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H. DAHL ET AL
HEADBOX FOR A PAPERMAKING MACHINE CONTAINING
MULTIPLE PARALLEL DUCTS

3,725,197

Filed Aug. 11, 1970

4 Sheets-Sheet 1

Fig. 1

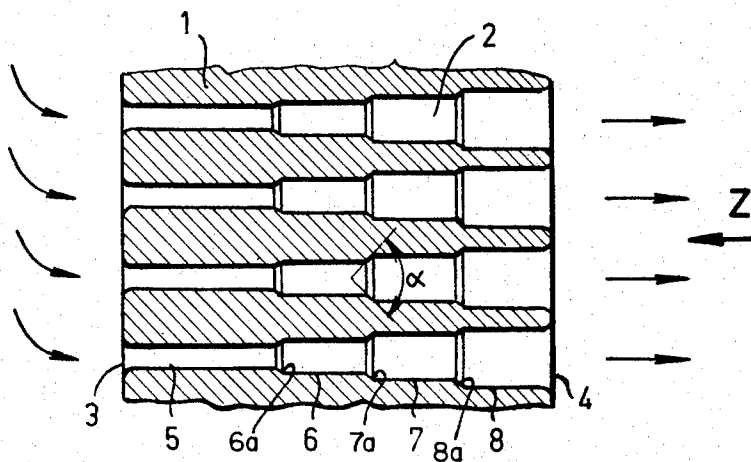
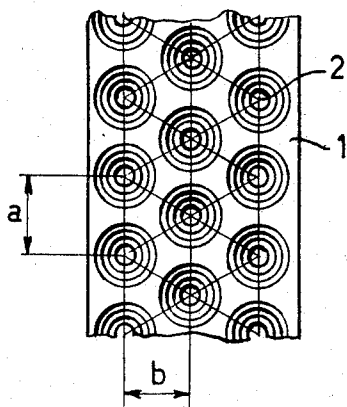


Fig. 2



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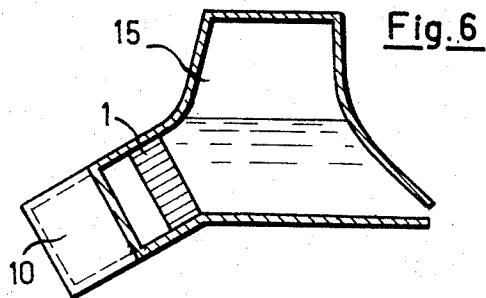
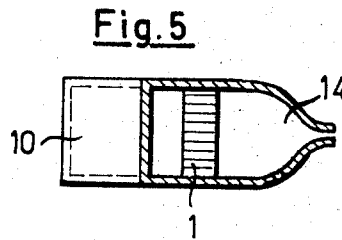
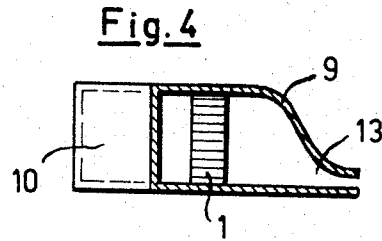
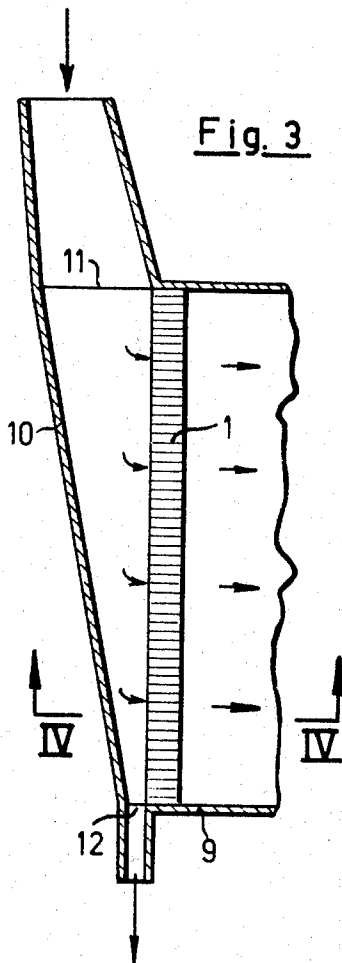
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Fig. 7

