April 18, 1967 O. G. HAYWOOD 3,314,162

PAPERMAKING APPARATUS

Filed Oct. 19, 1965

FIG. 1

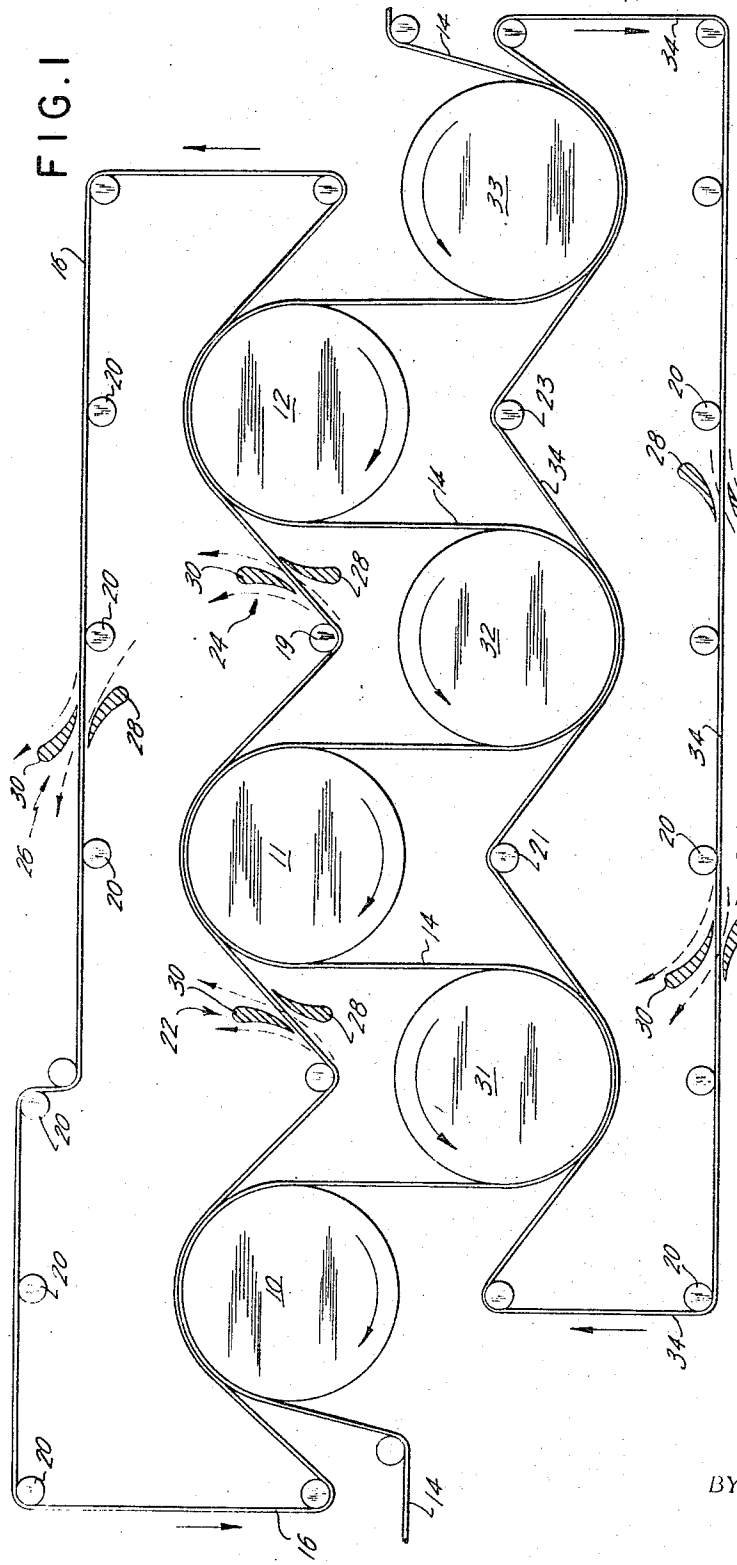


FIG. 3

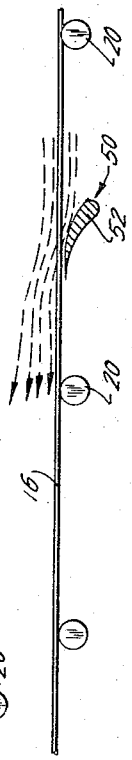


FIG. 2



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PAPERMAKING APPARATUS

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This invention relates to the manufacture and processing of paper and, more particularly, is concerned with improved apparatus which is useful in the dryer section of machinery on which continuous webs of "paper," meaning pulp, paper, paperboard, or other materials which are paperlike in form, may be made.

A typical continuous papermaking machine on which the invention taught herein may be practiced is the so-called Fourdrinier machine, which usually consists of three sections: the forming section, the press section, and the dryer section. In the forming section, an aqueous suspension of fibers is flowed onto an endless belt made from metal or synthetic filaments, and most of the water is removed therefrom by the use of well-known water extraction devices, such as foils, table rolls, and suction boxes. The continuous web formed thereby is then transferred to and passed through a series of nips formed by press rolls, which serves to remove additional water from the web and to compact it. Finally, the web is passed upward and downward over a series of heated dryer rolls or cylinders which are arranged parallel to each other in top and bottom arrays, for the purpose of further reducing its moisture content to the extent desired. In addition to effecting drying by the application of heat to the web, such dryer rolls may be made with a gas pervious roll surface through which air or other suitable drying media may be forced.

As the formed web of paper comes into sequential contact with the heated dryer rolls, it is pressed against each such dryer roll by means of one or more endless backing fabrics, which are usually referred to as "dryer fabrics" or "dryer felts," in order to increase the heat transfer from the rolls to the paper web, and to perfect the physical properties and characteristics of the finished sheet. Normally, separate dryer fabrics are used for the top and for the bottom dryer rolls. In the past, such dryer fabrics have ordinarily been heavy, relatively impervious, blanket-like structures called "dryer felts." More recently, dryer fabrics of a pervious or porous construction have been used whereby at least some of the moisture liberated from the paper