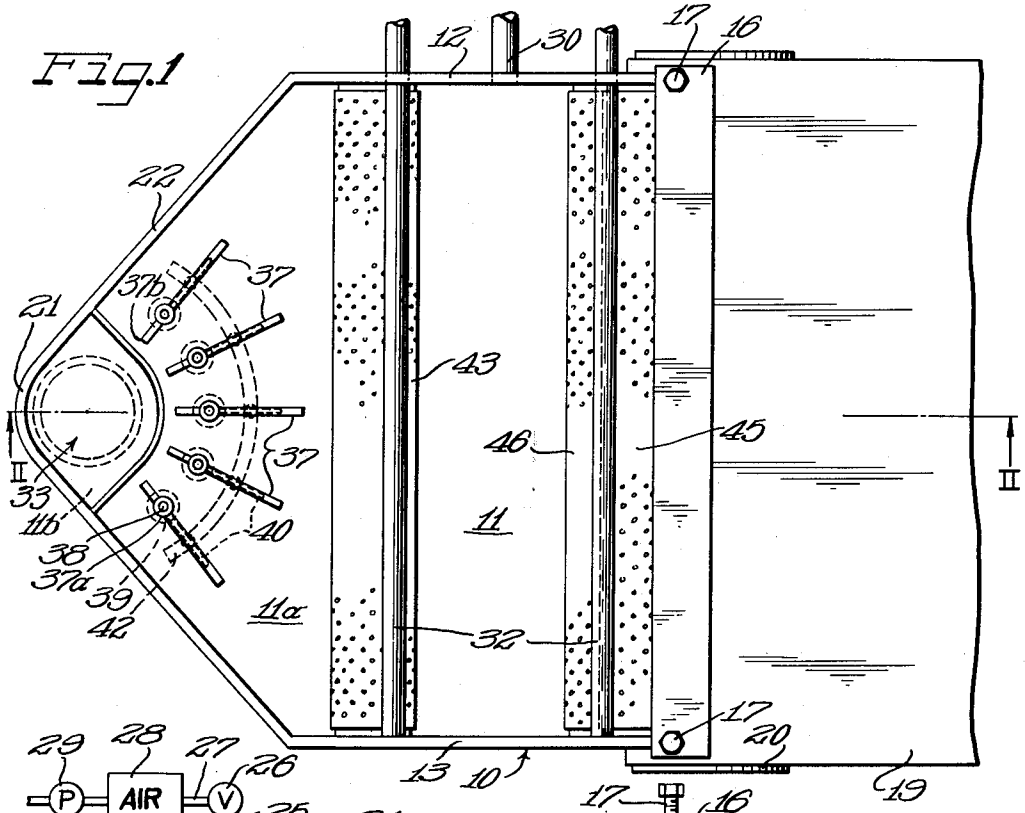
Feb. 28, 1956 L. HORNBOSTEL 2,736,247

VANE TYPE STOCK INLET

Filed Dec. 4, 1951

Fig. 1



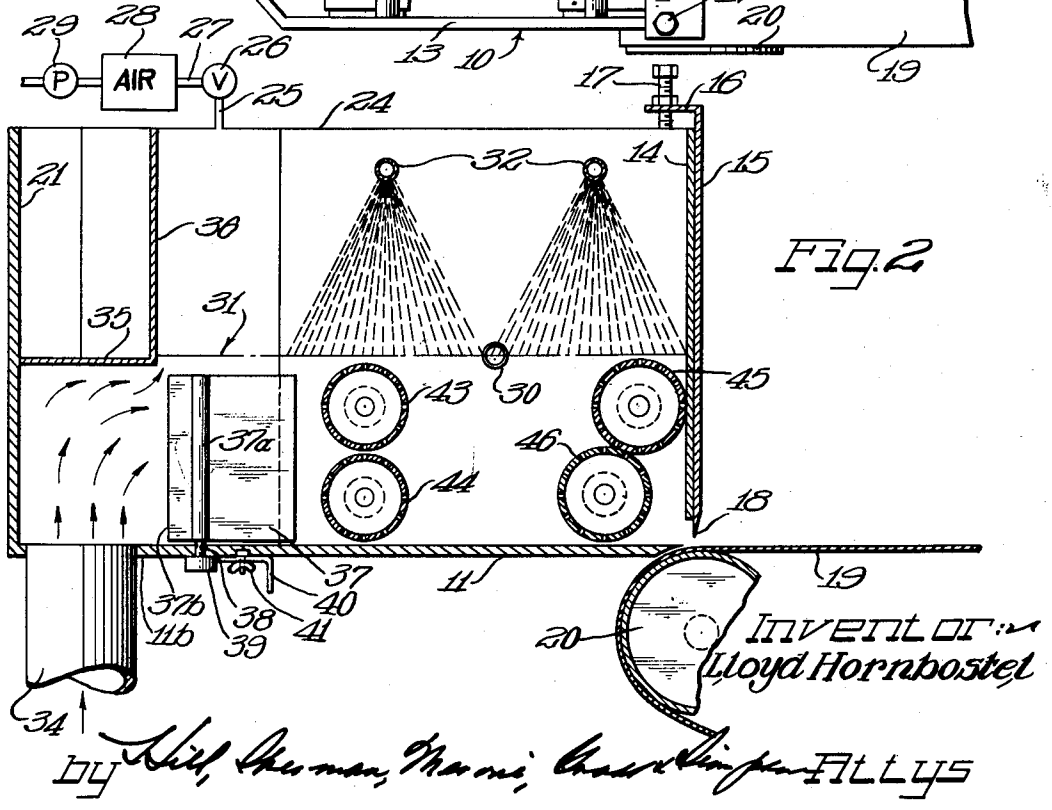


Fig. 2

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VANE TYPE STOCK INLET

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6 Claims. (Cl. 92—44)

This invention relates to an improved stock inlet for a paper machine and, more particularly, to a stock inlet having improved flow control means therein.

Transversely extending baffles or walls within the stock inlet boxes are used in the paper making art in an attempt to quiet stock flow through the box and to prevent the occurrence of eddy currents within the stock flowing therethrough. However, such baffles serve to divide the box into a plurality of stock compartments, and it is known that "dead areas" are formed within the separate compartments and that stock "rolling" can occur within the compartments. The paper stock within such dead areas tends to form lumps detrimental to paper quality when later introduced onto the forming wire, while the rolling stock within the separate compartments interferes with the uniform flow of stock through the inlet, thus aiding in the formation of dead areas.

Various devices which have been substituted for transversely extending baffles often have been found to reduce the length of stock travel in the inlet box to such an extent that uniform flow across the box cannot be adequately controlled. Ordinarily, the incoming stock is conducted to the inlet box from a suitable source by means of a pipe substantially narrower in width than the inlet box. Stock discharged into the box from the pipe tends to flow heavily through the box from the pipe discharge directly to the box discharge or slice gate, and accordingly fails to spread out uniformly during its travel through the box. The problem is additionally complicated in the case of "pressurized" inlet boxes, wherein air pressure on the surface of the stock is employed to accelerate the flow of stock from the box onto the forming wire, since in such pressurized stock inlet boxes a high rate of flow of the stock is used with a comparatively small overall volume in the stock inlet box.

The present invention provides an improved vane type flow distributor arrangement within the inlet box, permitting the use of a relatively short travel path through the inlet box and also permitting the use, in combination with such a flow distributor arrangement, of rectifier means such as rectifier rolls in certain arrangements so as to obviate the necessity of employing transversely extending baffles with the attendant operational difficulties heretofore encountered.

