March 12, 1968 D. W. APPEL ETAL 3,373,080

STOCK INLET FOR A PAPERMAKING MACHINE

Filed April 8, 1965 3 Sheets-Sheet 1

Fig. 1

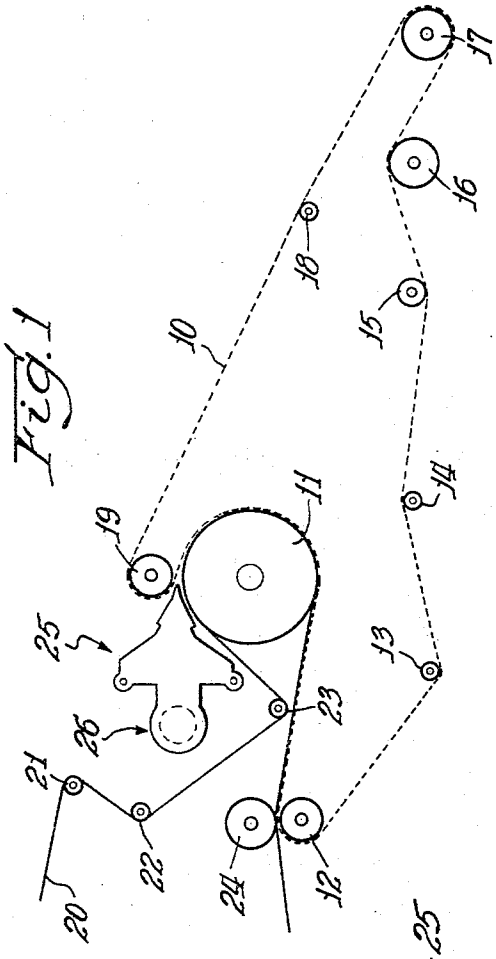


Fig. 4

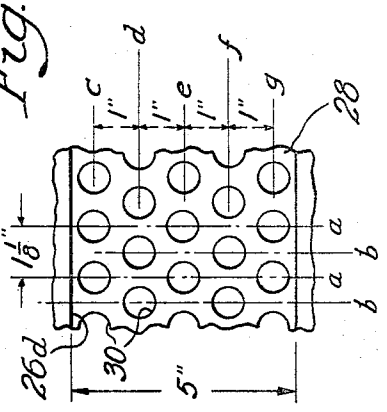
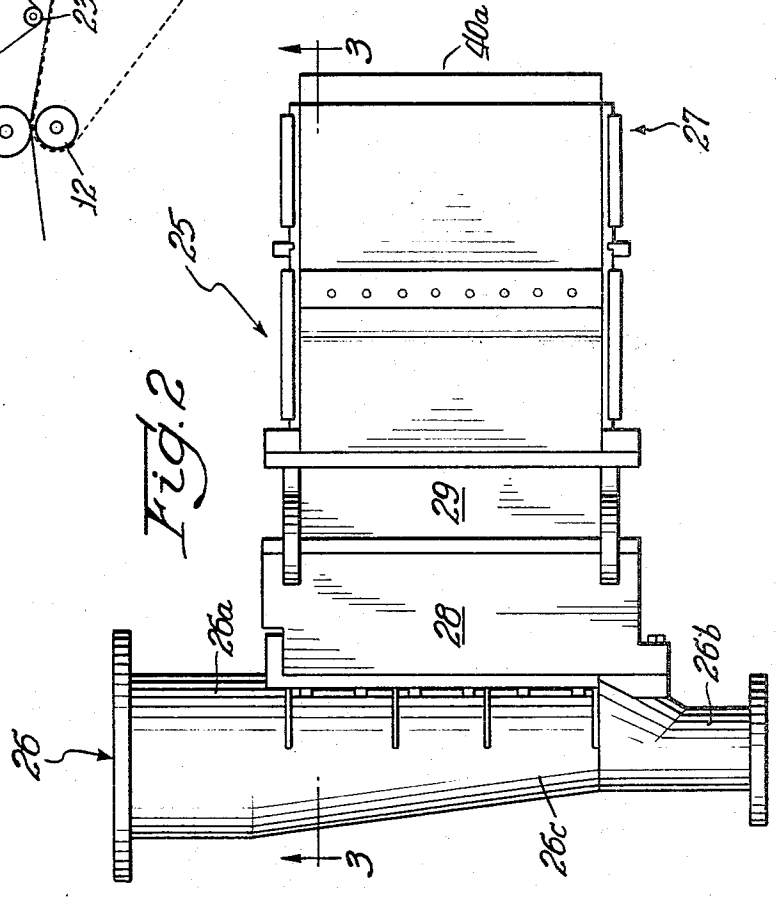


