air sheath to cool the binder composition. The air exits through plural vent holes provided in the air sheath. Attached to the binder applicator is a nozzle for applying binder to the furnish in the blowline.

The binder application assembly is plumbed to the blowline generally at an obtuse angle α as defined between the application assembly and a downstream wall of the blowline. As used herein, "upstream" and "downstream" refer to the direction cellulosic furnish travels in the blowline, with "upstream" being against the direction of travel, and "downstream" being with the direction of travel. Although the angle α may vary and the apparatus still function appropriately, angle α generally varies from about 90 degrees to about 135 degrees, with currently preferred angles being from about 110 degrees to about 120 degrees. Moreover, the binder application assembly is coupled to the blowline at a position of from about six inches to at least about twelve feet upstream from the blowline outlet, with a currently preferred coupling position being from about twelve inches to about forty-eight inches upstream from the blowline outlet.

Generally, the blowline outlet is positioned inside the dryer. The wall of the dryer adjacent the blowline inlet portion has an aperture therethrough through which the binder application assembly passes. The blowline may operate at a pressure less than ambient (negative pressure) or greater than ambient (positive pressure). When the blowline operates at a negative pressure, air is drawn through the vent holes, into the air sheath and around the binder applicator to help cool the binder composition. If the blowline operates at a positive pressure, then the air sheath generally is capped and includes a pressurized air inlet. Pressurized air is introduced through the pressurized air inlet to flow around the binder applicator.

Preferred embodiments of the invention also include a binder-diluent mixer that is operatively coupled to the binder applicator. The binder-diluent mixer includes a binder inlet for receiving a first stream containing a binder, a diluent inlet for receiving a second stream containing a diluent, and an inline mixer that is fluidly connected to the binder inlet and the diluent inlet to produce a mixed stream. The mixed stream is conveyed to the binder applicator and is applied to the furnish in the blowline. The mixer may include supplemental inlets for receiving supplemental materials that are useful for producing cellulosic products. The supplemental materials include, but are not limited to, materials selected from the group consisting of fire retardants, release agents and sizing agents.

The apparatus may further include a binder control valve at the binder inlet and a diluent control valve at the diluent inlet. The valves are fluid pressure operated to open by the respective downstream pressure of the first and second streams to allow the first and second streams to flow through the inlets and into the mixer. The valves are closable, respectively, in response to a reduction in the downstream pressures as applied by the first and second streams. A purger also may be used for purging the mixer of binder using the diluent. The purger maintains downstream pressure on the diluent control valve while reducing downstream pressure on the binder control valve to close the binder control valve, thereby purging downstream portions of the apparatus of binder by continuing flow of the diluent.

An especially preferred embodiment of the apparatus is used for the production of board products from cellulosic furnish and reactive isocyanate binder compositions. The apparatus comprises a refiner which produces hot and wet cellulosic fibers. A blowline transports cellulosic fibers from the refiner to a dryer through a blowline outlet positioned inside an inlet portion of the dryer. The binder application assembly described above applies binder to furnish in the blowline. A binder-diluent mixer also typically is operatively coupled to the binder applicator. A conveyor transports the cellulosic material from the dryer to a mat-forming apparatus to form a mat. A heated press compresses the mat and cures the binder to form a consolidated product.

The method of the present invention comprises conveying cellulosic material in a blowline to a dryer through a blowline outlet that is positioned inside an inlet portion of the dryer. Binder is applied to the cellulosic material in the blowline using a binder application assembly as described above. The cellulosic material may be formed into mats, and the mats compressed with a heated press to cure the binder.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram illustrating one embodiment of an apparatus and process of the present invention.

FIG. 2 is a schematic diagram illustrating mixing the binder and diluent prior to application to the fibers.

FIG. 3 is a schematic cross-sectional view of one embodiment of a nozzle useful for practicing the present invention.

FIG. 4 is a schematic drawing illustrating one embodiment of a blowline and a dryer of the present invention.

FIG. 5 is a schematic view illustrating a binder application assembly coupled to a negative pressure blowline.

FIG. 6 is a schematic view illustrating a binder application assembly coupled to a positive pressure blowline.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is useful for producing cellulosic or lignocellulosic products, particularly fiberboard, from furnish and isocyanate binders. FIG. 1 illustrates the process of the present invention. Briefly, FIG. 1 shows that cellulosic material, such as wood chips, is fed into a feeder 10 for delivery to a digester 12. The cellulosic material is subjected to steam and high pressure in digester 12 to soften the cellulosic material and break down the lignin. The processed chips are then transferred to a refiner 14. Refiner 14 separates the cellulosic material into its constituent fibers. The material in the refiner 14 consists of hot and wet cellulosic fibers.

Hot wet fibers and steam exit refiner 14. The fibers travel rapidly in a continuous moving stream through a blowline 16. Binder, and other compounds, such as fire retardants, release agents and sizing agents, are typically added to the furnish in the blowline 16. Although the binder may be virtually any binder useful for the production of cellulosic materials, the present invention is particularly useful for highly reactive binders such as those selected from the group consisting of monomeric isocyanates, oligomeric isocyanates, and mixtures thereof, wherein the binders have an isocyanate functionality of at least two.

