

April 1, 1958

G. S. BRENDEL ET AL
PAPER DRYING MACHINE

2,828,552

Filed April 22, 1954

5 Sheets-Sheet 1

FIG. 1.

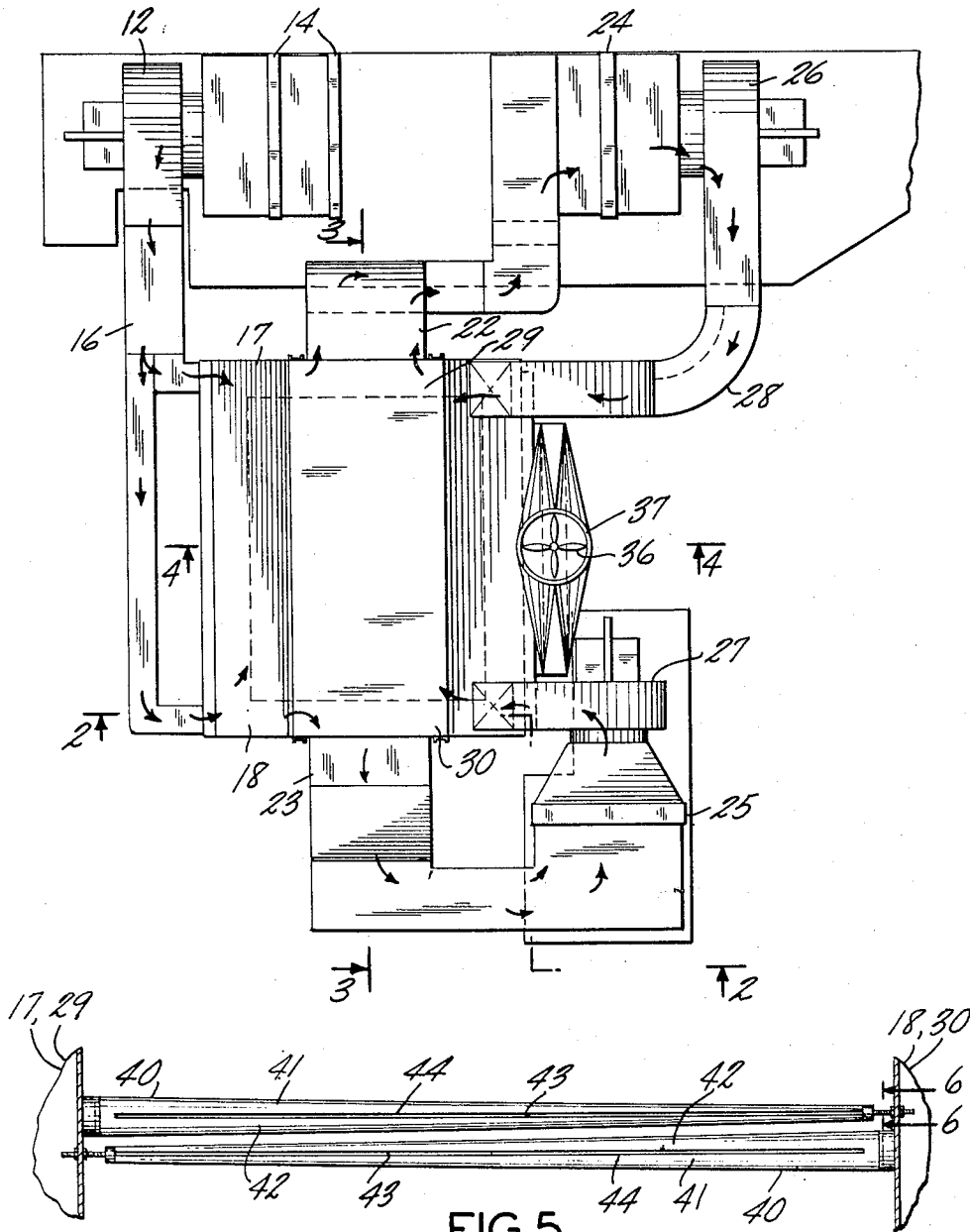


FIG. 5.