In general, the stock inlet box of the present invention includes a head box for a paper making machine provided with means for introducing stock into the interior of the box and a stock outlet immediately adjacent the forming wire of the paper making machine. At the inlet to the box there are positioned a plurality of independently adjustable flow directors adapted to divert stock flow laterally in controllable amounts, thereby to effect equal or uniform flow in the stock all the way across the head box. A rectifier roll or a stack of superimposed rolls extends transversely across the interior of the inlet behind the flow director means for the purpose of replacing the baffle arrangement heretofore employed, and preferably a second rectifier roll or group

of rolls is disposed adjacent the box outlet opening to additionally control the flow of stock through the opening onto the paper machine forming wire.

Since the depth of the stock pond in the head box and the air pressure exerted against the stock pond surface are calculated to give a definite velocity of stock flow in a horizontal path through the box onto the forming wire, the size and number of laterally directed flow distributors and the number of rectifier rolls in the stack and the size of the rolls will be determined by the velocity desired for stock flow. Preferably, the depth of stock of the box is held constant by suitable means acting in conjunction with or regulated by air pressure in a pressurized closed inlet box, the depth being controlled so that an appreciable amount of stock cannot flow over the top of the flow distributor means and the top rectifier roll in the stack. On the other hand, the depth should also be controlled so that the flow distributor means and the rectifier roll will be submerged.

The flow distributor means are preferably independently adjustable vanes extending vertically from the floor of the inlet box to just below the controlled stock level. The vanes may be arranged accordingly in a flow distribution chamber at the stock inlet opening, which comprises a duct expanding laterally from a pipe inlet means to approximately the head box width at its exit. The vanes positioned in the expanding duct are independently adjustable so that they may be adjusted to distribute the necessary amount of stock laterally at different flow rates in order to effectively equalize the flow of stock across the box. Also, it is preferable that the expanding duct is adapted to receive vertical, preferably upward stock flow from a pipe so that it impinges upon a baffle which converts the vertical stock flow to horizontal stock flow directed toward the vanes.

The rectifier rolls of the stack are spaced apart only sufficiently for operating clearance and should not provide a flow gap therebetween. A gap of from ⅛ to ½ inch between roll peripheries is satisfactory. Thus, the only restriction to the flow of stock past the vanes through the box is presented by the rectifier roll stack, and this resistance to flow is uniform throughout the entire depth of the stock pond.

The vanes effectively equalize the flow of stock all the way across the box as it approaches the rectifier roll stack, so that the rectifier roll stack is not subjected to a substantially greater flow of stock at any one given point which might happen to be aligned with the pipe inlet means from the stock source. In this manner, uniform flow both "laterally" and "longitudinally" is effected, and the rolling of stock, the occurrence of dead spots, and the creation of eddy current is prevented.

The additional rectifier rolls at the outlet end of the stock inlet box are arranged in spaced relation from the outlet opening to form any desired roll pattern, such as the illustrated arcuate arrangement, which will provide a uniform restriction to the flow of stock toward the outlet. The rolls are grouped so that the stock must flow therethrough, and each of the rolls extends transversely to the path of stock flow. By spacing the rectifier rolls of this group from the stock outlet, any eddy currents generated by the flow of stock through the rolls are dissipated prior to introduction of the stock onto the forming wire, and the group arrangement of the rolls also prevents the by-passing of stock around the rolls onto the forming wire.

It is therefore an important object of the present invention to provide an improved stock inlet for a paper making machine in which uniform flow of stock through the inlet is obtained without the employment of solid baffles, walls, or the like which are designed to increase appreciably the travel path of the stock through the inlet box.

Another important object of the present invention is to provide an improved stock inlet for a paper making machine suitably adapted for high velocity stock flow through a pressurized closed head box, employing flow distributors or vanes which are directed laterally and angularly with respect to the direction of stock flow in order to equalize the stock flow across the head box.

A further object of the present invention is to provide an improved stock inlet box having a plurality of laterally directed vanes cooperating with a plurality of rectifier rolls arranged in spaced relation from the outlet end of the box in order to effectively accomplish uniform stock flow.

