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(54) **Liquid-flow hank dyeing machine**

(57) A liquid-flow hank dyeing machine includes an upright tank, at least a pair of hank hanging rods, a nozzle mechanism, a dye storage space, and a pump. The hank hanging rods are disposed in the upright tank for allowing at least one hank to be hung thereon. At least one of the hank hanging rods is a hollow pipe. The hollow pipe has a pipe wall. The pipe wall defines a flow channel. The pipe wall has at least one flow-directing hole therein. The

flow-directing hole fluidly communicates with the flow channel through the pipe wall. The nozzle mechanism is disposed in the upright tank and above the hank hanging rods. The dye storage space is disposed in the upright tank and below the hank hanging rods. The pump fluidly communicates with the dye storage space, the flow channel, and the nozzle mechanism.

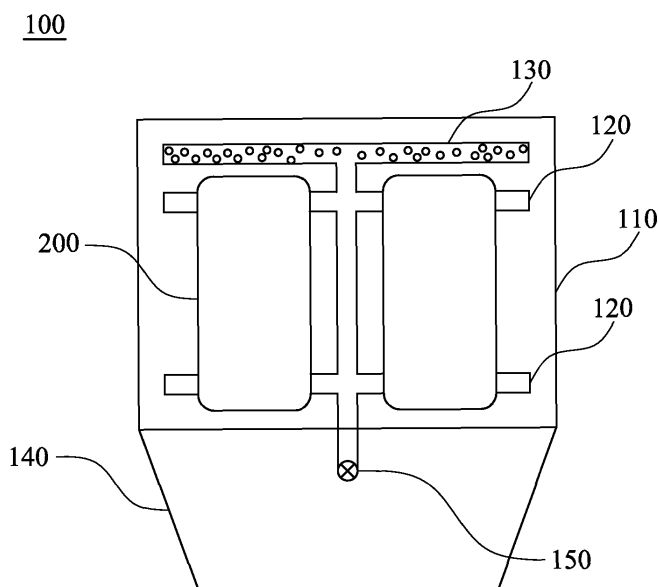


Fig. 1

Description**BACKGROUND**

5 Field of Invention

[0001] The present disclosure relates to dyeing machines. More particularly, the present disclosure relates to liquid-flow hank dyeing machines.

10 Description of Related Art

[0002] In traditional liquid-flow hank dyeing machines, the hank is softened as the temperature rises when the dye rises gradually. Therefore, in the contact region between the hank and the hank hanging rod, the hank is deformed by heat and/or mechanical external force, e.g. the floating of the hank, thereby causing bar mark, shape changing, twist loosing, and uneven dyeing problems. These problems affect the product quality and yield. Accordingly, how to improve the product quality and yield for liquid-flow hank dyeing machines has been a serious issue for related researchers.

SUMMARY

20 **[0003]** One aspect of the present invention is to provide a liquid-flow hank dyeing machine to improve the above-mentioned bar mark, shape changing, twist loosing, and uneven dyeing problems.

[0004] According to one embodiment of the present invention, a liquid-flow hank dyeing machine includes an upright tank, at least a pair of hank hanging rods, a nozzle mechanism, a dye storage space, and a pump. The hank hanging rods are disposed in the upright tank for allowing at least one hank to be hung thereon. At least one of the hank hanging rods is a hollow pipe. The hollow pipe has a pipe wall. The pipe wall defines a flow channel. The pipe wall has at least one flow-directing hole therein. The flow-directing hole fluidly communicates with the flow channel through the pipe wall. The nozzle mechanism is disposed in the upright tank and above the hank hanging rods. The dye storage space is disposed in the upright tank and below the hank hanging rods. The pump fluidly communicates with the dye storage space, the flow channel, and the nozzle mechanism for pumping a part of dye from the dye storage space to the nozzle mechanism and pumping another part of the dye from the dye storage space to the flow channel, such that the another part of the dye can be injected to the hank through the flow-directing hole.

[0005] In one or more embodiments of the present invention, at least two of the flow-directing holes are opposite each other across the flow channel.

[0006] In one or more embodiments of the present invention, each of the hank hanging rods is the hollow pipe.

35 **[0007]** In one or more embodiments of the present invention, a plurality of the flow-directing holes are disposed in the pipe wall.

[0008] In one or more embodiment of the present invention, the flow-directing holes are sized to substantially homogenize dye flow rates through the flow-directing holes.

