Aug. 27, 1963 E. J. JUSTUS 3,102,066

WEB FORMING METHOD AND APPARATUS

Filed March 9, 1961

Fig. 1

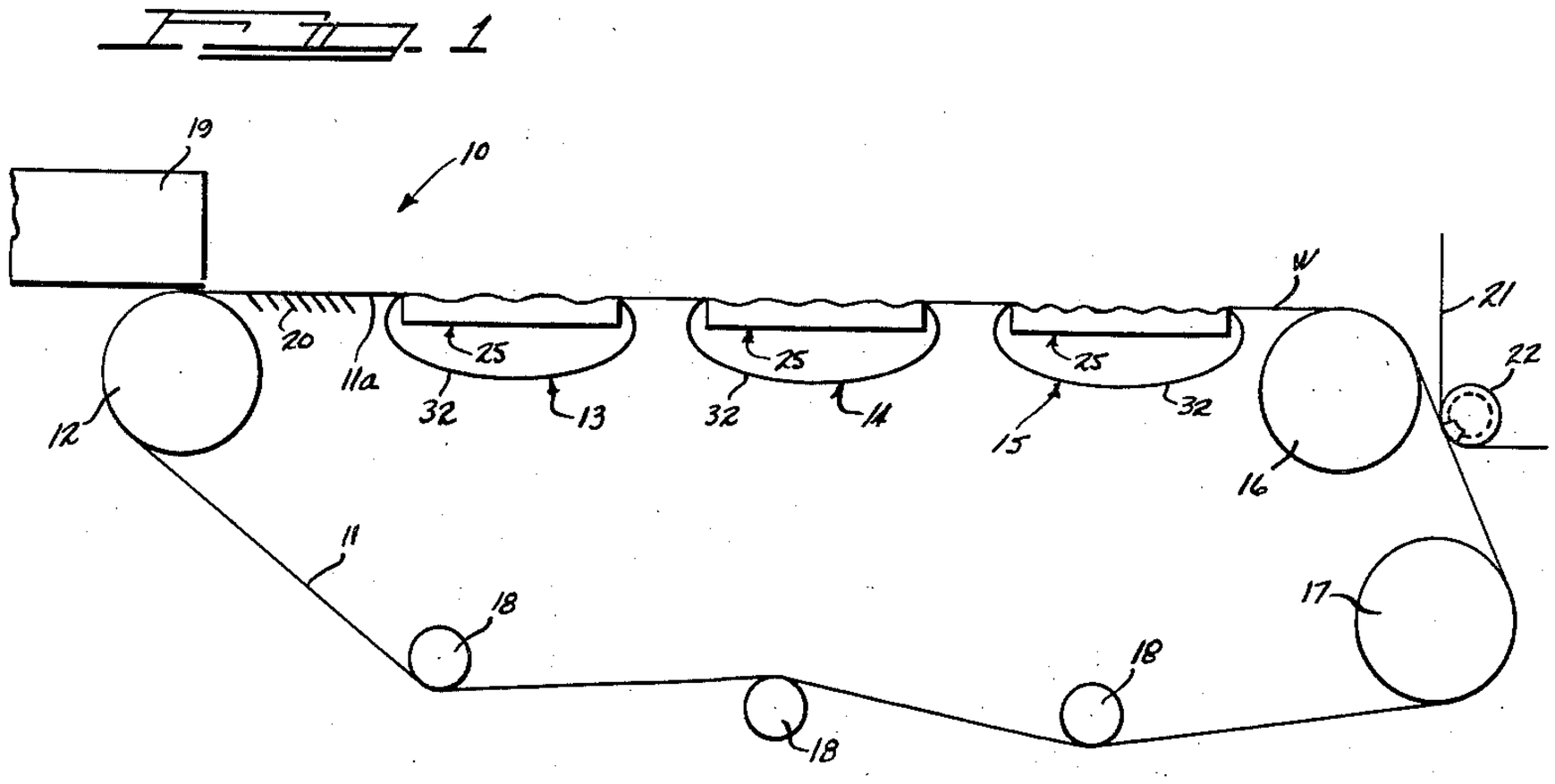


Fig. 2

