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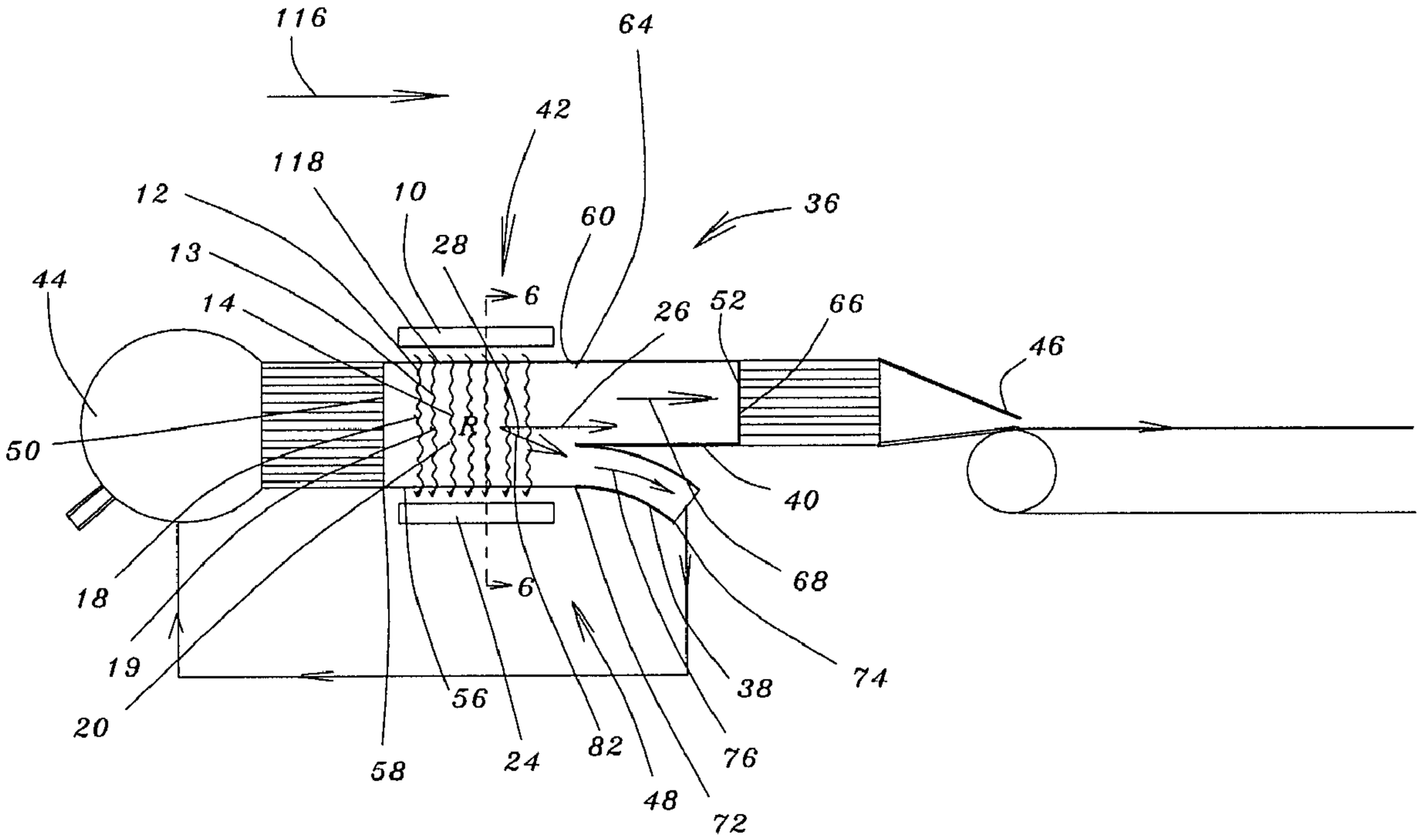

(57) Abrégé/Abstract:
An apparatus for controlling the consistency of a flow of stock solution in a papermaking machine comprises a generator (10) of ultrasonic waves (12-14) and an ultrasound absorber (24) arranged in such a way that the flow of the stock solution flows for deviating the fiber particles (18-20) suspended within the stock solution are deviated from the flow direction for the control of the cross machine direction stock solution consistency profile.

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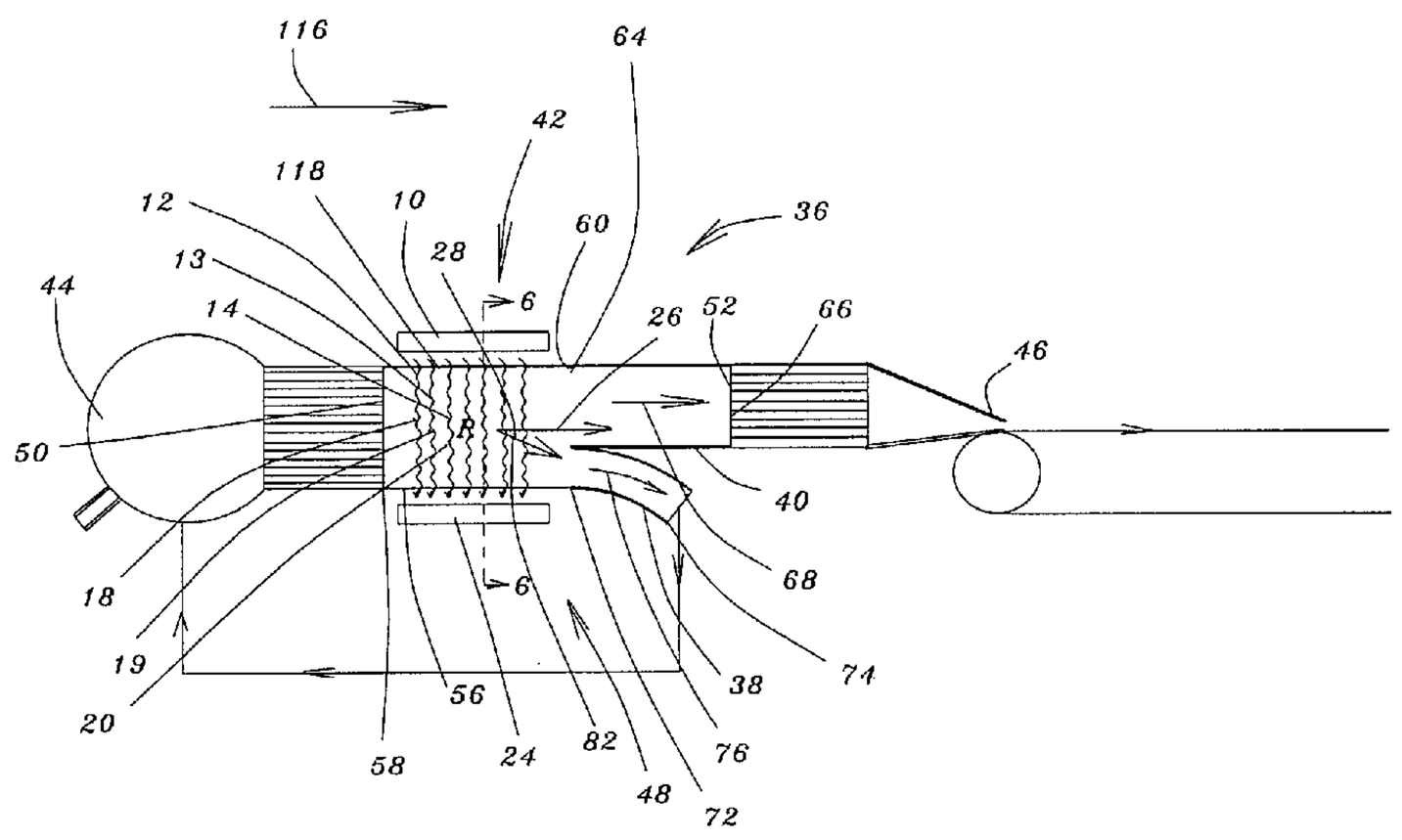

(57) Abstract: An apparatus for controlling the consistency of a flow of stock solution in a papermaking machine comprises a generator (10) of ultrasonic waves (12-14) and an ultrasound absorber (24) arranged in such a way that the flow of the stock solution flows for deviating the fiber particles (18-20) suspended within the stock solution are deviated from the flow direction for the control of the cross machine direction stock solution consistency profile.

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APPARATUS AND METHOD FOR CONTROLLING THE CONSISTENCY OF A FLOW OF STOCK SOLUTION IN A PAPERMAKING MACHINE

DESCRIPTION

Background of the invention.

Field of the invention.

The present invention relates to an apparatus for controlling the consistency of a flow of stock solution flowing from a header to a slice lip of a headbox of a papermaking machine. More specifically, the present invention relates to an apparatus and a method for controlling the consistency of a flow of stock solution flowing from a header to a slice lip of a headbox of a papermaking machine so that the cross machine direction profile of a resultant web is controlled.

Background information.

In the papermaking industry, a solution of paper stock is supplied to a headbox of a papermaking machine. The pressurized stock is guided through a plurality of headbox flow channels into a slice chamber of the headbox. The stock is then ejected as a thin ribbon through a slice lip defined by the downstream end of the headbox. The ejected stock is received onto a moving Fourdrinier screen where water drains from the stock solution to provide a formed web.

One of the more important quality parameters in the paper making process is the evenness of the cross machine direction basis weight profile. Even if the cross machine profile of the concentration of the stock ejected from the headbox slice is fairly even, the final basis weight profile is normally altered due to several defects produced along the process in the machine. These defects include an uneven flow profile of the stock ejected from the headbox, uneven retention of the fibers on the fourdrinier, uneven pick up of solids in the size press or in the coating station. The usual way to control the aforementioned defects is to compensate for them by controlling the consistency profile of the stock before it is ejected from the headbox.

The headbox is divided into several discrete cross machine sections of a certain width and in each of these sections the consistency of the stock is individually controlled according to the measure of the basis weight of the final sheet in the corresponding cross machine section.

The present invention provides an apparatus and method for controlling the consistency profile in a headbox and for providing a web having a more uniform cross machine direction basis weight profile.

