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(54) **Airbar for use in web processing**

(57) An air bar includes orifices 24 that are supplied with air from a plenum chamber 34 from a pressurised source. Air from the orifices 24 is blown in the direction of arrow A to exert a viscous drag effect on the web W to stretch the web in the directions C and D to remove wrinkles or flutes or creases in the web.

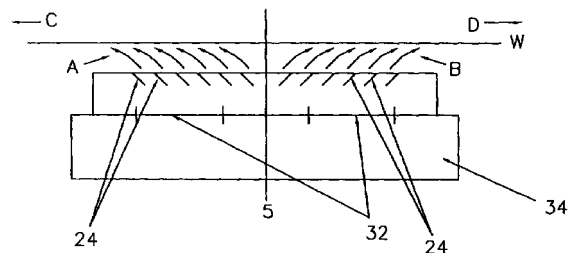


FIG. 7

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Description

[0001] The present invention relates to an air bar, a web flotation arrangement and a method of operating a web flotation arrangement.

[0002] The invention described here relates to the field of web processing. A web can be characterised in that over the extent of this invention said web is continuous in machine direction ie. it is not of the form of discrete items. The web processed in this invention is any of the commonly occurring web materials such as:-

Paper
Film
Steel
Aluminium and others

[0003] One problem associated with the processing of web materials is that under certain conditions they are prone to flutes, wrinkles and, in the extreme, creases. Devices which contact the web are available such as "Bowed Spreader Rolls" or "Crowned Rolls", the purpose of which is to alleviate the aforementioned problem. However it is quite often a requirement of process machinery that the web is handled without contact and as such said devices are not able to be utilised. Examples of process machinery handling webs in a non-contact manner are:

- Flotation drying systems
- Air Turns
- Jet Foils
- Stairbars (stabiliser) and others

[0004] In general they achieve non-contact process operation by generating a zone area of cushion pressure between the nozzles employed and the web being processed.

[0005] In the case of the flotation dryers and the Stairbar the web is processed in such a manner that it takes up a sinusoidal type wave form in the direction of travel. This is by virtue of the alternating stagger of the air bars employed.

[0006] In the case of the Air Turn and the Jet Foil the web is made to travel in an arcuate form by virtue of the nozzle arrangement being in an arcuate form.

[0007] For all of the flotation type systems described above the net effect of the web being "floated" and being subject to the arcuate form(s) (single or multiple) is that for the most part wrinkles/flutes/creases are eliminated/removed. This is achieved because of the following:

- being airborne the web has no contact surfaces over which creases etc. can be "ironed" in
- because the web is supported on a pressure cushion of fluid (likely to be air but not limited to) there is

a natural tendency for the air (fluid) to move from areas of higher pressure to areas of lower pressure. This movement that is present in the cross-machine direction (or component thereof) may have some effect in removing flutes/wrinkles/creases. This is because that air exerts small shear stress (or frictional force or viscous drag) on the web in the cross-machine direction disposed substantially symmetrically about the web centre line.

[0008] However there are instances where this effect is not of sufficient magnitude to overcome severe fluting/wrinkling creasing problems.

[0009] The factors causing fluting/wrinkling/creasing are very varied and are difficult to completely eliminate. However examples of the causes could be cited as:

- slight misalignment of mechanical components such as rolls etc
- thermal variation across the web or when in contact with mechanical components with thermal variation
- web non-uniformities
- moisture movement within paper webs. There are many more.

[0010] The present invention is an enhancement of the types of process machinery handling webs in a non-contact manner and seeks to enhance the flute/wrinkle/crease removal characteristics of said machinery to the point where said flutes/wrinkles/creases are removed.

[0011] According to one aspect of the present invention an air bar is arranged, in use, to extend transverse to a travelling web and is arranged, in use, to be spaced from the web, the air bar being characterised in that it includes at least one outlet arranged, in use, to direct air at least partially towards one edge of a web.

[0012] The outlet may be arranged to direct air substantially completely towards one edge of a web.

[0013] The outlet may be arranged to direct air at an angle greater than 0° and less than 90° towards the web with respect to the plane of the web and preferably in the range of 20 to 70° or 30 to 60° or 40 to 50° or in the region of 45°.

[0014] The outlet may comprise a rectangular orifice or a curved orifice or a cylindrical orifice.

[0015] Air may be arranged to exit from the outlet in a generally parallel air stream or in a convergent air stream, or a divergent air stream.

[0016] The outlet may be arranged to direct air towards a web at an angle of more than 0° to the upstream or downstream longitudinal extent of the web or more than 15° or more than 30° or more than 50° or more than 70° or substantially at 90° to the longitudinal

extent of the web.

[0017] The air bar may comprise a plurality of outlets. The outlets may be evenly or unevenly distributed, either over the complete extent of the air bar or towards each side of the air bar.

[0018] The air bar may include at least one outlet arranged to direct air at least partially towards one edge of the web and at least another outlet arranged to direct air towards the other edge of the web. A plurality of outlets may be arranged to direct air towards each edge of the web. The same number of outlets may be arranged to direct air to one edge of the web as the number of outlets arranged to direct air towards the other edge of the web.

[0019] The area of each outlet may be substantially the same.

[0020] The number of outlets multiplied by the open area of the or each outlet when divided by the area of the web facing the air bar may be between 0 and 20%. There may be a common air feed for all outlets. Alternatively different air feeds may be provided for different outlets. The outlets that are arranged to direct air towards one edge of the web may have a different air feed from the outlets that are arranged to direct air towards the other edge of the web. Means may be provided to vary the air feed to different outlets.

[0021] The air bar may include a plurality of outlets that are arranged to direct air at least partially towards one edge of the web, at least one of which outlets are arranged to direct air more towards the longitudinal extent of the web than other outlets. Such outlets that differ in the extent that they direct air towards the longitudinal extent of the web may also be arranged to direct air towards the same edge of the web. The extent to which outlets that direct air to a common edge of the web also direct air in line with the longitudinal extent of the web may be arranged to progressively decrease the extent that they direct air in line with the longitudinal extent of the web as the outlets approach the edge of the web towards which they direct air.

[0022] The air bar may also include at least one further outlet arranged to direct air at least partially towards the web, for instance directly towards the web or by a Coanda effect towards the web. Where an outlet directs air in a Coanda effect there may be two Coanda outlets spaced with respect to each other in the intended direction of web travel and those outlets may be arranged to direct air at least partially towards each other.

[0023] According to a further aspect of the present invention a web flotation arrangement includes at least one air bar extending transversely to the intended direction of travel of a web and arranged to be spaced from the web, the air bar being characterised in that an outlet thereof is arranged to direct air at least partially towards one edge of the web.

[0024] The air bar may be arranged to direct air towards a downwardly facing surface of the web or

towards an upwardly facing surface of the web or towards both sides of a web or towards either or both sides of an inclined web the incline of which could be of any spatial geometry or towards the web as the web travels around a corner, either from the inside of the corner or from the outside of the corner, or both or towards a concave or towards a convex surface of the web.

[0025] A plurality of such air bars may be provided arranged to direct air towards the same surface of the web or opposed surfaces of the web.

[0026] The outlets that are arranged direct air towards one edge of a web may be provided on a surface of the air bar that faces the web.

[0027] The arrangement may include a further air bar arranged to direct air towards the web on the opposite side to said at least one air bar that has an outlet that directs air towards one edge of the web. Said further air bar may also be arranged to direct air towards at least one edge of the web.

[0028] Said further air bar may be arranged to be on the opposite side of a web to said at least one air bar. The further air bar and the one air bar may be arranged to oppose each other. Alternatively they may be spaced from each other. Said further air bar may comprise a cushion air bar and may comprise a Coanda air bar that may comprise two outlets that are spaced from each other in the direction of intended travel of the web with the Coanda outlets being arranged to direct air towards each other. Alternatively, the further air bar may comprise an impingement air bar. Alternatively the further air bar may comprise a foil air bar. In addition, there may be further air bars comprising any combination of the above air bars.

[0029] Said one air bar may be arranged to have one outlet arranged to direct air towards one edge of the web and another outlet arranged to direct air towards the other edge of the web.

[0030] There may be a plurality of air bars that are in communication with a common air supply. Those air bars may comprise solely the air bars that are arranged to direct air towards one side of the web or solely the air bars that are arranged to direct air towards the web or in line with the longitudinal extent of the web or any combination thereof.

[0031] The arrangement may include means to vary the air supply to the outlet to at least one edge of the web, and preferably both edges. The arrangement may include means to detect the position of a web with respect to a desired position of the web with the air supply to at least the outlets of one edge of the air bar being varied in dependence upon the position of the web detected.

[0032] At least one of said air bars may be arranged to direct air at least partially towards one edge of the web as the web undergoes a change in direction such as by travelling around a bend. The or each one air bar may be located on the outside of the change of direction or bend.

[0033] According to another aspect of the present invention a method of operating a web flotation arrangement comprises directing air from an outlet of an air bar towards one edge of a web that is spaced from the outlet.

[0034] The method may comprise directing air from the air bar towards both edges of the web.

[0035] The method may comprise altering the amount of air emitted from the outlet towards one edge of the web as compared to the air emitted towards the other edge of the web in order to cause transverse movement of the web with respect to the direction of travel.

[0036] The method may comprise directing air towards an edge of the web in order to induce a transverse friction force on the web. That transverse friction force may comprise reducing the tendency of the web to form creases, wrinkles or folds or at least partially removing such creases, wrinkles or folds.

[0037] The present invention also includes an air bar arrangement incorporating an air bar as herein referred to or an air bar when incorporated in an air bar arrangement as herein referred to. The method may comprise a method of operating an air bar arrangement when the air bar arrangement is as herein referred to or where the air bar is as herein referred to.

[0038] The present invention includes any combination of the herein referred to features or limitations.

[0039] The embodiment of the invention may comprise the capability to move air in contact with the web in a cross-machine direction or a component thereof. This can be conducted either within the non-contact process equipment or the invention can be deployed on the opposite side of the web to the nozzle system.

[0040] An object of the present invention is that it will move air sideways in a cross-machine direction or a component thereof substantially symmetrical about the web centre line in a manner such that the ensuing air movement exerts a viscous drag effect on the web and in doing so reduces the problem of wrinkling/fluting/creasing to substantially zero. This effect is present over the effective area of the invention but also helps to reduce problems in the free draws between items of process equipment.

[0041] A further object of the invention is that the ability to remove wrinkles/flutes/creases will not be achieved at the expense of web stability i.e. the crease removal capability must not affect the inherent high quality web handling characteristics of the state of the art non-contact web processing equipment.

[0042] As mentioned earlier the cross-machine direction air movement can be achieved either in the generated static cushion pressure area of non-contact process equipment or between said air bars or it is possible to utilise the invention on the opposite side of the web to the cushion area (s).

[0043] In general the preferred embodiment is to utilise the invention within the generated cushion region.

This is because of the cost savings realised when combining the new invention into the non-contact process equipment. However there are instances where it is advantageous to utilise the invention on the opposite side. Such an example would be "retro-fitting" the invention to an existing piece of process equipment.

[0044] In view of this apparent dual capability one object of the invention is to position the invention to function within the generated cushion pressure region of the non-contact process equipment.

[0045] A further object of the invention is that the invention is positioned between the air bars of the non contact process equipment on either or both sides of the web.

[0046] A further object of the invention is that the invention is positioned on the opposite side of the web to the cushion pressure region(s) generated by non-contact process equipment.

[0047] A further object of the invention is that the cross-machine air moving device is placed on one or both sides of a web in a free draw without the presence of other non-contact process equipment.

[0048] In the arrangement in accordance with the present invention the orifices that are created to cause the sideways movement are orientated such that their axis (initial direction of air movement) is between zero and 180° relative to the web direction wherein zero degrees is the web direction of travel, except that the axis is neither zero nor 180°. The optimum/maximum effect of the orifices is achieved when their position is 90° to web travel. Although other angles (excepting zero and 180°) do exert a component in the normal direction it is (for a given air velocity) of lower magnitude than the 90° axis.

[0049] Within the scope of the invention the design of the orifice that moves the air in cross-machine direction is important, but not critical. Types of successful orifices would include air foil type slots, eyelet type slots, punched hole type slots, tube fed holes etc. For ease of construction and hence cost saving, the eyelet type nozzles are extensively used.

[0050] When the invention is utilised within non-contact process equipment, the orifices can be either fed from the same plenum chamber as said non-contact process equipment, or via a separate feed chamber arrangement.

[0051] When the invention is used as a separate device the orifices are fed from their own air supply.

[0052] The number of orifices per unit width of web and the length of the orifice in web direction is important but not critical. In physical terms the magnitude and frequency of the orifices is limited by the dimensions of the invention and in operability terms by the effect that is achieved i.e. at one extreme the multiplicity and magnitude of the orifices would render the structure of the invention weak and, at the other extreme, the invention would have minimal effect on flutes/wrinkles/crease removal.

[0053] The velocity of the air issuing from the orifices is a variable parameter, if the invention is used within non-contact process equipment and fed from the common air supply the air velocity of the invention is limited by the maximum air pressure available in the common supply, such items of equipment generally operate in the velocity region 10 to 150 metres per second, but more specifically in the region 20 to 120 metres per second, the preferred operating range is 20 to 120 metres per second. If the invention is fed by its own air supply the maximum velocity is governed by the normally available pressures typically 100 p.s.i. i.e. the velocity lies in the range generated by a pressure range of 0 to 100 p.s.i.

[0054] The temperature of the air issuing from the orifices is not critical but in general if the invention is incorporated into a drying machine the temperature of the issuing air will be substantially the same as the drying air and in the range 25°C to 500°C. If the invention is used with its own air supply the supply air can be either heated or unheated. If the air is unheated the temperature will be typically in the range 10°C to 70°C and if the air is heated will typically be in the range 25°C to 500°C.

