United States Patent [19]

Lee et al.

[11] **3,819,475**

[45] **June 25, 1974**

[54] **ROTATABLE PAPERMAKING MACHINE SUPPORT STRUCTURE THEREFOR**

[75] Inventors: **Charles A. Lee**, Knoxville; **Robert F. Hunt**, Concord, both of Tenn.

[73] Assignee: **International Paper Company**, New York, N.Y.

[22] Filed: **July 19, 1972**

[21] Appl. No.: **273,348**

[52] **U.S. Cl.** **162/354,** 162/352, 162/374

[51] **Int. Cl.** **D21f 1/36**

[58] **Field of Search** 162/354, 352, 374

[56] **References Cited**

UNITED STATES PATENTS

3,332,838	7/1967	Lee	162/352
3,515,636	6/1970	Reynolds et al.	162/352

Primary Examiner—S. Leon Bashore
Assistant Examiner—Richard H. Tushin
Attorney, Agent, or Firm—Fitch, Even, Tabin & Luedeka

[57] **ABSTRACT**

A support structure for supporting a plurality of ceramic drainage bar elements in end-to-end relation for substantially straight-line contact with the moving forming carrier of a Fourdrinier papermaking machine and the like, wherein the ceramic drainage elements have identical generally tubular configurations and are fixedly supported by mounting saddles on a support beam to maintain the elements in relatively rigid axial alignment. The support beam is mounted for rotation about an axis coincident with the longitudinal axis of the aligned drainage elements to control the suction acting on the forming carrier.

15 Claims, 6 Drawing Figures

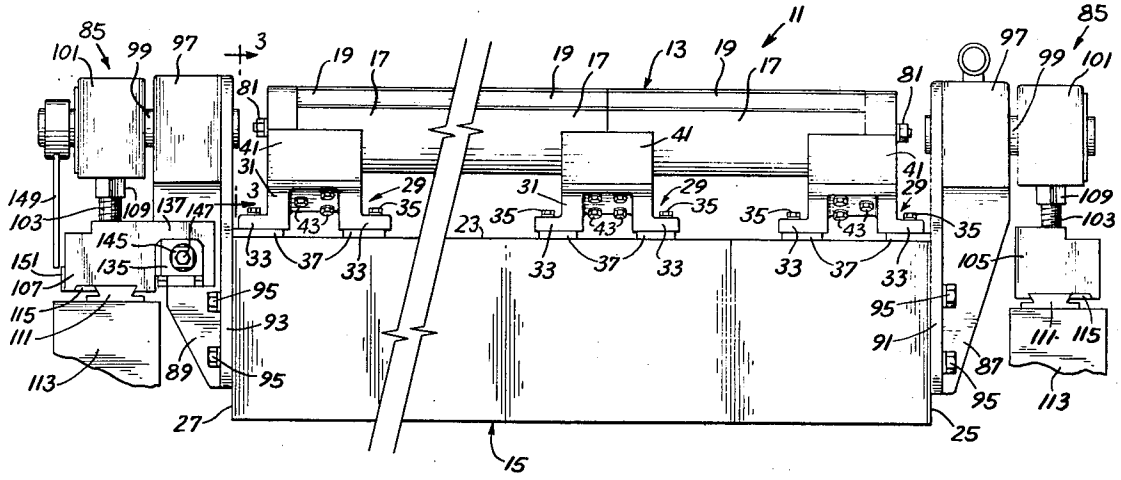
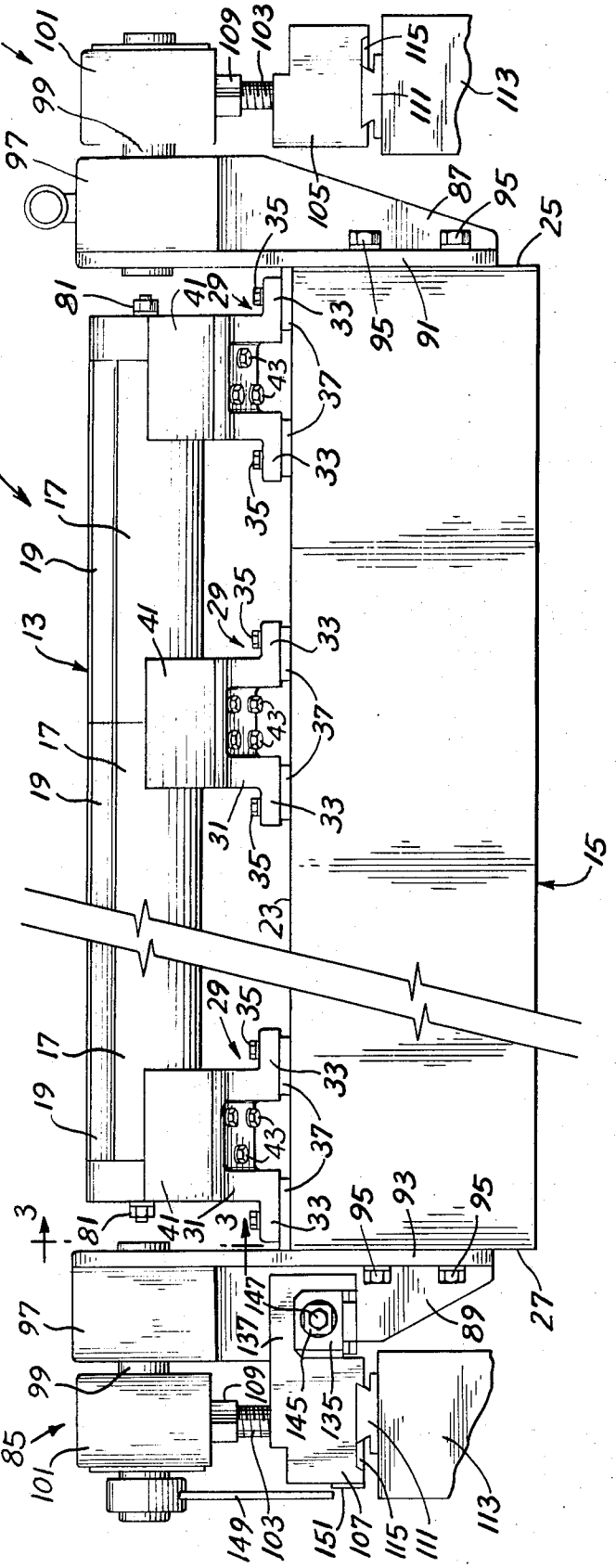


