

[54] **PAPER FORMATION UTILIZING A LARGE DIAMETER SUCTION ROLL**
[75] Inventor: **Lester M. Hill**, Beloit, Wis.
[73] Assignee: **Beloit Corporation**, Beloit, Wis.
[22] Filed: **Aug. 20, 1973**
[21] Appl. No.: **65,689**

Related U.S. Application Data

[63] Continuation of Ser. No. 680,173, Nov. 2, 1967, abandoned.
[52] U.S. Cl. **162/301, 162/203, 162/214, 162/303, 162/306, 162/317**
[51] Int. Cl. **D21f 1/00, D21f 2/00**
[58] Field of Search **162/203, 303, 214, 306, 162/370, 301**

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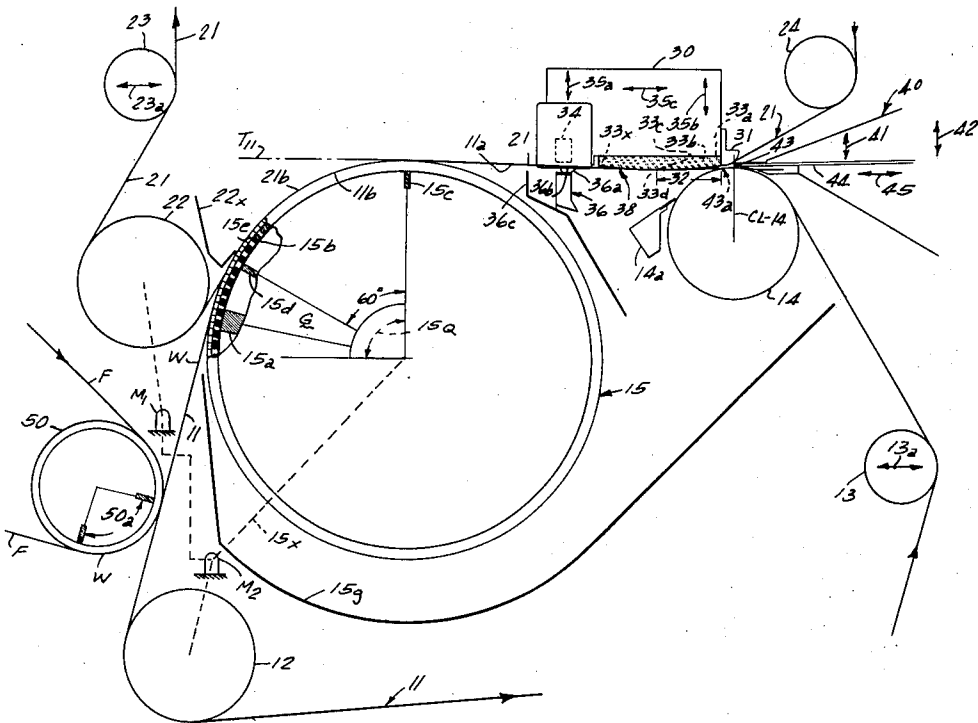
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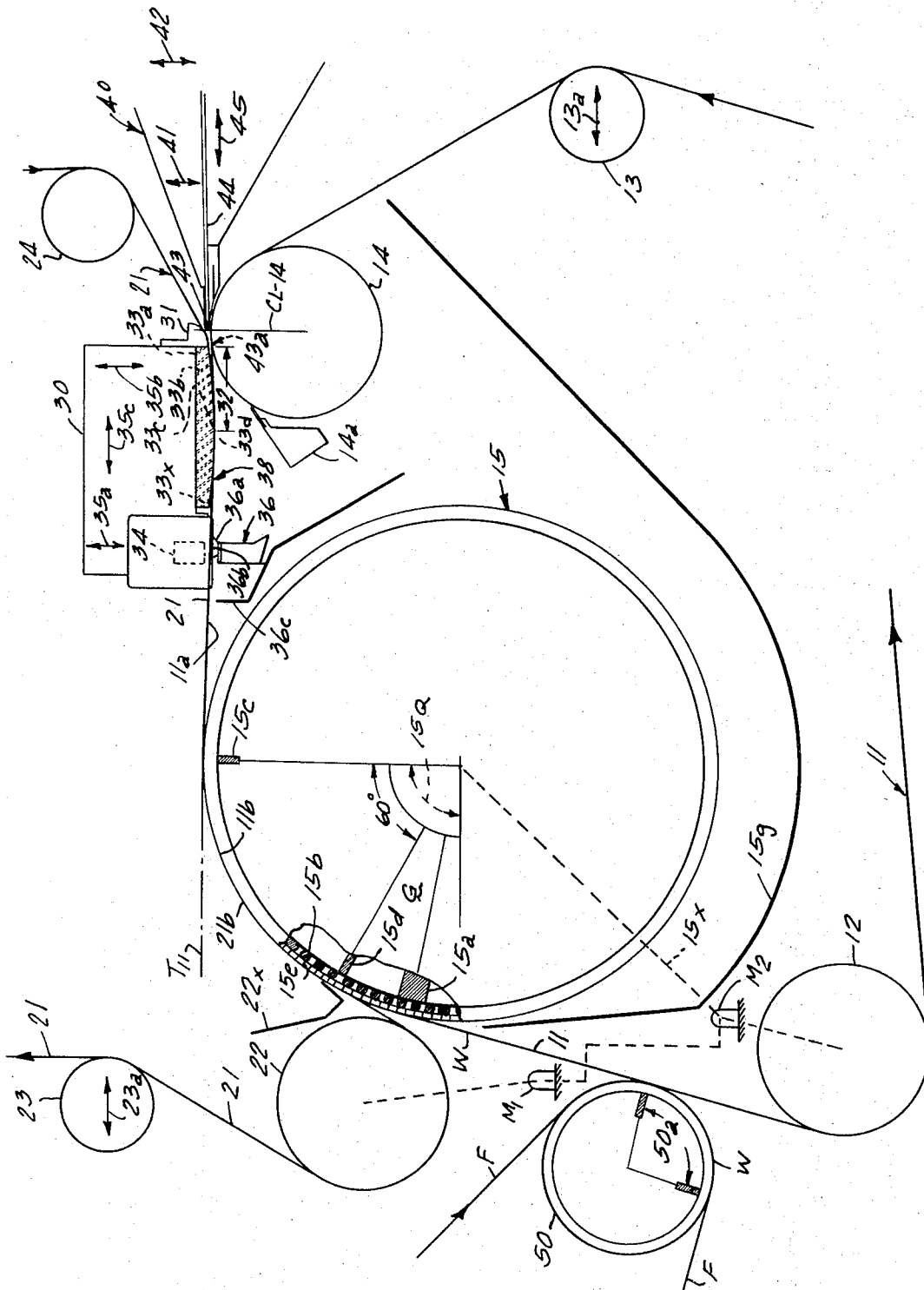
Primary Examiner—S. Leon Bashore
Assistant Examiner—Alfred D'Andrea, Jr.
Attorney, Agent, or Firm—Hill, Gross, Simpson, Van Santen, Steadman, Chiara & Simpson

