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(71) Applicant: **Falmer Investments Limited**
Road Town, Tortola (VG)

(72) Inventor: **Tsui Tak Ming, William**
Causeway Bay,
Hong Kong (CN)

(74) Representative: **McGowan, Cathrine**
D Young & Co
120 Holborn
London EC1N 2DY (GB)

(54) **Nozzle for jet fabric dyeing machine**

(57) A nozzle assembly (10) for a jet fabric dyeing machine (1) comprises a tubular nozzle member through which fabric travels, the nozzle member defined by four side walls (26) and having a rectangular cross-section, and a nozzle gap (24) in a side wall (26A) of the nozzle member through which a jet of fluid can be applied to fabric in the nozzle member to propel the fabric along a travel path (T). An entry end (29) of the nozzle member has a decreasing cross-section to funnel fabric into the nozzle member, and an exit end (30) of the nozzle member has a rectangular guide tube (3) of expanding cross-section terminating in a fan-shaped trough (32). A fluid diverter (25, 27) intercepts part of the fluid jet and delivers it to a different side of the fabric.

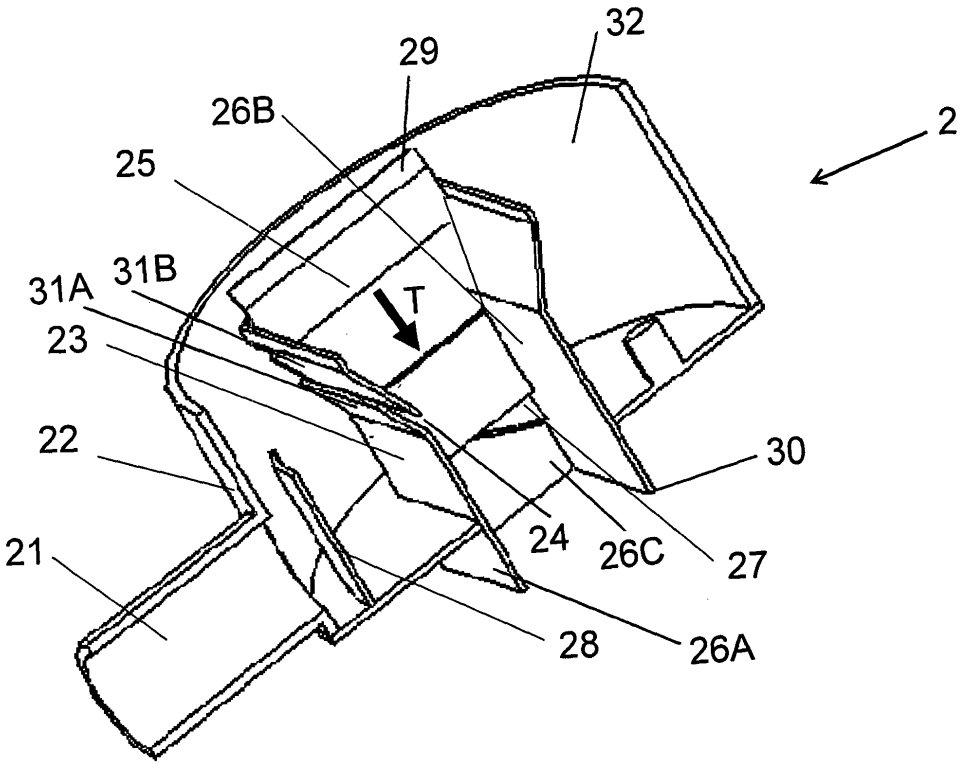

Figure 3

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a nozzle for a jet fabric dyeing machine.

[0002] Fabric is commonly dyed in high speed jet dyeing machines. Such machines comprise a series of pipes, tubes and chambers arranged in a communicating sequence to form an endless fabric travel path. The fabric, configured as an endless rope, passes around the path, and is propelled along by one or more jets of high pressure fluid (dye liquor) directed onto the rope.

[0003] The fluid jets are applied by a nozzle. The nozzle comprises a tubular aperture through which the fabric rope passes. One or more gaps in the wall of the aperture direct the jets, at high pressure, onto the rope inside the aperture, propelling it forward along the travel path.

[0004] The design of such a nozzle can be challenging. On one hand, the nozzle should not occupy too much space, as this would take up too much fluid volume within the machine and affect the liquor ratio (ratio of the volume of dye liquor to the weight/amount of fabric that is required to produce a desired dyeing result). On the other hand, the nozzle should be capable of delivering a sufficiently powerful jet and a large enough volume of dye liquor for even penetration and exchange of dye onto and into the fabric.