FIG. 1


85
101
99
97
109
103
115
111
113
105
87
95
25
35
29
41
81
33
91
43
37
11
17
19
13
31
23
15
3
93
89
27
147
137
145
135
107
151
149

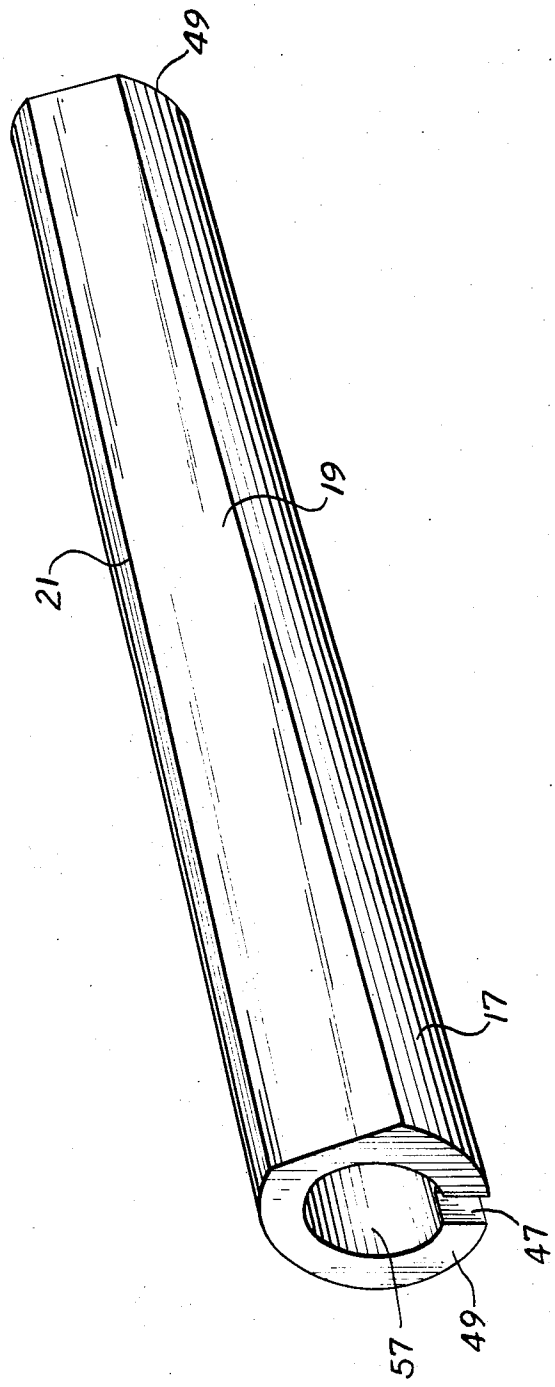


FIG. 2

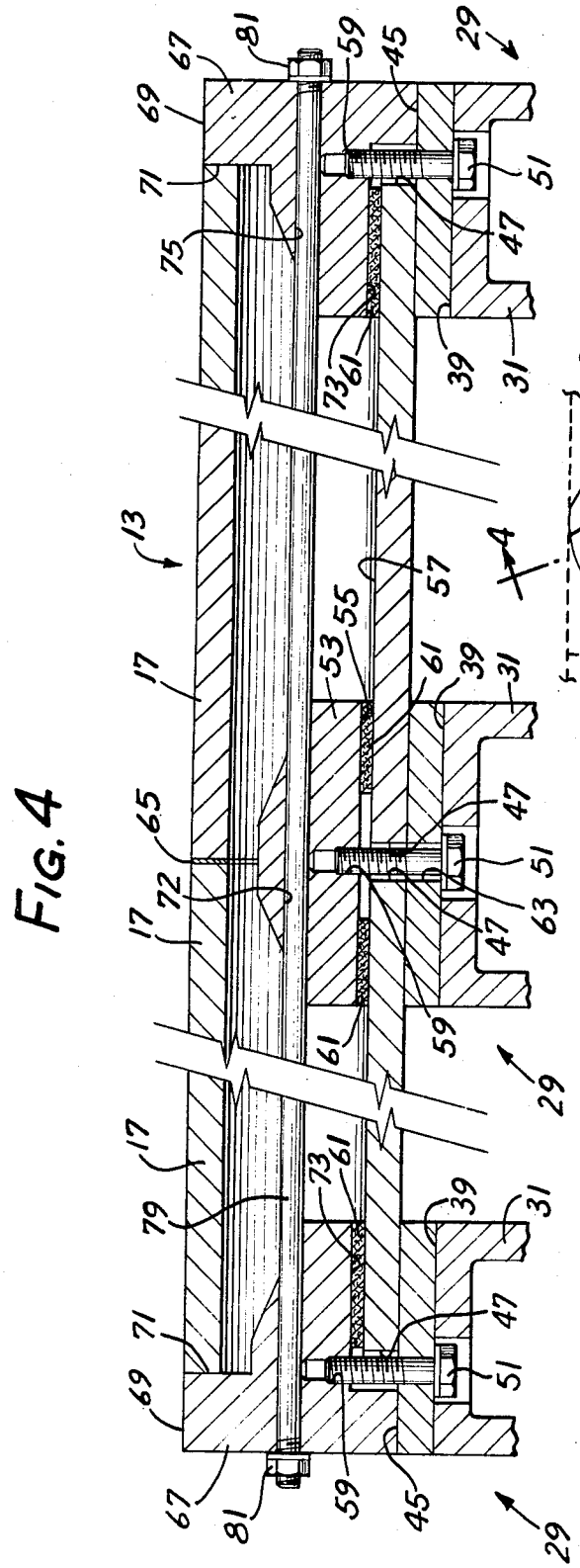


FIG. 4

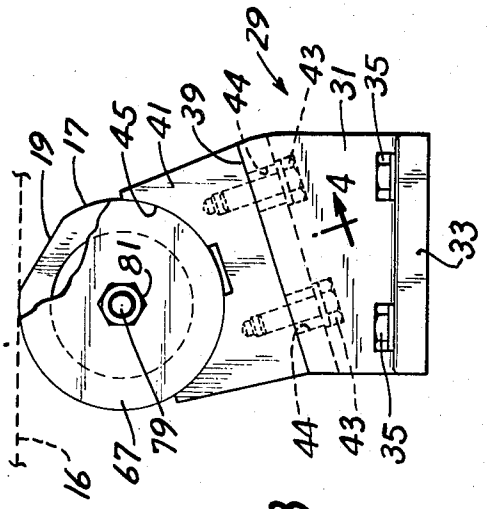
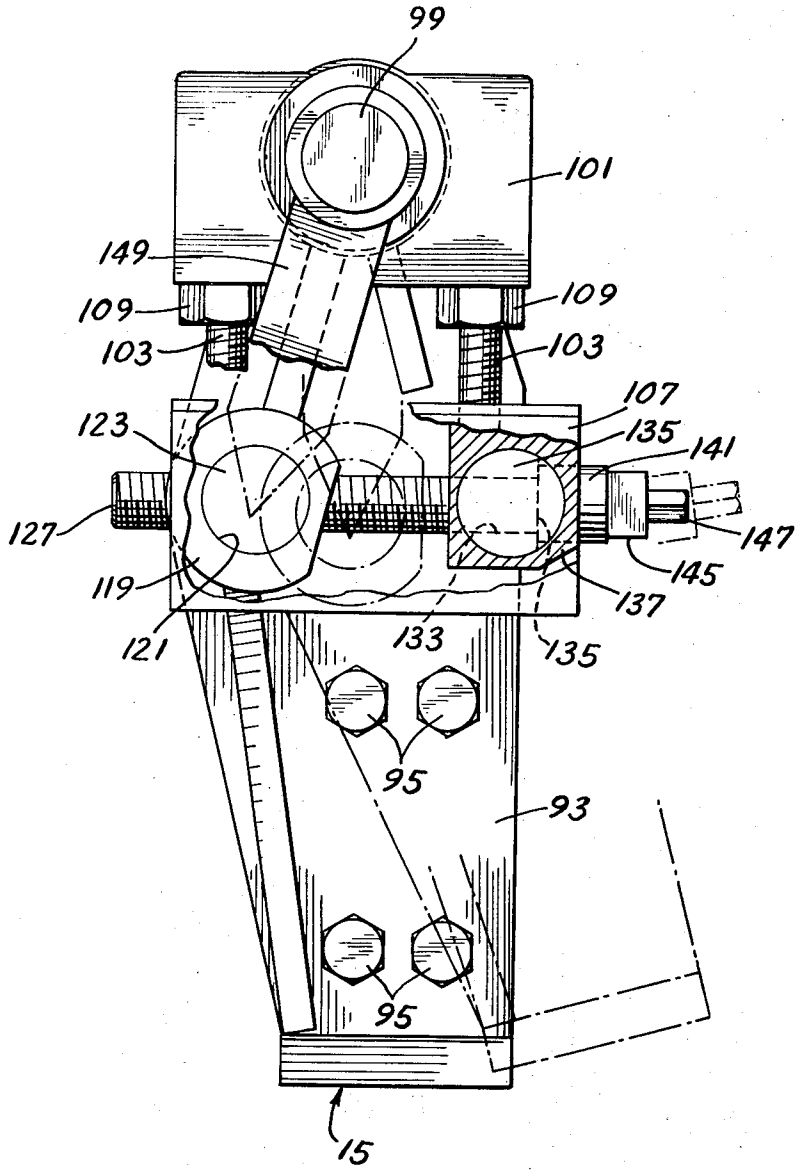


FIG. 3

FIG. 5


99
101
149
109
109
103
103
107
135
141
123
127
147
145
119
137
121
133
135
95
93
95
15

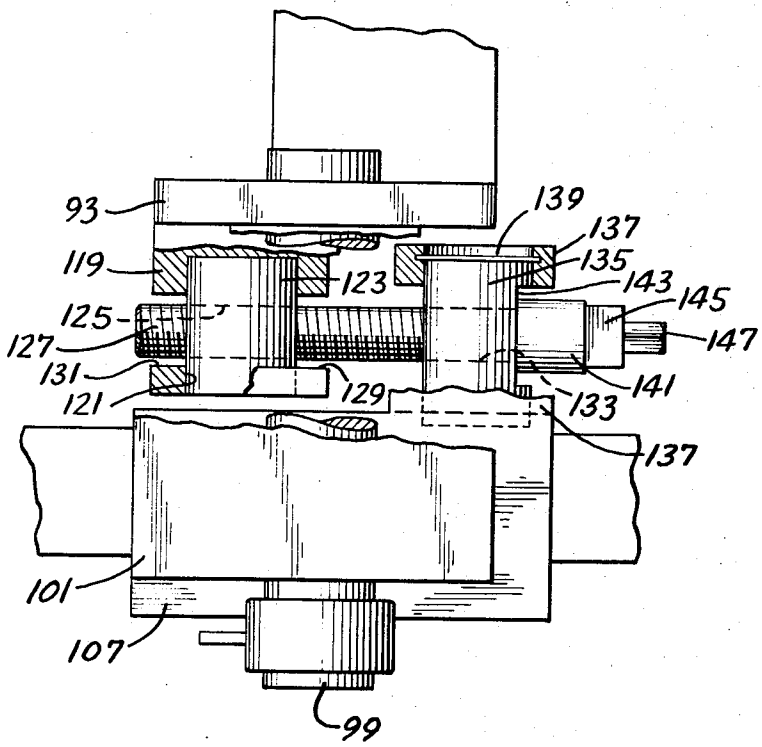

93
119
125
127
131
121
123
129
139
137
135
143
145
147
141
133
137
101
107
99

FIG. 6

ROTATABLE PAPERMAKING MACHINE SUPPORT STRUCTURE THEREFOR

The present invention relates generally to drainage devices for Fourdrinier papermaking machines and the like, and more particularly to a novel drainage bar device comprising a plurality of ceramic drainage bar elements and a support structure for supporting the elements in highly precision axially aligned end-to-end relation for straight-line contact with the fibrous web forming carrier of the papermaking machine.