Fig. 2



March 12, 1968 D. W. APPEL ETAL 3,373,080

STOCK INLET FOR A PAPERMAKING MACHINE

Filed April 8, 1965 3 Sheets-Sheet 2

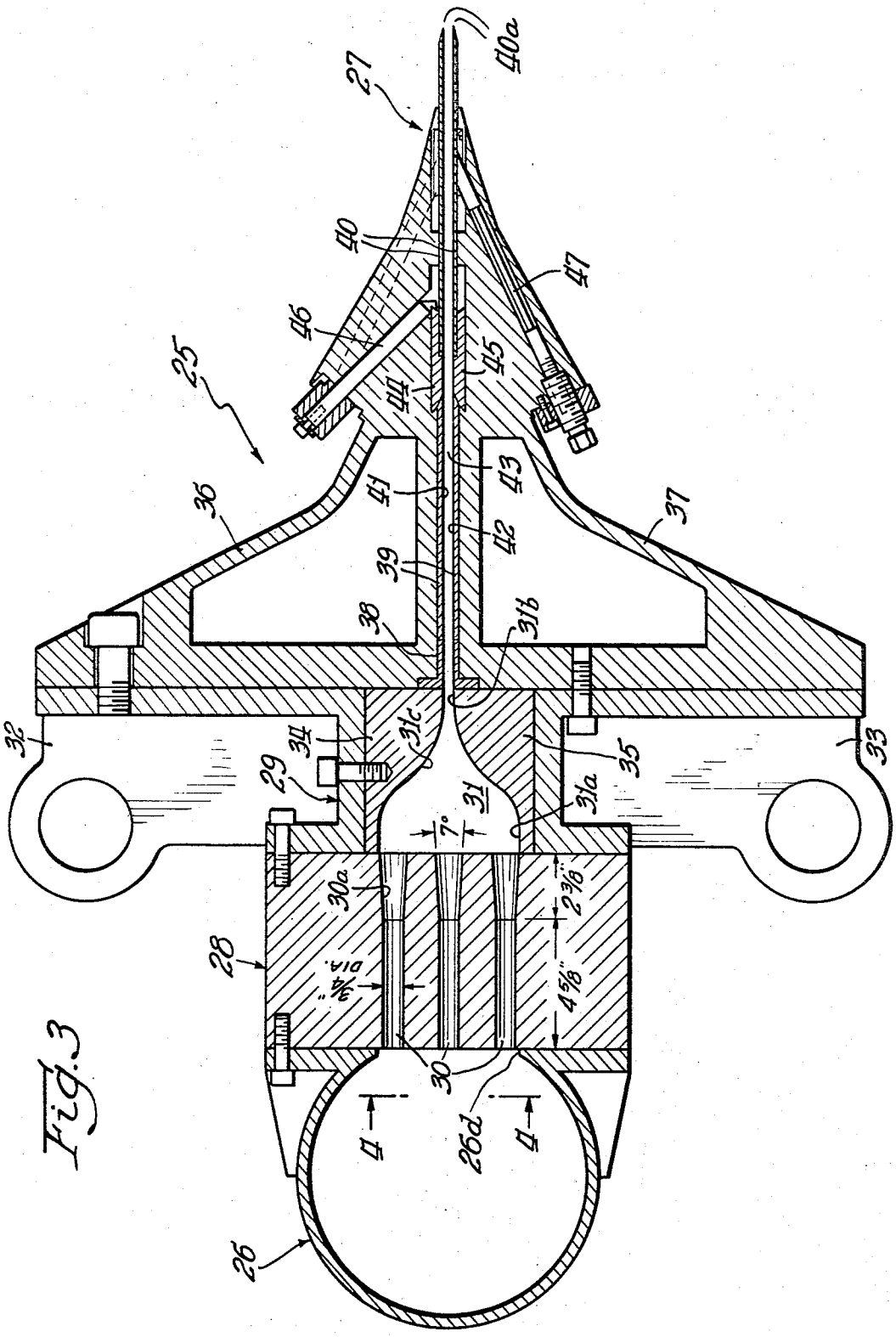


Fig. 3

March 12, 1968 D. W. APPEL ETAL 3,373,080

STOCK INLET FOR A PAPERMAKING MACHINE

Filed April 8, 1965 3 Sheets-Sheet 3

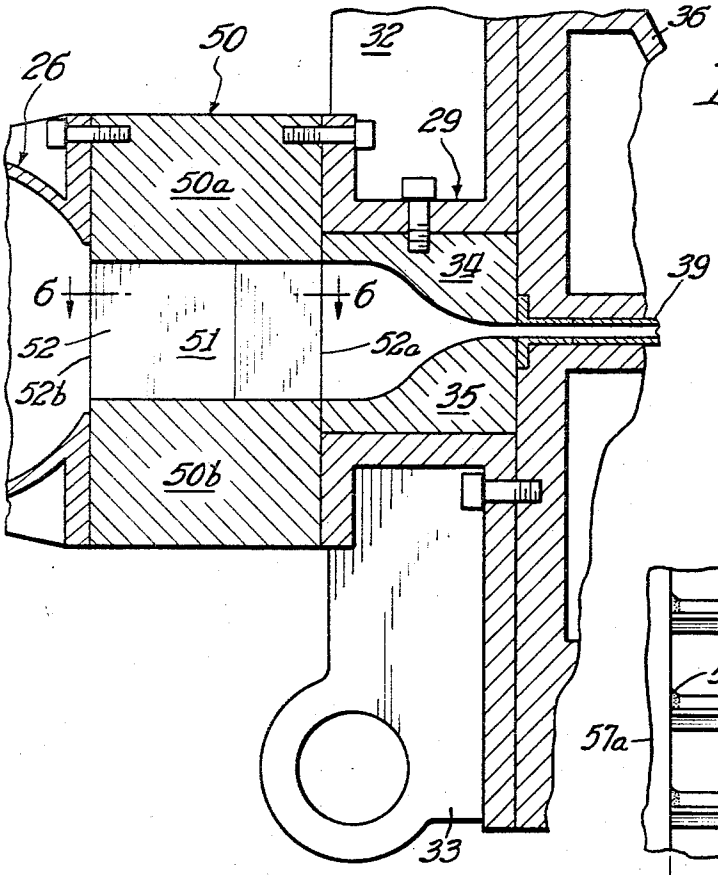


Fig. 5

Fig. 8

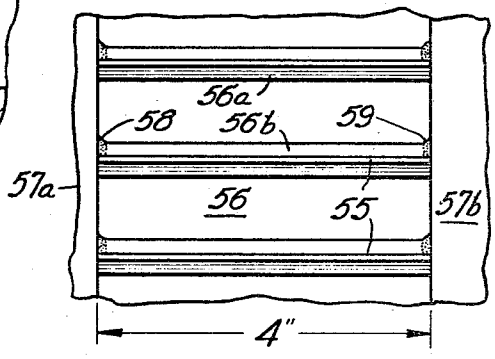


Fig. 6

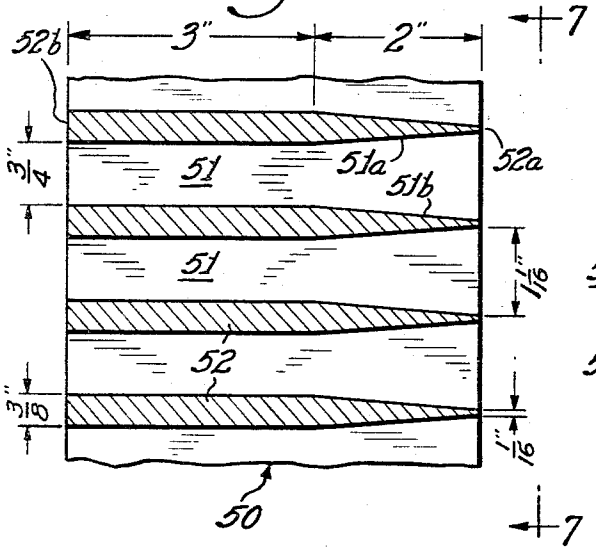
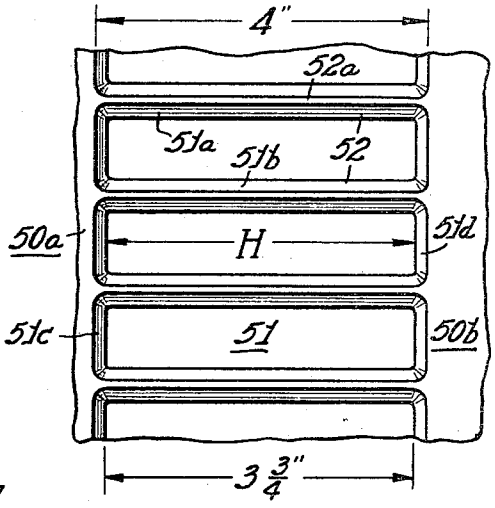


Fig. 7



United States Patent Office

3,373,080

Patented Mar. 12, 1968

3,373,080

STOCK INLET FOR A PAPERMAKING MACHINE

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Filed Apr. 8, 1965, Ser. No. 446,643
5 Claims. (Cl. 162—343)

ABSTRACT OF THE DISCLOSURE

A stock inlet for a papermaking machine including a stock redirecting section having an array of openings through it connected to the side of a stock header, a pair of parallel plates forming a thin stock turbulizing passage between them for directing stock onto a Fourdrinier fabric and a transition section formed with a passage therethrough which has the relatively large thickness at its entrance end of the array of openings and which has at its outlet end the relatively thin thickness of said passage for flowing the stock from said openings to said passage.