[0055] The present invention can be carried into practice in various ways but several embodiments will now be described, by way of example, with reference to the accompanying drawings which are listed below.

[0056] Herein descriptions are given to drawings which describe the State of the Art and embodiments of the invention. However it will be clear to addressees of the application who are skilled in the art that the invention is not confined to the details of said drawings and that many more useful uses of the invention are available whilst keeping within the flavour of the application.

Figure 1 is a cross-section of a State of the Art non contact flotation type drying machine using Coanda air bars 10;

Figure 2 is a cross-section of a non contact flotation type drying machine using "air foil" type nozzles;

Figure 3 is a cross-section of a non-contact web turning device;

Figure 4 is a cross-section of a non contact web turning device that also functions as a drying machine such as JETFOIL as sold under trademark by Spooner Industries Limited;

Figure 5 is a cross-section of a State of the Art piece of non-contact process machine used for stabilising webs in unsupported draws on process machines, such an example is STAIRBAR as sold under trademark by Spooner Industries Limited;

Figure 6 is a simplistic pictorial view of a flotation nozzle in accordance with the present invention

that can be used in the equipment as shown in Figures 1 to 5. The sketch is symbolic of all the types of nozzles but is an actual representation of the air bars as used in Figures 1 and 3 and 5. Furthermore the air bar is modified by incorporation into the web facing surface orifices that cause cross-machine direction air blowings;

Figure 7 is a side elevation of Figure 6;

Figure 8 is a pictorial view of a spreading air bar 44 in accordance with the present invention;

Figure 9 is a side elevation of the spreading air bar 44 in operation in an unsupported draw on a web processing machine;

Figure 10 is a cross-sectional view of a State of the Art non-contact flotation type drying machine utilising Coanda air bars interspersed with spreading air bars;

Figure 11 is a side elevation viewed on XT-XT in Figure 10 with the spreading air bar 44 being included;

Figure 12 is a cross-section of a non-contact drying machine using air foil type air bars and on the opposite side of the web are spreading air bars 44;

Figure 13 is a cross-section of a State of the Art non-contact web turning device and on the opposite side of the web are spreading air bars 44;

Figure 14 is a cross-section of a State of the Art web turning device that also functions as a drying machine such as JETFOIL as sold under trademark by Spooner Industries Limited and on the opposite side of the web are spreading air bars 44;

Figure 15 is a cross-section of a State of the Art piece of process equipment used for stabilising webs in unsupported draws on process machines such as STAIRBAR as sold under trade mark by Spooner Industries Ltd. and on the opposite side of the web are spreading air bars 44;

Figure 16 is a cross-section of a State of the Art piece of process equipment used for stabilising webs in unsupported draws on process machines wherein the flotation air bars are the combined flotation/spreading air bar 22 as shown in Figure 6;

Figure 17 is a cross-section of a State of the Art non-contact flotation type drying machine wherein the flotation air bars are the combined flotation/spreading air bars 22 as shown in Figure 6;

Figure 18 is a cross-section of a non-contact drying machine wherein the air foil air bars are replaced with the combined flotation/spread air bars 22 as described in Figure 6;

Figure 19 is a pictorial representation of one side of the spreading air bar and the range of angles over which the inventive orifices can be orientated. For clarity the web is shown transparent;

Figure 20A is a plan view of part of the spreading air bar wherein the inventive orifice is a punched eyelet;

Figure 20B is a side elevation of Figure 20A;

Figure 20C is a cross-section of 20B as viewed XP-XP;

Figure 21A is a pictorial representation of the spreading air bar wherein the inventive orifice is an "air foil" type nozzle;

Figure 21B is a side elevation of Figure 21A;

Figure 22A is a plan view of the spreading air bar wherein the inventive orifice takes the form of tubes affixed to the upper surface of said air bars;

Figure 22B is a side elevation of 22A as viewed on XL-XL;

Figure 23A shows the apparatus of Figure 10 in communication with a common supply duct;

Figure 23B shows the apparatus of Figure 17 (and 16) in communication with a common supply duct;

Figure 23C shows the apparatus of Figure 13 wherein the spreading air bars are in communication with separate supply ducts;

Figure 23D shows the apparatus of Figure 13 wherein the spreading air bars are in communication with a common supply duct.

Figure 24 is a cross-section of both the spreading air bar and the combined flotation/spreading air bar (for simplicity only one view shown) with sectionalised feed to the spreading orifices.

[0057] As shown in Figure 1, the web W is caused to pass between a series of Coanda air bars 10 that extend across the path of the web. The Coanda air bars at the top of the web run are spaced equally from each other as are the air bars on the bottom run with the top and bottom bars being staggered from each other.

[0058] Each air bar 10 emits air from elongate slots

12. That air exits the bars towards the web and also in a direction towards the centre of the bar as a result of the Coanda effect. Thus an air pressure cushion is provided to resist movement of the web towards each air bar. Consequently the web W takes up the sinusoidal configuration as the web passes through the air bars in a non-contact manner.

[0059] In Figure 2 air foil nozzles 14 are shown. Each nozzle includes a single elongate slot 500 that emits air towards the web. In operation the web W is held under tension. The top of each nozzle 14 comprises a plate 16 that extends across the web W with the plate being upwardly inclined. The air that is emitted from slot 500 travels between the web W and the top plate 16. Because of the incline of the top plate the gap through which the air has to travel gets progressively smaller. This change of cross-sectional flow area results in an acceleration of the air stream with a corresponding drop in the air pressure. This drop in pressure produces a hold-on effect which maintains the web in position and hence the web is caused to pass contactlessly over the nozzles 14.

[0060] Figure 3 shows a series of three Coanda air bars 10, as described in relation to Figure 1, that are arranged across the web but in an arc. The air cushions provided by the bars 10 prevent the web W from contacting the bars but allow the web to travel around a corner.

[0061] Figure 4 shows the web W being guided in a non-contact manner through almost 180° and back again. A first set of air bars 18 extend across the web with those air bars being mounted in a downwardly facing arc. A second set of air bars 20 are mounted in an upwardly facing arc with the leading and trailing air bars in that second set facing vertically. More set of air bars in an arc may also be provided to allow the web to continue to travel in the sinusoidal path shown.

[0062] Figure 5 shows a stabilising arrangement for a web W and comprises upper spaced Coanda air bars 10 and a lower Coanda air bar 10 located between the upper bars.

[0063] All of the air bars shown in Figures 1 to 5 and elsewhere in the specification may, in addition to supporting or guiding the web, also have a drying effect on a web.

[0064] Figure 6 shows a modified Coanda air bar 22. It will be appreciated though that any of the air bars shown in Figures 1 to 5 could have the modification. The air bar 22 includes three nozzles 24 on each side of the centre line 5. However, as shown in the cross-section of Figure 7, more or less nozzles 24 can be included. In Figure 7, six such nozzles are shown on each side. These nozzles 24 direct air upwardly from the upper surface 28 and outwardly away from the centre line. The effect of this air is described elsewhere in this specification. The air bar also has air that converges from each slot 12 that moves, at least initially after leaving the slot, in the direction of the longitudinal extent of the web.

[0065] Figure 6 illustrates a non-contact flotation nozzle 22 as utilised in equipment as shown in Figures 1-5. By way of example Figure 6 illustrates the type of nozzle as used in Figure 1, Figure 3 and Figure 5. The orifices 24 are formed in the upper surface 28 of the flotation nozzle, the orifices are distributed substantially equal about the web centre line 5. For the purposes of this patent application wherever web centre line is mentioned, this is essentially the same axial line as air bar centre line and machine centre line.

[0066] Figure 7 shows the nozzle of Figure 6 with a web W above it. For the sake of clarity only the air blowings from the orifices 24 are shown. Air is fed into the plenum chamber 34 from a pressurised source (not shown). The air is then fed into the nozzles 24 through a series of openings 32. The air blowings A are fed through orifices 24 on the left of centre line 5 and air blowings B are fed through the right orifices 24. The travelling of air blowings A and B in directions C and D respectively results in a viscous drag effect of the air on the web in the directions C and D. This has the effect of trying to stretch the web in directions C and D which also has the effect of removing wrinkles/flutes/creases.

[0067] Figure 8 illustrates the invention when not combined within non-contact process equipment. The orifices 38 and 40 are formed in the upper surface 42 of the "spreading nozzle" 44, the orifices are distributed substantially equally about the web centre line 5.

[0068] Figure 9 shows the spreading nozzle 44 operating against a web W in an unsupported draw on a web processing machine. Air is fed into the supply chamber 46 from a pressurised source (not shown), air is then fed into the spreading nozzle 44 through a series of openings 48. The air blowings V are fed through orifices 50 and the air blowings X are fed through orifices 52. The travelling of air blowings V and X in the direction Y and Z respectively result in a viscous drag effect in the directions Y and Z which also has the effect of removing wrinkles/flutes/creases.

[0069] Figure 11 shows the invention as depicted in Figure 8. The spreading nozzle 44 is disposed on the opposite side of the web W to the non-contact flotation nozzle 10 (nozzle 10 is embodied in any of the process equipment depicted in Figure 1, 2 or 5). Air is fed into the plenum chamber 46 from a pressurised source (not shown). The air is then fed into the spreading nozzle 44 through a series of openings 48, the air blowings E are fed through orifices 50 and the air blowings F are fed through orifices 52.

[0070] Air is also fed into the flotation nozzle 10 from a plenum chamber 60 which is, in turn, fed from a pressurised source (not shown). The air issuing from nozzle 10 is responsible for floating the web. The method by which this is achieved is well known to a person skilled in the art and as such is not described here. The travelling of air blowings E and F in directions G and H respectively results in a viscous drag effect of the air on the web in the directions G and H, which also has the

effect of removing wrinkles/flutes/creases.

[0071] Figure 10 shows a cross-sectional view of the invention as depicted in Figure 11. The spreading nozzles 44 are shown interposed between flotation nozzles 10 and on the opposite side of the web W to a flotation nozzle 10 such that in operation there is an alternate stagger of both flotation nozzles 10 and spreading nozzles 44. In Figure 10 the spreading nozzle 44 is shown directly opposite a flotation nozzle 10, this is the preferred embodiment although it is clear to skilled addressees of this patent that the nozzle 44 could be positioned anywhere in the space between successive pairs of flotation nozzles 10.

[0072] Figure 12 shows the spreading nozzle 44 disposed on the opposite side of a web W to air foil nozzles 14 as depicted in Figure 2. The air movements of the spreading effect are as described in Figure 11. Figure 12 is intended as a descriptive sketch to illustrate possible uses of the invention.

[0073] Figure 13 shows the spreading nozzle 44 disposed on the opposite side of a web W to an air turn 62 as shown in Figure 3. The air movements of the spreading effect are as described in Figure 11. Figure 13 is intended as a descriptive sketch to illustrate possible uses of the invention.

[0074] Figure 14 shows the spreading nozzle 44 disposed on the opposite side of the web W to a Jet Foil 21 as depicted in Figure 4. The air movements of the spreading effect are as described in Figure 11. Figure 14 is intended as a descriptive sketch to illustrate possible uses of the invention.

[0075] Figure 15 shows the spreading nozzle 44 disposed on the opposite side of the web W to the flotation nozzles 10 of the Stairbar 23 as depicted in Figure 5. The air movements of the spreading effect are as described in Figure 11. Figure 15 is intended as a descriptive sketch to illustrate possible uses of the invention.

[0076] Figure 16 shows a web stabilising device as depicted in Figure 5 wherein the flotation nozzles 10 have been replaced with the combined flotation/spreading air bar 22.

[0077] Figure 17 shows a drying machine wherein the flotation nozzles 10 have been replaced with the combined flotation/spreading air bar 22.

[0078] Figure 18 shows a drying machine wherein the air foil type air bars 14 have been replaced with the combined flotation/spreading air bar 22.

[0079] Figure 19 illustrates pictorially the range of angles over which the invention can work. For descriptive purposes the spreading nozzle 44 only is shown. The machine direction of the travel of the web is indicated by the arrow MD. Orifices 68, 70, 71, 72, 73 and 74 are shown to indicate examples of angles at which the air blowings can be orientated. The invention will not function if the orifices are orientated such that the direction of the air blowings is in a direction MD or the reverse direction ND. All other angles of air blowings will

exhibit a degree of air movement in the cross-machine direction CD.

[0080] Of the angles illustrated orifices 68 will exhibit no beneficial movement, 70,71 will possess more than 68, and 72,73 will possess more than 70,71, and 74 will possess more than 72 and 73. Orifice 74 is disposed in the CD direction, this direction displays the maximum spreading effect, this angular disposition is the preferred embodiment.

[0081] Figure 20A, 21A and 22A show possible variations of the form of the orifice used in the invention for generating the directional air blowings. This is by no means limited and persons skilled in the art will appreciate that other forms can be utilised. For the purpose of clarity the upper surface only of the spreading nozzle 44 is shown. 20B, 21B and 22B are side elevations of Figure 20A, 21A and 22A respectively and serve only to indicate the air blowings from nozzle 44 to the web W.

[0082] Figure 20A shows the orifices taking the form of "punched eyelets".

[0083] Figure 21A shows the orifices taking the form of "air foil" type slits.

[0084] Figure 22A shows the orifices taking the form of feed tubes.

[0085] In Figures 20A, 20B and 20C air in the chamber 76 exits each nozzle through an arcuate opening 78 and then passes over an upwardly inclined surface 80 that extends towards one end of the bar. The air streams may taper towards each other as the air flows along and leaves the nozzles.

