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Creapo et al.

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[54] **HIGH VELOCITY AIR WEB DRYER**

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[52] **U.S. Cl.** **34/156,** 34/229

[51] **Int. Cl.** **F26b 13/00**

[58] **Field of Search** 34/23, 155, 156, 34/160, 222, 229

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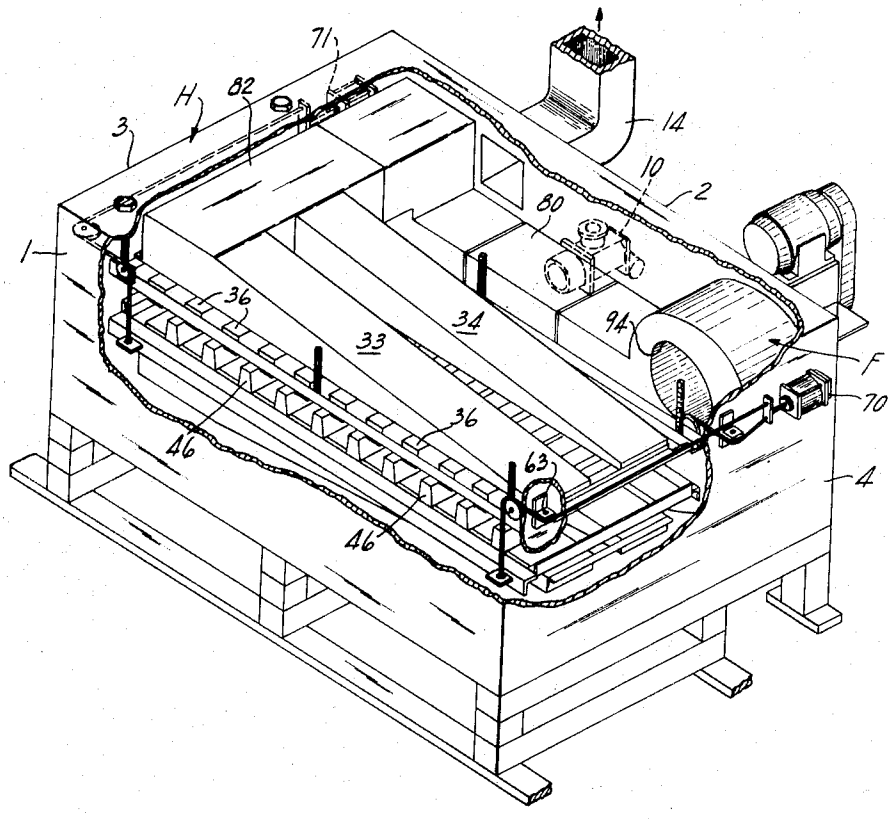
[57] **ABSTRACT**

A dryer for drying a running web by causing high-velocity, heated air to be impinged on the running web. High-velocity nozzles are located on opposite sides of the running web and arranged transversely to the direction of the web movement, and one set of nozzles is movable relative to the other set so as to readily vary the distance of the air nozzles from the web. The transversely arranged nozzles are supported on the air supply ducts and thus form an integral unit which is not subject to warpage and, consequently, the precise spacing of the nozzles from the web can be maintained. Means are provided for accurately and easily adjusting the position of the movable set of nozzles relative to the other set of nozzles. The device also includes a wall having a slideable seal and located between the inlet side of the air supply fan and one side of the web whereby the entire arrangement can be made very compact while at the same time insuring that the web will not be pulled into the air supply fan. An air make-up door is provided for controlling the source of make-up air and which also serves to keep the doors cool. The device also includes an easily replaceable gasket in the air plenum which eliminates the necessity of dismantling the air duct to replace the seal.