INVENTOR.
GEORGE S. BRENDEL &
HOWARD J. VOORHEES
BY *Richard S. Shreve*
ATTORNEY

April 1, 1958

G. S. BRENDEL ET AL

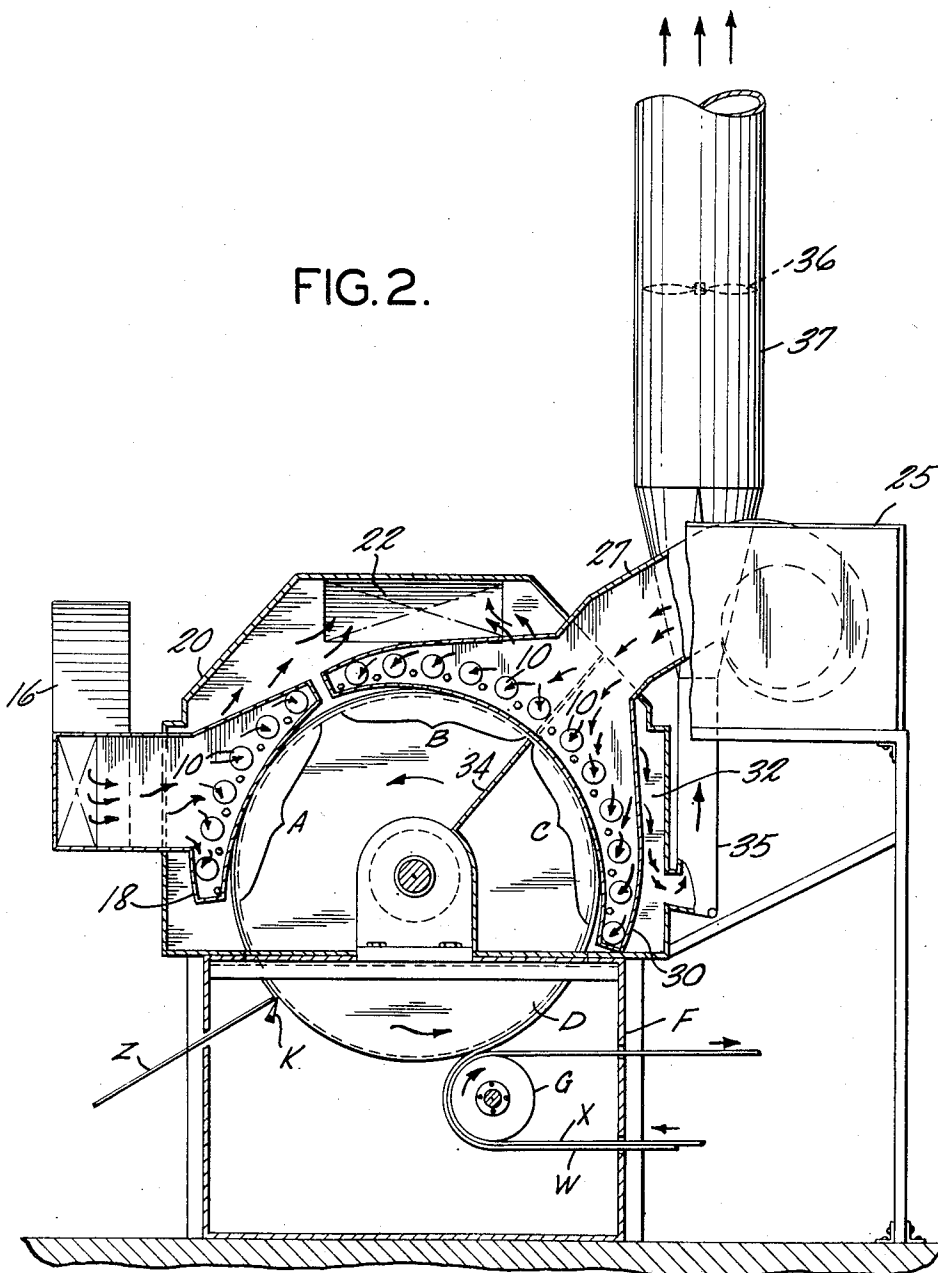
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5 Sheets-Sheet 2

FIG. 2.



INVENTOR.
GEORGE S. BRENDEL &
HOWARD J. VOORHEES
BY
Richard S. Shreve, Jr.
ATTORNEY

April 1, 1958

G. S. BRENDEL ET AL

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5 Sheets-Sheet 3

FIG. 6.