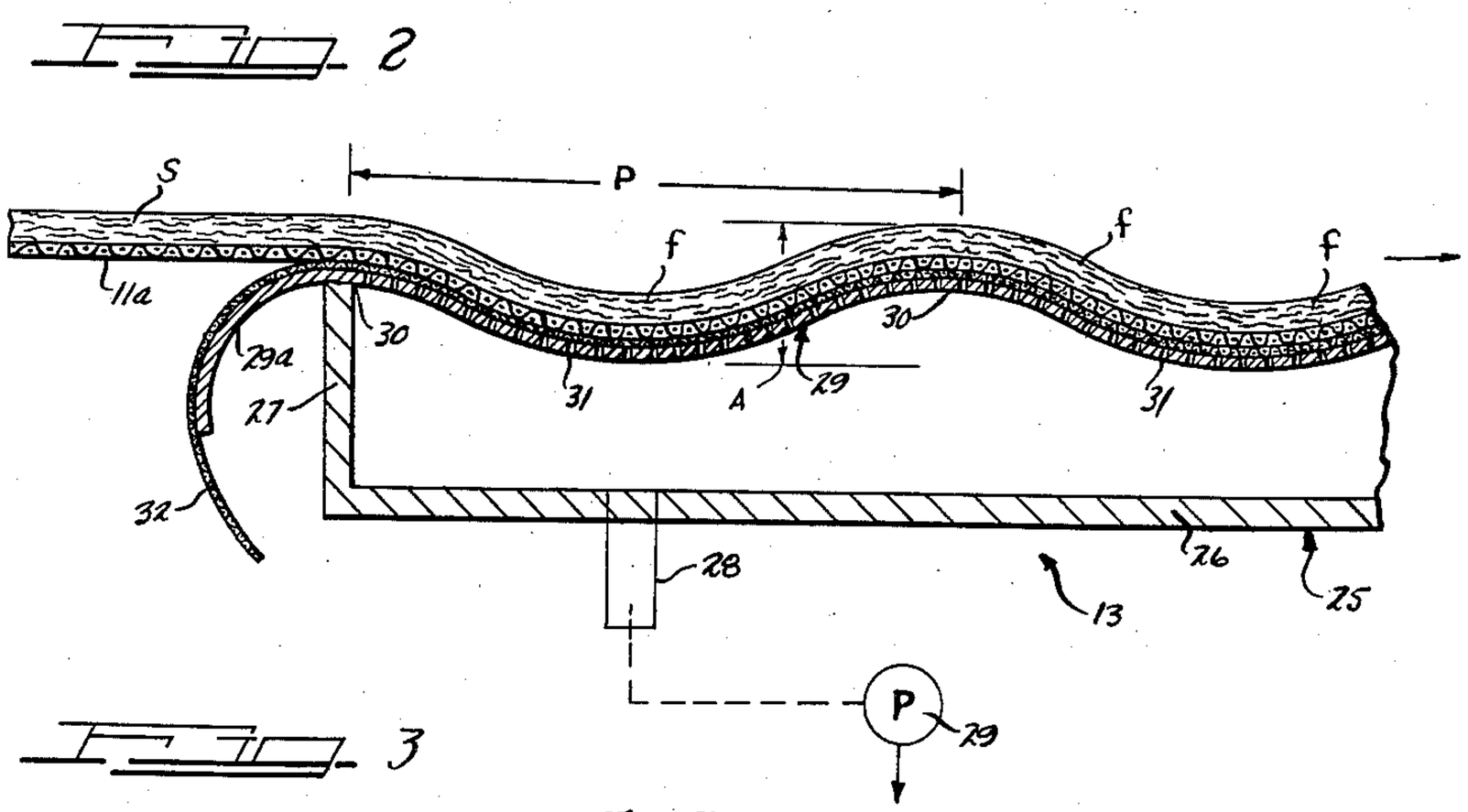
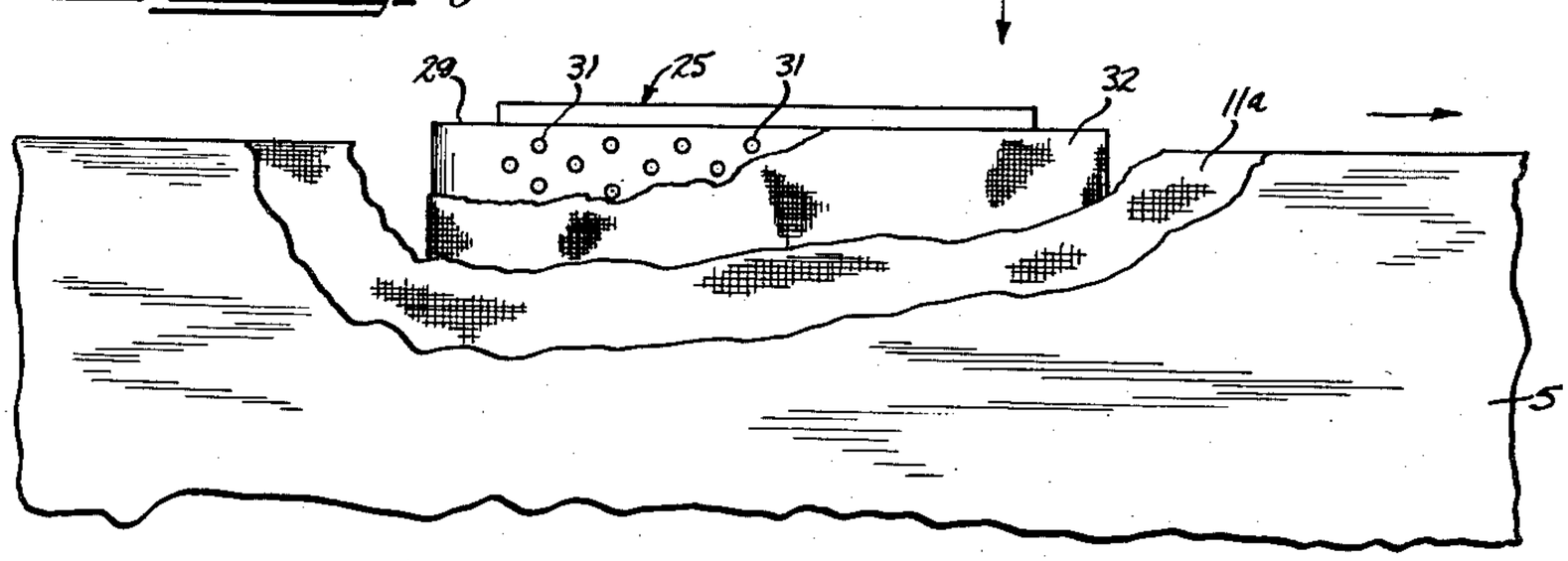