[0005] Conventionally, the nozzle aperture is circular in cross-section. The aperture is mounted in a nozzle casing which defines a chamber around the aperture. The casing has an inlet pipe through which dye liquor is supplied to the chamber, which communicates with the nozzle gap to deliver the jet of fluid through the aperture wall and onto the fabric.

[0006] To achieve an even dyeing effect, it is desirable that the fabric rope opens across the width of the fabric during dyeing, and changes position each time it passes through the nozzle. This provides an effective and even application of dye liquor onto and into the fabric. However, a circular nozzle tends to squeeze and compress the fabric passing through it rather than allowing the fabric to extend width-wise.

[0007] Nozzles with an oval cross-section have been proposed, to provide an elongated extent in the width direction in which the fabric can unfold as the fluid jets onto it. However, it has been found that an oval shape still produces a tendency for the fabric to be squashed and compressed.

[0008] Also, the delivery of the dye liquor to the nozzle gap via an inlet pipe in the side of the nozzle casing gives different fluid pressures to fluid exiting different parts of the nozzle gap. This may also contribute to unevenness in the dyeing.

SUMMARY OF THE INVENTION

[0009] Accordingly, a first aspect of the present invention is directed to a nozzle assembly for a jet fabric dyeing machine, the nozzle assembly comprising: a tubular nozzle member through which fabric travels, the nozzle member defined by four side walls and having a cross-section that has a parallelogram shape; and a nozzle gap in a first side wall of the nozzle member through which a jet of fluid can be applied to fabric in the nozzle member to propel the fabric along a travel path.

[0010] A nozzle member having a parallelogram cross-section provides a space into the fabric can be billowed and spread out by the force of the applied jet of fluid. Opening the fabric in this way allows a more even dyeing effect to be achieved, and also reduces compacting of the fabric so that less creasing occurs. Any parallelogram shaped can be employed, but a right-angled parallelogram may be more convenient to fabricate, and a rectangle may be found to provide a more suitable space for the spread-out fabric than a square. Therefore, in some embodiments, the nozzle member may have a substantially rectangular cross-section.

[0011] A fabric entry end of the nozzle member may have a cross-section that decreases along the direction of the fabric travel path. This funnels the fabric down to the nozzle gap, and also reduces the chance that the fabric will become caught on the edges of the nozzle member.

[0012] The nozzle assembly may further comprise an outer casing within which the nozzle member is mounted, the outer casing defining a chamber around the nozzle assembly from which fluid can be delivered to the nozzle gap.

[0013] The outer casing may have a fluid inlet pipe through which fluid can be delivered to the chamber. In some embodiments, the fluid inlet pipe may be aligned with the first side wall of the nozzle member. This provides the shortest path for fluid from the inlet pipe to the nozzle gap, so a smaller volume of fluid is needed inside the chamber. However, a direct path of this kind may result in an uneven jet through the nozzle gap, giving uneven dyeing. Therefore, the nozzle assembly may further comprise a deflecting plate mounted inside the outer casing to interrupt a direct fluid path from the inlet pipe to the nozzle gap. A deflecting plate disperses the incoming fluid so that it can be more evenly distributed across the nozzle gap.

[0014] In some examples, the outer casing may be cylindrical. This provides for ease of manufacture.

[0015] In some embodiments, the nozzle assembly may further comprise a fluid diverter configured to intercept part of a jet of fluid applied through the nozzle gap and direct it onto fabric in the nozzle member from a direction different to the direction of the non-intercepted part of the jet of fluid. A second fluid application direction can offer a more even dyeing effect. The fluid diverter may be configured to direct the intercepted part of the jet of fluid onto a part of the fabric substantially opposite to the part to which the non-intercepted part of the jet of fluid is applied.

[0016] The fluid diverter may comprise an inner wall of the nozzle member that is spaced inwardly from a side wall next to the first side wall to divide the nozzle gap into two parts, and a blade extending between the first side wall and the inner side wall to direct the intercepted part of the jet of fluid under a part of the inner side wall remote from the first side wall.

[0017] In some embodiments, the nozzle assembly may further comprise a guide tube extending from a fluid exit end of the nozzle member, the guide tube having a cross-section that has the shape of a parallelogram, the cross-section increasing along the direction of the fabric travel path. The guide tube provides an extended space in which the fabric can be spread out, contributing further to an improved dyeing effect. The guide tube may terminate in an open fan-shaped trough portion.

[0018] The nozzle assembly may be configured to be mounted within a jet fabric dyeing machine such that the first side wall of the nozzle member is lower than the remaining three side walls. This arrangement allows the jet of fluid to be applied to the underside of the fabric, so that the fabric is pushed upwards and then falls under gravity, which further enhances the opening up of the fabric.