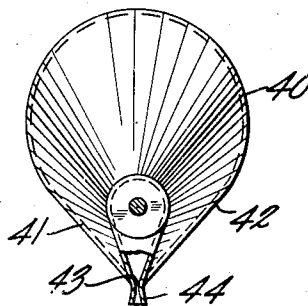
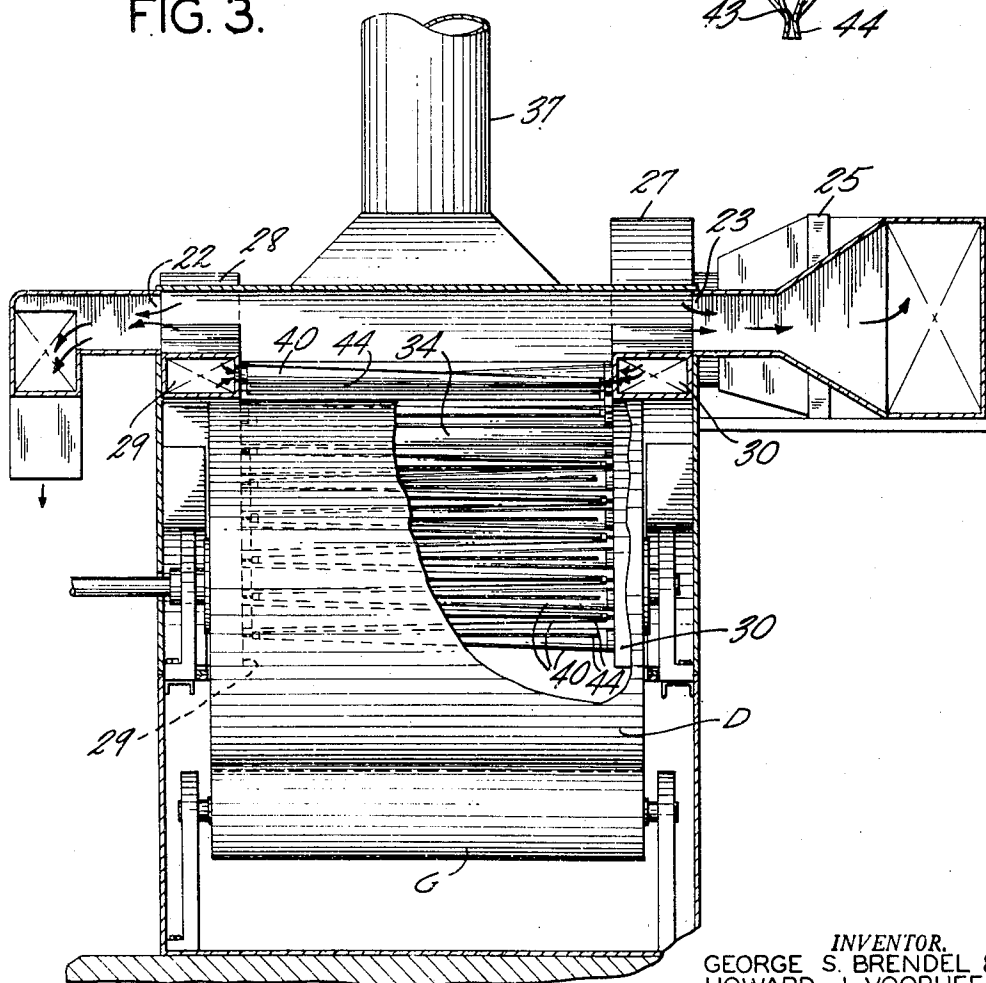


FIG. 3.