Fig. 3



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WEB FORMING METHOD AND APPARATUS

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The present invention relates generally to the formation of webs from stock dispersions without deleterious effects from high speed rotating members such as have heretofore been encountered. More specifically this invention deals with the elimination of the disadvantages of table rolls in a Fourdrinier type papermaking machine without losing the advantageous stock dispersing capacity of such rolls.

Conventional Fourdrinier type papermaking machines have their active forming run supported by table rolls in spaced parallel relation. The tautness of the forming wire is regulated so that the forming run of the wire may sag a bit between the areas passing over the supporting table rolls. In this manner, unformed pulp or slurry deposited on the forming run of the forming wire will be subjected to a series of vertical impulses as the wire passes over the successive spaced table rolls. These vertical impulses assist in the distribution of the fibers in the stock or slurry to create or maintain a good hodgepodge fiber orientation so that as the web or mat is formed on the wire it will have the desired intertwining of the fibers in all directions. Further, the vertiral impulses assist in the dispersion of floc or agglomerated bundles of fibrous material to minimize clot formation in the paper.

As Fourdrinier papermaking machine operating speeds increase, requiring increased speeds of rotation for the table rolls, the advantageous vertical impulses imparted to the forming run of the forming wire by the table rolls are largely offset. Thus at high speeds the table rolls tend to throw white water back through the forming wire on their uprunning sides. As this water is carried into the oncoming nip between the table roll and the underface of the forming wire considerable pressure is developed sufficient, at very high speeds, to throw the water through the forming web on the wire thereby disrupting the web formation. The disrupting action of course becomes more violent with increased speed and is generally proportional to the square of the speed. At speeds up to the vicinity of 2000 feet per minute the table rolls provide an agitation of the stock which is generally acceptable, but at speeds materially above 2000 feet per minute the table rolls create too much damage in web formation to receive any benefits from the stock dispersion effect of the vertical impulses produced by the table rolls.

Stated otherwise, it has been found that a relatively high pressure area exists at the uprunning side of the table roll while a relatively low pressure area or vacuum curtain exists at the downrunning side of the table roll. A portion the water in this curtain is carried in the form of a water film around the roll and upon entering the relatively high pressure area at the uprunning side of the roll, the water is carried into the nip between the roll and wire and an even greater pressure develops, which at the higher roll and wire speeds throws the water through the web being formed on the wire. This action is a function of the square of the speed and is tolerable at speeds between 1200 to 1500 feet per minute, being increasingly worse at increasing speeds, until at wire speeds of around 2000 feet per minute the deleterious effects of the table rolls more than offset the advantageous effects of the vertical impulses imparted to the wire and stock thereon by the table rolls.

In addition, of course, it is essential that table rolls of Fourdrinier papermaking machines be in balance, truly

concentric, accurately mounted in bearings. If a table roll is out of round, bent, or unbalanced, it will create a whipping action on the wire that will spoil good formation of the web on the wire. This whipping action of course worsens at higher speeds. Further, the maintenance of fully concentric, completely balanced table rolls becomes an increasingly serious problem as machine widths increase.

The present invention now provides supports for the forming run of a papermachine forming wire which are effective to develop the desired vertical impulses heretofore developed by the table rolls but without developing the deleterious effects of high speed rotating support members. The impulse inducing support members of the present invention may be stationary or may move with the wire, but do not have configurations or travel at speeds which throws water back through the web being formed on the wire. The supports of this invention are conveniently embodied in covers for suction boxes although they need not be associated with suction boxes. The support members create an undulated or corrugated path of travel for the forming run of the forming wire similar to the path created by the spaced table rolls and the alternate hills and valleys of this path develop the vertical impulses which disperse the stock being formed on the wire. The hills and valleys are parallel and extend transversely along the width of the machine. The corrugations or undulations should be smoothly curved and the pitch or wavelengths between adjacent peaks or hills should be correlated with the stiffness of the forming wire so that the forming surface will conform to produce the desired impulses. Likewise, the amplitude or height of the corrugations as measured from the depths of the valleys between the peaks will vary in accordance with the nature of the stock being used. In general the amplitude will range from a few thousandths of an inch up to one inch or more to provide the same vertical impulses or acceleration that would be given by table rolls at speeds where their performance was found to be beneficial.

In general it is desired to increase the vertical impulse effect or treatment as the wire advances toward the couch roll end of the machine or as the degree of mat formation increases. Thus a greater amplitude for the corrugations and a smaller pitch or wavelength between corrugations is used at the couch roll end of the forming run than at the breast roll end.

The specific form of the corrugations may be varied throughout a wide range of configurations although smooth curvatures such as sinewave curves are desirable.

A feature of the invention includes the provision of a traveling supporting band movable with the forming wire as it passes over the corrugated support of this invention.

It is then an object of this invention to maintain the desirable vertical impulse or acceleration treatment of slurries on a forming wire such as was heretofore developed by table roll supports for the forming wire without, however, encountering the deleterious effects of table roll supports when operated at high speeds.