17 Claims, 7 Drawing Figures



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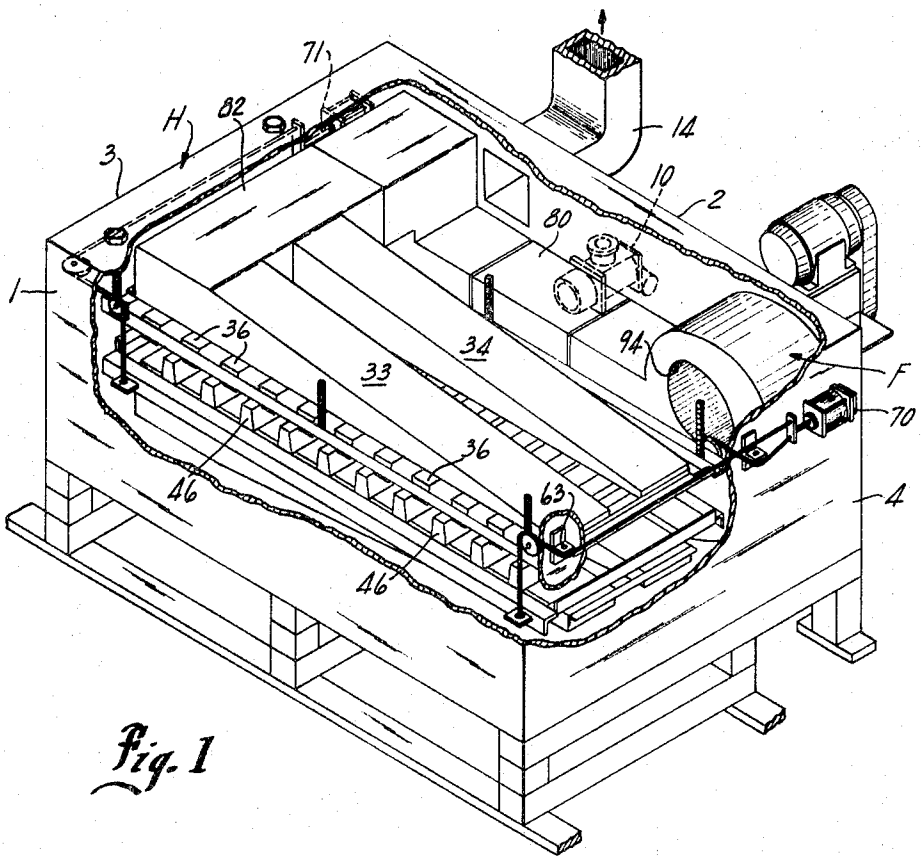