The invention relates to papermaking machines and more particularly to stock inlets for such machines. Still more particularly the invention relates to a stock inlet with a pair of parallel, long, flat, closely spaced plates defining a long, thin slot between them through which paper stock may be ejected on to a Fourdrinier wire or forming fabric and which provides desirable small scale turbulence in the stock.

It is an object of the present invention to provide, particularly in connection with an inlet of this type, an improved flow spreader and stock guiding means for effectively directing paper stock between the pair of closely spaced, parallel plates. More particularly, it is an object of the invention to provide such a flow spreader that utilizes a plurality of parallel passages connected to a stock supply conduit for laterally directing and guiding the stock with respect to its flow in the conduit. It is contemplated that the passages shall be so widely spaced at their inlet ends as to prevent the stapling of fibers between the openings and shall be more closely spaced at their outlet ends so as to reduce the effect of wakes in the stock. It is also contemplated that the flow spreader shall include an intermediate portion having a passage therein with a relatively wide end for collecting the stock from these openings and gradually tapering to the close spacing of the parallel plates so that the intermediate portion cooperates with the thin slot in evening the flow of stock across the inlet.

The invention consists of the novel constructions, arrangements and devices to be hereinafter described and claimed for carrying out the above stated objects, and such other objects, as will be apparent from the following description of a preferred form of the invention, illustrated with reference to the accompanying drawings, wherein:

FIG. 1 is a fragmentary diagrammatic illustration of a papermaking machine utilizing the improved paper stock inlet of the invention;

FIG. 2 is a top view of the stock inlet;

FIG. 3 is a sectional view taken on line 3—3 of FIG. 2;

FIG. 4 is an end view of a certain part of the inlet taken from line 4—4 of FIG. 3;

FIG. 5 is a fragmentary sectional view, similar to FIG. 3, of a modified stock inlet embodying the principles of the invention;

FIG. 6 is a sectional view on an enlarged scale taken on line 6—6 of FIG. 5;

FIG. 7 is a view taken from line 7—7 of FIG. 6; and

FIG. 8 is a view similar to FIG. 7 of still another modified form of inlet;

Like characters of reference designate like parts in the several views.

Referring now to FIG. 1, the illustrated papermaking machine may be seen to comprise an endless forming fabric 10 which is movably disposed on a plurality of supporting rolls 11, 12, 13, 14, 15, 16, 17, 18 and 19. The fabric 10 may for example be the usual Fourdrinier wire made of interwoven metal wires or the fabric 10 may be made of interwoven synthetic filaments if desired. Such a fabric or wire, as is well known, has many interstices therethrough allowing water drainage for the formation of a paper web from a supply of paper stock deposited on the fabric.

The roll 11 may be termed a slice roll; the roll 19 may be termed a breast roll and the roll 12 may be termed a couch roll. The rolls 13, 14, 17 and 18 are simple turning rolls; the roll 16 may be a conventional stretch roll for tightening or loosening the fabric 10 on its supporting rolls; and the roll 15 may be a conventional guide roll one end of which is fixed and the other movable for causing the fabric 10 to move about its supporting rolls in a certain predetermined path.

An endless top felt 20 also extends about the slice roll 11 and is located between the fabric 10 and the roll 11. The felt 20 is movably supported by means of a plurality of additional rolls, including rolls 21, 22, 23 and 24. The rolls 21, 22, and 23 are simple turning rolls, and the roll 24 is disposed immediately above the couch roll 12 to have a nip with the latter roll. The felt 20 may be brought into contact with a suitable steam heated drier (not shown), and the felt 20 may be passed through presses (not shown) along with bottom felts not shown) for dewatering of the paper web, which is carried on the bottom side of felt 20 (as will be hereinafter described) for the purpose of providing a completed paper web on the drier. Such constructions are disclosed, for example, in a co-pending patent application of John B. Graham, Ser. No. 419,765, filed Dec. 21, 1964, and generally similar constructions are disclosed in a co-pending application of Charles A. Lee at al., Ser. No. 161,058, filed Dec. 21, 1961.

