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(54) Air float bar.

(57) An air float bar for use in floating and drying a continuous planar web of a material in a dryer includes at least one lamp (36) radiating electromagnetic energy which may, for example, be ultra-violet or infra-red. Direct radiated or reflected electromagnetic energy from the lamp in a removable air bar channel assembly accelerates drying, or evaporation of solvents, or curing of planar web material passing in proximity to the air float bar either by electromagnetic energy, or in combination with web-supporting air flow. The lamp is cooled by pressurized air passing through an interior portion of the removable air bar channel. The web supporting air flow may be subject to the Coanda effect.

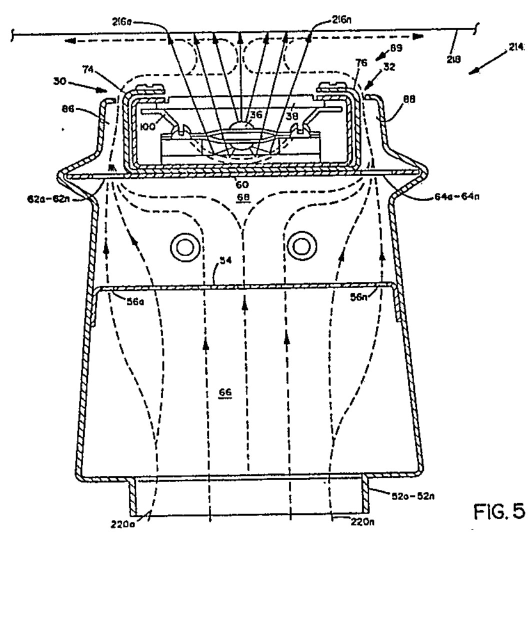

FIG. 5

EP 0 346 081 A1

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Description

AIR FLOAT BAR

The present invention relates to an air float bar for use in positioning, drying or curing a continuous planar flexible material for example a web, printed web, news print, film material, or plastic sheet.

Accordingly, the invention provides an air flotation bar comprising:

(a) air bar header including a bottom, opposing sides affixed to said bottom, end plates affixed between said bottom and said sides, a support plate with opposing holes affixed to said sides, a fixed air bar channel secured to said plate and forming air discharge slots between said sides and each side of said air bar channel for web-supporting air; and,

(b) a removable channel supported in said air bar channel, opposing electrical connector means in said removable channel, at least one lamp mounted between said connector means for emitting electromagnetic radiation to impinge on a web passing and being supported by said air flotation bar, and a lens arranged at upper ends of said removable channel whereby said lens provides a pressure pad area between said air discharge slots. The electromagnetic energy may, for example, be ultra-violet or infra-red.

The electromagnetic energy emitted by the lamp serves to enhance accelerated heating of a web material to cause solvent evaporation, drying or curing. Electromagnetic heat energy in combination with columns of heated air impinging upon the web surface provides for concentrated heating of the web material thereby providing subsequent rapid evaporation, drying or curing from the surface of the material.

The demand for increased production volume and production speed of web material in dryers has caused the printing industry to increase web speed on their printing lines. Typically this requirement for speeding-up resulted in the dryer being inadequate in drying the web, because, due to the increased web speed, the web did not remain in the dryer adjacent to a series of air bars for a sufficient length of time to dry the web. The solution for adequate drying was either to replace the entire dryer with a longer dryer, or to add additional drying zones in series with a first dryer zone. This, of course, is expensive and often not feasible due to a shortage of physical floor space.

The present invention overcomes the disadvantages of the prior art dryers by providing an electromagnetically radiating air float bar to replace existing air float bars in web dryers. In addition to air flow of dry air from the web-supporting air flow slots at the upper and outer extremities of the air float bar, the energy emitting lamp, with a lens and optionally a reflector positioned between the air flow slots, transmits electromagnetic radiation to the traversing web. The drying of the traversing web is accomplished by impingement of a combination of both heated web-supporting air flow and electromagnetic radiation. The combined concentration of heat from the web-supporting air flow and the electromagnetic radiation from the lamp is of a sufficient magnitude to allow the web to dry at a higher speed than normal prior art speed.

The present invention thus provides an air float bar having a radiant lamp for the generation and transmission of ultra-violet electromagnetic radiation by itself or in combination with a heated web-supporting air flow upon a web traversing through the dryer. The lamp is located between the slots for the web discharging air flow and at the point of highest heat transfer, namely between the air flow slots. Ultra-violet or infra-red electromagnetic energy may pass in a straightforward, direct manner through the lens to impinge upon a traversing web, but may also be reflected in an indirect manner from a reflector surface (where present) and through the same lens to impinge upon the traversing web. An air supply duct may introduce cooling air into an enclosed terminal chamber and about the area containing the lamp, and overboard through an opposing enclosed terminal area.

In one embodiment of the present invention an air bar header member provides the framework for support and includes V or like channels on each side for the inclusion of an internal diffusion plate. Lips on the upper portion of the air bar header form one edge of air outlet slots, which may optionally use the Coanda effect, and a fixed position channel member forms the other portion of the slots. In that case the fixed position channel member includes Coanda curves. A removable channel fits inside a fixed position channel and contains the lamp, a reflector and a lens element. An enclosed terminal box juxtaposes with each end of the removable channel member containing the lamp, the reflector, and the lens element. A cooling air supply duct placed in close proximity with one enclosed terminal box supplies cooling air which flows through the enclosed terminal chamber, through the area surrounding the lamp, through an opposing enclosed terminal chamber and finally through an exhaust air duct channel. Oval air supply inlets on the bottom of the air bar header provide air flow for the web-supporting air slots.

The air float bar of the present invention offers an increased heat transfer rate per unit size of the air bar which is a practical alternative solution to increasing production requirements.

The use of cooling air flow across the lamp and the surrounding area cools the lamp.

The air float bar of the present invention can be used to dry products that require high controlled heat and non-contact support. This air float bar can be used in curing of pre-impregnated products such as polymer coatings that require airing, and are affected by high air impingement rates. The air float bar can also be used for drying of low solids coatings, and water-based coatings that are sensitive to high air impingement during the first stages of drying process. The air float bar can also be used for drying water based coatings on steel strip webs which require high controlled heat loads. Because of the ability to switch the lamp on or off almost instantly, the air bars can be run with cold convection air for support, and the lamp can be used as the only heat source so that the bar is useful for drying webs that cannot endure high temperatures and that experience frequent web stops.

Other objects of the present invention and many of the attendant advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, in which like reference numerals designate like parts throughout the Figures thereof and wherein:

FIGURE 1 illustrates a perspective view of a first embodiment of the air float bar of the present invention;

FIGURE 2 illustrates a cross-sectional view of the air float bar taken along line 2-2 of Figure 1;

FIGURE 3 illustrates a cross-sectional view of the air float bar taken along line 3-3 of Figure 1;

FIGURE 4 illustrates a top cutaway view of the air float bar;

FIGURE 5 illustrates a cross-sectional end view of the mode of operation of the air float bar;

FIGURES 6A-6D illustrate arrangements of pluralities of air float bar systems about a traversing web;

FIGURES 7-9 illustrate alternative methods of cooling the energy-emitting lamp; and,

FIGURES 10-12 illustrate spatial relationships between air bars and energy sources.