Still another important object of the present invention is to provide an improved stock inlet for paper making machines wherein vane pipe flow distributors cooperate with baffle means to receive upward flowing stock from a pipe, to convert the same to horizontally flowing stock and finally to uniformly distribute the horizontally flowing stock laterally.

Other objects, features and advantages of this invention will become apparent to one skilled in the art from the following description of the embodiment illustrated in the accompanying drawings.

On the drawings:

Figure 1 is a top plan view of a stock inlet box embodying the invention, having the top lid removed; and

Figure 2 is a sectional elevational view, taken substantially along the line II—II of Figure 1, showing parts in whole view and parts diagrammatically.

As shown on the drawings:

Reference numeral **10** refers generally to a stock inlet box embodying the invention. The stock inlet box **10** has a horizontal floor **11** and arising vertically therefrom, on opposite sides thereof, side walls **12** and **13** and a front vertical wall **14**, slidably engaged on its front outside surface with a slice gate **15**. The slice gate **15** has an inwardly turned top flange **16** which mounts a set screw assembly **17** for adjusting the position of the beveled slice tip **18** with respect to the beveled forward tip of the floor **11**.

The relative positions of the forward tip of the floor **11** and the beveled slice tip **18** determine the size of the box outlet opening and, therefore, the amount of stock which flows out of the inlet box and onto the forming wire **19** which is trained about the breast roll **20**.

As is best shown in Fig. 2, the inlet box **10** has a generally horizontal floor **11** extending longitudinally (in the direction of stock flow) from an inlet opening at the left hand and to an outlet opening at the right hand end.

As shown best in Figure 1 in plan view, the floor **11** of the inlet box **10** is generally rectangular in shape from the forward end underneath the front wall **14** back between the side walls **12** and **13** until the ends of the side walls are reached. Thereafter, the floor **11** tapers sharply in the portion designated by the reference numeral **11***a*, finally forming a curved apex portion designated by the reference numeral **11***b*. The vertically extending back wall of the inlet box **10** is shaped to conform with the contour of the floor **11** and, therefore, consists of a curved central portion **21** having one arm **22** extending angularly and forwardly to join the side wall **12** and another correspondingly shaped arm **23** extending angularly and forwardly to join with the side wall **13**.

A top member **24** (shown diagrammatically in Figure 2) completes the stock inlet box **10**. The top member has substantially the same contour as that of the floor **11** and joins with the vertically extending wall members **12**, **13**, **14**, **21**, **22** and **23** to form a closed box. The box so formed is adapted to be pressurized, or to permit the flow of a stock therethrough under controlled air pressure. As shown diagrammatically in Figure 2, the means for effecting air pressure against the stock in the inlet box may consist of a compressed air inlet line **25** having a valve **26** therein for controlling the flow of compressed air into the box **10**. The valve **26** is, in turn, connected by an air line **27** to a compressed air tank **28** wherein compressed air is maintained at a given pressure by means of the compressed air pump **29**.

It will be appreciated that by the use of compressed air alone under given flow conditions it will be possible to maintain a given stock level in the box. On the other hand, such a procedure is greatly simplified by the use of compressed air in conjunction with a "blow" hole **30** suitably positioned, for example, in the side wall **12**, at the desired stock level, designated herein by the reference numeral **31**.

In maintaining a stock level **31** by the use of combination air pressure and the hole **30**, it can be seen that if the stock level rises above the hole **30** the additional effect of air pressure will tend to force the stock level back down again by increasing the rate of flow of stock onto the forming wire. On the other hand, if the stock level falls back down to the level of the hole **30**, then the air pressure above the stock pond is instantly released through the hole **30**.

A pair of spray lines **32** extend transversely from one side wall **13** to and through the other side wall **12** and are connected to a suitable water source (not shown). The spray lines **32** contain small holes in the bottom peripheral portion of each and are adapted to send out a fine spray of water, so as to effectively wet the inside walls of the stock inlet box **10** and thereby prevent the settling out of small stock particles upon the inside walls during slight fluctations in stock level.