It will be observed that roll 19 is located with its center above the center for the roll 11 and that there is a gap, which may be of less than an inch, provided between the rolls 11 and 19. The fabric 10 bridges the gap between the rolls 11 and 19 and travels for substantially 180° around the roll 11. The felt 20 extends for a greater arc around the roll 11, and together the fabric 10 and felt 20 extend from the roll 11 to the rolls 12 and 24.

A paper stock inlet 25 is provided for directing stock between the rolls 11 and 19 and on to the portion of the fabric 10 that bridges the gap between the rolls 11 and 19. The stock passes around the roll 11, in a sandwich between the fabric 10 and felt 20. The fabric 10, due to the tension in the fabric, exerts a substantial pressure on the roll 11; and, due particularly to this pressure, the stock in this sandwich is dewatered with white water passing outwardly through the interstices of the fabric 10 and forms a paper web. Centrifugal force is also effective in causing water to drain from the stock in this sandwich, and further drainage takes place as the wire-web-felt sandwich passes from the roll 11 to the rolls 12 and 24. The wire 10 separates from the felt 20 in the nip between the rolls 12 and 24, and the paper web continues to travel on the lower surface of the felt 20

for further dewatering and drying by the presses and drier drum.

The inlet **25** comprises a stock supply pipe or conduit **26** (see FIG. 2) having a relatively large diameter inlet portion **26***a*, a relatively small diameter outlet portion **26***b* and a tapered connecting portion **26***c*. In addition to the conduit **26**, the inlet **25** comprises a stock discharge portion **27** and connecting intermediate parts **28** and **29**.

The part **28** is a rigid member having a plurality of openings **30** drilled therethrough which are disposed in vertical rows *a* and *b* (see FIG. 4). The conduit **26** is split along one side to have a side opening **26***d* in it, and the part **28** is screwed on to the conduit **26** so that the openings **30** are in communication with the opening **26***d*. Each of the rows *a* has three openings **30** in it, and each of the rows *b* has two openings **30** in it. In the particular embodiment illustrated, the openings **30** are ¾ inch in diameter; the rows *a* are spaced 1⅛ inches apart; and the rows *b* are spaced 1⅛ inches apart. The openings **30** are also disposed in horizontal rows *c*, *d*, *e*, *f*, and *g* which are spaced 1 inch apart in the particular embodiment illustrated. The diameters of the openings **30** and the spacing of the rows are such that there is at least a distance of ⅜ inch between edges of the openings **30**. If the openings **30** had their edges in contact or overlapping, hang-up of paper fibers on the sharp edges from stock flowing into the openings **30** could be expected; and, therefore, the ⅜ inch spacing has been provided. In this described embodiment, the openings **30** on the side of the intermediate part **28** opening into the conduit **26** provide a 42 percent open area in the intermediate part **28**.

The openings **30** have a uniform diameter for much of their length; however, each of these openings is preferably flared outwardly to have a flared portion **30***a* at the side of the intermediate part **28** in contact with the intermediate part **29**. It is preferable, for reasons to be hereinafter described, that the openings **30** do not flare greatly on their ends adjacent the portion **29**, and a flaring of approximately 7° has been found satisfactory. In the particular embodiment illustrated, the openings **30** are of uniform diameter for about 4⅝ inches of their length, and the flared portions **30***a* are about 2⅜ inches long, so that the complete part **28** is about 7 inches thick. As will be hereinafter more fully described, the openings **30** have flared ends **30***a* for the purpose of reducing the open area of the part **28** adjacent to the part **29** so that no appreciable wakes of the stock occur at these ends of the openings **30**. The diameter of each of the openings **30** at this side of the part **28** is about 1 inch, and the flaring has the effect of reducing the minimum distances between openings to about ⅛ inch. This side of the part **28** has about 68 percent open area in the particular embodiment described.

The intermediate part **29** is provided with a cavity **31** which has a wide portion **31***a* adjacent the part **28** and has a narrow portion **31***b* at the other end of the part **29**. An intermediate cavity portion **31***c*, which is formed by curved side walls and which narrows from the width of the portion **31***a* to that of the portion **31***b*, connects the portions **31***a* and **31***b*. In order that there shall be no rapid reductions in width of the cavity **31**, it is desirable that the part **29** be about as thick as the part **28**, such as 6 inches. The part **29** is formed by upper and lower casing portions **32** and **33** which are screwed to the part **28** and upper and lower internal parts **34** and **35** which form the cavity **31** between them. The parts **34** and **35** are fixed by means of screws with respect to the upper and lower casing portions **32** and **33**.