sheet as it is pressed against each dryer roll can pass directly through such dryer fabric. Typically, such fabrics may be of woven construction, but may also be sheet-like belts which have been perforated, or other suitable structures. Preferably, such fabrics, belts, or structures are made from natural and/or synthetic materials, such as polymer resins, which are moisture resistant and substantially stable, physically and chemically, at the temperatures to which they are raised in the dryer section of the paper machine. Such temperatures usually are at least 50° F. less than the maximum temperature of the dryer rolls which, in current practice, rarely exceed 425° F. Such fabrics, belts, or structures are made "endless," which is to say, into the form of a closed loop, by being woven endless by the tubular weaving techniques which are well-known in the art of fabricating papermaker's fabrics, or by being woven flat and later having ends joined together by means of clipper hooks and pintle yarns, sewn seams, adhesives, ultrasonic sealing in the case of plastic sheet-like belts, or other well-known joining techniques.

Regardless of the exact structure used, such a dryer fabric will, as it moves along its endles path, cause at least that layer of the air, steam, or other gas which is immediately adjacent to the fabric to be "entrained" or carried along by it. The physical characteristics of the entrained layer of air are readily determinable by well-known techniques. In general, it may be said that those gas molecules which are in direct contact with the fabric will move at or nearly at the speed of the fabric, but that the entrainment effect diminishes rapidly at positions incrementally removed from either surface of the fabric, so that the layer which is effectively entrained normally is relatively thin. It may also be shown that the thickness of the entrained layer is a function of the speed of the fabric and, to a greater extent, to the "roughness" or degree of surface irregularity of the fabric. In view of the latter consideration, it will be apparent that since dryer fabrics are usually made pervious by "opening" the weave of a woven fabric or by eliminating elements of the structure (e.g. needled batts of staple fibers from "needled" felt structures) which are intended to smooth out the surface or surfaces of the fabric, such pervious fabrics usually will, by entrainment, effect a deeper layer of movement in the adjacent gas than will the blanket-like felts heretofore referred to.