[0019] A second aspect of the present invention is directed to a jet fabric dyeing machine comprising a nozzle assembly according to the first aspect. The nozzle assembly may be mounted within the jet fabric dyeing machine such that the first side wall of the nozzle member is lower than the remaining three side walls.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] For a better understanding of the invention and to show how the same may be carried into effect reference is now made by way of example to the accompanying drawings in which:

Figure 1 shows a side view of a conventional jet fabric dyeing machine within which a nozzle assembly according to the present invention can be used;
Figure 2 shows a perspective exterior view of a nozzle assembly according to an embodiment of the present invention;
Figure 3 shows a cut-away perspective interior view of part of the nozzle assembly of Figure 2; and
Figure 4 shows a perspective view of a fluid diverter incorporated in the nozzle assembly of Figure 2.

DETAILED DESCRIPTION

[0021] Figure 1 shows a side view of an example of a conventional jet fabric dyeing machine. The machine 1 comprises a cylindrical main chamber 11 and a smaller diameter travelling tube 13 arranged under the main chamber 11 and connected to each end of the main chamber 11. The main chamber 11 and the travelling tube 13 thereby form a continuous enclosed pathway around which an endless rope of fabric can be circulated while being brought into contact with dye liquor or another treatment fluid. The fabric is dyed or otherwise treated during a specified treatment time circulating around the machine.

[0022] The fabric rope is propelled along the travel path around the machine by a nozzle assembly 12, located at one end of the main chamber 11 at the entrance to the travelling tube 13. The nozzle assembly conventionally comprises a tubular nozzle member through which the fabric passes (the nozzle member thereby forming part of the fabric travel path). High pressure jets of fluid such as dye liquor or other treatment fluid are directed onto the fabric through gaps in the side wall of the nozzle member, the pressure of the fluid pushing the fabric along its path. A rotating roller may be provided near to the entrance of the nozzle assembly 12 to feed fabric from the main chamber into the tubular nozzle member.

[0023] Figure 2 shows a perspective view of the exterior of a nozzle assembly according to an embodiment of the invention, which may be employed in a jet fabric dyeing machine, for example a jet fabric dyeing machine such as that shown in Figure 1.

[0024] The nozzle assembly 10 comprises a nozzle part 2 connected to a guide tube 3. The nozzle part 2 has a central aperture extending through it (see Figure 3) which communicates with the guide tube 3 to form an extended tubular aperture. When incorporated into a jet fabric dyeing machine the extended tubular aperture forms part of the continuous travel path for a fabric rope, the fabric rope passing through the tubular aperture. The arrow T in Figure 2 indicates the direction of travel of fabric through the nozzle assembly.

[0025] Figure 3 shows a cut-away perspective view of the interior of the nozzle part 2 of the nozzle assembly 10. The nozzle part 2 includes a tubular nozzle member 23, which forms the central aperture through the nozzle part 2. The nozzle member 23 is formed from four side walls arranged such that the nozzle member 23 has a cross-section that is substantially rectangular. Shown in Figure 3 are a first side wall 26A, a second side wall 26B opposite the first side wall, and a third side wall 26C joining the first and second side walls. A fourth side wall opposite the third side wall is cut away in the Figure and hence not visible. The side walls extend from a fabric entry end 29 of the nozzle member 23 to a fabric exit end 30 of the nozzle member 23. Again, the arrow T shows the direction of travel of fabric through the nozzle member 23, from the fabric entry end 29 to the fabric exit end 30. In this example, the side walls 26 flare outwards towards the fabric entry end 29, so that the cross-section of the nozzle member 23 decreases along the direction of fabric travel. This helps to funnel the fabric rope into the nozzle member and reduces the risk of the fabric catching on the edges of the nozzle member, but is not essential.

[0026] A nozzle gap 24 is formed in the first side wall 26A of the nozzle member 23. In this example, the nozzle gap 24 is a slot extending across the width of the first

side wall, and defined between two parallel sloping plates 31A, 31B so that the gap 24 is angled along the axis of the nozzle member 23. Thus, fluid jetting from the gap 24 is directed substantially along the direction of fabric travel and thereby propels fabric in the nozzle member 23 is a forward direction along the fabric travel path.

[0027] Fluid is delivered through the nozzle gap 24 from a fluid chamber 32 outside the nozzle member 23. An outer casing or shell 22 is provided around the nozzle member 23, the nozzle member being mounted within the outer casing 22. The void between the outer casing 22 and the nozzle member 23 forms the chamber 32. In this example, the outer casing 22 is cylindrical, having a circular cross-section in the plane in which the nozzle member 23 has its rectangular cross-section. This shape of outer casing provides for ease of manufacturer as compared to a square or rectangular outer casing, but other shapes are not precluded.