INVENTOR.
GEORGE S. BRENDEL &
HOWARD J. VOORHEES

BY
Richard S. Shore
ATTORNEY

April 1, 1958

G. S. BRENDEL ET AL

2,828,552

PAPER DRYING MACHINE

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5 Sheets-Sheet 4

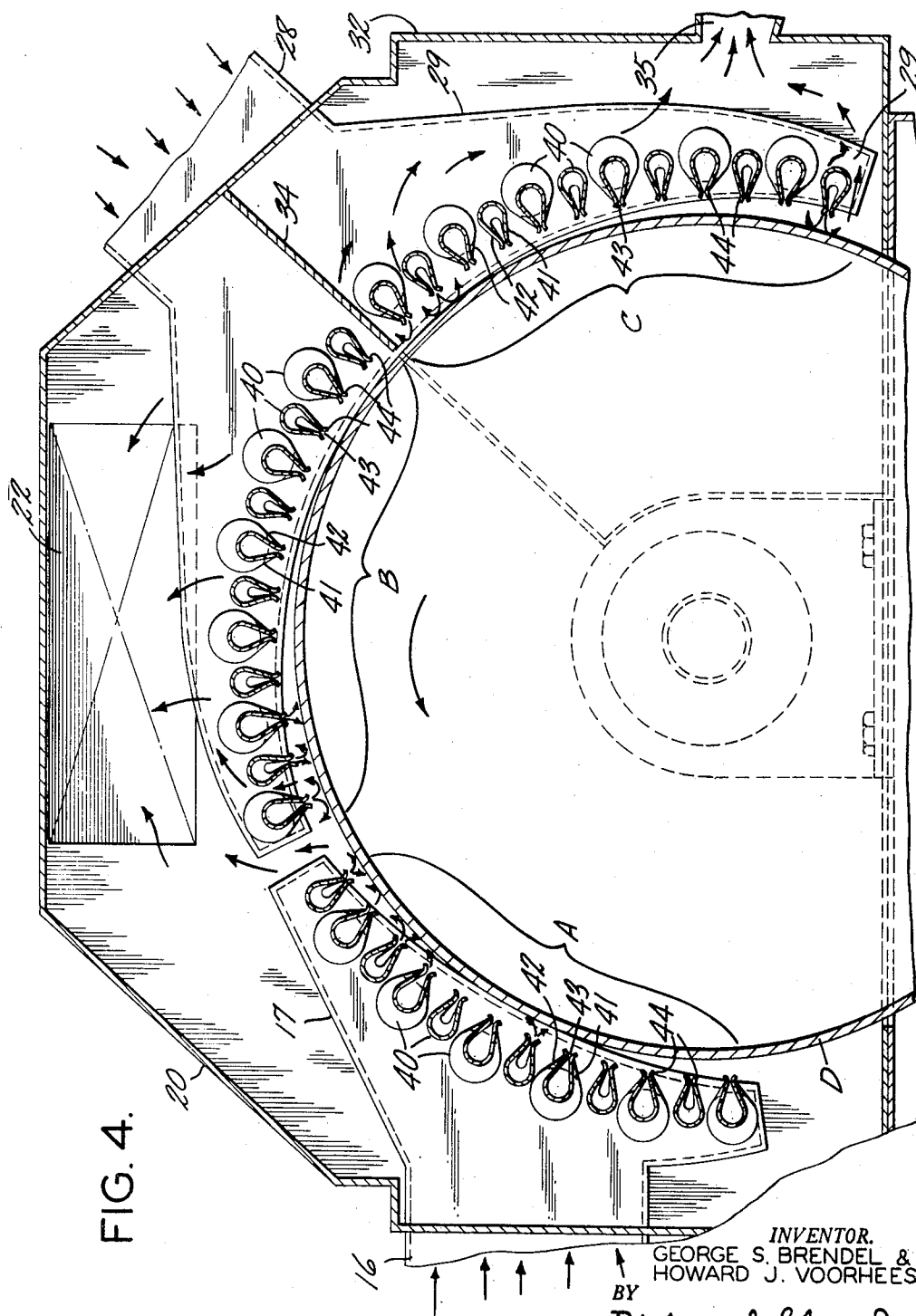


FIG. 4.

INVENTOR.
GEORGE S. BRENDEL &
HOWARD J. VOORHEES
BY
Richard S. Shreve, Jr.
ATTORNEY

April 1, 1958

G. S. BRENDEL ET AL
PAPER DRYING MACHINE

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5 Sheets-Sheet 5

FIG. 7.