Fig. 1

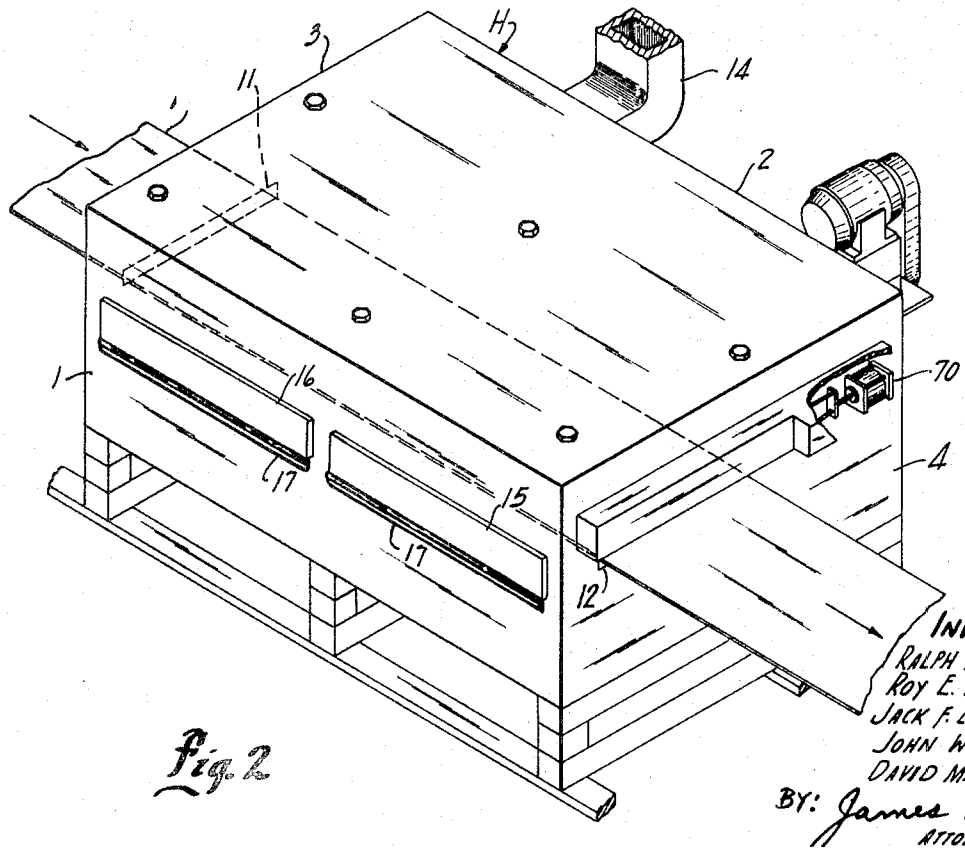

Fig. 2

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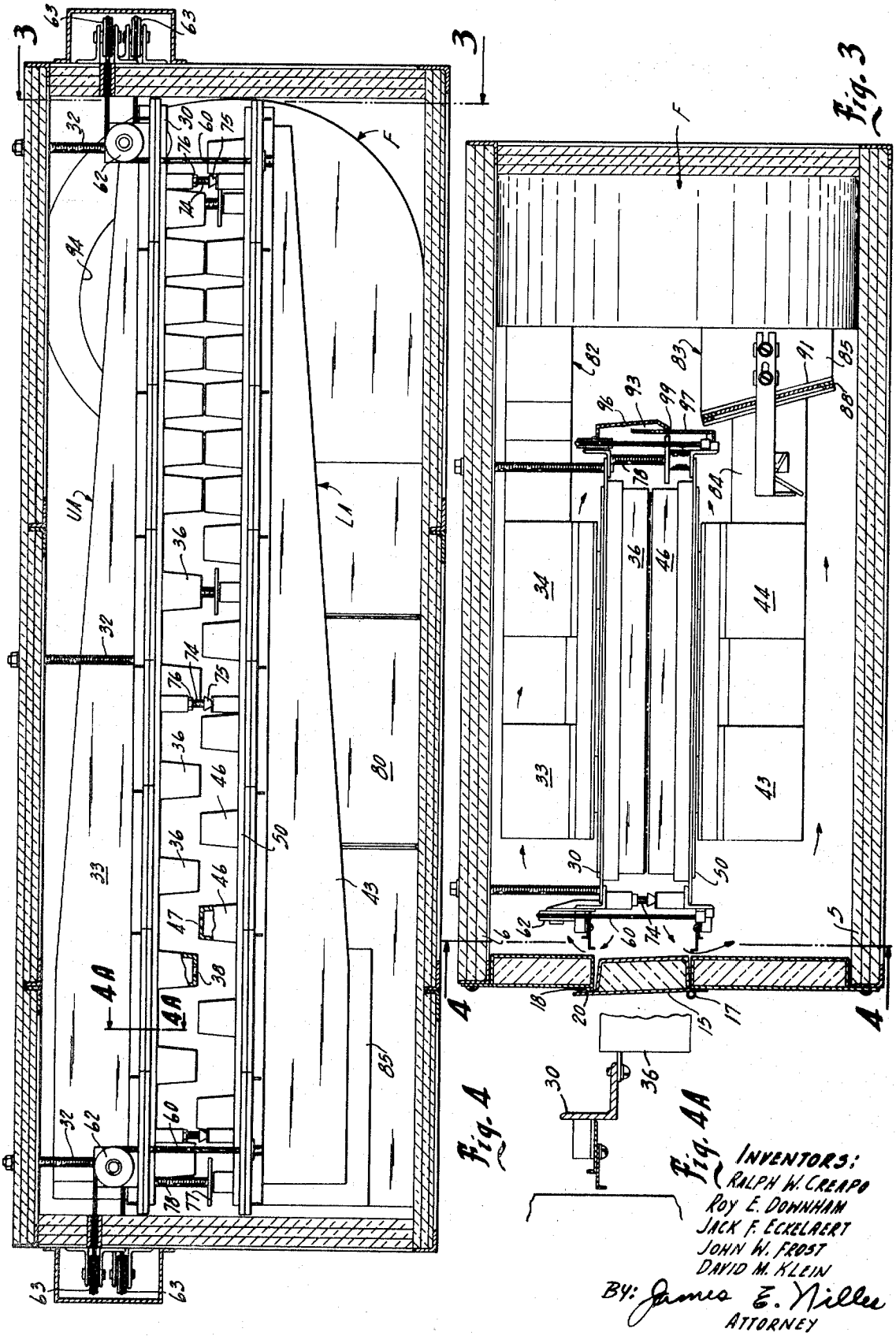

Fig. 3

Fig. 4

Fig. 4A

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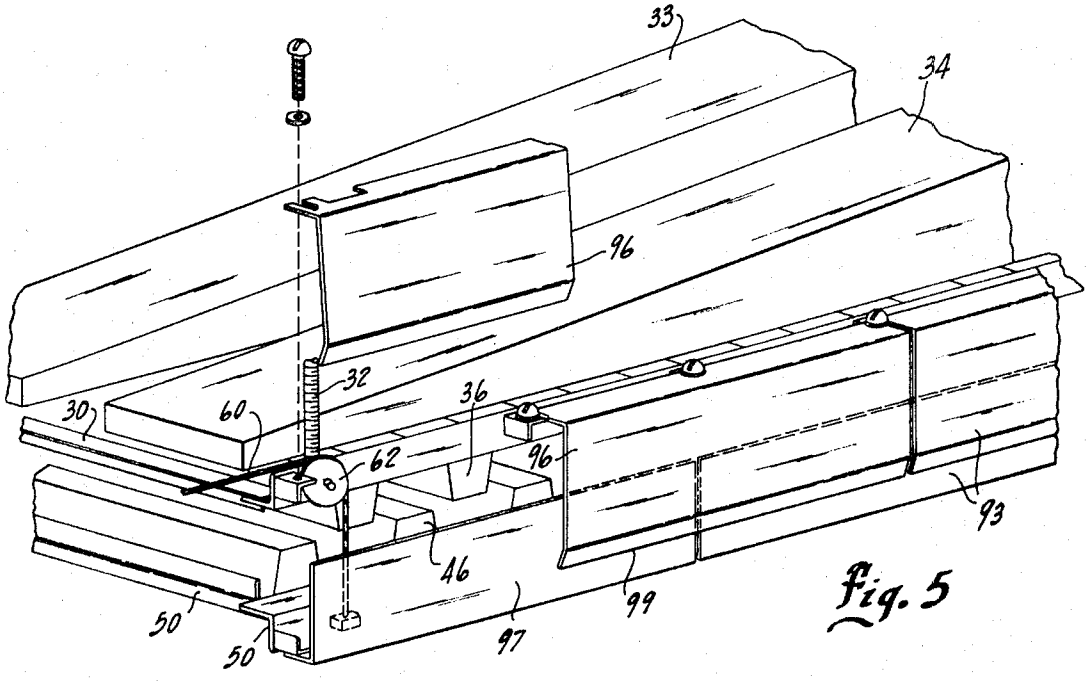