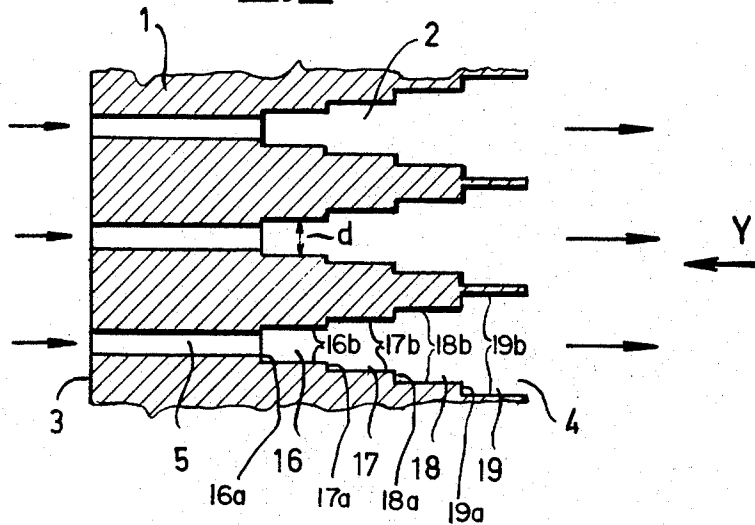
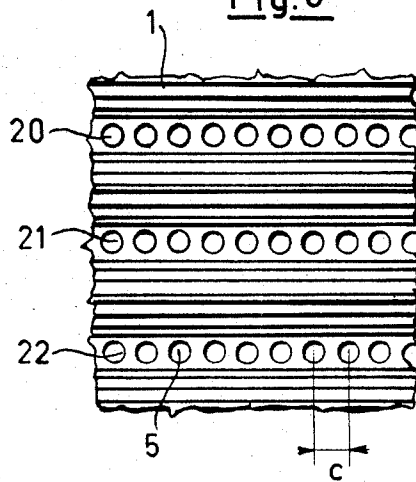


Fig. 8



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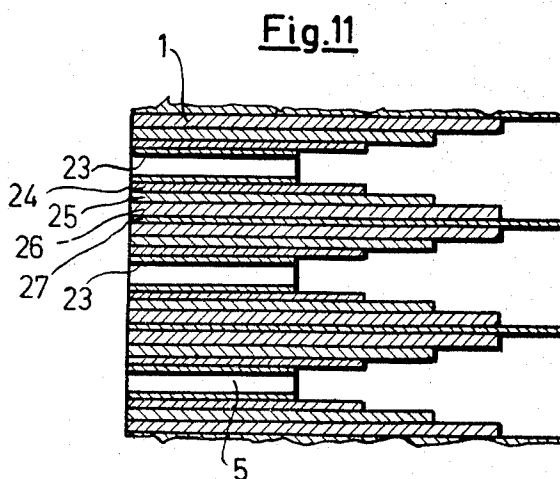
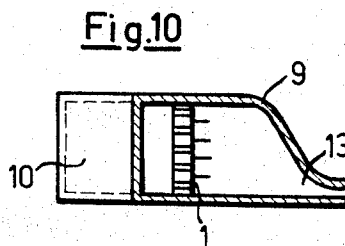
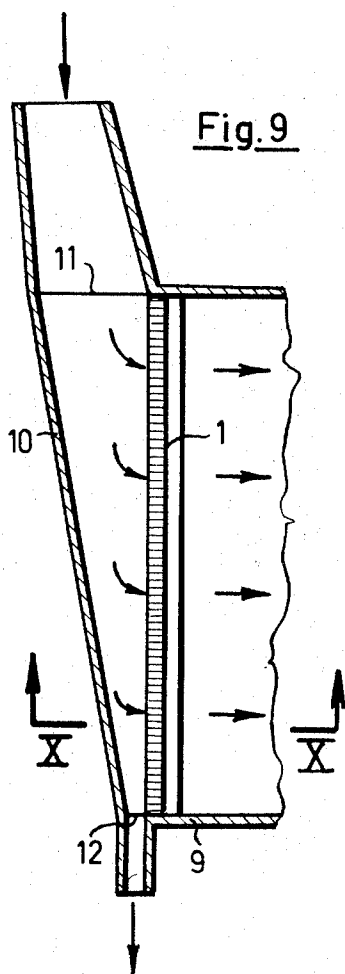
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HEADBOX FOR A PAPERMAKING MACHINE CONTAINING MULTIPLE PARALLEL DUCTS

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8 Claims

ABSTRACT OF THE DISCLOSURE

A headbox for a papermaking machine which includes a plate which extends over the width thereof and contains a plurality of parallel ducts, each of which widen in stepwise fashion with the opening angle between each successively larger duct portion being between 100° and 180°. The stock suspension feeds to the headbox plate directly from the supply conduit and is discharged from the parallel ducts to the headbox outlet by an unobstructed flow path.

