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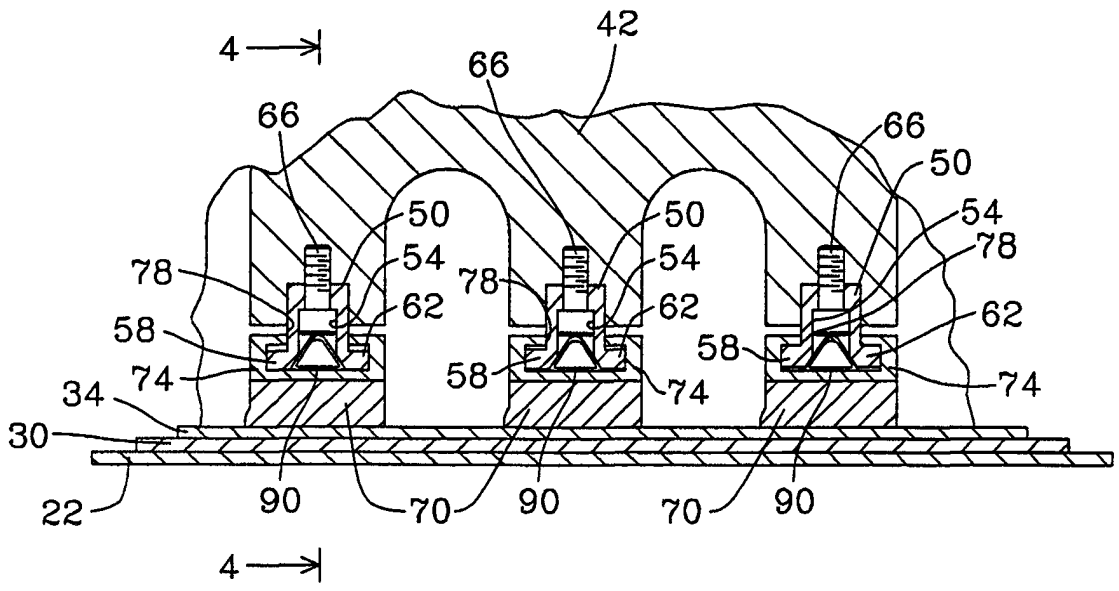

(57) Abstract

An apparatus for removing fluid from a fibrous web (30) in a papermaking machine having a machine direction and a cross machine direction, the apparatus comprising a plurality of generally parallel supports (50) extending in the cross machine direction, the supports being spaced in the machine direction, the supports having mounted thereon respective blades (70) extending in the cross machine direction, the blades being spaced in the machine direction along a convex path for movement of the web over the blades, each blade (70) being movable relative to the respective support (50) in a direction perpendicular to the web such that outward movement of the blade (70) relative to the support (50) presses the blade against the web (30), and a control system for exerting, on each of the blades (70), a force in the direction toward the web (30) so as to press the blade against the web, the control system being operable to vary the force exerted on each of the blades (70) independent of the force exerted on the remaining blades.

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TITLE:

APPARATUS FOR REMOVING FLUID FROM A FIBROUS WEB

BACKGROUND OF THE INVENTION

The invention relates to papermaking machinery, and more particularly to apparatus for removing fluid from a fibrous web in a papermaking machine. Still more particularly, the invention relates to a curved inverted vacuum box.

A known type of twin-wire or twin-fabric former is the Bel Bond former, which is designed as a retrofit to an existing fourdrinier wire. Bel Bond is a registered trademark of Beloit Corporation. A Bel Bond former includes a looped top wire cooperating with the existing fourdrinier or bottom wire. The Bel Bond former also includes a curved inverted vacuum box positioned within the loop of the top wire.

The curved inverted vacuum box typically includes a box that is made from stainless steel or the like and that defines an enclosure connected to a source of partial vacuum. The box includes a base having a convex curved surface for guiding the top wire. A plurality of dewatering blades, usually ceramic, extend in the cross machine direction and are spaced in the machine direction along the curved surface of the curved inverted vacuum box. The top and bottom wires sandwich the web, and dewatering takes place due to tension of both wires, combined with centrifugal force. The vacuum source urges water upwardly out of the web through the top wire. A portion of water is removed from the formed web downwardly through the bottom wire during movement of the wires and the web over the blades.