Many prior art arrangements have been devised in an attempt to provide a relatively uniform grammage or basis weight in a cross machine direction of the web. Early attempts at controlling the aforementioned characteristic of the web included the provision of a plurality of slice lip screw jacks spaced a few inches from each other in a cross machine direction. Such jacks were connected to a movable slice lip of the slice opening. Controlled movement of the jacks would warp the slice lip in such a way that a relatively uniform ribbon of stock would be ejected through the slice opening. Nevertheless, such arrangements were complex. Also, the adjustment of one of the jacks had the tendency to alter the basis weight of stock flowing past an adjacent jack.

A further development included the provision of uniformly spaced slice lips while controlling the consistency or dilution of the stock in a cross machine direction upstream relative to the slice lips. More particularly, immediately upstream from the tube bank, a flow of diluting white water or the like was selectively introduced into one or more of the headbox tubes of the tube bank so that the consistency of the stock flowing through that particular tube would be changed or diluted relative to the consistency of stock flowing through an adjacent tube.

More particularly, in the prior art dilution arrangement, by controlling the injected suspension flow in the vicinity of the tube bank, it was possible to a large extent to control the concentration of the resultant suspension downstream from the injection point. Such an injection arrangement has the disadvantage that the correction of suspension concentration requires the adding of an extraneous means to the suspension itself which can generate technological problems into the paper making process. Such an arrangement also necessitates the provision of additional circuitry for the dilution water and the provision of additional pumping apparatus. The need of the addition of a secondary suspension to control the concentration of the main suspension makes it almost impossible to selectively change the suspended particles without interacting with the hosting liquid phase.

The present invention provides a unique means for achieving a uniform basis weight or grammage in a cross machine direction by the application of ultrasonic waves for controlling in a cross machine direction, the grammage of the resultant web.

According to the present invention, when ultrasonic waves are applied to a liquid suspension, such ultrasonic waves have the capability of moving the suspended particles. In particular, particles suspended in a stationary suspension and contained within a reservoir are located in between an ultrasound generator and a ultrasound absorber

device. When ultrasonic waves are applied to the particles, such particles are moved by the ultrasound waves in a direction extending from the generator to the absorber.

Similarly, the same effect occurs when ultrasonic waves are applied to a moving suspension of particles. For example, when a flow of the suspension is moving in a generic direction at a generic speed and the suspension flow crosses a region between the ultrasound generator and the absorber, then the suspended particles will be deviated from the flow direction by a motion component which is parallel to the line going from the generator to the absorber.

The result is that downstream from the ultrasonic device, the suspension will not have the same homogeneity as the homogeneity of the suspension upstream relative to the ultrasonic device. This is so because the suspended particles will tend to migrate toward the absorber. As a consequence of such migration downstream from the ultrasonic device, the suspension flow will have been concentrated on the absorber side and diluted on the generator side.

The object of the present invention is the application of the aforementioned physical principle to control the concentration of a paper making fibrous material suspension or stock solution through a head box.

In a paper machine head box, according to the present invention, the control of fiber suspension concentration or consistency in any specific cross machine section of the headbox is used to control the final paper sheet cross machine grammage profile.

Applying the above-mentioned effect of ultrasonic waves on fluid suspensions in a specific cross machine section of the headbox by the use of an ultrasonic device dedicated that specific headbox cross machine section, it is possible to exert a force on any single solid particle suspended in the region corresponding to the same specific cross machine section of the headbox and move it inside the liquid hosting phase. As a consequence, it is possible to locally concentrate or dilute the suspension. More specifically, by applying energy in the form of ultrasound waves, it is possible to create a degree of dis-homogeneity into the suspension. By controlling the amount of energy supplied to the generator, or the capacity of the absorber, it is possible to control the state of dis-homogeneity of the suspension in the specific section and as a consequence, to control local concentration of the suspension.

As an example, in the system of the present invention, the effect is applied to a suspension such as paper stock flowing into a channel from left to right.

Ultrasound waves cross the channel from the top to the bottom. Such waves push suspended particles or fibers toward the bottom side of the channel. Downstream from the ultrasonic device, the channel is split into secondary channels, that is a supply channel and a recirculation channel. It is evident that the average concentration of the suspension received by the supply channel is in this case lower than the average concentration of the suspension received by the recirculation channel. The difference between the two concentrations is in some way related to the power delivered by the ultrasonic device. In particular, the higher the power, of the generator or the capacity of the absorber, the bigger is the difference in concentration between the supply channel and the recirculation channel. By controlling the ultrasonic device, it is possible to control the concentration in at least one of the two secondary channels.

By controlling the power delivered by the ultrasonic device, it is possible to control the concentration in at least one of the two secondary channels.

In a paper machine headbox according to the present invention, the fiber suspension of the stock solution enters the headbox from a supply header and is transferred to a tube bank through a bank of flow channels. The adjacent channels forming the flow channels can be either physically separated one from the other by sidewalls or not. The principle of two secondary channels is applied to each single flow channel. Each flow channel is equipped with its own ultrasonic device. Also, each ultrasonic device includes an independent control. Each flow channel is split into two secondary channels, one top channel and one bottom channel. One of the two secondary channels is a supply channel of a corresponding cross machine direction section of the headbox tube bank. The other secondary channel or recirculation channel of each flow channel permits recirculation to the supply system of the headbox. A recirculation header collects the flow from each of the recirculation channels of all the flow channels. The stock collected by the recirculation header is simply recirculated into the stock approach system with no need for any extra equipment.

Applying the principle of the present invention, it is evident that it is possible to individually control the concentration of the suspension in any secondary supply channel covering a specific respective headbox cross machine section by controlling its respective ultrasonic generator. From previous knowledge of paper machine technology, it is known that if one is able to control independently the stock concentration into each specific cross machine section of a headbox, then it is possible to control the cross machine grammage profile of the finished paper.

Therefore, it is a primary feature of the present invention to provide an apparatus and method for controlling the cross machine consistency profile of a stock solution within a headbox of a papermaking machine that overcomes the problems associated with the prior art arrangements.

Another feature of the present invention is the provision of an apparatus for controlling the cross machine consistency profile of a stock solution within a headbox of a papermaking machine so that the grammage profile of the resultant web can be controlled.

Other features and advantages of the present invention will be readily apparent to those skilled in the art by a consideration of the detailed description of a preferred embodiment of the present invention contained herein.

Summary of the invention.

The present invention relates to an apparatus for controlling the cross machine consistency profile of a flow of stock solution flowing from a header to a slice lip of a headbox of a papermaking machine so that the cross machine direction consistency profile of a resultant web is controlled. The apparatus includes a flow channel which is disposed within the headbox between the header and the slice lip. The flow channel has an upstream and a downstream end such that the flow of the stock solution is in a flow direction from the upstream end towards the downstream end of the flow channel. The flow channel includes a primary channel having a first and a second extremity such that the flow of the stock solution is through the primary channel from the first extremity to the second extremity of the primary channel. A supply channel has a first and a second end and is disposed downstream relative to the primary channel for the flow therethrough of a supply portion of the flow of the stock solution. The second end of the supply channel is connected to the slice lip so that the supply portion of the flow of the stock solution flows to the slice lip. A recirculation channel has a first and a second termination, the recirculation channel being disposed downstream relative to the primary channel for the flow therethrough of a recirculation portion of the flow of the stock solution. The second termination of the recirculation channel is connected to the header so that the recirculation portion of the flow of the stock solution flows to the header. A generator is disposed adjacent to the primary channel for generating ultrasonic waves within the flow of the stock solution flowing through the primary channel. The ultrasonic waves move fiber particles suspended within the stock solution for controlling the consistency of the stock solution flowing through the primary channel. Also, an

ultrasound absorber is disposed adjacent to the primary channel such that the flow of the stock solution flows in the flow direction within a region disposed between the generator and the absorber so that in operation of the apparatus, when the stock solution is flowing within the region, the fiber particles suspended within the stock solution are deviated from the flow direction. The arrangement is such that the consistency of the stock solution flowing from the primary channel through the supply channel is different from the consistency of the stock solution flowing from the primary channel through the recirculation channel so that the consistency of the supply portion of the stock solution flowing through the slice lip is controlled thereby controlling the cross machine direction profile of the resultant web.

In a more specific embodiment of the present invention, the apparatus includes a further generator which is disposed adjacent to the primary channel and laterally relative to the generator for generating ultrasonic waves within the flow of the stock solution flowing through the primary channel. The ultrasonic waves move fiber particles suspended within the stock solution for controlling the consistency of the stock solution flowing through the primary channel.

Furthermore, a further ultrasound absorber is disposed adjacent to the primary channel and laterally relative o the absorber such that the flow of the stock solution flows in the flow direction within a further region disposed between the further generator and the further absorber such that in operation of the apparatus, when the stock solution is flowing within the further region, the fiber particles suspended within the stock solution are deviated from the flow direction so that the consistency of the stock solution flowing from the primary channel downstream from the further region through the supply channel is different from the consistency of the stock solution flowing from the primary channel downstream from the further region through the recirculation channel. The arrangement is such that the consistency of a further supply portion of the stock solution flowing through the slice lip downstream from the further region is controlled relative to the supply portion of the stock solution flowing downstream from the region through the slice lip thereby controlling the cross machine direction consistency profile of the resultant web.

In a preferred embodiment of the present invention, the flow direction is approximately parallel to a direction from the header to the slice lip.

Also, the primary channel defines a primary conduit of rectangular cross sectional configuration, the primary conduit extending from the first extremity to the second extremity of the primary channel.

More particularly, the first end of the supply channel extends from the second extremity of the primary channel and the supply channel is disposed above the recirculation channel.

However, in another embodiment of the present invention, the supply channel is disposed below the recirculation channel.

Additionally, the first termination of the recirculation channel extends from the second extremity of the primary channel such that the flow of the stock solution flowing through the primary channel is split into the supply portion and the recirculation portion adjacent to the second extremity of the primary channel.

In one embodiment of the present invention, the apparatus further includes a control device which is electrically connected to the generator for controllably altering the generation of the ultrasonic waves by the generator.

However, in an alternative embodiment of the present invention, a device is mechanically connected to the generator for controllably altering a location of the generator relative to the primary channel so that generation of the ultrasonic waves within the region by the generator is altered.

In another embodiment of the present invention, a controller is electrically connected to the ultrasound absorber for controllably altering absorption of the ultrasonic waves by the absorber.

Alternatively, a control device is mechanically connected to the absorber for controllably altering a disposition of the absorber relative to the primary channel so that absorption of the ultrasonic waves by the absorber is altered.