Near the rear apex portion **11***b* of the tapered floor **11** is an opening **33** at which is suitably mounted a stock inlet pipe **34**. The inlet pipe **34** is connected to a suitable stock source (not shown) adapted to supply the stock under pressure and thereby to introduce into the inlet box **10** a vertical upward flow of stock, as shown by the arrows in Figure 2.

The upwardly flowing stock, entering through the pipe **34** and the opening **33**, impinges against a baffle **35** extending horizontally in spaced relation with the opening **33**. The baffle **35** is a generally circularly shaped, flat, rigid sheet extending from the curved central portion **21** on the back wall and conforming therewith on one side and having a protecting wall **36** joining and rising vertically from the forward arcuate edge portion of the baffle **35** not joined to the curved central portion **21** of the back wall. The baffle **35** is preferably positioned so that it is just below the level **31** and the protecting wall **36** prevents flow of stock above and behind the baffle **35** into what might constitute a dead spot in the stock inlet box **10**. It will thus be seen that the baffle **35** converts vertical stock flow to horizontal stock flow in the inlet box **10** and in so doing it diverts the horizontal flow of stock against a plurality of (generally upright) vanes **37**.

As shown best in Figure 2, wherein only one vane **37** is shown for the sake of simplicity, the vane **37** is an essentially rectangular vertically extending sheet of suitable rigid material such as a metal. The vane **37** has a sleeve portion **37***a* positioned near the leading edge **37***b*. The sleeve portion **37***a* receives and fixedly engages a shaft **38** extending throughout the sleeve **37***a* from the top of the vane **37** out to the bottom of the sleeve **37***a* through an aperture in the floor **11**. A hub **39** is mounted on the bottom of the shaft **38** below the floor **11**. The hub **39**, the shaft **38** and the apertured portion of the floor **11** cooperate to permit rotation of the shaft **38** and to form a fluid-tight seal so as to avoid stock leakage. The hub **39** and the shaft **38** are mounted for rotation upon the floor **11** by means (not shown) which are well known in the art and the axial movement of the shaft **38** is prevented thereby.

Each of the vanes **37** is independently adjustable. An adjusting arm **40** extends generally parallel to the floor **11** and below the floor **11** and is connected to the hub **39** for rotation thereof. The adjusting arm **40** is slotted

longitudinally to receive slidably a wing nut assembly **41**. The bolt portion of the wing nut assembly **41** is adapted to slidably engage an arcuate slot or groove **42** cut in the bottom edge of the floor **11**. It will be appreciated that when the wing nut is loose in the wing nut assembly **41**, the actuating arm **40** may be moved to rotate the vane **37** and the wing nut assembly will slide freely in the arcuate groove **42** and the slotted portion of the adjusting arm **40**. When the proper position has been reached the wing nut may be tightened and the vane **37** is then held in position.

By the use of the individually adjustable vanes **37** it is possible to make adjustment for various flow rates so that proper distribution laterally of the flowing stock may be obtained in each case. It can also be seen that the overall travel path of the stock is not appreciably affected by the use of the instant vanes **37**. As the stock leaves the vanes **37** it flows uniformly across the inlet box **10**, in that the rate of flow at any of the various points on either side section of the inlet box **10** is substantially the same as the rate of flow through the middle of the inlet box **10**. The rate of flow is thus equalized or uniform at all points across the stock inlet box **10** as the stock passes out of the expanding duct portion defined by the tapered floor portion **11***a* and the arms **22** and **23** of the back wall.

As the stock departs from the vanes **37** it comes into contact with a plurality of superimposed horizontally aligned rectifier rolls, in this case a pair of rolls **43** and **44**, rotatably journaled in the opposite side walls **12** and **13** of the box **10** and adapted to be rotated by suitable means (not shown), as for example by means of individual variable speed reversible electric motors.