Fig. 5

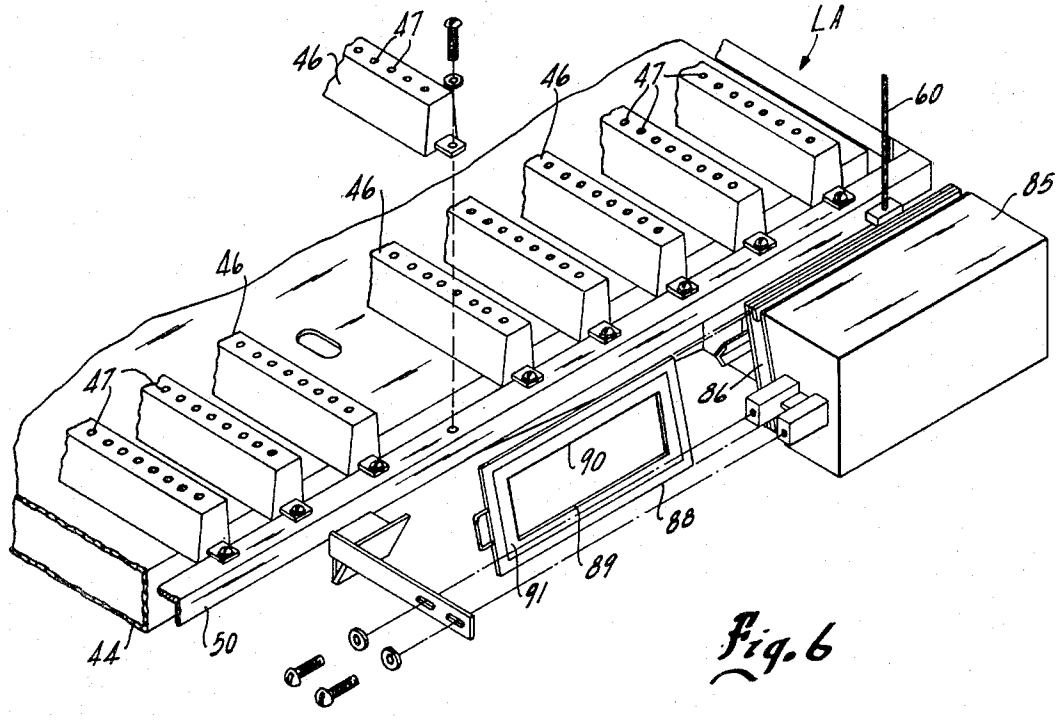

Fig. 6

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HIGH VELOCITY AIR WEB DRYER

BACKGROUND OF THE INVENTION

The invention pertains to high-velocity air web dryers which force heated air transversely across the moving web to be dried, and air nozzles for so directing the heated air are positioned transversely along each of opposite sides of the moving web. Prior art dryers of this general character have been used with a certain degree of success but have had certain shortcomings such as frequently being of considerable size and thereby requiring excessive installation space. Furthermore, these prior art devices mounted the air nozzles in such a manner that they became warped and which furthermore were difficult to adjust relative to the web. This difficulty in mounting the nozzles and providing for their adjustment occurred in large part due to the heat differential between various parts of the nozzles and/or their air ducts. Furthermore, these prior devices had seals in their air ducts which required replacement or repair and which often necessitated disassembly of the duct system in order to accomplish such replacement or repair. Still another shortcoming of the prior art devices was that the operator's doors became hot and, consequently, dangerous due to the necessary metal-to-metal construction in that area.

The general type of air bars or air nozzles utilized with the present invention are shown in the U.S. Pat. No. 3,549,070 issued Dec. 22, 1970 to Frost et al and entitled "Flotation of Sheet Materials."