Regardless of which type of dryer fabric is employed, however, there is a tendency for the steam and/or moisture-laden air which is generated as a result of the drying process to become entrapped on one or both sides of the dryer fabrics at various points along their paths of travel. This is especially so where tent-like "pockets" are formed by the various elements normally present in the dryer section of the papermaking machine. One such group of pockets is formed where a top dryer fabric is supported by rolls along its return run back toward the forward or web receiving end of the dryer section. Another group of such pockets is formed directly below each of the top dryer rolls, and directly above each of the bottom dryer rolls; each such pocket being an open-ended, substantially tubular enclosure extending in the cross-machine direction, directly below each such top roll or above each such bottom roll as the case may be, and being bounded by the roll itself, the web of paper on each side of the enclosure, and the dryer fabric opposite the roll in question. Still another such group of pockets is formed where a bottom dryer fabric is supported by fabric rolls positioned between the bottom dryer rolls.

Such moist air and steam must, of course, be removed continually, in order to ensure that the moisture content of the web may be controlled and to promote the efficiency of the drying process. This is usually accomplished by forcing air transversely through the dryer section using suitably positioned blowers, and by drawing air from the general area of the dryer section with overhead exhaust fans. However, the effectiveness of these removal procedures is not entirely satisfactory for a number of reasons, among which are the resulting uneven temperature and moisture profiles across the web. It is readily apparent, therefore, that improvement in such removal procedures is desirable and presently needed.

It has now been found that the removal of such moist air and steam from the dryer section of a continuous paper-making machine utilizing one or more pervious dryer fabrics can be materially facilitated. This objective is achieved in accordance with this invention by providing a vane or vanes extending across the width of such dryer fabric at one or more desired locations and within the layer or layers of gas entrained by the fabric, and disposing such vane or vanes at an angle with respect to the dryer fabric such that, acting in concert with the gas entrained by the moving fabric so as to set up a zone of altered air pressure along at least one side of each such vane, a pressure drop from one side to the other side of such dryer fabric will be created, thereby inducing a transfer of gas, including steam and/or moisture-laden air,

from one side of the dryer fabric through the fabric to its other side.

The arrangement provided by the present invention may take any of several specific forms of embodiment. For example, a vane may be positioned on one side of the dryer fabric and disposed with respect thereto at an angle *diverging* from the direction of movement of the dryer fabric, so that air entrained by the dryer fabric moving past the vane will induce a *decrease* of pressure in the zone between the vane and the dryer fabric. Alternatively, the vane may be positioned on one side of the fabric and disposed with respect thereto at an angle *converging* toward the direction of movement of the dryer fabric, so that air entrained by the dryer fabric moving past the vane will induce an *increase* of pressure in the zone between the vane and the dryer fabric. In either case, the resulting pressure gradient across the dryer fabric causes at least a portion of the gas on the one side of the dryer fabric to flow *through* the fabric to the other side.

Advantageously, a converging vane positioned on one side of the dryer fabric as indicated above is utilized in conjunction with a diverging vane positioned on the other side of the dryer fabric, also as indicated above. The two vanes in such case may be so situated with respect to each other than the area of decreased pressure created on one side of the dryer fabric by the diverging vane acts in concert with the area of increased pressure created on the other side of the dryer fabric by the converging vane; the zone of decreased pressure tending to pull gas through the fabric while the zone of increased pressure tends to push gas through the fabric at the same time. It has been found that one way to enhance such a concerted action of two vanes is to position the diverging vane so that, using as a reference the direction of travel of the moving fabric, its point of divergence from the fabric is slightly ahead of the point of convergence of the other vane with the fabric, thereby causing gas in the zone of increased pressure to flow through the fabric directly into the zone of decreased pressure on the opposite side of the fabric.

