United States Patent [19]

Stibbe

[11] **3,873,013**

[45] **Mar. 25, 1975**

[54] **HIGH VELOCITY WEB FLOATING AIR BAR HAVING CENTER EXHAUST MEANS**

[75] Inventor: **Paul H. Stibbe,** DePere, Wis.

[73] Assignee: **TEC Systems, Inc.,** DePere, Wis.

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[21] Appl. No.: **403,510**

[52] **U.S. Cl.** **226/97,** 34/156

[51] **Int. Cl.** **B65h 17/32**

[58] **Field of Search** ..... 226/7, 97; 34/57 R, 57 A, 34/156

[56] **References Cited**

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Primary Examiner—Richard A. Schacher

Attorney, Agent, or Firm—James E. Nilles

[57] **ABSTRACT**

An air bar for floating web material and which includes two slot nozzles, one along each of its longitudinal edges and which nozzles direct air streams toward the web and partially toward one another. The bar has a lengthwise center exhaust means for immediately removing a percentage of the two converging air streams at the center of the air bar and directing them into a separate exhaust chamber within the air bar for ultimate discharge out of the opposite ends of the air bar.

9 Claims, 11 Drawing Figures

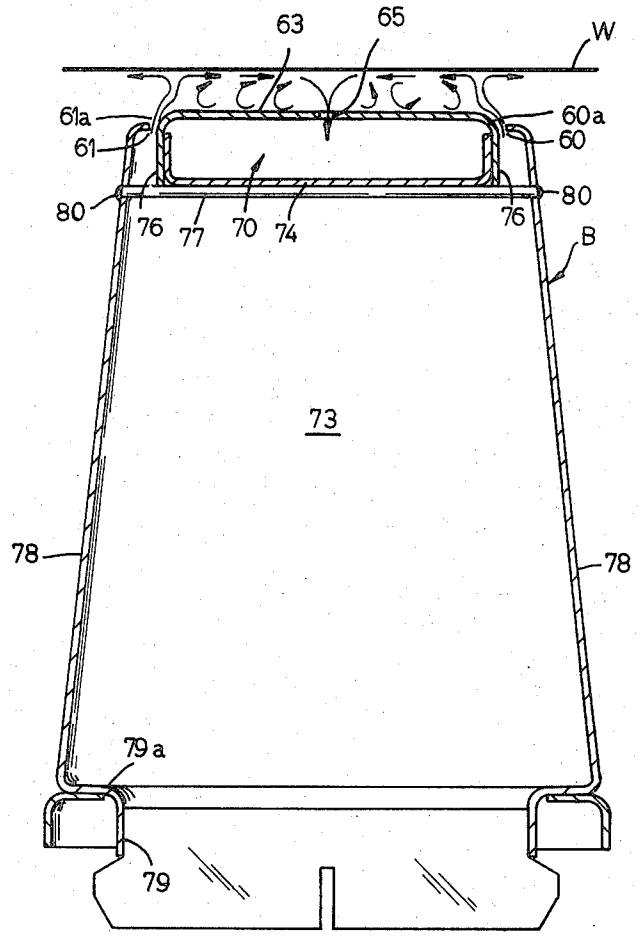
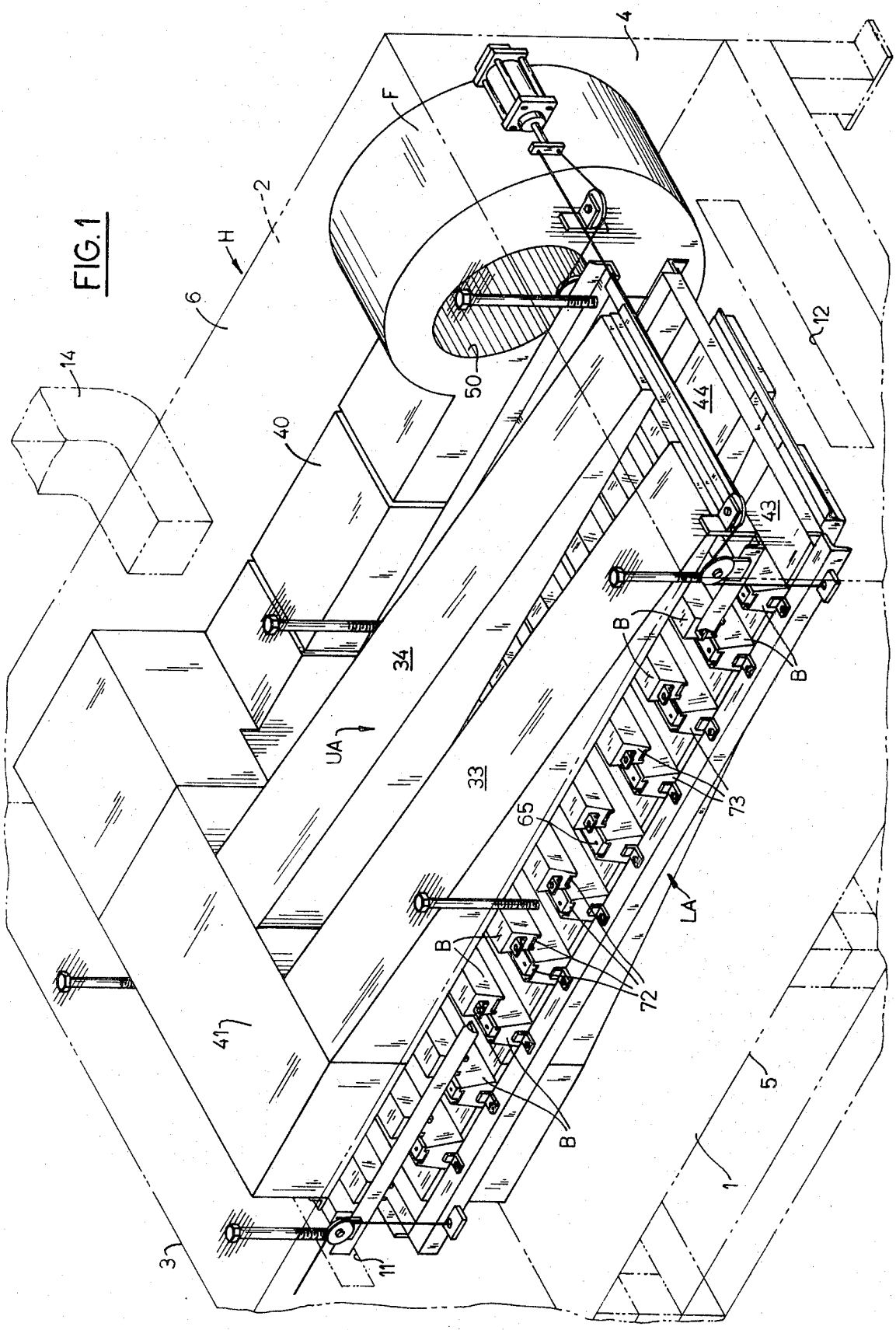