SUMMARY OF THE INVENTION

The present invention provides a high-velocity air web dryer having a plurality of elongated air nozzles arranged transversely to the direction of movement of the web and located on each of opposite sides of the web, the nozzles being secured directly to and supported by the longitudinally extending supply air ducts. The ducts themselves are insulated so as to equalize the heat differential between the nozzle opening side of the air supply means and the remote side of the means. The combined air nozzles and ducts are mounted for movement relative to one another, for example, the lower duct and nozzle assembly being vertically shiftable relative to the upper assembly in order that the distance of the nozzles from the web can be accurately adjusted. The arrangement is such that the lower assembly is resiliently biased against prepositioned but adjustable stops whereby the distance between the nozzles and web is accurately maintained, regardless of the change in size of the various parts, for example, due to temperature changes thereof. More specifically, this aspect of the invention relates to having the upper nozzle and duct assembly stationarily mounted while the lower nozzle and duct assembly is suspended by a fluid cylinder and flexible cable means, the fluid cylinder means acting to bias the lower assembly upwardly against prepositioned but adjustable stops. As the cables or other parts change in size due to temperature changes, the position of the lower assembly relative to the upper assembly is nevertheless assured.

By having the supply ducts act as the support for the nozzles, the supply ducts actually act as support beams and provide considerable flexibility and also prevent problems which otherwise occur due to warping.

Another aspect of the invention relates to a high-velocity dryer of the above type and which is made particularly compact. This is accomplished by having the air supply fan located closely adjacent one longitudinal side of the web, and providing an intervening wall between the web and the fan, the wall in turn having a sliding seal which permits relative vertical movement between the upper and lower nozzle assemblies and prevents the suction action of the fan from tearing the web sideways from between the nozzle assemblies.

Still another aspect of the invention relates to a removable seal for the lower air header and which considerably reduces the maintenance problems heretofore encountered when it was necessary to replace or repair such a seal. This aspect of the invention provides a removable frame which can be moved sideways and into and out of the duct and which frame has a flexible seal mounted thereon. Thus, the frame and its seal can be readily replaced in the duct without moving or removing the duct itself.

Still another aspect of the invention relates to the operator's doors located alongside the web for inspection of the latter. These doors are necessarily insulated but also have metal-to-metal contact with the outer cover of the dryer which metal-to-metal contact has heretofore resulted in hot spots along the outside of the dryer which are dangerous to the operator. This aspect of the invention provides for maintaining the door open slightly so as to not only control the source of make-up air for the supply fan but also acts to maintain the door and surrounding area cool. The door is maintained open a predetermined amount so that the amount of predetermined infiltrating air acts to cool the exterior surfaces of the door and the area of the dryer surrounding it and, at the same time, provides for minor preheating of the infiltration air.

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 the dryer embodying the present invention, certain parts being shown broken away and in section for clarity in the drawings;

FIG. 2 is a perspective view similar to the dryer shown in FIG. 1 but without certain of the parts broken away or in section;

FIG. 3 is a transverse sectional view through the dryer, the view being taken generally along the line 3—3 in FIG. 4;

FIG. 4 is a longitudinal sectional view through the dryer, the view being taken generally along the line 4—4 in FIG. 3;

FIG. 4A is an enlarged, fragmentary, sectional view taken along line 4A—4A in FIG. 4;

FIG. 5 is a perspective, exploded view of the intervening wall and its sliding seal which is also shown in FIG. 3;

FIG. 6 is a perspective, exploded view of the removable seal for the air duct, such seal also being shown in FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The dryer provided by the present invention includes an outer housing H fabricated from sheet metal and having a front side 1, 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 forms an enclosure. It will be noted that the walls and the top and bottom of the housing are all of insulated construction as the interior of the housing is heated by the burner 10 located on the rear side of the housing. The inlet side of the housing has a web inlet 11 through which the web W passes into the housing. A web outlet 12 is located at the web outlet side 4 of the housing and thus the web passes directly through the housing and runs at a speed, for example, of several hundred feet per minute.

An air 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.

On the front side of the housing are the doors 15 and 16 mounted on their continuous hinges 17 and, as shown in FIG. 3, these doors are maintained in a slightly open position by the projections 18 on the front wall 1. Thus, a certain amount of make-up air is permitted to continually pass through the opening 20 around the door and the adjacent wall and this make-up air passes into the housing and is immediately heated. The air passing through the opening 20 also serves to maintain the metal door and the metal of the wall 1 surrounding the door, cooled. That is to say, the metal-to-metal contact between the door and wall is maintained relatively cool and is prevented from becoming dangerously hot as in other prior art dryers.

Make-up air is also able to pass into the housing through the web inlet 11 and the web outlet 12. As a result, the air within the housing is heated by the burner and is continually recycled within the housing, as will appear. As mentioned, a certain percentage of air is exhausted through the exhaust duct 14 and this exhausted air is replenished by the make-up air as mentioned.

An upper air bar and supply duct assembly UA is stationarily mounted within the housing. This upper assembly includes horizontally disposed frame 30 fabricated from angle iron, and which is hangingly suspended from the top wall of the housing by means of the vertically disposed threaded bolts 32. The upper assembly also includes a bar of longitudinally disposed duct means 33 and 34 which taper towards one of their ends and are generally rectangular in cross section. A plurality of generally tubular air bars 36 are arranged transversely in respect to the direction of web movement through the housing and are secured to and in fluid communication with the duct means 33, 34.