The stack of superimposed rectifier rolls **43** and **44** presents a uniform restriction to the flow of stock entering into the full width of the box **10**. It will be noted that the top roll **43** extends to just below the stock level **31**. The rolls **43** and **44** are spaced apart through the height of the stacks, the peripheries of the rolls preferably being about ¼ to ½ inch apart. Such a distance is not sufficient to open a flow path between the rolls, while the rolls are maintained out of peripheral contact to prevent the formation of pressure nips therebetween which might interfere with the uniform stock flow through the box. The direction of drive of the rolls relative to one another is selective to suit conditions desired and the rolls are preferably rotated at very low speeds with rotation serving merely to clean the holes. The speed of rotation may be as low as about 5 to 10 R. P. M., with the holes being cleaned by the reversed flow through the rolls as they are rotated. Thus a flow through the box is caused by the introduction of stock under pressure into the box **10** and not by any pumping action which might be exerted by the rolls **43** and **44**.

As has been mentioned before, it is preferred that the stack of rolls **43** and **44** be of such height that the upper roll **43** is substantially submerged within the stock flowing through the inlet box **10**. It is likewise preferred that the vertically extending vanes **37** each do not extend above the top peripheral portion of the upper roll **43**, and the vanes **37** will likewise be substantially submerged within the stock flowing through the inlet box **10**. It will be appreciated that the extent to which the uppermost roll **43** and the vanes **37** are submerged is exaggerated in Figure 2, for the sake of emphasizing this preferred feature of the invention. Actually, the extent to which the rolls or the vanes are submerged is essentially that extent which is necessary to avoid the possibility of stock particles collecting at the top portions of such members. In addition, the rotation of the rolls **43** and **44** tends to reduce appreciably any tendency of stock particles to collect on such members. The divergent, probably fluctuating, flow against the leading edge **37***b* of the vanes **37** caused by the sharp change of direction of the stock thereat, also tends to reduce appreciably any accumulation of stock particles upon the leading edge **37***b* of each vane.

The individual rolls **43** and **44** are each provided with a plurality of graded perforations in a manner well known in the art, such as to diminish in capacity inwardly from the ends of the rolls, the ends of each of the rolls being scalloped or perforated with semi-apertures formed by the intersection of the terminal apertures of the ends of the rolls. The aperture arrangement is such that a uniform flow rate along the entire length of the roll is maintained, the frictional drag or skin effect on the flow of the flowing stock normally imparted by the stationary side walls **12** and **13** of the box **10** being thus compensated for by the reduced capacity hole of the mid-section of the roll.

It will, of course, be appreciated that the equalizing effect of the variations in the apertures in the rolls is essentially a final touch in the flow control and is not adapted to equalize radically different flow rates across the inlet box. The vanes **37** of the instant apparatus serve to accomplish the basic equalization of flow, whereas the rolls **43** and **44** more or less perfect the uniformity of flow.

Although in the specific embodiment of Figure 2 a stack consisting of two rectifier rolls **43** and **44** has been shown, it will be appreciated that the number of rolls in the stack and the relative sizes of the rolls may be varied in accordance with the level of stock within the chamber. Under some conditions, it is possible to use only one rectifier roll with a given height of stock and the number of rolls in the stack generally increases in accordance with an increase in desired depth for the stock pond.

In Figures 1 and 2 it will also be noted that a plurality of rectifier rolls, in this case a pair of rolls **45** and **46**, are mounted adjacent the front wall **14** of the box **10**. The rolls **45** and **46** are peripherally apertured and are substantially identical in construction with the rolls **43** and **44**. The rolls **45** and **46** are each provided with a separate, variable speed reversible motor (not shown) to provide individual control for the direction of speed of rotation of each roll. It is preferred that the rolls **45** and **46**, which are spaced as hereinbefore explained, be driven in opposite directions to flow stock uniformly and at a given rate onto the forming wire **19**. The rolls **45** and **46** may be so arranged, as illustrated, so that the portion of the peripheries nearest the slice tip **18** falls on an arc subtended by a radius having its center generally forward of the inlet box and along the forming wire **19**.