[0009] In one or more embodiments of the present invention, the at least one of the hank hanging rods has an upstream end, the pump is upstream connected to the upstream end, and the flow-directing hole closer to the upstream end is smaller than that farther away from the upstream end.

[0010] In one or more embodiments of the present invention, the at least one of the hank hanging rods has an upstream end, the pump is upstream connected to the upstream end, the flow-directing holes are grouped into a plurality of groups, the flow-directing holes of each group have the same size, and the flow-directing holes of the group closer to the upstream end are smaller than those farther away from the upstream end.

[0011] In one or more embodiments of the present invention, the pipe diameter of the at least one of the hank hanging rods is sized to substantially homogenize dye flow rates through the flow-directing holes.

[0012] In one or more embodiments of the present invention, the at least one of the hank hanging rods has an upstream end, the pump is upstream connected to the upstream end, and the pipe diameter of the at least one of the hank hanging rods closer to the upstream end is smaller than that farther away from the upstream end.

[0013] In one or more embodiments of the present invention, the flow-directing hole has a length in the range from 6 mm to 9.2 mm.

BRIEF DESCRIPTION OF THE DRAWINGS

55 **[0014]**

Fig. 1 is a front view of a liquid-flow hank dyeing machine according to one embodiment of the present invention.

Fig. 2 is a longitudinal sectional view of one of the hank hanging rods of Fig. 1.

Fig. 3 is a transverse sectional view of one of the hank hanging rods of Fig. 1.

Fig. 4 is a side view of one of the hank hanging rods and the hank of Fig. 1.

Fig. 5 is a top view of a hank hanging rod according to one embodiment of the present invention.

Fig. 6 is a top view of a hank hanging rod according to another embodiment of the present invention.

Fig. 7 is a side view of a hank hanging rod according to yet another embodiment of the present invention.

DETAILED DESCRIPTION

[0015] In the following detailed description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are schematically shown in order to simplify the drawing.

[0016] Fig. 1 is a front view of a liquid-flow hank dyeing machine 100 according to one embodiment of the present invention. As shown in Fig. 1, the liquid-flow hank dyeing machine 100 includes an upright tank 110, at least a pair of hank hanging rods 120, a nozzle mechanism 130, a dye storage space 140, and a pump 150. The hank hanging rods 120 are disposed in the upright tank 110 for allowing at least one hank 200 to be hung thereon. The nozzle mechanism 130 is disposed in the upright tank 110 and above the hank hanging rods 120. The dye storage space 140 is disposed in the upright tank 110 and below the hank hanging rods 120. The pump 150 fluidly communicates with the dye storage space 140 and the nozzle mechanism 130 for pumping a part of dye from the dye storage space 140 to the nozzle mechanism 130, such that the part of the dye can be injected to the hank 200 through the nozzle mechanism 130.

[0017] Fig. 2 is a longitudinal sectional view of one of the hank hanging rods 120 of Fig. 1. Fig. 3 is a transverse sectional view of one of the hank hanging rods 120 of Fig. 1. As shown in Figs. 2-3, at least one of the hank hanging rods 120 is a hollow pipe. The hollow pipe has a pipe wall 122. The pipe wall 122 defines a flow channel 124. The pipe wall 122 has at least one flow-directing hole 126 therein. The flow-directing hole 126 fluidly communicates with the flow channel 124 through the pipe wall 122. The pump 150 further fluidly communicates with the dye storage space 140 and the flow channel 124 for further pumping another part of the dye from the dye storage space 140 to the flow channel 124, such that the another part of the dye can be injected to the hank 200 through the flow-directing hole 126.

[0018] In the present embodiment, the dye can be further injected to the hank 200 through the flow-directing hole 126 in addition to through the nozzle mechanism 130. Therefore, the contact area between the hank 200 and the hank hanging rods 120 is not only decreases, but the hank 200 can be in contact with the dye by the flow-directing hole 126, thereby improving the above-mentioned bar mark, shape changing, twist loosing, and uneven dyeing problems.

[0019] As shown in Fig. 2, the pipe wall 122 may be wave shaped, but this should not limit the claimed scope of the present invention. In one or more embodiments of the present invention, the pipe wall 122 may be straight shaped. The person having ordinary skill in the art should select a proper shape for the pipe wall 122 according to actual requirements.