Each of the air bars have openings 38 along their length and adjacent the web so as to direct high-velocity jets of air against the web as the web rapidly moves past the air bars. The bolts 32 permit the adjustment of the upper assembly UA, in a vertical direction, and in respect to the distance of its nozzles from the upper side of the web.

A lower air bar and supply duct assembly LA is also provided within the housing and is of generally similar construction to the upper assembly. The lower assembly includes the longitudinally disposed duct means 43 and 44 to which are attached the transversely positioned, tubular air bars 46. The air bars 46 are in air-receiving communication with the duct means 43, 44 and also openings 47 along their length through which air is ejected onto the web. The lower assembly includes the generally horizontally disposed frame 50 which is fabricated from angle iron.

The lower assembly is mounted within the housing for shifting in the vertical direction, that is, toward and away from the upper assembly, so as to thereby vary the distance between the air bars 36 of the upper assembly and the air bars 46 of the lower assembly. The lower assembly is vertically shiftable by means of the flexible cables 60 which are attached to the frame of the lower assembly and which extend upwardly and are trained over the pulleys 62 rotatably mounted on the upper assembly. The flexible cables then pass around the guide pulleys 63 and are connected to an air-operated cylinder and piston unit 70. More specifically, a pair of such cables are located at each end of the lower frame and the pairs of cables are connected to their respective air-operated piston cylinder units 70 and 71 mounted, respectively, on the outlet end 4 and the inlet end 3 of the housing H.

Adjustable stop means 74 are mounted on the upper assembly and their lower ends are adapted to be abutted against by the lower assembly, as shown in FIGS. 3 and 4, when the lower assembly is in upper operative, web-drying position. These stop means include a threaded cone-shaped locator 75 that is threadably engaged in the upper assembly and are locked in place by the lock nut 76. The lower assembly locates and stops against the lower end of the threaded cone-shaped locator 75 so as to precisely locate the lower assembly relative to the upper assembly. An apertured adjusting wheel 77 is fixed to the threaded rod 78 which, in turn, is engaged in the upper assembly whereby the spacing between the assemblies can be accurately determined.

The air-operated cylinder piston units 70, 71 constitute power means which act through the thrust-transmitting means formed by the flexible cables, and thereby vertically position the lower assembly, this lower assembly as determined by the adjustable stop means. The power means are continually biased to urge the lower assembly upwardly against the stop means. In other words, the air cylinder-piston units are continually actuated to cause tension on the cables and thereby continually and resiliently bias the lower assembly upwardly against the stops. With this construction, as the temperature of the cables and other parts change, the lower assembly is held in proper position regardless of the change of size of the various parts due to thermal expansion and contraction.

With the above construction, the upper assembly is stationarily and hangingly suspended within the housing and is thus free to slightly change size due to thermal expansion and contraction, with damaging any of the parts. The lower assembly is suspended from the upper assembly and is also free or flexible to change size slightly due to changing thermal conditions. Nevertheless, the power means and its flexible cable arrangement acts to precisely hold the lower assembly relative to the upper assembly so as to maintain the proper spacing between the air bars and the web.

The duct means are covered on three of their sides with insulation material 79, the side adjacent the bars having no insulation, and this prevents warpage of the assembly.

Means for supplying air to the duct means 33, 34 and 43,44 are provided as follows. An air supply fan F is located within the housing and along one of its longitudinal sides and closely adjacent one side of the upper and lowe assemblies. The fan includes duct 80 which is in communication with the duct means of the upper and

lower assemblies. The duct **80** includes a transverse duct **82** which feeds the upper duct means **33** and **34.** The duct means **80** also includes a lower, transverse duct means **83** which is comprised of two ducts **84** and **85.** A joint **86** is formed between the ducts **84** and **85** and this joint, as shown in FIG. **3,** is inclined to the vertical. Duct **85** is rigidly attached to the main duct **80** of the fan while duct **84** is rigidly attached to the vertically shiftable, lower assembly LA. Thus, by providing the joint **86** between ducts **84** and **85,** the vertical movement of the lower assembly relative to the fixed duct **85** is accommodated. As shown in FIG. **6,** a flexible gasket means **88** is insertable in the joint **86,** that is to say, it can be slid into and out of the joint **86** (FIG. **6**) and provides a seal between the ducts **84** and **85.** This gasket means includes a rectangular frame **89,** to one side of which and around its central opening **90** is attached a thick flexible gasket means **91.** This gasket means is sufficiently thick and resilient so as to effect a seal between the ducts **84, 85** even though slight vertical movement between the ducts occurs. In any event, when the lower assembly is in the fully upper position, the gaskets form a tight seal.