In each of the alternative embodiments of the present invention, the flow direction within the region is disposed non parallel to a direction from the generator to the absorber.

However, more specifically, the flow direction within the region is disposed substantially normal to a direction from the generator to the absorber.

Moreover, the direction from the generator to the absorber is substantially normal to the flow direction within the region such that in use of the apparatus, the ultrasonic waves deviate movement of the fiber particles in a component direction which is

disposed angularly between the flow direction and the direction from the generator to the absorber.

The present invention also includes a method for controlling the consistency of a flow of stock solution flowing from a header to a slice lip of a headbox of a papermaking machine so that the cross machine direction consistency profile of a resultant web is controlled. The method includes the steps of guiding the flow of the stock solution through a flow channel which is disposed within the headbox between the header and the slice lip. The flow channel includes a primary channel which has a first and a second extremity. A supply channel has a first and a second end, the supply channel being disposed downstream relative to the primary channel for the flow therethrough of a supply portion of the flow of the stock solution. The second end of the supply channel is connected to the slice lip so that the supply portion of the flow of the stock solution flows to the slice lip. A recirculation channel has a first and a second termination, the recirculation channel being disposed downstream relative to the primary channel for the flow therethrough of a recirculation portion of the flow of the stock solution. The second termination of the recirculation channel is connected to the header so that the recirculation portion of the flow of the stock solution flows to the header.

The method also includes the steps of generating ultrasonic waves within the flow of the stock solution flowing through the primary channel by an ultrasonic generator. The ultrasonic waves move fiber particles suspended within the stock solution for controlling the consistency of the stock solution flowing through the primary channel.

Additionally, the method includes absorbing the ultrasonic waves by an ultrasound absorber disposed adjacent to the primary channel such that the flow of the stock solution flows in the flow direction within a region which is disposed between the generator and the absorber. The arrangement is such that when the stock solution is flowing within the region, the fiber particles suspended within the stock solution are deviated from the flow direction so that the consistency of the stock solution flowing from the primary channel through the supply channel is different from the consistency of the stock solution flowing from the primary channel through the recirculation channel. The method is such that that the consistency of the supply portion of the stock solution flowing through the slice lip is controlled thereby controlling the cross machine direction consistency profile of the resultant web.

Many modifications and variations of the present invention will be readily apparent to those skilled in the art by a consideration of the detailed description contained hereinafter taken in conjunction with the annexed drawings which show a preferred embodiment of the present invention. However, such modifications and variations fall within the spirit and scope of the present invention as defined by the appended claims.

Brief description of the drawings.

Fig. 1 is a schematic to demonstrate the effect of the application of ultrasonic waves on a stock solution according to the present invention;

Fig. 2 is a similar view to that shown in Fig. 1 but shows the generator energized;

Fig. 3 is a similar view to that shown in Fig. 2 but shows the fiber suspension or stock solution in motion;

Fig. 4 is a diagrammatic representation of an apparatus according to the present invention for controlling the consistency of stock solution within a headbox of a papermaking machine;

Fig. 5 a side elevational view of an apparatus for controlling the consistency of a flow of stock solution flowing from a header to a slice lip of a headbox of a papermaking machine;

Fig. 6 is a sectional view taken on the line 6-6 of Fig. 5;

Fig 7 is a similar view to that shown in Fig. 6 but shows another embodiment of the present invention;

Fig. 8 is a sectional view taken on the line 8-8 of Fig. 7;

Fig. 9 is a side elevational view of another embodiment of the present invention;

Fig. 10 is a similar view to that shown in Fig. 6 but shows a further embodiment of the present invention;

Fig. 11 is a similar view to that shown in Fig. 10 but shows a further embodiment of the present invention;

Fig.12 is a similar view to that shown in Fig. 10 but shows another embodiment of the present invention; and

Fig. 13 is a similar view to that shown in Fig. 11 but shows a further embodiment of the present invention.

Similar reference characters refer to similar parts throughout the various views and embodiments of the drawings.

Detailed description of the drawings.

Fig. 1 is a schematic to demonstrate the effect of the application of ultrasonic waves on a stock solution according to the present invention. As shown in Fig. 1, a generator 10 is disposed adjacent to a first side of a container 16 and an absorber 24 is disposed on the opposite side of the container 16. The container 16 is filled with a suspension of fiber particles 18, 19 and 20 randomly dispersed throughout the host liquid such as water.

Fig. 2 is a similar view to that shown in Fig. 1. However, as shown in Fig. 2, the generator 10 is energized so that the generator 10 emits ultrasonic waves 12, 13 and 14 through the container 16 containing the fiber particles 18, 19 and 20 suspended in water. Accordingly, the ultrasonic waves 12-14 cause the particles 18-20 to move through the water in a direction as indicated by the arrow 22 from the generator 10 towards the absorber 24.

Fig. 3 is a similar view to that shown in Fig. 2 but shows the fiber suspension or stock solution in motion. As shown in Fig. 3, the stock solution which includes the fibers 18-20 is moving through the container 16 in a flow direction as indicated by the arrow 26. As shown in Fig. 3, the flow direction 26 is normal to the direction 22. In this case, the fiber particles 18-20 will move in a component direction which is indicated by the arrow 28. The component direction 28 is disposed angularly between the directions 22 and 26. Consequently, in a downstream location relative to the generator 10, the suspension or stock solution will be more concentrated or will have a higher consistency on the side 30 of the container 16 nearest to the absorber 24. Similarly, the stock solution will be diluted or will be of a lower consistency on a further side 32 of the container 16 nearest to the generator 10 as shown in Fig. 3.

Fig. 4 is a diagrammatic representation of an apparatus according to the present invention for controlling the consistency of the stock solution 34 which includes the fibers 18-20, within a headbox generally designated 36 of a papermaking machine. As shown in Fig. 4, when the generator 10 is activated, ultrasonic waves 12-14 are emitted through the stock solution 34 flowing in the flow direction 26 through the headbox 36. The ultrasonic waves 12-14 move in the direction 22 from the generator 10 across the flow direction 26 of the stock solution 34 towards the absorber 24. Consequently, the consistency or concentration of the fibers within the stock solution 34 is greater on the side 30 of the headbox 36 which is nearest to the absorber 24. Such concentrated stock is diverted through a downstream recirculation channel 38. However, on the further side 32 of the headbox 36 nearest to the generator 10, the stock solution 34 is diluted because

many of the fibers 18-20 have migrated towards the side 30 under the influence of the applied ultrasonic waves 12-14. Such diluted stock is guided through a downstream supply channel 40.

Fig. 5 a side elevational view of an apparatus generally designated 42 according to the present invention for controlling the consistency of a flow of stock solution flowing from a header 44 to a slice lip 46 of a headbox generally designated 36 of a papermaking machine so that the cross machine direction consistency profile of a resultant web is controlled. The apparatus 42 includes a flow channel generally designated 48 which is disposed within the headbox 36 between the header 44 and the slice lip 46. The flow channel 48 has an upstream and a downstream end 50 and 52 respectively such that the flow of the stock solution is in a flow direction 26 from the upstream end 50 towards the downstream end 52 of the flow channel 48. The flow channel 48 includes a primary channel 56 having a first and a second extremity 58 and 60 respectively such that the flow of the stock solution is through the primary channel 56 from the first extremity 58 to the second extremity 60 of the primary channel 56. A supply channel 40 has a first and a second end 64 and 66 respectively and is disposed downstream relative to the primary channel 56 for the flow therethrough of a supply portion as indicated by the arrow 68 of the flow of the stock solution. The second end 66 of the supply channel 40 is connected to the slice lip 46 so that the supply portion 68 of the flow of the stock solution flows to the slice lip 46. A recirculation channel 38 has a first and a second termination 72 and 74 respectively, the recirculation channel 38 being disposed downstream relative to the primary channel 56 for the flow therethrough of a recirculation portion as indicated by the arrow 76 of the flow of the stock solution. The second termination 74 of the recirculation channel 38 is connected to the header 44 so that the recirculation portion 76 of the flow of the stock solution flows to the header 44. A generator 10 is disposed adjacent to the primary channel 56 for generating ultrasonic waves 12-14 within the flow of the stock solution flowing through the primary channel 56. The ultrasonic waves 12-14 move fiber particles 18-20 suspended within the stock solution for controlling the consistency of the stock solution flowing through the primary channel 56. Also, an ultrasound absorber 24 is disposed adjacent to the primary channel 56 such that the flow of the stock solution flows in the flow direction 26 within a region R disposed between the generator 10 and the absorber 24 so that in operation of the apparatus 42, when the stock solution is flowing within the region R, the fiber particles 18-20 suspended within the stock solution are deviated as indicated by the arrow 28 from

the flow direction 26. The arrangement is such that the consistency of the stock solution flowing from the primary channel 56 through the supply channel 40 is different from the consistency of the stock solution flowing from the primary channel 56 through the recirculation channel 38 so that the consistency of the supply portion 68 of the stock solution flowing through the slice lip 46 is controlled thereby controlling the cross machine direction consistency profile of the resultant web.

Fig. 6 is a sectional view taken on the line 6-6 of Fig. 5. As shown in Fig. 6, the flow channel 48 extends across most of the cross machine width of the headbox 36. Also, the supply channel 40 is shown leading to the slice lip. Furthermore, the recirculation channel 38 is shown for returning concentrated stock solution to the header.

Fig 7 is a similar view to that shown in Fig. 6 but shows another embodiment of the present invention. As shown in Fig. 7, an apparatus 42a includes a further generator 84 disposed adjacent to the primary channel 56 for generating ultrasonic waves within the flow of the stock solution flowing through the primary channel 56. The ultrasonic waves move fiber particles suspended within the stock solution for controlling the consistency of the stock solution flowing through the primary channel 56.

Fig. 8 is a sectional view taken on the line 8-8 of Fig. 7. As shown in Figs. 7 and 8, a further ultrasound absorber 86 is disposed adjacent to the primary channel 56 such that the flow of the stock solution flows in the flow direction 26 within a further region r disposed between the further generator 84 and the further absorber 86. The arrangements is structured such that in operation of the apparatus 42a, when the stock solution is flowing within the further region r, the fiber particles suspended within the stock solution are deviated from the flow direction 26 so that the consistency of the stock solution flowing from the primary channel 56 through the supply channel 62 downstream from the region r is different from the consistency of the stock solution flowing from the primary channel 56 downstream from the region r through the recirculation channel 38. The arrangement is such that the consistency of a further supply portion 88 of the stock solution flowing downstream from the region r through the slice lip 46 is controlled relative to the supply portion 68 of the stock solution as shown in Fig. 5, flowing downstream from the region R through the slice lip 46 thereby controlling the cross machine direction consistency profile of the resultant web.