[0086] In Figures 21A and 21B air in a chamber 82 exits the nozzles 84 through an outwardly facing slit 86 and passes over an upwardly and outwardly inclined ramp 88.

[0087] In Figures 22A and 22B air enters a cylindrical tube 90 from a chamber 92. The tubes 90 are directed upwardly and outwardly and terminate with a horizontal opening flush with the surface of the bar.

[0088] The invention can be generally fed with air from one of three sources: either from a common supply chamber utilised for feeding air to the non-contact process equipment, or from a common supply chamber utilised for feeding air only to the spreading nozzles, or from a single chamber for each spreading nozzle.

[0089] Figure 23A shows the spreading air bar 44 used when disposed between flotation type nozzles 10 as in Figure 1 and Figure 5. For the purposes of explanation the upper and lower halves of the invention are substantially symmetrical and can be described with reference to one half only.

[0090] The air is fed into the supply duct 110 from a pressurised source (not shown). The air then enters the common plenum chamber 29. From 29 the air is then fed into both sets of nozzles 10 and 44. The spreading effect is achieved in accordance with earlier descriptions.

[0091] Figure 23B shows the invention with the flotation/spreading type nozzle 22. Again for purposes of

clarity the air movements to one half only are described. The air is fed into the supply duct 94 from a pressurised source (not shown), the air then enters the common supply chamber 31. From 31 the air is fed into the combined flotation/spreading nozzle 22. The air leaving slits 12 is responsible for the high quality flotation and is well understood by persons skilled in the art. The air leaving orifices 24 is responsible for the spreading effect which removes the wrinkles/flutes/creases and is fully described earlier.

[0092] Figure 23C illustrates the invention when used as a spreading nozzle 44 disposed on the opposite side of the web to a non-contact process device, in this example an air turn 62, as shown in Figure 3. The spreading nozzles 44 are mounted on separate supply chambers, 112, 114 and 116. The supply chambers are fed from pressurised sources not shown. In operation the degree of crease removal available from nozzle to nozzle can be varied by varying the pressure in the various supply chambers.

[0093] Figure 23D illustrates the invention as described in 23C except that the spreader nozzles 44 are mounted on a common supply chamber 120.

[0094] Figure 24 shows a further use for the invention in addition to flute/wrinkles/crease removal, illustrated is the invention being utilised as a non-contact web guiding unit.

[0095] A web guiding spreading nozzle 118 can be either of the combined flotation/spreading type nozzle 22 or the spreading nozzle 44. The guiding is achieved by sectionalising the supply chamber to the spreading orifices 41 and 43 into separate feed chambers 37 and 39 positioned substantially equally about the centre line of the web. Air is fed into supply chamber 39 from a pressurised source (not shown), the air exits the nozzle through the orifices 43 as air blowings J, similarly air from 37 exits the nozzle as air blowings K through orifices 41.

[0096] A proprietary device for detecting the position of the web edge is used. If the detector senses that the web has moved in the direction Q a signal is sent to a transducer which causes the pressure to be raised in the supply chamber 39, this results in a higher degree of air blowings J (relative to K) which causes the web to move back to the equilibrium position and vice versa had the initial web movement been in the direction P.

[0097] The preferred embodiment of the invention is when utilised within a piece of non-contact process machinery used for stabilising webs in unsupported draws on web processing machines. The non-contact stabilising device is one sold under the trade mark STAIRBAR by Spooner Industries Ltd. The STAIRBAR normally comprises three or five Coanda air bars 10. Although other variants of air bars can be used, the three air bar version is shown in Figure 5. In the invention as shown in Figure 16 the Coanda air bar is replaced with a modified air bar 22. The air bar 22 is 104 mm wide and 130 mm in height, the length of the air bar

is chosen dependent on the web width to be handled. The air bar includes inlets 96 of dimension 300 mm x 75 mm through which air is fed to the air bar 22 from the supply chamber 98. Air is fed to the supply chamber 98 from the supply duct 100, the air is fed to the supply duct 100 from a pressurised source (not shown).

[0098] On its face 102 which in use faces the web W, a pair of parallel linear nozzles 12 are sited. Air passes through the nozzles 12 to impinge on the web W to support the web W in a non-contact stable manner. The nozzles 12 are arranged such that they are aligned with the longitudinal axis of the air bar such that the nozzles 12 are transverse to the direction of travel of the web W. On the face 102 there is a central top plate which lies between the nozzles 12 where each edge of the top plate forms one edge of a respective nozzle 12. The edges of the plate are radiused such that air flowing from nozzles 12 is caused to flow over the radius surface and therefore towards the centre of the bar. Also included in the top plate are orifices 24.

[0099] With reference to the longitudinal axis of the air bar orifices 24 are positioned substantially symmetrical about the centre line of the air bar such that in operation they are positioned substantially symmetrical about the centre line of the web W. Orifices 24 are pitched substantially uniformly at a frequency of 50 mm, the first orifice being positioned circa 25 mm from the centre line of the air bar thus leaving a portion of the air bar in the middle with no orifice of circa 50 mm length. Orifices 24 are formed in the top plate by a mechanical punching production technique. The longitudinal axis of the punched eyelet is aligned to the longitudinal axis of the air bar and is coincident with the longitudinal centre line axis.

[0100] With reference to Figure 20A and 20B the punching depth T is 5 mm over a distance R of 15 mm. This gives an orifice of arcuate form as indicated in Figure 20C, the area of metal deformed by the punching technique tapers towards the top plate over a distance S of 30 mm.

[0101] With reference to Figure 16.

[0102] Air is fed from a pressurised source (not shown) to the supply duct 100 through apertures 104 to the supply chambers 98. From 98 the air is fed through apertures 96 into the crease removal air bar(s) 22. The air blowings issuing through the nozzles 12 perform the operation of floating the web in a non-contact stable manner. The method by which the stable non-contact flotation of webs using Coanda air bars is well known and understood by addressees skilled in the art. This knowledge is incorporated by reference.

[0103] Nozzles 24 Figure 16 are also the nozzles 24 in Figure 7. Air passing through nozzles 24 form air blowings A and B. The travelling of air blowing A in the direction C imparts a viscous drag effect of the air on the web W in the direction C, similarly for air blowing B in the direction D. The net effect of the resultant frictional forces on the web in the directions C and D is that they

attempt to stretch the web in said directions. This also has the effect of removing wrinkles/flutes/creases.

[0104] The velocity of the gas or air issuing from the spreader nozzle orifices may be in the range of 20 to 120 metres per second or up to 1000 metres per second. The temperature of the gas or air issuing from the orifices may be in the range 10°C to 500°C. The pressure of the air in the region of the orifices may be in the range of 0 to 100 p.s.i.

[0105] It will be appreciated that where the term "air" or "air bar" is used in this specification they are intended to cover any fluid or gas and not just air.

[0106] The number of orifices multiplied by the free open area of each orifice divided by the area of the web facing the top plate may be in the range of 0 to 20 per cent.

[0107] The angle of air leaving the orifices with respect to the plane of the web may be between 0° and 90° or in the region of 20° to 70° or in the region of 30° to 60° or in the region of 40° to 50° or in the region of 45°.

[0108] The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0109] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0110] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0111] The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. An air bar (22,34,44,46,82,92,118) arranged, in use, to extend transverse to a travelling web, the air bar being arranged, in use, to be spaced from the web, the air bar being characterised in that it includes at least one outlet arranged, in use, to direct air at least partially towards one edge of a web.

2. An air bar as claimed in Claim 1 in which the outlet is arranged to direct air at an angle greater than 0° and less than 90° towards the web with respect to the plane of the web. 5
3. An air bar as claimed in any preceding claim in which the outlet is arranged to direct air towards a web at an angle of more than 0° to the upstream or downstream longitudinal extent of the web. 10
4. An air bar as claimed in any preceding claim comprising a plurality of outlets. 15
5. An air bar as claimed in any preceding claim including at least one outlet arranged to direct air at least partially towards one edge of the web and at least another outlet arranged to direct air towards the other edge of the web. 20
6. An air bar as claimed in any of Claims 1 to 5 including different air feeds for different outlets with the outlets that are arranged to direct air towards one edge of the web having a different air feed from the outlets that are arranged to direct air towards the other edge of the web. 25
7. An air bar as claimed in any preceding claim including a plurality of outlets that are arranged to direct air at least partially towards one edge of the web, at least one of which outlets is arranged to direct air more towards the longitudinal extent of the web than other outlets. 30
8. A web flotation arrangement including at least one air bar extending transversely to the intended direction of travel of the web and arranged to be spaced from the web, the air bar being characterised in that an outlet thereof is arranged to direct air at least partially towards one edge of the web. 35
9. An arrangement as claimed in Claim 8 including a plurality of air bars arranged to direct air towards opposed surfaces of the web. 40
10. An arrangement as claimed in Claim 8 or 9 including means to detect the position of a web with respect to a desired position of the web with the air supply to at least the outlet of one edge of the air bar being varied in dependence upon the position of the web detected. 45
11. A method of operating a web flotation arrangement comprising directing air from an outlet of an air bar towards one edge of a web that is spaced from the outlet. 50
12. A method as claimed in Claim 11 comprising directing air from the air bar towards both edges of the web. 55
13. A method as claimed in Claim 12 comprising altering the amount of air that is emitted from the outlet towards one edge of the web as compared to the air emitted towards the other edge of the web in order to cause transverse movement of the web with respect to the direction of web travel.