SUMMARY OF THE INVENTION

Known prior art curved inverted vacuum boxes do not allow changing the drainage pressure from one blade to the next so as to allow experimentation with formation and sheet strength. The invention provides a curved inverted vacuum box in which each blade is loaded independently, thus providing the ability to change the drainage pressure at each blade location. With the consistency of the web or sheet changing along the curved surface of the curved inverted vacuum box, a controlled induced drainage curve can be achieved to follow consistency changes along the curved surface.

More particularly, the invention provides an apparatus for removing fluid from a fibrous web in a papermaking machine, the apparatus comprising a plurality of generally parallel supports that extend in the cross machine direction and that are spaced in the machine direction. Each support has mounted thereon a respective blade extending in the cross machine direction. The blades are spaced in the machine direction along a convex path for movement of the web and, in the preferred embodiment of the invention, the fabrics, over the blades. Each blade is movable relative to its respective support in a direction perpendicular to the web such that outward movement of the blade relative to the support presses the blade against the web. The apparatus also comprises a control system for exerting, on each of the blades, a force in the direction toward the web so as to press the blade against the web. The control system is operable to vary the force exerted on each of the blades independent of the force exerted on the remaining blades.

Preferably, the supports are tee bars extending in the cross machine direction. An air loaded tube is saddled in each tee bar between the tee bar and the base of the respective blade. When the tube is pressurized, a force

is exerted, pushing the blade into the fabrics and the web, changing the drainage pressure at the leading and trailing edges of the blade. A control panel equipped with gauges, regulators and air lines connected to the individual air tubes is provided for independent air pressure regulation.

Other features and advantages of the invention will become apparent to those skilled in the art upon review of the following detailed description, claims and drawings.

DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partial side elevational of a papermaking machine embodying the invention.

Fig. 2 is an enlarged portion of Fig. 1, partially in section.

Fig. 3 is a further enlarged portion of Fig. 2.

Fig. 4 is a partial view taken along line 4-4 in Fig. 3.

Before one embodiment of the invention is explained in detail, it is to be understood that the invention is not limited in its application to the details of the construction and the arrangements of components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or being carried out in various ways. Also, it is understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A papermaking machine **10** embodying the invention is partially illustrated in Fig. 1. More particularly, the portion of the papermaking machine **10** illustrated in Fig. 1 is a Bel Bond former **14**. As is known in the art, the Bel Bond former **14** comprises a frame **18** supporting a looped

bottom fabric or wire **22** moving in the machine direction (from left to right in Fig. 1). A secondary headbox **26** is mounted on the frame **18** above the bottom fabric **22**. A fibrous web **30** (see Fig. 3) is supported on top of and moves with the bottom fabric **22**. Mounted on the frame **18** downstream of the secondary headbox **26** is (see Fig. 1) a looped top fabric or wire **34** positioned such that the web **30** is sandwiched between and moves with the top fabric **34** and the bottom fabric **22**. A curved inverted vacuum box **38** is mounted on the frame **18** within the endless loop of the top fabric **34**. The curved inverted vacuum box **38** includes a box **42** defining an enclosure connected to a source **46** of partial vacuum. The base of the box **38** has a convex curved surface. The Bel Bond former **14** and the curved inverted vacuum box **38** as thus far described are conventional and will not be described in further detail.

As shown in Figs. 2 and 3, a plurality of generally parallel supports **50** are mounted on the curved surface of the box base. The supports **50** extend in the cross machine direction and are spaced in the machine direction. Preferably, as shown in Fig. 3, the supports **50** are tee bars that are generally T-shaped in cross-section. Each tee bar **50** has therein an outwardly or downwardly opening recess **54** extending in the cross machine direction, and each tee bar **50** includes opposed flanges **58** and **62** extending in the machine direction on opposite sides of the recess **54**. Each tee bar **50** is secured to the box base by a plurality of bolts **66**, as best shown in Figs. 3 and 4.