The inclined joint **86** above described is very desirable in reducing maintenance on the machine, for example, when a new web is to be strung through the machine after the machine has been shut down. For example, it is necessary to separate the assemblies to permit stringing of the web through the nozzle sections. Thus, with the inclined joint arrangement, there is no need to disconnect the ducts when it is desired to lower the lower assembly for stringing the web, but instead the joint automatically opens because of its inclined relationship to the vertical. Conversely, the joint is automatically sealed when the lower assembly is raised to the operative position.

With this gasket means provided by the present invention, the seal between the ducts **84, 85** may be conveniently and easily replaced or repaired without disassembly or removal of the ducts. This is accomplished simply by sliding the gasket means outwardly from the joint and the gaskets can then be easily replaced on the frame and the gasket means assembly then reinserted in the joint.

It will be noted that the fan has an air inlet **94** located closely adjacent one side of the upper and lower assemblies and more particularly, located closely adjacent the web passing between these assemblies. The present dryer is particularly compact by having the fan close to the assemblies, and this is possible because of the intervening wall **93** located between the air inlet **94** and the web and which prevents the fan from sucking the web laterally out from between the nozzles and into the fan. The wall means **93** includes relatively movable portions **96** and **97,** portion **96** being secured directly to the upper assembly while portion **97** is connected directly to and shiftable with the lower assembly. A sliding seal is thereby produced at **99** between the wall portions whereby the air inlet of the fan is shielded from the web regardless of the vertical position of the lower assembly.

The intervening wall permits the complete return air flow into the fan and at the same time permits full retraction of the assemblies. With this construction, it is possible to permit the supply fan to continue to run while the nozzles are being retracted from one another and although generally the supply fan is turned off while the nozzles are retracted, nevertheless coasting of the fan would continue to effect a suction on the web, causing a web break.

RECAPITULATION

The high-velocity air dryer provided by the present invention utilizes a pair of air bar and duct means assemblies, one of which assemblies is movable relative to the other. Each assembly includes the plurality of air bars and their supply duct means which are mounted together on a frame as a unit. The duct means are insulated on three of their sides so as to minimize the temperature differential between the nozzle side of the assembly and the back side of the assembly remote from the web. This construction prevents the distortion due to the otherwise bimetallic strip effect. The assemblies are mounted relatively free of the housing and can change size to a certain degree without affecting their relative position or efficiency. More specifically, the upper assembly is hangingly suspended within the outer housing and the lower assembly is, in turn, suspended from the upper assembly and is adjustable relative thereto by the flexible thrust-transmitting means in the form of flexible cables. The power means for adjusting the lower assembly takes the form of an air-operated cylinder and piston unit which is arranged so that it does not bottom when fully contracted and thereby continuously and resiliently biases the lower assembly upwardly against the fixed predetermined position stops.

The supply fan can be located closely adjacent one longitudinal edge of the web resulting in a compact dryer, because of the intervening wall acting as a shield between the web and the fan inlet. This wall is of such a construction that it forms a movable seal so as to accommodate vertical shifting movement of the lower assembly relative to the stationary fan, duct and upper assembly.

The air supply duct leading from the main duct of the fan to the lower assembly has a joint which is automatically sealed even though the lower assembly is vertically shiftable within limits. This automatically sealable joint contains flexible gasket means which can be easily removed from and inserted into the joint for quick replacement of the gasket itself without disturbing the duct. The entire air supply and exhaust is nicely balanced, the operator door, although having metal-to-metal contact with the housing, nevertheless remains cool and avoids hot spots which are dangerous to the operator; at the same time, the partially-open door provides a source of make-up air which is quickly preheated for use by the fan and for distribution throughout the dryer.

We claim:

1. A high velocity air dryer for a running web comprising, an outer housing, a web inlet at one end of said housing and a web outlet at the opposite end of said housing, an upper air bar and supply duct assembly stationarily mounted in said housing and located above a web passing through said inlet and outlet in said housing, said assembly including air supply duct means extending longitudinally in said housing in respect to the direction of web travel, and a plurality of generally tubular air bars extending transversely to said web, and at longitudinally spaced locations along said web, said bars being in air-receiving communication with said duct means and having air discharging openings for dis-

charging high-velocity air against said web, a lower air bar and supply duct assembly shiftably mounted in said housing and located beneath said web and in opposition to said upper assembly, said lower assembly including air supply duct means extending longitudinally in said housing, and a plurality of generally tubular air bars extending transversely to said web at spaced locations therealong, said bars being in air-receiving communication with said lower duct means and having air discharging openings for discharging high-velocity air against said web, power means for shifting said lower assembly toward said upper assembly, and flexible means connected between said lower assembly and said power means and also trained over said upper assembly whereby said lower assembly is suspended from said upper assembly and said lower assembly is shifted via said flexible means by said power means.

2. The dryer set forth in claim **1** including fixed stop means against which said lower assembly abuts when in the operative position, and said power means resiliently biases said lower assembly against said stop means.