Figure 1 illustrates a perspective view of an air float bar 10 of the present invention, for use in drying a web in a web dryer. Externally visible members of the air float bar 10 include a channel-like air bar header 12 with opposing sides 14 and 16, a bottom 18, and opposing and parallel vertically aligned air bar end plates 20 and 22 affixed between sides 14 and 16. V channels 24 and 26 are formed and aligned horizontally in sides 14 and 16 to accommodate an air bar mounting flange as later described in detail. V channel 26 is illustrated in Figure 2. A fixed air bar channel 28 aligns longitudinally in a precise manner between the upper regions of sides 14 and 16 to provide for forming longitudinally aligned and uniformly sized Coanda slots 30 and 32 for web-supporting air as later described in detail. As later explained in detail in Figure 2, a second removable channel 34, including an ultra-violet lamp 36 and a quartz lens 38, is accommodated in a sliding fashion by the fixed air bar channel 28. Air supply ducts 40 and 50 fit adjacent to covered terminal chambers 42 and 44 at each end of the removable channel 34 of the air float bar 10 and provides cooling air for the ultra-violet lamp 36. The cooling air passes through the air supply ducts 40 and 50, through the covered terminal chambers 42 and 44, into the removable channel 34, thus cooling the ultra-violet lamp 36, and leaks out of the ultra-violet lamp chamber through the clearance provided between the quartz lens 38 and the cover plates 46 and 48 for the terminal chambers 42 and 44. The covered terminal chamber 42 includes a cover plate 46, and covered terminal chamber 44 includes a cover plate 48. The covered terminal chamber 44 is secured above the air duct channel 50. Solvent-laden air is kept from the interior of the chamber in which the ultra-violet lamp resides by pressurization of the covered terminal chambers 42 and 44 and the area therebetween. A plurality of oval-shaped air inlets 52a-52n positioned on the bottom surface 18 of the air bar header 12 serves to supply drying air through the air bar header 12 to the Coanda slots 30 and 32.

Figure 2 illustrates a cross-sectional view of the air float bar 10 taken along line 2-2 of Figure 1; all numerals correspond to those elements previously described. The removable channel 34 and the ultra-violet lamp 36 are accommodated by the fixed air bar channel 28. A diffuser plate 54 with a plurality of holes 56a-56n secured between sides 14 and 16 serves to provide for even flow of drying air from the plurality of oval-shaped air inlets 52a-52n. A support plate 60 positioned between V channels 24 and 26 includes a plurality of holes 62a-62n. A plurality of holes 64a-64n align longitudinally in two rows along the support plate 60. The bottom 18, sides 14 and 16, and the diffuser plate 54 define a first chamber 66. The diffuser plate 54, sides 14 and 16, and the support plate 60 define a second chamber 68. The fixed air bar channel 28 is secured by welding or other suitable attachment to the support plate 60, and includes sides 70 and 72, Coanda curves 74 and 76, and horizontal planar surfaces 78 and 80 at right angles to sides 70 and 72. Lips 82 and 84, as extensions of sides 16 and 14, extend inwardly at right angles to form Coanda slots 30 and 32 between the ends of lips 82 and 84 and Coanda curves 74 and 76, respectively, each slot being of a finite size. Chamber 86 is formed by the fixed air bar channel side 70, the outer portion of support plate 60, the upper portion of side 16, and the lip 82. In a similar fashion, chamber 88 is formed by the fixed air bar channel side 72, the outer portion of support plate 60, the upper portion of side 14, and the lip 84. The area between the Coanda slots 30 and 32, known as the pressure pad 89, includes the quartz lens 38, the ultra-violet lamp 36, and the reflector 100.

Removable channel 34 is illustrated inserted within the fixed air bar channel 28. The quartz lens 38, which can also be manufactured of other material, is essentially rectangular in shape and includes shoulders 90 and 92 which correspondingly engage beneath ends 94 and 96 of the removable channel 34. A trough-like reflector 100 is illustrated as parabolic, but may also be any other desired geometrical shape and may be fashioned of a suitable material such as stainless steel, aluminium, or other reflective material. The reflector 100 includes planar feet 102 and 104 along the edge of the reflector 100 and a curved portion 106 therebetween. The curved portion 106 of the reflector 100 is positioned against the bottom member 34a of the removable channel 34. The planar feet 102 and 104 spring against the quartz lens 38 to ensure engagement of the shoulders 90 and 92 of the quartz lens 38 against the end portions 94 and 96 of the removable channel 34. Rectangular Teflon terminal mounting blocks 110 and 112, for mounting of the ultra-violet lamp 36 and related components, are secured to a mounting plate 114 with machine screws 116 and 118. Opposing sides 120 and 122 of a clip style mounting bracket 124 engage over the flat ultra-violet lamp end terminal 126 as machine screws 128 and 130 bring tension to bear upon the clip-style mounting bracket 124. While a single ultra-violet lamp 36 is illustrated, a plurality of lamps mounted in a parallel fashion can be used for applications requiring yet even more ultra-violet magnetic radiation. Larger air float bar assemblies can include multiple parallel ultra-violet lamps to transmit ultra-violet electromagnetic radiation to a traversing web.

Figure 3 illustrates a cross-sectional side view of the air float bar 10 taken along line 3-3 of Figure 1; all numerals correspond to those elements previously described. Figure 3 illustrates the air float bar 10 secured to and across dryer framework members 132 and 134. A bracket 135 affixed to the air supply duct 40 is secured to framework 132 by machine screws 136 and 138. A bracket 140 aligned beneath the upper horizontal portion of the framework 132 provides vertical positioning of the air float bar 10. Bracket 140 is secured to the mounting bases 141 and 143 in the air bar end plate 20 with the machine screws 142 and 144. Another bracket 146 is secured to mounting bases 145 and 147 in the air bar end plate 22 by machine screws 148 and 150.

The air duct channel 50 is secured to the underside of the covered terminal chamber 44. A bracket 152 secured to the bottom of the air duct channel 50 serves to provide support for the air duct channel 50 and associated components. A bracket 152 is secured to the framework 134 by machine screws 154 and 156. Teflon mounting blocks 160 and 162, similar to the Teflon mounting blocks 110 and 112, are secured to a mounting plate 164 with machine screws 166 and 168 as also illustrated in Figure 4. Opposing sides 170 and 172 of the clip style mounting bracket 174 engage over the flat ultra-violet lamp end terminal 175 as machine screws 176 and 178 bring tension to bear upon the clip style mounting bracket 174 as also illustrated in Figure 4.

Air duct channel 50 houses common electrical bus bars 180 and 182 which extend to and between other parallel mounted air float bars. the bus bars 180 and 182 are secured to the upper side of stand-off insulators 184 and 186 which are secured to the air duct channel with machine screws 188 and 190. Connector pads 192 and 194 are secured through the bus bars 180 and 182 to the stand-off insulators 184 and 186. A typical connector cap 196, fitted over and about the connector pad 192, has a wire 198 connected to the ultra-violet lamp end terminal 175 via a mounting bracket 174. Another connector cap 200, similar to the connector cap 196, is connected between the connector pad 194 with wire 202 to the opposing end terminal 126 of the ultra-violet lamp via the mounting bracket 124 as illustrated in Figure 4. The wires 198 and 202 pass through orifices 204 and 206 in the air duct channel 50 and through orifice 208 in the removable channel 34.

Access cover plate 46 and cover plate 48 are secured to the upper side of the removable channel 34 with a plurality of machine screws 210a-210n (omitted from Figures 1 and 2), and are removable for the purpose of accessing the end areas of the ultra-violet lamp 36 and the associated electrical hardware. Orifices 212, 204 and 206 in the air supply duct 40 ports transfer cooling air from the air supply ducts 40 and 50 to the covered terminal chambers 42 and 44.