The tee bars **50** have mounted thereon respective blades **70** extending in the cross machine direction. The blades **70** are preferably ceramic, as is known in the art. The blades **70** are spaced in the machine direction along a convex path, as best shown in Fig. 2. The blades **70** face generally downwardly such that the fabrics **22** and **34** and the web **30**

pass beneath the blades **70**, with the blades **70** pressing against the top fabric **34**. Each blade **70** is movable relative to its respective tee bar **50** in a direction generally perpendicular to the web **30** (vertically in Fig. 3) such that outward movement of the blade **70** relative to the tee bar **50** (downward movement in Fig. 3) presses the blade **70** against the top fabric **34** and the web **30**. To this end, each of the blades **70** is secured to a respective blade base **74** which extends in the cross machine direction and which is generally C-shaped in cross-section. The blade base **74** has therein an inwardly or upwardly opening channel **78** receiving the flanges **58** and **62** of the respective tee bar **50** such that the flanges limit vertical movement of the blade **70** relative to the tee bar **50**. Each blade **70** is movable relative to its tee bar **50** between an uppermost position and a lowermost position. In Fig. 3, the left-hand blade **70** is shown in its uppermost position, the right-hand blade **70** is shown in its lowermost position, and the middle blade **70** is shown in an intermediate position between the uppermost and lowermost positions. Each blade base channel **78** and the respective tee bar recess **54** define (see Fig. 4) a variable volume chamber **82** extending substantially the entire length of the blade **70**. The chamber **82** has a volume that changes in response to movement of the blade **70** toward and away from the web **30**. Specifically, the volume increases in response to downward movement of the blade **70** and decreases in response to upward movement of the blade **70**.

The curved inverted vacuum box **38** also includes (see Fig. 2) a control system **86** (shown schematically) for exerting, on each of the blades **70**, a downward force so as to press the blade **70** against the fabrics **22** and **34** and the web **30**. The control system **86** is operable to vary the force exerted on each of the blades **70** independent of the force exerted on the remaining blades **70**. The control system **86** includes, for each blade **70**, a respective flexible conduit or air tube **90** (Figs. 3 and 4)

saddled in the tee bar **50** between the tee bar **50** and the base **74** of the blade **70** (i.e., in the variable volume chamber **82**). Each tube **90** extends substantially the entire length of the respective blade **70** and has a closed end (not shown) and an opposite open end (the left end in Fig. 4). The control system **86** includes a source **94** of variable pressure connected to the open end of each tube **90**. The control system **86** also includes (see Figs. 2 and 4) air lines **98** connected between the pressure source **94** and the individual air tubes **90**. The control system **86** is operable to vary the pressure in each of the tubes **90** independent of the pressure in the remaining tubes **90**. In the preferred embodiment of the invention, the control system **86** includes a control panel (not shown) equipped with gauges, regulators and a manually adjustable control for each tube **90**. When a tube **90** is pressurized, the tube **90** expands, increasing the volume of its chamber **82** and pushing the blade **70** downwardly into the fabrics **22** and **34** and the web **30**, thereby changing the drainage pressure at the leading and trailing edges of the blade **70**.

Various features of the invention are set forth in the following claims.

WHAT IS CLAIMED IS:

1. An apparatus for removing fluid from a fibrous web in a papermaking machine having a machine direction and a cross machine direction, the apparatus comprising

a base,

a plurality of generally parallel supports mounted on the base, the supports extending in the cross machine direction and being spaced in the machine direction, the supports having mounted thereon respective blades extending in the cross machine direction, the blades being spaced in the machine direction along a convex path for movement of the web over the blades, each blade being movable relative to the respective support in a direction perpendicular to the web such that outward movement of the blade relative to the support presses the blade against the web, and

a control system for exerting, on each of the blades, a force in the direction toward the web so as to press the blade against the web, the control system being operable to vary the force exerted on each of the blades independent of the force exerted on the remaining blades.

2. An apparatus as set forth in claim 1 wherein each of the supports is generally T-shaped in cross-section, each of the supports having therein an outwardly opening recess extending in the cross machine direction, and each of the supports including opposed flanges extending in the machine direction on opposite sides of the recess, and wherein each of the blades is mounted on the respective support such that the flanges limit movement of the blade relative to the support in the direction perpendicular to the web.

3. An apparatus as set forth in claim 2 wherein each of the blades is secured to a respective blade base which extends in the cross machine direction and which is generally C-shaped in cross-section, the blade base having therein an inwardly opening channel receiving the flanges of the respective support.