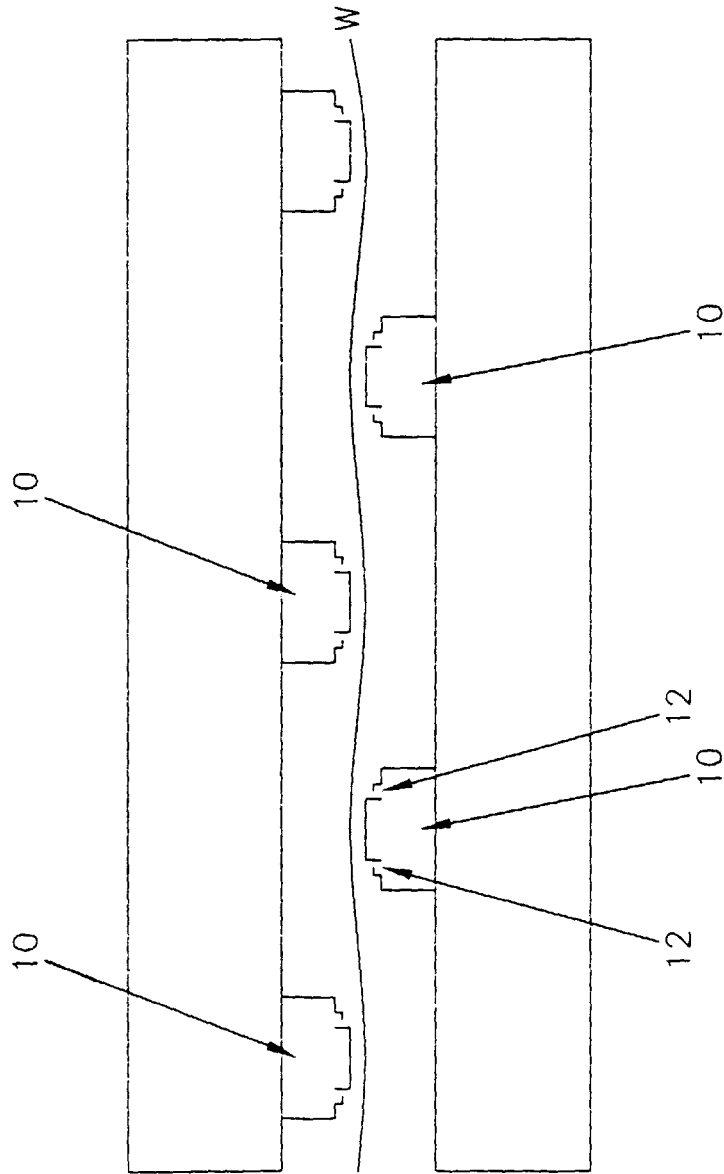


FIG. 1

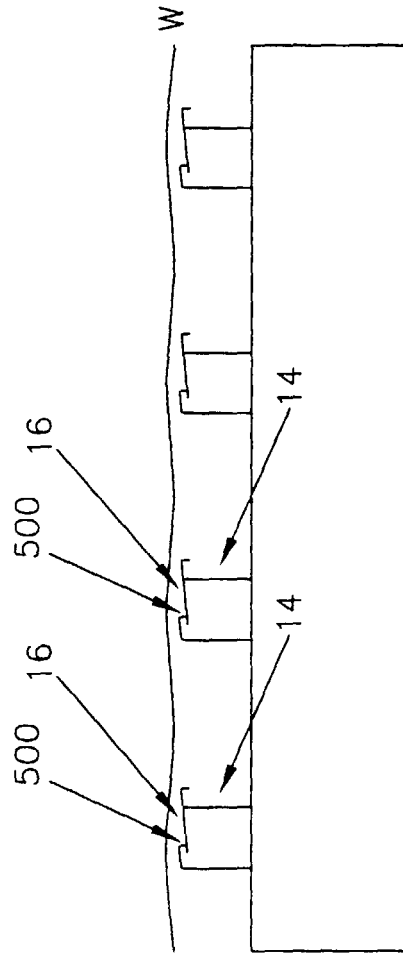


FIG. 2

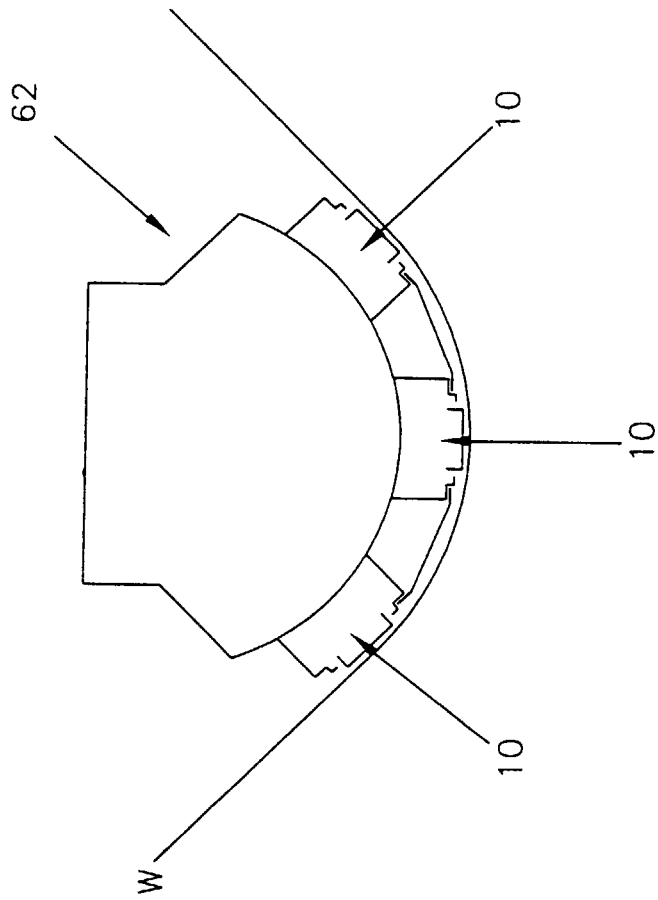


FIG. 3

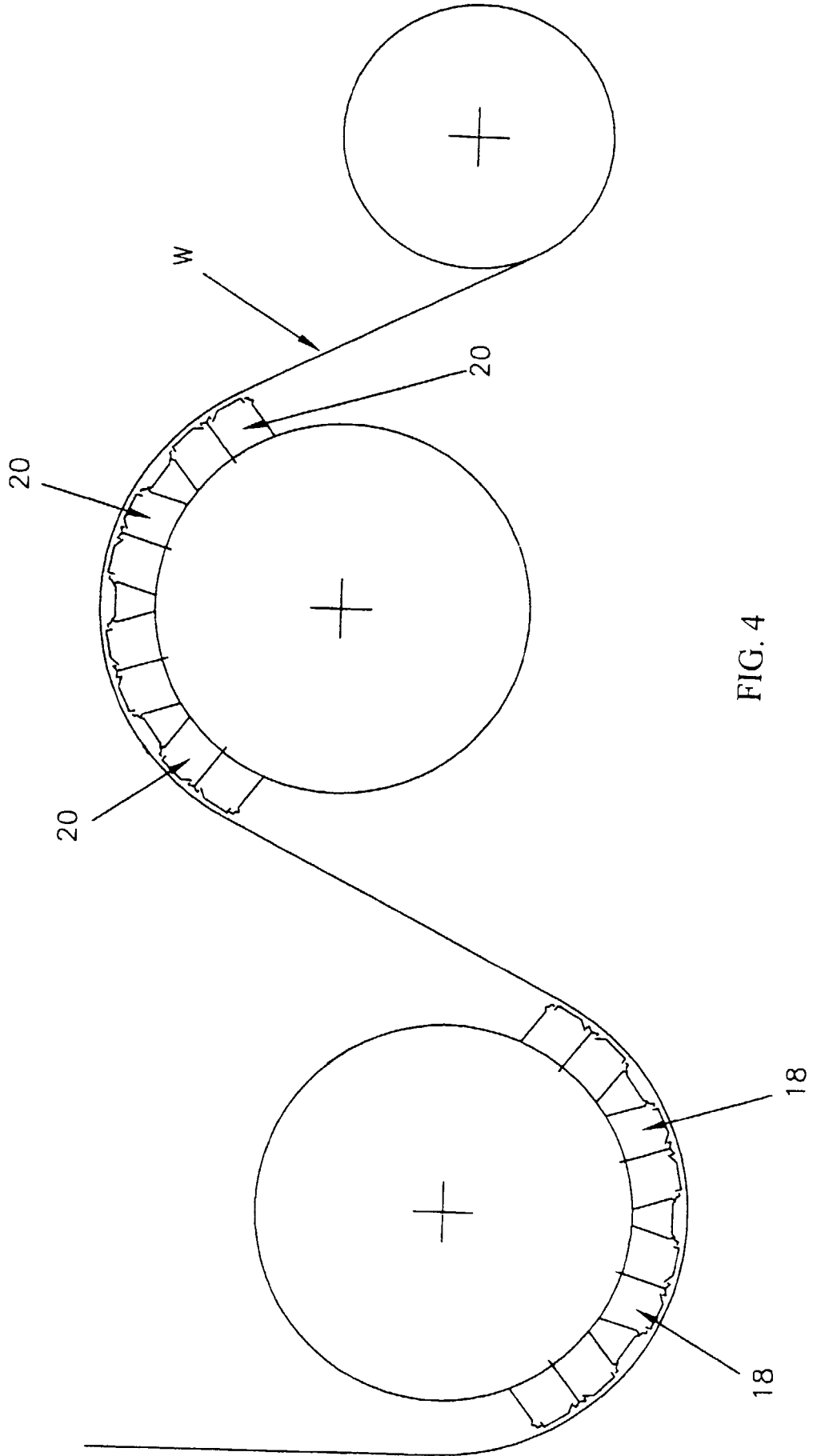


FIG. 4

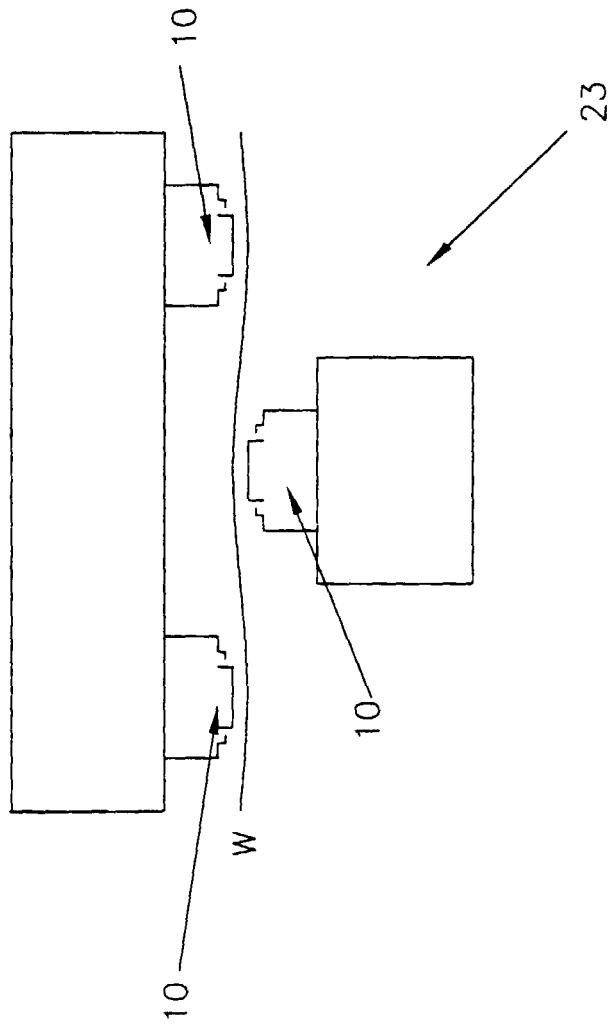


FIG. 5

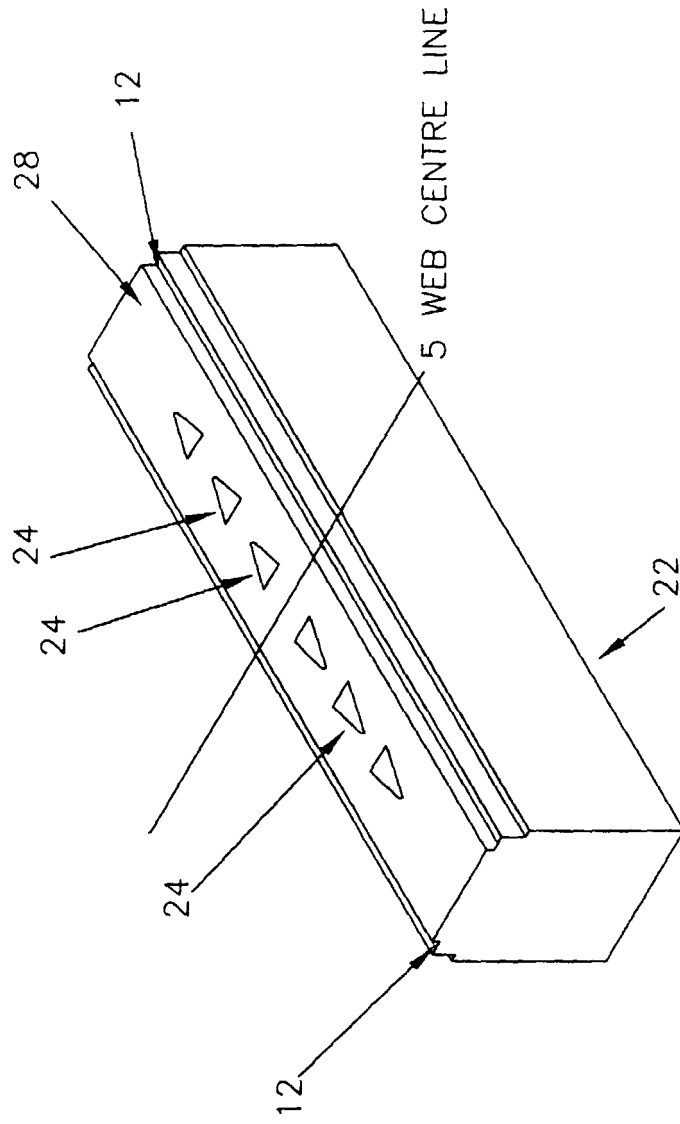


FIG. 6

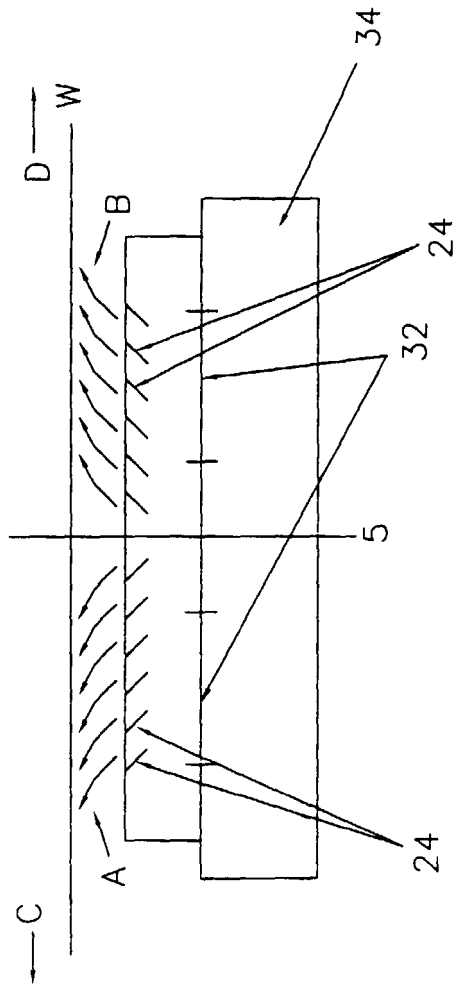


FIG. 7

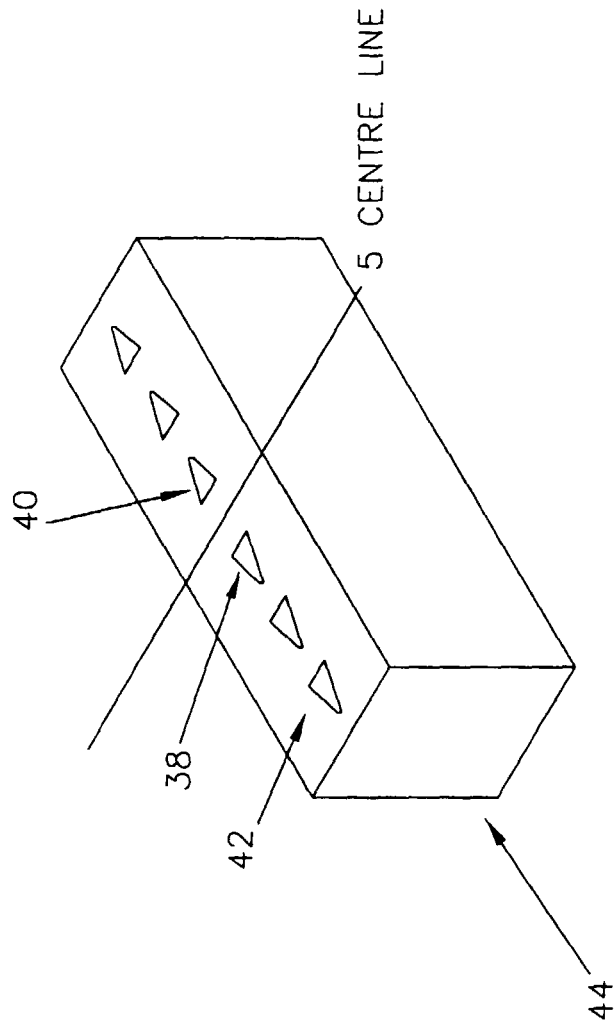


FIG. 8

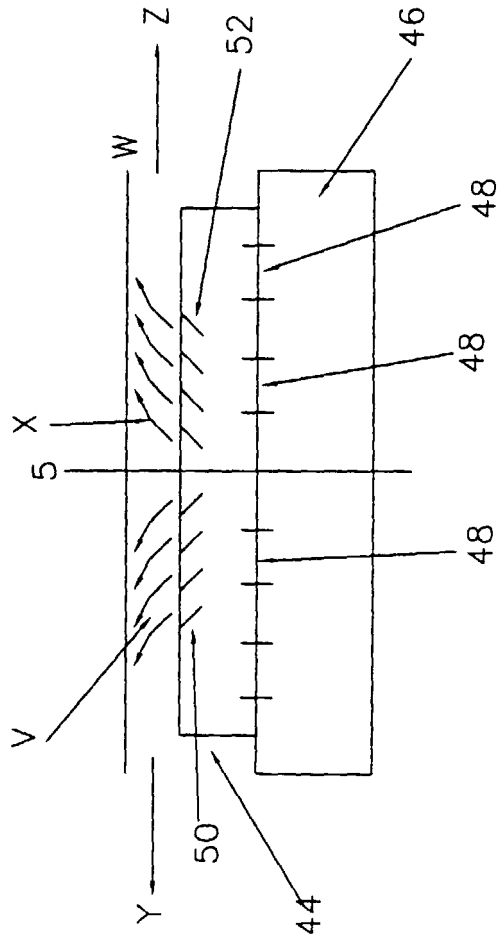


FIG. 9

