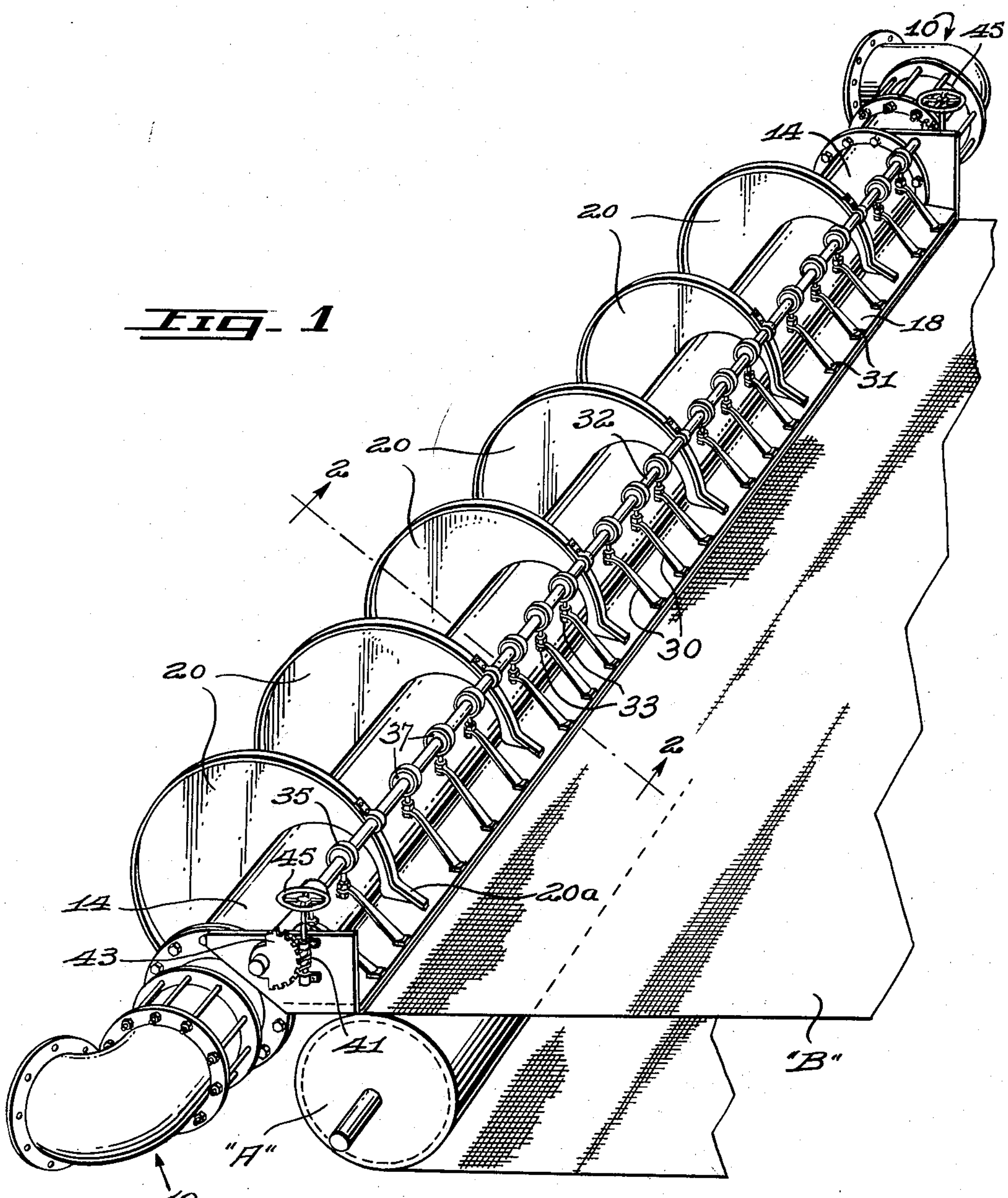
Jan. 9, 1962 D. R. WEBSTER 3,016,089

CYLINDRICAL PRESSURE HEADBOX

Filed Dec. 18, 1958 3 Sheets-Sheet 1

Fig. 1



Inventor
David R. Webster

By [signature]