[57] **ABSTRACT**

This relates to a compact paper making machine wherein the moist web is prepared initially by merging incipient webs formed on a pair of opposed forming wires in a converging forming zone wherein the wires are brought together under controlled conditions for internal pressure control within the zone coupled with rapid water removal; and the moist web thus formed is further rapidly dewatered as it is passed over a large suction roll while sandwiched between the wire runs under sufficient tension to assist in squeezing water out of the web in order to effect rapidly formation of a self-sustaining web in condition for further processing in press and/or dryer sections.

2 Claims, 1 Drawing Figure





INVENTOR.
LESTER M. HILL

BY *Hill, Skorman, Mann, Gable & Simpson*

ATTORNEYS

PAPER FORMATION UTILIZING A LARGE DIAMETER SUCTION ROLL

This is a continuation-in-part application of my U.S. Ser. No. 680,173 filed Nov. 2, 1967, now abandoned.

As the art of paper making has progressed in more recent times, greater operating speeds for the paper making machines have become necessary, in view of such practical considerations as the capital investment involved in paper machines. On the other hand, there has been increasingly greater demand in the trade for high quality paper and the speed-up of many of the prior art paper machines in an effort to meet production demands has resulted in product quality leaving something to be desired.

In more recent developments, detailed studies have been done to develop a greater understanding of the exact nature of the phenomena involved in forming a paper web by deposition of stock fibers on a rapidly moving paper machine forming wire from a very dilute aqueous suspension of these fibers. These studies have produced certain developments including the recognition of a certain so-called non-circular drainage curve which materially aids in predetermining the required drainage conditions for certain relatively well standardized paper stocks. The nomenclature results from the fact that when such a curve is plotted on a graph, it takes the form of an elongated non-circularly contoured convex curve. Paper stocks outside this area appear to require somewhat different drainage conditions and appear to follow drainage curves which may or may not be within the family of curves, of which the non-circular drainage curve is a member. One aspect of the invention resides in using a guide element for the forming wires and which serves to conform the travel path of at least one such wire to a reasonable approximation of such drainage curves. Another aspect of the invention resides in using two opposed forming wires, between which wires formation of a moist paper web is rapidly accomplished under extremely favorable conditions for quality web formation. In the practice of the instant invention, it has been found that a more compact forming arrangement allowing rapid formation and dewatering of a moist web is achieved by combining additional dewatering conditions and equipment in such a way as to effect the ultimate formation of a self-sustaining web which can be processed through the remaining portions of a conventional paper machine, but which web is itself produced in a very compact and simplified paper web forming device.

It is, therefore, an important object of the instant invention to provide an improved compact paper making machine.

Another object of the instant invention is to provide an improved device for rapidly producing good quality paper using a relatively nominal number of operating machine parts and functioning elements.

Another object of the instant invention resides in the provision of a compact paper making machine wherein paper of good quality is formed between a pair of forming wires which are arranged in such device so as to engage in a minimum amount of abrupt directional changes and also a minimum amount of wear on such forming wires, as by virtue of dragging the same over conventional suction boxes or the like devices heretofore used in many paper making machines.

Other and further objects, features and advantages of the present invention will become apparent to those skilled in the art from the following detailed disclosure thereof and the drawing attached hereto.

In the Drawing, it will be seen that a generally schematic elevational view is shown in a preferred arrangement of a paper web forming device for a paper making machine.

Referring to the drawing specifically, it will be seen that there is provided a first looped forming wire or porous forming belt here designated generally by the reference numeral 11. Although the complete run of this looped first forming wire 11 need not be shown herein, it will be seen that the wire 11 travels around a conventional turning roll 12 (and then through a section of travel which is not shown), next over a guide and tensioning roll 13 (with the tensioning indicated schematically by the double-headed arrow 13a); and then over a plain breast roll 14 (sometimes referred to as a first guide) and then over a large suction roll indicated generally at 15 (sometimes referred to as a third guide) which is downstream from or longitudinally displaced from the breast roll 14. There is an active wire run 11a extending generally along a common tangent T-11 for the breast roll 14 and the suction roll 15. Also, there is a portion of the looped forming wire 11 extending just beyond the active portion 11a and wrapping the suction roll 15 for approximately the top down-running quadrant thereof and this portion of the forming wire 11 is designated 11b, which forming wire portion actually engages the surface of the large suction roll 15 in the arrangement here shown.

A second looped forming wire or porous belt 21 is shown partially (at least in connection with the significant portions of the travel of this second forming wire loop 21) traveling around a guide roll 24 then over a foil box 30 (sometimes referred to as a second guide) which causes an active portion 21a of the forming wire 21 to converge with the active run 11a of the first forming wire. The active wire runs 11a and 21a thus brought into convergence travel together until they reach substantially the top of the suction roll 15, at which location a portion 21b of the second wire 21 travels in general parallelism with the previously mentioned portion 11b of the first forming wire over substantially the upper down-running quadrant 15Q of the suction roll 15. Just before reaching the end of such down-running quadrant 15Q, the second forming wire 21 is separated from the suction roll 15 and passes around a turning roll 22 and then about a guide and tension roll 23 (with its tension effecting control indicated by the double-headed arrow 23a). The forming wire 21 then passes through conventional travel (not shown) until it returns again to the guide roll 24.

As indicated schematically at M₁ and M₂ conventional synchronized or interconnected drive means serve to drive the wires 11 and 21 may have substantially the same operating speeds. Preferably there is also a helper drive connection for the suction roll 15 (as indicated diagrammatically at 15x). The drive arrangements for synchronizing a pair of wires and also for helping drive a large operating roll such as the suction roll 15 are known and need not be described in further detail herein. Likewise the conventional auxiliary equipment for tension control indicated schematically at 13a and 23a relates to conventional and well known equipment for carrying out this function. The wiping

doctor 14a shown in operative association with the down-running side of the breast roll 14 is also conventional in structure and is used essentially to keep the breast roll clean in a conventional and well known manner.