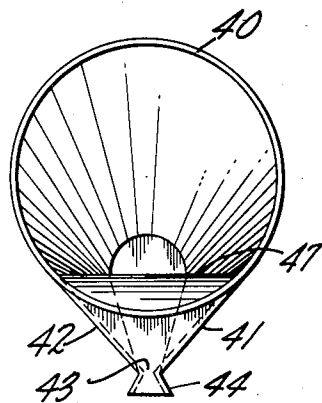
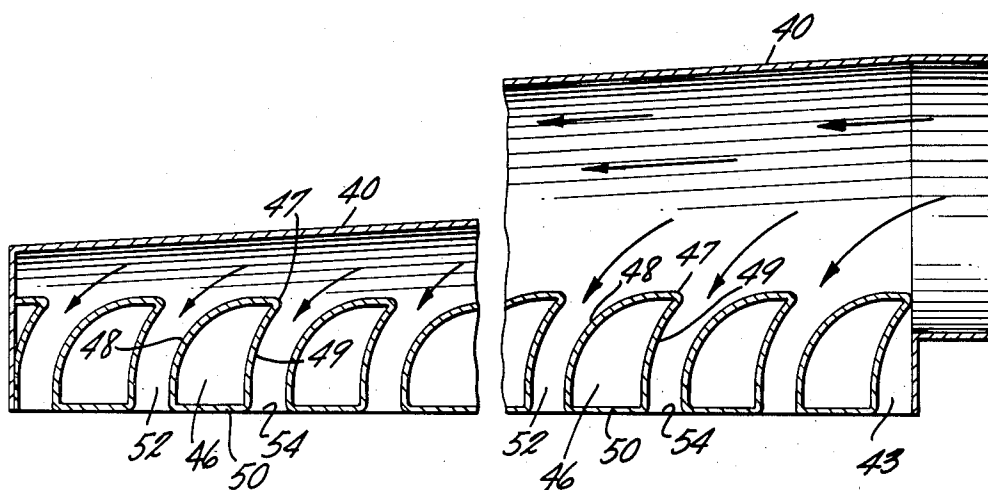


FIG. 8.

INVENTOR.
GEORGE S. BRENDEL &
HOWARD J. VOORHEES
BY
Richard S. Shreve, Jr.
ATTORNEY

1

2,828,552

PAPER DRYING MACHINE

George S. Brendel, Highland Park, and Howard J. Voorhees, New Brunswick, N. J.

Application April 22, 1954, Serial No. 424,822

6 Claims. (Cl. 34—86)

This invention relates to paper drying machines and more particularly to drying machines employed in the manufacture of the paper receiving the moist paper from the Fourdrinier machine for drying and glazing as finishing operations.

Paper drying machines of this character comprise a large diameter heated drum or cylinder around which the moist paper is passed, and against which it is pressed in passage. The heating vaporizes the moisture, but the resulting vapor tends to cling to the paper. Hence to expedite the drying it is customary to impinge blasts of air against the surface of the heated paper, to disrupt the vapor and carry it away to a suitable exhaust.

The air blasts have been provided by rows of pipes arranged around the periphery of the heated drum in longitudinally extending parallel relation. These pipes each have a row of nozzles spaced along their sides toward the drum to project the air against the paper, and the air and entrained vapor passes out between the pipes to the exhaust. The pipes are connected to a header which supplies air under pressure to one end of each of its pipes, but inasmuch as the pipes are round and of uniform diameter, each of the longitudinally spaced nozzles taking off air from the pipe, causes an increment of pressure drop, and consequently the velocity of impact of the nozzles decreases progressively toward the closed end thereof.

It has been proposed to alternate the pipes from headers at each end, causing flow in opposite directions in adjacent pipes, in an endeavor to balance the velocity drop, but the greater velocity at the header end of the pipes overcompensates for the lower velocity, so that the sides are dried while the center of the sheet remains moist, recognized as a wet center condition.

It is therefore the main object of the present invention to increase the uniformity of the velocity of air blast longitudinally of the drying cylinder.

In previous endeavors to facilitate the drying operation, valuable dry air has been discharged from the system before its drying power has been completely utilized. Attempts to economize this condition by recycling the exhaust air have resulted in wet air being projected onto the paper. A twofold object of the present invention is to prevent valuable dry air from being wasted; and to prevent wet air from being reused.