FIG. 1



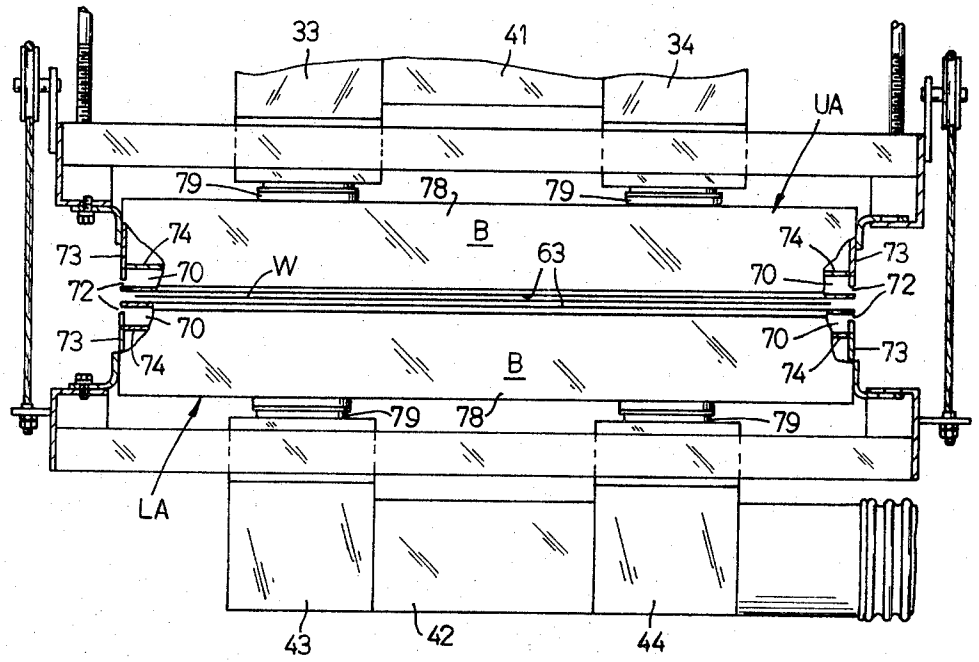

33
41
34
UA
79
78
79
B
74
73
70
W
63
72
LA
43
42
44

FIG. 2

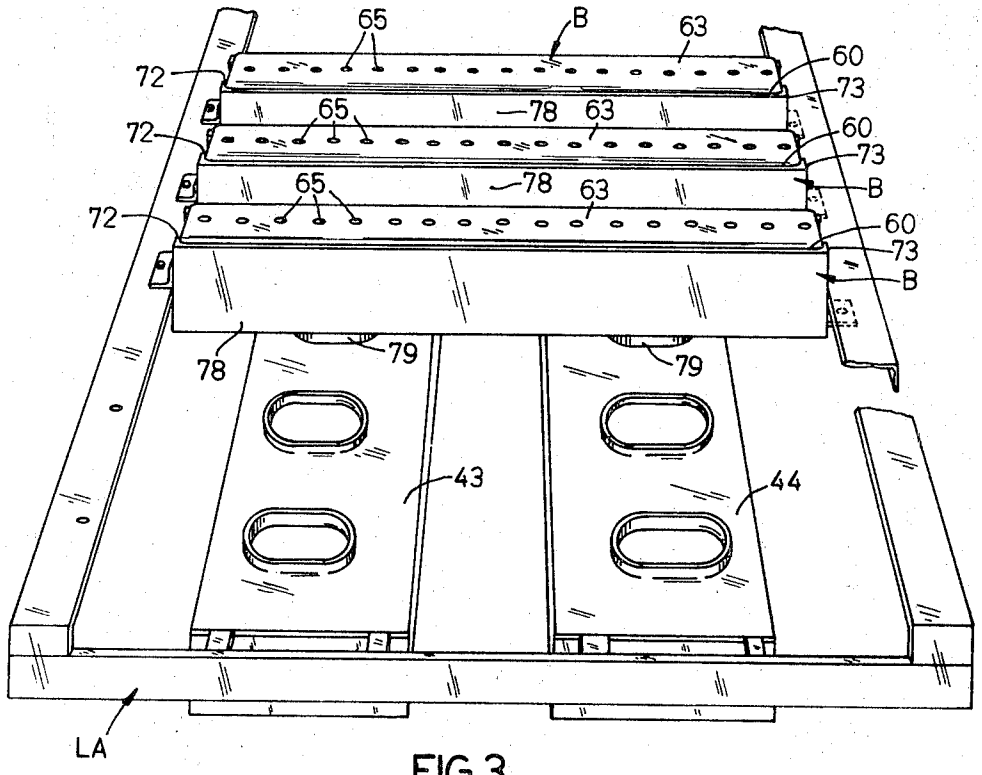

65
B
63
72
60
73
78
B
79
LA
43
44

FIG. 3

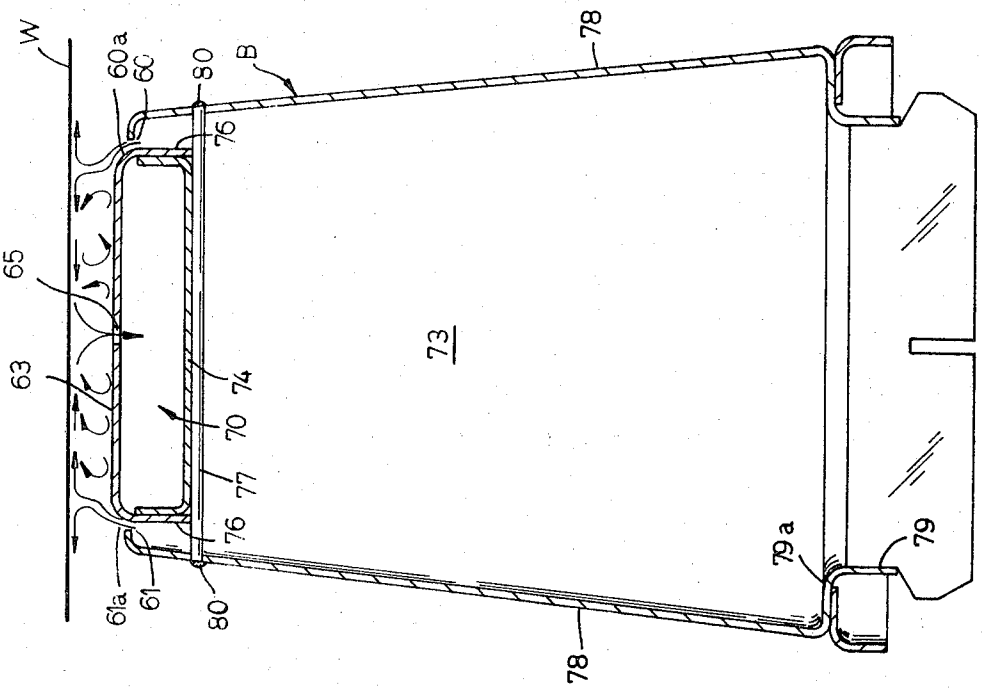

W
60a
60
80
B
78
76