Alternatively, cooling air can be channeled from the covered terminal chambers 42 and 44 to flow about the convex side of the reflector 100.

Figure 4 illustrates a top cutaway view of the air float bar 10; again all numerals correspond to those elements previously described. This Figure illustrates the placement of the ultra-violet lamp 36 within the confines of the removable channel 34, and the location of the mounting brackets 124 and 174 with the associated hardware.

Figure 5 best illustrates the mode of operation 214 of the air float bar 10. Again all numerals correspond for those elements previously described. A plurality of ultra-violet electromagnetic energy rays 216a-216n increase the drying capacity because the ultra-violet lamp 36 is located at the point of highest heat transfer, namely between the Coanda slots 30 and 32, and radiate from the ultra-violet lamp 36 either directly or indirectly through the quartz lens 38. The ultra-violet drying energy is transmitted for heating a traversing web 218 being processed in a dryer. A plurality of the ultra-violet rays 216a-216n reflect off the parabolic reflector 100 and through the quartz lens 38 to impart ultra-violet drying energy upon and to heat the web 218. The lamp 36 is positioned at a point of maximum energy transfer.

Pressurized air to support the web 218 floatingly enters the air float bar 10 through the plurality of oval shaped air inlets 52a-52n to float the web 218 above the pressure pad 89. From the oval-shaped air inlets 52a-52n, the pressurized air flow paths 220a-220n proceed as indicated by dashed arrow lines through the first chamber 66, through holes 56a-56n of the diffuser plate 54, into the second chamber 68, through the pluralities of holes 62a-62n and 64a-64n of the support plate 60, through chambers 86 and 88, through the Coanda slots 30 and 32 along Coanda curves 74 and 76, and then inwardly along the upper surface of the quartz lens 38 and upwardly, thus providing float lift for the web 218 and also carrying away solvent vapors in the web. Direct and indirect ultra-violet energy rays 216a-216n impinge on the web and heat the web 218 as it passes over the pressure pad 89, thus drying and evaporating solvents from the web 218. This, in combination with impinging air flows 220a-220n, maximizes the heat transfer in the area of the pressure pad 89.

Output of the lamp 36 can be variably controlled, such as by an SCR, so that the amount of energy output transmitted from the lamp 36 can be chosen from a range extending from full power to no power.

In an alternative embodiment, which will appear identical to that illustrated in Figures 1 to 5, the lamp 36 is an infra-red lamp. The mode of operation will be exactly as described above regarding the use of ultra-violet emission.

The wavelength of the infra-red electromagnetic rays 216a-216n emitted from the ultra-violet lamp 36 in Figure 5 can be short with a wavelength of .78 to 1.2 microns, medium wavelength with a wavelength of 1.2 to 4.0 microns or long wavelength of 4.0 to at least 10 microns.

Generally, any suitable wavelength of energy-imparting electromagnetic radiation may be selected.

Figures 6A-6D illustrate arrangements of pluralities of radiant air float bars with respect to a traversing web 270.

Figure 6A illustrates a plurality of radiant air float bars 272a-272n positioned below a traversing web 270.

Figure 6B illustrates a plurality of radiant air float bars 274a-274n positioned above a traversing web 270.

Figure 6C illustrates a plurality of radiant air float bars 276a-276n and a plurality of radiant air float bars 278a-278n in an opposing vertically aligned arrangement about a traversing web 270 for rapid drying of the traversing web 270.

Figure 6D illustrates a plurality of radiant air float bars 280a-280n and a plurality of radiant air float bars 282a-282n arranged in alternating opposing vertical arrangement about a traversing web 270 creating a sinusoidal shape for the traversing web 270.

Figure 7 illustrates air flow from an air bar, which enters through an orifice in the reflector, around the lamp, and out through holes in the lens.

Figure 8 illustrates air flow from an air bar, which flows between the reflector and the lens, around and about the lamp, and exits through holes in the lens.

Figure 9 illustrates an air bar, in which air enters through holes in the lens, passes around and about the lamp, and exits through ends of the removable channel.

Figure 10 illustrates a radiant unit, comprising a lamp and a reflector, external to and interposed between two air flotation bars.

Figure 11 illustrates horizontally interposed radiant units employing an ultra-violet lamp and a reflector in alternate vertical opposition with air flotation bars.

Figure 12 illustrates horizontally interposed radiant units with opposing air flotation bars, in direct vertical opposition.

Various modifications can be made to the present invention without departing from the apparent scope thereof as defined by the claims. The air bar can also be used to cure or dry adhesive coatings on a web, encapsulated coatings, and like applications. The air bar also provides for enhanced quality of drying or treatment of a web.

Claims

1. An air flotation bar comprising:

(a) air bar header including a bottom (18), opposing sides (14, 16) affixed to said bottom, end plates (20, 22) affixed between said bottom and said sides, a support plate (60) with opposing holes affixed to said sides, a fixed air bar channel (28) secured to said plate and forming air discharge slots (30, 32) between said sides and each side of said air bar channel for web-supporting air; and,

(b) a removable channel (72) supported in said air bar channel, opposing electrical connector means (120, 124; 170, 174) in said removable channel, at least one lamp (36) mounted between said connector means for emitting electromagnetic radiation to impinge on a web passing and being supported by said air flotation bar, and a lens (38) arranged at upper ends (94, 96) of said removable channel whereby said lens provides a pressure pad area between said air discharge slots.

2. An air flotation bar according to claim 1, wherein the path of electromagnetic energy radiating from said lamp is directly through said lens to transmit electromagnetic energy to the traversing web.

3. An air flotation bar according to claim 1 or 2, wherein said opposing electrical connector means comprise opposing terminal block means in said removable channel, wherein said lens is a quartz lens engaged beneath said upper ends of said removable channel, and wherein a reflector (100) is positioned between said lamp and said removable channel.

4. An air flotation bar according to claim 3, wherein the path of electromagnetic energy radiating from said lamp reflects off said reflector and through said quartz lens to impart ultra-violet energy to the traversing web.

5. An air flotation bar according to any one of claims 1 to 4, wherein said lamp is positioned at the point of optimum energy transfer.

6. An air flotation bar according to any one of claims 1 to 5, wherein said lamp radiates ultra-violet electromagnetic energy.

7. An air flotation bar according to any one of claims 1 to 5, wherein said lamp radiates infra-red electromagnetic energy.

8. An air flotation bar according to claim 7, wherein said infra-red energy is short wave of 0.78 to 1.2 microns.

9. An air flotation bar according to claim 7, wherein said infra-red energy is medium wave of 1.2 to 4.0 microns.

10. An air flotation bar according to claim 7, wherein said infra-red energy is long wave of 4.0 to at least 10 microns.

11. An air flotation bar according to any one of claims 1 to 10, and comprising means (40, 50) for passing air between ends of said removable channel for cooling said lamp and for flushing out solvent laden air.

12. An air flotation bar according to claim 11, wherein said air passing means (40, 50) is pressurized by cool air and air flow is an open

end to an opening in an underside surface of said removable channel.

13. An air flotation bar according to any one of claims 1 to 12, including opposing Coanda curves (74, 76) on said air bar channel.

14. An air flotation bar according to any one of claims 1 to 13, including a longitudinal cooling hole in said quartz lens.

15. An air flotation bar according to any one of claims 1 to 14, wherein, in use of the bar, web-supporting air flow impinges on the traversing web to dry said web.

16. An air flotation bar according to any one of claims 1 to 15, wherein electromagnetic energy from said lamp impinging on the traversing web serves to dry said web.