Inasmuch as the drying operation in this type of machine is progressive, the air exhausted from between the tubes nearer the end of the operation where the sheet is drier, has less entrained moisture than that exhausted from between the tubes nearer the beginning of the operation where the sheet is wetter. It is therefore another object of the invention to collect the air exhausted from the delivery side of the drum, and supply it to the tubes nearer the feeding side of the drum.

In the old type of tubes which had nozzles spaced along their sides toward the drum, caused an abrupt change in direction of flow at the outlets. It is therefore

2

another object of the present invention to provide streamlined structure within the tube to decrease the internal resistance to flow and facilitate the change in direction. By providing sides of the tube converging toward the outlets when viewed in cross section the resistance in that plane is reduced, and by providing longitudinally curved guiding vanes for each outlet, the resistance in the longitudinal plane is reduced. Thus the tube-outlet condition is streamlined in two directions to facilitate the flow, in two dimensions.

In the drawings:

Fig. 1 is a plan view of a drying machine according to the preferred embodiment of the present invention;

Fig. 2 is a vertical transverse section taken along the line 2—2 of Fig. 1;

Fig. 3 is a vertical longitudinal section taken along the line 3—3 of Fig. 1;

Fig. 4 is a vertical transverse section taken along the line 4—4 of Fig. 1;

Fig. 5 is an inverted plan of a pair of the tapered nozzle tubes;

Fig. 6 is a section taken along the line 6—6 of Fig. 5, showing one of the nozzle tubes in end elevation;

Fig. 7 is a longitudinal section through one of a pair of modified nozzle tubes; and

Fig. 8 is an end elevation of the tube shown in Fig. 7.

The drying machine shown comprises a large drum or cylinder D rotatably mounted in a frame F. The drum D is suitably heated in the customary manner, and receives the wet paper W from the Fourdrinier machine over a felt conveyor belt X, passing over a roll G. The dried paper Z is removed from the drum D by a doctor K from which it is delivered in the usual way.

The greater part of the drum D above the frame F is surrounded by tubes 10, which project streams of heated air to impinge upon the paper on the drum D, to disrupt the vapor thereon and carry it away.

The tubes 10 are divided into three groups, A, B, and C. With respect to the paper passing through the machine and being progressively dried, that portion operated upon by the group A is the driest, by group B intermediate, and by group C the wettest.

Heated dry air is supplied to the tubes 10 of group A by a fan or blower 12, which draws dry air through heaters 14 and delivers it through a duct 16 to a pair of arcuate headers 17 and 18, between which extend the nozzle tubes 10 of group A. The heated dry air discharged by these tubes impinges upon the already largely dried paper, and removes the last of the vapor therefrom. The air and entrained vapor escapes between the tubes 10 of group A into a hood 20, and passes therefrom out through ducts 22 and 23 at the respective sides of the hood.

The duct 22 delivers the air from one side of the hood 20 through a heater 24 to a fan or blower 26, which discharges the reheated air through a duct 28 to a header 29 which supplies one end of alternate tubes of groups B and C. The duct 23 delivers the air from the other side of hood 20 through a heater 25 to a fan or blower 27 which discharges the reheated air through a header 30 which supplies the other half of the tubes of groups B and C.

The tubes of group B project streams of reheated air onto the intermediately dried portion of the paper W, disrupt the vapor thereon and carry it away between the tubes of group B into the hood 20, where it commingles with the air discharged by the tubes of group A.

The tubes of group C project streams of reheated air onto the wettest portion of the paper W, disrupt the vapor thereon, and carry it away between the tubes of group C into the hood 32 which is separated from the hood 20 by a partition 34. The hood 32 is connected by a duct

35 through exhaust fan 36 to the stack 37 which exhausts it to the atmosphere.

The construction of the tubes 10 according to the preferred embodiment of the present invention is shown in Figs. 5 and 6. These tubes are tapered from their inlet ends downwardly toward their closed ends, so as to be of uniformly decreasing cross section to avoid drop in pressure and provide substantially uniform velocity for their outlets throughout the lengths of the tubes. The tubes are preferably formed of sheet metal into substantially conical form 40 at the top, or side away from the drying drum, thereby having a partly circular cross section of decreasing radius toward the closed end.