65
63
74
70
77
73
76
61a
61
80
79a
79
78

FIG. 5

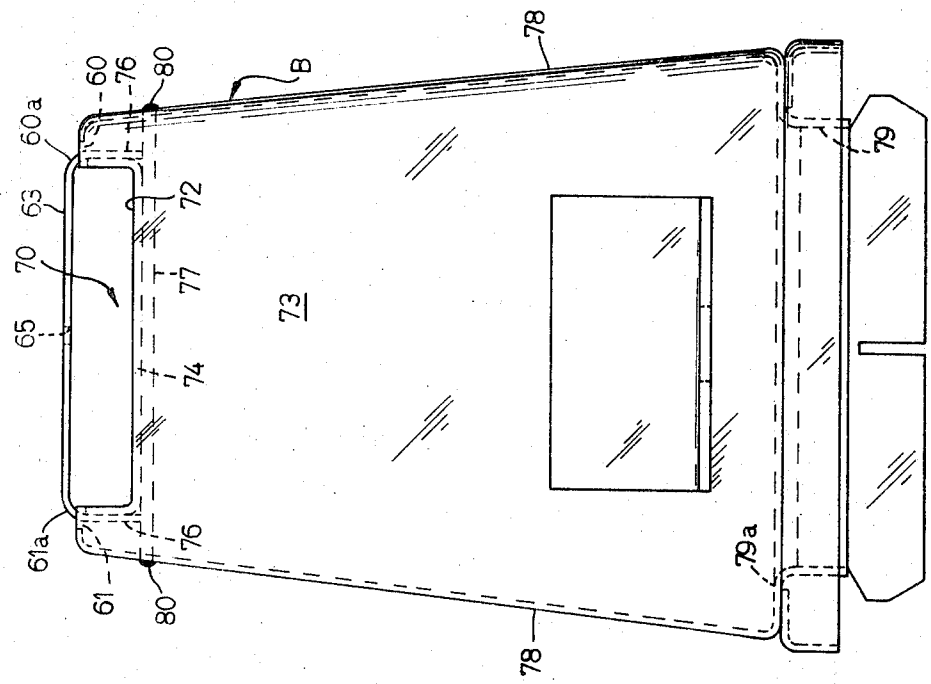

78
B
60
76
80
60a
63
72
70
77
65
73
74
79
61a
76
61
80
79a
78

FIG. 4

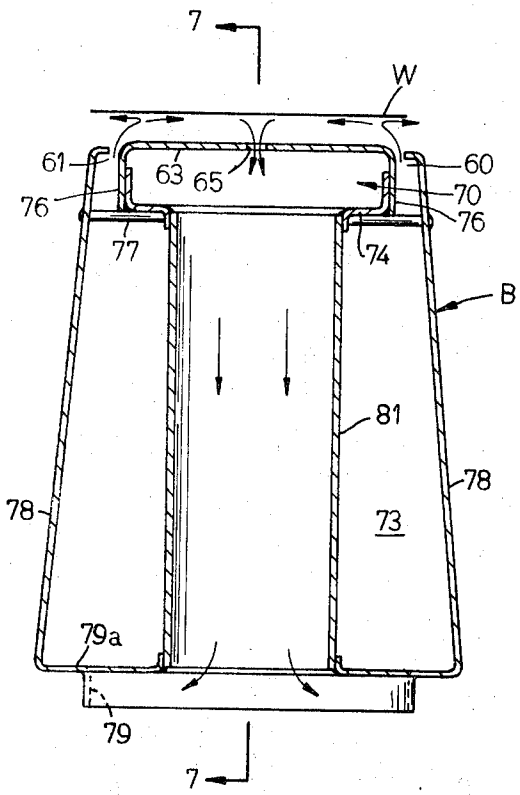


FIG. 6

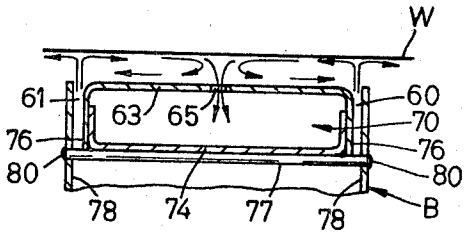