According to this invention, such vane or set of vanes may be located at any point or points along the path traversed by a dryer fabric where it is desired to effect a flow of gas, such as moisture-laden air or steam, through the dryer fabric from one side to the other thereof. For example, such a vane or set of vanes can be utilized in conjunction with a dryer fabric at any location along its return run back to the forward end of the dryer section, to move gas upward through a top fabric (which backs the web against the top periphery of each top dryer roll) or to move gas upward or downward through a bottom fabric (which backs the web against the bottom periphery of each bottom dryer roll). In addition, a plurality or series of two or more single vanes or sets of vanes may be used wherever appropriate.

Such vanes may have a flat, curved, or polyhedral surface facing the dryer fabric as desired and, obviously, the remaining surfaces may be made to assume any shape. Desirably, however, the vane is made in the shape of an airfoil with a convexly curved surface facing the dryer fabric. Generally, vanes may be formed from any suitable metal, although they may also be made from a wide variety of other materials, such as plastic, wood, or fiberglass, preferably possessing high heat and moisture resistance.

It also will be apparent to those skilled in the art that while the descriptions set forth herein are directed toward webs of paper, pulp, or paperboard, the principles of this invention may be practiced in a wide variety of applications where it is desired to transfer a gaseous medium from one side to the other of a moving pervious sheet, such as a fabric, used in processing materials as, for example, in paper-coating processes.

The invention will now be described in detail in connection with the accompanying drawings, in which:

FIG. 1 is a diagrammatic view of a portion of the dryer section of a continuous paper-making machine provided with several installations of the preferred embodiment of this invention;

FIG. 2 is a diagrammatic view of a portion of the return run of fabric in a dryer section of a paper-making machine which has been provided with an installation of another embodiment of this invention; and

FIG. 3 is a diagrammatic view of a portion of the return run of fabric in a dryer section of a papermaking machine which has been provided with an installation of still another embodiment of this invention.

The dryer section partially shown in FIG. 1 includes a plurality of horizontally disposed top dryer rolls **10**, **11**, **12**, and bottom dryer rolls **31**, **32**, **33**; all of which are rotatable and, usually, heated. The continuously formed web **14** is successively passed between the top and bottom dryer rolls for the purpose of driving off residual moisture from the web to a predetermined extent. Means (not shown) are provided for rotating such dryer rolls in unison so that the continuous web **14** can be moved through the dryer section without breaking. In addition, other means (not shown) are provided for controllably admitting steam or some other suitable heating medium into the dryer rolls in order to furnish the heat utilized to effect the desired drying of the web. The surfaces of such rolls which come in contact with the web may optionally be made from porous material such as sintered metal fibers, or sintered powder metal, or fused glass, or thermoplastic or thermosetting material, through which gas may be blown or sucked.

Movable in conjunction with the web and arranged to press such web against at least the top portion of each of the top dryer rolls **10**, **11**, **12** is an endless, porous, top dryer fabric **16**. As indicated in FIG. 1, such dryer fabric passes under rotatable fabric rolls **18**, **19** positioned between each pair of dryer rolls somewhat below the center of rotation of each such dryer roll, so that good contact between the continuous web **14** and the successive top dryer rolls is assured. On the return run (shown in the upper portion of FIG. 1), the dryer fabric **16** passes over (or under as required) a plurality of rotatable return rolls **20**. Means (not shown) may be provided for rotating one or more of the fabric rolls and/or one or more of the return rolls as may be necessary to insure proper movement of the endless dryer fabric. Similarly, the bottom dryer rolls **31**, **32**, **33** are operated in conjunction with a bottom backing fabric **34**, positioned below the bottom dryer rolls, which also is supported by fabric rolls **21**, **23** positioned between the bottom dryer rolls, and by return rolls **20**.