Another object of this invention is to provide supports for the forming run of paper machine forming wires which are effective to impart vertical impulses to the stock being formed on the wire without throwing water drained from the stock back into the web being formed on the wire.

Another object of this invention is to provide an undulated or corrugated support for the active run of a Fourdrinier forming wire with the amplitude and pitch of the corrugations correlated with respect to the nature of the stock being formed on the wire and the stiffness of the wire for effecting uniform distribution of stock fibers on the wire.

A specific object of this invention is to provide a suction box for the active run of the forming wire of a Fourdrinier type of papermaking machine with a corrugated cover to support the wire and effect vertical impulses in the stock being formed on the wire.

Another specific object of this invention is to provide a suction box with a corrugated cover and a traveling band of a foraminous type trained around the suction box and following the corrugations of the cover to support the forming wire and travel with the wire as it passes over the suction box.

Other objects and advantages of the invention will become more apparent during the course of the following description, particularly when taken in connection with the accompanying drawings.

In the drawings, wherein like numerals designate like parts throughout the same:

FIGURE 1 is an essentially diagrammatic elevational view of a paper machine embodying the novel structure of this invention and effective to practice the method herein disclosed;

FIGURE 2 is a fragmentary vertical sectional view through the suction device of this invention and showing particularly the sinuously corrugated perforate top supporting a foraminous carrier member and drain band and showing on said band a fibrous slurry in somewhat exaggerated form; and

FIGURE 3 is a top plan view of the structure of FIGURE 2 and with parts thereof broken away to facilitate a more complete understanding of the invention.

Referring now to the drawings, there is shown in FIGURE 1 a paper machine indicated generally by the reference numeral **10**, and comprising a looped forming wire or drain band **11** trained over a breast roll **12**, suction devices **13**, **14** and **15**, a couch roll **16**, a turning roll **17** and return rolls **18**. Stock is deposited on the upper wire run **11***a* from a head box **19** in the region of the top center of the breast roll **12**.

The stock on the upper wire run **11***a* moves over a forming board **20**, and is progressively dewatered to form a web W which may be removed from the wire **11** by a pickup felt **21** urged against the web by a suction pickup roll **22**. Alternatively, the couch roll **16** may be of the suction type, and in substitution for the felt **21** and roll **22**, an open draw may be used.

The breast roll **12** may be of the solid or "grilled type," and intermediate the forming board **20** and first suction device **13** there may be utilized table rolls of the grilled or grooved type so that no pumping is performed thereby. The head box **19** can take various forms, and stock is supplied thereto by any conventional stock inlet channel arrangement.

The instant invention is directed particularly to the suction devices or web dewatering apparatus **13**, **14** and **15**, and with the exception of the pitch and amplitude of the corrugations in the tops thereof, the suction devices **13–15** are essentially identical. The description of one will accordingly suffice for the others.

As appears in FIGURE 2, the suction device **13** includes a box or housing **25** having a bottom wall **26**, opposed side walls **27**, and opposed end walls (not shown). The bottom wall **26** of each suction box **25** may mount therein a drop leg **28** connected to pump means **29** to exhaust the interior of the respective housings.

Supported upon the upper ends of the side and end walls of each suction box **25** and secured thereto in any suitable manner is a perforated top or cover **29** having formed therein a plurality of transversely extending corrugations or undulations **30** lying generally parallel one to the other and disposed perpendicularly to the path of travel of the forming wire **11** and slurry S carried thereon. The corrugations or flutes **30** may be formed in the cover or top by die pressing techniques, and illustratively the plate-like member providing the cover may have a thickness of the order of one-quarter inch. The cover **29** is provided with a plurality of spaced drain perforations **31** therein communicating with the interior of the suction box **29** to provide drainage paths for white water during dewatering of the web. The drain perforations **31** may be arranged in any desired manner, and as appears in FIGURE 3, an exemplary pattern of holes may consist of a plurality of staggered rows of transversely spaced drain perforations. Of course, this particular array may be varied, and it may be found that grooves are suitable for certain applications.