The stock discharge portion **27** comprises upper and lower casings **36** and **37** and, in addition, flanged parts **38** and flat plates **39** and **40** which provide opposite, parallel, plane surfaces **41** and **42**. The surfaces **41** and **42** form the boundaries of a thin passage **43** of about ⅜ inch thickness, which is in alignment with the portion **31***b* of the cavity **31**. Connecting parts **44** and **45** are provided between the plates **39** and **40**, as illustrated; and lugs **46** hold the parts **44** and **45** in place. Screws **47** are provided for adjusting the plates **40** so that their inner surfaces are parallel for the complete width of the inlet. It will be observed that the plates **40** have relatively sharp edged terminal portions **40***a*, and the paper stock exits from the passage **43** between these portions **40***a* into the gap between the rolls **11** and **19**.

In operation, stock slurry is supplied to the conduit **26** at its large diameter end **26***a*, and the stock slurry flows into the openings **30** in the connecting part **28** from the conduit **26**. A small portion of the stock slurry that is supplied to the conduit **26** at its inlet end **26***a* is allowed to discharge from the end **26***b* of the conduit **26**, so that there are no dead ends in the conduit **26** adjacent any of the openings **30** in the connecting part **28**. Between 7 percent and 15 percent of the stock may be allowed to discharge through the conduit end portion **26***b* for this purpose.

The openings **30** function to uniformly change the original direction of stock flow longitudinally of the conduit **26** to a direction at right angles, that is, in the direction of the openings **30**. The stock flows through the openings **30** with a relatively low velocity; however, the pressure of the stock remains relatively high; and little turbulence of the stock exists in the openings **30** since they are relatively large diameter. In view of the fact that there is at least ⅜ inch between each of the openings **30** at their entrance ends, due to the diameters and spacings of the openings **30**; there is no stock hang-up or stapling between the openings. Kraft and sulfite fibers, which are relatively long fibers, generally are of about ⅛ inch in length; and hence, they cannot drape over any of the connecting parts between the openings **30** which are considerably wider. The relatively long, uniform diameter, portions of the openings **30**, which in the illustrated embodiment are about 4⅝ inches long, are provided so that the openings **30** have an appreciable effect in changing the flow of the stock to be at right angles to its direction of flow through the conduit **26**; and, in addition, this relatively great opening length assures that the intermediate part **28** has considerable strength and rigidity.

The stock flows through the flared portions **30***a* of the openings **30** and into the cavity **31**. In view of the fact that the flaring is preferably about 7°, there is no substantial separation between the flaring walls of openings **30** and the stock, and hence no stock vortices are formed in the flared opening portions **30***a*. Also, no substantial stock wakes exist as the stock flows from the openings **30** into the cavity **31**, particularly in view of the fact that the flared portions **30***a* of the openings **30** increase the open area of the end of the part **28** containing the flared opening portions **30***a* to 68 percent and decreases the separation between the openings **30** to about ⅛ inch.

The stock, in flowing from the thick portion **31***a* to the thin portion **31***b* of the cavity **31**, has its velocity substantially increased and its pressure lowered. The cavity **31**, in so narrowing the thickness of the stock flow, tends to even the flow crosswise of the inlet (in the direction of the conduit **26**), so that substantially the same velocity and pressures of the stock exist in the passage **43** from one side of the inlet to the other. In view of the fact that the connecting portion **29** is preferably about 6 inches thick, and since the cavity **31** has this same length, the decrease in thickness of the stock flow from about 5 inches in the wide passage portion **31***a* to ⅜ inch in the thin passage portion **31***b*, does not take place unduly abruptly, and there are thus substantially no zones of separation of the stock and the sides of the cavity **31**, and hence no substantial vortices in the stock are formed in the cavity **31**.

The stock, in flowing through the thin passage **43**, is given a fine scale turbulence due to the frictional action on the stock of the closely spaced surfaces **41** and **42** of the passage. This action of the thin passage results in a paper sheet being formed that has nearly the same strength

in the cross-machine direction as in the machine direction, which is very desirable.

The above described stock inlet advantageously accommodates the high stock pressures desirable for the turbulent type of inlet in which stock is discharged from between two closely spaced, parallel plates for the high speed production of paper. The stock under high pressures is brought to the inlet from the side through the round conduit **26** which resists these high stresses by the hoop action of the conduit rather than across flat plates as are found in conventional inlets receiving stock from the end of the machine, for example. The inlet furthermore is compact, lightweight and simple in construction due to the fact that the stock is brought to the inlet from the side through the round conduit **26** while still being strong enough to withstand these pressures.