In a preferred embodiment of the present invention, the flow direction 26 is approximately parallel to a direction as indicated by the arrow 116 from the header 44 to the slice lip 46.

Also, as shown in Fig. 5, the primary channel 56 defines a primary conduit 118 of rectangular cross sectional configuration. As shown in Fig. 6, the primary conduit 118 extends from the first extremity 58 to the second extremity 60 of the primary channel 56.

More particularly, as shown in Fig. 5, the first end of the supply channel 40 extends from the second extremity 60 of the primary channel 56 and the supply channel 40 is disposed above the recirculation channel 38.

Fig. 9 is a side elevational view of another embodiment of the present invention. As shown in Fig. 9, the supply channel 40b is disposed below the recirculation channel 38b.

Additionally, as shown in Fig. 5, the first termination 72 of the recirculation channel 38 extends from the second extremity 60 of the primary channel 56 such that the flow of the stock solution flowing through the primary channel 56 is split into the supply portion 68 and the recirculation portion 76 adjacent to the second extremity 60 of the primary channel 56.

Fig. 10 is a similar view to that shown in Fig. 6 but shows a further embodiment of the present invention. As shown in Fig. 10, the apparatus further includes a control device 120 which is electrically connected to the generator 10c for controllably altering the generation of the ultrasonic waves by the generator 10c.

Fig. 11 is a similar view to that shown in Fig. 10 but shows a further embodiment of the present invention. As shown in Fig. 11, a device 122 such as a hydraulic or a pneumatic ram is mechanically connected to the generator 10d for controllably altering a location of the generator 10d relative to the primary channel 56 as indicated by the arrow 123 so that generation of the ultrasonic waves within the region R by the generator 10d is altered.

Fig. 12 is a similar view to that shown in Fig. 10 but shows a further embodiment of the present invention. As shown in Fig. 12, a controller 124 is electrically connected to the ultrasound absorber 24e for controllably altering absorption of the ultrasonic waves by the absorber 24e.

Fig. 13 is a similar view to that shown in Fig. 11 but shows a further embodiment of the present invention. As shown in Fig. 13, a control device 126 such as a hydraulic or pneumatic ram is mechanically connected to the absorber 24f for controllably altering a disposition of the absorber 24f relative to the primary channel 56 as indicated by the arrow 127 so that absorption of the ultrasonic waves by the absorber 24f is altered.

In each of the alternative embodiments of the present invention, the flow direction 26 within the region R and r is disposed non parallel to a direction 22 from the generator 10 to the absorber 24.

However, more specifically, the flow direction 26 within the region R is disposed substantially normal to the direction 22 from the generator 10 to the absorber 24.

Moreover, the direction 22 from the generator 10 to the absorber 24 is substantially normal to the flow direction 26 within the region R such that in use of the apparatus, the ultrasonic waves deviate movement of the fiber particles in a component direction 28 shown in Fig. 5 which is disposed angularly between the flow direction 26 and the direction 22 from the generator 10 to the absorber 24.

The present invention also includes a method for controlling the cross machine consistency profile of a flow of stock solution flowing from a header 44 to a slice lip 46 of a headbox 36 of a papermaking machine so that the cross machine direction profile of a resultant web is controlled. The method includes the steps of guiding the flow of the stock solution through a flow channel 48 which is disposed within the headbox 36 between the header 44 and the slice lip 46. The flow channel 48 includes a primary channel 56 which has a first and a second extremity 58 and 60. A supply channel 40 has a first and a second end 64 and 66, the supply channel 40 being disposed downstream relative to the primary channel 56 for the flow therethrough of a supply portion 68 of the flow of the stock solution. The second end 66 of the supply channel 40 is connected to the slice lip 46 so that the supply portion 68 of the flow of the stock solution flows to the slice lip 46. A recirculation channel 38 has a first and a second termination 72 and 74, the recirculation channel 38 being disposed downstream relative to the primary channel 56 for the flow therethrough of a recirculation portion 76 of the flow of the stock solution. The second termination 74 of the recirculation channel 38 is connected to the header 44 so that the recirculation portion 76 of the flow of the stock solution flows to the header 44.

The method also includes the steps of generating ultrasonic waves within the flow of the stock solution flowing through the primary channel 56 by an ultrasonic generator 10. The ultrasonic waves move fiber particles suspended within the stock solution for controlling the consistency of the stock solution flowing through the primary channel 56.

Additionally, the method includes absorbing the ultrasonic waves by an ultrasound absorber 24 disposed adjacent to the primary channel 56 such that the flow of

the stock solution flows in the flow direction 26 within a region R which is disposed between the generator 10 and the absorber 24. The arrangement is such that when the stock solution is flowing within the region R, the fiber particles suspended within the stock solution are deviated from the flow direction 26 so that the consistency of the stock solution flowing from the primary channel 56 through the supply channel 40 is different from the consistency of the stock solution flowing from the primary channel 56 through the recirculation channel 38. The method is such that that the consistency of the supply portion 68 of the stock solution flowing through the slice lip 46 is controlled thereby controlling the cross machine direction consistency profile of the resultant web.

In operation of the apparatus according to the present invention, a stock solution is supplied to the header under pressure. The stock flows through the flow channel 48 so that when the generator and absorber 10 and 24 respectively are activated, diluted stock flows from the region R through the downstream supply channel 40 to the slice lip 46. However, in a lateral disposition in a cross machine direction as shown in Fig. 8, the further generator and further absorber 84 and 86 respectively act upon the region r which is disposed laterally relative to the region R as shown in Fig. 7. Consequently, the dilution of the stock flowing downstream from the region r through the supply channel 40 can be controlled or altered relative to the dilution of the laterally disposed flow of stock flowing downstream from the region R. In this manner, by the provision a number of generators and corresponding absorbers, the cross machine directional consistency profile of the resultant web can be controlled. Such control can be achieved as shown in Figs. 10-13 by either controlling the electrical supply to the generator or to the absorber or by mechanically moving the disposition of the generator or the absorber or both the generator and the absorber relative to the primary channel 56.

According to the present invention, the generation capacity of the generator can be changed by increasing or decreasing the electrical input or by moving the generator towards or away from the primary channel.

Similarly, the absorption factor of the absorber can be changed by increasing or decreasing the electrical input to the absorber or by moving the absorber towards or away from the primary channel. Any combination of the above can be used for controlling the ultrasonic waves within the primary channel.

By altering the power to all of the generators such as 10 and 84 and/or the corresponding absorbers 24 and 86 to the same power level would have a similar effect to altering the grammage valve on a conventional headbox. Typically, in a conventional

headbox, when the grammage valve is altered, there would be a delay of two minutes before such change would take effect downstream on the grammage of the resultant web.

One of the advantages of the arrangement according to the present invention when using an electrical control for the generator and/or absorber is that the consistency control is accomplished by entirely an electrical device rather than a mechanical device in the case of slice lip control.

Although the present invention describes the recirculation portion of the stock as returning to the header, it will be apparent to those skilled in the art that in fact, the recirculation portion will usually be returned to the header via the stock supply silo.

The present invention provides a unique apparatus and method for controlling the cross machine direction profile of a web.

CLAIMS

1. An apparatus for controlling the consistency of a flow of stock solution flowing from a header to a slice lip of a headbox of a papermaking machine so that the cross machine direction consistency profile of a resultant web is controlled, said apparatus comprising:

a flow channel disposed within the headbox between the header and the slice lip, said flow channel having an upstream and a downstream end such that the flow of the stock solution is in a flow direction from said upstream end towards said downstream end of said flow channel;

said flow channel including:

a primary channel having a first and a second extremity such that the flow of the stock solution is through said primary channel from said first extremity to said second extremity of said primary channel;

a supply channel having a first and a second end, said supply channel being disposed downstream relative to said primary channel for the flow therethrough of a supply portion of the flow of the stock solution;

said second end of said supply channel being connected to the slice lip so that said supply portion of the flow of the stock solution flows to the slice lip;

a recirculation channel having a first and a second termination, said recirculation channel being disposed downstream relative to said primary channel for the flow therethrough of a recirculation portion of the flow of the stock solution;

said second termination of said recirculation channel being connected to the header so that said recirculation portion of the flow of the stock solution flows to the header;

a generator disposed adjacent to said primary channel for generating ultrasonic waves within the flow of the stock solution flowing through said primary channel, said ultrasonic waves moving fiber particles suspended within the stock solution for controlling the consistency of the stock solution flowing through said primary channel; and

an ultrasound absorber disposed adjacent to said primary channel such that the flow of the stock solution flows in said flow direction within a region disposed between said generator and said absorber so that in operation of said apparatus, when the stock solution is flowing within said region, said fiber particles suspended within the stock solution are deviated from said flow direction so that the consistency of the stock

solution flowing from said primary channel through said supply channel is different from the greater consistency of the stock solution flowing from said primary channel through said recirculation channel so that the consistency of said supply portion of the stock solution flowing through the slice lip is controlled thereby controlling the cross machine direction consistency profile of the resultant web.

2. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 including:

a further generator disposed adjacent to said primary channel and laterally relative to said generator for generating ultrasonic waves within the flow of the stock solution flowing through said primary channel, said ultrasonic waves moving fiber particles suspended within the stock solution for controlling the cross machine direction consistency profile of the stock solution flowing through said primary channel;

a further ultrasound absorber disposed adjacent to said primary channel such that the flow of the stock solution flows in said flow direction within a further region disposed between said further generator and said further absorber such that in operation of said apparatus, when the stock solution is flowing within said further region, said fiber particles suspended within the stock solution are deviated from said flow direction so that the consistency of the stock solution flowing from said primary channel downstream from said further region through said supply channel is different from the greater consistency of the stock solution flowing from said primary channel downstream from said further region through said recirculation channel so that the consistency of a further supply portion of the stock solution flowing through the slice lip downstream from said further region is controlled relative to said supply portion of the stock solution flowing downstream from said region through the slice lip thereby controlling the cross machine direction profile of the resultant web.

3. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 wherein

said flow direction is approximately parallel to a direction from the header to the slice lip

4. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 wherein

said primary channel defines a primary conduit of rectangular cross sectional configuration, said primary conduit extending from said first extremity to said second extremity of said primary channel.

5. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 wherein

said first end of said supply channel extends from said second extremity of said primary channel.

6. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 wherein

said supply channel is disposed above said recirculation channel.

7. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 wherein

said supply channel is disposed below said recirculation channel.

8. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 wherein

said first termination of said recirculation channel extends from said second extremity of said primary channel such that the flow of the stock solution flowing through said primary channel is split into said supply portion and said recirculation portion adjacent to said second extremity of said primary channel.

9. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 further including:

a control device electrically connected to said generator for controllably altering generation of said ultrasonic waves by said generator.

10. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 further including:

a device mechanically connected to said generator for controllably altering a location of said generator relative to said primary channel so that generation of said ultrasonic waves within said region by said generator is altered.

11. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 further including:

a controller electrically connected to said ultrasound absorber for controllably altering absorption of said ultrasonic waves by said absorber.

12. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 further including:

a control device mechanically connected to said absorber for controllably altering a disposition of said absorber relative to said primary channel so that absorption of said ultrasonic waves by said absorber is altered.

13. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 wherein

said flow direction within said region is disposed non parallel to a direction from said generator to said absorber.

14. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 1 wherein

said flow direction within said region is disposed substantially normal to a direction from said generator to said absorber.

15. An apparatus for controlling the consistency of a flow of stock solution as set forth in claim 14 wherein

said direction from said generator to said absorber is substantially normal to said flow direction within said region such that in use of said apparatus, said ultrasonic waves deviate movement of said fiber particles in a component direction which is disposed angularly between said flow direction and said direction from said generator to said absorber.

16. A method for controlling the consistency of a flow of stock solution flowing from a header to a slice lip of a headbox of a papermaking machine so that the cross machine direction consistency profile of a resultant web is controlled, said method comprising the steps of:

guiding the flow of the stock solution through a flow channel which is disposed within the headbox between the header and the slice lip, the flow channel including:

a primary channel having a first and a second extremity;

a supply channel having a first and a second end, the supply channel being disposed downstream relative to the primary channel for the flow therethrough of a supply portion of the flow of the stock solution, the second end of the supply channel being connected to the slice lip so that the supply portion of the flow of the stock solution flows to the slice lip;

a recirculation channel having a first and a second termination, the recirculation channel being disposed downstream relative to the primary channel for the flow therethrough of a recirculation portion of the flow of the stock solution, the second termination of the recirculation channel being connected to the header so that the recirculation portion of the flow of the stock solution flows to the header;

generating ultrasonic waves within the flow of the stock solution flowing through the primary channel by an ultrasonic generator, the ultrasonic waves moving fiber

particles suspended within the stock solution for controlling the consistency of the stock solution flowing through the primary channel; and

absorbing the ultrasonic waves by an ultrasound absorber disposed adjacent to the primary channel such that the flow of the stock solution flows in the flow direction within a region disposed between the generator and the absorber such that when the stock solution is flowing within the region, the fiber particles suspended within the stock solution are deviated from the flow direction so that the consistency of the stock solution flowing from the primary channel through the supply channel is different from the greater consistency of the stock solution flowing from the primary channel through the recirculation channel so that the consistency of the supply portion of the stock solution flowing through the slice lip is controlled thereby controlling the cross machine direction consistency profile of the resultant web.

17. An apparatus for controlling the consistency of a flow of stock solution flowing from a header to a slice lip of a headbox of a papermaking machine so that the cross machine direction consistency profile of a resultant web is controlled, said apparatus comprising:

a flow channel disposed within the headbox between the header and the slice lip, said flow channel having an upstream and a downstream end such that the flow of the stock solution is in a flow direction from said upstream end towards said downstream end of said flow channel;

said flow channel including:

a primary channel having a first and a second extremity such that the flow of the stock solution is through said primary channel from said first extremity to said second extremity of said primary channel;

a supply channel having a first and a second end, said supply channel being disposed downstream relative to said primary channel for the flow therethrough of a supply portion of the flow of the stock solution;

said second end of said supply channel being connected to the slice lip so that said supply portion of the flow of the stock solution flows to the slice lip;

a recirculation channel having a first and a second termination, said recirculation channel being disposed downstream relative to said primary channel for the flow therethrough of a recirculation portion of the flow of the stock solution;

said second termination of said recirculation channel being connected to the header so that said recirculation portion of the flow of the stock solution flows to the header;

a generator disposed adjacent to said primary channel for generating ultrasonic waves within the flow of the stock solution flowing through said primary channel, said ultrasonic waves moving fiber particles suspended within the stock solution for controlling the consistency of the stock solution flowing through said primary channel;

an ultrasound absorber disposed adjacent to said primary channel such that the flow of the stock solution flows in said flow direction within a region disposed between said generator and said absorber so that in operation of said apparatus, when the stock solution is flowing within said region, said fiber particles suspended within the stock solution are deviated from said flow direction so that the consistency of the stock solution flowing from said primary channel through said supply channel is different from the greater consistency of the stock solution flowing from said primary channel through said recirculation channel so that the consistency of said supply portion of the stock solution flowing through the slice lip is controlled thereby controlling the cross machine direction consistency profile of the resultant web;

a further generator disposed adjacent to said primary channel and laterally relative to said generator for generating ultrasonic waves within the flow of the stock solution flowing through said primary channel, said ultrasonic waves moving fiber particles suspended within the stock solution for controlling the consistency of the stock solution flowing through said primary channel;

a further ultrasound absorber disposed adjacent to said primary channel and laterally relative to said absorber such that the flow of the stock solution flows in said flow direction within a further region disposed between said further generator and said further absorber such that in operation of said apparatus, when the stock solution is flowing within said further region, said fiber particles suspended within the stock solution are deviated from said flow direction so that the consistency of the stock solution flowing from said primary channel downstream from said further region through said supply channel is different from the greater consistency of the stock solution flowing from said primary channel downstream from said further region through said recirculation channel so that the consistency of a further supply portion of the stock solution flowing through the slice lip downstream from said further region is controlled relative to said supply portion of the stock solution flowing downstream from said region through the slice lip thereby controlling the cross machine direction consistency profile of the resultant web;

said flow direction being approximately parallel to a direction from the header to the slice lip;

said primary channel defining a primary conduit of rectangular cross sectional configuration, said primary conduit extending from said first extremity to said second extremity of said primary channel;

said first end of said supply channel extending from said second extremity of said primary channel;

said supply channel being disposed above said recirculation channel;

said first termination of said recirculation channel extending from said second extremity of said primary channel such that the flow of the stock solution flowing through said primary channel is split into said supply portion and said recirculation portion adjacent to said second extremity of said primary channel; and

said direction from said generator to said absorber being substantially normal to said flow direction within said region and said further region such that in use of said apparatus, said ultrasonic waves deviate movement of said fiber particles in a component direction which is disposed angularly between said flow direction and said direction from said generator to said absorber.

Fig. 1.

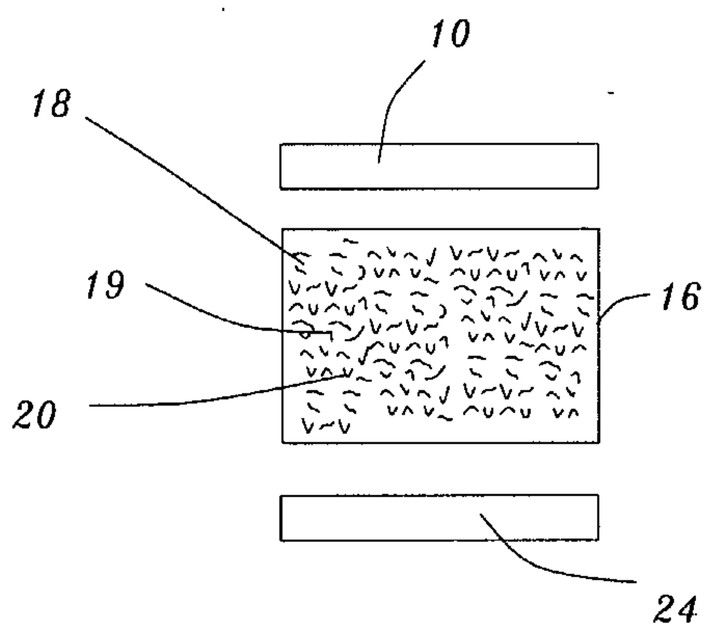


Fig. 2.

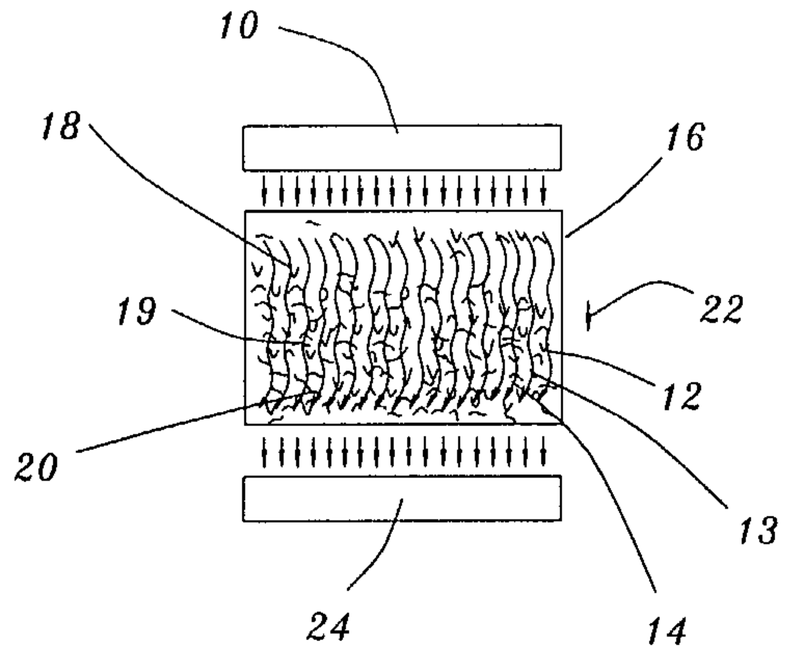
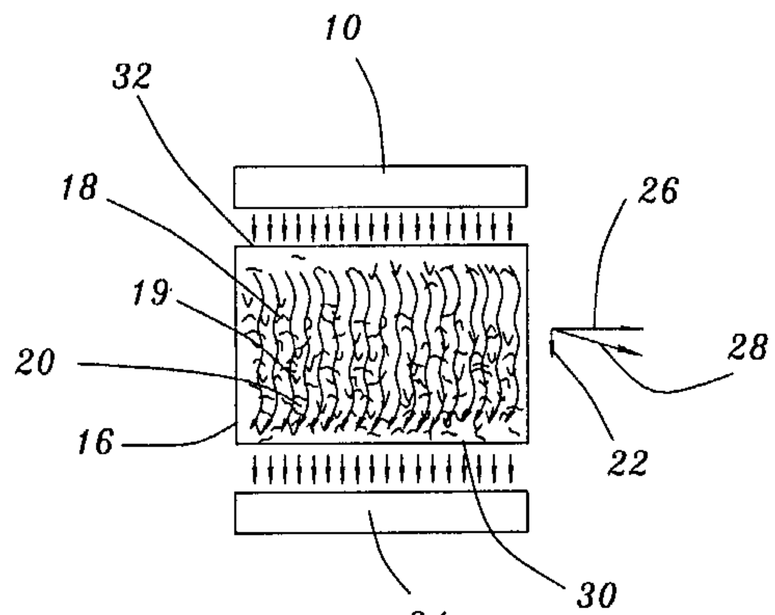