FIG. 6a

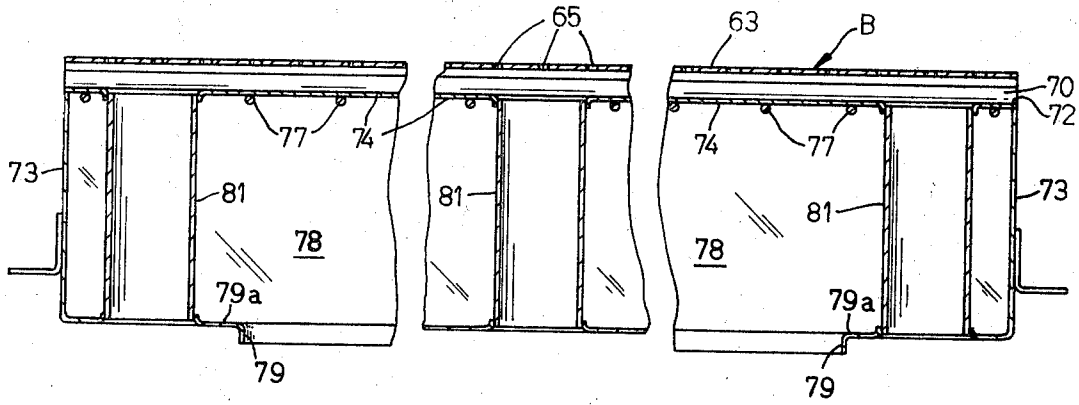


FIG. 7

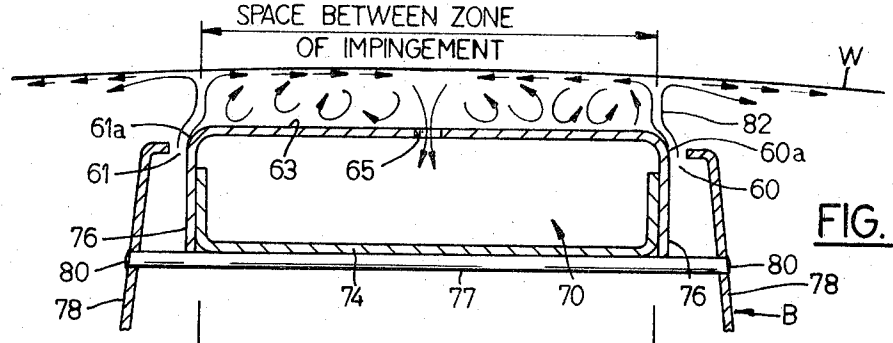


FIG. 8

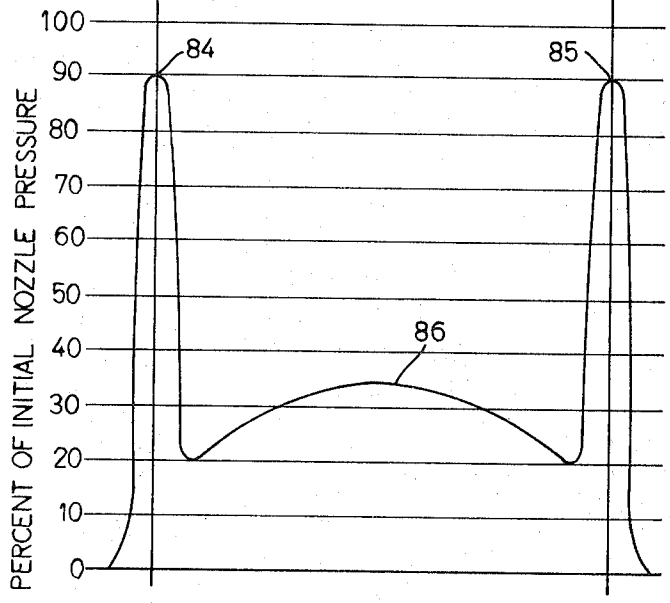


FIG. 9

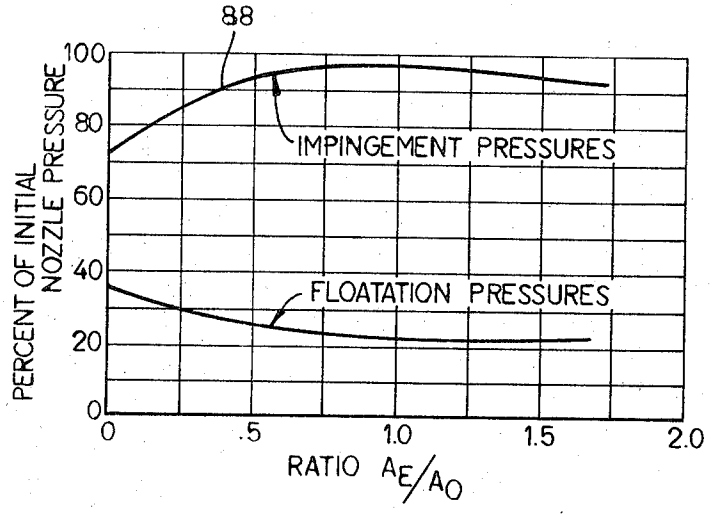


FIG. 10

HIGH VELOCITY WEB FLOATING AIR BAR HAVING CENTER EXHAUST MEANS

BACKGROUND OF THE INVENTION

The invention pertains to web handling equipment such as air bars for floatingly suspending a web and drying the material such as ink on the web, all without permitting the web to touch any supporting surfaces.