[0020] In a traditional liquid-flow hank dyeing machine, there is resistance to the dye when the dye flows across the hank hanging rod because the hank hanging rod does not have any flow-directing hole therein. Moreover, there may be serious turbulence to the dye when the dye flows across the hank hanging rod. Therefore, the hank may be kinked or tangled by the dye.

[0021] Fig. 4 is a side view of one of the hank hanging rods 120 and the hank 200 of Fig. 1. As shown in Figs. 2, 3, and 4, at least two of the flow-directing holes 126 are opposite each other across the flow channel 124. In use, since the flow-directing holes 126 are opposite each other across the flow channel 124, the dye can flow across the hank hanging rod 120 along the arrow F. Therefore, the hank hanging rod 120 can cause less resistance and turbulence to the dye, thereby improving the kinking or tangling problems.

[0022] Each of the hank hanging rods 120 of Fig. 1 is the hollow pipe shown in Figs. 2, 3, and 4, but this should not limit the claimed scope of the present invention. In one or more embodiments of the present invention, one of the hank hanging rods 120 may be the hollow pipe shown in Figs. 2, 3, and 4, and another of the hank hanging rods 120 may be a solid rod.

[0023] As shown in Figs. 2-3, a plurality of the flow-directing holes 126 are disposed in the pipe wall 122 of the hank hanging rod 120. In the present embodiment, the flow-directing holes 126 are substantially equally spaced, but this should not limit the claimed scope of the present invention. The person having ordinary skill in the art should select a proper arrangement for the flow-directing holes 126 according to actual requirements.

[0024] In the embodiment that a plurality of the flow-directing holes 126 are disposed in the pipe wall 122 of the hank hanging rod 120, the flow-directing holes 126 may be sized to substantially homogenize dye flow rates through the flow-directing holes 126. In this way, the dye flow can be more uniform, thereby preventing the hank 200 from being kinked or tangled.

[0025] The volume flow rate through one of the flow-directing holes 126 is given by (Pitot tube measurement):

$$Q=VA.....\text{Formula 1}$$

, where Q is the volume flow rate through one of the flow-directing holes 126, V is the average velocity through the one of the flow-directing holes 126, and A is the cross-sectional area of the one of the flow-directing holes 126.

[0026] Moreover,

$$V = \sqrt{2g\Delta h} \text{Formula 2}$$

, where g is acceleration of gravity, and Δh is the manometer reading. Therefore,

$$Q = \sqrt{2g\Delta h} A \text{Formula 3}$$

[0027] From the Formula 3, if the volume flow rates through the flow-directing holes 126 are the same, the higher the pressure through the flow-directing hole 126, the smaller the cross-sectional area of the flow-directing hole 126 is.

[0028] Fig. 5 is a top view of a hank hanging rod 120 according to one embodiment of the present invention. As shown in Fig. 5, the hank hanging rod 120 has an upstream end 128. The pump 150 is upstream connected to the upstream end 128. Since the pump 150 is upstream connected to the upstream end 128, the dye in the hank hanging rod 120 closer to the upstream end 128 has higher pressure than that farther away from the upstream end 128. Therefore, if the volume flow rates through the flow-directing holes 126 are the same, the flow-directing hole 126 closer to the upstream end 128 is smaller than that farther away from the upstream end 128.

[0029] In addition that the sizes of the flow-directing holes 126 vary gradually, the sizes of the flow-directing holes 126 can vary in groups. Fig. 6 is a top view of a hank hanging rod 120 according to another embodiment of the present invention. As shown in Fig. 6, the flow-directing holes 126 are grouped into a plurality of groups 126a, 126b, and 126c. The flow-directing holes 126 of each group 126a, 126b, and 126c have the same size. The flow-directing holes 126 of the group 126a, 126b, or 126c closer to the upstream end 128 are smaller than those farther away from the upstream end 128. Specifically, the flow-directing holes 126 of the group 126a are closest to the upstream end 128, the flow-directing holes 126 of the group 126b are the second closest group to the upstream end 128, and the flow-directing holes 126 of the group 126c are farthest away from the upstream end 128. Therefore, the flow-directing holes 126 of the group 126a are smallest, the flow-directing holes 126 of the group 126b are the second smallest, and the flow-directing holes 126 of the group 126c are largest.