Attorney

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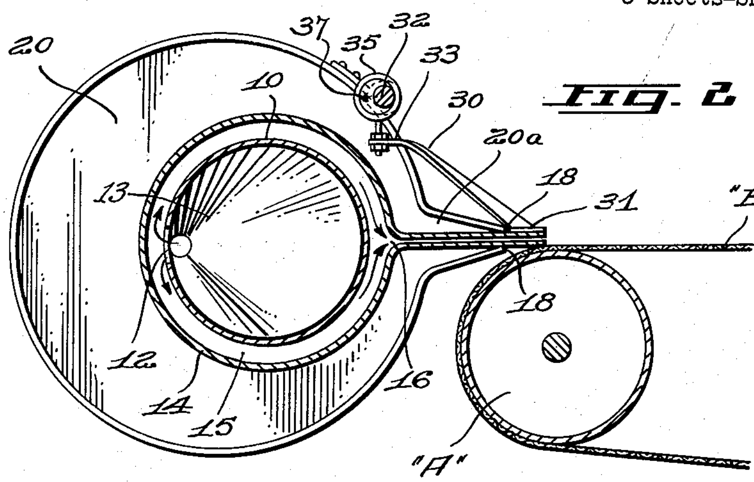

FIG. 2

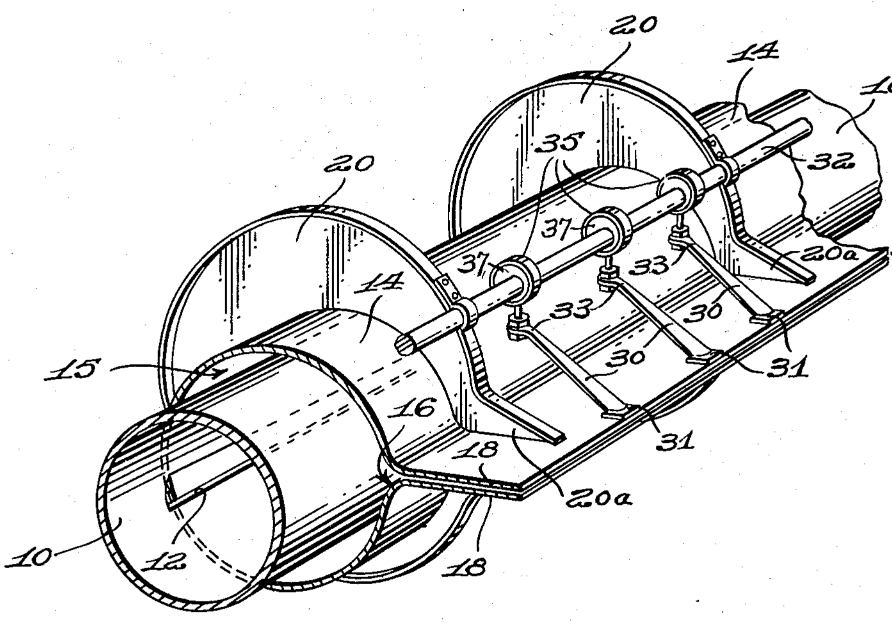

FIG. 3

Inventor
David R. Webster
By [signature]
Attorney

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Fig. 4

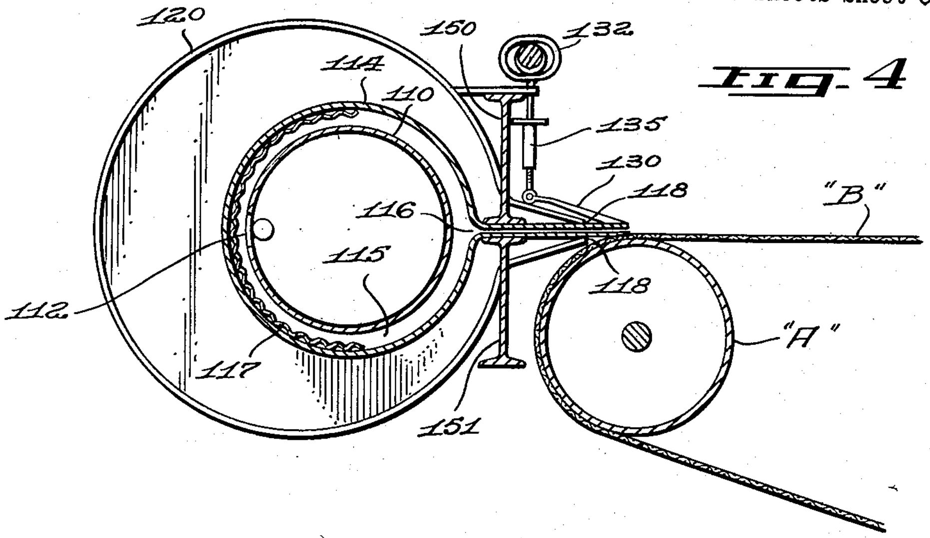
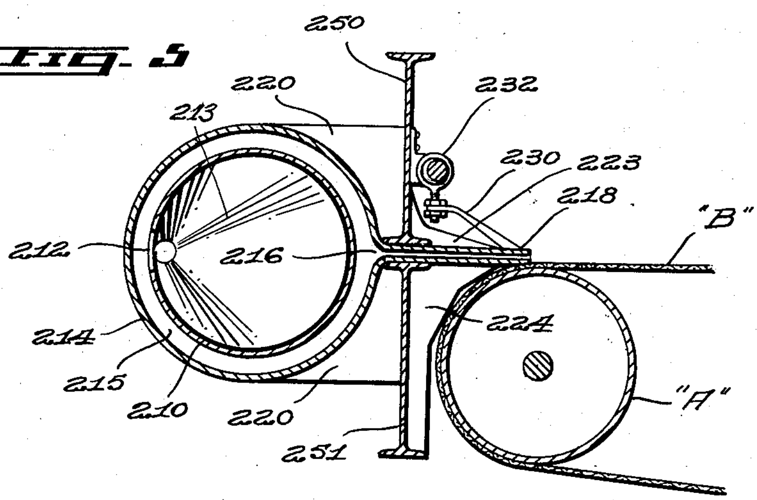


Fig. 5



Inventor
David R. Webster
By [signature]
Attorney

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CYLINDRICAL PRESSURE HEADBOX

David R. Webster, Mount Royal, Quebec, Canada (1070 Graham Blvd., Apt. 1, Montreal 16, Quebec, Canada)

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6 Claims. (Cl. 162—339)

The present invention relates to papermaking and more particularly to improvements in paper-machine headboxes. This is an improvement on the type of headbox disclosed in my co-pending continuation-in-part application, Serial No. 742,894, filed June 18, 1958.

Briefly, the headbox disclosed in this earlier application is constructed so as to have a substantially V-shaped casing with an outlet orifice and slice lips disposed at the apex of the V. The forward portion of the frame supporting this casing comprises a series of cantilevers in the direction of the paper machine. Due to its construction, that headbox in large sizes has certain limitations.

Firstly, that prior headbox, by reason of its conformation for converting static pressure to kinetic energy relieves pressure appreciably against the headbox casing only near the convergence of the distributor-exterior surface with the casing-interior surface, and near the tip of the nozzle. Consequently, the cantilevers deflect more than is desirable at high pressures.

Secondly, when the inlet pipe utilized in this prior construction is relatively large for a wide paper machine the frame has necessarily longer cantilevers than is desirable for micro deflections.

The first disadvantage of the prior construction in converting static pressure to kinetic energy is overcome in the present invention by providing a continuously shallow type of flow passage to maintain the kinetic energy at a high level.