With respect to a stock inlet designated generally at 40, it will be appreciated that the inlet 40 itself is not novel per se, but the type of inlet 40 here used involves a substantial housing structure that is mounted on adjustable elements indicated by the double-headed spaced arrows 41 and 42 for limited tilting of the stock jet outlet, i.e., the slice indicated at 43 which is generally aligned with a stock outlet channel indicated essentially schematically at 44. The stock or dilute aqueous suspension of entangled co-moving fibers exits at high speeds from the slice in the form of a high speed substantially uni-directional ribbon-thin jet stream. The direction of such "uni-directional" jet stream is indicated generally by the schematic alignment for the channel 44 shown herein as horizontal (and the adjusting means 41 and 42 accommodate certain limited tilting of this stock jet direction determining channel 44). As will be appreciated other alignments such as angular or vertical may be utilized as desired. The slice opening 43 may thus be at substantially the top of the breast roll 14 (i.e., substantially along the vertical centerline CL-14) as here shown, or the slice outlet 43 may be adjustably moved forward to substantially a location indicated at 43a (which will be shown hereinafter to be approximately at the location at which the foil box 30 is capable of receiving drainage water from the stock through the second wire 21.

The foil box 30 has a convexly curved stationary surface in direct contact with the wire 21 for guiding the wire 21 into initially close spacing with the wire 11 for receiving jet stream thereon. The convexly curved surface of the foil box 30 urges the wires 21 and 11 into immediate convergence with the jet stream therebetween and into a web forming zone 32. This foil box surface can be water-permeable, as shown, or may be water impermeable, i.e., solid, depending on the stock being utilized. Generally, it is preferred to have a water-permeable and non-circulating convexly curved guided surface as shown, however, solid curved guide surfaces are within the scope of the invention.

Referring more specifically to a preferred construction of the foil box 30, attention is directed to the fact that such foil box 30 has substantially the structure and function described in E. J. Justus U.S. Pat. No. 3,382,143, owned by the instant assignee and incorporated herein by reference. Certain aspects of the preferred foil or blade box 30 should be considered in connection with the present invention. First of all, the box 30 carries on its forward end a solid water impermeable curved shoe 31 which functions as a guide for the on-coming second forming wire 21 so that the wire 21 may be guided smoothly into the forming zone, indicated schematically and approximately by the dimension 32. In the forming zone 32 the active portion 21a of the second wire 21 is brought into controlled gradual convergence with the active portion 11a of the first forming wire 11. This is done by first passing the second forming wire over the curved solid shoe portion 31 and then passing the active wire portion 21a over a plurality of longitudinally closely spaced transversely extending blades which are aligned substantially as indicated at 33a, 33b, 33c, etc. on down to the end at 33x of the

active face for the foil box 30. The second wire 21 is operated at sufficient tension establish a travel path for the active wire portion 21a over the blades 33a, 33b, etc. which will resemble a plurality of short chords. The blades 33a, 33b, etc. actually define very narrow transverse wire contacting edge portions which will guide the travel of the active wire portion 21a and cause the same to converge with the first active wire portion 11a in accordance with a predetermined drainage curve for the particular stock or aqueous suspension that is to be used in the paper formation process employed in the present device. It will be understood that the box 30 is equipped with a rear side takeoff indicated schematically at 34 for drawing off water and air and maintaining substantially a subatmospheric pressure within the interior of the box 30 so as to facilitate removal of water from the stock through the active wire portion 21a, up over the internal blades 33a, 33b, etc. and on out through the side takeoff 34. By such an arrangement there is a predetermined and controlled ability for the box 30 to remove water expressed from the stock being fed into the forming zone 32. In the operation of the foil or blade box 30 in the practice of the invention it will be appreciated that this box may be selectively tilted to a limited extent by virtue of adjustable mounting means here indicated by the vertically aligned double-headed arrows 35a and 35b. The box 30 may also be shifted longitudinally or in the machine direction by comparably controls indicated schematically at 35c. The stock inlet 40 may, likewise be shifted to a limited extent along the longitudinal or downstream direction as indicated schematically by the double-headed arrow 45. Controls for adjustably mounting the stock inlet 40 and the foil box 30 are already known and understood and need not be described in greater detail herein, except to note once again that the slice outlet 43 may be advanced longitudinally or downstream to approximately the location 43a for certain purposes in the operation of the instant device. Of course, a solid water-impermeable curved guide surface may also be utilized in place of the just described foil box.