[0030] In addition that the sizes of the flow-directing holes 126 vary, the pipe diameter of the hank hanging rod 120 may vary to substantially homogenize the dye flow rates through the flow-directing holes 126. Fig. 7 is a side view of a hank hanging rod 120 according to yet another embodiment of the present invention. As shown in Fig. 7, the pipe diameter of the hank hanging rod 120 closer to the upstream end 128 is smaller than that farther away from the upstream end 128 to substantially homogenize the dye flow rates through the flow-directing holes 126.

[0031] In the above-mentioned embodiments, at least one or each of the flow-directing holes 126 is a slotted hole, and at least one or each of the flow-directing holes 126 has a length of about 6 mm to about 9.2 mm. It should be understood that the above-mentioned shapes and sizes for the flow-directing holes 126 are for illustrative purposes only and should not be considered all-inclusive. The person having ordinary skill in the art should select proper shapes and sizes for the flow-directing holes 126 according to actual requirements.

[0032] In the above-mentioned embodiments, the pump 150 may be a centrifugal pump. It should be understood that the above-mentioned centrifugal pump are for illustrative purposes only and should not be considered all-inclusive. The person having ordinary skill in the art should select a proper type of pump according to actual requirements.

Claims

1. A liquid-flow hank dyeing machine comprising:

an upright tank;

at least a pair of hank hanging rods disposed in the upright tank for allowing at least one hank to be hung thereon, wherein at least one of the hank hanging rods is a hollow pipe, the hollow pipe has a pipe wall, the pipe wall defines a flow channel, the pipe wall has at least one flow-directing hole therein, and the flow-directing hole fluidly communicates with the flow channel through the pipe wall;

a nozzle mechanism disposed in the upright tank and above the hank hanging rods;

a dye storage space disposed in the upright tank and below the hank hanging rods; and

a pump fluidly communicating with the dye storage space, the flow channel, and the nozzle mechanism for pumping a part of dye from the dye storage space to the nozzle mechanism and pumping another part of the dye from the dye storage space to the flow channel, such that the another part of the dye can be injected to the hank through the flow-directing hole.

2. The liquid-flow hank dyeing machine of claim 1, wherein at least two of the flow-directing holes are opposite each other across the flow channel.

3. The liquid-flow hank dyeing machine of claim 1 or 2, wherein each of the hank hanging rods is the hollow pipe.

4. The liquid-flow hank dyeing machine of claim 1, wherein a plurality of the flow-directing holes are disposed in the pipe wall.

5. The liquid-flow hank dyeing machine of claim 4, wherein the flow-directing holes are sized to substantially homogenize dye flow rates through the flow-directing holes.

6. The liquid-flow hank dyeing machine of claim 4 or 5, wherein the at least one of the hank hanging rods has an upstream end, the pump is upstream connected to the upstream end, and the flow-directing hole closer to the upstream end is smaller than that farther away from the upstream end.

7. The liquid-flow hank dyeing machine of any one of claims 4 to 6, wherein the at least one of the hank hanging rods has an upstream end, the pump is upstream connected to the upstream end, the flow-directing holes are grouped into a plurality of groups, the flow-directing holes of each group have the same size, and the flow-directing holes of the group closer to the upstream end are smaller than those farther away from the upstream end.

8. The liquid-flow hank dyeing machine of any one of claim 4 to 6, wherein the pipe diameter of the at least one of the hank hanging rods is sized to substantially homogenize dye flow rates through the flow-directing holes.

9. The liquid-flow hank dyeing machine of any one of claims 4 to 8, wherein the at least one of the hank hanging rods has an upstream end, the pump is upstream connected to the upstream end, and the pipe diameter of the at least one of the hank hanging rods closer to the upstream end is smaller than that farther away from the upstream end.

10. The liquid-flow hank dyeing machine of any one of the preceding claims, wherein the flow-directing hole has a length of about 6 mm to about 9.2 mm.