The result of the successive passage of the continuous web **14** around and in contact with the dryer rolls is the generation of steam, causing liberation of the moisture from the web. A portion of such generated steam escapes through the porous dryer fabric while the web **14** is held in contact with each dryer roll by the dryer fabric. The remainder of such generated steam escapes as the continuous web is removed from intimate contact with the surface portion of each dryer roll. In the former case, such steam tends to accumulate, for example, in the area under the return run portion of the endless dryer fabric **16**, and in the pockets formed by the bottom fabric **34** and the fabric rolls **21**, **23**; and in the latter case pockets of steam tend to form, for example, in the pockets formed above and below the dryer rolls by the dryer fabric, the web of paper, and the several dryer rolls. Of course, a certain amount of migration of such steam as well as heated, moisture-laden air upward through the various layers of dryer fabric takes place by natural convection. However, in order to accelerate expulsion of such steam as it accumulates, means (not shown), such as fans, may be provided for causing air to move transversely through the dryer section, and other means (not shown) may be provided for exhausting steam and/or moisture-laden air from the general region of the dryer section.

In accordance with the invention, such steam removal is aided by the provision of one or more arrangements to facilitate the passage of moist air through a porous dryer fabric at points along its path of travel where it is not pressing the web into intimate contact with a dryer roll. Any number of such arrangements may be installed in a given dryer section as its layout permits, and such arrangements may take any of several forms of embodiment, as previously indicated.

The five arrangements, **22**, **24**, **26**, **35**, and **38** shown in FIG. 1 are similar and comprise the preferred form of embodiment of the invention. As will be apparent, arrangement **22** is associated with the top dryer fabric **16** about midway between fabric roll **18** and dryer roll **11**; arrangement **24** is similarly associated with the top dryer fabric **16** about midway between fabric roll **19** and dryer roll **12**; arrangement **26** is associated with the top dryer fabric **16** along its return run portion; and arrangements **35** and **38** are associated with the bottom dryer fabric **34** along its return run portion. Each such arrangement comprises a vane **28** positioned adjacent to one side of one of the dryer fabrics and extending in the cross-machine direction thereof, and a vane **30** located near the vane **28** and positioned adjacent to the opposite side of the same dryer fabric therefrom, and also extending in the cross-machine direction.

It will be understood that, as used in this specification with regard to the position of the vane devices described herein with respect to the dye fabric with which each is associated, "adjacent to" means at least partially within the layer of gas effectively entrained by the moving dryer fabric.

Each vane **28** is disposed with respect to the backing fabric at an angle *converging* in the direction of movement of such dryer fabric. In other words, each vane **28** is so positioned that its leading edge (i.e. the edge *facing* toward the direction from which the fabric is coming) is remote from the dryer fabric and its trailing edge (i.e. the edge facing in the direction toward which the fabric is moving) is closely adjacent to the dryer fabric. As a result, the entrained layer of air moving along with one of the surfaces of the dryer fabric interacts with the converging vane **28** to produce an *increase* of pressure in the zone between such vane and the dryer fabric.

Each vane **30** is disposed with respect to the dryer fabric at an angle *diverging* in the direction of movement of such dryer fabric. That is to say, each vane **30** is so positioned that its leading edge is closely adjacent to the dryer fabric and its trailing edge is remote from the dryer fabric. As a result, the entrained layer of air moving along with the other of the surfaces of the dryer fabric interacts with the diverging vane to produce a *decrease* of pressure in the zone between such vane and the dryer fabric.

The net effect of both the diverging vanes **30** and the converging vanes **28** is to set up a pressure gradient from one side of the dryer fabric to the other side thereof. As a consequence, gas, such as moist air and/or steam, on one side of the dryer fabric is caused to flow therethrough. It should be noted that in each of the embodiments illustrated in FIG. 1, the converging vane **28** was positioned so that its trailing edge was slightly behind the location of the leading edge of its associated diverging vane **30**. By this means, gas may be moved from the zone of increased pressure created by the interaction of each converging vane **28** with the moving fabric directly into the corresponding zone of decreased pressure created behind its associated diverging vane **30**. In the case of arrangements **22** and **24**, moist air is moved from the steam pockets formed by the top dryer fabric **16** and the paper web with dryer rolls **31** and **32** respectively into the region immediately above such top dryer fabric **16** and the dryer rolls **11**, **12**, from whence it can more readily be blown transversely out of the dryer section by fans or other means, or transferred upward through fabric **16** on its return run. Similarly, in the case of arrangement **26**, the moist air is moved from the area of accumulation below the return run of the top dryer fabric **16** into the region above such return run, from whence it can much more readily be exhausted.