The improved flow spreader and stock guiding means of the invention, including the intermediate parts **28** and **29**, assure that the stock flow is substantially uniform from one side of the papermaking machine to the other. Due to the relatively long length of the openings **30**, the stock is effectively turned laterally from its original direction through the supply conduit **26**, and, for this purpose, the openings **30** are preferably greater than eight times their diameter in length, and they thus assure that the flow of the stock is not angled across the inlet as might be experienced with simple perforated plates. The partial recirculation of the stock through the outlet end **26***b* of the conduit **26**, in addition, assures good distribution of stock flow into the openings **30**. The openings **30** are relatively small in diameter at their entrance ends as compared to their outlet ends and therefore sharp narrow bridging portions between the openings **30** at their inlet ends do not exist on which stock fibers might staple. Also, there are no substantial wakes between jets of stock flowing out of the openings **30**, since the openings **30** flare outwardly at their outlet ends. The cavity **31** in the intermediate part **29** has no sharp angles and gradually tapers from a relatively wide width to a very narrow slot with gradually converging walls, so that there are no zones of separation between the walls of the cavity and the stock flowing through the part **29**, whereby large scale vortices that would produce stock disturbances and streaks in the resulting paper web are avoided. Also, the tapering cavity **31** acting in conjunction with the narrow passage **43** effectively uniforms the stock flow crosswise of the inlet for producing a uniform sheet. The structure of the invention thus provides a well designed and gradual transition of fluid conduits and passages from the supply pipe **26** to the discharge end of the passage **43** and obviates stock disturbances in the passage **43**, due to an inadequate stock supply system for the passage **43**, to which light basis weight areas in the sheet might be attributed.

The part **29** is preferably only about 5 inches or 6 inches in length (measured in the direction of flow through the cavity **31**). The distributor part **28** is thus located closely ahead of the turbulent flow nozzle comprising the parts **38**, **39** and **40** which provide the thin parallel walled passage **43**; and no intermediate distributor rolls, rods or stilling sections providing alternate acceleration and deceleration of the flow need be provided. The openings **30** have such size and spacing to give negligible wakes, but yet they are practical to fabricate. The part **28** may be of stainless steel or bronze, for example, and may have the openings **30** provided either by casting the openings in the part **28** or drilling them into the part **28**.

The part **28** acts as a structural tie between the upper and lower sides of the inlet. The conduit **26** is provided with the elongated opening **26***d* in its side; and the part **28**, which has substantial structural strength even though perforated with the openings **30**, prevents the opening **26***d* from widening. The casing portions **32**, **33**, **36** and **37** are subject to force due to the stock pressure between the parts **34**, **35**, **38**, **39** and **40**; and the part **28**, being screwed to the casing portions **32** and **33**, holds the portions **32** and **33** from separating. The structural rigidity of the intermediate part **28** is particularly important with high speed paper machines in which high stock pressures are utilized. It is also important in this connection to have a close structural connection between the stock entrance end of the slot **43** and the intermediate part **28**, since these high pressures do exist.

The part **28** is also preferably quite thin, and the openings **30** are quite short, such as about 6 inches; and the close coupling of the conduit **26** and the slot **43** advantageously imposes a low head loss on the stock slurry flowing from the conduit **26** to the slot **43**. The length of the openings **30** is primarily dictated by the structural strength desired in the distributor part **28** for tying the casing portions **33** and **37** with respect to the casing portions **32** and **36** and for tying the edges of the opening **26***d* together—otherwise the holes **30** should be sufficiently long to fully turn the stock so that it flows longitudinally of the holes. In this connection, 6 diameters (that is 6 times the minimum diameter of each of the holes **30**) is sufficient; and a length of about 5″ for the holes **30** is substantially the minimum length that is desirable.

Certain dimensions of the various parts have been given above by way of example, and it will be understood that these dimensions may well be changed while yet securing the advantages of the invention. The lands on the upstream ends of the openings **30** (the distance between the holes on lines between centers) should be as small as possible without fiber stapling. A land width of ⅜″ has been found to be satisfactory, and ¼″ is also acceptable for the lands between the openings **30** at their upstream ends. The diameters of the openings **30** are determined primarily by the allowable width of lands on the outlet ends of the openings and by the economic feasibility of drilling or casting various diameter openings. A hole diameter of ¾″ is optimum, and the openings may well vary from ½″ to ¾″ in diameter. With smaller size openings **30**, the number of openings would be increased and the number of horizontal and vertical rows of openings **30** (as the openings are shown in FIG. 4) would also be increased.

The lands between the holes **30** on their discharge ends should be as small as possible. ⅛ inch lands between the openings **30** on lines between their centers is considered as large as desirable, and 1/16″ is more preferable. The maximum distance between any point on a land and the nearest opening **30** at the discharge ends of the openings should preferably be only ⅛″ which would restrict the diameter of the openings **30** to one inch. Since the lands on the outlet ends of the openings **30** should preferably be not more than ⅛″ in width and the lands on the inlet ends of the openings **30** should preferably be ¼″ to ⅜″, an enlargement of diameter for the length of the openings **30** must be provided. To get a minimum head loss and the least likelihood of scale or slime forming within the openings **30**, a tapered section for the openings **30** is desirable. We have indicated a preferable flaring of the openings **30** to be 7°, but this angle may well vary from 3° to 10°.