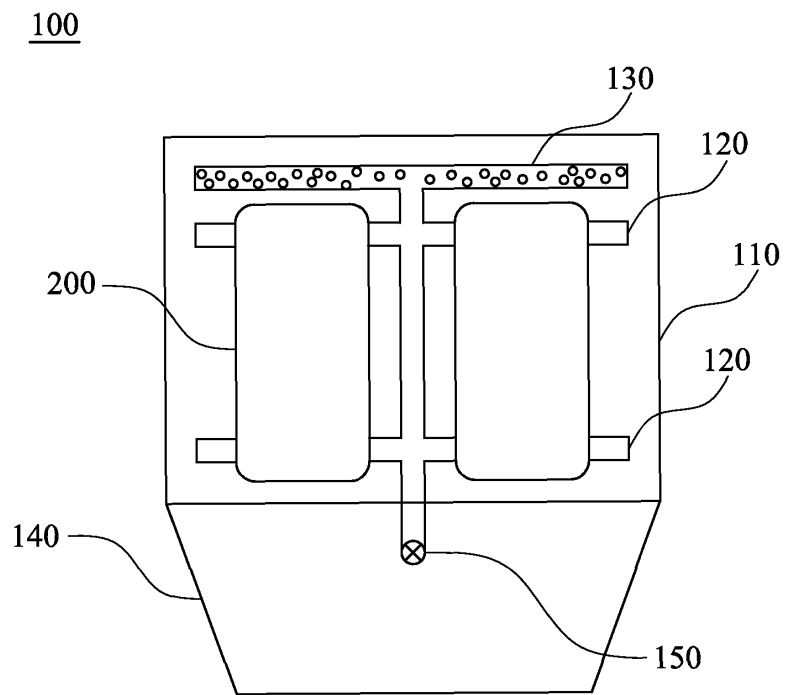


Fig. 1

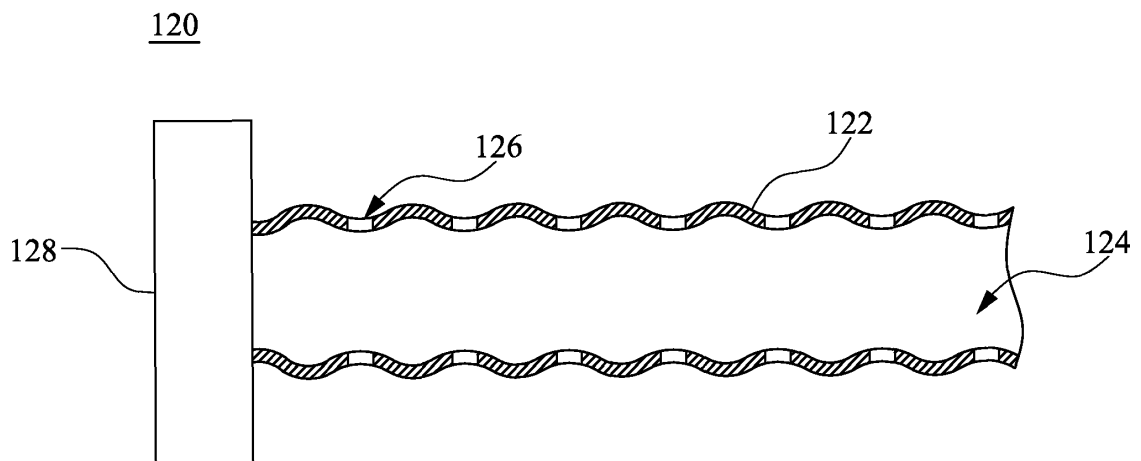


Fig. 2

120

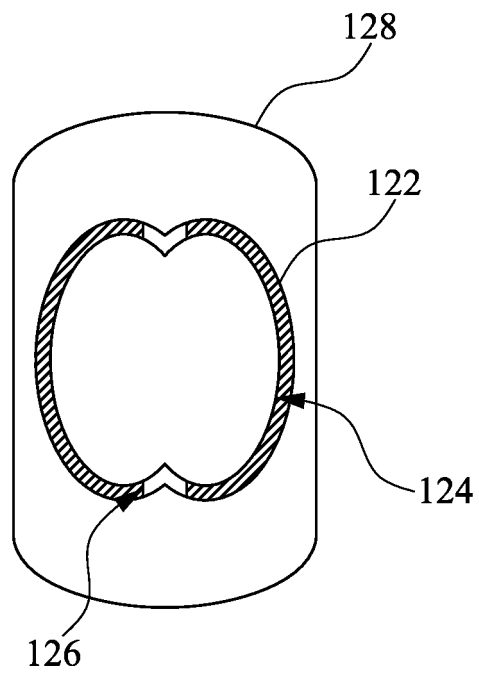


Fig. 3

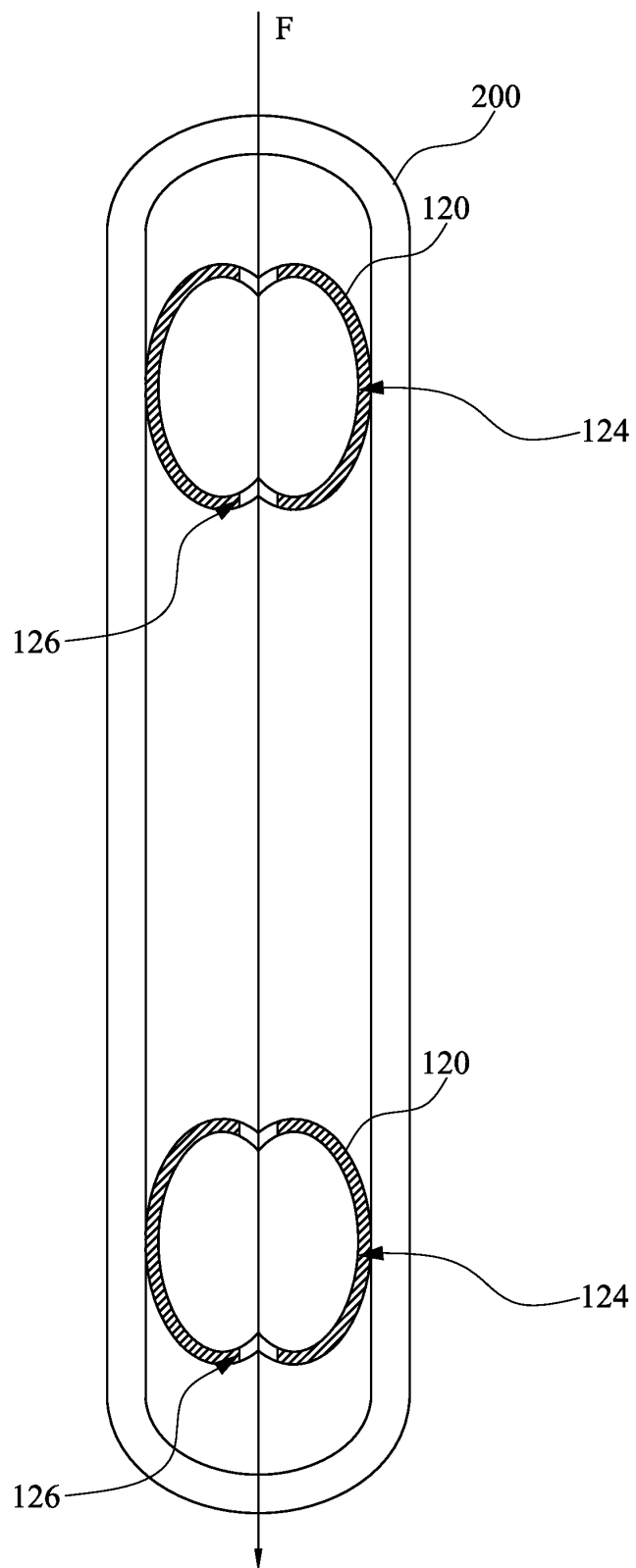


Fig. 4

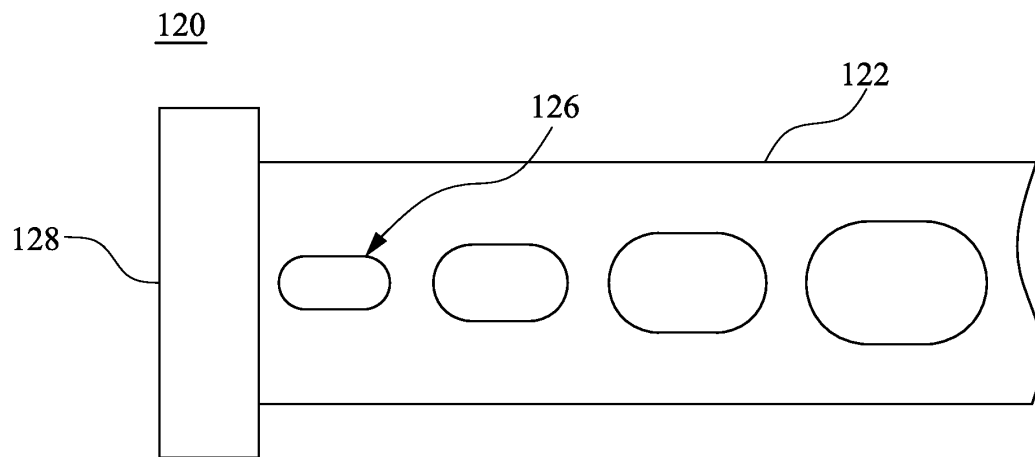