In arrangement **35**, relatively cool and/or dry air is moved from below the return run of the bottom dryer fabric **34** through the fabric into the zone enveloped by the fabric **34**. The effect of this is to replace the steam and moisture-laden air entrapped in that zone after liberation from the web **14** through the fabric **34** as they pass together over the surfaces of the bottom dryer rolls **31**, **32**, **33**. Such replaced steam and moisture-laden air will be forced outward from the zone of entrapment both ways in the cross-machine direction, and also will be forced upward through the fabric **34** from the pockets formed by the fabric **34** as it passes over the fabric rolls **21**, **23** into the pockets formed by the top dryer rolls **11**, **12** with the paper web and the bottom fabric **34**, from whence it may be moved outward both ways from such pockets in the cross-machine direction by fans or other propelling means.

It will be noted that in all of the heretofore discussed arrangements **22**, **24**, **26**, **35**, the natural tendency of the steam and/or moisture-laden warmed air to move upward through the layers of fabric has supplemented the dynamic effect of each such arrangement. Arrangement **38** demonstrates how the principles of this invention may be used advantageously to counteract such a natural tendency of relatively warm or hot gas to rise through convection, in order to deal more effectively with the problems heretofore discussed. In arrangement **38**, in contrast to arrangements **22**, **24**, **26**, **35**, the converging vane **28** is positioned adjacent to the *upper* surface of the fabric **34**; that is, the surface toward which air would naturally tend to move by convection. Diverging vane **30** is positioned adjacent to the lower surface of the fabric **34**, with its leading edge slightly ahead of the point at which the converging vane **28** would converge with the fabric **34**. The effect of this arrangement is to overcome the natural tendency of hot air to move upward through the fabric **34** by convection, to a point where steam or hot moisture-laden air, for example, in the enclosure formed by its backing fabric **34** actually will be moved downward through the fabric to its underside, from whence it may be exhausted away from the dryer area by fans or other means.

It will be apparent that a similar arrangement might be used to advantage at other points. Thus, by utilizing such an arrangement of vanes, for example, between bottom fabric roll **21** and the point of contact of the backing fabric **34** with bottom dryer roll **32**, steam and/or moisture-laden air may readily be removed downward from the pocket formed by the bottom dryer fabric **34**, the web **14**, and the top dryer roll **11**. Conversely, the vanes could be arranged at this point to transfer steam and/or moisture-laden air upward from the pocket below roll **21** to the pocket above roll **21**. As will be clear, then, each of the arrangements heretofore described exerts a positive acceleration on the steam or moisture-laden air being removed from the continuous web as it passes through the dryer section, and facilitates removal of such air from the dryer section region.

The individual effect of such diverging and converging vanes is illustrated respectively in FIGS. 2 and 3; each of which in itself constitutes another useful embodiment of this invention. Arrangement **41** is shown in FIG. 2 as being associated with a top dryer fabric **16** along its return run portion, although it could obviously be associated with a bottom dryer fabric too. Arrangement **41** is comprised of the vane **42** positioned on the top side of the dryer fabric and extending in the cross-machine direction thereof. Like vane **30** of arrangement **26** shown in FIG. 1, vane **42** is disposed with respect to the dryer

fabric at an angle *diverging* therefrom in the direction of movement of such dryer fabric. The effect is also similar in that ambient gas entrained by the dryer fabric moving past vane 42 creates a zone of decreased pressure between such vane and the dryer fabric, with the result that gas, such as moist air or steam, on the under side of the backing fabric is caused to flow therethrough. Obviously such a diverging vane might be positioned on the *underside* of a top or a bottom dryer fabric to cause gas to be moved through the fabric from the upper to the underside thereof in the fashion of vane 30 in arrangement 38 in FIG. 1.