The longitudinal contour of the locii of bottom edges of the blades 33a, 33b, etc. contacting the active wire portion 21a constitutes the contour of the non-circular drainage curve which may be expressed in the formula:

$$H = CD^k$$

wherein H is the distance in inches on an H-line ordinate (starting at the mouth 43) and D is the distance in inches (downstream from the forming zone mouth 43) on a D-line abscissa. As indicated in the arrangement of the present drawing, the abscissa for such curve is in substantial alignment with the active wire run 11a and also with the common tangent line T-11; and H would then be the perpendicular distance therefrom to the active second wire portion 21a starting at the large end of the forming zone 32, i.e., substantially at the mouth thereof indicated at 43a. [As here shown, the jet-stream may travel undisturbed from the centerline CL-14 to such mouth region 43a primarily because drainage through either wire 21, 11 is substantially precluded until the mouth region 43a is reached; or appropriate side seals (not shown) may be used to close in this area so that the jet stream may be fed into the mouth 43a under substantial pressure, and such ar-

rangement also involves a sliding sealing engagement between the inlet 40 and the traveling wires 21, 11.]

In any event, curve: $H = CD^k$ for the preferred active bottom cover for the box 30 in the specific arrangement shown in the drawing may be referenced to the D-line abscissa identified in the previous paragraph; and C may then be a constant within the range of substantially 0.5 to 1.6 and k is the negative exponent ranging from substantially -0.2 to -0.8 . In the case of a pressure loaded sealed slice inlet and/or the desirability of greatly accelerated dewatering in the forming zone, the negative exponent k may be increased (negatively) to as much as -1 to -2 . Hence an overall range for k may be -0.2 to -2 . Also, in actual operation of the machine it is generally found desirable to move the box 30 farther against the wires 11, 21 so that both are deflected and both will wrap the active faces or edges of the foils 33a, 33b, etc. In such instances the constant C may range as low as 0.1 (under such conditions that H represents merely the spacing between the wires 11a, 21a under deflection.

In computing the curve for the active face of the box 30, it will be appreciated that there is less criticality about the curve contour for the initial 0.75 to 1 inch (e.g., as the circularly curved element 31 merges) but the curve contour is important for the next 6 to 8 inches at least (and possibly longer in the case of very slow drainage characteristics in the stock). For reference, one may consider the forming area 32 to extend substantially 8 to 10 inches over all (at which time substantially effective merging of the incipient webs on the wires will take place).

Since, however, the operating structure of this device requires certain reference points on the basis of an adequate ordinate-abscissa reference, to conform the active face of the box 30 to a predetermined drainage curve for a selected paper stock, it should be understood that the abscissa or D-line is a straight line in general longitudinal alignment with the (opposite or) first wire run 11a. On this basis the contour of the active face of the box 30 may readily be determined in terms of the spacing H, always being perpendicular to such reference abscissa or D-line. The value for the constant C may thus be 0.5 to 1.6 and the value for the negative exponent k may then be determined, within the previously recited range, on the bases of the desired operating speeds and pressures, and the physical properties (i.e., freeness, etc.) of the stock selected for use. The shaping of the box cover and/or selective positioning of the thin transverse wire contacting blade edges is thus effected according to the curve already defined. During operation, this elongated non-circular convex curve on the box face will not change, even though the box 30 may be and no doubt will be shifted about to some extent so that the actual numerical value of the spacing (previously H) between the wires may change some. This is true even though such alignment of the box 30 (a) may cause the curve to intersect the initial stock jet-stream direction (as projected from the slice 43); (b) may and preferably does cause deflection of the opposite wire run 11a, and/or (c) may and preferably does cause the opposite wire run 11a to partially wrap the curved box face.

The first active wire run 11a is, of course, permitted to conform as above indicated since it is mounted free from contact with restraining means opposite such forming zone 32, even though such wire run 11a is

maintained under relatively high tension. Such wire run 11a may be supported between the tops of the breast and suction rolls 14, 15; or it may also be given some support by the foil 36. In contrast to the blades 33a, etc. (which terminate abruptly at their off-running sides of preclude a pumping effect) the foil 36 has a smoothly rounded upstream edge 36a and then a top face portion 36b which tapers gradually away from contact with the wire run 11a (at an angle of about 3° to 5°) so as to achieve a substantial off-running pumping effect to assist in dewatering the moist web sandwiched between the wire runs 11a, 21a. Such pumping-dewatering effect is achieved best if the foil 36 actually engages and supports the wire run 11a; but the foil 36 may be mounted in spaced but close-running relation to the wire run 11a and at least be effective in stripping off droplets tending to cling to the bottom of the wire run 11a.