It is within the contemplation of this invention that the top or cover **29** of each suction box **25** directly receive and support the forming wire **11**. For this purpose, and in order that the forming wire may conform to the undulations **30**, by action of the suction pressures utilized, the forming wire should be flexible or supple enough to easily adapt itself to the shape of the undulations. In order to minimize wear on the wire and to achieve a better drainage pattern it is preferred that there be interposed between the forming wire **11** and suction box cover **29** an endless foraminous carrier band **32**. This band or belt may be observed to be of reduced thickness as compared with the forming wire **11**, and may be provided by a woven plastic or wire mesh of a suitable gauge and mesh size. To properly guide the carrier band **32** as it moves onto the oncoming side of the suction box **25** and passes outwardly from the off-running side thereof the cover **29** is formed with curvate end portions **29***a* coextensive with the width of the suction box **25** and width of the carrier band **32**. Naturally, the guide surfaces **29** at the oncoming and off-running sides of the suction box need not be integral with the cover **29**, but could be separate members attached to the suction box wall structure.

It is of course appreciated that the stock slurry flowed from the head box **19** onto the forming wire reach **11***a* is in a highly liquid state and continues to be such to a point or region not substantially far removed from the couch roll **16**. Thus, in the exemplary arrangement of FIG. 1, it may be considered that the stock does not thicken to form a mat until reaching the suction device **15**, and in fact, the mat may not be in a 3% bone dry condition until having been dewatered by the third suction device **15**. In view of the highly liquid state of the slurry until it thickens to form a mat and reaches approximately 3% bone dry condition, it is important that the vacuum forces applied by the suction devices **13**, **14** and **15** be carefully controlled. While the number of suction devices may be varied by an increase in the number thereof, and this would change to a degree the suction pressures applied, generally stated the suction boxes **25** forming a part of the suction devices **13** and **14** should apply negative pressures less than two inches of mercury. On the other hand, in the region at which the slurry thickens to form a mat, and which may take place in the region of the third suction device **15**, slightly higher vacuum forces may be used, but preferably should not be in excess of four inches of mercury.

It has been stated hereinabove that the corrugations **30** at the wet end of the machine and as used on the first suction device **13** are of relatively small amplitude and relatively large pitch, and that the amplitude increases while the pitch decreases on the corrugations as the stock advances from the wet end toward the region whereat it thickens to form a mat. Thus, the high liquid content slurry S is subjected to a relatively light treatment of agitations or vertical impulses as it travels over the first suction device **13**, is agitated to a somewhat greater degree by the suction device **14**, and relatively speaking, receives a somewhat more severe treatment during travel over the third suction device **15**. In other words, the pitch and amplitude of the corrugations are controlled so that when the liquid content of the slurry is at the maximum, the slurry is not so agitated as to disrupt the fiber formation which is taking place. Thus, if the amplitude of the corrugations **30** at the first suc-

tion device 13 was sufficiently high and the pitch sufficiently low, the dispersive treatment effected by the corrugations would become too severe.

In FIGURE 2 there has been applied the legend "P" designating the pitch or distance between the crests on the corrugations or undulations. In this same view the legend "A" designates the amplitude or wave form of a particular flute or corrugation. The pitch of the corrugations or the peak to peak period thereof is selected in accordance with the suction pressures applied by the boxes 25, as well as being based upon the stiffness of the forming wire 11 alone and upon the stiffness of the forming wire and carrier band 32 when the combination of FIGURE 2 is utilized. It is essential in order that the slurry be subjected to the desired agitation that the forming wire 11 or forming wire and carrier band 32 conform to the sinuously corrugated cover 29 essentially entirely throughout its travel thereon. This conformity depends naturally upon the negative pressures applied and the stiffness of either or both of the carrier bands 11 and 32, and presently the pitch range is between approximately one inch and about six inches or more.