[0028] The outer casing 22 has a fluid inlet pipe 21 let into its side wall, through which fluid enters the chamber 32 for delivery to the nozzle gap 24. The fluid inlet pipe 21 is connectable to the fluid circulation pipework of the fabric dyeing machine for supply of fluid to the inlet pipe by a pump in the pipework. The fluid inlet pipe 21 can be positioned anywhere on the outer casing 22. However, in the illustrated example, the fluid inlet pipe 21 is located so that it is aligned with the first side wall 26A of the nozzle member 23, in which the nozzle gap 24 is situated. In other words, the fluid inlet pipe 21 is closest to the first side wall 26A, and substantially orthogonal to the first side wall 26A.

[0029] With this arrangement, fluid entering the chamber 32 from the fluid inlet pipe 21 can flush immediately through the nozzle gap 24, which reduces the amount of fluid volume that has to be present in the chamber 32 for delivery of fluid through the nozzle gap 24. This can be beneficial in reducing the liquor volume of the fabric dyeing machine (volume of dye liquor per weight of fabric needed for a satisfactory dyeing result). However, it may be found that such a direct path from the fluid inlet pipe 21 to the nozzle gap 24 does not give an even distribution of fluid across the nozzle gap 24, resulting in an uneven fluid jet. To address this, a deflecting plate 28 may be provided. This is mounted to the outer casing 22 just beyond the mouth of the fluid inlet pipe 21, and interrupts the direct path between the fluid inlet pipe 21 and the nozzle gap 24 so as to redistribute the fluid before it reaches the nozzle gap 24. The deflecting plate 28 may be convex with respect to the incoming fluid, to offer less resistance.

[0030] In Figure 3, the nozzle assembly 2 is shown tilted at an angle such that the fabric path through the nozzle member 23 slopes downhill. The nozzle assembly 2 may be configured such that it can be mounted within a fabric dyeing machine at a downward sloping angle. Also, the nozzle assembly is arranged such that the first side wall 26A of the nozzle member 23, having the nozzle gap 24, is the lowest of the four side walls 26. When arranged like this, the fluid jet from the nozzle gap 24 is applied to the underside of the fabric rope. This forces the fabric rope upwardly towards the opposite side wall 26B. This upward and outward movement away from the fluid jet, combined with subsequent falling back of the fabric under gravity as it moves past the fluid jet, allows the fabric to billow, spread out and rearrange itself. The rectangular shape of the nozzle element 23 accommodates this opening up of the fabric rope, so that compacting of the fabric is reduced and a more even dyeing effect can be achieved.

[0031] Despite the advantages offered by such an arrangement, it may be found that applying the fluid to only one side of the fabric rope produces uneven dyeing. To address this, the nozzle assembly may further comprise a fluid diverting arrangement to direct part of the fluid jet to a different side of the fabric rope as it passes through the nozzle member 23. In particular, part of the jet may be delivered to the opposite side of the fabric rope to that to which the nozzle gap 24 directly applies fluid.

[0032] This may achieved by intercepting part of the fluid jetting through the nozzle gap 24 and redirecting it away from the nearest, underside of the fabric rope and onto another part of the rope. Any suitable construction can be used to achieve this; an example is shown in Figure 3. The nozzle member 23 comprises an additional wall portion in the form of an inner wall 25 arranged substantially parallel to and inwardly spaced from the third side wall 26C adjacent to the first side wall 26A. The inner wall 25 extends across the side wall 26C so as reach to the nozzle gap 24 in the first side wall 26A. The nozzle gap 24 is thereby divided down its height into two parts. Fluid passing through a main part of the gap 24 is applied directly to fabric in the nozzle member 23. Fluid passing through the other part of the gap enters the space between the inner wall 25 and the third side wall 26C and is hence separated from the fabric in the nozzle member 23.

[0033] A blade 27, which may be curved and twisted to better direct and channel fluid, is arranged between the inner wall 25 and the third side wall 26C so that it extends across the space between the two walls downstream from the nozzle gap 24. The blade slopes downwards with respect to the direction of fabric travel to direct fluid entering the space down under the lower side of the inner wall 25, at a location close to the second side wall 26B opposite to the first side wall 26A. Hence, fluid is channelled onto fabric in the nozzle member 23 substantially opposite to the side of the fabric that receives fluid direct from the nozzle gap 24.

[0034] Figure 4 shows the inner wall 25 and the blade 27 in more detail. Note the outward curvature of the leading edge of the inner wall 25; this reduces snagging of fabric entering the nozzle member 23 on the inner wall 25.

[0035] Returning to Figure 3, the nozzle assembly 10 also comprises a guide tube 3 connected to the fabric exit end 30 of the nozzle member 23. The guide tube 3 is formed from four side walls, so that it has a rectangular

cross-section. The side walls are arranged to flare outwardly so that the cross-section increases along the direction of fabric travel. The guide tube therefore provides an additional, larger rectangular volume in which the fabric can expand and spread out under the action of the applied jet of fluid.