The rolls **45** and **46** are preferably mounted in a bridging arrangement adjacent the outlet opening so as to control the entire flow of stock from the inlet box onto the forming wire **19**. It has been found that one roll positioned adjacent a slice, as heretofore conventionally employed in the art, sometimes results in the streaking of stock deposited on the wire and the formation of "fingers" on the wire, or a "broom effect" in the deposited stock. By the employment of the plurality of bridging rolls **45** and **46**, any turbulence which might be introduced in the stock by the passage through the rolls **45** and **46** may be dissipated prior to introduction of the stock onto the forming wire **19**.

As in the case of the rolls **43** and **44**, it is desirable to have the uppermost rolls **45** substantially submerged below the stock level **31**, for the reasons hereinbefore mentioned.

It will thus be seen that by the combination of the vanes **37** and the stack of rectifying rolls **43** and **44**, it is possible to obtain substantially uniform stock flow both longitudinally of the direction of flow and transversely of that direction. The baffle **35** and the expanding duct housing the baffle **35** and the vanes **37** are uniquely adapted to effect the main correction or equalization of the stock flow laterally and the rectifier rolls **43** and **44** in cooperation therewith accomplish the final touches in the stock control.

This is a continuation-in-part of my copending applica-

tion, Serial No. 81,951, filed March 17, 1949 and issued September 14, 1954 as U. S. Patent No. 2,688,905, and owned by the assignee of this application.

It will, of course, be understood that various details of construction may be varied through a wide range without departing from the principles of this invention, and it is, therefore, not the purpose to limit the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. A stock inlet box for a paper making machine comprising a head box having a generally horizontal floor extending longitudinally from an inlet opening at one end for receiving stock from a source thereof to an outlet opening at the other end for flowing stock onto the forming wire of the machine, a duct mounted at the head box inlet, said duct expanding laterally from a pipe inlet opening to a head box size exit from which stock flows into the head box inlet, a horizontally aligned transversely extending rectifier roll mounted within the box in spaced relation from the duct exit to present a uniform restriction to the flow of stock through the box for preventing rolling of stock and the formation of dead stock areas within the box, laterally directed upright vanes mounted in the duct for equalizing the stock flow across the head box, and means for maintaining a level of stock in the box that will submerge the roll and the vanes.

2. A stock inlet box for a paper making machine comprising a head box having a generally horizontal floor extending longitudinally from an inlet opening at one end for receiving stock from a source thereof to an outlet opening at the other end for flowing stock onto the forming wire of the machine, a duct mounted at the head box inlet, said duct expanding laterally from a pipe inlet opening to a head box size exit from which stock flows into the head box inlet, means flowing stock upwardly through said pipe inlet, a horizontal baffle opposing said pipe inlet to convert upward flow of stock therefrom into horizontal flow in said duct, a horizontally aligned transversely extending rectifier roll mounted within the box in spaced relation from the duct exit to present a uniform restriction to the flow of stock through the box for preventing rolling of stock and the formation of dead stock areas within the box, laterally directed upright vanes mounted in the duct for equalizing the stock flow across the head box, and means for maintaining a level of stock in the box that will submerge the roll and the vanes.

3. A stock inlet box for a paper making machine comprising a head box having a generally horizontal floor extending longitudinally from an inlet opening at one end for receiving stock from a source thereof and to an outlet opening at the other end for flowing stock onto the forming wire of the machine, a duct mounted at the head box inlet, said duct expanding laterally from a pipe inlet opening to a head box size exit from which stock flows into the head box inlet, means flowing stock upwardly through said pipe inlet, a horizontal baffle opposing said pipe inlet to convert upward flow of stock therefrom into horizontal flow in said duct, a plurality of superimposed horizontally aligned transversely extending rectifier rolls mounted within the box in spaced relation from the duct exit to present a uniform restriction to the flow of stock through the box for preventing rolling of stock and the formation of dead stock areas within the box, laterally directed upright vanes mounted in the duct for equalizing the stock flow across the head box, and means for maintaining a level of stock in the box that will submerge the roll and the vanes.