Below the conical part, the tubes are of triangular pyramid form, having flat sides 41 and 42 converging toward a slot 43 at the bottom, or part nearest the drying drum. The sheet metal of both sides continues beyond the slot 43 and is flared outwardly at both sides, forming diverging flanges 44 to reduce orifice loss.

A modified form of one of a pair of the tubes 10 is shown in Figs. 7 and 8. The body is formed exactly the same as Figs. 6 and 7, but inside the tube mounted in the pyramid portion between the flat sides 41 and 42 are transversely extending longitudinally curved guiding vanes 46. These are preferably constructed of sheet metal, but may be die cast if desired, and welded or otherwise secured inside the tube. In the longitudinal section of the tube shown in Fig. 8, each vane 46 has a cross section comprising an apex 47 from which curved and diverging sides 48 and 49 depend to the bottom 50 of the vane, which lies in the plane of the slot 43. The wall 48 of one vane is uniformly spaced from the wall 49 of the next vane, leaving therebetween a streamlined passage 52 of uniform width in the plane of Fig. 8. The bottom 50 of the vanes form the slot 43 into a series of uniformly spaced orifices 54.

We claim:

1. Drying machine for sheet material comprising a rotatably mounted drum over which a moist sheet is continuously fed and from which the dried sheet is continuously delivered, a plurality of tubes mounted above said drum and extending transversely of said sheet and arcuately spaced over and close to the upper portion of the surface of said drum, said tubes having outlets to impinge air against said sheet so as to disrupt the vapor and being spaced apart sufficient to allow free escape of vapor-entrained air between the tubes, said tubes being arranged in first, second and third circumferentially sequential groups, means for supplying hot dry air to the first group of tubes toward the delivery side of said drum where the sheet is drier, means for collecting together the least vapor-entrained air from between the tubes of said first group along with the intermediately vapor-entrained air from between the tubes of said second group but unmixed with the most vapor-entrained air from between the tubes of said third group, means for delivering said collected less and intermediately vapor-entrained air to the tubes of said second and third groups, and means for separately collecting and exhausting from the feeding side of the machine the most vapor-entrained air from between the tubes of said third group.

2. Drying machine for sheet material comprising a rotatably mounted heated drum over which a moist sheet is continuously fed and from which the dried sheet is continuously delivered, a plurality of tubes mounted above said drum and extending transversely of said sheet and arcuately spaced over and close to the upper portion of the surface of said drum, said tubes having outlets to impinge air against said sheet so as to disrupt the vapor and being spaced apart sufficient to allow free escape of vapor-entrained air between the tubes, said tubes being arranged circumferentially in sequence, a partition dividing the tubes toward the delivery side of the drum where the sheet is drier from those toward the feeding side

where the sheet is wetter, header means for supplying hot dry air to at least a part of said delivery side tubes, hood means for collecting the less vapor-entrained air from between said delivery side tubes unmixed with the more vapor-entrained air from between said feeding side tubes, header means for delivering at least a part of said separately collected unmixed less vapor-entrained air to said feeding side tubes, and hood means for separately collecting and exhausting from the machine the more vapor-entrained air from between said feeding side tubes, at least one of said header means comprising a pair of headers, said header supplied tubes each being connected to its header at one end and closed at the other, said tubes having cross sections with portions concave toward the drum and having a radius of curvature uniformly decreasing longitudinally from their header ends toward their closed ends to avoid drop in pressure and provide substantially uniform velocity for their outlets throughout the lengths of the tubes.

3. Drying machine for sheet material comprising a rotatably mounted heated drum over which a moist sheet is continuously fed and from which the dried sheet is continuously delivered, a plurality of tubes mounted above said drum and extending transversely of said sheet and arcuately spaced over and close to the upper portion of the surface of said drum, said tubes having outlets to impinge air against said sheet so as to disrupt the vapor and being spaced apart sufficient to allow free escape of vapor-entrained air between the tubes, said tubes being arranged circumferentially in sequence, a partition dividing the tubes toward the delivery side of the drum where the sheet is drier from those toward the feeding side where the sheet is wetter, header means for supplying hot dry air to at least a part of said delivery side tubes, hood means for collecting the less vapor-entrained air from between said delivery side tubes unmixed with the more vapor-entrained air from between said feeding side tubes, header means for delivering at least a part of said separately collected unmixed less vapor-entrained air to said feeding side tubes, and hood means for separately collecting and exhausting from the machine the more vapor-entrained air from between said feeding side tubes, at least one of said header means comprising a pair of headers, said header supplied tubes being connected to their headers at one end and closed at the other, said tubes decreasing in cross section from their header ends toward their closed ends, said headers being located at opposite ends of said drums with the closed ends of their tubes toward each other and alternately interfitting, whereby a greater number of tubes are mounted in a given arc of a circumference around said drum while maintaining their spacing apart sufficient to allow free escape of vapor-entrained air between the tubes.