Slots may be utilized in lieu of the openings **30** through the intermediate part **28**, and such a slotted construction is illustrated in FIGS. 5, 6 and 7. The part **50** corresponding to the part **28** is provided with a plurality of slots **51** therethrough which are of rectangular cross section and which are defined by vanes or partitions **52** extending perpendicularly to the plates **39** and **40**. The partitions are uniform in thickness for most of their lengths, for example 3″ out of a total length of 5″; and the partitions on their outlet ends are beveled so as to provide outwardly flaring beveled slot portions **51***a* and **51***b* (see FIGS. 6 and 7). The vanes **52** thus have narrower slot separating lands **52***a* on their discharge ends than the lands **52***b* on their inlet ends. The discharge lands **52***a* may, for example, be 1/16″ wide; and the inlet lands **52***b* may, for example, be ⅜″ wide.

The vanes **52** extend between upper and lower portions **50***a* and **50***b* of the part **50**, and the vanes are preferably cast integral with the portions **50***a* and **50***b*. The portions **50***a* and **50***b* are preferably beveled in the same manner as are the vanes **52** so as to provide outwardly flaring slot portions **51***c* and **51***d* on the upper and lower edges of the slots **51**.

The lands **52***a* and the lands **52***b* may vary in width; however, the lands **52***a* are preferably 1/16" to 1/8" in width and the lands **52***b* are preferably 1/4" to 3/8" wide. The width of the slots **51** is preferably from 1/2" to 1" and the length of the slots **51** is preferably from 6" to 10". The height H of the slots **51** as they are viewed in FIG. 7 is preferably 2 1/2" to 5". The slots **51** effectively provide substantially the same action on the stock slurry as the holes **30** and may be easier to form than the holes **30**.

FIG. 8 shows vanes **55** which may be substituted for the vanes **52** and which provide slots **56** between them. The vanes **55** are made from flat stock and in lieu of being formed integrally with upper and lower portions **57***a* and **57***b*, which correspond to portions **50***a* and **50***b*, the vanes **55** are welded to the latter portions by means of welds **58** and **59**. The vanes of **55** have the same longitudinal sectional outline as the vanes **52** illustrated in FIG. 6 and provide outwardly flaring slot portions **56***a* and **56***b* corresponding to the flaring slot portions **51***a* and **51***b*. The vanes **55** may have inlet and discharge lands of the same width as those provided by the vanes **52**.

Although we have, in particular, illustrated the round openings **30** and the slots **51** and **56** of rectangular cross section, it will be understood that openings of other shapes may instead be used, such as openings of hexagonal cross section (not shown). We wish it to be understood that the invention is not to be limited to the specific constructions and arrangements shown and described, except only insofar as the claims may be so limited, as it will be understood to those skilled in the art that changes may be made without departing from the principles of the invention.

What is claimed is:

1. An inlet for a papermaking machine comprising a paper stock conduit extending transversely of the inlet, a pair of closely spaced parallel surfaces extending longitudinally of the inlet and defining between them a thin stock discharge passage with the ends of said surfaces defining an open end of the passage adapted to directly discharge the stock onto a moving web forming fabric, and means providing a connection for flowing stock between said conduit and said passage, said last named means including a member having a plurality of spaced openings extending therethrough which lie at angles to said conduit and are directly in communication with said conduit and are arranged in an array having a substantially greater thickness than the thickness of said passage, said last named means also including an element providing a passage which receives stock from said openings and has an entrance end of substantially the same thickness as said array and which has an outlet end of substantially the same thickness as said first named passage to discharge stock into said first named passage and which gradually tapers in thickness from its entrance end to its outlet end.

2. An inlet for a papermaking machine as set forth in claim **1**, said spaced openings each having a transverse dimension substantially greater than the thickness of said passage defined by said parallel surfaces.

3. An inlet for a papermaking machine as set forth in claim **1**, said parallel surfaces and said passage defined by said surfaces being substantially longer than said spaced openings and also being substantially longer than said passage through said element.

4. An inlet for a papermaking machine as set forth in claim **1**, said spaced openings being round in cross section and being arranged in rows.

5. An inlet for a papermaking machine as set forth in claim **1**, said passage between said parallel surfaces having a thickness of substantially 3/8 inch.

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DONALL H. SYLVESTER, *Primary Examiner.*

A. C. HODGSON, *Assistant Examiner.*