4. A stock inlet box for a paper making machine comprising a head box having a generally horizontal floor extending longitudinally from an inlet opening at one end for receiving stock from a source thereof to an outlet opening at the other end for flowing stock onto the forming wire of the machine, a duct mounted at the head box inlet, said duct expanding laterally from a pipe inlet opening to a head box size exit from which stock flows into the head box inlet, a plurality of superimposed horizontally aligned transversely extending rectifier rolls mounted within the box in spaced relation from the duct exit to present a uniform restriction to the flow of stock through the box for preventing rolling of stock and the formation of dead stock areas within the box, laterally directed upright vanes mounted in the duct for equalizing the stock flow across the head box, and means for maintaining a level of stock in the box that will submerge the roll and the vanes.

5. A stock inlet box for a paper making machine comprising a head box having a generally horizontal floor extending longitudinally from an inlet opening at one end for receiving stock from a source thereof to an outlet opening at the other end for flowing stock onto the forming wire of the machine, a duct mounted at the head box inlet, said duct expanding laterally from a pipe inlet opening to a head box size exit from which stock flows into the head box inlet, a horizontally aligned transversely extending rectifier roll mounted within the box in spaced relation from the duct exit to present a uniform restriction to the flow of stock through the box for preventing rolling of stock and the formation of dead stock areas within the box, laterally directed upright vanes mounted in the duct for equalizing the stock flow across the head box, means for maintaining a level of stock in the box that will submerge the roll and the vanes, and means for controllably exerting air pressure against the stock in said box.

6. A stock inlet for a paper making machine comprising a closed head box having a generally horizontal floor extending longitudinally from an inlet opening at one end thereof for receiving stock from a suitable source to an outlet opening adjacent the other end for flowing stock onto the forming wire of the machine, a duct mounted at the head box inlet, said duct expanding laterally from a pipe inlet opening to a head box size exit from which stock flows into the head box inlet, a horizontal baffle in said duct positioned to convert upward inlet stock flow to horizontal stock flow, a plurality of upright vanes directly behind said baffle, each of said vanes being independently adjustable to divert stock flow laterally in controllable amounts, a vertically extending stack of rectifier rolls extending transversely to the horizontal stock flow behind said vanes, a plurality of horizontally aligned rectifier rolls mounted adjacent said outlet opening to permit dissipation of turbulence in the stock prior to its exit through said opening, means for controllably exerting air pressure against the stock in the closed head box, and means for maintaining a level of stock in the box that will submerge said rolls and said vanes.

References Cited in the file of this patent

UNITED STATES PATENTS

1,771,600	Yoder	July 29, 1930
1,846,406	Sweeny	Feb. 23, 1932
1,909,150	Bell-Irving et al.	May 16, 1933
2,186,761	Malkin	Jan. 9, 1940
2,281,293	Lang	Apr. 28, 1942
2,345,647	Witham	Apr. 4, 1944
2,381,286	Hornbostel et al.	Aug. 7, 1945
2,396,695	Goodwillie	Mar. 19, 1946
2,465,445	Goldsmith	Mar. 29, 1949
2,509,822	Hornbostel	May 30, 1950
2,548,108	Hornbostel	Apr. 10, 1951
2,550,552	Goodwillie	Apr. 24, 1951
2,608,912	Davis	Sept. 2, 1952
2,664,033	Hornbostel et al.	Dec. 29, 1953
2,684,690	Lee	July 27, 1954
2,688,905	Hornbostel	Sept. 14, 1954

FOREIGN PATENTS

254,873	Germany	Dec. 17, 1912
359,594	Great Britain	Oct. 29, 1931
469,203	Great Britain	July 21, 1937
478,859	Canada	Nov. 27, 1951