4. An apparatus as set forth in claim 3 wherein each blade has a length in the cross machine direction, wherein each blade base channel and the respective support recess define a variable volume chamber extending substantially the entire length of the blade, the chamber having a volume that changes in response to movement of the blade toward and away from the web, wherein the control system includes, in each chamber, a respective flexible conduit extending substantially the entire length of the blade, the conduit having a closed end and an opposite open end, and wherein the control system also includes a source of variable pressure connected to the open end of each conduit, the control system being operable to vary the pressure in each of the conduits independent of the pressure in the remaining conduits.

5. An apparatus as set forth in claim 1 wherein each blade and the respective support define a variable volume chamber having a volume that changes in response to movement of the blade toward and away from the web, and wherein the control system is operable to vary the pressure in the chamber.

6. An apparatus as set forth in claim 5 wherein the force exerted on the blade increases in response to an increase in the pressure in the chamber.

7. An apparatus as set forth in claim 6 wherein the control system includes, in each chamber, a respective flexible conduit, and wherein the control system varies the pressure inside the conduit to vary the pressure in the respective chamber.

8. An apparatus as set forth in claim 7 wherein each of the conduits has a closed end and an opposite open end, and wherein the control system also includes a source of variable pressure connected to the open end of each conduit, the control system being operable to vary the pressure in each of the conduits independent of the pressure in the remaining conduits.

9. An apparatus as set forth in claim 1 wherein each blade is ceramic.

10. An apparatus as set forth in claim 1 wherein adjacent blades define therebetween spaces, wherein fluid removed from the web by the blades flows into the spaces, and wherein the apparatus further comprises a vacuum system for removing fluid from the spaces.

11. An apparatus as set forth in claim 1 wherein the blades face generally downwardly such that the web passes beneath the blades.

12. A papermaking machine having a machine direction and a cross machine direction, the machine comprising

a frame,

inner and outer fabrics for carrying a fibrous web therebetween, the fabrics being supported on the frame for movement in the machine direction, and

an apparatus for removing fluid from the web, the apparatus being supported by the frame, and the apparatus including a plurality of generally parallel supports extending in the cross machine direction, the supports being spaced in the machine direction, the supports having mounted thereon respective blades extending in the cross machine direction, the blades being spaced in the machine direction along a convex path for movement of the fabrics and the web over the blades, with the inner fabric between the web and the blades, each blade being movable relative to the respective support in a direction perpendicular to the web such that outward movement of the blade relative to the support presses the blade against the web, and the apparatus also including a control system for exerting, on each of the blades, a force in the direction toward the web so as to press the blade against the web, the control system being operable to vary the force exerted on each of the blades independent of the force exerted on the remaining blades.

13. A machine as set forth in claim 12 wherein each of the supports is generally T-shaped in cross-section, each of the supports having therein an outwardly opening recess extending in the cross machine direction, and each of the supports including opposed flanges extending in the machine direction on opposite sides of the recess, and wherein each of the blades is mounted on the respective support such that the flanges limit movement of the blade relative to the support in the direction perpendicular to the web.

14. A machine as set forth in claim 13 wherein each of the blades is secured to a respective blade base which extends in the cross machine

direction and which is generally C-shaped in cross-section, the blade base having therein an inwardly opening channel receiving the flanges of the respective support.

15. An apparatus as set forth in claim 14 wherein each blade has a length in the cross machine direction, wherein each blade base channel and the respective support recess define a variable volume chamber extending substantially the entire length of the blade, the chamber having a volume that changes in response to movement of the blade toward and away from the web, wherein the control system includes, in each chamber, a respective flexible conduit extending substantially the entire length of the blade, the conduit having a closed end and an opposite open end, and wherein the control system also includes a source of variable pressure connected to the open end of each conduit, the control system being operable to vary the pressure in each of the conduits independent of the pressure in the remaining conduits.

16. A machine as set forth in claim 12 wherein each blade is ceramic.

17. A machine as set forth in claim 12 wherein adjacent blades define therebetween spaces, wherein fluid removed from the web by the blades flows into the spaces, and wherein the apparatus further comprises a vacuum system for removing fluid from the spaces.

18. A machine as set forth in claim 12 wherein the blades face generally downwardly such that the web passes beneath the blades.