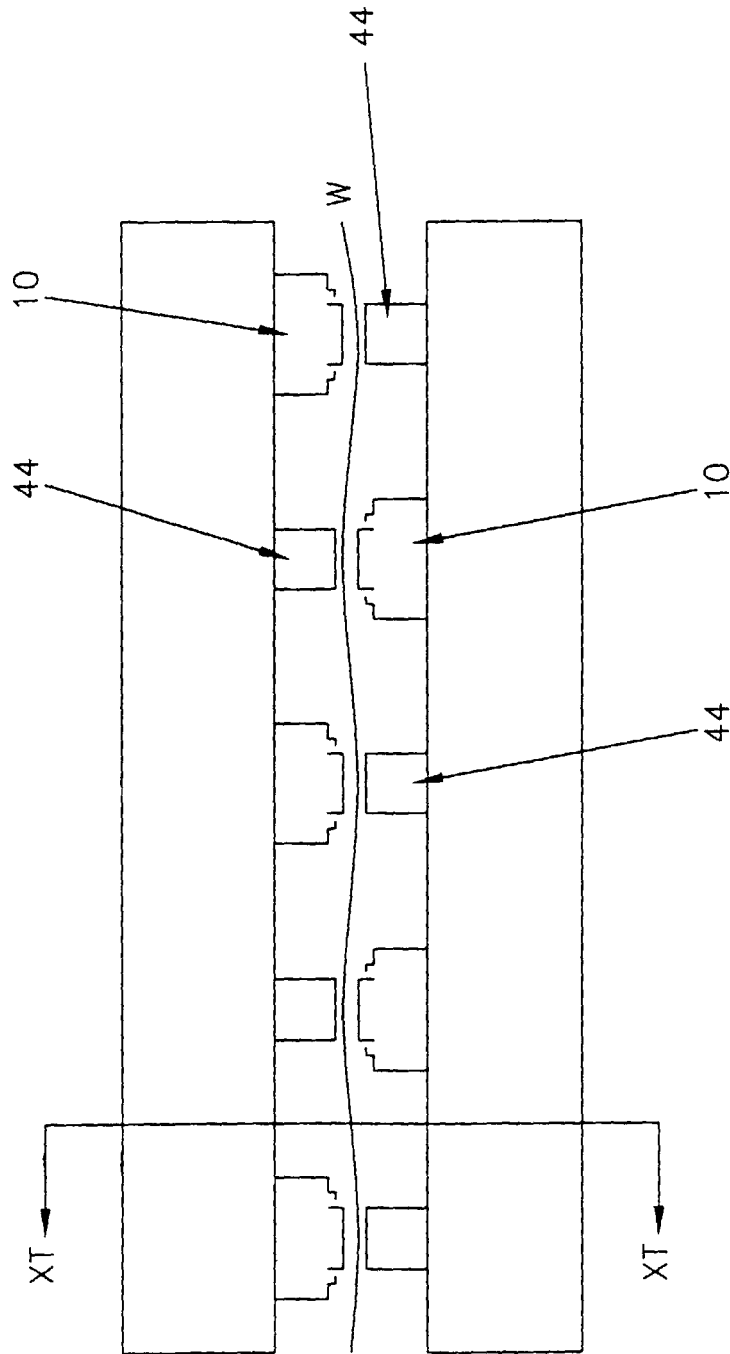


FIG. 10

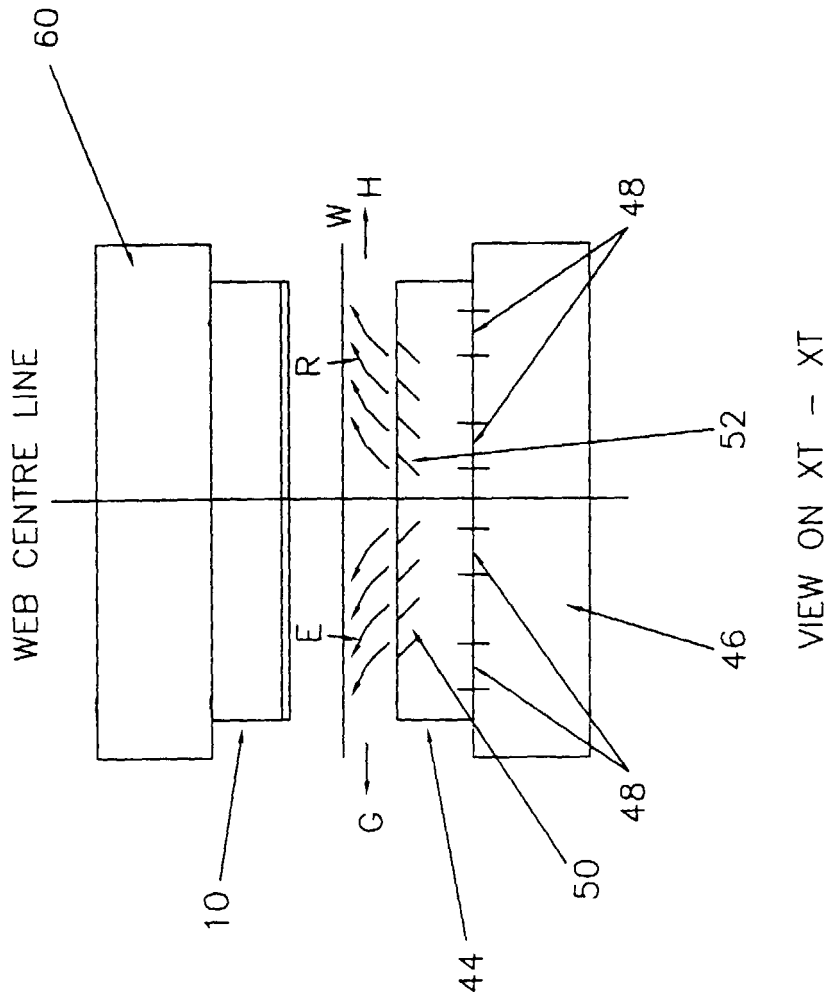


FIG. 11

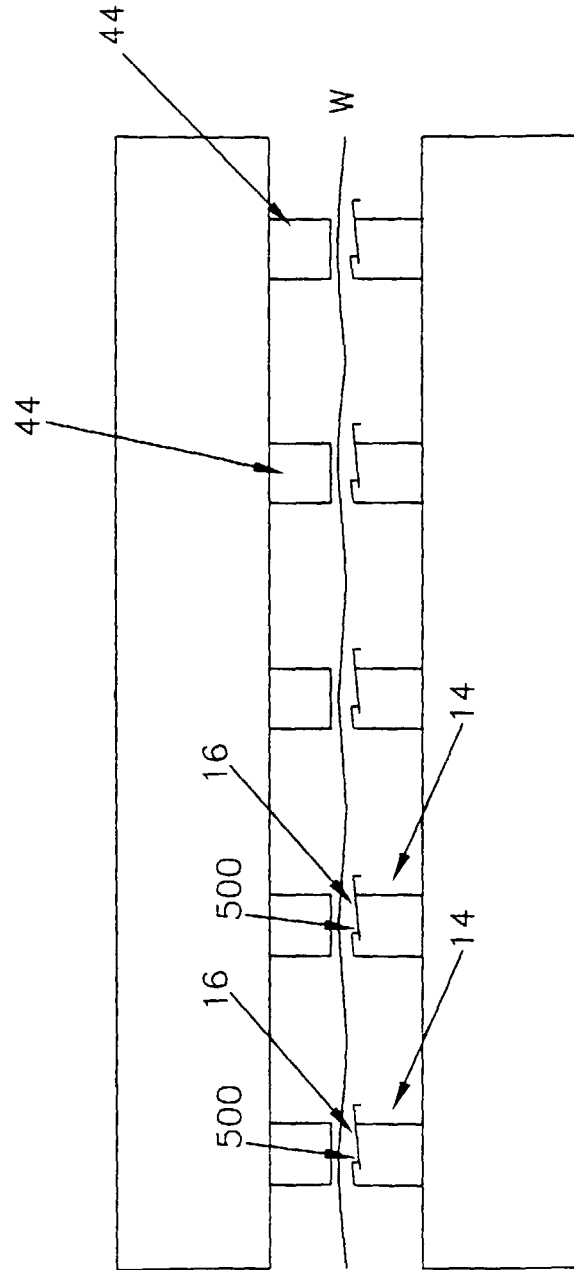


FIG. 12

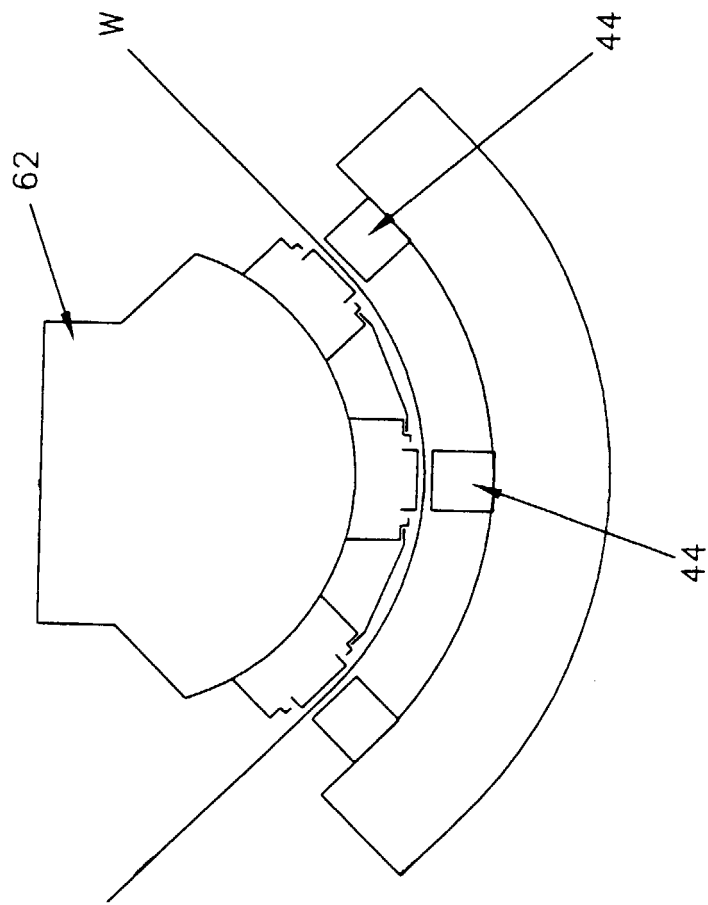


FIG. 13

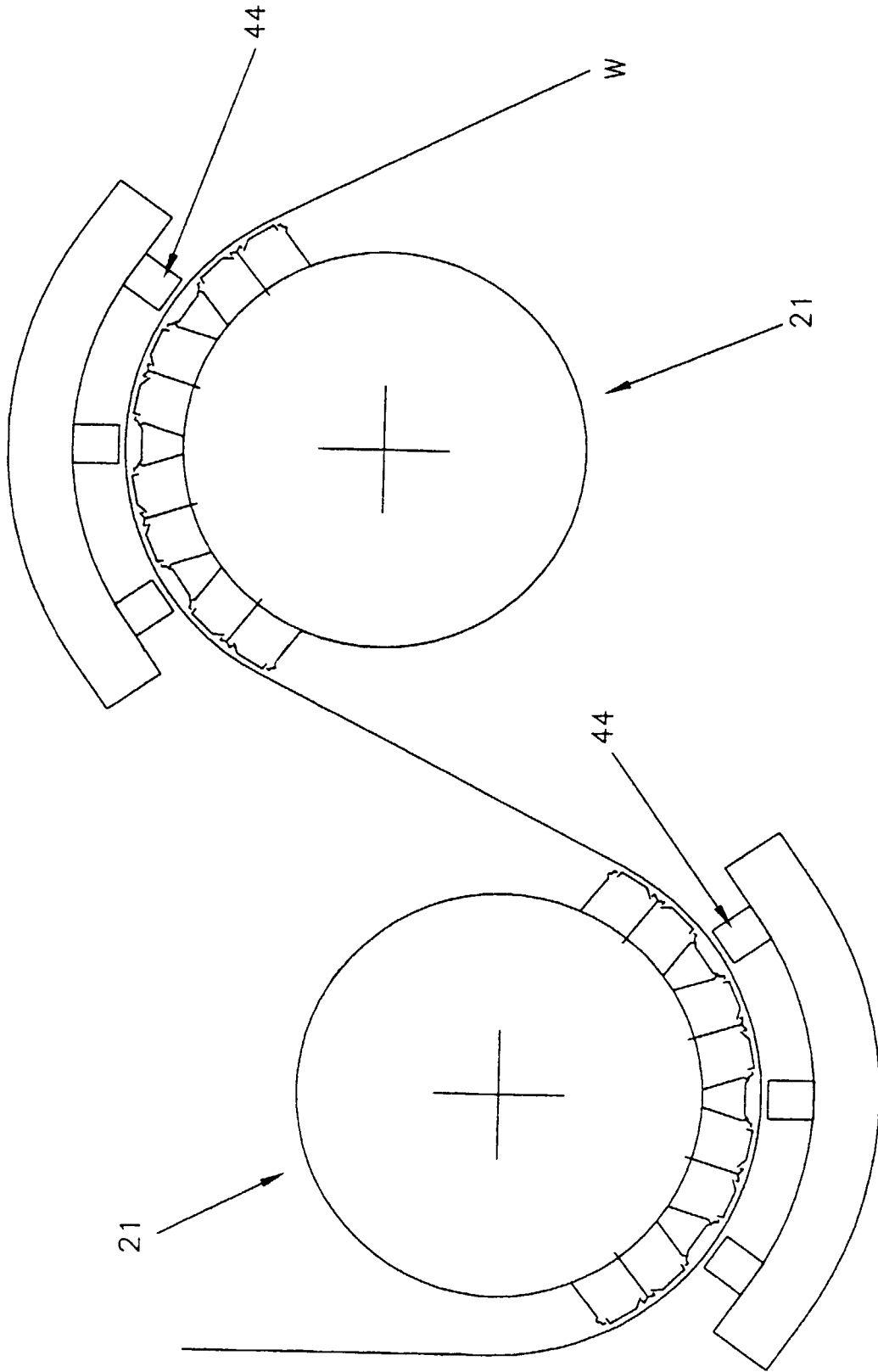


FIG. 14

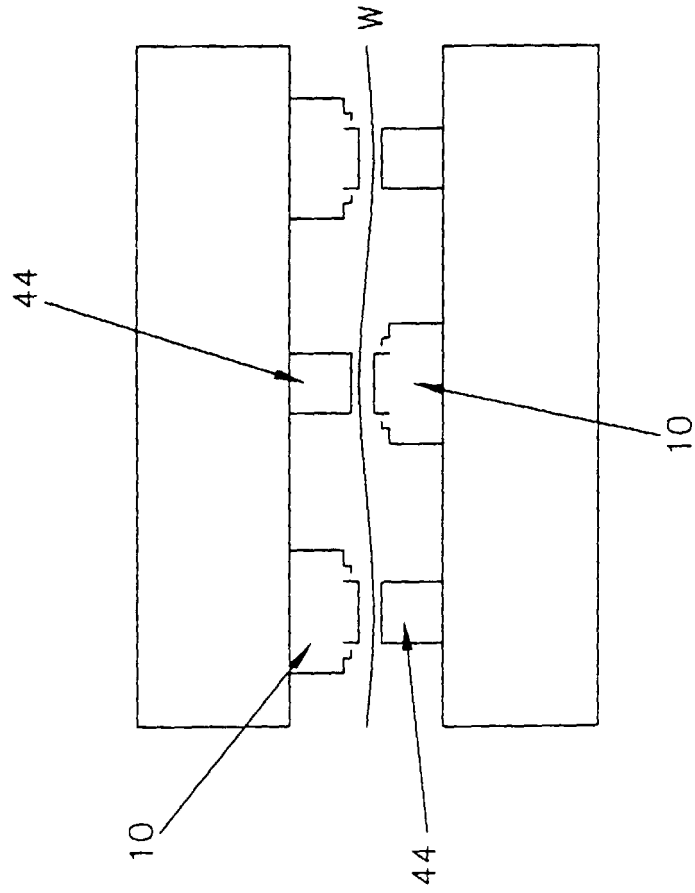


FIG. 15

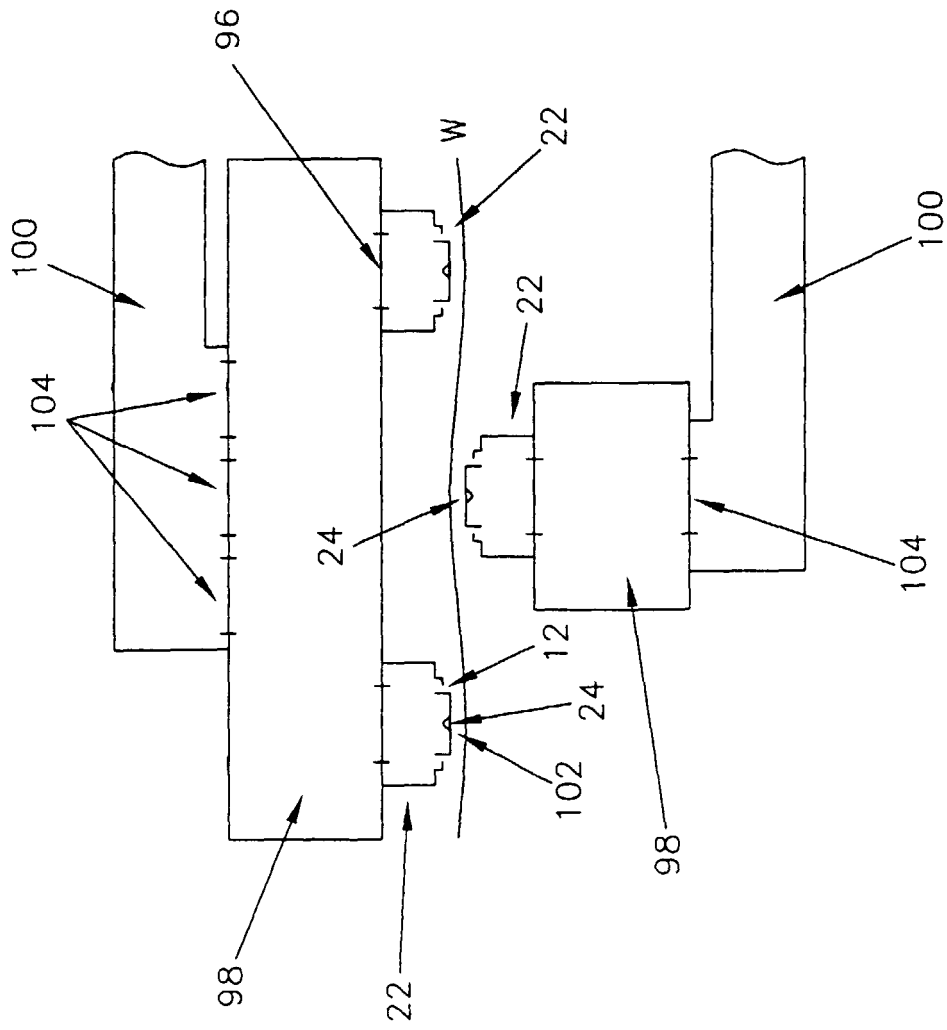


FIG. 16

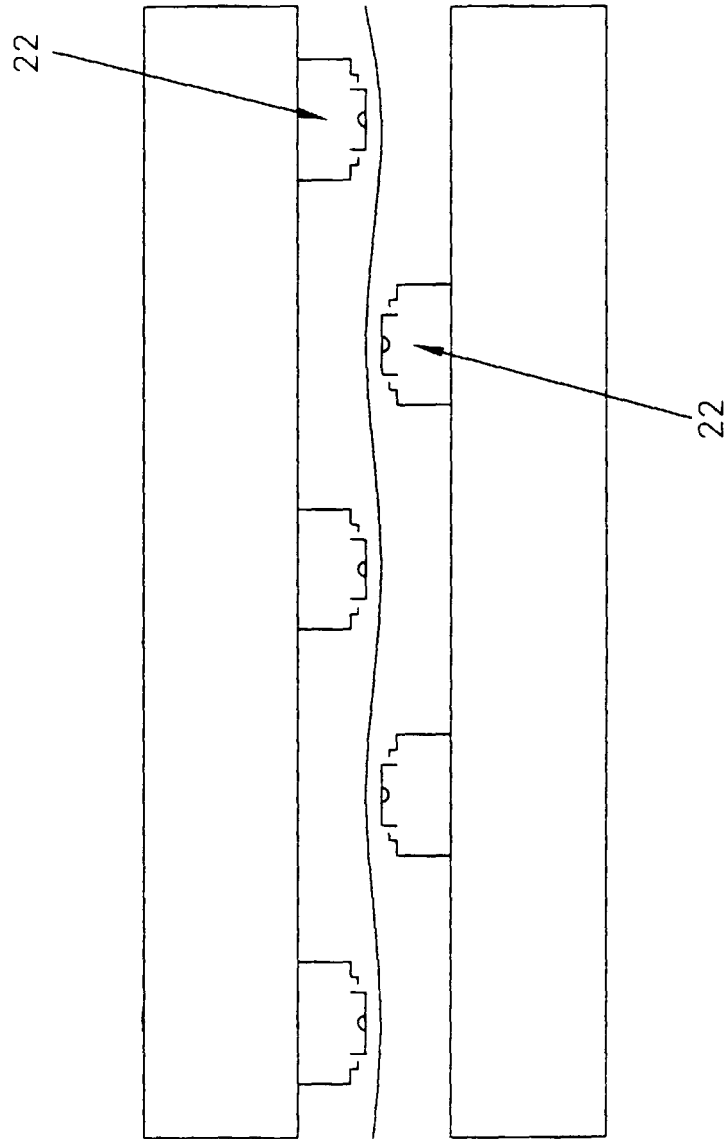


FIG. 17

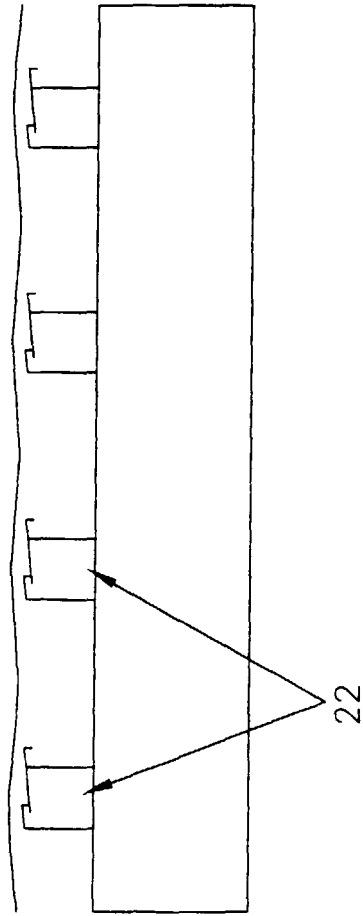


FIG. 18