Heretofore, to ensure adequate mixing of the binder in the fiber stream, binder compositions have been introduced into the blowline 16 immediately adjacent the refiner 14. This causes the isocyanate binders to cure in the interior portions of the blowline 16, causing obstructions that require periodic removal while the equipment is shut down. The present apparatus and method, which significantly reduce or substantially eliminate blowline obstructions, allow for the application of binder to furnish at a location downstream of that used to practice known inventions while still, surprisingly, providing adequate mixing of binder and fibers. It previously was believed that deposits of the binder composition on blowline wall 18 would be minimized due to the presence of a continuous film of water condensate. Furthermore, it was believed that the turbulence within the blowline 16 would produce a scouring action which would keep blowline wall 18 clean of cured binder, or cured binder/cellulosic mixtures. Finally, it was believed that the binder residence time in the blowline 16, which is on the order of a few seconds, was sufficiently short that deleterious isocyanate binder reactions had insufficient time and energy to occur. These beliefs have proven untrue in practice. The aforementioned features have not sufficiently prevented obstruction of blowline 16 to enable efficient and continuous production of cellulosic binder composites. Prior to the present invention it was virtually impossible to continuously operate an isocyanate binder/blowline addition process for periods of greater than about 48 hours.

FIG. 1 illustrates a nozzle assembly 20 that is plumbed to an assembly for dispensing binder into the fiber stream in the blowline 16 as described below. FIG. 1 shows that additional conventional nozzles 22, 24, may be plumbed to the blowline 16 for applying other additive materials, such as fire retardants, release agents and sizing agents, to the fibers. These materials also may be applied to the fibers by attaching supplemental inlet lines to the nozzle assembly 20 for each of the materials that might be added to the cellulosic material in the blowline 16.

The fiber-binder stream exits the blowline 16 at an outlet 128 (FIG. 5) into a draw tube 106 leading into a dryer section 26 for partial dewatering. A cyclone 28 and an airlock 30 are provided to separate the cellulosic material from the dryer airstream. The fibers next pass to a blender 32 wherein additional agents, including additional binders, sizing agents, release agents, and/or other desired materials, can be mixed with the cellulosic material. Once all desired compounds have been added to form a binder-cellulosic composite, the composite is then directed through a transfer system 34. Transfer system 34 leads directly to a second cyclone 36. Second cyclone 36 has an airlock 38, which leads to a fiber storage bin 40. The fibers are fed from storage bin 40 to one or more forming head apparatuses 42. Apparatuses 42 dispense a mat of fibers 44 onto a forming belt 46. Mat 44 is deaerated by one or more prepresses 48 and then compressed to the final press thickness by a hot press 50, which also cures the binder to form the desired product.

FIG. 2 is a schematic diagram which illustrates mixing the binder, diluent and other agents to form binder compositions prior to applying the composition to the fibers. For instance, FIG. 2 illustrates that release agents and sizing agents may be added, separately or together, to binder stream 52, diluent stream 54, combined binder-diluent stream 56, or directly to fiber stream 58, as shown by dashed line 60. Additional compounds also can be added to form the binder composition at various locations, such as those locations shown by dashed lines 62-66. In this manner, diluent, binder, and additional compounds are merged and mixed immediately prior to application to the fiber stream 58.

FIG. 3 illustrates one embodiment of a mixing assembly 20 useful for mixing the binder and diluent, and other desired materials. FIG. 3 shows that mixing assembly 20 comprises a diluent inlet 68, a binder inlet 70, and a mix section 72 for mixing the diluent and binder. Mixing assembly 20 also may include a threaded portion 74 for coupling the assembly 20 to other structures, such as the binder applicator described below. A stream of a diluent, such as water, is introduced through diluent inlet 68. A stream of binder, which preferably is selected from the group consisting of isocyanate, polyisocyanate, or other suitable thermosetting binders, is introduced through binder inlet 70. Diluent inlet 68 may include a quick disconnect coupling 76, which allows for the quick connection or disconnection to a diluent supply line 78. A pressure relief check valve 80 may be used for diluent inlet 68, which is operated by a control spring 82 and is connected, such as threadedly connected, to coupling 76. The diluent check valve 80 prevents backflow from mix section 72 from entering diluent supply line 78. In addition, diluent check valve 80 only opens to allow diluent into mix section 72 when the pressure of the water stream is above a certain minimum pressure of about fifteen psi. This assures that there will be no admixing of water and binder until the water stream has achieved proper operating pressure. This also assures that the flow of diluent into mixing assembly 20 will stop immediately upon stopping flow of the diluent stream or upon a drop in the pressure of the stream. Suitable check valves 80 are commercially available.

Binder inlet 70 similarly includes a coupling 84 for connection to a binder supply line 86 with a coupling 88 through which binders are delivered to mixing assembly 20. Pressure relief check valve 90 is used for binder inlet 70. Check valve 90 includes a control spring 92, and is strutedly connected to coupling 84. Check valve 90 operates to prevent backflow from mix section 72 from entering binder supply line 86. Check valve 90 also prevents the admixing of water and binder before the binder stream has achieved its proper operating pressure.

Mix section 72 includes an intersecting T section 94. Intersecting T section 94 is strutedly attached to the outlets of diluent check valve 80 and binder check valve 90 for receiving the binder stream 52 and the diluent stream 54. T section 94 also is connected to an in-line mix section 96 that is equipped with a plurality of interior baffles 98 which cause mixing of the binder and the diluent. The exact number and the exact configuration of the baffles 98 is not a critical feature. The important aspect of the mix section 96 is that sufficient mixing occurs so as to produce a suitably mixed binder composition for application to the fibers.