A critical step in the process of making paper is the removal of water from the fibrous web which is carried on a moving endless forming carrier, such as a metal or plastic screen, as in Fourdrinier papermaking machines and the like. The general problems involved and various of the parameters which affect the removal of water from the fibrous web are described in U.S. Pat. No. 3,332,838, dated July 25, 1967, and assigned to the assignee of the present invention. The referenced patent describes and claims an improved drainage device which, in one embodiment, comprises a cylindrical bar supported in underlying line contact with the forming carrier generally traverse to the direction of movement of the forming carrier. The cylindrical bar has a flat surface portion formed longitudinally thereon. The drainage bar is adjusted about its longitudinal axis to vary the area of suction acting on the forming wire for obtaining optimum drainage under different operating conditions. The forming carriers in papermaking machines may approach thirty feet in transverse width which results in substantial side and torsional loading of the drainage bars due to frictional drag and the weight of the carrier wire and fibrous web carried thereon. As a result, the drainage bars of known construction tend to wear in a manner which adversely affects the rate of water removal from the fibrous web. One means of minimizing the rate of wear of a drainage bar is disclosed in the aforereferenced U.S. Pat. No. 3,332,838, and comprises mounting wear resistant inserts along the length of the drainage bar at the regions of contact with the forming carrier. While such use of wear inserts on steel alloy drainage bars has provided a significant improvement over prior drainage bars, the present invention represents a further improvement through providing a drainage bar device which employs a plurality of precision ceramic drainage bar elements and a support structure therefor which rigidly supports the bar elements in exacting end-to-end relation for straight-line contact with a moving forming carrier while preventing torsional moments from adversely affecting the assembled drainage bar elements.

Accordingly, one of the primary objects of the present invention is to provide a novel ceramic drainage bar device which finds particular application in Fourdrinier papermaking machines and the like.

Another object of the present invention is to provide a novel ceramic drainage bar device which employs a plurality of ceramic drainage bar elements supported in fixed axially aligned end-to-end relation.

Another object of the present invention is to provide a novel support structure for supporting a plurality of ceramic drainage bar elements in end-to-end relation, which support structure employs a relatively massive rigid support beam having a plurality of mounting saddles secured thereon to receive the ends of the bar elements in supporting relation therewith, so that the support structure is subjected to substantially all of the loading forces resulting from interaction of the drainage bar elements with the forming carrier of a papermaking machine.

A feature of the present invention is the provision of means for rotating the rigidly assembled ceramic drainage bar elements about their longitudinal axis without subjecting the assembled bar elements to torsional loading forces.

Further objects and advantages of the present invention, together with the organization and manner of operation thereof, will become apparent from the following detailed description of the invention when taken in conjunction with the accompanying drawings wherein like reference numerals designate like elements throughout the several views, and wherein;

FIG. **1** is a foreshortened from elevational view of a drainage device in accordance with the present invention;

FIG. **2** is an enlarged perspective view of one drainage bar element as employed in the drainage device of FIG. **1**;

FIG. **3** is an end view taken generally along the line **3—3** of FIG. **1**, looking in the direction of the arrows, and illustrating a mounting saddle and associated drainage bar element;

FIG. **4** is a foreshortened longitudinal section view of the aligned drainage bar elements and associated mounting saddles, taken generally along the line **4—4** of FIG. **3**;

FIG. **5** is an enlarged left-hand end view of FIG. **1**, with portions broken way or removed for clarity, and with the support beam shown in an adjusted position in phantom; and

FIG. **6** is a partial top view of the end of the drainage device shown in FIG. **5**, portions of the support structure being broken way to illustrate the means for rotationally adjusting the support beam.

Referring now to the drawings, and in particular to FIG. **1**, a drainage device in accordance with the present invention is indicated generally at **11**. The drainage device **11** finds particular use in Fourdrinier papermaking machines and the like and includes drainage bar means, indicated generally at **13**, mounted on support beam means, indicated generally at **15**, which, in turn, is supported in underlying generally transverse relation to a moving forming carrier, such as shown schematically at **16** in FIG. **3**, of the papermaking machine. Conventionally, the forming carrier of a Fourdrinier papermaking machine comprises an endless metallic or plastic screen which carries a fibrous web, the screen carrier being passed over one or more forming boards followed by various water removing devices which engage the underside of the forming carrier and effect removal of water from the fibrous web carried on the forming carrier.

In drainage devices of the table roll type, as disclosed in the above referenced U.S. Pat. No. 3,332,838, the roll or bar theoretically is caused to engage the underside of the moving carrier in straight-line contact. In actual practice, however, the suction acting on the moving carrier downstream of the theoretical tangential line of contact causes the carrier to partially wrap around the roll for a short distance which results in a "surface" contact rather than "line" contact. The phrase "straight-line contact" as used herein is meant to define the theoretical straight-line contact of the

drainage bar means **15** with the forming carrier **16** when the forming carrier is stationary.

Conventional drainage bars for Fourdrinier papermaking machines are made of unitary lengths sufficient to extend the full width or transverse dimension of the forming carriers with which they are used. The forming carriers of relatively large papermaking machines may approach thirty feet in width, thus requiring drainage bars of substantial length. Such long length drainage bars are subjected to relatively high torsional loading moments due to the frictional drag of the forming carrier as well as the weight of the carrier and the wet fibrous web carried thereon. While the known drainage bar devices made of steel alloys and the like can withstand such torsional bending moments, they exhibit poor wear characteristics and therefore require undesirably frequent replacement or surface refinishing to maintain the high degree of carrier contact accuracy desired in most papermaking operations.

In accordance with the present invention, the drainage bar means **13** includes a plurality of substantially identically shaped relatively short length drainage bar elements, each of which is indicated at **17,** supported in axially aligned end-to-end relation. With reference to FIG. **2,** each of the drainage bar elements **17** comprises a highly precision finished cylindrical tubular member made of a wear resistant ceramic material. Alumina, boron carbide, silicon nitride and silicon carbide are ceramic materials having properties of the kind found useful in the drainage bar of the disclosed device, particularly as regards their hardness, wear resistance and the smooth surface which can be developed on the elements.