It will be appreciated that the operation of the instant device involves first of all the formation of incipient partial webs on the opposed wire runs 21a and 11a, starting at the large end of the forming zone 32 or zone convergence, as soon as drainage through the wires is permitted, i.e., approximately starting at the mouth indicated at 43a. Such incipient web formation on the opposed wires 11a and 21a continues through the forming zone or zone of convergence 32 until the opposed incipient webs are merged together into an integral substantially uniform moist web in approximately the general region designated by the reference numeral 38 at the off-running or downstream side of the forming zone 32. During the formation of such incipient webs on the opposed forming wire runs 11a and 21a disturbances in connection with such incipient web formation will cause a number of difficulties in operation and ultimate quality defects in the paper formed. In the instant arrangement, however, the blade elements 33a, 33b, etc. are defined so as to have very narrow (in longitudinal dimension) surfaces so that they may contact the forming wire run 21a essentially along a plurality of longitudinally spaced transverse lines of contact. This arrangement results in a minimum of pressure variations at the wire run 21a during the time of such incipient web formation. Likewise the unsupported but tensioned reach of opposed forming wire 11a at the forming zone is not contacted with any elements which might cause pressure variations or fluctuations during the incipient web formation in the forming zone on such wire run 11a. The two wires 11a and 21a are thus merged together near the end of the forming zone 32, i.e., at the converged end, in such condition that they form a substantially uniform and homogeneous moist web which then commences to develop additional internal strength as dewatering continues (by virtue of the tension maintained on the wire run 11a urging the web against the other wire run 21a). This results in a structure wherein the moist web is sandwiched between the two wire-runs 11a and 21a, while such wire runs squeeze against the web to continue to develop strength in the web continued dewatering thereof. By the time this sandwich structure reaches the foil 36, the moist web between the wires 11 and 21 has sufficient internal strength to undergo the pumping action characteristic of the foil 36, which action will effect additional dewatering of the moist web. A save-all indicated schematically at 36c is positioned to receive droplets of water from the underside of the wire run 11a which are driven away

from the underside of the wire run 11a primarily by virtue of the foil 36.

The wires 11 and 21 with the web sandwiched therebetween then continues to travel in substantial parallelism onto the large suction roll 15 and along the upper quadrant 15Q at the down-running side of the suction roll 15. In this arrangement the wire runs are designated 11b and 21b (while traveling in substantial parallelism over the suction roll 15). Just prior to the last sealing strip 15a in the suction roll 15, along the down-running side thereof, it will be noted that the second or top wire 21 is guided away from the suction roll 15 about a turning roll 22 and then back in its return run past the previously described tension roll 23. By so separating the wire 21 from the sandwich structure defined by the two wires with the web W therebetween, it will be noted that the suction area will hold the web W on the first wire 11, which in turn carries the web W away from the suction roll approximately at the last sealing strip 15a in the down-running side. Shortly after the web W is carried away from the suction roll 15 on the wire 11 (which is traveling toward the turning roll 12) the web W is engaged by a pickup felt F wrapping a suction pickup roll 50, which is provided with a suction gland 50a extending from approximately the point of contact of the felt F with the traveling web W. The suction area or suction gland 50a within the suction pickup roll 50 then retains both the felt and the web W carried thereby around the suction roll 50, so that the web may be carried into the subsequent processing sections of the paper machine. The forming wire 11 continues on to the turning roll 12 after the web W has been carried away on the pickup felt F in the manner just described. At this stage in the processing of the moist web W, it will be found that the web W has sufficient strength to be carried away on the pickup felt in the manner shown.

In referring to the manner in which the top wire 21 is separated from the web W and the web in turn is separated from the bottom wire 11 and carried away on the pickup felt F, it will be appreciated that the operations here involved make use of suction first of all to hold the web on the wire 11 when the top wire 21 is separated therefrom and secondly to carry the web W away on the pickup felt F when the web is separated from the wire 11. On the other hand, the travel of the wire elements 11 and 21 and the relative positioning of the suction roll 15 and the suction pickup roll 50 are all such as to afford greatest ease in handling of the web without causing any damage thereto. Additionally, it must be appreciated that the comparatively delicate moist web that is initially formed at the downstream or converged end of the forming zone 32 is carefully protected by being sandwiched between the wire runs 11 and 21 during a certain amount of additional travel and a substantial amount of effective dewatering of this comparatively delicate moist web so that it is capable of functioning without damage thereto during its downward travel on the wire 11 and during its pickup by the pickup felt F. Such dewatering of this initially delicate web is accomplished in the instant compact paper making machine without the necessity of using the conventional substantial number of flat boxes or suction boxes as they are known in the trade. In fact, the wire 11 is so operated under substantial tension in the practice of the instant invention that it is not necessary to engage the wire 11 with any guiding surfaces that are not co-

moving therewith. The foil 36 does not have to contact the wire run 11a, as previously mentioned, but if it does contact the wire run 11a this will be the only element that is a stationary device that does not present a surface co-moving with the wire 11. It will be appreciated that this type of arrangement for the wire 11, which must operate under high tension for effective use in the instant machine, results in much less wear on the wire 11 and a much greater wire life, which is of considerable importance in the art of paper making.