FIGS. 1 and 4-6 show that a portion of the blowline 16 generally is encompassed by or positioned within an inlet portion of dryer 26. Furthermore, FIGS. 4-6 illustrate that blowline 16 includes a downstream section 100 which has a smaller diameter than the upstream portions 10 of the blowline 16. The velocity of the cellulosic material increases as it enters section 100, which enhances the mixing of the binder composition and the cellulosic material. The diameters of sections 100, 101 may vary depending upon the cellulosic throughput. One working prototype of the apparatus utilizes a blowline 16 having an upstream section 101 of six-inch inner diameter, and a downstream section 100 with a four-inch inner diameter. These diameters are satisfactory for processing cellulosic throughputs of from about 175 pounds/minute to about 750 pounds/minute. The amount by which the diameter of the blowline 16 is reduced from its upstream section 101 to form section 100 should be such as to increase stream flow velocity sufficiently to provide adequate mixing of binder and fibers from the point at which the binder is introduced into the stream of fibers to the outlet of the blowline, and as discussed later, to provide the desired effect in drawing binder into the fiber flow. It currently is believed that the best results may be obtained by reducing the diameter of blowline 16 by about 30-35%, and more typically by about 33%.

To put the foregoing and other dimensions in perspective, in practice the dimensions of the various components of a fiberboard manufacturing system as described will vary considerably from one facility to another. In a working prototype apparatus for practicing the present invention, for example, the dryer tube 26 was about 150 feet long with an inner diameter of about six feet. The blowline 16 had a length of about sixty feet from the refiner to the outlet in the inlet of the dryer tube 26. The main upstream section 101 of the blowline had an inside diameter of six inches, and the reduced-diameter downstream section 100 had an inside diameter of about four inches, with the length of the downstream section being at least twelve feet, and generally greater than about fifteen feet. Dimensions of other components of the prototype apparatus are mentioned where appropriate in the detailed description for illustrative purposes. Before the present invention, the binder inlet into the blowline was positioned ten feet from the refiner outlet. In the working prototype, the binder inlet has been successfully positioned at various distances from the blowline outlet ranging from about six inches to about twelve feet, and always much closer to the blowline outlet than to the blowline inlet.

FIGS. 4-6 illustrate the coupling of a binder application assembly 102 to the blowline portion 100. FIG. 4 illustrates that the binder application assembly 102 is plumbed to the blowline portion 100 at an angle α as defined between the binder application assembly 102 and that portion of wall 18 that is downstream of the binder application assembly 102. It has been found that certain angles provide a beneficial venturi effect immediately adjacent to the binder composition injection point 104 in section 100. This facilitates thorough mixing of the binder-diluent compositions and the cellulosic furnish. Thorough mixing of the binder compositions and the cellulosic material also is benefitted by the increased velocity that occurs when the cellulosic material enters section 100.

Binder application assembly 102 passes through dryer wall 106 at dryer wall inlet 108. Binder application assembly 102 comprises two tubes, an outer air sheath 110 and a binder applicator 112. Binder applicator 112 passes through a conduit that is defined by air sheath 110. Air sheath 110 is attached to blowline wall 18 of portion 100 by a threaded attachment 114. A gasket 116 is positioned about the air sheath 110 to reduce or prevent air leaks through inlet 108 about the air sheath 110. Binder applicator 112 also is threadedly connected to blowline wall 18 by a threaded attachment 130.

The inner diameters of the air sheath 110 and binder applicator 112 may vary depending upon the particular application of interest and the cellulosic throughput. There likely is a practical upper limit on the diameter of the binder applicator 112 in view of the amount of binder and other agents that will be applied to the cellulosic material entrained in the blowline section 100. This practical upper limit has not been determined, but it would depend on several factors, including the cellulosic material throughput. It has been found that an air sheath 110 having an inner diameter of about 2.0 inches and a binder applicator having an inner diameter of about 0.75 inch operate effectively for cellulosic furnish throughputs that vary from about 175 pounds/minute to about 750 pounds/minute.

Dryer 26 may operate at either positive pressure or negative pressure relative to the pressure external to the dryer wall 106, which is referred to herein as ambient pressure. FIG. 5 illustrates a binder application assembly 102 coupled to a negative pressure dryer 26 by threaded attachment 114. Because dryer 26 operates at a negative air pressure, air is drawn into the interior of the dryer 26 through plural vent holes 118 in air sheath 110. A working prototype of the invention uses vent holes 118 having a diameter of about 0.5 inch. Vent holes 118 are separated by a distance of about 2.0 inches. Vent holes 118 also generally are separated by about 90 degrees around the circumference of the air sheath 110. Vent holes 118 exhaust cool air from the air sheath 110 as a result of the lower pressure inside the dryer 26 compared to ambient pressure. The number of vent holes 118 is best determined by considering, amongst other things, the binder residence time in binder applicator 112 prior to application to the cellulosic material, the ambient temperature, and the particular binder being used and its reactivity. Current embodiments of the invention include from about eight to about twelve vent holes 118. Some care should be taken to place vent holes 118 adjacent the threaded coupling 114 of the binder application assembly 102 to prevent "hot spots" from developing in this portion of the apparatus.

FIG. 6 shows an embodiment of the invention that is useful for applying binder compositions to cellulosic material in blowlines operating at positive pressures. FIG. 6 illustrates a binder application assembly 102 coupled to a positive pressure dryer 26 by threaded attachment 114. Application assembly 102 includes a cap 132 through which binder applicator 112 passes. Air sheath 110 includes a pressurized air conduit 134. Conduit 134 is coupled to a compressor 136 by a pressurized air line 138. When dryer 26 operates at a positive air pressure, pressurized air is forced into the application assembly 102 by compressor 136. The pressurized air flows around applicator 112 and through plural holes 118 in air sheath 110.

FIGS. 5 and 6 illustrate that the mixing assembly 20 is fluidly coupled (plumbed) to binder applicator 112. Any suitable method for coupling the mixing assembly 20 to the binder applicator can be used to practice the present invention. For instance, FIGS. 5 and 6 illustrate that a threaded portion 114 of mixing assembly 20 can by threadedly coupled to mating threads 120 of binder applicator 112.