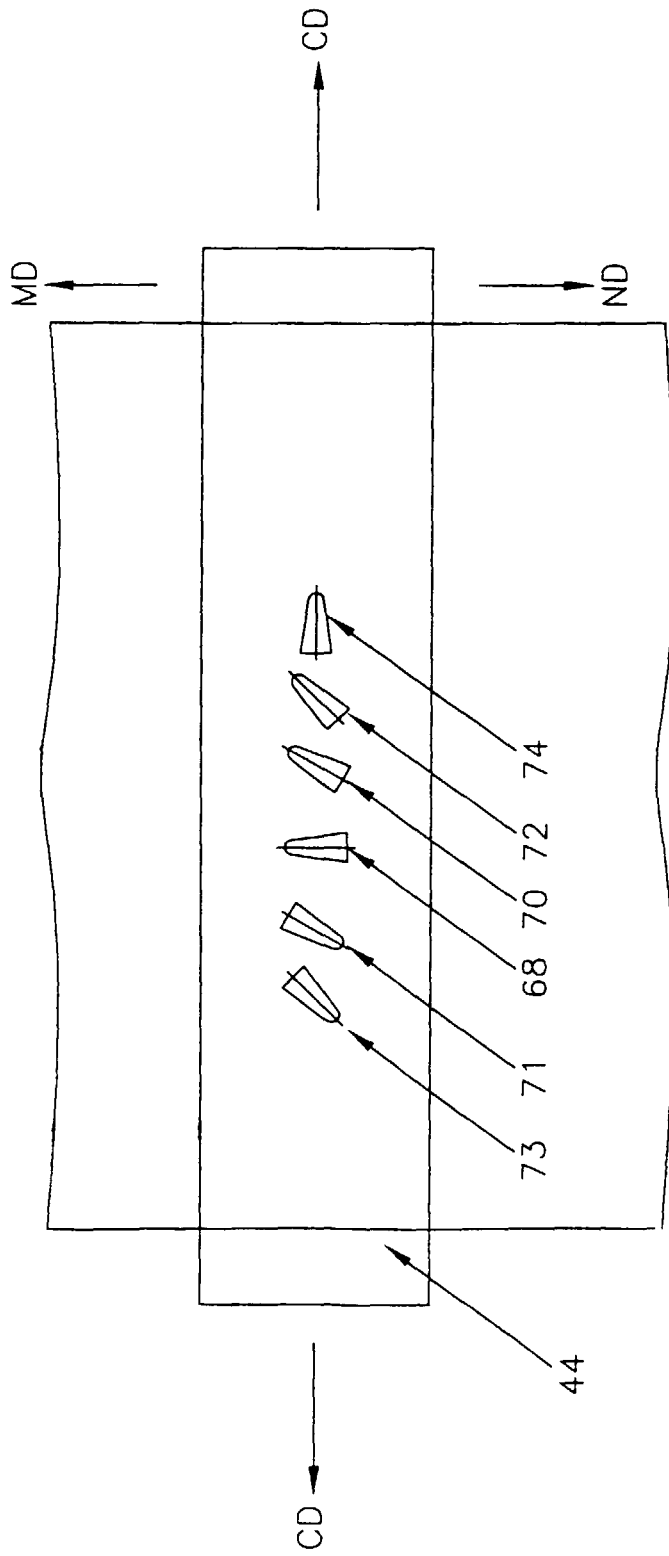


FIG. 19

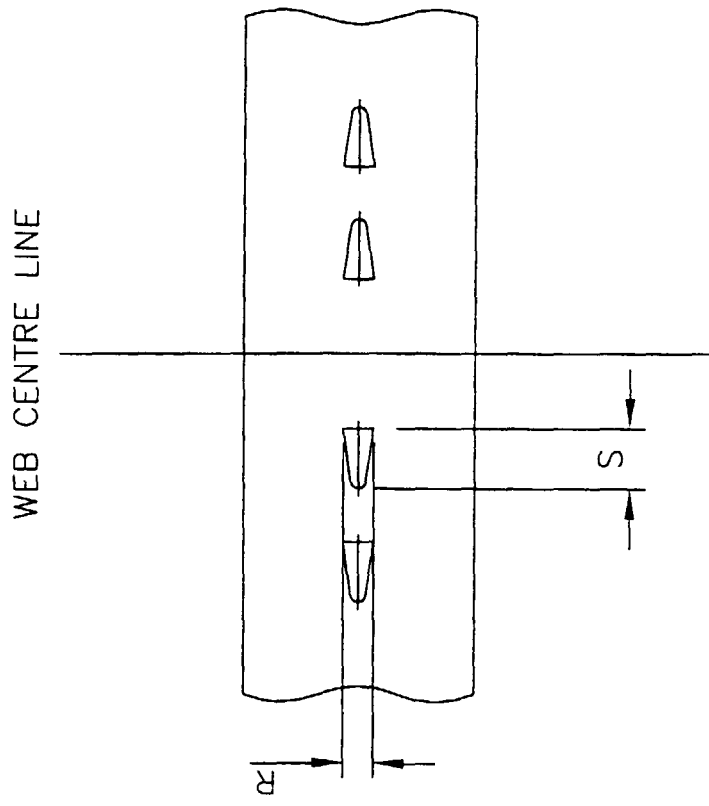


FIG. 20A

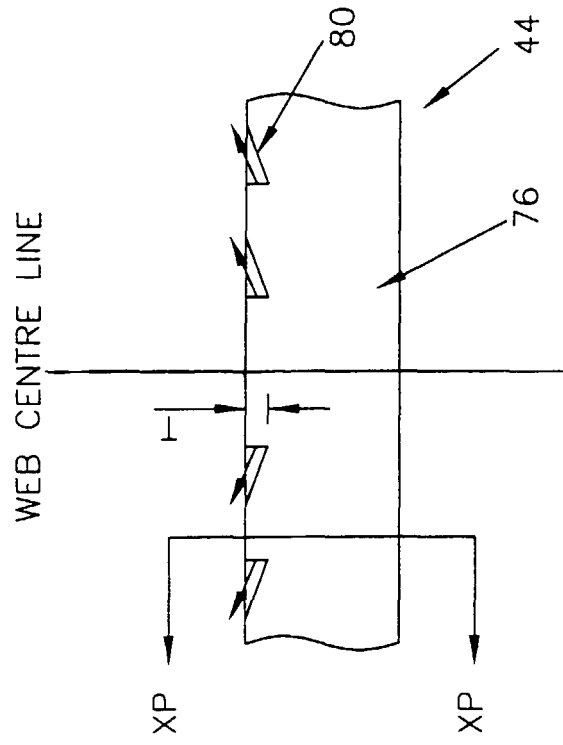


FIG. 20B

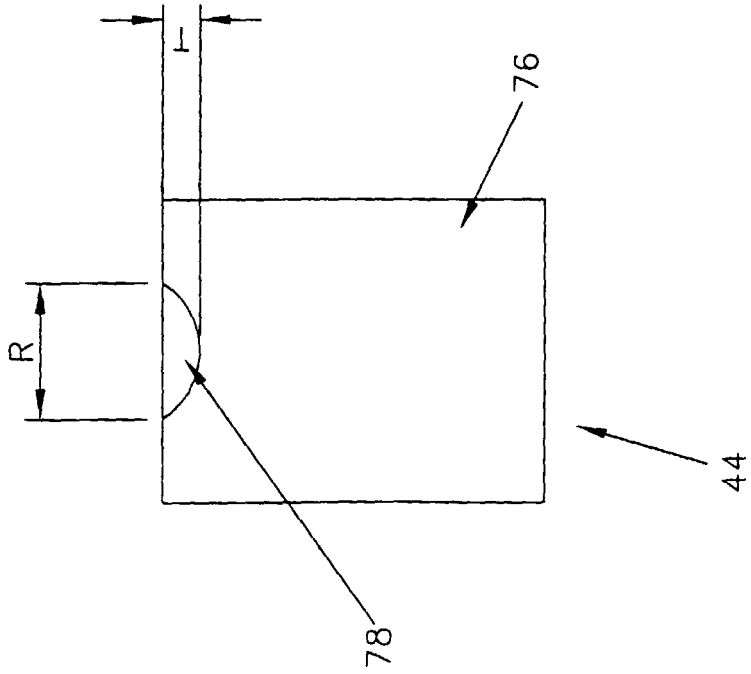


FIG. 20C

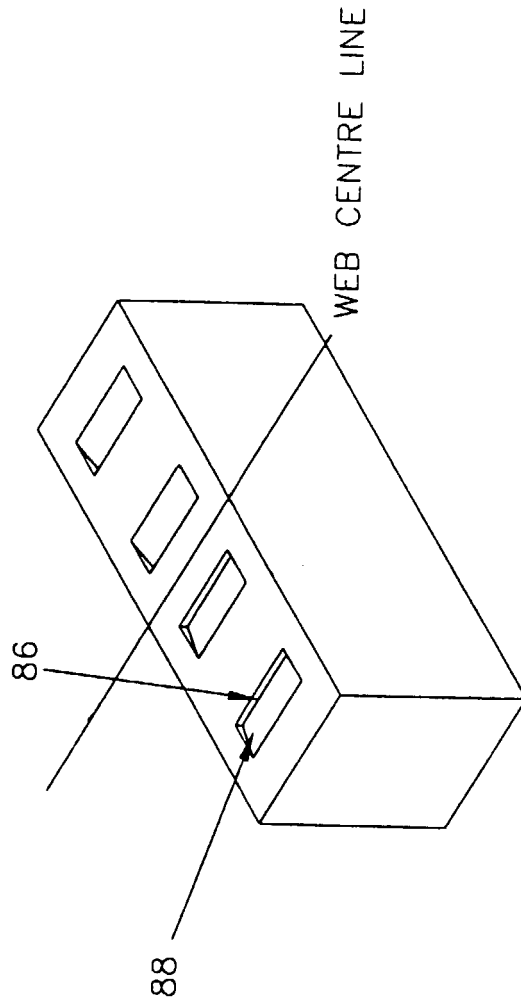


FIG. 21A

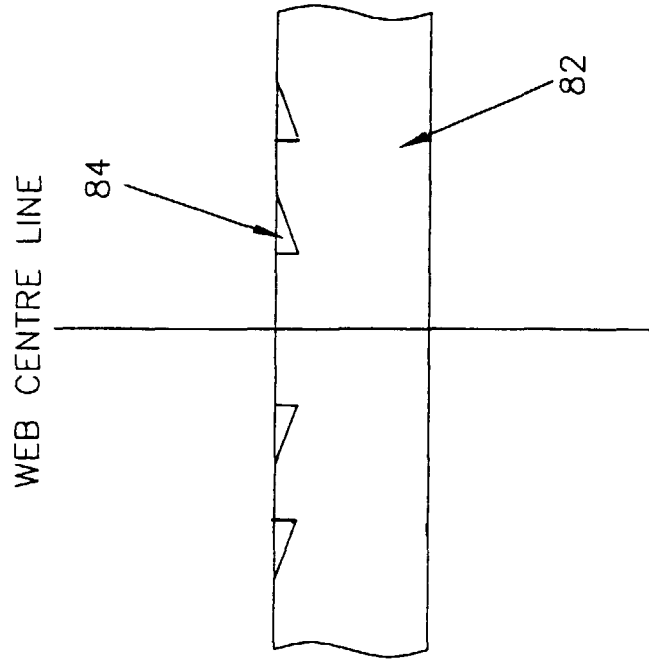


FIG. 21B

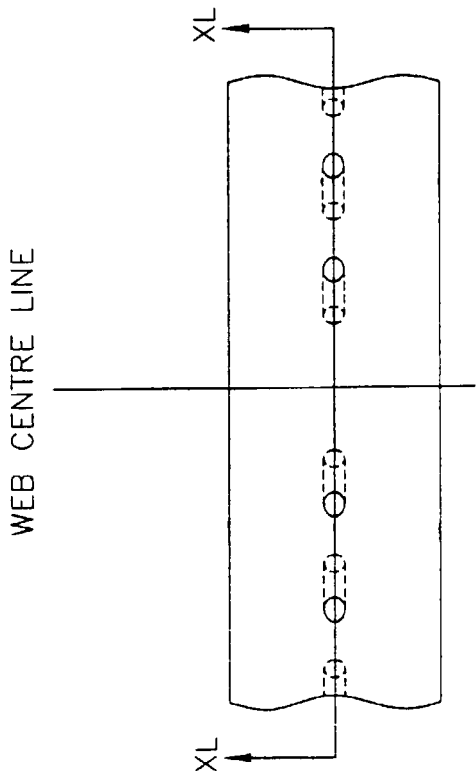


FIG. 22A

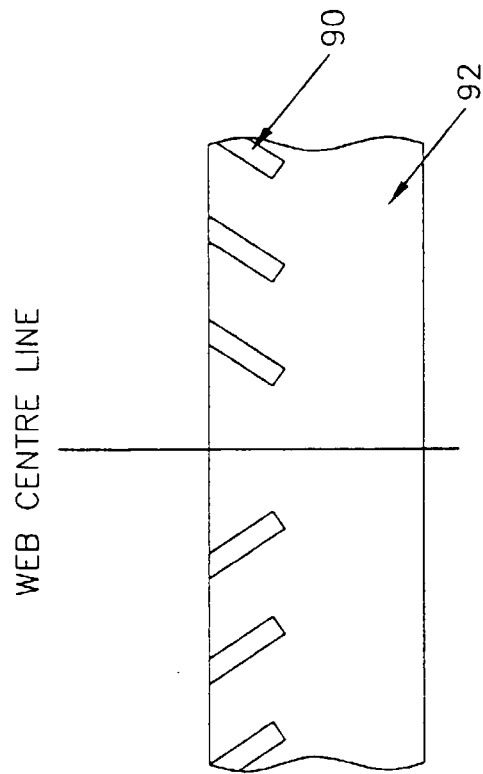


FIG. 22B

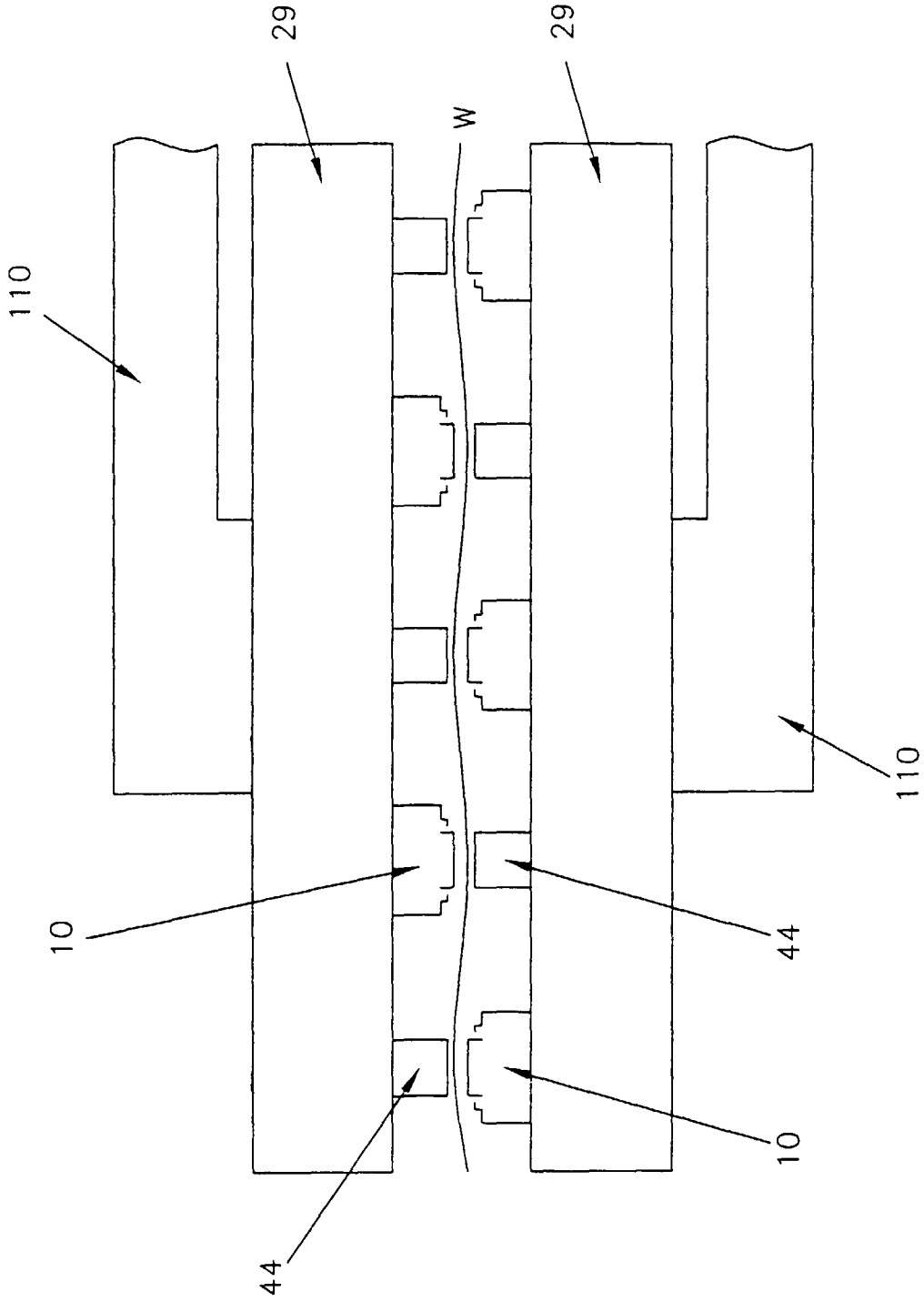