4. Drying machine for sheet material comprising a rotatably mounted heated drum over which a moist sheet is continuously fed and from which the dried sheet is continuously delivered, a plurality of tubes mounted above said drum and extending transversely of said sheet and arcuately spaced over and close to the upper portion of the surface of said drum, said tubes having outlets to impinge air against said sheet so as to disrupt the vapor and being spaced apart sufficient to allow free escape of vapor-entrained air between the tubes, said tubes being arranged circumferentially in sequence, a partition dividing the tubes toward the delivery side of the drum where the sheet is drier from those toward the feeding side where the sheet is wetter, header means for supplying hot dry air to at least a part of said delivery side tubes, hood means for collecting the less vapor-entrained air from between said delivery side tubes unmixed with the more vapor-entrained air from between said feeding side tubes, header means for delivering at least a part of said separately collected unmixed less vapor-entrained air to said feeding side tubes, and hood means for separately collecting and exhausting from the machine the more

5

vapor-entrained air from between said feeding side tubes, at least one of said header means comprising a pair of headers, said header supplied tubes being connected to their headers at one end and closed at the other, said tubes being tapered longitudinally and having cross sections with their lower sides converging toward their outlets to effect streamline flow thereto.

5. Drying machine for sheet material comprising a rotatably mounted heated drum over which a moist sheet is continuously fed and from which the dried sheet is continuously delivered, a plurality of tubes mounted above said drum and extending transversely of said sheet and arcuately spaced over and close to the upper portion of the surface of said drum, said tubes having outlets to impinge air against said sheet so as to disrupt the vapor and being spaced apart sufficient to allow free escape of vapor-entrained air between the tubes, said tubes being arranged circumferentially in sequence, a partition dividing the tubes toward the delivery side of the drum where the sheet is drier from those toward the feeding side where the sheet is wetter, header means for supplying hot dry air to at least a part of said delivery side tubes, hood means for collecting the less vapor-entrained air from between said delivery side tubes unmixed with the more vapor-entrained air from between said feeding side tubes, header means for delivering at least a part of said separately collected unmixed less vapor-entrained air to said feeding side tubes, and hood means for separately collecting and exhausting from the machine the more vapor-entrained air from between said feeding side tubes, at least one of said header means comprising a pair of headers, said header supplied tubes being connected to their headers at one end and closed at the other, said tubes being tapered longitudinally and having cross sections with lower sides converging toward the drum to effect streamline flow and further flared divergently to reduce orifice loss.

6. Drying machine for sheet material comprising a rotatably mounted heated drum over which a moist sheet is continuously fed and from which the dried sheet is con-

6

tinuously delivered, a plurality of tubes mounted above said drum and extending transversely of said sheet and arcuately spaced over and close to the upper portion of the surface of said drum, said tubes having outlets to impinge air against said sheet so as to disrupt the vapor and being spaced apart sufficient to allow free escape of vapor-entrained air between the tubes, said tubes being arranged circumferentially in sequence, a partition dividing the tubes toward the delivery side of the drum where the sheet is drier from those toward the feeding side where the sheet is wetter, header means for supplying hot dry air to at least a part of said delivery side tubes, hood means for collecting the less vapor-entrained air from between said delivery side tubes unmixed with the more vapor-entrained air from between said feeding side tubes, header means for delivering at least a part of said separately collected unmixed less vapor-entrained air to said feeding side tubes, and hood means for separately collecting and exhausting from the machine the more vapor-entrained air from between said feeding side tubes, at least one of said header means comprising a pair of headers, said header supplied tubes being connected to their headers at one end and closed at the other, and longitudinally curved guiding vanes inside said tubes convergent in the direction of flow to facilitate streamlined flow toward their outlets.

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