FIGS. 4-6 also illustrate the relationship of the blowline portion 100 to the binder application assembly 102. More specifically, FIGS. 4-6 illustrate that a preferred embodiment of the binder application assembly 102 is positioned at an obtuse angle α relative to a downstream portion of the blowline wall 18. By attaching the binder application assembly 102 to section 100 at an angle α of greater than 90 degrees, i.e., an obtuse angle, a Venturi effect can be established in that portion of section 100 adjacent to binder composition injection point 104. Moreover, the angle α should be such that the binder composition exiting nozzle 122 that is attached to the binder applicator 112 has an opportunity to disperse and coat the air-entrained furnish without impinging upon the inner surface 124 of blowline wall 18.

Angle α also depends on the nozzle 122, and on the position of the nozzle 122 relative to the injection point 104 of binder applicator 112. Nozzles 122 can be obtained commercially having different binder dispersion angles. For instance, commercial nozzles 122 can be purchased wherein the spray dispersion angle is either 90 degrees or 120 degrees. Although either of these commercially available nozzles 122 can be used to practice the invention, a working prototype of the present invention currently uses a nozzle 122 having a spray angle of about 120 degrees with the angle α being about 110-120 degrees to provide the desired venturi effect and binder-fiber mixing. If nozzle 112 is recessed too far in air sheath 110, then the binder dispersion angle from nozzle 122 becomes more important.

The positioning of the binder application assembly 102 in terms of the angle α and on the distance of nozzle 122 from the injection point 104 is best summarized by considering (1) maximizing the efficiency of binder application to the furnish entrained in blowline portion 100, and (2) on eliminating or substantially reducing the amount of binder composition that collects on the inner surface 124 of blowline wall 18.

The distance between the injection port 104 for the binder application assembly 102 and the blowline outlet 128 as measured along the blowline wall 18 is important to the continuous, obstruction-free production of binder-cellulosic products, but will vary depending on the sizing and configuration of the various components. Certain positions of the binder inlet relative to the blowline outlet provide either (1) inadequate mixing of binder composition and cellulosic furnish, and/or (2) no better results than previous inventions in terms of operating continuously by avoiding obstructions of the system. Certain discrete positions of the application assembly 102 binder inlet from the outlet 128 have been evaluated in a working prototype to determine the efficiency of binder application to the entrained cellulosic material and the prevention of blowline obstruction. These discrete positions include four inches, six inches, twelve inches and thirty-six inches. With a throughput of from about 175 pounds/minute to about 750 pounds/minute, the four-inch position provides inadequate mixing time to mix the binder composition with the cellulosic furnish. The six-inch position provides better mixing than the four-inch position, although distances of greater than about six inches provide even better results in terms of mixing the binder composition with the cellulosic furnish. Currently, placing the binder injection point 104 at a distance of from about twelve inches to about forty-eight inches from the outlet 128 provides both adequate binder-cellulosic material mixing and prevention of blowline obstruction.

However, there likely are other positions that also would both (1) decrease clogging times, and (2) provide adequate mixing of the binder and the cellulosic material relative to known techniques. This distance is best described not in absolute distances, but rather in functional terms. Cellulosic throughput through the system often varies considerably. If the injection point 104 is too close to the blowline outlet 128, then as the cellulosic material throughput varies, which occurs during normal operation, the binder composition may accumulate at the outlet 128 of the blowline portion 100, and subsequently on the walls of the dryer 26. As this continues, the binder material accumulating in the blowline portion 100 and/or the dryer 26 carbonizes. The carbonized material eventually starts to burn inside the system, which causes significant production disruption.

The present invention allows for the continuous operation of the apparatus, including the blowline, for periods well in excess of the forty-eight hours achieved by known inventions. Tests of the present invention have resulted in no blowline obstructions to date. Thus, the present invention provides significantly superior results when compared to previous apparatuses and methods.

Having illustrated and described the principles of the present invention in several preferred embodiments, it will be apparent to those skilled in the art that the invention can be modified in arrangement and detail without departing from such principles. We claim all modifications coming within the spirit and scope of the following claims.

Claims

1. An apparatus for the production of products from cellulosic furnish and reactive binder compositions, comprising: a blowline (16) for transporting cellulosic fibers in an air stream from a refiner (14) through a blowline outlet (128) into a dryer (26); a binder applicator (20) having a binder outlet for applying a binder into the blowline (16) through a binder inlet port (104), the binder inlet port (104) being positioned along the blowline (16) substantially closer to the blowline outlet (128) than to the refiner (14).

2. An apparatus according to Claim 1, wherein the blowline (16) includes a section of reduced diameter along its length and wherein the binder inlet port (104) is located along the section.

3. An apparatus according to Claim 2, wherein the section of reduced diameter is at a downstream end portion of the blowline (16).

4. An apparatus according to any preceding claim, wherein the binder outlet is a nozzle (122) located at an outlet end of the binder applicator (20).

5. An apparatus according to any preceding claim, wherein the binder applicator (20) intersects the blowline (16) at an obtuse angle (α) defined between the binder applicator (20) and a downstream wall (124) of the blowline (16).

6. An apparatus according to Claim 5, wherein the angle (α) is from about 90 degrees to about 135 degrees.

7. An apparatus according to any preceding claim, wherein the binder applicator (20) is plumbed to the blowline (16) at a position adjacent the blowline outlet (128).

8. An apparatus according to Claim 7, wherein the binder applicator (20) is coupled to the blowline (16) at a position from about six inches (152.4mm) or greater upstream from the blowline outlet (128).