The amplitude A, on the other hand, depends principally upon the particular type of furnish being used, that is, whether the stock is free or slow. A free stock from which water drains rapidly or which contains a relatively greater volume of water in order to produce the required degree of suspension could, generally stated, be subjected to somewhat more agitation than a slow stock or one containing less water, and accordingly, the amplitude of the corrugations could be somewhat higher. However, the amplitude of the corrugations in a particular suction device are sized to produce generally the same vertical accelerations or impulses as are obtained from table rolls used with machines operating at speeds less than the 2,000 feet per minute speed limit earlier noted. As was stated, the amplitude of the corrugations is dependent upon the furnish used, and generally speaking, an operating range is from a few thousandths of an inch up to approximately one inch or more.

It is important that the transversely extending corrugations or flutes 30 be parallel one to the other, and that they be perpendicular to or square with the path of travel of the forming wire 11 and/or carrier band 32. In this manner, each particle of stock ("*f*" in FIGURE 2) is subjected to or experiences the same agitative treatment in all particulars, and successive particles pass through the same sequence of conditions. Fibrous agglomerations are thereby dispersed and the fibrous particles are distributed uniformly throughout the water vehicle so that as the water is removed the fibers are intertwined or interlaced in the desired manner for maximum properties. Uniform treatment of the slurry is difficult of accomplishment with table rolls even at relatively lower machine speeds, since upon occasion the table rolls become out of balance, and as was earlier noted, may from time to time become out of round or bent which spoil the formation of the web.

By provision of a suction device having a sinuously corrugated top or cover 29, and wherein the pitch and amplitude of the corrugations are of predetermined values, the stock slurry S carried upon the upper forming wire reach 11*a* is subjected to controlled vertical impulses or accelerations generally equivalent to that obtained from table rolls, but without the important disadvantages of disruption of fiber formation by the table rolls casting water into the nip, and without the further cause of spoilage to fiber formation by damaged or unevenly balanced table rolls. The slurry by this invention is vibrated or agitated in a uniform manner entirely thereacross along bands of uniform treatment conditions, producing the desired floc dispersion and fiber distribution.

As used herein, the term "sinuous" refers to corrugations or undulations which are smoothly curved in order to provide the desired fiber treatment. The corrugations

may be sinusoidal, cycloidal, trochoidal, and may even take the form of non-harmonic curves.

It should be further emphasized that while illustrative machine speeds were given at which the table rolls produce deleterious effects on web formation, these values are exemplary only as like effects may be noted at different speeds, depending upon a number of variables. Also, many modern machines operate at substantially greater speeds than 2000 feet per minute, as for example, at about 3000 feet per minute, which of course accentuates the problem.

It has been noted hereinabove that the carrier band 32 is not required for all applications and that variations may be practiced in the pattern of drain perforations employed. These and other modifications may of course be accomplished without departing from the novel concepts of the present invention.

I claim as my invention:

1. The method of forming a web on the forming wire of a papermaking machine which comprises depositing a layer of paper stock on the forming run of the paper machine forming wire, subjecting the stock on said forming run of the wire to a series of upright impulses, increasing the amplitude and decreasing the wavelength of said series of upright impulses as the web formation on the forming run progresses, and removing the formed web from said forming wire.

2. The method of making paper on a Fourdrinier type papermaking machine which comprises depositing a layer of paper stock on the forming run of a forming wire, advancing said forming run of the forming wire over a series of suction areas to withdraw water from the layer of stock, directing the wire in an undulating path over said series of suction areas, thus subjecting the stock being formed to upright impulses at the crest areas of said undulating paths, and decreasing the distance between the crests while increasing the height of the crests in the successive suction areas.

3. In a Fourdrinier type papermaking machine having a forming wire providing an active forming run, the improvement which comprises a support for the active run of said forming wire having an undulating contour effective to create a series of upright impulses to the wire as it advances along said active run.

4. In a Fourdrinier type papermaking machine including a looped forming wire defining an active forming run, the improvement which comprises a suction box in the loop of said wire having a support surface for said active run contoured to create a series of vertical impulses to the wire as the wire advances over the suction box.

5. Support means for a traveling band carrying a fibrous slurry thereon, comprising an elongated support member having a plurality of smoothly curved undulations receiving said band in essentially complete conformity therewith for subjecting the slurry to vertical accelerations to disperse floc in said slurry and uniformly distribute the fibers therein.