Fig. 5

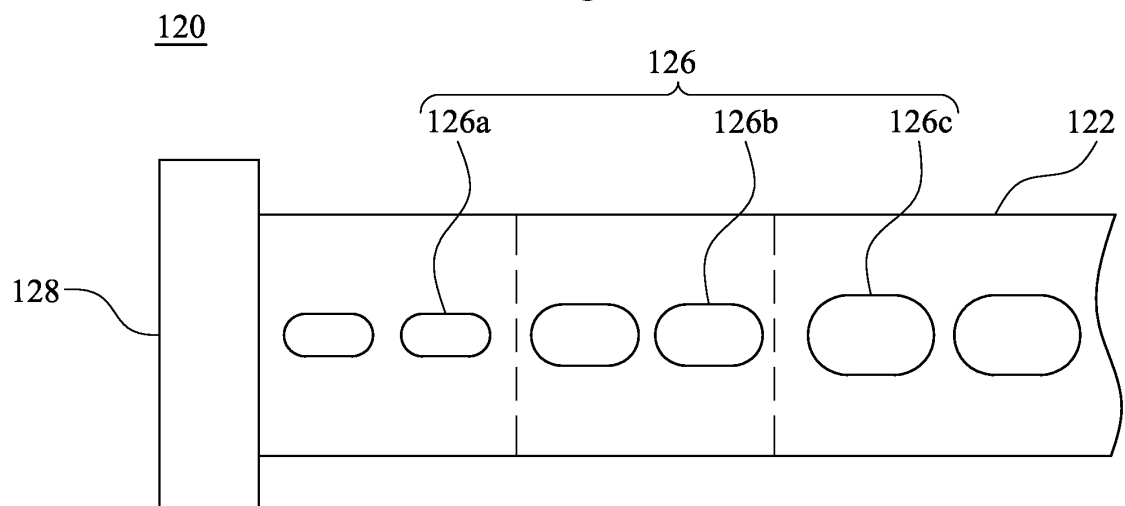


Fig. 6

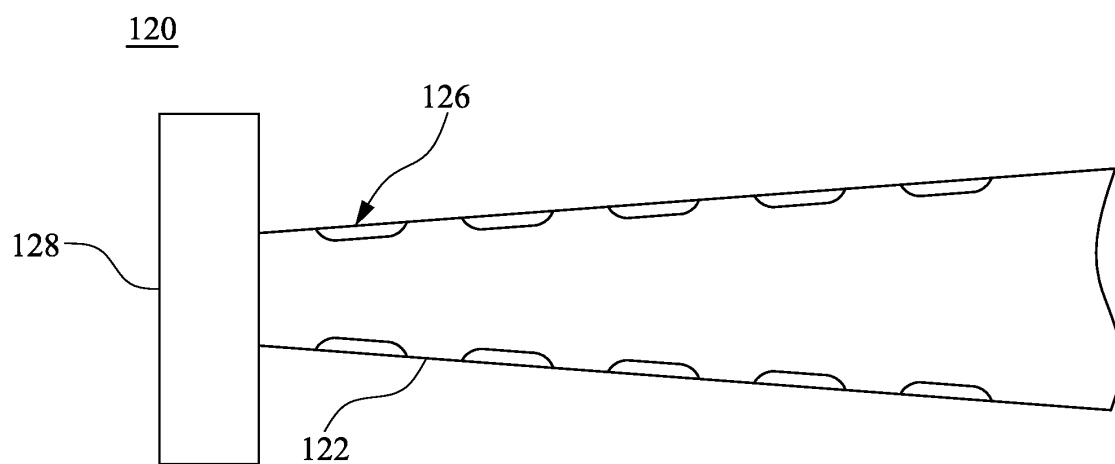


Fig. 7



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Application Number
EP 13 16 0701

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Place of search Munich		Date of completion of the search 27 August 2013	Examiner Bichi, Marco
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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