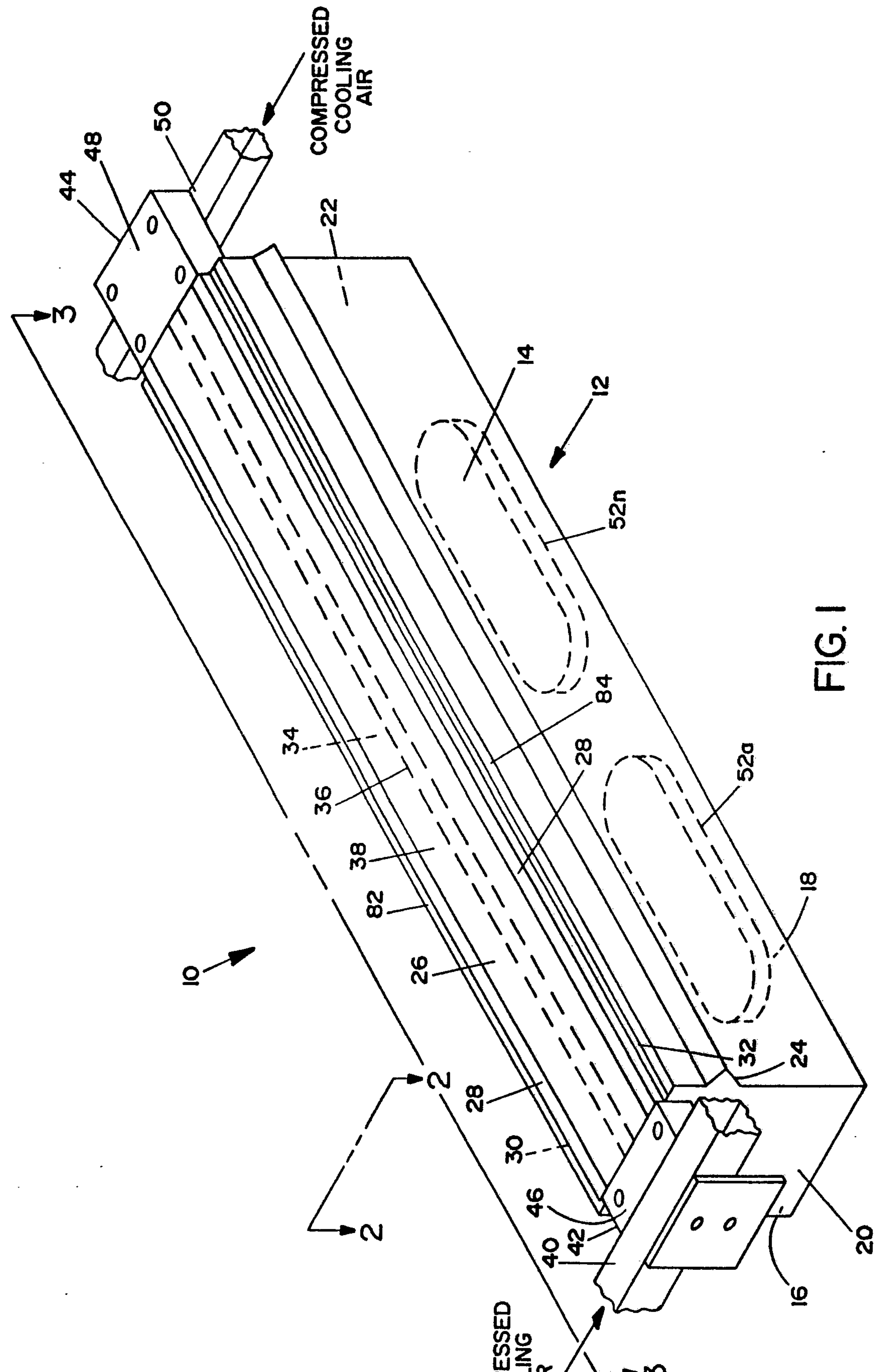
17. A web flotation support system including a plurality of air float bars according to any one of claims 1 to 16 positioned below the traversing web.

18. A web flotation support system including a plurality of air flotation bars according to any one of claims 1 to 16 positioned above the traversing web.

19. A web flotation system according to claims 17 and 18 taken together, wherein said air flotation bars are opposing one another on opposite sides of the web.

20. A web flotation system according to claims 17 and 18 taken together, wherein said air flotation bars are arranged alternatingly on opposite sides of said web.

21. An air flotation bar according to any one of claims 1 to 16, wherein the air inlet (52a ... 52n) for the web-supporting air is formed in the bottom (18) of the air bar header.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COMPRESSED
COOLING
AIR