The invention is in the nature of an improvement over the U.S. Pat. No. 3,549,070, which issued Dec. 22, 1970 to Frost et al and is entitled "Floatation of Sheet Materials," which patent will be referred to later.

SUMMARY OF THE INVENTION

A web floating air bar for floating and drying a rapidly moving web, which air bar has a pair of slot nozzles, one along each of its edges and which are located adjacent the web passing thereover. The air bar provided by the present invention also includes exhaust passages along the center of the air bar and which remove a percentage of the two streams of air which are directed by the slot nozzles toward the web and then toward one another where they meet at the center of the air bar. A separate exhaust chamber is in communication with the exhaust passages and is located within the air bar for receiving the air discharged by the nozzles, removing it from the area of the web and into the exhaust chamber and then discharging the removed air out the ends of the air bars. The chamber is economically formed from two nested fabricated pieces of steel and are accurately located within the air bar by supports which in no way impede the flow of air being discharged through the slot nozzles.

With the air bar provided by the present invention, much higher impingement pressures are obtained on the web at the location almost directly across from each of the two longitudinal air slots in the bar. The result is more efficient drying of the web with better web floatation.

These and other objects and advantages of the present invention will appear hereinafter as this disclosure progresses, reference being had to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a high velocity web drying with which the present invention is used, certain parts being shown in phantom line for clarity in the drawing;

FIG. 2 is a transverse sectional view through the dryer shown in FIG. 1, certain parts being shown as broken away, in section, or removed for the sake of clarity;

FIG. 3 is a perspective view of a portion of the lower air bar assembly shown in FIGS. 1 and 2, certain air bars being removed for the sake of clarity and certain other parts being shown as broken away or removed;

FIG. 4 is an elevational end view, on an enlarged scale of one of the air bars shown in the other figures;

FIG. 5 is a view similar to FIG. 4, but being in section;

FIG. 6 is a view similar to FIG. 5, but showing a modified form of air bar;

FIG. 6*a* is another modification of the air bar;

FIG. 7 is a longitudinal cross sectional view taken generally along the line 7—7 in FIG. 6, but on a reduced scale;

FIG. 8 is a fragmentary, enlarged view of a portion of the air bar shown in FIG. 5;

FIG. 9 is a graph showing percent of initial pressure plotted against the various locations across the air bar shown in FIG. 8;

FIG. 10 is a graph showing the percent of initial nozzle pressure plotted against the ratio of the area of the center exhaust openings in the bar to the area of both of the supply slot nozzles.

DESCRIPTION OF A PREFERRED EMBODIMENT

The general organization of the high velocity web dryer with which the present improved air bar is used, shown by way of illustrating the invention, is of the type shown in the U.S. Pat. No. 3,739,491, issued June 19, 1973 to Creapo et al and entitled "High Velocity Air Web Dryer." In connection with the general structure of the high velocity web dryer, it is believed sufficient to say that it includes an outer housing H fabricated from sheet metal, and having a front side 1 and a rear side 2, a web entry side 3 and a web discharge side 4, the housing also includes a bottom 5 and a top 6 which thereby form an enclosure. The inlet side of the housing has a web inlet 11 through which the web also passes into the housing, and a web outlet 12 located at the opposite outlet side of the housing 4 for permitting the web to pass directly through the housing. An exhaust duct 14 extends from the rear side 2 of the housing and is in air receiving communication with the interior of the housing and serves to exhaust a certain amount of air continually from the housing.

An upper air bar and supply duct assembly UA is mounted within the housing and includes a pair of longitudinally disposed duct means 33 and 34 which taper toward one of the ends and are generally rectangular in cross section.

A plurality of generally tubular air bars B are arranged transversely in respect to the direction of web movement through the housing and are secured and in fluid communication with the duct means 33 and 34, all as taught in the said U.S. Pat. No. 3,739,491, or in the U.S. application Ser. No. 327,995, filed Jan. 30, 1973, which issued on Dec. 4, 1973, as U.S. Pat. No. 3,776,440.

Similarly, a lower air bar and supply duct assembly LA is also provided within the housing and includes longitudinally disposed duct means 43 and 44 to which are attached the transversely positioned, tubular air bars B. These air bars B are in air receiving communication with the duct means 43, 44.

An air supply fan F is located within the housing and supplies air to the duct means 33, 34 and 43, 44 from the supply duct means 40, 41 and 42 in the known manner as taught in said patents.