6. A suction device for dewatering fibrous slurries, comprising a housing having a perforated cover mounted thereon, said cover being provided with a plurality of undulations therein for subjecting the slurry to vertical accelerations to disperse floc in said slurry and uniformly distribute the fibers therein.

7. In a dewatering apparatus for fibrous slurries including a suction device and a drain band trained thereover carrying said slurry, the improvement of a sinuously corrugated perforated top on said suction device supporting said band and during travel of said band thereon agitating the slurry and thereby dispersing floc in said slurry and uniformly distributing the fibers therein.

8. In a dewatering apparatus for fibrous slurries including a suction device and a drain band trained thereover carrying said slurry, the improvement of a perforated cover on said suction device having a plurality of trans-

versely extending and parallelly disposed corrugations therein of predetermined pitch and amplitude, said cover supporting said band and during travel of said band thereon agitating the slurry and thereby dispersing floc in said slurry and uniformily distributing the fibers therein.

9. In a dewatering apparatus for fibrous slurries including a drain band and a plurality of suction devices spaced along the drain band and progressively dewatering said slurry while supported on said band, the improvement of a sinuously corrugated perforated top on each of said suction devices supporting said band and during travel of said band thereon agitating the slurry and thereby dispersing floc in said slurry and uniformily distributing the fibers therein, the corrugations in said tops being of increasing amplitude and decreasing pitch from adjacent a first region at which said slurry is deposited on said band to adjacent a second region whereat said slurry thickens to form a mat, whereby said slurry is subjected to increasing agitation as it travels from said first to said second regions.

10. In a dewatering apparatus for fibrous slurries including a suction device and a drain band trained thereover carrying said slurry, the improvement of an undulated perforated cover on said suction device receiving said band in essentially complete conformity therewith and subjecting said slurry while on said band to vertical impulses to disperse floc in said slurry and uniformly disperse the fibers therein.

11. In a dewatering apparatus for fibrous slurries including a suction device and a drain band trained thereover carrying said slurry, the improvement of a corrugated perforated top on said suction device and a foraminous carrier member intermediate said drain band and top during travel of said band over said top, said band and said carrier member conforming to the corrugations in the top and said top agitating the slurry and thereby dispersing floc in said slurry and uniformly distributing the fibers therein.

12. Apparatus for making paper or the like, comprising a looped traveling forming wire, means guiding and driving said wire, stock flow means delivering stock to said forming wire, and web dewatering means downstream of said stock flow means including a suction device and a sinuously corrugated perforated top on said suction device receiving said traveling wire with stock thereon and agitating said stock to disperse floc therein and uniformly distribute the fibers in said stock.

13. Apparatus for making paper or the like, comprising a looped traveling forming wire, means guiding and driving said wire, stock flow means delivering stock to said forming wire, web dewatering means downstream of said stock flow means including a plurality of suction boxes spaced along and beneath the upper reach of said forming wire, each of said boxes supporting thereon a perforated cover having a plurality of transversely extending and parallelly disposed corrugations therein of predetermined pitch and amplitude, said cover receiving said traveling wire with stock thereon and agitating said stock to disperse any floc therein and uniformly distribute the fibers in said stock.

14. Apparatus for making paper or the like, comprising a looped traveling forming wire, means guiding and driving said wire, stock flow means delivering stock to said forming wire, web dewatering means downstream of said stock flow means including a plurality of suction boxes spaced along and beneath the upper reach of said forming wire, each of said boxes supporting thereon a perforated cover having a plurality of transversely extending and parallelly disposed corrugations therein of predetermined pitch and amplitude, a looped foraminous carrier member between said forming wire and said cover during travel of said wire over said cover, and guide means at the oncoming and off-running sides of each suction box to guide said looped carrier, said cover receiving said traveling wire and said carrier member with stock thereon and agitating said stock to disperse any floc therein and uniformly distribute the fibers in said stock.

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