Arrangement 50 is shown in FIG. 3 as being associated with a top dryer fabric 16 along its return run portion, although it too could be associated with a bottom dryer fabric, as will be apparent from the discussion which follows. Arrangement 50 comprises a vane 52 positioned on the underside of the dryer fabric and extending in the cross-machine direction thereof. Like vane 28 of arrangement 26 shown in FIG. 1, vane 52 is also disposed with respect to the dryer fabric at an angle converging in the direction of movement of such dryer fabric. Again, a similar effect is obtained in that air entrained by the dryer fabric moving past vane 52 creates a zone of increased pressure in the area between such vane and the dryer fabric, with the result that gas, such as moist air or steam, on the underside of the dryer fabric is also caused to flow therethrough. It will also be obvious that such a converging vane might be positioned on the top side of a bottom or top dryer fabric to cause gas to be moved through the fabric from the upper to the underside thereof in the fashion of vane 28 of arrangement 38 in FIG. 1. It will be readily apparent that single vane embodiments, such as those discussed heretofore in connection with arrangements 41 and 50, are by no means confined, in their utilization, to any particular location along the path of travel of the dryer fabric with which they are associated, but may be used to advantage at many different points along such paths of travel, including locations between the dryer and fabric rolls. It will also be apparent that single vane embodiments may be advantageously used in groups of several such single vanes each, with the vanes in each group arrayed in proximity and in parallel to each other along one surface of a given fabric.

It should be understood that the terms, and expressions used herein and the embodiments which have been illustrated and discussed are by way of illustration, but not of limitation, of the principles of this invention, and that this invention may be practiced in a wide variety of papermaking and processing apparatus, as well as other machinery by persons skilled in the art.

I claim:

1. In an apparatus for drying a continuous sheet of material, an endless pervious belt movable in conjunction with said sheet and arranged to press said sheet against the drying means in said apparatus, and two vanes positioned in proximity to each other but on opposite sides of said belt from each other, each of said vanes having an elongated surface positioned adjacent to said belt at desired locations along the path of travel of said belt where it is not in contact with said sheet with the long dimension of each such elongated surface oriented substantially in the width direction of said belt, one of the long edges of said surface of each of said vanes residing within the mass of gas entrained by said belt when it is in motion, the distance between the belt and each of said elongated surfaces of said vanes increasing at positions which are progressively removed from each of said edges along a line which is parallel to the path of travel of said belt.

2. The device described in claim 1 wherein, in the direction of motion of said belt, the elongated surface of one of said vanes converges toward the surface of said belt toward which it faces, and the elongated surface of the other of said vanes diverges away from the surface of said belt toward which it faces.

3. The device described in claim 2 wherein the point of convergence of said converging vane with said belt is slightly further along the path of travel of said belt than the point of divergence of said diverging vane from said belt.

4. The device described in claim 3 wherein the belt is made from material which is characterized by resistance to moisture and by being substantially chemically and physically stable at temperatures in the range which said belt encounters along its path of travel through said apparatus.

5. The device described in claim 4 wherein the belt is a woven fabric.

6. The device described in claim 4 wherein said vanes are air-foil shaped with the convexly curved surface of each facing toward said belt.

7. In an apparatus for drying a continuous fibrous web, an endless pervious belt movable in conjunction with said web and arranged to press said web against each of the drying means in said apparatus seriatim, and a vane extending substantialy in the direction of the width of said belt adjacent to one surface thereof at a desired location along the path of travel of said belt where it is not in contact with said web, said vane having a surface which faces said surface of said belt one of the long edges of which vane surface faces the direction from which said belt moves along its path of travel through said apparatus, said edge being positioned within the mass of gas entrained by said belt as it moves, said surface of said vane diverging from said surface of said belt in the direction of motion of said belt, whereby said vane acting in concert with the gas entrained by said belt as it moves along its path of travel will induce a reduction of pressure in the zone between said surface of said vane and said belt causing gas to migrate through said belt.