Fig. 3.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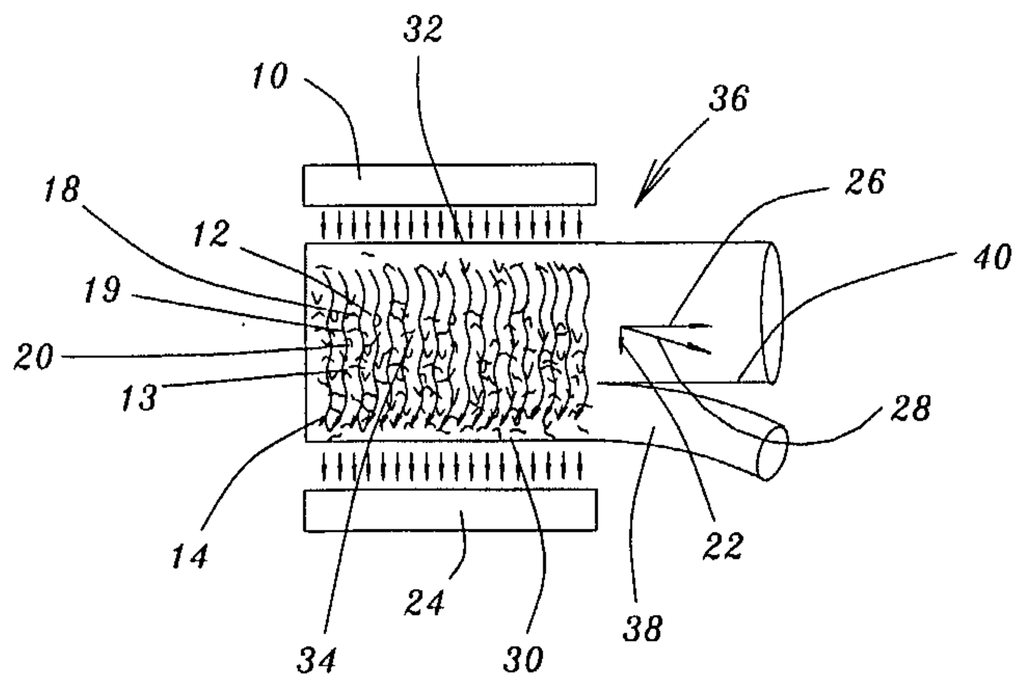
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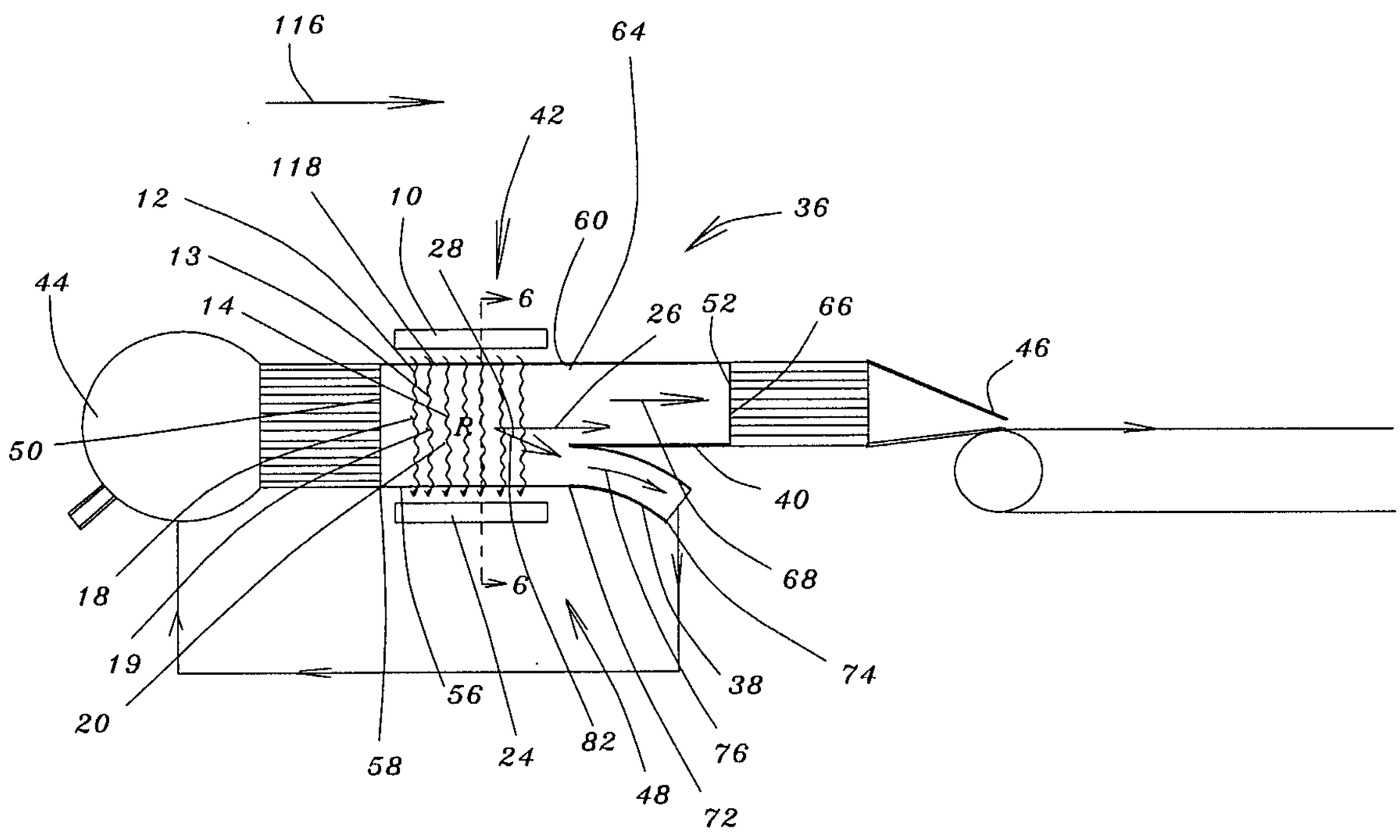
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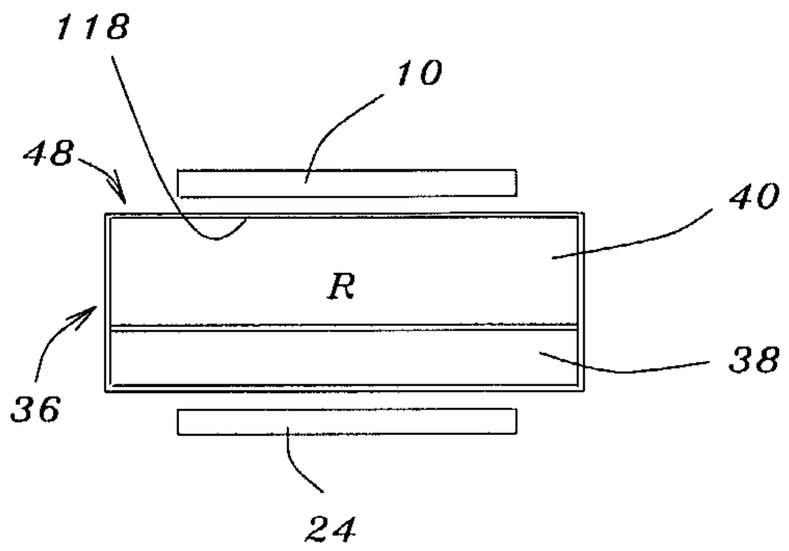
Fig. 5.

Fig. 6.



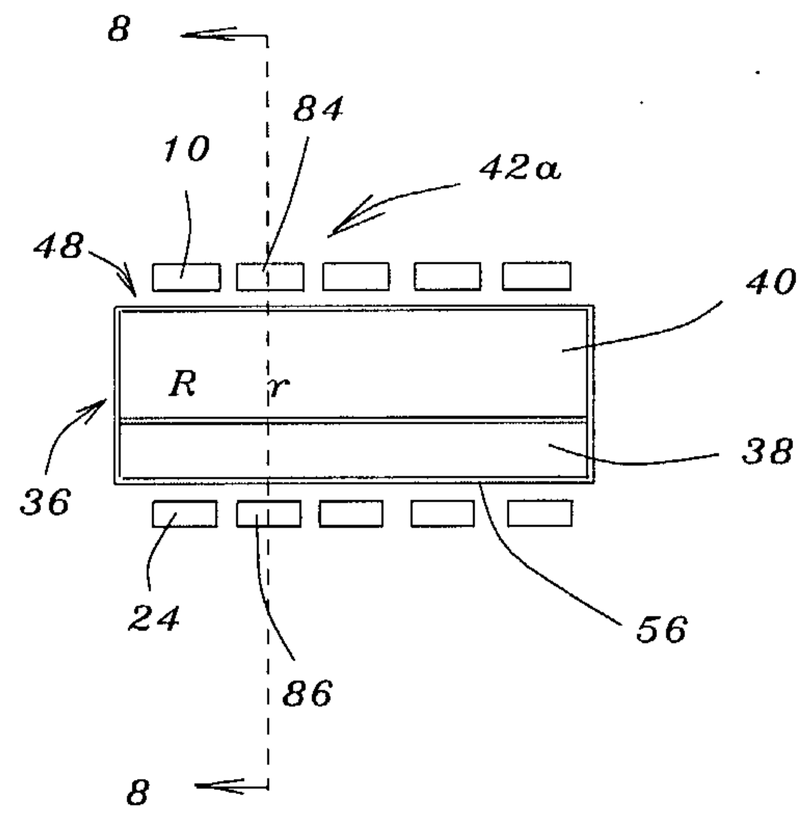


Fig. 7.