The second limitation of long cantilevers is overcome by having the cantilever path curve closely around the inlet pipe to be short instead of extending almost tangent from the exterior of the inlet pipe. These improvements permit the headbox to have a lighter than usual frame.

A further feature is provided in the present invention and comprises the use of a cylindrical casing instead of a flat-walled casing. The advantage is that the casing, by its cross-section, becomes self-supporting against liquid pressure, except at the place where it is interrupted by the necessary aperture to the slice. Some framing is used therefore wholly outside the aperture to the slice but this is considerably lighter than required in the prior constructions and it permits unobstructed flow.

Accordingly, this invention resides in an improved construction of a paper-machine headbox which comprises in combination, a material inlet conduit on a horizontal axis with a discharge slot or orifices extending along at least one element of the conduit, and a cylindrical casing also on a horizontal axis and surrounding the conduit to constitute the main casing of the headbox. The cylindrical casing is provided with an outlet aperture extending along its length which is disposed to deliver all flow in a direction diametrically opposite the discharge slot of the inlet conduit. A pair of slice lips are attached radially to the casing in register with the outlet aperture, and frame means preferably in the form of a battery of substantially C-shaped cantilevers, are mounted in spaced relationship along the length of the casing to prevent possible distortion under load. A vertical wall of substantially annular shape at both sides of the paper machine holds the casing in spaced relationship from the conduit exterior and seals the edges of the flow passage therebetween.

Having thus generally described the nature of the invention, particular reference will be made to the accompanying drawings showing by way of illustration a preferred embodiment thereof, and in which:

FIGURE 1 is a somewhat diagrammatic view in perspective of a preferred pressure headbox construction in accordance with the invention.

FIGURE 2 is a cross-sectional view of the construction shown in FIGURE 1 along the line 2—2.

FIGURE 3 is a somewhat enlarged portion of the construction shown in FIGURE 1 to illustrate the construction and relative position of the material inlet conduit, the cylindrical casing and slice lips and the framing constituted by substantially C-shaped cantilevers.

FIGURE 4 is a sectional view of an alternative pressure headbox construction in accordance with the invention illustrating a further preferred form wherein the C forms are supplemented by beams spanning the aperture to the slice lips.

FIGURE 5 is a sectional view of a still further alternative construction wherein the C framing is replaced by a combination of beams and gusset brackets supporting the slice lips.

With particular reference to the drawings, a preferred construction of a pressure headbox in accordance with the invention is shown in operative position relative to a breast roll A and forming-wire B of a paper machine. This construction includes a material inlet conduit **10** of sufficient length to span the paper machine and is provided with an elongated discharge orifice or slot **12** directed away from the paper machine (see FIGURES 2 and 3). The conduit **10** is mounted axially of and surrounded by a cylindrical headbox casing **14** with the spacing therebetween constituting an unobstructed cylindrical flow passage **15** leading to a casing outlet aperture **16** extending the length of the casing in the direction of the paper machine. The casing outlet aperture is unobstructed and is provided with opposed slice lips **18** which extend outwardly therefrom forming an unobstructed outlet nozzle, as shown most clearly in FIGURE 2.

While the cylindrical casing **14**, as will be discussed later, is in some respects self-supporting, it is provided with supplementary supporting framing webs or cantilevers **20** which are mounted in axially spaced apart relationship along the length of the casing **14** with portions **20***a* extending onto and reinforcing the opposed slice lips **18**. As shown, opposite cantilevers are joined together and each such pair lies in a vertical plane in the machine direction and curves along a substantially C-shaped path around the headbox casing.

In order to provide means for adjusting the opposed slice lips **18**, a plurality of levelling rods **30** are spaced along the slice lips and are mounted, as shown in FIGURE 1, in spaced relationship along the length of the casing **14** for levering action against the marginal edge of at least one slice lip **18** under the control of a common shaft **32** mounted for rotary movement along the front of the casing **14**. One end **31** of each of the levers **30** is secured to the upper lip **18** while the other end **33** is connected by an adjustable eye bolt assembly **35** to an eccentric bearing **37** mounted on the common shaft **32**.