BACKGROUND OF THE INVENTION

The invention relates to a headbox for papermaking and the like machines, wherein the suspension of fibres is lead through a perforated plate which extends over the entire width of the web to be formed and has a plurality of ducts which are parallel to one another.

In the British patent specification 1,120,742 there is shown a forward end of a papermaking machine wherein a distributor is interposed between the supply line for the pulp and the headbox. This distributor is used for slowing-down the flow from the speed in the supply line to the speed in the headbox, and is constructed to widen stepwise, so that its widening angle may be greater than that of a normal diffuser.

In the headbox shown in the German patent specification 853,256 there is interposed between a mixing chamber on the one hand to which pulp is supplied from a tube distributor, and the stuff box on the other hand, a cluster of tubes which extend over the entire width of the web to be formed and comprise a plurality of tubes arranged parallel to one another. The laminar flow constrainedly brought about by guidance in the long tubes is also intended to be maintained in the stuff box.

A further headbox with a tube group comprising very long tubes is shown in the German patent application as laid open for public inspection 1,461,071. It is true that the long tube group opens directly into the outlet, but it must be preceded by a device for bringing about uniform pressure conditions.

In the official publication of the abridged description of the French patent specification 1,558,396, long ducts arranged in the manner of tube groups are known which have a conically widening initial portion. But these ducts must be followed by a grid in order to make the flow towards the outlet of the stuff box uniform.

In modern headboxes, long tube groups have been replaced by short perforated plates. But in the case of one such headbox shown in the German patent application as laid open for public inspection 1,290,797, relatively long diffusers have to be connected with the perforated plates. In the headbox according to German patent specification 1,236,922, the perforated plate has to be followed by perforated discs which are arranged with spacing therefrom, and guide surfaces extending parallel to the direction of wire travel are proposed which follow the last perforated disc.

The headboxes using tube groups which have been described require a considerable overall length and a com-

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plicated distributing or pressure compensating arrangement. The headboxes with perforated plates which have been described are complicated owing to the elements connected with the said plate, and also require a fairly considerable overall length.

SUMMARY OF THE INVENTION

The invention has as its object to permit a simpler and more compact headbox which is relatively inexpensive to produce.

In a headbox provided with a perforated plate, of the type mentioned initially, this problem is solved according to the invention in that the ducts of the plate are widened stepwise after an initial portion in the throughflow direction of the suspension of fibres, whereby the transition between two successive portions of said ducts has an opening angle of at least 100°.

The opening angle preferably may be 180°, and advantageously there will be at least two stage portions following said initial portion.

Advantageously the fibre suspension is fed to the perforated plate through a supply conduit extending transversely to the throughflow direction thereof, as is known from the two last-mentioned publications. Preferably the inlet cross-section of the supply conduit is so dimensioned that the flow speed in this inlet cross-section amounts to 45–85% of the flow speed in the initial portion of the ducts of the perforated plate. Preferably, the diameter of the ducts in the plate at the inlet side thereof amounts to at least 8 mm. and at the outlet side thereof at the most 40 mm.

More particularly the diameter of the ducts at their inlet side is to amount to 8 to 20 mm., the sum of the cross-sectional areas of the ducts amounting to 5 to 20% of the total cross-sectional area of the perforated plate. Furthermore the length of the initial portion is to amount to 5 to 10 times the diameter of the ducts at their inlet side. Finally, the diameter of the ducts at their outlet side is to amount to 25 to 40 mm., the sum of the cross-sectional areas of the ducts amounting to 40 to 85% of the total cross-sectional area of the perforated plate.

Particularly advantageous results are obtained if the diameter of the ducts at their inlet side amounts to 10 to 15 mm., the sum of the cross-sectional areas of the ducts amounting to 8 to 15% of the total cross-sectional area of the perforated plate, and if the length of the initial portion amounts to 6 to 8 times the diameter of the ducts at their inlet side, and if the diameter of the ducts at their outlet side amounts to 25 to 40 mm., the sum of the cross-sectional areas of the ducts amounting to 50 to 75% of the total cross-sectional area of the perforated plate.