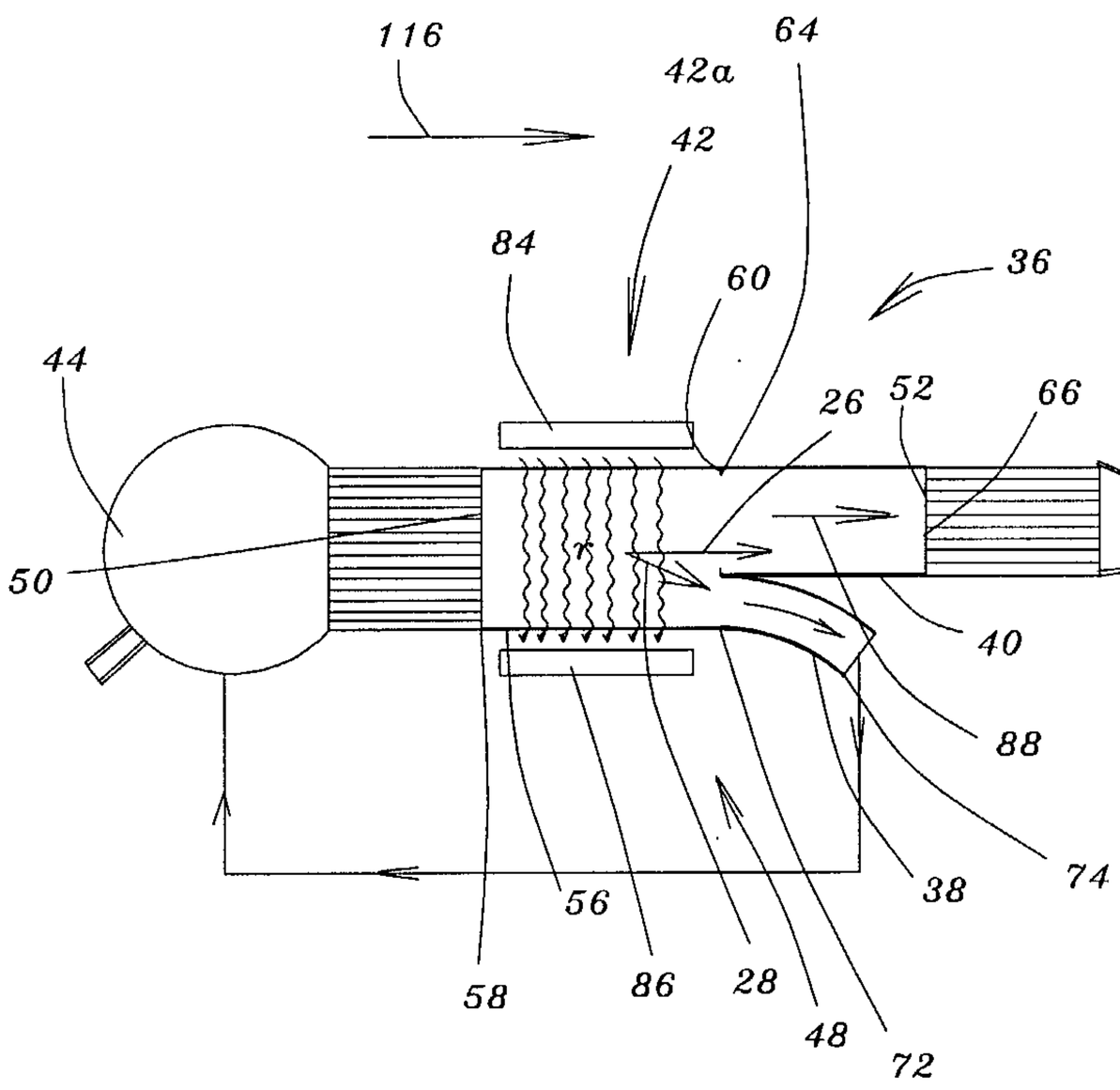


Fig. 8.

Fig. 9.

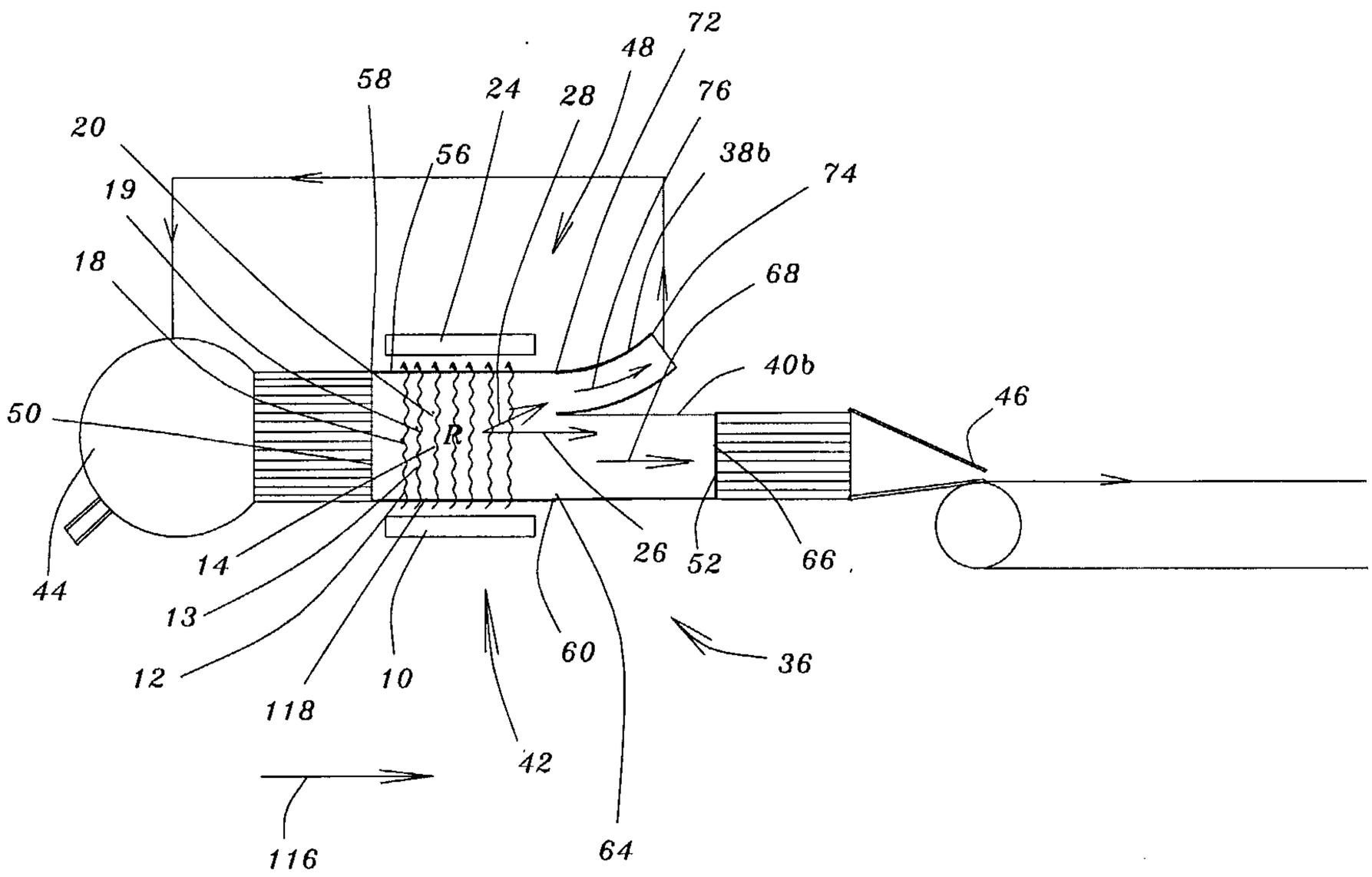

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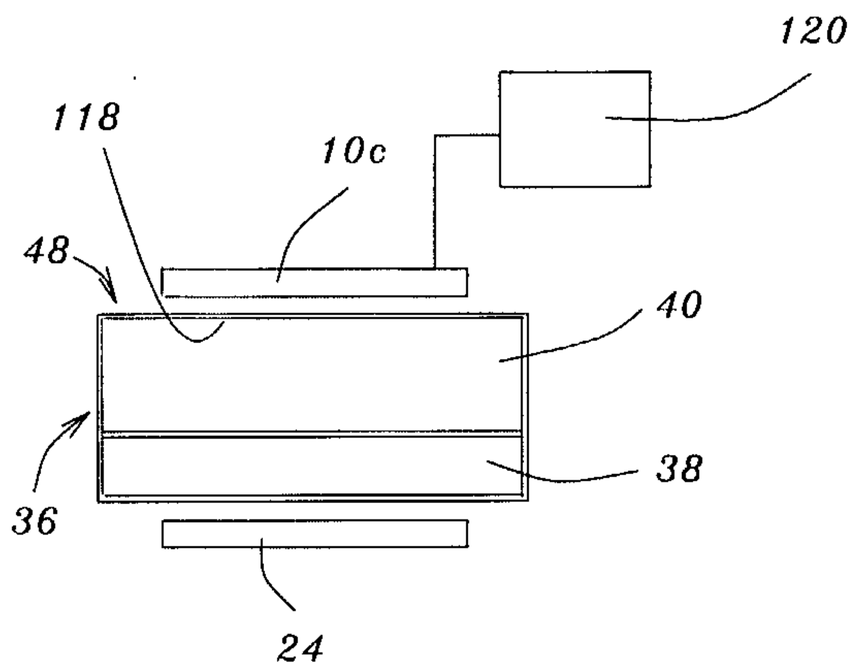
Fig. 10.