A ceramic material which has been found to be highly effective for use in making the drainage bar elements **17** is commercially available from Coors Porcelain Company as Coors AD90. This ceramic material nominally comprises 90 percent aluminum-oxide and exhibits high mechanical strength, extreme hardness, and high chemical resistance. The AD-90 ceramic material has a compressive strength of 360,000 p.s.i. which exceeds the compressive strength of most high-strength alloy steels. At high temperatures, the AD-90 ceramic maintains a much greater percentage of its room-temperature strength than metals do. Of significant importance is the fact that the AD-90 ceramic maintains its shape up to its softening point, which is substantially higher than the temperatures reached during use of the drainage bar elements **17** in a papermaking machine or the like. The high hardness and low thermal expansion of the AD-90 ceramic provide an extremely hard and dimensionally stable drainage bar element under conditions of aging, high loads, and high temperatures. Through centerless grinding techniques, a surface finish of 6 to 12 microinches AA (arithmetic average) may be obtained for the ceramic drainage bar elements **17.** This low magnitude surface finish provides a greatly reduced coefficient of friction between the drainage bar elements **17** and the moving forming carrier **16** of a papermaking machine, and thereby substantially reduces the frictional drag on the forming carrier and the horsepower requirements needed to pull the forming carrier over the drainage bar means **13,** as compared to conventional metallic drainage bar devices.

It has been found that limiting the longitudinal lengths of the ceramic drainage bar elements **17** to less than 24 inches provides economic advantages over drainage bar elements of greater length. A longitudinal length of 21 inches for each drainage bar element **17** has been found to be highly efficient.

Each of the drainage bar elements **17** is provided with a precision ground uniform flat surface portion **19** extending the full longitudinal length thereof. The intersection of the flat surface portion **19** with the cylindrical peripheral surface of each drainage bar element **17** defines a straight edge **21.** As will be described below, the drainage bar elements **17** are assembled in end-to-end relation so that the straight edges **21** are accurately aligned and are disposed on the downstream or trailing side of top dead center of the drainage bar means **13** relative to the direction of travel of the web forming carrier in a Fourdrinier papermaking machine. As described in the aforereferenced U.S. Pat. No. 3,332,838, the suction acting on the moving carrier downstream of the line of contact of the drainage bar elements **17** with the forming carrier will drop abruptly to substantially zero at the trailing edges **21** such that selective rotation of the aligned drainage bar elements about their longitudinal axis will serve to vary the suction area acting on the forming carrier. By providing for adjustment of the trailing edges **21** of the aligned drainage bar elements **17** relative to top dead center, optimum suction may be obtained for the particular operating conditions of the Fourdrinier papermaking machine with which the drainage device **11** is used.

The support beam means **15** comprises an elongated structural beam having a longitudinal length greater than the transverse width dimension of the forming carrier of the papermaking machine with which the drainage device **11** may be employed. The support beam means **15** is preferably made of tubular structural steel and has a generally rectangular cross sectional configuration providing a substantial rigid mass. The support beam means **15** has a planar support surface **23** thereon disposed in normal relation to the planes of opposite end surfaces **25** and **27.** The planar support surface **23** has a plurality of mounting saddles, each of which is indicated generally at **29,** supported thereon which serve to rigidly support the drainage bar elements **17** as will be described more fully hereinbelow.

Noting FIG. **1** taken in conjunction with FIGS. **3** and **4,** each of the mounting saddles **29** includes a base portion **31** having spaced mounting pads **33.** The mounting pads **33** have openings therethrough to receive suitable mounting bolts **35,** the mounting bolts **35** being threadedly attached to the support beam means **15** to fixedly secure the base portions **31** of the mounting saddles **29** to the planar support surface **23.** Noting FIG. **3,** each of the base portions **31** has an upper rearwardly and downwardly inclined planar surface **39** which receives in mounted relation thereon a corresponding planar surface of an upper cradle member **41.** The upper cradle members **41** are secured to their associated base portions **31** through suitable bolts **43.** The shank portions of the bolts **43** are received through elongated openings **44** in the base portions **31,** the upper threaded ends of the bolts **43** being secured in suitable tapped holes in the cradle members **41.** The elongated openings **44** allow adjustment of the cradles **41** relative to their associated base portions **31** during assembly and alignment of the mounting saddles **29** onto the support beam means **15.** Each of the cradle members **41** has a concave recess **45** formed in the upper surface thereof.

In the illustrated embodiment, each recess **45** has a generally semi-cylindrical curvature having a radius corresponding to the radius of the cylindrical drainage bar elements **17** so as to provide substantially full surface contact with the associated drainage bar element when mounted therein. Suitable spacers or shims **37** are provided as necessary between the lower surfaces of the mounting pads **33** and the planar support surface **23** to provide exact longitudinal alignment of the ceramic drainage bar elements **17** when secured in the mounting saddles **29** as will become apparent hereinbelow.

The mounting saddles **29** are secured to the planar support surface **23** in longitudinally spaced relation therealong, the mounting saddles being spaced apart a distance sufficient to receive and support the opposite end portions of a plurality of the drainage bar elements **17.** Each of the drainage bar elements **17** is provided with a longitudinally directed slot **47** (FIG. 2) in each of its end surfaces **49,** the slots **47** being of sufficient size to receive the shank portion of a mounting bolt **51** therethrough. The end surfaces **49** of the drainage bar elements **17** lie in parallel planes normal to the longitudinal axes of the bar elements. The drainage bar elements **17** are supported by the mounting saddles **29** such that the drainage bar elements are disposed in axially aligned end-to-end relation. The mounting saddles **29** intermediate the opposite ends of the assembled end-to-end drainage bar elements **17** each serve to support the adjacent end portions of two aligned drainage bar elements as illustrated in FIG. **4.** The mounting saddles **29** serving to support the outermost opposite ends of the assembled drainage bar elements **17** are of slightly reduced width, as compared to the intermediate mounting saddles **29,** and similarly receive and support the outer end portions of the end drainage bar elements **17.**

With reference to FIG. **4,** when assembling the drainage bar elements **17** into the recesses **45** of the mounting saddles **29,** hold-down members **53** are inserted into the tubular drainage bar elements to overlie adjacent end portions of the aligned drainage bar elements. The hold-down members **53** have outer peripheral surface portions **55** which have curvatures substantially equal to the curvature of the inner bores **57** of the drainage bar elements **17.** Each hold-down member **53** has a length sufficient to allow one-half of the hold-down member to extend into adjacent ends of a pair of end-to-end drainage bar elements **17,** and includes a threaded opening **59** therein to receive the threaded end portion of an associated one of the mounting bolts **51.** The mounting bolts **51** extend through the slots **47** in the drainage bar elements **17.** Preferably, a suitable compressible thin gasket material **61** is inserted between the surface **55** of each hold-down member **53** and the inner cylindrical bores **57** of the associated drainage bar elements **17.** In this manner, tightening the associated mounting bolt **59** within the threaded opening **57,** after inserting the bolt **51** through an opening **63** in the associated mounting saddle **29,** will draw the hold-down member **53** against the gasket material **61** and effect a firm engagement of the associated ends of the aligned drainage bar elements against the recess surface **45** of the mounting saddle without unduly stressing the ceramic drainage bar elements.