8. The device described in claim 7 wherein said belt is made from material which is characterized by resistance to moisture and by being substantially physically and chemically stable at temperatures in the range which said belt encounters along its path of travel through said apparatus.

9. The device described in claim 8 wherein said belt is a woven fabric.

10. The device described in claim 8 wherein said vane is air-foil shaped and said surface facing said belt is convexly curved.

11. In an apparatus for drying a continuous fibrous web, an endless pervious belt movable in conjunction with said web and arranged to press said web against each of the drying means in said apparatus seriatim, and a vane extending substantially in the direction of the width of said belt adjacent to one surface thereof at a desired location along the path of travel of said belt where it is not in contact with said web, said vane having a surface which faces said surface of said belt one of the long edges of which vane surface faces the direction toward which said belt normally moves along its path of travel through said apparatus, said edge being positioned within the mass of gas entrained by said belt as it moves, said surface of said vane converging toward said surface of said belt in the direction of motion of said belt, whereby said vane acting in concert with the gas entrained by said belt as it moves along its path of travel will induce an increase of pressure in the zone between said vane and said belt causing gas to migrate through said belt.

12. The device described in claim 11 wherein said belt is made from material which is characterized by resistance to moisture and by being substantially physically and chemically stable at temperatures in the range which said belt encounters along its path of travel through said apparatus.

13. The device described in claim 12 wherein said belt is a woven fabric.

14. The device described in claim 12 wherein said vane is air-foil shaped and said surface facing said belt is convexly curved.

15. In an apparatus for removing liquid from a sheet of material, the combination of a vane, and a belt for positioning said sheet next to the liquid removing means in said apparatus, said belt comprising a closed loop of pervious material, said vane being positioned at a location along the path of travel of said belt where said belt is not in contact with said sheet, said vane having an elongated surface facing one surface of said belt which vane surface is oriented with its long axis at substantially right angles to the path of travel of said belt, one of the long edges of said surface of said vane being substantially parallel to said surface of said belt and positioned within the mass of gas entrained by said belt as it moves relative to said vane, the distance between said surface of said vane and said surface of said belt increasing at positions which are progressively removed from said edge of said vane along a line which is parallel to the path of travel of said belt.

16. The device described in claim 15 wherein said belt is made from material which is characterized by resistance to moisture and by being substantially chemically and physically stable at least at temperatures which the belt encounters along its path of travel through said apparatus.

17. The device described in claim 16 wherein said belt is a woven fabric.

18. The device described in claim 16 where said belt is made from a synthetic polymeric material.

19. The device described in claim 16 wherein said elongated surface of said vane is convex in cross section.

20. In an apparatus for drying a continuous web of paper which comprises a plurality of horizontally disposed rotatable heated dryer rolls over at least part of the circumference of each of which the formed paper web is passed seriatim in order to drive off moisture therefrom, an endless, pervious heat and moisture resistant, open weave backing fabric movable in conjunction with said web and arranged to press the web against each dryer roll,

and first and second vanes positioned at a desired location along the path of travel of said fabric where it is not in contact with said web, said first vane extending across the width of said backing fabric adjacent to one surface thereof and fixedly disposed with respect thereto at an angle diverging from said backing fabric in the direction of movement of said backing fabric with its leading edge residing within the mass of air entrained by the fabric when it is in motion so as to act in concert with said air and thereby create a decrease in pressure in the zone between said first vane and the backing fabric, said second vane extending across the width of said backing fabric adjacent to the opposite surface thereof from said first vane and fixedly disposed with respect to said fabric at an angle converging toward said backing fabric in the direction of movement of said backing fabric with its trailing edge residing within the mass of air entrained by the fabric when it is in motion so as to act in concert with said air and thereby create an increase in pressure in the zone between said second vane and the backing fabric, said two vanes being so situated with respect to each other that said zone of decreased pressure and said zone of increased pressure act in concert with each other to cause at least a portion of the gas which is adjacent to the side of the backing fabric on which said second vane is located to flow through said fabric to the side thereof on which said first vane is located.

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