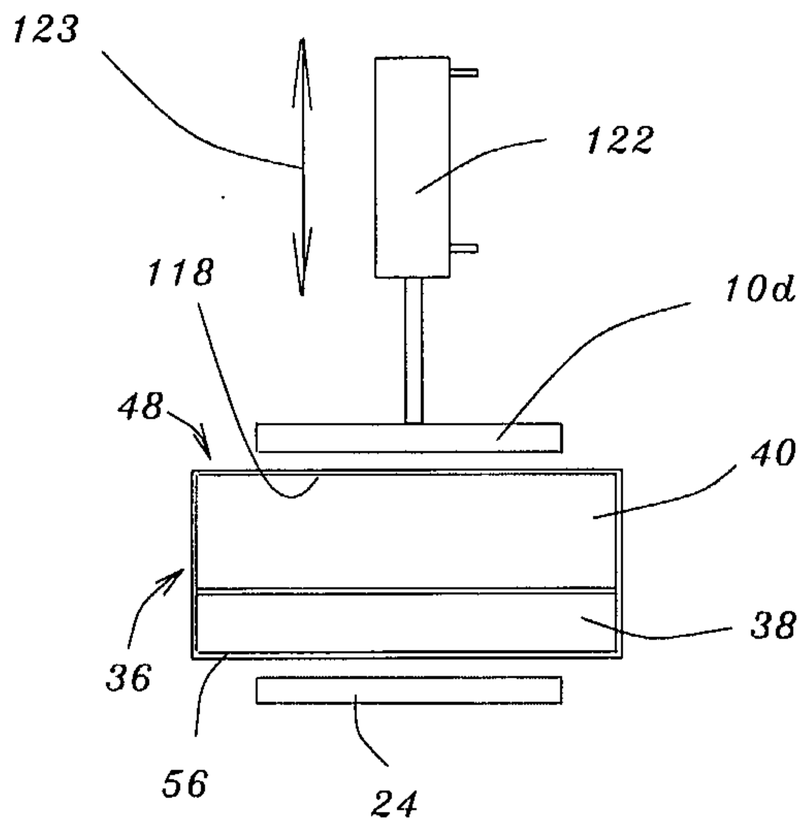
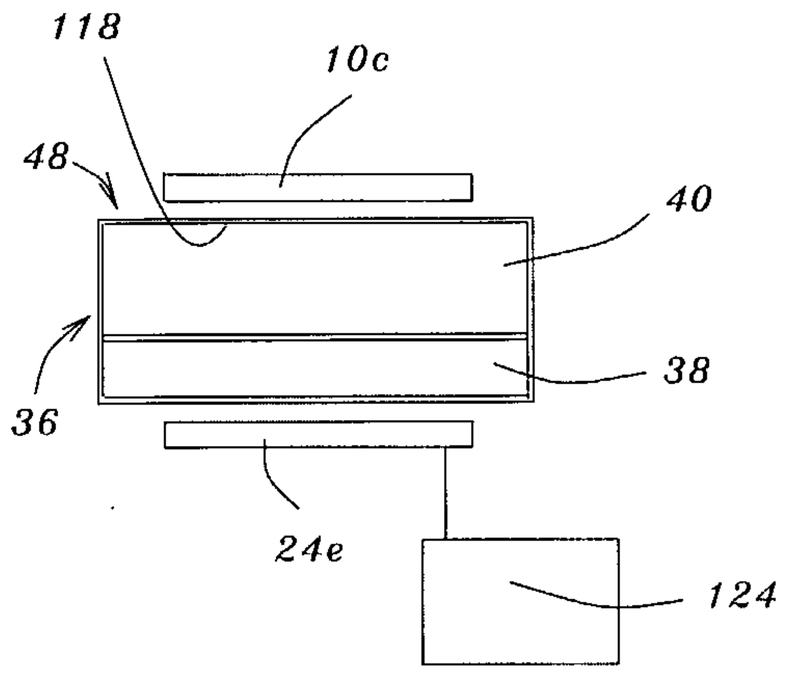


Fig. 11.

Fig. 12.



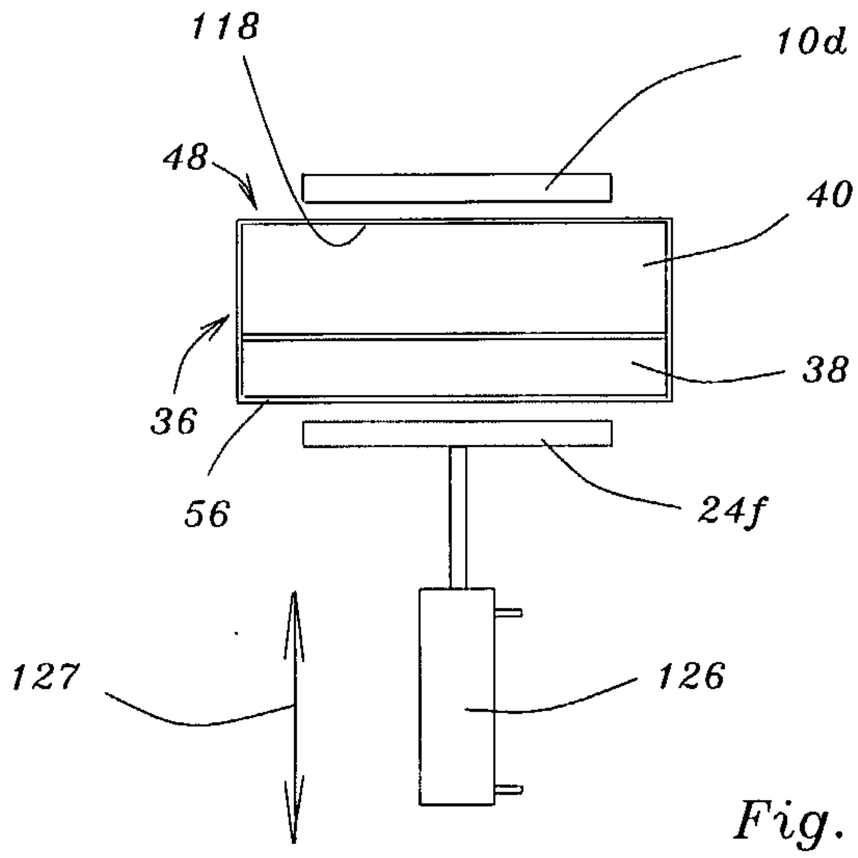
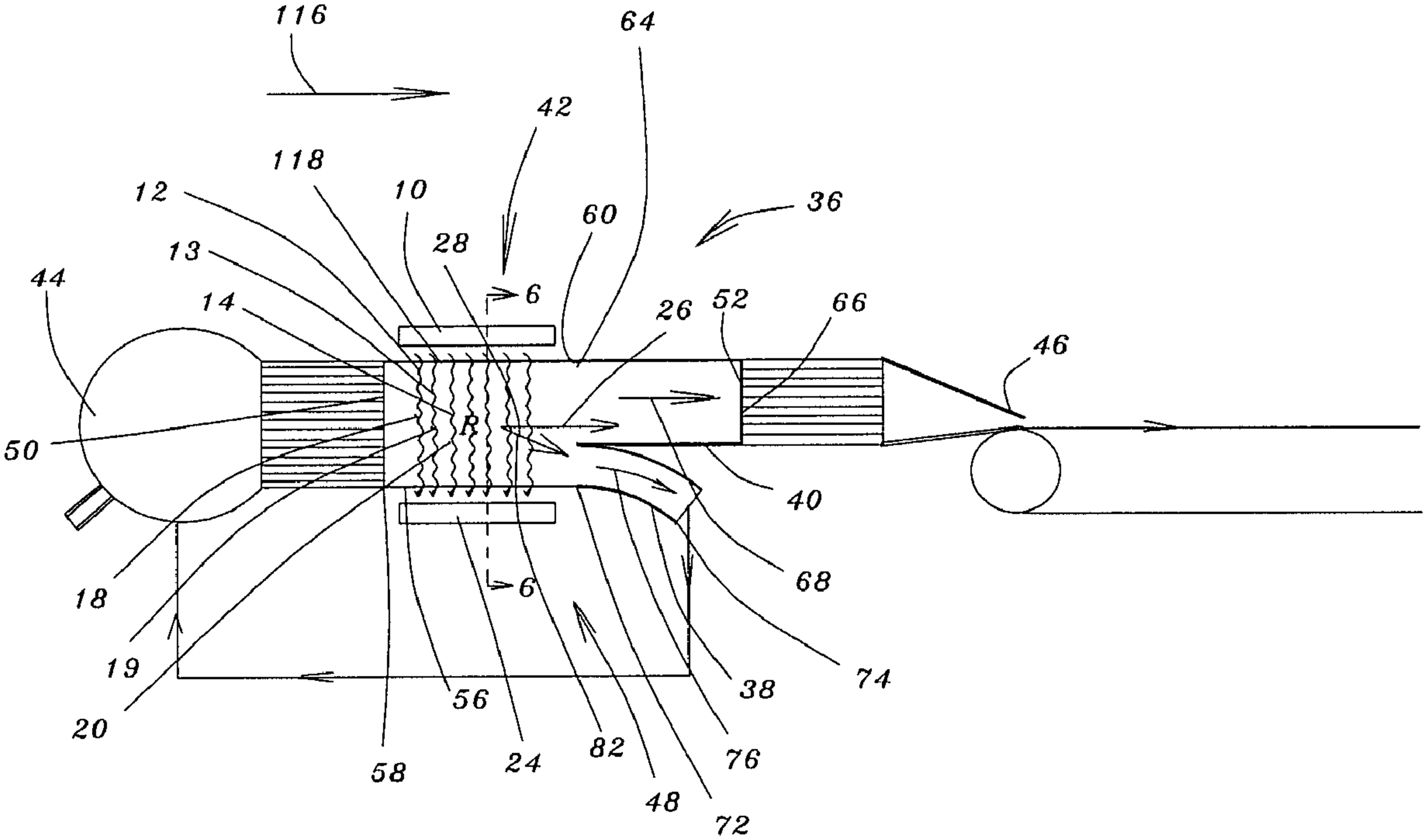


Fig. 13.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