This kind of perforated plate can be produced in a particularly simple manner by arranging the ducts in individual rows and making one or more stage portions of a duct and the corresponding stage portions of the ducts adjoining it in the same row merge into one another in the direction of the row, the walls of the stage portions which merge into one another extending at least substantially in the direction of the row.

It is particularly advantageous if all those stage portions of the ducts of a row which follow the initial portion merge into one another in the direction of the row, and the walls of the stage portions extend exactly in the direction of the row. In this way it is possible to avoid drilling the stage portions. The stage portions can be formed by joining strips side by side which extend over the entire length of a row.

The headbox according to the invention has important advantages relatively to the known headboxes. Owing to the preferred acceleration of the flow at the inlet region of the ducts in the perforated plate a considerable throt-

ting effect occurs and this ensures good distribution of the fibre suspension over all ducts. The transverse arrangement of the supply conduit has the effect that the flow in the supply conduit passes along the inlet side of the plate and keeps this clean. Perforated cylinders arranged at the inlet side, or other turbulent-producing means with their negative consequences for flow stability, are no longer necessary. Owing to the stepped arrangement of the widening of the ducts in the plate, the slowing-down of the flow in the plate which follows the aforesaid acceleration can take place without unstable flow detachment phenomena and detrimental precipitation over a short distance. The flow speed at the end of the ducts can be only slightly above the speed in the part of the stuff box following the perforated plate, and perforated discs downstream of the perforated plate, on which accretions can form, can be dispensed with.

BRIEF DESCRIPTION OF THE DRAWING

Examples of embodiment of the invention are shown in simplified manner in the drawings by means of which further forms of embodiment of the invention are also described. In the drawings:

FIG. 1 shows a fragmentary horizontal sectional view of a perforated plate, taken in the direction of the ducts,

FIG. 2 shows a view of the perforated plate in the direction of the arrow Z in FIG. 1,

FIG. 3 shows a horizontal sectional view through a perforated plate and a supply conduit associated therewith for the fibre suspension,

FIG. 4 shows a sectional view taken on the line IV—IV of FIG. 3,

FIG. 5 shows a view in section corresponding to FIG. 4 through another form of embodiment,

FIG. 6 shows a view in section corresponding to FIG. 4 through a further form of embodiment,

FIG. 7 shows a section in fragmentary manner through a perforated plate, taken in the direction of the ducts,

FIG. 8 shows a view of the perforated plate in the direction of the arrow Y in FIG. 7,

FIG. 9 shows a horizontal section through a perforated plate and a supply conduit associated therewith for the fibre suspension,

FIG. 10 shows a sectional view taken on the line X—X of FIG. 9, and

FIG. 11 shows a view in section corresponding to FIG. 7 through a further form of embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A perforated plate 1 which is shown in FIGS. 1 and 2 and is intended for a headbox for papermaking or the like machine—the drawings show only a fragmentary part of the said plate—extends over the entire width of the web to be formed and comprises a plurality of ducts 2 for the fibre suspension, which are parallel to one another. As four arrows show in each case, the fibre suspension enters the duct 2 of the plate 1 at the inlet side 3 which is at the left in the drawing, and issues from the ducts at their outlet side 4.

The ducts 2 of the plate 1 are widened stepwise after an initial portion 5—in the direction of throughflow of the fibre suspension. The three stage portions formed by the steps 6a, 7a and 8a following the initial portion 5 are designated as 6, 7 and 8.

The diameter of the ducts 2 at their inlet side 3 i.e. the diameter of the initial portion 5, amounts to 8 to 20 mm. and preferably 10 to 15 mm., the sum of the cross-sectional areas of the ducts 2 then amounting to 5 to 20%, preferably 8 to 15% of the total cross-sectional area of the perforated plate 1. The length of the initial portion 5 amounts to 5 to 10 times, preferably 6 to 8 times the diameter of the ducts 2 at their inlet side 3 i.e. the diameter of the initial portion 5. The diameter of the ducts 2 at their outlet side 4 i.e. the diameter of

the stage portion 8, amounts to 25 to 40 mm., the sum of the cross-sectional areas of the ducts 2 then amounting to 40 to 85%, preferably 50 to 75% of the total cross-sectional area of the perforated plate 1.