FIG. 1

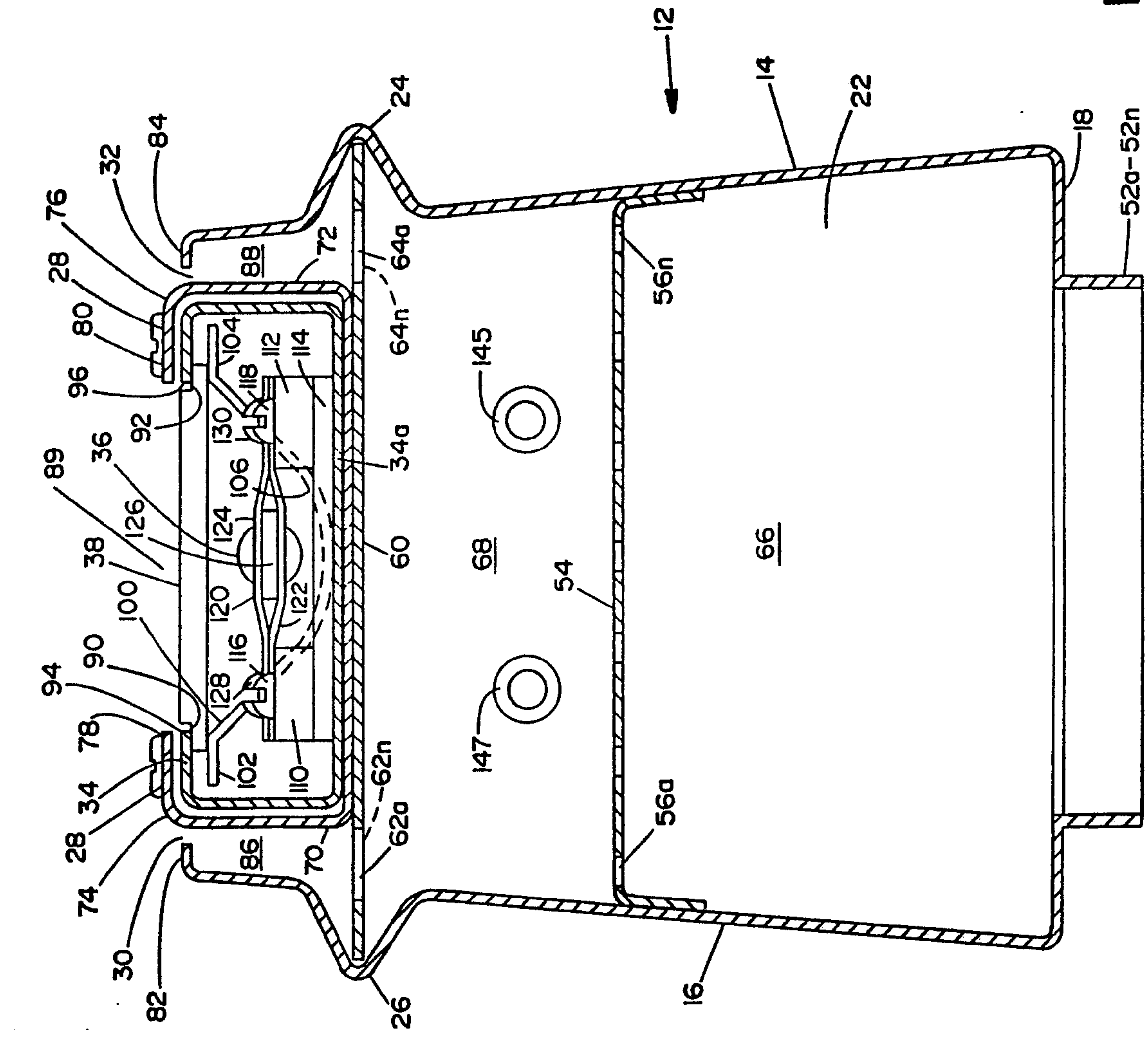
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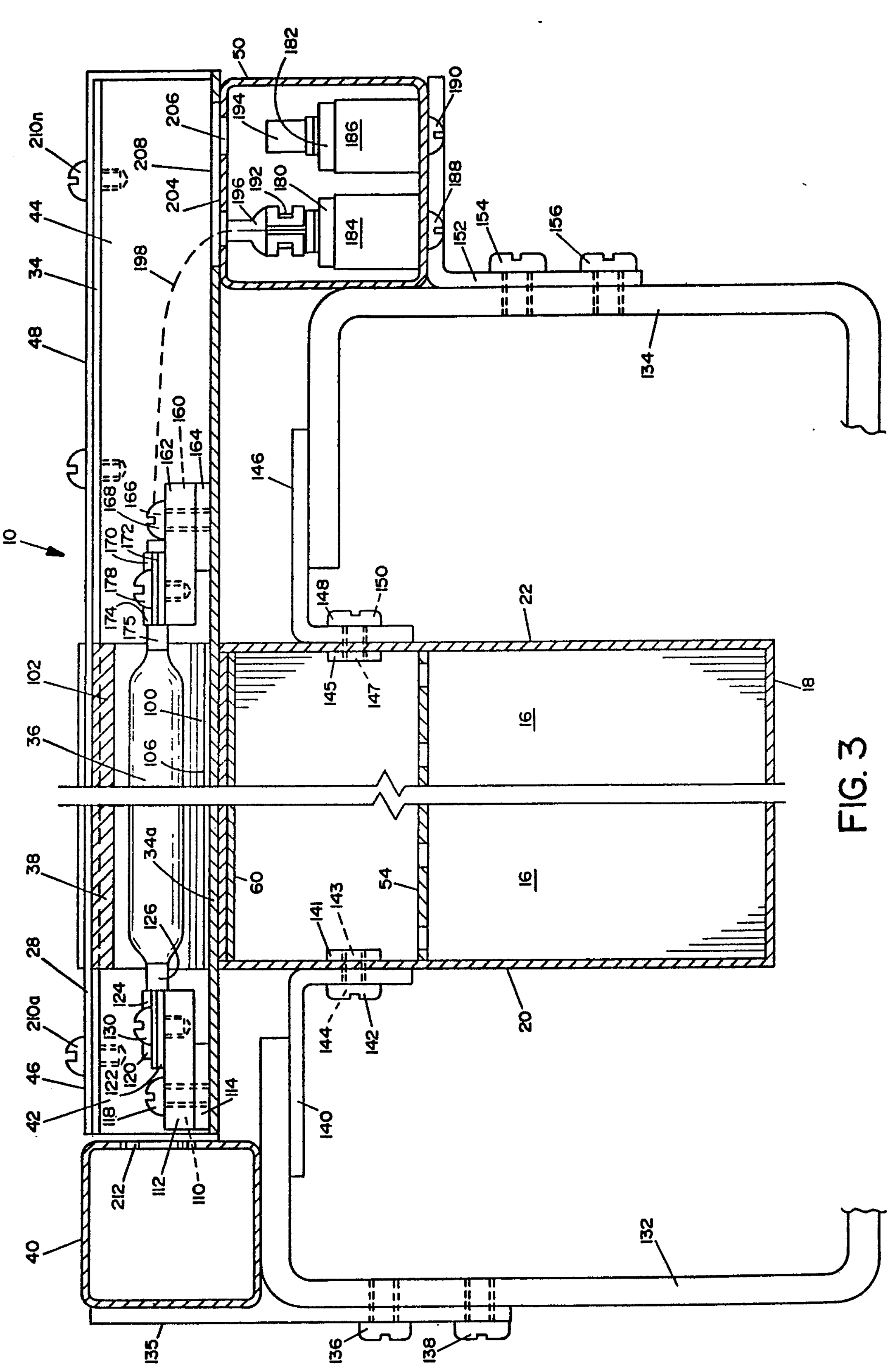
FIG. 2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210a
210n
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FIG. 3