19. A curved inverted vacuum apparatus for removing fluid from a fibrous web in a papermaking machine having a machine direction and a cross machine direction, the apparatus comprising

a plurality of generally parallel supports extending in the cross machine direction, the supports being spaced in the machine direction, each of the supports being generally T-shaped in cross-section, each of the supports having therein an outwardly opening recess extending in the cross machine direction, and each of the supports including opposed flanges extending in the machine direction on opposite sides of the recess, the supports having mounted thereon respective blades extending in the cross machine direction, the blades being spaced in the machine direction along a convex path for movement of the web over the blades, the blades facing generally downwardly such that the web passes beneath the blades, adjacent blades defining therebetween spaces so that fluid removed from the web by the blades flows into the spaces, each blade having a length in the cross machine direction and being movable relative to the respective support in a direction perpendicular to the web such that outward movement of the blade relative to the support presses the blade against the web, each of the blades being secured to a respective blade base which extends in the cross machine direction and which is generally C-shaped in cross-section, the blade base having therein an inwardly opening channel receiving the flanges of the respective support such that the flanges limit movement of the blade relative to the support in the direction perpendicular to the web, each blade base channel and the respective support recess defining a variable volume chamber extending substantially the entire length of

the blade, the chamber having a volume that changes in response to movement of the blade toward and away from the web,

a control system for exerting, on each of the blades, a force in the direction toward the web so as to press the blade against the web, the control system being operable to vary the force exerted on each of the blades independent of the force exerted on the remaining blades, the control system including, in each chamber, a respective flexible conduit extending substantially the entire length of the blade, each of the conduits having a closed end and an opposite open end, and the control system including a source of variable pressure connected to the open end of each conduit, the control system being operable to vary the pressure in each of the conduits independent of the pressure in the remaining conduits, and

a vacuum system for removing fluid from the spaces between adjacent blades.