Preferably an annular gasket **65** is provided between the adjacent end surfaces **49** of the aligned drainage bar elements **17** to allow axial thermal expansion of the drainge bar elements without substantially increasing the axial compressive loading thereon when secured in assembled relation. The annular gaskets **65** have outer peripheral configurations corresponding to the outer peripheral surfaces of the drainage bar elements **17** and are preferably made of polypropylene or other suitable material.

An end hold-down member **67** is inserted into each of the opposite ends of the assembled drainage bar elements **17** during assembly of the drainage bar elements onto the mounting saddles **29.** Each of the end hold-down members **67** has an annular peripheral surface portion **69** of a diameter substantially equal to or less than the outer diameter of the associated drainage bar element **17** associated therewith, and has a planar surface **71** for engagement with the opposing end surface **49** of the adjacent drainage bar element.

Each of the hold-down members **67** also has a peripheral surface portion **73** having a curvature similar to the curvature of the drainage bar element bores **57,** each surface **73** engaging suitable gasket material **61** and having a threaded opening **59** therein to receive the threaded end portion of an associated mounting bolt **51** to secure the end of the associated drainage bar element **17** against the associated mounting saddle **29.**

The end hold-down members **67** and the intermediate hold-down members **53** are provided with longitudinally extending openings **75** and **77,** respectively, which are axially aligned and receive a clamping rod **79** therethrough. The clamping rod **79** extends the full longitudinal length of the assembled end-to-end drainage bar elements **17** and has threaded end portions which receive clamping nuts **81** thereon. The clamping nuts **81** abut the outer end surfaces of the hold-down members **67** and assist in maintaining the drainage bar elements **17** in assembled end-to-end relation. The nuts **81** are tightened onto the ends of the rod **79** so as to apply negligible axial compressive loading on the drainage elements **17.**

When assembling the mounting saddles **29** onto the planar surface **23** of the support beam means **15,** the planar surfaces **39** of the base portions **31** may first be optically aligned by a precision optical level. The cradle members **41** may then be assembled onto the base portions **31** and the surfaces **45** optically aligned to receive the end portions of the drainage bar elements **17.** If necessary, shim stock may be placed in the cradle recesses **45** to insure exact surface alignment of the drainage bar elements. With the mounting saddles **29** rigidly secured on the planar support surface **23** of the support beam means **15,** and with the ceramic drainage bar elements **17** fixedly secured to the mounting saddles as described, it can be seen that the drainage device **11** in accordance with the present invention provides means for accurately mounting a plurality of ceramic drainage bar elements in axially aligned end-to-end relation whereby to present a cylindrical surface portion to the underside of a moving forming carrier, as schematically illustrated at **16** in FIG. **3,** for straight-line engagement with the forming carrier, the trailing edges **29** of the bar elements being disposed downstream of the theoretical tangential line contact of the forming carrier **16** with the drainage bar elements.

The drainage device **11** includes means, indicated generally at **85,** for mounting the support beam means **15** for rotation about an axis coincident with the longi-

tudinal axis of the assembled drainage bar elements **17** secured on the support beam means. Noting FIG. **1**, taken in conjunction with FIGS. **5** and **6**, the means **85** for mounting the support beam means **15** includes a pair of mounting brackets **87** and **89** having plate portions **91** and **93**, respectively, secured to the opposite end surfaces **25** and **27** of the support beam means **15**, as through mounting bolts **95**. The mounting brackets **87** and **89** extend vertically upwardly above the plane of the support surface **23** and each has an annular boss portion **97** thereon which has fixedly secured thereto a pivot shaft **99**, the longitudinal axes of the pivot shafts **99** being axially aligned and being normal to the planes of the associated plate portions **91** and **93**. Each of the mounting shafts **99** is rotatably supported in a bearing block **101** through suitable bearing means (not shown) to allow rotation of the axially aligned mounting shafts **99** within the bearing blocks. Each of the bearing blocks **101** is, in turn, supported on a pair of vertically upstanding parallel threaded support legs **103** the lower ends of which are fixedly secured to mounting blocks **105** and **107** disposed at opposite ends of the support beam means **15**. The upper ends of the threaded support legs **103** are received in suitable close tolerance bores in the associated upper bearing blocks **101**, and have adjustable nuts **109** threadedly secured thereon. The adjustment nuts **109** are rotatable on the legs **103** to raise or lower the bearing blocks **101** to adjust the vertical position of the assembled drainage bar elements **17** and effect uniform line contact of the drainage bar means **13** with the lower surface of the forming carrier of the papermaking machine. The mounting blocks **105** and **107** are supported on parallel guide rails **111** secured on suitable support foundations **113**. The mounting blocks **105** and **107** are adjustable longitudinally along the guide rails **111** and are selectively secured thereto by clamp members **115** carried by the mounting blocks **105** and **107** in a known manner.

Noting FIGS. **5** and **6**, the plate portion **93** of the mounting bracket **89** has an outwardly extending boss **119** secured in normal relation thereto. The cylindrical boss **119** has a central cylindrical bore **121** therein which rotatably receives and supports a pin member **123**. The pin **123** has a transverse threaded opening **125** therethrough which receives a threaded adjustment rod **127** for threaded cooperation therewith. The boss **119** has a pair of transverse slots or grooves **129** and **131** formed therein to provide clearance for rotational movement of the adjustment rod **127** about the axis of the pin **123** during adjustment as will become more apparent hereinbelow.