9. An apparatus according to Claim 7, wherein the binder applicator (20) is coupled to the blowline (16) at a position of from about six inches (152.4mm) to about twelve feet (3.66m) upstream from the blowline outlet (120).

10. An apparatus according to Claim 7, wherein the binder applicator (20) is coupled to the blowline (16) at a position of from about six inches (152.4mm) to about thirty-six inches (914.4mm) upstream from the blowline outlet (128).

11. An apparatus according to any preceding claim, wherein the binder applicator (20) includes an air sheath (110) that surrounds an applicator tube (112) and defines a conduit around the applicator tube (112).

12. An apparatus according to Claim 11, wherein the air sheath (110) has plural vent holes (118) therethrough.

13. An apparatus according to Claim 12, wherein the blowline (16) is operable at a pressure less than ambient so that air is drawn through the vent holes (118), into the air sheath (110) and around the binder applicator tube (112).

14. An apparatus according to Claim 12, wherein the blowline (16) is operable at positive pressure, and wherein the air sheath (110) has attached thereto a source of pressurized air (136) for introducing pressurized air into the air sheath (110) and around the binder applicator tube (112).

15. An apparatus according to any preceding claim further comprising: a binder-diluent mixer that is operatively coupled to the binder applicator (20), the binder-diluent mixer including a binder inlet (70) for receiving a first stream containing a binder, a diluent inlet (68) for receiving a second stream containing a diluent, and an inline mixer (72) that is fluidly

connected to the binder inlet (70) and the diluent inlet (68) to produce a mixed stream that is conveyed to the binder applicator (20) for application to the furnish in the blowline (16).

16. An apparatus according to Claim 15, wherein the mixer includes supplemental inlets for receiving supplemental materials selected from the group consisting of fire retardants, release agents and sizing agents.

17. An apparatus according to Claim 15 or 16 further including a binder control valve (90) at the binder inlet (70) and a diluent control valve (80) at the diluent inlet (68), the valves (80,90) being fluid pressure operable to open by the respective downstream pressure of the first and second streams to allow the first and second streams to flow through the inlets (68,70) and into the mixer, the valves being closable, respectively, in response to a reduction in the downstream pressures as applied by the first and second streams.

18. An apparatus according to any one of Claims 15 to 17 including a purger for purging the mixer of binder using the diluent.

19. An apparatus according to Claim 18, wherein the purger maintains downstream pressure on a diluent control valve (80) while reducing downstream pressure on a binder control valve (90) to close the binder control valve (90), thereby purging downstream portions of the apparatus of binder by continuing flow of the diluent.

20. An apparatus according to any preceding claim further comprising: a conveyor for transporting cellulosic materials from the dryer (26) to a mat-forming apparatus (42) to form a mat (44); and a heated press (50) for compressing the mat and curing the binder, thereby forming a consolidated board product.

21. A method for forming cellulosic products using reactive binder compositions, comprising: transporting cellulosic material in a blowline (16) and through a blowline outlet (128) into a dryer (26); and applying binder to the cellulosic material in the blowline (16) using a binder applicator (20) which comprises an air sheath (110) that defines a conduit through which a binder applicator tube (112) passes, the binder applicator (20) being plumbed to the blowline (16) at a position adjacent the blowline outlet (128).

22. A method according to Claim 21, wherein the binder is applied by the binder applicator (20) which is plumbed to the blowline (16) at a position that is from about six inches (152.4mm) to about twelve feet (3.66m) upstream from the blowline outlet (128).

23. A method according to Claim 22, wherein the binder is applied by the binder applicator (20) which is plumbed to the blowline (16) to form an obtuse angle between the air sheath (110) and a downstream wall of the blowline (16).

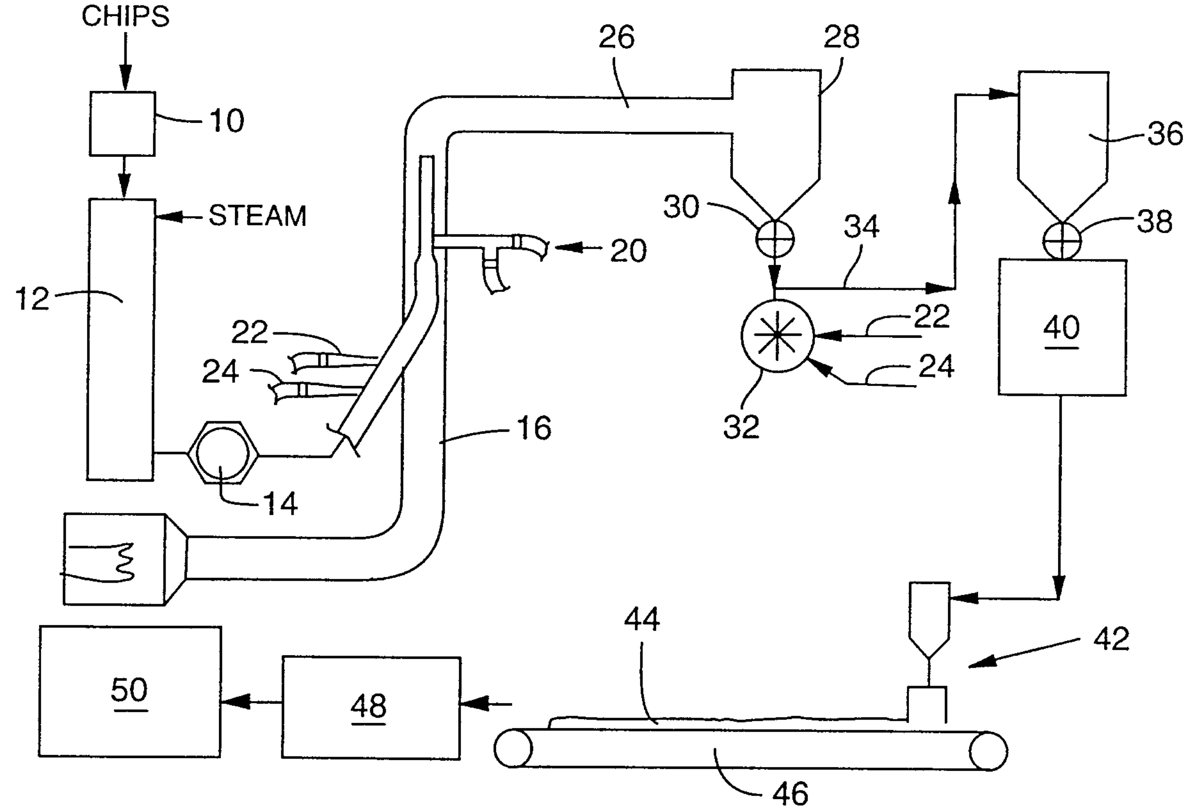
24. A method according to Claim 22 or 23, further comprising: forming the cellulosic material into mats (44); and compressing the maters (44) with a heated press (50) to cure the binder.

25. A method according to any one of Claims 22 to 24, wherein the binder is selected from the group consisting of monomeric isocyanates, oligomeric isocyanates, and mixtures thereof.

26. A method according to any one of Claims 22 to 25, wherein the binder includes a material selected from the group consisting of fire retardants, sizing agents and release agents.

27. A method according to any one of Claims 22 to 26, comprising the further steps of: extracting hot and wet fibers from cellulosic materials; transporting a diluent stream and a stream of the binder separately generally towards the blowline (16); merging the diluent stream and the binder stream to form a mixed stream; and applying the mixed stream to the fibers in the blowline (16).

FIG. 1


CHIPS
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STEAM
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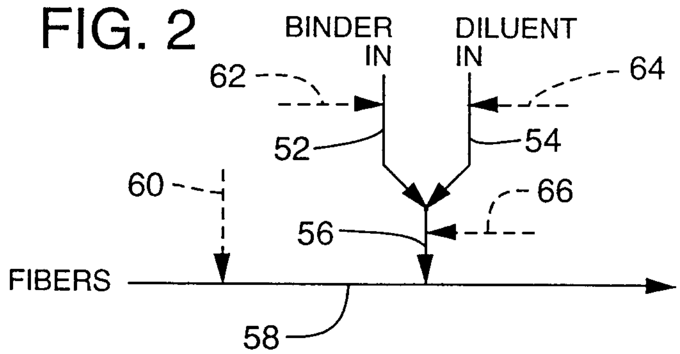
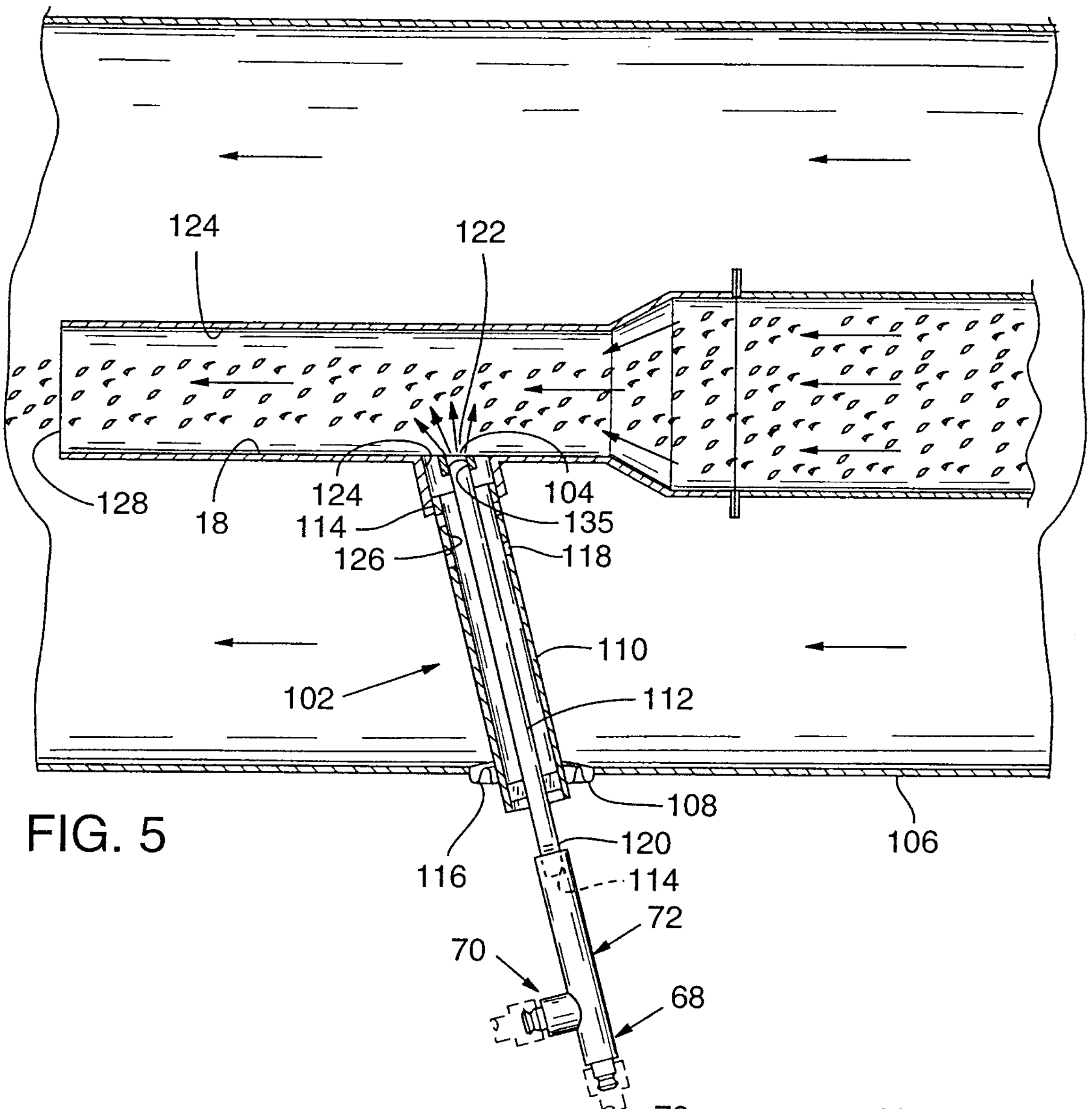
FIG. 2