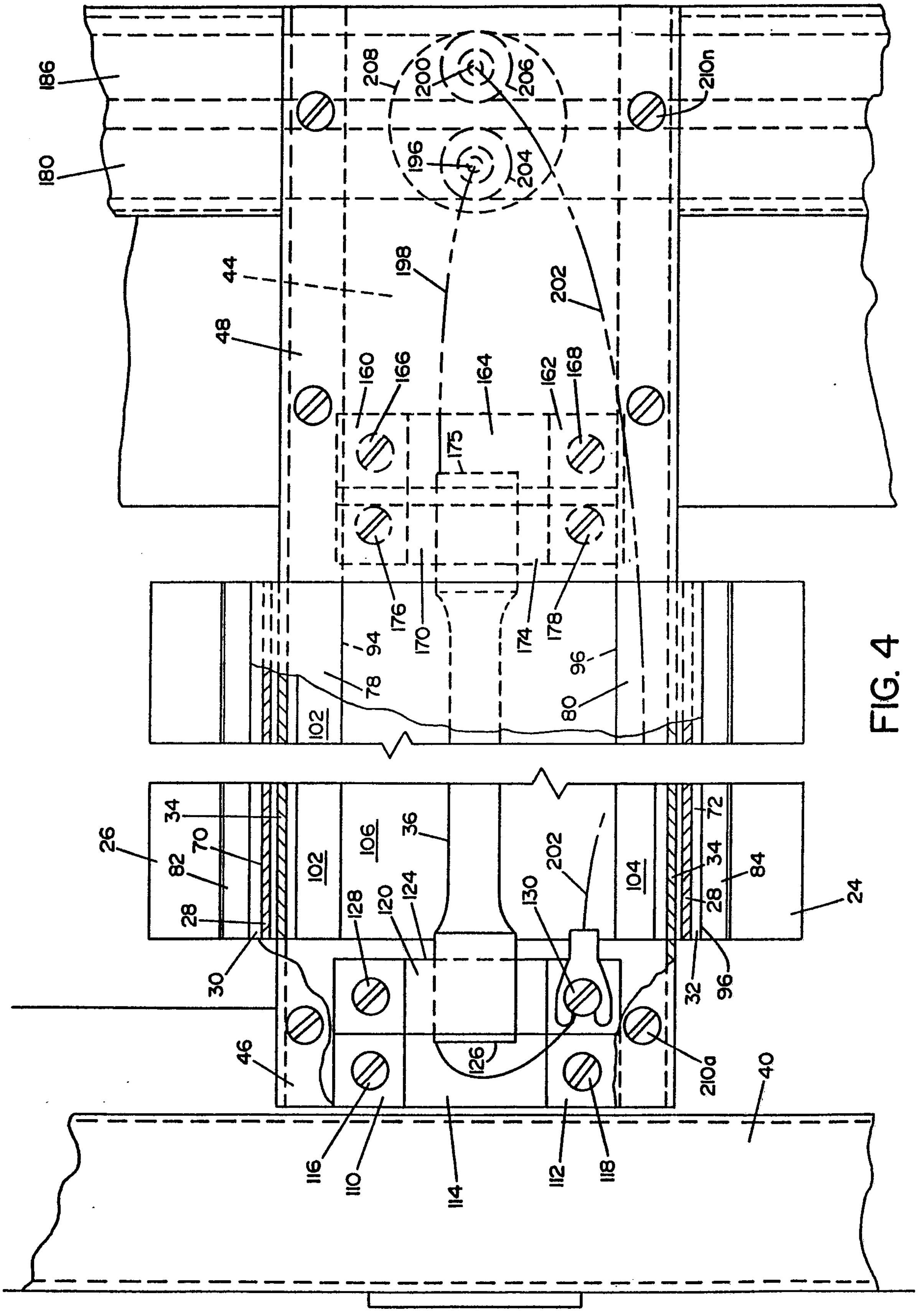
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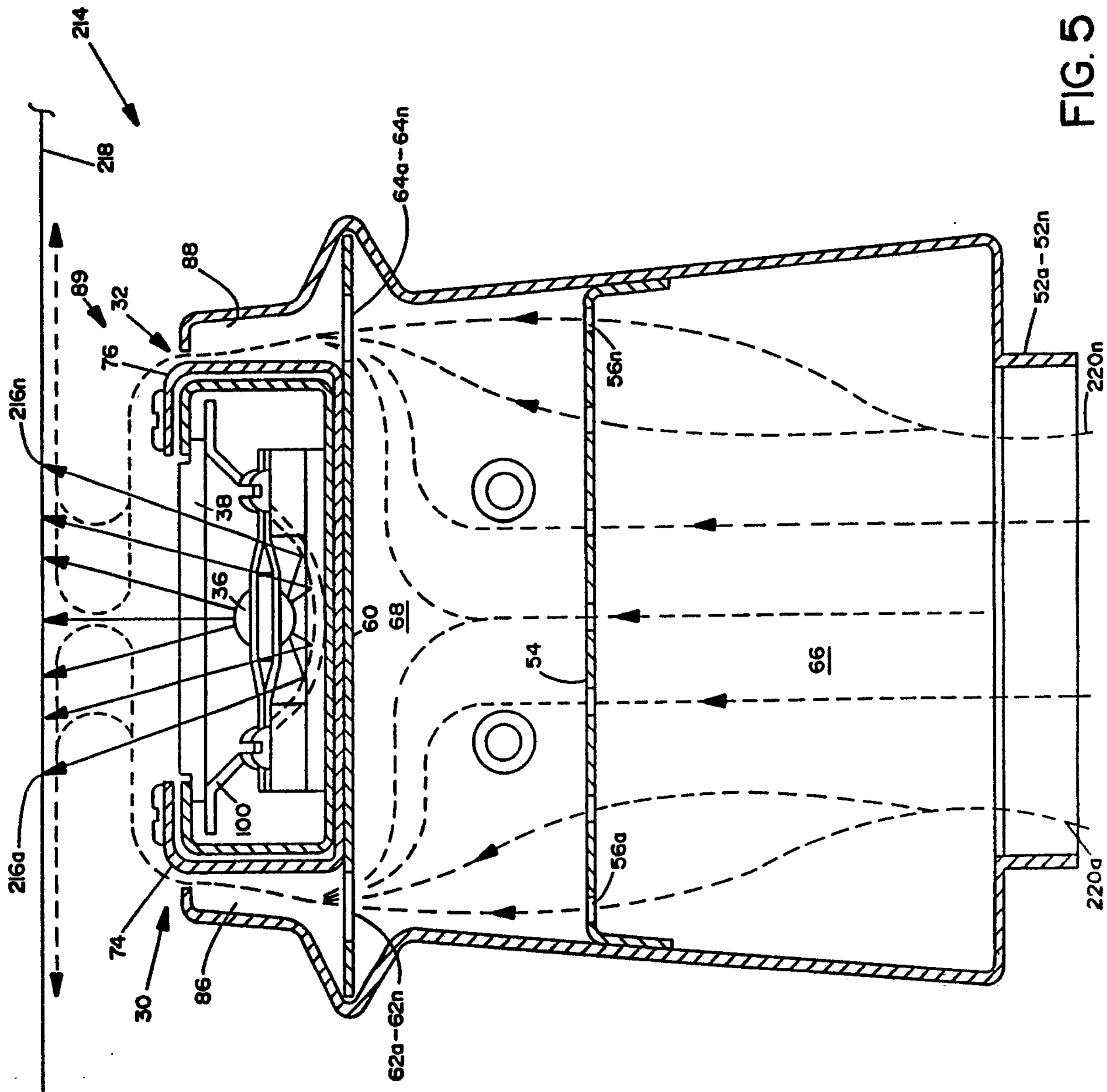
FIG. 4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62a-62n