The fan has an air inlet 50 located adjacent one side of the upper and lower assemblies and acts to suck the return air which has been discharged from the air bars, as will presently be described, back into the fan F for circulation through the duct system. Some of the return air is also exhausted via the exhaust duct 14.

The air bars B are an improvement over those shown in the said U.S. Pat. No. 3,739,491 and also an improvement over the air bars shown in the U.S. Pat. No. 3,549,070, issued Dec. 22, 1970 to Frost et al and entitled "Floatation of Sheet Material." Both of these patents have been assigned to an assignee common with the present application.

The general purpose of the air bars is set forth in the said U.S. Pat. No. 3,549,070 and is for the purpose of floating sheet material in the nature of strips or webs so that the material does not touch any object as it moves through the high velocity dryer and is dried thereby.

The supply air that is received in the interior of the air bars is discharged, as shown in FIG. **5**, under pressure, and through elongated slots **60, 61** which extend continuously along and adjacent each edge of the air bar. These slots together with their adjacent curved surfaces **60***a* and **61***a* respectively, constitute Coanda air nozzles which cause a portion of the drying air to follow the curved surfaces and pass between the Coanda plate surface **63** and the web W being dried.

Thus the two streams of air from the pair of opposing Coanda nozzles for any one air bar, are directed toward one another and toward the center of the air bar as shown in FIG. **5**.

The center of the air bar has a series of apertures or openings **65** extending along the length of the air bar and transversely to the direction in which the web moves.

In the said U.S. Pat. No. 3,549,070, these center openings are used as a supply of high velocity drying air and by means of which the air from within the air bar of said U.S. Pat. No. 3,549,070 is discharged against the web, to thereby create a turbulent, dynamic air condition between the Coanda plate surface **63** and the web.

In accordance with the present invention however, a separate chamber is formed beneath the Coanda plate **63** and within the air bar, this chamber **70** extending along the length of the air bar and being opened at either of its ends, as shown by the openings **72** (FIG. **2**) in the end walls **73** of the air bars.

Thus the present invention provides an inner chamber in the air bars for removing the drying air which has been discharged against the web by the two opposing Coanda nozzles, and permitting this removed air to then flow lengthwise towards the ends of the air bars where it is discharged out of the openings **72** in each end of the air bars. This discharged air is then returned to the fan F or to the exhaust duct **14**, as previously mentioned.

The chamber **70** is formed by the Coanda plate **63** and also by a lower plate **74** which is nested within the downwardly turned edges **76** of the Coanda plate **63**, and this plate **74** is secured with the coanda plate **63** to define the air removing chamber **70.**

As shown clearly in FIG. **5**, a series of supports **77** extend across and within the air bar and act to accurately support the plates **63** and **74** so as to precisely form the Coanda slots **60** and **61.** Thus the Coanda slots **60** and **61** are unobstructed by any welds and this furthermore contributes to a smooth and continuous Coanda flow of drying air over the curved Coanda nozzle surfaces. The members **77** are welded at their ends to the side walls **78** of the air bar.

Air supply inlet openings **79** are formed in the bottom **79**a of the bar.

The modification shown in FIG. **6** utilizes a series of tubular exhaust members **81** which extend from the exhaust chamber **70** and exhaust air to the general interior of the dryer. This modification finds particular utility in dryers of wide webs and results in more uniform pressure in the exhaust chambers which would otherwise have a higher pressure in the center of the exhaust chamber and a lower pressure towards the ends of the exhaust chambers.

As shown in the enlarged view of the upper portion of the air bar in FIG. **8**, the high velocity air stream **82** issuing from the air slot **60** tends to follow the curved surface of the Coanda nozzle for a very short distance and then impinges directly on the web W across from the slot. This high velocity impingement is sufficient to break through the boundary layer of the web and results in high heat transfer coefficients. A portion of this high velocity stream is then turned inwardly toward the center of the web and a portion is turned in the opposite direction along the web. That portion which is directed towards the center of the web follows along the web surface as indicated by the arrows and upon reaching the center of the air bar, a portion of this flow is then directed through the exhaust openings **65.** Other portions of the air flow issuing from the slotted supply nozzles create a turbulent area between the web and the surface **63** of the nozzle and this turbulent air has been found to generally follow a path from the center of the web and outwardly towards each of the slotted nozzles in the bar. In other words, this general turbulent air movement seems to be from the center of the bar and outwardly towards the edges thereof.

FIG. **6***a* shows a bar generally similar to the bar shown in FIG. **5** and corresponding elements have been similarly numbered. However, the shape of the members adjacent the slotted nozzles are somewhat different and as shown.