BINDER IN
DILUENT IN
62
64
52
54
60
66
56
FIBERS
58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122
128
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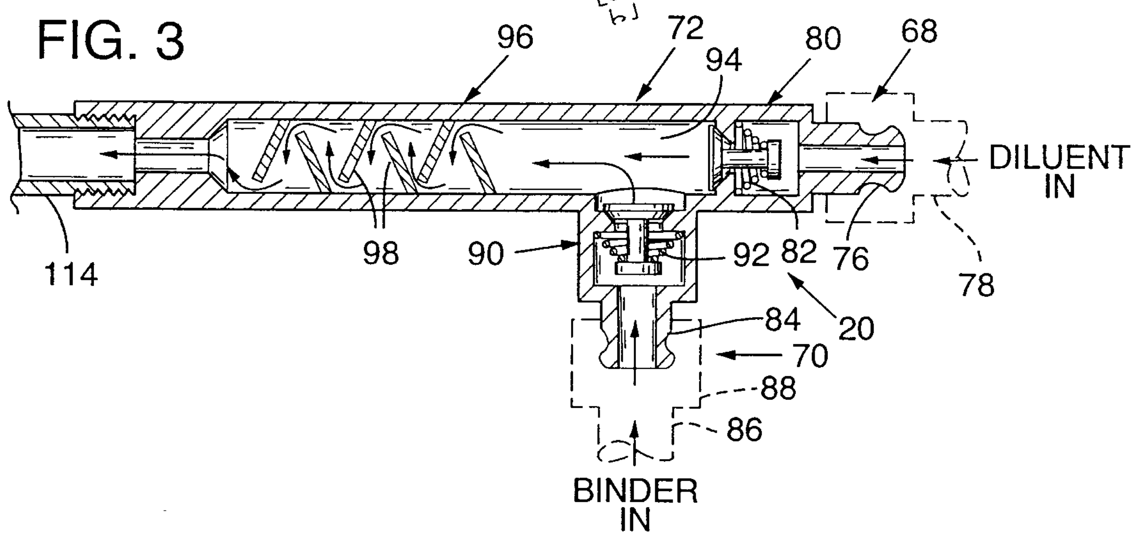
106