FIG. 23A

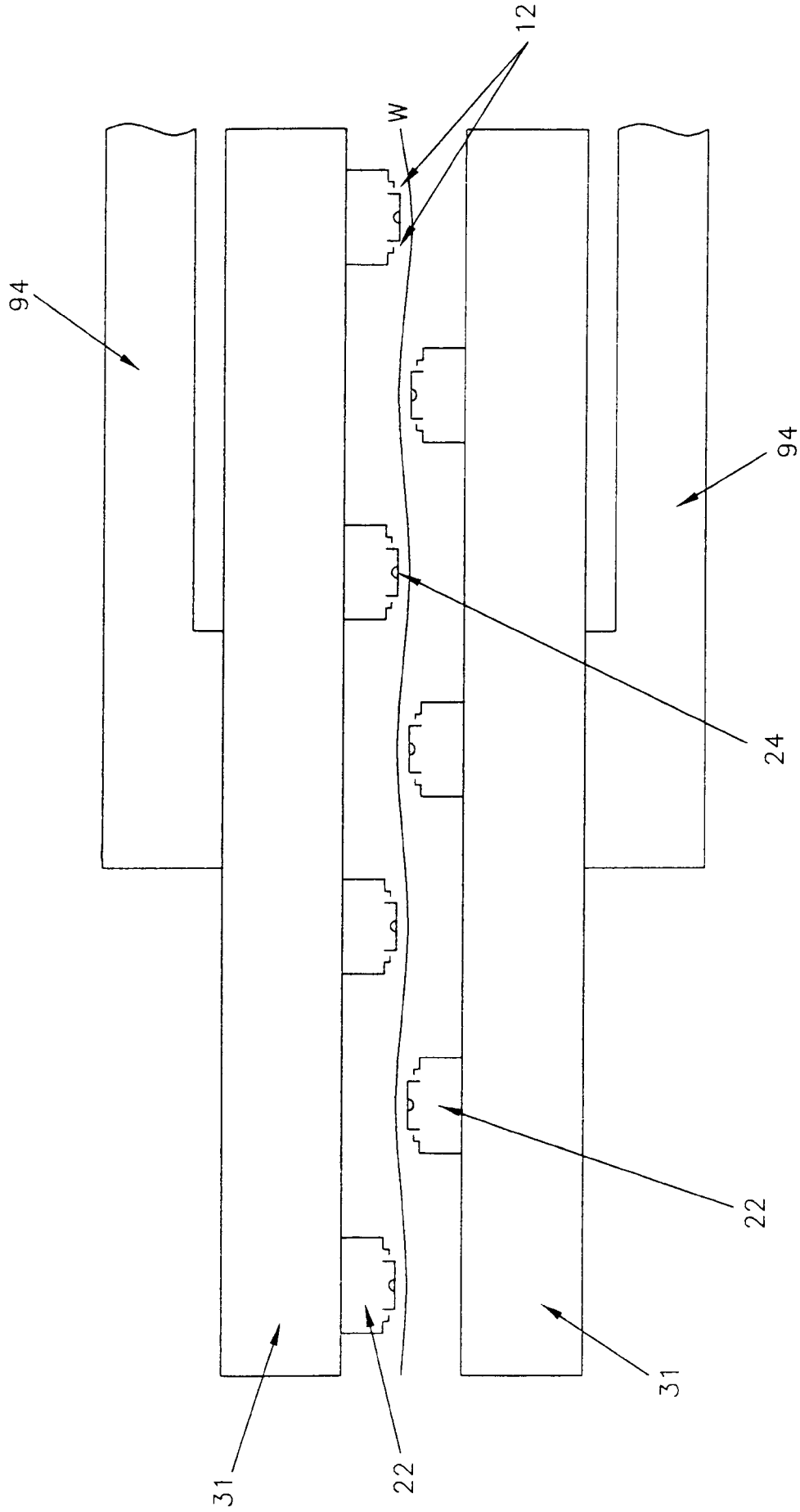


FIG. 23B

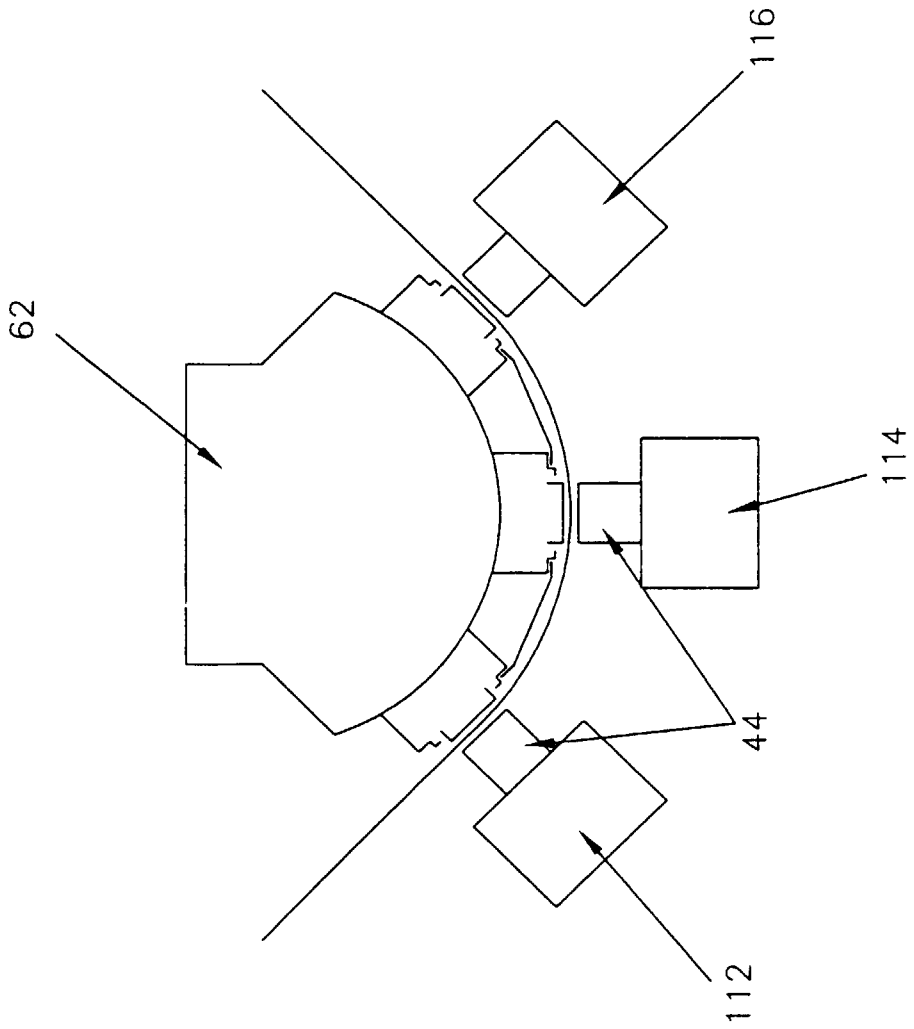


FIG. 23C

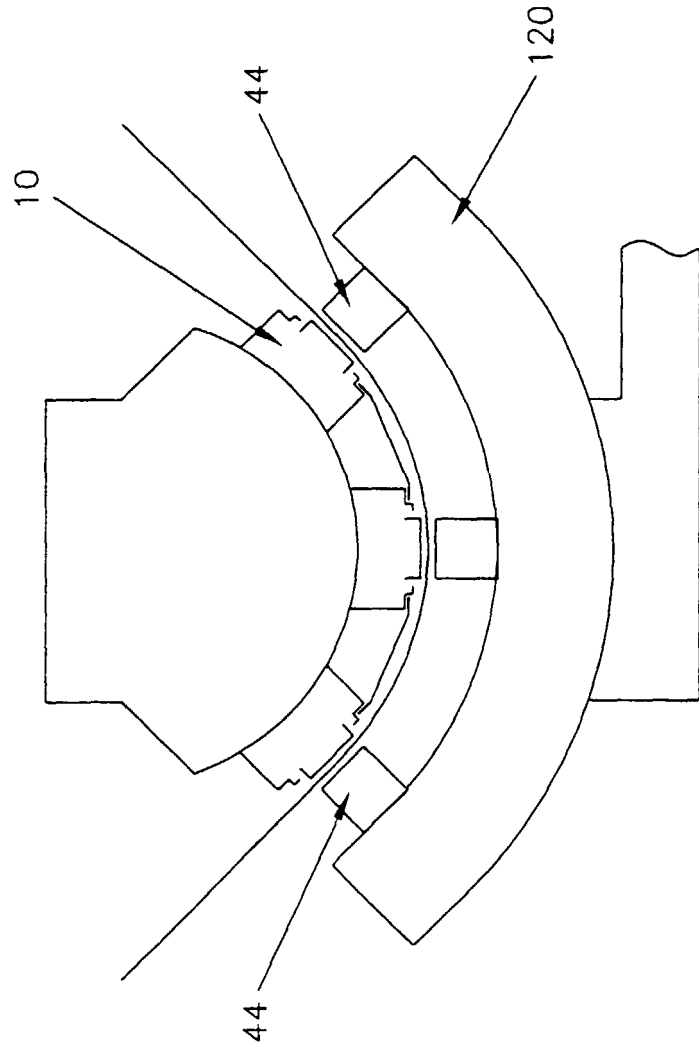


FIG. 23D

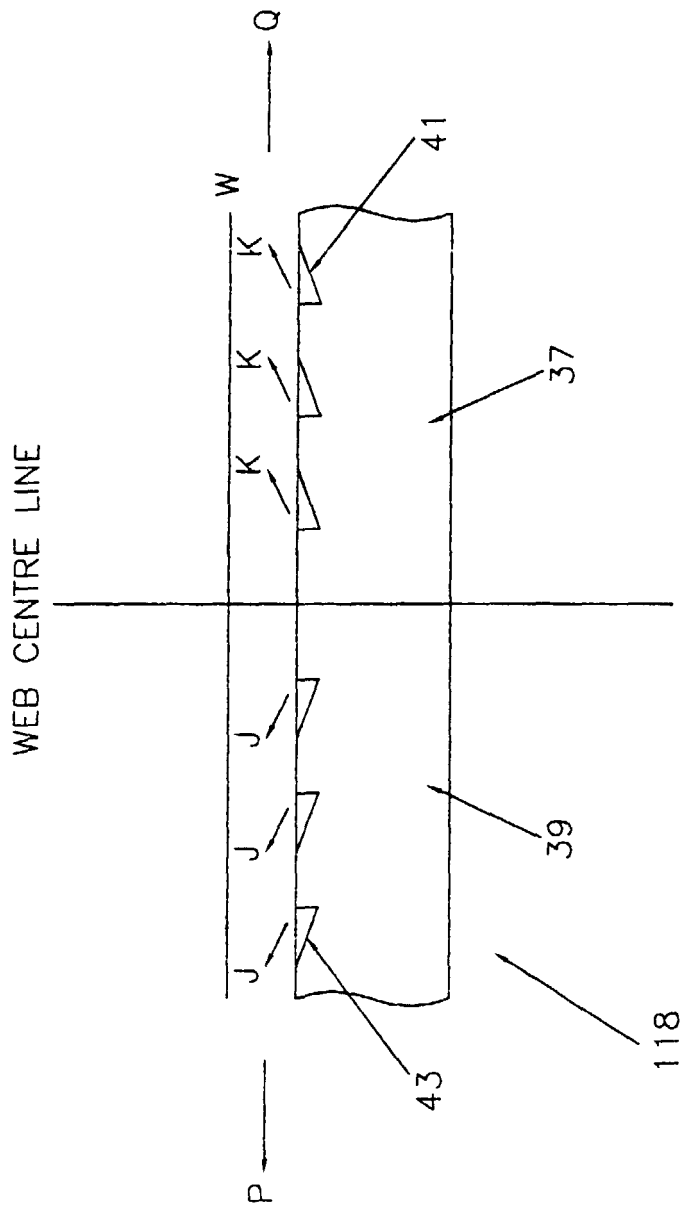


FIG. 24



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Application Number
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The present search report has been drawn up for all claims				
Place of search THE HAGUE		Date of completion of the search 1 March 2000	Examiner Haaken, W	
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons</p> <p>& : member of the same patent family, corresponding document</p>				



European Patent
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EUROPEAN SEARCH REPORT

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Place of search THE HAGUE		Date of completion of the search 1 March 2000	Examiner Haaken, W
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