As shown in FIG. **9**, the stagnation pressure of the air jets is extremely high at points **84** and **85** where they impinge against the web W. This pressure then drops off considerably and gradually increases until it reaches the point **86** at the center exhaust openings. Large decreases in the stagnation pressure indicate a particularly high kinetic energy level of air.

As shown in FIG. **10**, the percentage of initial nozzle pressure discharging from the slot is plotted against the ratio of the area of the center exhaust openings A_E in the air bar to the area A_O of both of the supply slot nozzles. As shown by the curve **88**, the impingement pressures increase from zero (not center exhaust openings) and to a maximum location where the ratio is approximately .75 to 1.0. It will also be noted from this graph that the floatation pressure does not appreciably drop but is generally uniform in that range.

The above charts illustrate that there has been an increase in the stagnation pressures at the two zones of air impingement on the web and this results in increased heat transfer coefficients. It is furthermore noted that the floatation pressures diminish only slightly as the ratio A_E to A_O increases from zero and then level off. With the present invention, the use of center exhaust means has permitted improved impingement on the web without seriously effecting floatation characteristics.

With the present invention, high overall heat transfer coefficients are obtained as are good floatation pressures. The air between the web and the air bar surface is dynamic in its nature and continually moving and insures that there are no quiet or turbulent free zones.

I claim:

1. An individual and replaceable air bar for floating a continuous running web and being elongated and of enclosed tubular shape and including opposite end walls, opposite side walls, and a generally flat plate lo-

cated between said side walls, said plate having spaced apart longitudinal and curved edges and locatable closely adjacent the running web to be supported, said bar also having a pair of air supply slots one extending along each of said edges to form opposed Coanda nozzles therewith for directing a stream of pressurized air out of the interior of said air bar and against said web, a portion of said stream turning toward the center of said bar and along said web whereby said portions of said streams discharged by said pair of opposed nozzles merge at the center of said plate, an exhaust chamber formed within said air bar and under said plate, and exhaust passage means generally in the center of and through said plate and communicating with said exhaust chamber whereby said opposed portions of said streams of air are directed through said exhaust passage means and into said exhaust chamber for removal therefrom.

2. An air bar set forth in claim **1** further characterized in that said exhaust chamber opens through each of the opposed end walls for discharge of air therefrom.

3. The air bar set forth in claim **2** further characterized in that said exhaust chamber is defined by said plate and also by another plate secured thereto and within said air bar.

4. The air bar set forth in claim **1** further characterized in that said exhaust chamber is defined by said plate and also by another plate secured thereto and within said air bar.

5. An individual and replaceable elongated and generally tubular air bar for positioning a running web and including opposite end walls, opposite side walls, a plate with spaced apart longitudinal edges locatable closely adjacent the running web to be supported, said plate located between said side walls, and a pair of air supply slots one extending along each of said edges to form air discharging nozzles therewith for directing a stream of pressurized air out of the interior of said air bar and against said web, a portion of said streams turning toward the center of said bar and along said web whereby said portions of said streams discharged by said pair of nozzles move toward the center of said plate, an exhaust chamber formed within said air bar and under said plate, exhaust passage means generally in the center of and through said plate and communicating with said exhaust chamber whereby said portions of said streams of air are directed through said exhaust passage means and into said exhaust chamber for removal therefrom, and air supply inlet openings in said bar through which pressurized air is supplied to the interior of said air bar.

6. An air bar set forth in claim **5** further characterized in that said exhaust chamber opens through each of the opposed end walls for discharge of air therefrom.

7. The air bar set forth in claim **6** further characterized in that said exhaust chamber is defined by said plate and also by another plate secured thereto and within said air bar.

8. The air bar set forth in claim **5** further characterized in that said exhaust chamber is defined by said plate and also by another plate secured thereto and within said air bar.

9. An individual and replaceable air bar for being positioned transversely of and for floating a continuous running web, said bar being elongated and of enclosed tubular shape and including opposite end walls, two opposed side walls, and a Coanda plate between said side walls and having spaced apart and curved edges along its length and locatable closely adjacent the running web to be supported, said bar also having a pair of air supply slots one extending along each of said edges to form opposed Coanda nozzles therewith for directing a stream of pressurized air out of the interior of said air bar and against said web, a portion of said stream turning toward the center of said bar and along said web whereby said portions of said streams discharged by said pair of opposed nozzles tend to merge at the center of said Coanda plate, said supply slots being defined by said curved edges of said Coanda plate and said side walls, an exhaust chamber formed within said air bar and under said Coanda plate, said exhaust chamber being defined by said Coanda plate and also by another plate secured to said Coanda plate and within said air bar, and exhaust passage means generally in the center of and through said Coanda plate and communicating with the interior of said exhaust chamber whereby said opposed portions of said streams of air are directed through said exhaust passage means and into said exhaust chamber for removal therefrom.

* * * * *