FIG. 5

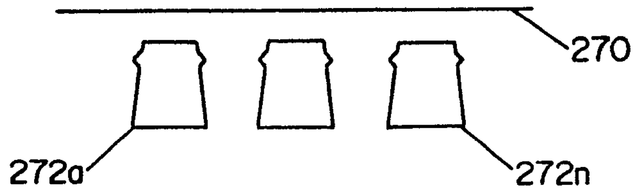

FIG. 6A

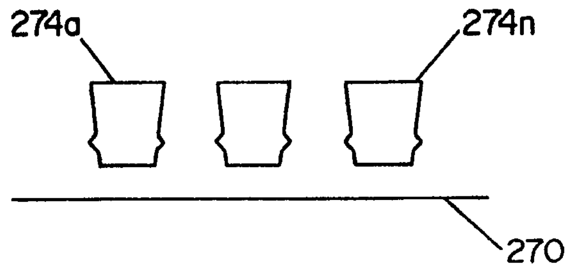

FIG. 6B

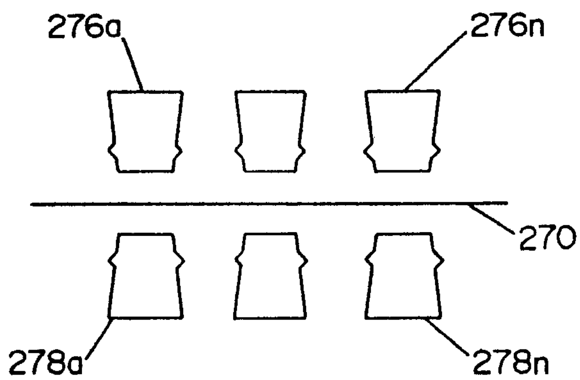

FIG. 6C

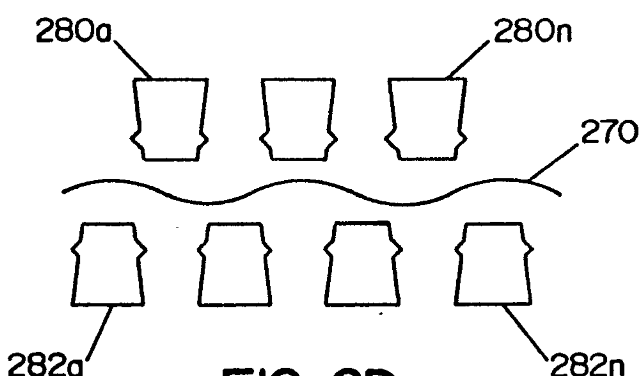

FIG. 6D

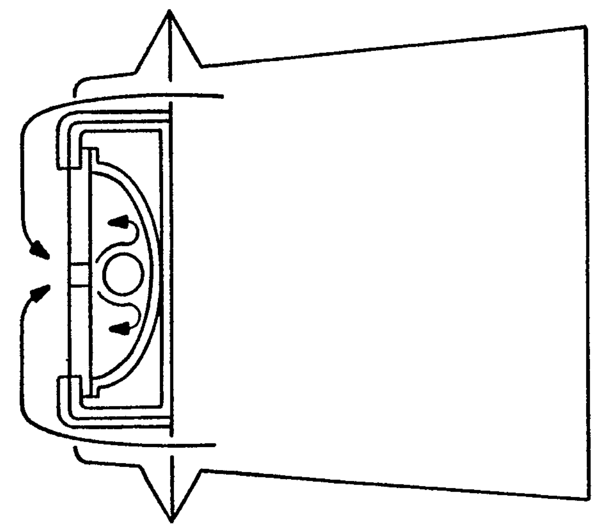

FIG. 9

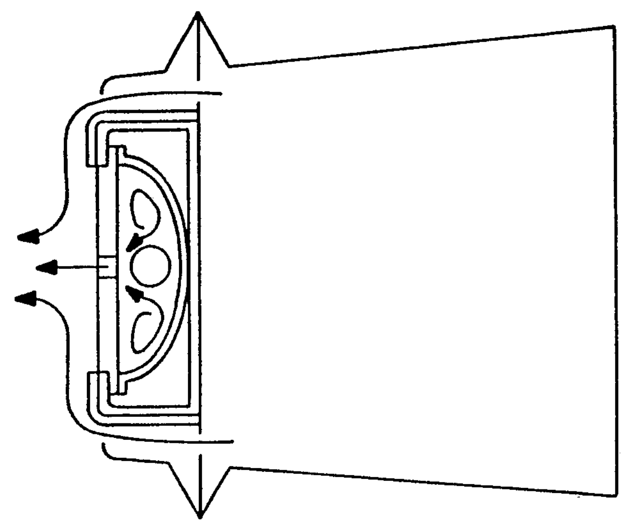

FIG. 8

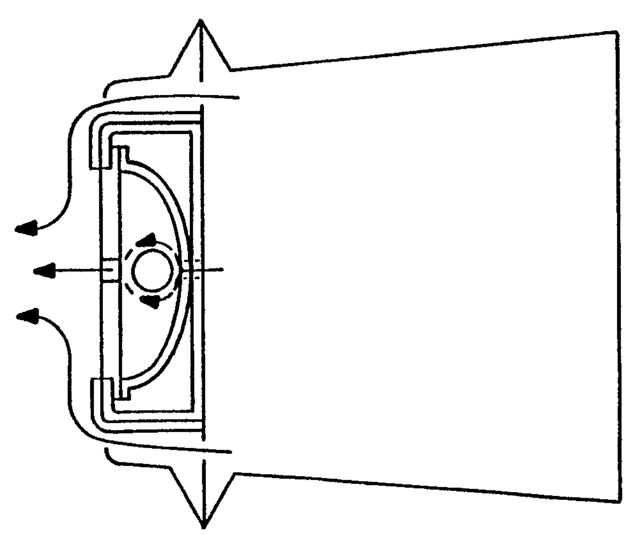

FIG. 7

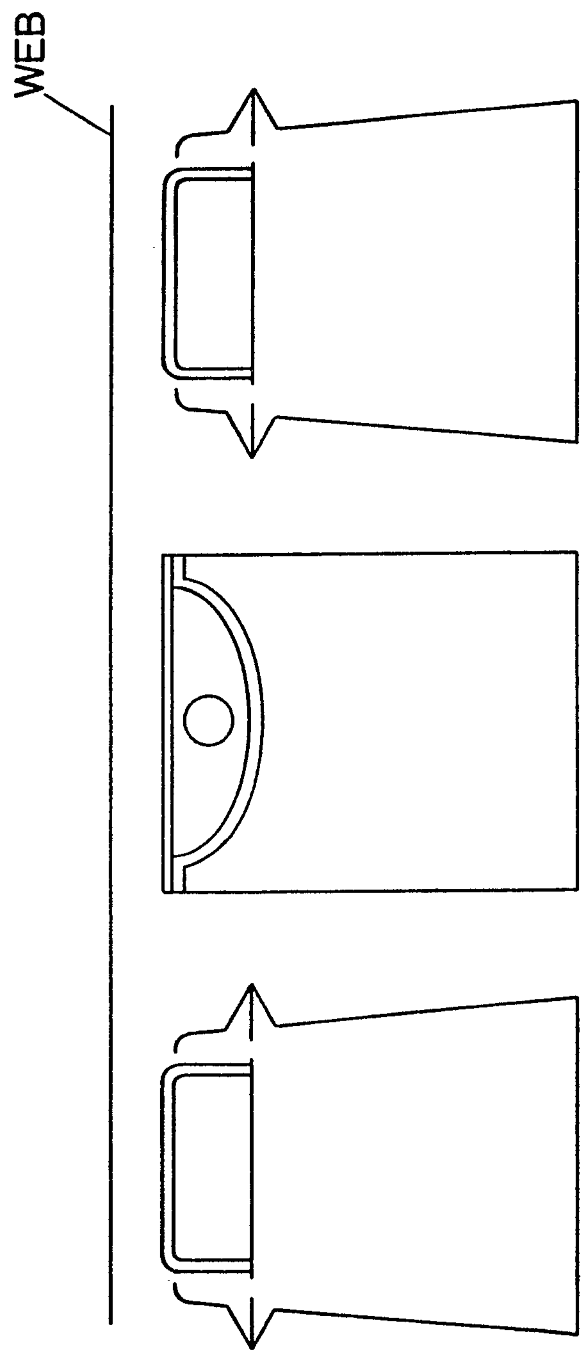

FIG. 10

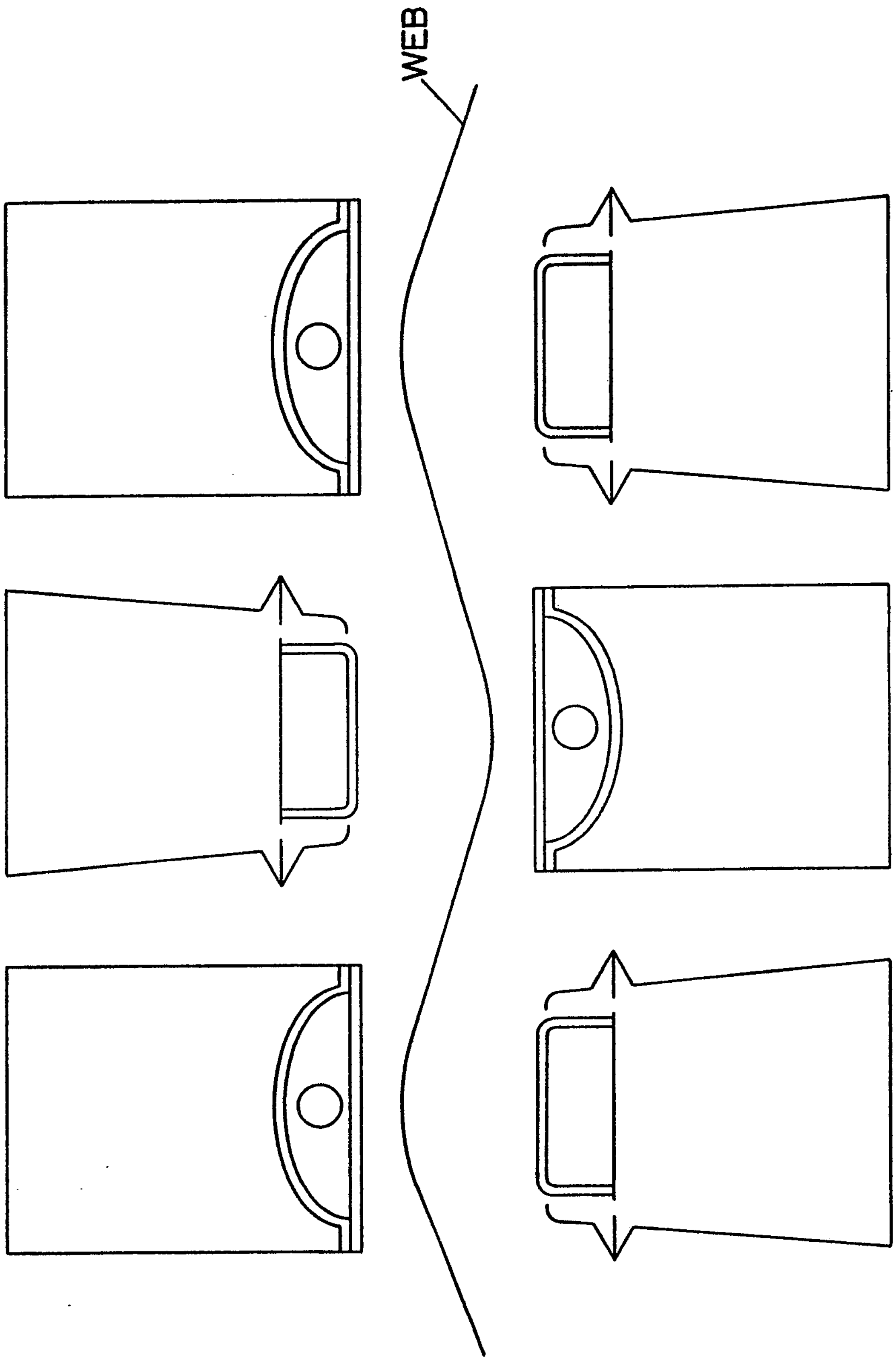

FIG. 11

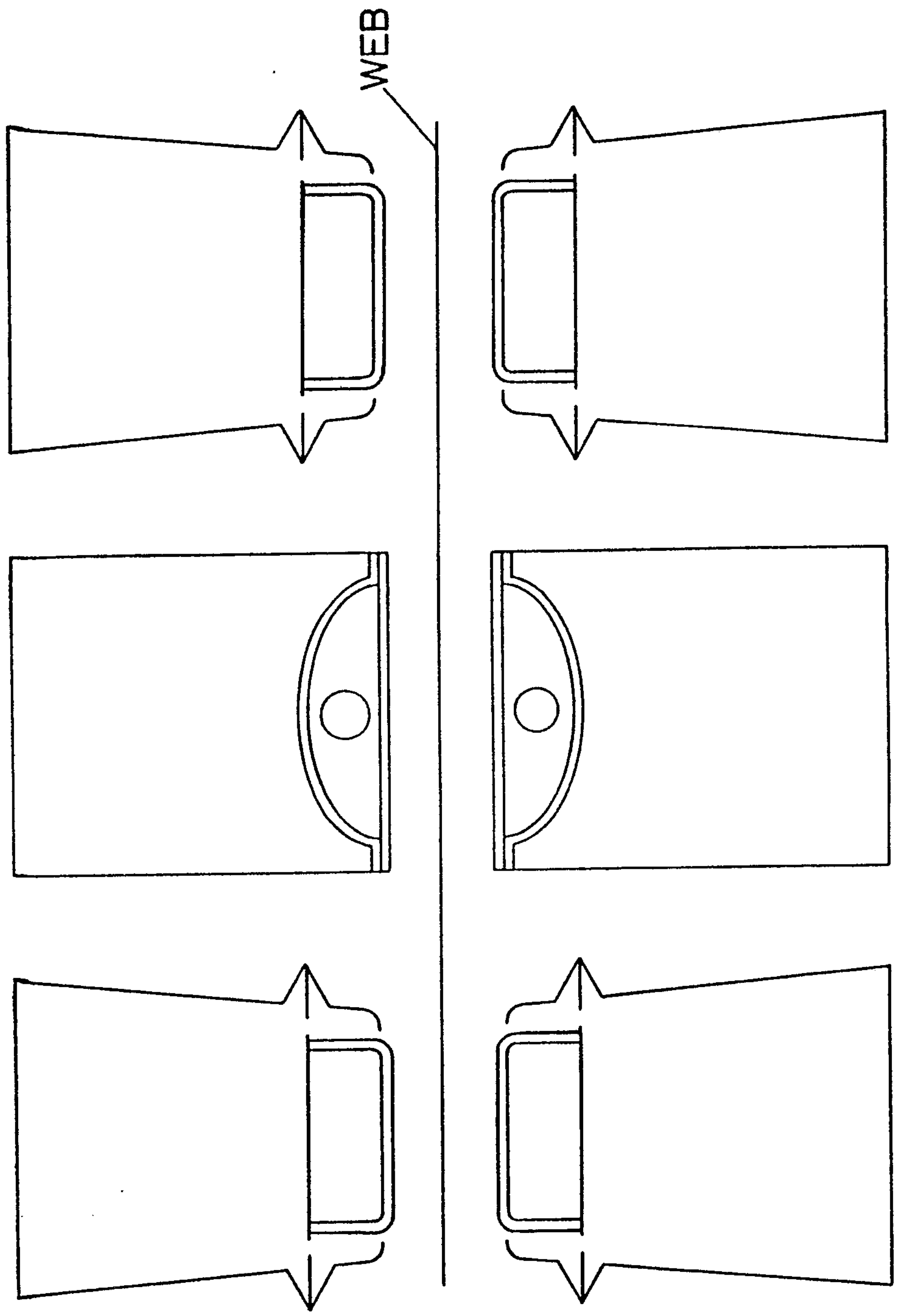

FIG. 12

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 5719

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	WO-A-8 705 644 (VALMET PAPER MACHINERY INC.) * Whole document * ---	1-5,7, 13,15-18,20, 21	F 26 B 13/20 F 26 B 3/28
Y	FR-A-2 438 613 (W.R. GRACE & CO.) * Whole document * ---	1-5,7, 13,15-18,20, 21	
A	US-A-4 501 072 (JACOBI, Jr. et al.) * Whole document * ---	1,7,8,9,11,12, 19	
A	DE-A-2 112 706 (WIGGINS TEAPE RESEARCH & DEVELOPMENT LTD) * Whole document * ---	1,9,10, 19	
A	US-A-4 646 446 (BUBLEY) * Abstract; figure 3 * ---	6	
P,A	US-A-4 768 695 (STIBBE) * Column 3, lines 25-37; figure 3 * ---	1	**TECHNICAL FIELDS SEARCHED (Int. Cl.4)**
A	FR-A-2 247 687 (BUTTNER-SCHILDE-HAAS AG) ---		F 26 B B 41 F D 21 F B 65 H
A	US-A-4 594 795 (STEPHANSEN) -----		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14-09-1989	SILVIS H.

CATEGORY OF CITED DOCUMENTS

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