[0036] At the downstream end of the guide tube 3, a terminal trough portion 32 is provided in which an upper side wall is absent, and at least the lower of the remaining walls continues to flare outwardly. The terminal portion thus provides a fan-shaped or spade-shaped trough that accommodates the spread-out fabric rope before the fabric is passed to the next part of the dyeing machine, thus extending the length of the part of the fabric travel path over which the fabric is not compacted.

[0037] The nozzle assembly 2 shown in Figures 2, 3 and 4 is an example of the invention only. The invention may be implemented using components shaped and configured differently from those shown. The deflecting plate 28, the fluid diverter, the outer casing 22 and guide tube 3 may be omitted or included as desired, and may be shaped differently from those illustrated while still performing their described functions. Also, the nozzle member 23 may have a square cross-section. Use of the term "rectangular" herein is intended to include the specific example of "square". Non-right angled parallelogram shapes may also be used; "rectangular" is intended to include these shapes also.

Claims

1. A nozzle assembly (10) for a jet fabric dyeing machine (1), the nozzle assembly comprising:

   a tubular nozzle member (23) through which fabric travels, the nozzle member defined by four side walls (26) and having a cross-section that has a parallelogram shape; and
   a nozzle gap (24) in a first side wall (26A) of the nozzle member through which a jet of fluid can be applied to fabric in the nozzle member to propel the fabric along a travel path (T).

2. A nozzle assembly according to claim 1, in which the nozzle member has a substantially rectangular cross-section.

3. A nozzle assembly according to claim 1 or claim 2, in which a fabric entry end (29) of the nozzle member has a cross-section that decreases along the direction of the fabric travel path.

4. A nozzle assembly according to any of claims 1 to 3, further comprising an outer casing (22) within which the nozzle member is mounted, the outer casing defining a chamber (32) around the nozzle assembly from which fluid can be delivered to the nozzle gap.

5. A nozzle assembly according to claim 4, in which the outer casing has a fluid inlet pipe (21) through which fluid can be delivered to the chamber.

6. A nozzle assembly according to claim 5, in which the fluid inlet pipe is aligned with the first side wall of the nozzle member.

7. A nozzle assembly according to claim 6, further comprising a deflecting plate (28) mounted inside the outer casing to interrupt a direct fluid path from the inlet pipe to the nozzle gap.

8. A nozzle assembly according to any one of claims 4 to 7, in which the outer casing is cylindrical.

9. A nozzle assembly according to any one of the preceding claims, further comprising a fluid diverter (25, 27) configured to intercept part of a jet of fluid applied through the nozzle gap and direct it onto fabric in the nozzle member from a direction different to the direction of the non-intercepted part of the jet of fluid.

10. A nozzle assembly according to claim 9, in which the fluid diverter is configured to direct the intercepted part of the jet of fluid onto a part of the fabric substantially opposite to the part to which the non-intercepted part of the jet of fluid is applied.

11. A nozzle assembly according to claim 9 or claim 10, in which the fluid diverter comprises an inner wall (25) of the nozzle member that is spaced inwardly from a side wall (26C) next to the first side wall to divide the nozzle gap into two parts, and a blade (27) extending between the first side wall and the inner side wall to direct the intercepted part of the jet of fluid under a part of the inner side wall remote from the first side wall.

12. A nozzle assembly according to any one of the preceding claims, further comprising a guide tube (3) extending from a fluid exit end (30) of the nozzle member, the guide tube having a cross-section that has the shape of a parallelogram, the cross-section increasing along the direction of the fabric travel path.

13. A nozzle assembly according to claim 12, in which the guide tube terminates in an open fan-shaped trough portion (32).

14. A nozzle assembly according to any one of the preceding claims, in which the nozzle assembly is configured to be mounted within a jet fabric dyeing machine (1) such that the first side wall of the nozzle member is lower than the remaining three side walls.

15. A jet fabric dyeing machine (1) comprising a nozzle assembly (10) according to any one of the preceding claims.

16. A jet fabric dyeing machine according to claim 15, in which the nozzle assembly is mounted within the jet fabric dyeing machine such that the first side wall of the nozzle member is lower than the remaining three side walls.