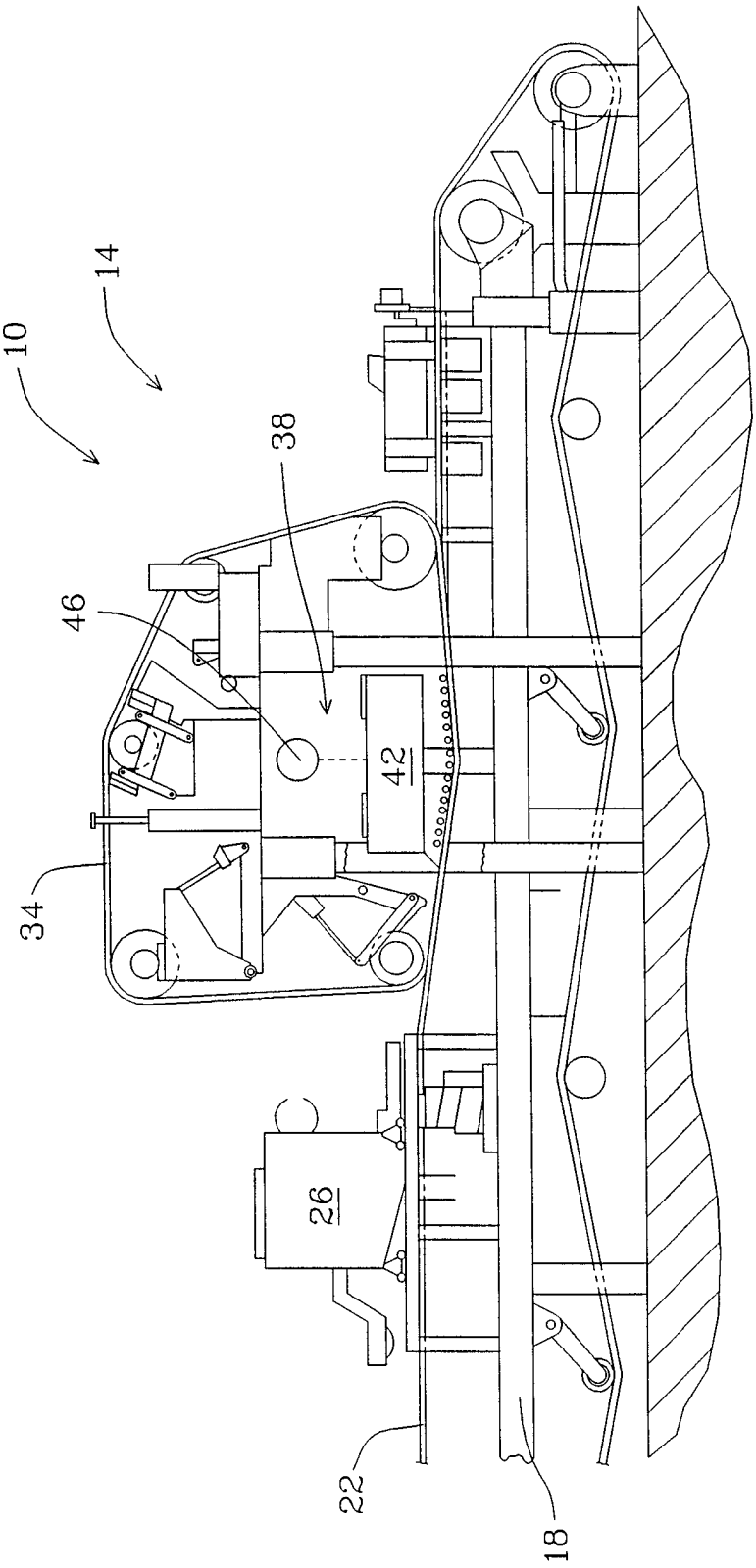

Fig. 1

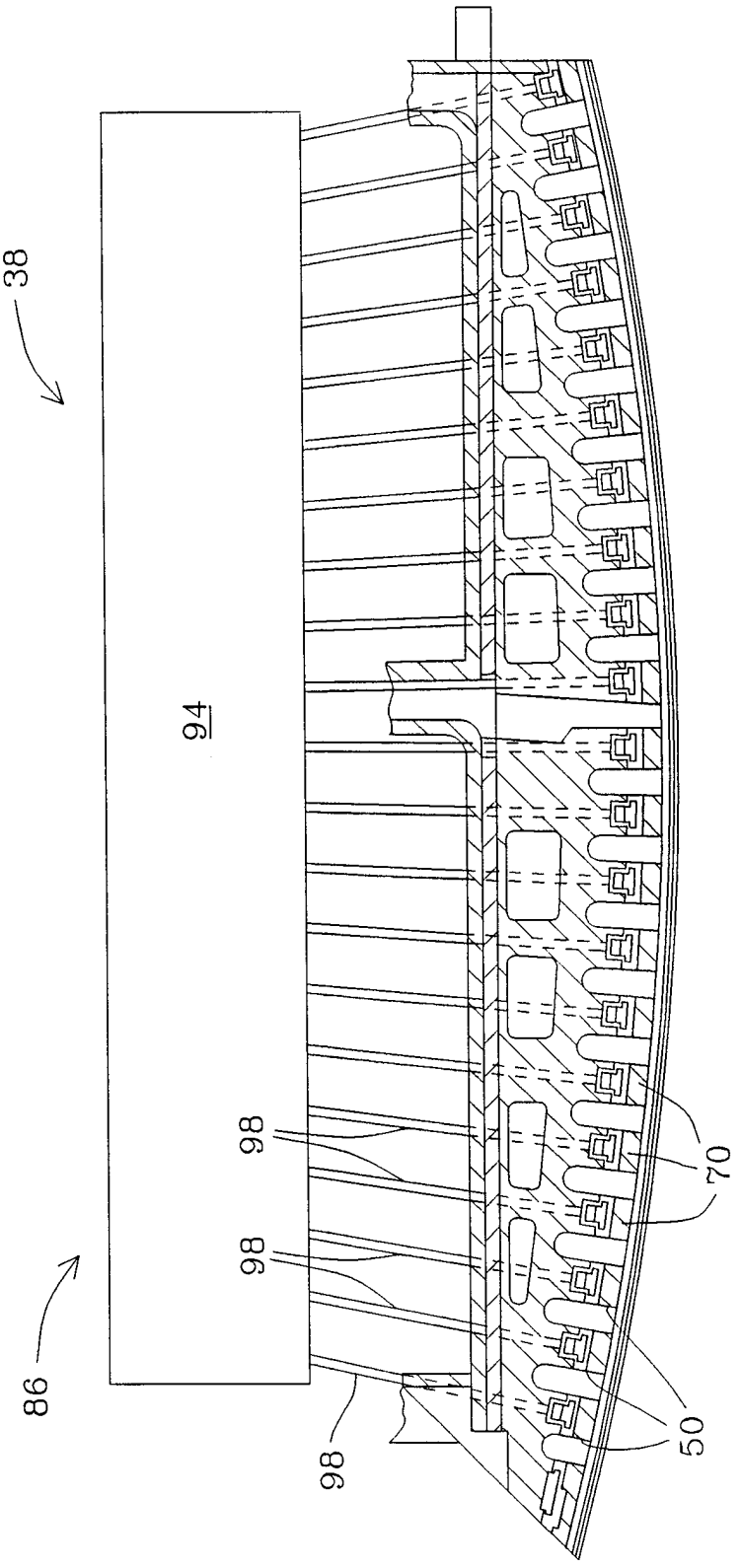

Fig. 2

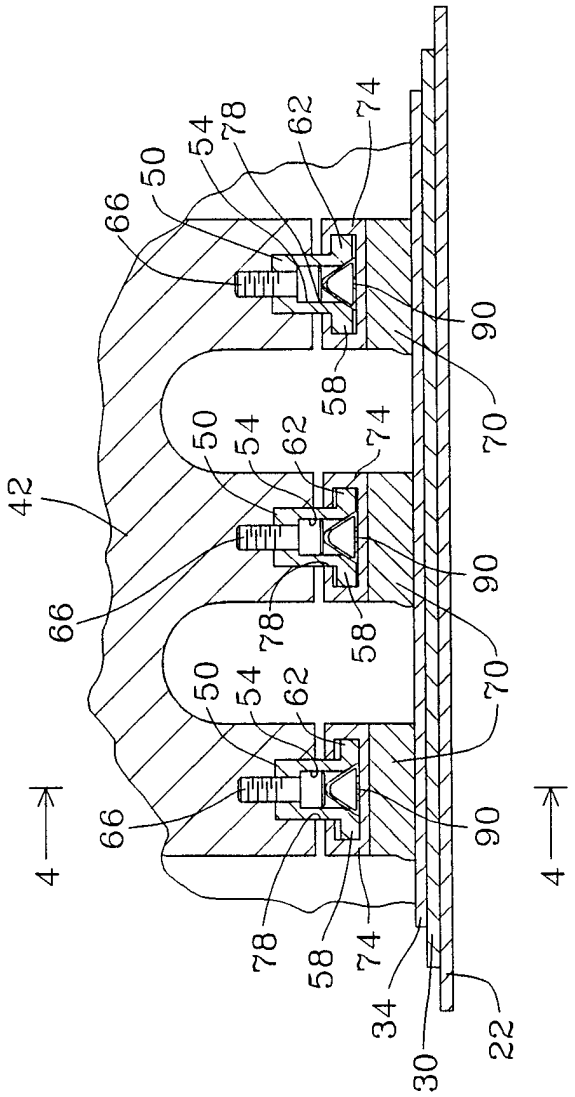
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Fig. 3

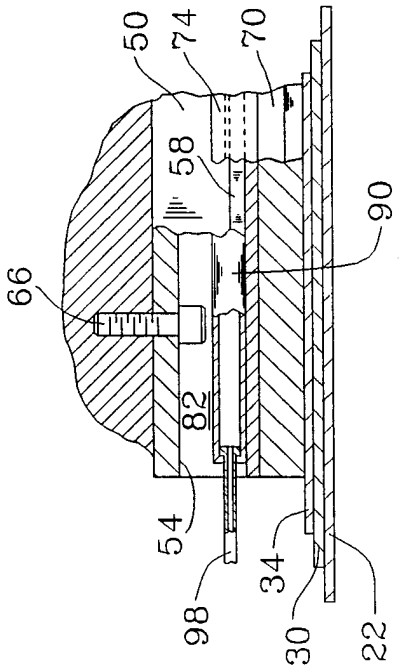
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Fig. 4

INTERNATIONAL SEARCH REPORT

In. ational Application No
PCT/US 98/04286

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 D21F9/00 D21F1/48 D21F1/52

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical. search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document. with indication. where appropriate. of the relevant passages	Relevant to claim No.
Y	EP 0 742 314 A (VALMET PAPER MACHINERY INC) 13 November 1996 see the whole document	1-19
Y	EP 0 552 139 A (VALMET PAPER MACHINERY INC) 21 July 1993 see the whole document	1-19

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26 June 1998	09/07/1998

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Int tional Application No
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