With respect to the other wire 21, it will be appreciated that this wire also is guided primarily only by guiding surfaces that are co-moving therewith, as in the case of the various rolls 22, 23 and 24. It is true that the wire 21 does pass over the very thin (but stationary) wire guiding blades 33a, 33b, etc. which form the functioning face of the box 30. Nevertheless, there is not as great a necessity for the use of high tension on the wire 21, first of all because the blades 33a, 33b, etc. are so closely spaced longitudinally that they provide excellent support for maintaining the wire 21 in the desired contour of alignment consistent with the drainage curve already described, but also because the wire 21 will have to operate at a tension sufficiently low enough to permit the same to stretch somewhat in its travel as the outside wire portion 21b over the suction roll 15. The tension and stretching effect upon this wire portion 21b is of course useful in squeezing additional water out of the moist web W that is sandwiched between the wire portions 21b and 11b on the suction roll 15. In this respect, however, the wire 21 may be a plastic or fabric wire which can be used to advantage in traveling over the active face of the foil box 30 so as to minimize wear on the wire. For that matter, both of the wires 11 and 21 may be plastic or fabric wires for use in the practice of the instant invention.

Referring now to certain of the more specific aspects of the suction roll 15, it will be noted that the suction roll 15 is comparatively substantial in size as compared to the other rolls used in the instant device and it is capable of presenting an active suction area (approximately covering the entire quadrant 15Q) which is at least about two or three times (in peripheral dimension) greater than the actual longitudinal dimension of the forming zone itself 32. It will be seen that the surface of the suction roll 15 is an open surface which permits maximum water drainage through the wire portion 11b in contact therewith. It will be appreciated that such an open faced suction roll will have much less resistance to water removal through the wire 11b than would be the case for conventional flat boxes or suction boxes as they are used in the trade.

Referring specifically to the outer periphery of the suction roll 15, it will be seen that this roll is constructed from a perforate shell 15b having conventional suction roll perforations therein with the perforations spaced in conventional manner relative to intermediate land areas. The first two suction glands 15c and 15d are shown schematically to designate a suction area of maximum subatmospheric pressure for approximately the first 60° along the down-running side of the roll 15. The sealing strips are shown engaging the inner periphery of the perforate suction roll shell (shown only partially) so as to define an area designated as the "high suction area" wherein maximum water removal is effected from the web traveling in general parallelism sandwiched between the wires 11b and 21b. The dewa-

tering of the web W in this high suction area is not limited or reduced by the comparatively substantial amount of land area which is required to give adequate strength to a normally perforated suction roll shell, for the reason that the extreme outer periphery of the suction roll 15 is provided with what is known as an open roll surface 15e. Such open roll surface 15e is here indicated as a honeycomb structure having a plurality of very thin radially extending walls defining the honeycomb open area and affording maximum volume for water being squeezed out of the web between the wires 11b and 21b. The high suction area is adapted to remove as much of this water from the outer honeycomb structure 15e as is possible in the course of the approximately 60° of travel for the high suction area zone. On the other hand, whatever water may not be removed immediately from the outer honeycomb area of the open roll periphery 15e by virtue of the pressure differential created through the high suction area such water will still be retained within the open roll cells at 15e and will not be thrown back upwardly against the web sandwiched between the wire runs 11b and 21b (since these wires are running over a top portion of the suction roll 15).

Additionally, it will be noted that the turning roll 22 separates the wire reach 21b from the web W carried on the remaining wire reach 11a at approximately the end of the high suction area opposite the sealing strip 15d. Whatever water may have accumulated or be temporarily retained in the open portion 15e of the suction roll 15 beyond the sealing strip 15d is then much more easily drawn into the second suction area G between the sealing strip 15a and 15d. Whatever resistance to withdrawal of water into the gland G that may have been afforded by the presence of the outside wire run 21b is eliminated in this region and any tendency toward rewetting the web W on the wire 11 as the suction roll 15 continues to rotate downwardly is substantially eliminated by virtue of the second suction gland G. It will thus be appreciated that, in the practice of the instant invention, there are definite advantages in passing the sandwich structure of the web W sandwiched between the wires 11 and 21, traveling in substantial parallelism, over the top half of the suction roll 15, because gravity forces tend to assist in removing water from the vicinity of the web W rather than tending to assist in rewetting the web as might be the case in another position.