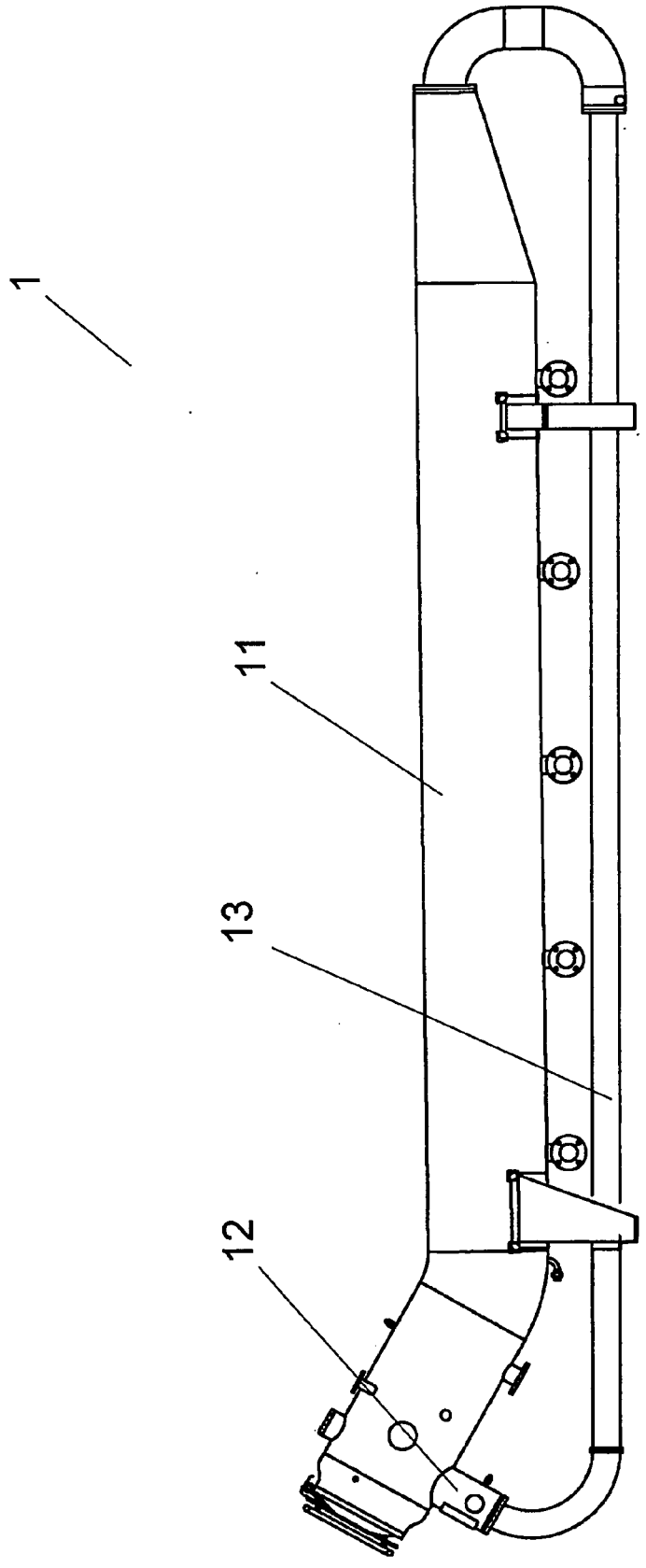

Figure 1

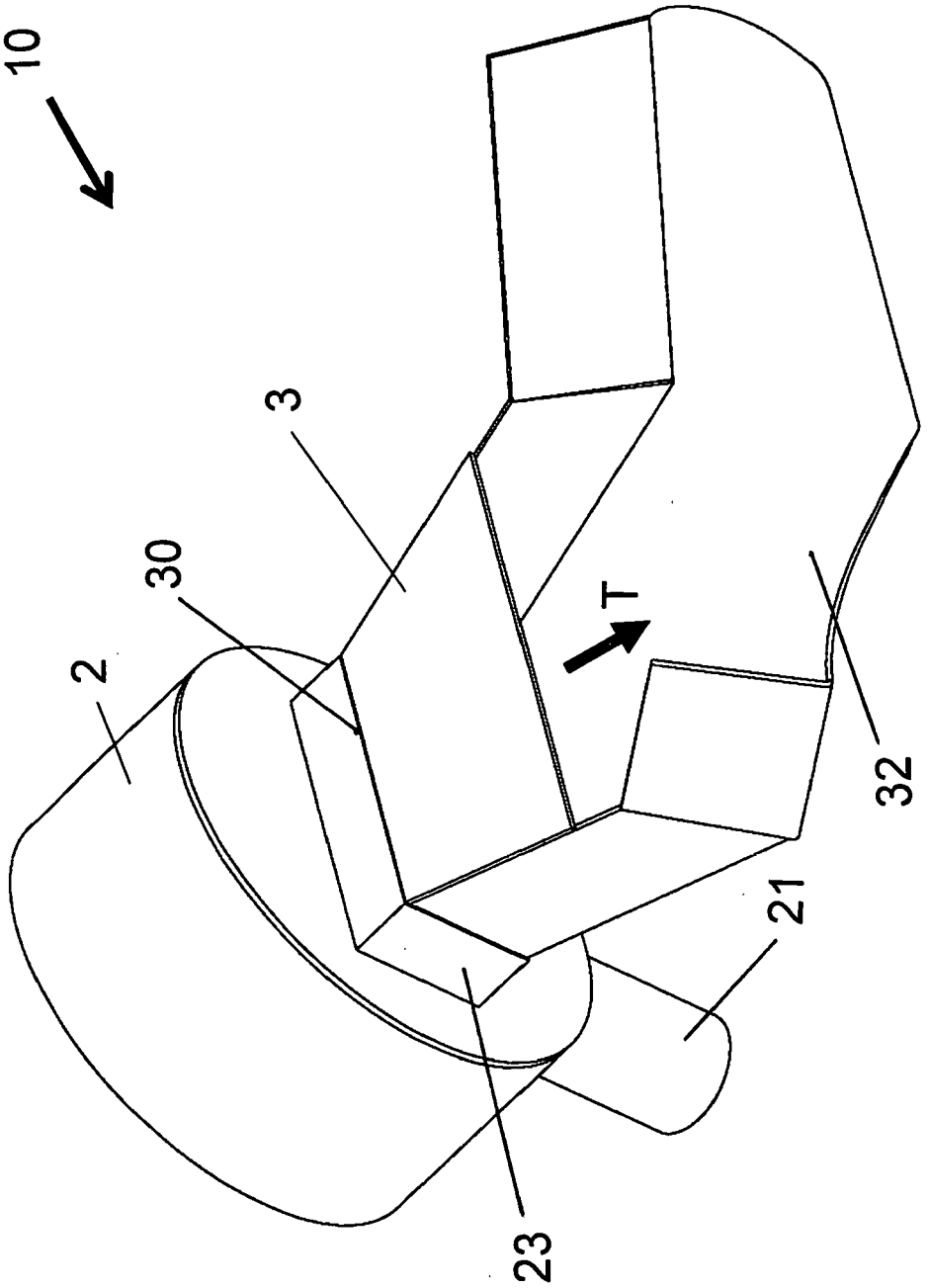

Figure 2