The diameters of the stage portions 6, 7 and 8 of the ducts 2 amount to 1.2 to 1.5 times the diameter of the immediately preceding portion 5, 6, 7 respectively. The length of the individual stage portions 6, 7, 8 amounts to 30 to 60 mm. preferably 40 to 50 mm.

The inlet edge of each of the ducts 2 is rounded with a radius which amounts to 25 to 35% of the diameter of the ducts at their inlet side i.e. the diameter of the initial portion 5. Instead, the inlet edge of the ducts 2 can be bevelled with a bevelling which amounts to 15 to 25% of the diameter of the initial portion 5. The outlet edge of the ducts 2 is rounded with a radius of 2 to 3 mm.

The ducts are advantageously given a circular cross-section as in the example of embodiment. If they are given a different cross-sectional form, for example a hexagonal cross-section, the valid diameter is the hydraulic diameter of the cross-section.

The transition or step 6a, 7a or 8a between two successive portions of a duct is given a frusto-conical shape, widening in the direction of throughflow of the fibre suspension, with an opening angle α of 100 to 150°. Alternatively, the transition may be formed of a surface extending at right angles to the duct axis, in which case the corner in the niche formed by the step is advantageously rounded.

The initial portion 5 and the following stage portions 6, 7, 8 are of cylindrical shape. However, these portions of the ducts may be constructed so that they widen in the direction of throughflow of the fibre suspension with an opening angle of at the most 3°. However, advantageously an opening angle of only 1 to 2° will be chosen.

The circular-section ducts 2 are arranged as close together as possible. They all have the same spacing a , the spacing b between neighbouring rows amounting to $a/2 \cdot \sqrt{3}$. This honeycomb arrangement is indicated by the grid pattern formed of equilateral triangles drawn by means of thin lines in FIG. 2.

In the example of embodiment shown in FIG. 3, the perforated plate 1 is shown in its entire extent over the width of the web to be formed. It is arranged in a headbox 9. The fibre suspension is fed to the perforated plate 1 by way of a supply conduit 10 which extends transversely to the direction of throughflow through the said plate. The inlet cross-section 11 of the supply conduit 10 is so dimensioned that the speed of flow in this inlet cross-section amounts to 45 to 85% of the speed of flow in the initial portion 5 of the ducts 2 of the perforated plate 1. The cross-section of the supply conduit 10 also decreases proportionally to the width of the perforated plate 1, i.e. the width of the web to be formed.

For the return of the fibre suspension, the supply conduit 10 has an outlet cross-section 12 amounting to 8 to 15% of the inlet cross-section 11.

The example of embodiment shown in FIGS. 3 and 4 illustrates the advantages of the invention particularly clearly. The perforated plate 1 can be preceded immediately by the simple supply conduit 10 feeding the fibre suspension in transversely, and can be followed immediately by the outlet 13 of the headbox 9.

As FIG. 5 shows, instead of the outlet 13 situated at the height of the lower edge of the perforated plate 1, it is also possible to use an outlet 14 which is arranged centrally of the height of the perforated plate 1.

In the compressed-air headbox which is shown in FIG. 6 and which uses a compressed-air cushion 15 also, the perforated plate 1 constructed according to the invention affords important advantages. The short perforated plate 1 can immediately precede the stuff box, and again a simple supply conduit 10 is sufficient for distribution of the fibre suspension.

In the case of the perforated plate 1 shown in FIGS.

7 and 8, four stage portions following the initial portion 5 are designated as 16, 17, 18 and 19.

The ducts 2 are arranged in individual rows 20, 21 and 22, and the stage portions 16, 17, 18 and 19 which follow the initial portion 5 in the ducts 2 of the rows 20, 21, 22 merge into one another in the direction of the relevant row in each case. The bounding walls 16b, 17b, 18b and 19b of the stage portions 16, 17, 18, 19 which merge into one another extend in the direction of the relevant row.

The diameter of the ducts 2 at their inlet side 3, i.e. the diameter of the initial portion 5, amounts to 8 to 20 mm., preferably 10 to 15 mm., the sum of the cross-sectional areas of the ducts 2 then amounting to 5 to 20%, preferably 8 to 15% of the total cross-sectional area of the perforated plate 1. The length of the initial portion 5 amounts to 5 to 10 times, preferably 6 to 8 times the diameter of the ducts 2 at their inlet side 3, i.e. the diameter of the initial portion 5.