While, as will be appreciated, many and varied types of arrangements could be utilized to rotate the shaft **32** for the necessary adjustments, a simple worm and gear arrangement **41, 43** is shown as being mounted at each end of the shaft and actuated by the rotation of suitable handwheels **45**. As the eccentric bearing portions **37** are fixed to the shaft **32** the rotation of the shaft causes a common raising or lowering of the eye bolt assemblies **35** and consequently the lever arms **30** adjust the slice lip **18** as required.

To more clearly explain the principle underlying the present invention and with reference to the preferred construction described above, it should be noted that relieving static pressure is governed by the well-known Torricelli theorem $h=v^2/2g$ which relates pressure to velocity. In accordance with that law, flow must reach high velocity before the relief of pressure is appreciable. Hence, the flow passage must be shallow to relieve the static pressure.

For example, the velocity must reach about 8 ft./sec. before the total head is relieved by so much as 1 ft. For what is currently considered a high speed for a paper machine, such as 2400 ft./min. equalling 40 ft./sec., the passage depth to relieve 1 ft. from the total head would need to be

$$\frac{40\ \text{ft./sec.}}{8\ \text{ft./sec.}}$$

equalling 5 times the depth of the jet issuing to atmosphere. The depth of the jet at the delivery to atmosphere depends largely upon the stock consistency, and is often of the order of 1" deep.

Thus, for a stock so characterized, a relief of 1 ft. would require the passage to be 5 times the 1", i.e. 5" deep. But 1 ft. head is only about 4% of the approximate 25 ft. head needed according to the Torricelli theorem to spurt the jet at the abovementioned 40 ft./sec. and hence for any appreciable relief of pressure the passage depth would need to be considerably less than 5".

These calculations reveal that for a uniformly-tapering nozzle, in a pressure headbox construction, the conversion to kinetic energy occurs at an increasing rate on approaching the slice lips. Thus, to avoid too sudden a conversion, and to benefit from a light load throughout the length of the nozzle, its taper is preferably moderated near the slice lips. The resulting nozzle is slightly bell-shaped, which is doubly desirable because that provides a smooth transition from the headbox casing to the slice lips.

As there are two flow passages **15** around the inlet conduit **10**, and only one flow passage at the outlet **16**, most of the conversion to kinetic energy occurs at the smaller cross-sectional area, viz, within the nozzle formed by the opposed lips **18**.

Therefore, for any given type of paper stock, this invention provides a headbox casing that may have any size, as determined by the width of the paper machine, while the nozzle has virtually a fixed entry-depth. The result is that in large headboxes, there is a pronounced distinction between the casing shape and the nozzle shape, whereby the casing and nozzle have a well-defined juncture.

The cylindrical casing **14** as supported is novel in headbox structures and provides the result of a pressure headbox being substantially self-supporting against liquid pressure, except for the aperture from the casing to the slice lips where an external framing means can be relatively light because the shallow passages cause a high flow velocity and therefore a lighter than usual internal pressure from conversion of static to kinetic pressure. Heretofore, headboxes needed heavy external support against liquid pressure, or tie bolts through the flow passage which adversely subdivide the flow.

The headbox casing **14** acts as a horizontal beam spanning the paper-machine width, and thereby is self-supporting in that respect as well as against liquid pressure, except for the interruption of the casing by aperture **16**. As the aperture **16** to the slice occurs at the mid-depth of that beam, which is the zone of zero bending stress, the strength of the casing as a beam is not seriously affected by the aperture.

But some type of framing is needed to bind the casing together where it is interrupted by aperture **16**, and such framing is preferably by an arrangement of **C**-shaped cantilevers **20**, or alternatively by a pair of beams spanning the paper machine width.

Framing along the aperture **16** to the slice can be solely by cantilevers **20** in the machine direction, as shown in

FIGURES 1, 2 and 3, or solely by beams spanning the width of the paper machine, as shown in FIGURE 5, or by these two methods combined, as shown in FIGURE 4, the supports being wholly outside the headbox. The present invention provides an improved shape of cantilever **20** which tapers continuously for optimum efficiency, and yet is of simple shape, vis. a circle.