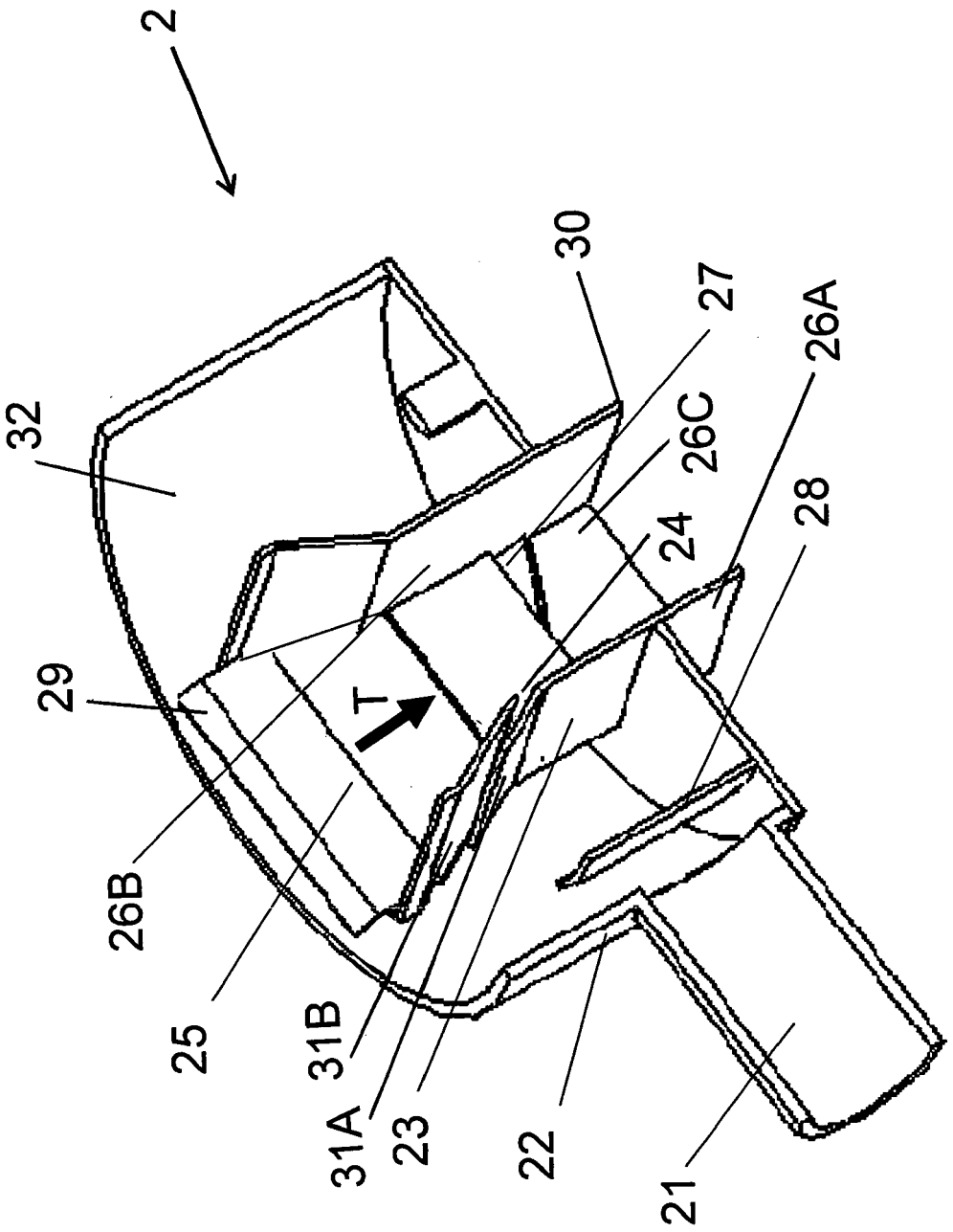

Figure 3

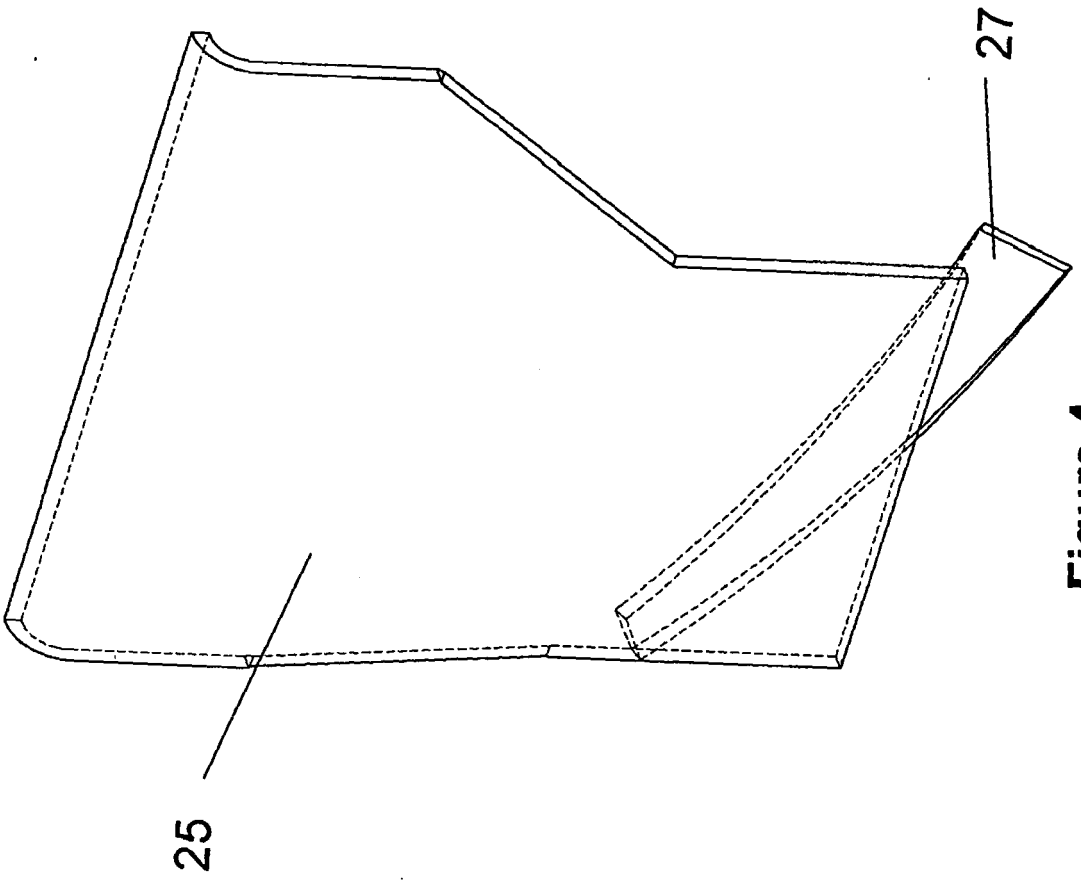

Figure 4

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 September 2007	Bichi, Marco

CATEGORY OF CITED DOCUMENTS

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