In accordance with the cross-sectional area percentages given hereinbefore, the initial portions 5 are arranged close together. The width *d* of the stage portion 16 directly following the initial portion 5 is equal to the spacing *c* of the centres of the initial portions 5.

The cross-sectional area of the merged stage portions 16 for the stuff throughflow amounts to 1.3 to 2.3 times the sum of the cross-sectional areas of the initial portions 5. Furthermore the cross-sectional area of a stage portion 17 or 18 or 19 respectively amounts to 1.3 to 2.3 times the cross-sectional area of the immediately preceding stage portion 16 or 17 or 18. The length of the individual stage portions 16, 17, 18, 19 amounts to 30 to 60 mm., preferably 40 to 50 mm.

Again, the inlet edge of the ducts 2 is rounded with a radius which amounts to 25 to 35% of the diameter of the ducts at their inlet side, i.e. the diameter of the initial portion 5. Instead, the inlet edge of the ducts 2 can be bevelled with a bevelling which amounts to 15 to 25% of the diameter of the initial portions 5.

The intermediate walls remaining between the last stage portions 19 of two neighbouring rows 20, 21 or 21, 22 are to be very thin. The edges at the outlet side 4 are advantageously rounded; said intermediate walls may also be constructed to narrow continuously towards the outlet end 4.

The transition or step 16a, 17a, 18a or 19a between two successive duct portions 5, 16 or 16, 17 or 17, 18 or 18, 19 can be effected in the ways described with reference to FIGS. 1 and 2. Likewise the portions of a duct need not have a constant cross-sectional area over their entire length, and instead the duct walls may be given an opening angle of 1 to 2° (at the most 3°)—widening the throughflow cross-section.

FIGS. 9 and 10 show that the FIG. 7 embodiment of the plate 1 may be used in the same way as the FIG. 1 version. In this example, the rows of ducts 2 in the perforated plate 1 extend over the width of the web to be formed, i.e. parallel to the drawing plane in FIG. 9. The rows of ducts 2 may, alternatively, extend for example at right angles to the width of the web to be formed.

The perforated plate 1 shown in FIG. 11 is composed of individual parts, namely a perforated strip 23 with the holes of the initial portion 5, and strips 24, 25, 26, 27 which are glued to one another and to the perforated strip 23.

We claim:

1. A headbox for papermaking and similar machines including an inlet for fiber suspension, a supply conduit leading from the inlet, and an outlet for delivering the suspension to the web to be formed by the machine, and characterized by a plate which extends over the entire width of said web and contains a plurality of parallel ducts having entrances which communicate directly with the supply conduit and each of which is divided into successive portions of larger cross section by steps which afford opening angles of at least 100°, each duct having an initial portion and at least two additional downstream portions; and by an unobstructed flow path which leads the suspension issuing from the ducts to the outlet.

2. The headbox defined in claim 1 in which each step affords an opening angle of 180°.

3. The headbox defined in claim 1 in which the supply conduit is arranged transversely to the ducts; and the inlet is sized so that the flow velocity therein is 45% to 85% of the velocity in said initial portion of the ducts.

4. The headbox defined in claim 3 in which the duct entrances have a diameter of 8 to 20 mm.; the sum of the cross-sectional areas of said entrances is 5 to 20% of the total cross-sectional area of said plate; the length of said initial portion is 5 to 10 times the diameter of said duct entrances; the duct exits have a diameter of 25 to 40 mm.; and the sum of the cross-sectional areas of said exits is 40 to 85% of the total cross-sectional area of said plate.

5. The headbox defined in claim 1 in which the diameter of each additional duct portion is 1.2 to 1.5 times the diameter of the immediately preceding duct portion.

6. The headbox defined in claim 1 in which said ducts are arranged in individual rows, and one or more of said additional portions of each duct and the corresponding portion of the neighbouring ducts of the same row merge into one another in the direction of the row; and the portions which merge into one another have bounding walls which extend at least substantially in the direction of the row.

7. The headbox defined in claim 6 in which the cross-sectional area of each additional portion of a duct is 1.3 to 2.3 times the cross-sectional area of the immediately preceding portion.

8. The headbox defined in claim 1 in which the length of each additional duct portion is 30 to 60 mm.

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