Thus the casing can act as its own cross-spanning beam to support the dead weight of liquid and structure, but the **C** clamps or alternatively cross-spanning beams are needed to restrain the live load of liquid pressure in the headbox.

The tapered cantilever absorbs its load uniformly around the circumference of the headbox casing **14**, and as a result there is no concentration of loading in the machine direction, as occurs when cross spanning beams support the headbox only at the juncture of the headbox and nozzle.

Framing in prior art has been disclosed of generally a circular shape, as in Canadian Patent No. 464,219 to Hurter and in U.S. Patent No. 2,749,815 to Stewart. But the ends of their beams are not free-springing cantilevers as in the preferred construction of the present disclosure. Hence they can bulge to a maximum deflection at mid-machine. Also their depth does not taper from a minimum near the slice lips to a maximum half-way around the frame circle following a substantially **C**-shaped path. The Hurter frame is not continuous, and the Stewart frame of generally circular path does not terminate in slice lips, but instead it expands for a different result.

In the alternative construction shown in FIGURE 4 and as previously described, the cantilever frames **120** are augmented by upper **150** and lower **151** beams which extend across the headbox casing **114** above and below the nozzle formed by the slice lips **118** and directly after the casing outlet **116**. Cross-spanning beams inherently bulge to a maximum deflection at mid-span, but in this disclosure means have been described for lowering the static pressure throughout the flow direction via high velocity, and thereby providing a means of reducing such bulge, and permitting the use of a light frame. The arrangement of the inlet conduit **110** having a discharge slot **112** and the surrounding casing **114** is the same as previously described providing a flow passage **115** with the exception that a portion of the interior of the flow passage **115** adjacent to the discharge slot **112** may be corrugated as indicated at **117**.

Corrugations of this nature might also be utilized in the constructions shown in FIGURES 1–3 and are more effective in the relatively shallow flow passages **15**—**115** than in the type of headbox having a **V**-shaped forward portion. When disposed for example in an arc about the inner periphery of the headbox casing the corrugations **117** interrupt streaking in the machine direction and ease the migration of equalizing currents in the cross machine direction. The corrugated surface can be disposed so as to extend any desired distance about the interior of the headbox casing. For some distance opposite slot **112** the corrugations could be disposed in the machine direction, or around the exterior of inlet conduit **110**, or they could be substituted by some embossed pattern to offer resistance to the flow and thereby to equalize any possible irregularities of flow.

A plurality of lever members **130** (only one shown) operated through a common shaft **132** are again utilized to manipulate the opposed slice lips **118**. Adjustable link members **135** (only one shown) supported from the upper beam **150** are utilized to interconnect the lever member **130** and the shaft **132** which is mounted for eccentric rotary movement as before.

In the further alternative construction shown in FIGURE 5 a modified type of cantilever or framing is utilized rather than the **C** type indicated at **20** and **120** in the previous constructions. In this construction (FIG-

URE 5) the forward portion only of the casing **214** is supported by the members **220** and these extend to upper and lower beams **250**, **251** spanning the headbox structure. The arrangement of the discharge slot **212**, the inlet conduit **210** and cylindrical casing **214** providing the passage **215** are the same as previously described with the slice lips **218** extending from the outlet aperture **216** to constitute the outside nozzle. Supplementary gusset bracket members **223**, **224**, extend from the webs of the beams **250**, **251** to support the slice lips **218** and levers **230** (only one shown) co-operate with a common eccentric shaft **232** to provide a means of adjustment.