FIG. 5


96
72
94
80
68
DILUENT IN
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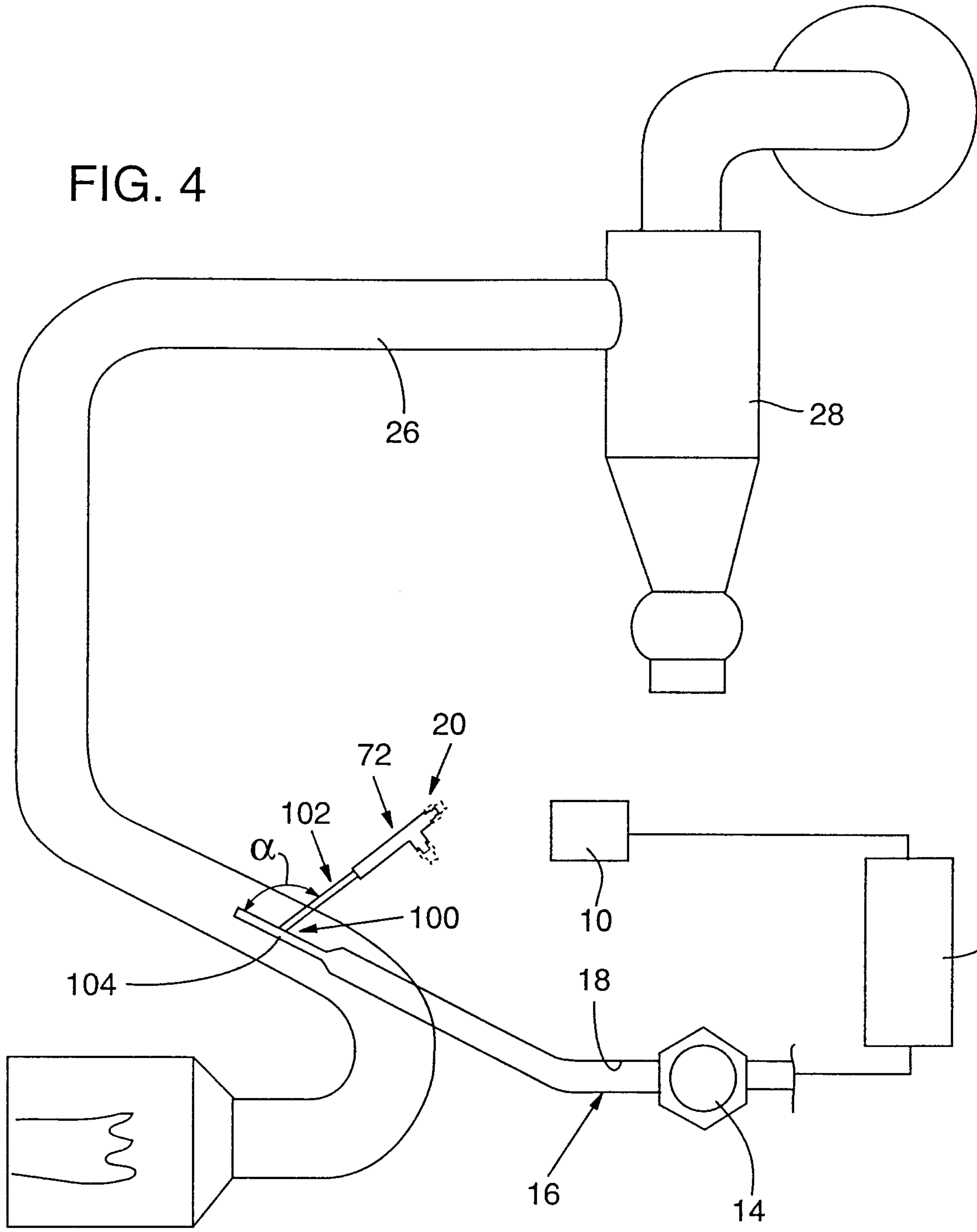
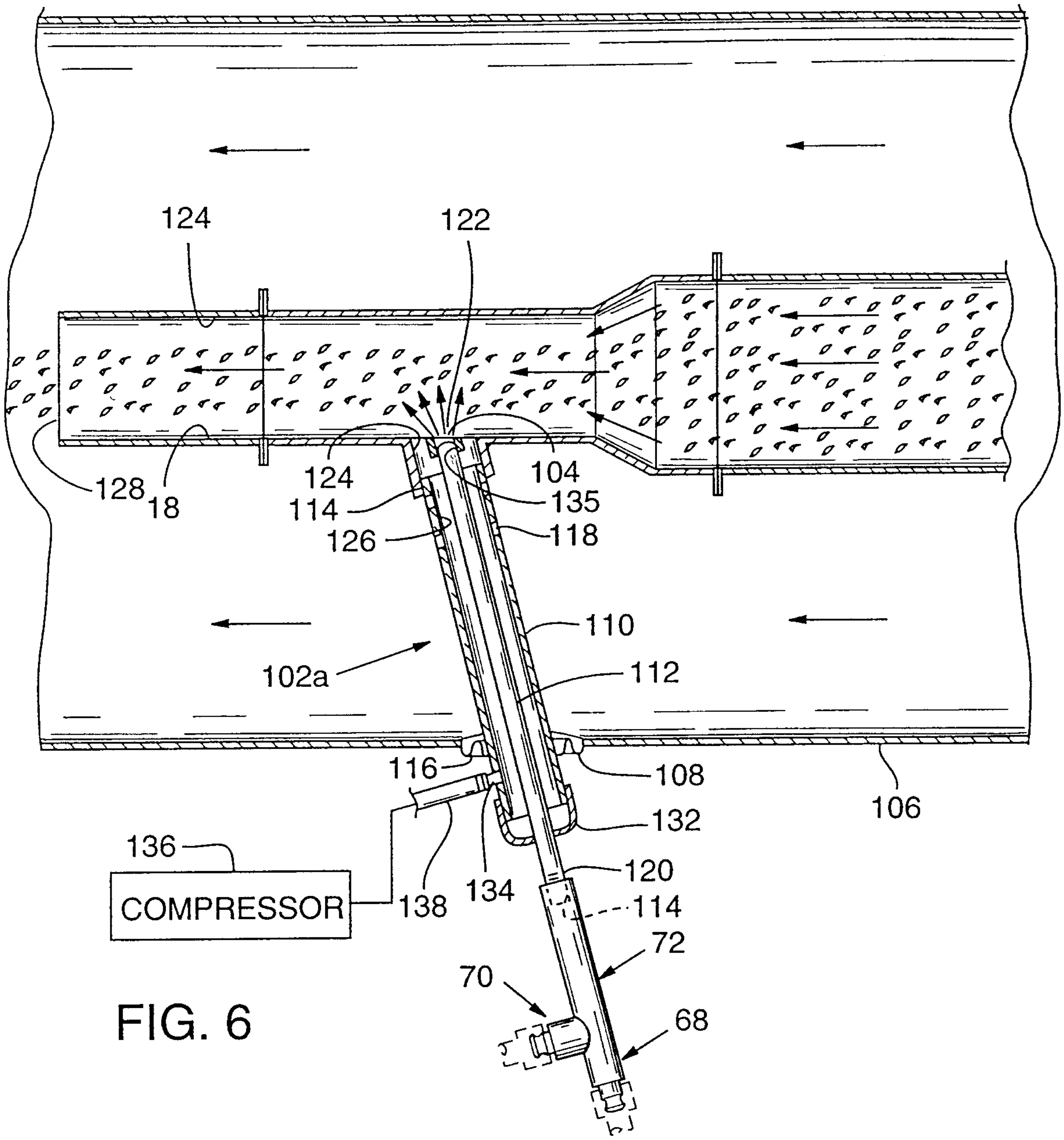
90
92
82
76
78
20
84
70
88
86
BINDER IN

FIG. 3

FIG. 4




124
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124
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128
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102a
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106
132
136
COMPRESSOR
138
134
120
114
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FIG. 6