3. The dryer set forth in claim **1** further characterized in that said flexible means includes flexible cables connected to said power means, and said upper assembly has pulley means mounted thereon and over which said cables are trained.

4. The dryer of claim **3** including stop means abuttable by said lower assembly when the latter is in an upper operative position, and said power means is biased in a direction to maintain said lower assembly against said stop means.

5. The dryer of claim **4** further characterized in that said power means is a fluid cylinder means.

6. The dryer set forth in claim **1** including, an air supply fan in said housing for supplying air to said assemblies, said fan having an air inlet located along one side of said assemblies, and wall means interposed between said air inlet and said assemblies and having relatively moveable portions whereby said air inlet is shielded from the web located between said assemblies regardless of the vertical position of said lower assembly, to thereby prevent said web from being sucked into said air inlet.

7. The dryer set forth in claim **6** including an air duct placing said fan in air delivering communication with said lower assembly, said duct having a joint therethrough which is inclined to the vertical, and flexible gasket means around said joint for sealing the joint when said lower assembly is vertically shifted upwardly to an operative position.

8. The dryer in accordance with claim **7** further characterized in that said gasket means includes a frame slideably and removably mounted in said joint, and a flexible gasket is detachably secured to said frame for removal therewith from said duct.

9. A high-velocity air dryer for a running web comprising, an outer housing, a web inlet at one end of said housing and a web outlet at the opposite end of said housing for permitting a running web to pass through said housing, an upper air bar and supply duct assembly mounted in said housing and located above said web, a lower air bar and supply duct assembly shiftably mounted in said housing and located beneath and in opposition to said upper assembly, said assemblies discharging high-velocity air against said web, means for vertically shifting said lower assembly relative to said upper assembly, an air supply fan in said housing for supplying air to said assemblies and having an air inlet located along one longitudinal side of said assemblies, and wall means interposed between said air inlet and said assemblies and having relatively movable portions whereby said air inlet is shielded from the web located between said assemblies regardless of the vertical position of said lower assembly, to thereby prevent said web from being sucked into said air inlet.

10. The dryer set forth in claim **9** including an air duct placing said fan in air delivering communication with said lower assembly, said duct having a joint therethrough which is inclined to the vertical, and flexible gasket means around said joint for sealing the joint when said lower assembly is vertically shifted upwardly to an operative position.

11. The dryer in accordance with claim **10** further characterized in that said gasket means includes a frame slideably and removably mounted in said joint, and a flexible gasket is detachably secured to said frame for removal therewith from said duct.

12. The dryer described in claim **9** further characterized in that said means for vertically shifting said lower assembly includes power means, and thrust-transmitting means connected between said lower assembly and said power means, said transmitting means also being in engagement with said upper assembly to suspend said lower assembly from said upper assembly.

13. A high-velocity air dryer for a running web comprising, an outer housing, a web inlet at one end of said housing and a web outlet at the opposite end of said housing, an upper air bar and supply duct assembly stationarily mounted in said housing and located above a web passing through said inlet and outlet in said housing, a lower air bar and supply duct assembly shiftably mounted in said housing and located beneath said web and in opposition to said upper assembly, said assemblies discharging high-velocity air against said web, means for shifting said lower assembly toward said upper assembly, an air supply fan in said housing, an air duct placing said fan in air-delivering communication with said lower assembly, said duct having a joint therethrough which is inclined to the vertical, and flexible gasket means around said joint for sealing the joint when said lower assembly is vertically shifted upwardly to an operative position.

14. The dryer in accordance with claim **13** further characterized in that said gasket means includes a frame slideably and removably mounted in said joint, and a flexible gasket is detachably secured to said frame for removal therewith from said duct.

15. The dryer described in claim **13** further characterized in that said means for vertically shifting said lower assembly includes power means, and thrust-transmitting means connected between said lower assembly and said power means, said transmitting means also being in engagement with said upper assembly to suspend said lower assembly from said upper assembly.

16. The dryer described in claim **14** further characterized in that said means for vertically shifting said lower assembly includes power means, and thrust-transmitting means connected between said lower assembly and said power means, said transmitting means also being in engagement with said upper assembly to suspend said lower assembly from said upper assembly.

17. A high-velocity air dryer for a running web comprising, housing means, a web inlet at one end of said housing means, and a web outlet at the opposite end of

said housing means for permitting a running web to pass through said housing means, an upper air bar and supply duct assembly mounted in said housing means and located above said web, a lower air bar and supply duct assembly mounted in said housing means and located beneath and in opposition to said upper assembly, said assemblies discharging high-velocity air against said web, means for vertically shifting one assembly relative to the other assembly, an air supply fan in said housing means and located along one longitudinal side of said assemblies and for supplying air to said assemblies, said fan having an air inlet, and intervening wall means interposed between said fan air inlet and said assemblies and including relatively movable portions whereby the web located between said assemblies cannot be sucked into said fan inlet regardless of the vertical position of said assemblies.

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