In all cases the continuously shallow passages **15**, **115** and **215** about the exterior surfaces of the conduit **10**, **110**, **210** create the new result that wall friction becomes a substantial factor in mixing the flow. A second advantage resulting from relatively shallow flow passages adhering close around almost the entire circumference of the inlet conduit is that the split flow converges at a point diametrically opposite the conduit discharge slot. The result is a smooth flaring of flow towards the slice outlet, just as two opposed streams impinging in the atmosphere will flare smoothly. A localized and desirable mixing also occurs within the composite stream. The inlet conduit and casing may be concentric as shown in the drawings, or may be eccentric, in which case the two flow passages can have converging walls to aid flow stability.

Various patterns of inlet may be used, and as a preferred construction FIGURES 2 and 5 for example show the inlet conduits **10** and **210** respectively to have a conical liner, after the construction of applicant's co-pending application S.N. 739,093, filed June 2, 1958. Such a conical liner, or a pair of such cones arranged opposed within the inlet conduit, is represented by radial lines **13** in FIGURE 2 and lines **213** in FIGURE 5.

In use, all constructions described work in the same manner. The casing **14**, **114** or **214** is maintained full and under pressure by the delivery of liquid to either or both ends of the inlet conduit **10**, **110**, or **210** respectively. The liquid issues from the respective outlet slots to impinge against the interior of the headbox casing so that the flow splits into two layers to fold back through the flow passages between the interior of the headbox casing and the exterior of the inlet conduit. These fluid layers merge virtually head-on at the casing outlet aperture or entrance to the outlet nozzle and create localized turbulence. The liquid then issues between the opposed slice lips with a defined ribbon-like shape.

I claim:

1. A pressure headbox adapted to deliver stock to a paper machine comprising, a material inlet conduit having discharge means extending along at least one element thereof, a cylindrical casing surrounding said conduit, a vertical wall at both sides of the paper machine to support said conduit and casing in spaced relationship from each other to form an unobstructed annular flow passage

of cylindrical form therebetween, an unobstructed aperture along the length of said casing in diametrically opposed relationship to said conduit discharge means, a pair of opposed flexible slice lips connected to and extending outwardly from said casing in register with said outlet aperture to form an unobstructed outlet nozzle, said unobstructed annular flow passage terminating at the juncture of said cylindrical casing and said slice lips whereby stock delivered from said material inlet conduit through said discharge means is divided into two contained liquid streams adapted to impinge head-on at said juncture and issue as a composite stream between said slice lips, means to adjust the spacing between said lips, and framing means disposed exteriorly of said casing adapted to support said casing against liquid pressure created within said unobstructed annular flow passage, outlet aperture and opposed flexible lips constituting said outlet nozzle.

2. A paper-making headbox as claimed in claim 1, with corrugations comprising a lining along a portion of the interior of the said cylindrical casing.

3. A paper-making headbox as claimed in claim 1, wherein said framing means includes a frame comprising a battery of cantilevers each in the vertical plane in the machine direction, each cantilever curving along a C-shaped path around the cylindrical casing, the cantilever along said path tapering from a minimum web-depth near the tips of the C to a maximum web-depth half-way along the C path.

4. A pressure headbox as claimed in claim 1, wherein the framing means mounted about said casing exterior comprises a plurality of substantially C-shaped cantilevers disposed in axially spaced relationship along the length of said casing, said cantilevers each surrounding said cylindrical casing and including portions extending transversely of each of said opposed slice lips.

5. A pressure headbox as claimed in claim 1 wherein said framing means includes a pair of external beams spanning said casing longitudinally one along each exterior surface of said casing outlet nozzle.

6. A pressure headbox as claimed in claim 1, wherein said material inlet and cylindrical casing are eccentric to each other and their axes are in a common plane with the axis of said conduit discharge means and casing outlet.

References Cited in the file of this patent

UNITED STATES PATENTS

1,534,080	Russell	Apr. 21, 1925
1,889,819	Berry	Dec. 6, 1932
2,394,509	Boettinger	Feb. 5, 1946
2,688,276	Showers	Sept. 7, 1954
2,749,815	Stewart	June 12, 1956
2,859,668	Berlyn	Nov. 11, 1958

FOREIGN PATENTS

1,008,564	Germany	May 16, 1957