The adjustment rod **127** is also received through a suitable bore **133** in a bearing pin **135** formed integral with or otherwise suitably secured to the mounting block **107**, as best seen in FIG. **6**. A retaining ring **139** is received within an annular groove in the bearing pin **135** and cooperates with a mating annular groove in the inner bore of the bearing block **137** to maintain the bearing pin **135** in fixed longitudinal relation within the bore of the bearing support block **137**. The adjustment rod **127** has a bearing sleeve **141** thereon which abuts a flat groove surface **143** provided on the bearing pin **135**, the bearing sleeve **141** being fixed on the adjustment rod against an enlarged head portion **145** of the adjustment rod. Rotation of the adjustment rod **127** through a drive end **147** causes the boss **119** and its associated mounting bracket **89** to be drawn toward the bearing support block **137** to thereby effect rotation of the support beam means **15** about the axis of the axially aligned drainage bar elements **17** about their longitudinal axes.

The mounting shaft **99** on the left-hand end of the support beam means **15**, as considered in FIG. **1**, extends outwardly from the associated bearing block **101** and has a pointer member **149** suitably affixed thereon. The pointer member **149** depends downwardly in slightly outwardly spaced relation from the mounting block **107**, and overlies a plate **151** secured to the outer vertical surface of the mounting block **107**. The plate **151** has angle indicia thereon cooperative with the pointer **149** to indicate the angular relation of the support beam means **15** relative to a predetermined "zero" position, which is normally the position defined by the support beam means **15** when in vertical position as indicated in full lines in FIG. **5**.

With the drainage bar elements **17** secured in fixed relation to the mounting saddles **29** on the support beam means **15**, it can be seen that rotational adjustment of the adjustment rod **127** will effect rotational movement of the support beam means and associated drainage bar elements about the axis of the mounting shafts **99**, which axis is coincident with the longitudinally axis of the assembled drainage bar elements **17**. In this manner, the trailing edges **21** on the aligned drainage bar elements may be adjusted relative to the web forming carrier **16** of the papermaking machine with resultant variation in the suctional area acting on the forming carrier. An important feature of the drainage device **11** is the manner of fixedly mounting the drainage bar elements **17** on the massive support beam means **15**, while providing means for rotating the support beam means about the axis of the drainage bar elements so as to selectively vary the suction acting on the forming carrier. Thus, when the support beam means **15** is rotated, all of the aligned drainage bar elements are rotated equally about their axes and a straight-line trailing edge **21** is maintained to effect uniform suction across the forming carrier. This is in contrast to the prior art drainage devices wherein provision is made for rotating a unitary drainage bar independently of its support structure, with the result that torsional bending occurs along the length of the bar which causes a non-uniform suction across the width of the forming carrier.

The drainage device **11** in accordance with the present invention provides an extremely high precision drainage bar means which, through its associated massive rigid support means, is able to maintain appreciably narrower tolerance limits than have heretofore been obtainable. By providing the massive rigid support beam means **15**, which in one embodiment has a rectangular cross-sectional configuration having a vertical height of approximately 15 inches and a width of approximately 7 inches, extremely narrow tolerances for both outer diameters and surface finishes may be maintained for the ceramic drainage bar elements **17**. Narrow alignment tolerances may also be maintained in mounting the drainage bar elements in axial alignment on the associated mounting saddles **29**. The flat surfaces **19** can thus be accurately formed on the drainage bar elements **17** and the trailing edges **21** can be maintained in precision straight-line alignment on the support beam means **15**. The massive support beam **15** having the mounting saddles **29** spaced along the length

of the beam such as at approximately 21-inch intervals, allows the support beam to take substantially all of the loading that would otherwise be taken by the drainage bar elements. This serves to prevent chipping of the ceramic drainage bar elements and also prevents center bowing or deflection of the drainage bar means as has been experienced in drainage devices heretofore used in papermaking machines. The ceramic drainage bar elements **17** of the present invention lend themselves to precision grinding manufacturing techniques. Additionally, by making the drainage bar elements **17** fully out of ceramic material, there are no additional wear inserts necessary which may become dislodged from the associated drainage bar supports. Still further, mounting a plurality of relatively short length drainage bar elements, such as 21-inch lengths in end-to-end relation as hereinabove described, minimizes the adverse effects of torsional loading moments acting on the drainage bar elements. The drainage bar elements **17** in accordance with the present invention may be readily manufactured having 6-inch outer diameters and 1-inch thick annular walls, while maintaining the very low surface finish and low coefficient of friction as described hereinabove.

While the drainage bar elements **17** have been described as having generally cylindrical tubular configurations, it will be understood that the present invention contemplates drainage bar elements of varied cross-sectional configurations. For example, the drainage bar elements could be made cylindrical and have the opposite ends thereof counterbored to receive the hold-down members **53** and **67.** It is desirable that the drainage bar elements or sections for a particular drainage device be of identical configuration and have convex generally cylindrical surface portions for engaging the underside of the associated web forming carrier of a papermaking machine whereby to effect substantially straight-line contact therewith.

Thus, while a preferred embodiment of the present invention has been illustrated and described, it will be understood to those skilled in the art that changes and modifications may be made therein without departing from the invention and its broader aspects.

What is claimed is:

1. In a Fourdrinier papermaking machine having a moving forming carrier on which a fibrous web is formed, the combination therewith comprising drainage device means adapted to remove liquid from the fibrous web being formed on the moving carrier, said drainage device means including support beam means disposed in underlying generally transverse relation to the direction of movement of the forming carrier and extending substantially the transverse width of the forming carrier, drainage bar means including a plurality of substantially identically shaped ceramic drainge elements, means rigidly affixed to said support beam means and supporting said drainage elements in axially aligned end-to-end relation, said drainage elements defining a uniform surface engageable with the underside of the forming carrier in substantially straight line contact therewith and being substantially non-rotatable relative to said support beam means, and means mounting said support beam means for rotation about an axis coincident with the longitudinal axis of said ceramic drainage elements so as to adjustably angularly rotate said drainage elements relative to the forming carrier without torsional stress being applied to said drainage elements.

2. The combination of claim **1** wherein said means supporting said drainage elements on said support beam means includes a plurality of mounting saddles fixedly secured in aligned relation along the longitudinal length of said support beam means, said mounting saddles being spaced for cooperation with at least the end portions of said drainage elements, and means for fixedly securing each of said drainage elements to an associated pair of said mounting saddles.