In an actual comparison of dimensions here indicated, it will be appreciated that the actual forming zone of maximum effectiveness is ordinarily even smaller than the dimension 32 indicated in the present drawing, and it is perhaps in the neighborhood of from 8 to 12 inches for the dimension D, i.e., downstream from the large end of the zone of convergence (i.e., the mouth 43a). In contrast, the large suction roll 15 is of such size that the overall suction areas from the sealing strip 15a to the sealing strip 15c is a dimension of substantially 48 inches which is thus in the neighborhood of some four to six times the downstream dimension of the forming zone itself. As mentioned, the instant 48 inches of overall suction glands is more efficient and more effective for water removal than most flat boxes or suction boxes of the conventional type, not only because of the additional benefit of the squeezing effect of the outside wire 21b but also because of the greatly

reduced total land area in the water receiving outer periphery 15e of this roll.

In summarizing the general nature of the instant subject matter, it might be noted that the instant device uses, in combination, spaced successive first (14), second (30) and third (15) guides with first (11) and second (21) opposed porous forming belt runs traveling substantially at the jet-stream speed from the inlet 40. The first wire 11 travels over the first guide 14 and the second wire 21 travels over the second guide 30, whereat immediate gradual convergence is effected in a web forming zone in order to obtain in general parallelism the fibrous web W sandwiched between the two wires 11 and 21, traveling in parallelism downstream and over the third guide 15. The specific structures and functions of the three guides 14, 30 and 15 have already been discussed in considerable detail and the advantages of the particular arrangement as well as the structures of these guide elements have been explained. In using the term guide herein, it will be appreciated that the same is used to indicate an actual direction changing guide for one or more of the forming wires herein described. In particular, attention is directed to the concept of using essentially that portion of the suction roll 15 which is above its centroidal axis for effecting the dewatering of the web traveling in the sandwiched condition between the two wires 11 and 21 in tension so as to assist in squeezing water therefrom. To the extent that some water might be squeezed outwardly opposite the high suction area there may be positioned in close running but spaced relation from the wire 21b a save-all 22x and there would also be a conventional save-all indicated schematically at 15g for the suction roll 15 and also to receive downwardly flowing water from the forming zone 32 and perhaps off the save-all 36c and onto the lower save-all 15g.

As indicated previously, the effective peripheral (or longitudinal) dimension of the suction area (over the top of the roll 15) acting upon the moist web W sandwiched between the wires 11b, 21b is substantially greater (e.g., at least four times) than the longitudinal dimension for the forming zone 32. This is made possible by the use of the suction roll 15 of substantial diameter (i.e., hereabout 72 inches, e.g., some five to 10 times the forming zone longitudinal dimension). In addition to the substantial suction area dimension afforded by the large diameter roll 15, there is the significant advantage of an effective reduction in centrifugal force at the roll periphery tending to resist movement of the water into the foraminous suction roll 15. The reduction in centrifugal force is in direct proportion to the increase in diameter, since the wire speeds remain the same for a given set of operating conditions.

It will be understood that modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the present invention.

I claim as my invention:

1. An apparatus for forming fibrous webs comprising;

first and second continuous looped foraminous forming wires which are arranged to converge and provide an entrance nip for the reception of web-forming stock;

an elongated convexly contoured stationary unyielding surface positioned adjacent said entrance nip and in running contact with said second wire;

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means for supporting said wires within their respective loops and moving said wires into said entrance nip;
said forming wires being arranged to travel over said stationary surface downstream of said entrance nip while having stock therebetween;
a relatively large diameter suction roll positioned downstream of said stationary surface and in running contact with said first wire, said suction roll having suction gland means substantially commensurate with its upper down-running quadrant;
said wires traveling around the top of said suction roll and along a down-running surface substantially commensurate with said upper down-running quadrant while having stock therebetween so as to dewater the same and form a web; and
a first guide roll positioned just before the off-

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running end of said upper down-running quadrant of said suction roll in running contact with said second wire for separating said second wire from the web traveling on said first wire.

2. An apparatus as defined in claim 1 including a second guide roll positioned downstream of said suction roll in running contact with said first wire for separating said first wire with the web thereon from said suction roll just after the off-running end of the upper down-running quadrant of said suction roll and a third guide roll wrapped with a pick-up felt and positioned downstream of said first guide roll, with said pick-up felt in running contact with the web at the on-coming side of said second guide roll for removing the web away from said first wire.

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