3. The combination of claim **2** including a clamping rod extending longitudinally through said axially aligned drainage elements, said clamping rod having means on its opposite ends serving to maintain said drainage sections in said end-to-end relation.

4. The combination of claim **2** wherein said means for securing said drainage elements to said mounting saddles includes hold-down members disposed within said drainage elements generally adjacent each end thereof, and including means interconnecting each of said hold-down members to an associated one of said mounting saddles to secure the associated drainage elements therebetween.

5. A support structure for supporting a plurality of ceramic drainage elements for line contact with a moving forming carrier in a Fourdrinier papermaking machine and the like, said drainage elements being of predetermined length and each having a generally convex cylindrical surface portion for engagement with the forming carrier, said support structure comprising, in combination, support beam means including a rigid support beam of a length sufficient to extend substantially the full transverse width of the forming carrier and having a generally planar support surface thereon, a plurality of mounting saddles fixedly secured to said support surface in longitudinally aligned relation therealong, said mounting saddles being adapted to support said drainage elements in axially aligned end-to-end relative with said cylindrical surface portions of said elements defining a uniform surface for substantially line contact with the moving forming carrier, means fixedly securing said drainage elements to said mounting saddles in substantially non-rotatable relation relative to said support beam, and means supporting said rigid support beam means and said drainage elements for rotation about the axis of said drainage elements so that said drainage elements may be rotatably adjusted relative to the forming carrier without being subjected to external torsion during rotational adjustment thereof.

6. A support structure as defined in claim **5** wherein said drainage elements have identical tubular configurations, said mounting saddles being positioned to support said drainage elements adjacent their end portions, and wherein said means fixedly securing said drainage elements to said mounting saddles include a plurality of hold-down members disposed within said drainage elements adjacent said mounting saddles, and means for attaching each of said hold-down members to at least one of said mounting saddles to secure the associated drainage elements against said mounting saddles.

7. A support structure as defined in claim **6** including a hold-down end cap received in each of the opposite open ends of the drainage elements when disposed in said end-to-end relation, and including a clamping rod

extending the full length of said aligned drainage elements internally thereof, said clamping rod being secured at its opposite ends to said end caps to maintain said drainage elements in end-to-end relation.

8. A support structure as defined in claim **7** including gasket means disposed between adjacent ends of said drainage elements to allow axial thermal expansion thereof without substantially increasing the axial compressive forces on said drainage elements.

9. A mounting arrangement for supporting a plurality of tubular sections of a drainage bar in end-to-end relation to provide a highly accurate drainage bar surface for line contact with the underside of a moving web carrying member as in a Fourdrinier papermaking machine and the like, which arrangement comprises rigid support beam means having a planar support surface thereon, a plurality of mounting saddles fixedly secured on said planar support surface in longitudinal alignment therealong, said mounting saddles being spaced predetermined distances apart and having generally semi-cylindrical concave surface portions formed therein the axes of which are in longitudinal alignment and equidistant from said planar support surface, a plurality of identical tubular drainage bar sections each having generally cylindrical outer surface portions adapted to be received in substantially fixed mating relation within said concave surfaces of said mounting saddles to establish said sections in axially aligned relatively nonrotatable end-to-end relation, means including a clamping rod extending longitudinally of said drainage section and securing said drainage sections in said end-to-end relation, means operative with each of said mounting saddles to secure the associated drainage sections within said concave recesses of said mounting saddles, and means supporting said rigid support beam means and associated drainage sections for selective rotational adjustment about the axis of said drainage elements.

10. A mounting arrangement as defined in claim **9** wherein said drainage bar sections are of equal length, said mounting saddles being disposed to support the opposite end portions of each drainage bar section.

11. A mounting arrangement as defined in claim **10** including a pair of hold-down members disposed within each of said tubular drainage bars sections adjacent the opposite end portions thereof, and means securing each of said hold-down members to an associated one of said mounting saddles to secure said bar sections thereto.

12. A mounting arrangement as defined in claim **11** wherein said drainage bar sections are made of ceramic material.

13. A drainage bar device for use in Fourdrinier papermaking machines and the like having movable forming carriers, comprising, in combination, rigid support beam means disposed in generally transverse relation to the forming carrier, drainage bar means supported by said support beam means and including a plurality of ceramic drainage bar elements each having a uniform peripheral ceramic surface portion for engaging the forming carrier in straight-line contact therewith, means fixedly mounting said drainage bar elements to said rigid support beam means in axial alignment so that said rigid support beam means is subjected to substantially all of the loading forces resulting from interaction of said drainage bar elements with the forming carrier during operation of the associated papermaking machine, said surface portions of said drainage bar elements each having a surface finish of approximately 6 to 12 microinches AA, and means supporting said rigid support beam means for rotation about the axis of said drainage bar elements.

14. A drainage bar device as defined in claim **13** wherein said drainage bar means includes a plurality of generally cylindrical tubular ceramic drainage bar elements supported by said support beam means in axially aligned end-to-end relation, each of said ceramic drainage bar elements having a peripheral surface finish of between approximately 6 to 12 microinches AA.

15. A drainage bar device as defined in claim **14** wherein each of said drainage bar elements has an outer diameter of approximately 6 inches and a longitudinal length of less than 24 inches.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,819,475 Dated June 25, 1974

Inventor(s) Charles A. Lee and Robert F. Hunt

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

The title "ROTATABLE PAPERMAKING MACHINE SUPPORT STRUCTURE THEREFOR" should be --PAPERMAKING MACHINE DRAINAGE DEVICE AND ROTATABLE SUPPORT STRUCTURE THEREFOR--

Column 1, line 27, "adjusted" should be --adjustable--

Column 2, line 17, "from" should be --front--

Column 2, line 32, "way" should be --away--

Column 2, line 37, "way" should be --away--

Column 3, line 37, "AD90" should be --AD-90--

Column 8, line 2, "the axis of the axially" should be --the axis of the support shafts 99, with a resultant rotational movement of the axially--

--drainage--

Column 10, line 40, "relative" should be --relation--

Column 11, line 31, "section" should be --sections--

Signed and sealed this 11th day of March 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks