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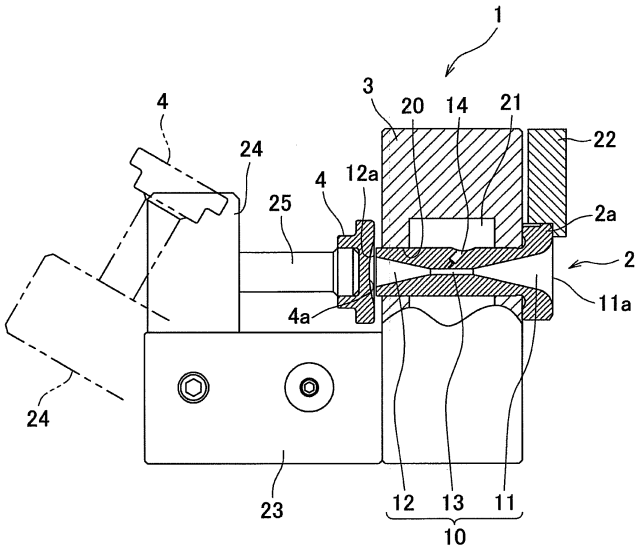
(54) YARN PROCESSING DEVICE

(57) A yarn processing device having high yarn processing performance is provided. The yarn processing device (1) is provided with a yarn passage (10) provided with a yarn introduction section (11) and a yarn ejection section (12); a nozzle (2) having an air injection hole (14) that injects air into the yarn passage (10) ; and a collision body (4) facing an outlet (12a) positioned at the leading edge of the yarn ejection section (12). The part of the collision body facing the outlet (12a) is formed in a concave shape.

FIG.3



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Description

Technical Field

[0001] The present invention relates to a yarn processing device that imparts loftiness to yarns by ejecting fluid onto the yarns and forming entanglements, loops, or the like.

Background Art

[0002] A known yarn processing device imparts loftiness to a yarn constituted by filaments made of synthetic resin or the like by ejecting fluid onto the yarn and forming entanglements, loops or the like on the filaments.

[0003] Each of Patent Literatures 1 and 2 discloses a yarn processing device including a yarn path having a yarn introducing part and a yarn ejecting part, a nozzle having an air injection hole that ejects compressed air into the yarn path, and a spherical collision body arranged to oppose a yarn ejecting part of the nozzle.

[0004] In the yarn processing devices of Patent Literatures 1 and 2, a yarn is introduced from the yarn introducing part, passes through the yarn path to which air is ejected, and is discharged from the yarn ejecting part. In this regard, the air ejected from the yarn ejecting part collides the spherical collision body and flows along the surface thereof. By this air flow, the yarn is ejected through a gap between the yarn ejecting part and the collision body. At the same time, loops, entanglements or the like are formed on the filaments by the airflow in the yarn ejecting part, with the result that loftiness is imparted to the yarn.

Citation List

Patent Literatures

[0005]

Patent Literature 1: PCT application entering national phase in Japan No. 2000-514509 (in particular, FIG. 5, FIG. 6, and FIG. 8)

Patent Literature 2: Japanese unexamined patent publication No. 2000-303280

Summary of Invention

Technical Problem

[0006] However, there is still a room for improvement in the conventional yarn processing device including the spherical collision body, because occasionally the loftiness-imparting process is improper. The inventors diligently studied to solve the problem above, and have consequently found that the shape of the collision body significantly influences on the processing capability of the yarn processing device, and the processing capability is improved by modifying the shape of the collision body.

[0007] An object of the present invention is to provide a yarn processing device with high yarn processing capability.

Solution to Problem

[0008] A yarn processing device according to the first aspect of the invention includes: a nozzle including a yarn path constituted by a yarn introducing part and a yarn ejecting part and a fluid injection hole configured to eject fluid into the yarn path; and a collision body having a surface which opposes, over a gap, a leading end face of the yarn ejecting part on which face an outlet is formed, on the surface of the collision body which surface opposes the leading end face of the yarn ejecting part, an opposing part opposing the outlet being formed to have a concave shape.

[0009] According to the present invention, because the opposing part of the collision body opposing the outlet of the nozzle has a concave shape, a large space is formed between the yarn ejecting part of the nozzle and the collision body, and this facilitates the generation of turbulence of the flow of the fluid in the space. With this, because the generation of loops and entanglements in the filaments ejected from the yarn ejecting part is facilitated by the turbulence of the flow of the fluid in the space, the yarn processing capability is improved. When the yarn processing capability is improved, the quality of produced yarns is unchanged or improved even if the processing is conducted at a higher yarn speed, and hence the productivity is improved.

[0010] According to the second aspect, the yarn processing device of the first aspect is arranged so that an inner surface of the concave opposing part of the collision body is formed by a curved surface.

[0011] When the inner surface of the concave opposing part of the collision body is formed by a curved surface, the fluid ejected from the yarn ejecting part together with the yarn flows along the inner surface of the inner space of the

opposing part. This restrains the fluid from being locally stagnant, and hence the generation of loops and entanglements in the filaments is further facilitated and the yarn processing capability is improved.

[0012] According to the third aspect, the yarn processing device of the first or second aspect is arranged so that the opposing part of the collision body is formed to be deepest at a central part.

[0013] When the opposing part of the collision body is deepest at its central part, the yarn ejected from the yarn ejecting part converges on and collides the deepest part of the concave portion. Because the yarn intensively collides a part of the collision body, the subsequent yarn processing (the formation of loops and entanglements) is stably carried out, and hence the yarn processing capability is improved.

[0014] According to the fourth aspect, the yarn processing device of the first is arranged so that the opposing part of the collision body is circular-arc-shaped or partial-elliptical-shaped in cross section.

[0015] When the opposing part of the collision body is circular-arc-shaped or partial-elliptical-shaped in cross section, the inner surface of the opposing part is curved and deepest at the central part thereof. Therefore, as described in the second and third aspects, the fluid is hardly locally stagnant and the generation of loops and entanglements in the filaments is further facilitated and stably done, with the result that the yarn processing capability is further improved.

[0016] According to the fifth aspect, the yarn processing device of any one of the first to fourth aspects is arranged so that, on the opposing part of the collision body, a concave portion and a flat portion, which is in parallel to the leading end face of the yarn ejecting part including the outlet and surrounds the concave portion, are formed.

[0017] When the entirety of the opposing part of the collision body opposing the outlet has a concave shape, the periphery of the part is sharp. In such a case, processing variation of the shape of the periphery of the collision body is not negligible and small cracks may be formed at the periphery, and the yarn processing is significantly influenced. Furthermore, variations in the tension of the yarn and the occurrence of fluffs are caused. In this regard, because in the present invention the opposing part of the collision body has the concave portion and the flat portion surrounding the concave portion, processing variation of the shape of the periphery of the collision body is small and cracks hardly occur, with the result that the yarn processing is stably done.

[0018] According to the sixth aspect, the yarn processing device according to any one of first to fifth aspects further includes a nozzle holder that holds the nozzle, the collision body being attached to the nozzle holder, and the nozzle holder being provided with a yarn guide which is configured to guide a yarn having passed through a gap between the yarn ejecting part of the nozzle and the collision body.

[0019] To stabilize the running of the yarn ejected from the yarn ejecting part of the nozzle, a yarn guide is preferably provided on the downstream of the nozzle. In this regard, because the tension of the yarn varies in accordance with the position of the nozzle with respect to the yarn guide, when a yarn guide is provided independently of the yarn processing device, it is necessary to conduct a tiresome operation to suitably adjust the tension of the yarn, that is, an operation to adjust the position of the yarn guide with respect to the yarn processing device (i.e., the nozzle) after the yarn processing device is installed. Because in the present invention the nozzle holder including the nozzle and the collision body further includes the yarn guide and hence the nozzle, the collision body, and the yarn guide are integrated, the position of the yarn guide is automatically determined when the yarn processing device is installed at a predetermined position, and it is therefore unnecessary to adjust the position of the yarn guide.

Advantageous Effects of Invention

[0020] According to the present invention, because the opposing part of the collision body opposing the outlet of the nozzle has a concave shape, a large space is provided between the yarn ejecting part of the nozzle and the collision body, and the turbulence of the flow of the fluid in the space is facilitated. For this reason, the turbulence of the flow of the fluid in the space facilitates the formation of loops and entanglements in the filaments ejected from the yarn ejecting part, and the yarn processing capability is improved. When the yarn processing capability is improved, the quality of produced yarns is unchanged or improved even if the processing is conducted at a higher yarn speed, and hence the productivity is improved. Brief Description of Drawings

[0021]

FIG. 1 is a front elevation of a yarn processing device according to an embodiment of the present invention.
FIG. 2 is a left side view of the yarn processing device shown in FIG. 1.
FIG. 3 is a cross section of a part of the yarn processing device shown in FIG. 1.
FIG. 4(a) is an enlarged view of the nozzle and the collision body shown in FIG. 3, whereas FIG. 4(b) is a right side view of the collision body shown in FIG. 4(a).
FIG. 5 is a cross section of collision bodies of a modification.
FIG. 6 is a cross section of nozzles and collision bodies of another modification.
FIG. 7 is a cross section of nozzles and collision bodies in examples and comparative examples.

Description of Embodiments

[0022] Now, an embodiment of the present invention will be described. FIG. 1 is a front elevation of a yarn processing device of the present embodiment, FIG. 2 is a left side view of the yarn processing device, and FIG. 3 is a cross section of a part of the yarn processing device shown in FIG. 1. FIG. 4(a) is an enlarged view of the nozzle and the collision body shown in FIG. 3, whereas FIG. 4 (b) is a right side view of the collision body shown in FIG. 4(a). Note that, hereinafter, the directions, i.e., upward, downward, leftward, and rightward in FIG. 1 and FIG. 3 are used throughout the descriptions below. As shown in FIG. 1 to FIG. 3, the yarn processing device 1 includes a nozzle 2, a nozzle holder 3 holding the nozzle 2, and a collision body 4 provided at the nozzle holder 3.

[0023] First of all, the nozzle 2 will be described. As shown in FIG. 3 and FIG. 4 (a), the nozzle 2 is a cylindrical component made of a hard material such as metal and ceramics, and is provided with, at one end, a flange portion 2a protruding in radial directions. Inside the nozzle 2 is provided a yarn path 10 that extends in an axial direction of the cylindrical nozzle 2. The yarn path 10 includes a yarn introducing part 11 formed on the flange portion 2a side (i.e., right side) of the nozzle 2, a yarn ejecting part 12 formed on the side opposite to the flange portions 2a (i.e., left side) of the nozzle 2, and an air introducing part 13 connecting the yarn introducing part 11 with the yarn ejecting part 12.

[0024] At the end face of the flange portion 2a at the right end of the nozzle 2, an inlet 11a is formed to introduce a yarn 31. The yarn introducing part 11 is formed such that the internal diameter thereof reduces from the inlet 11a side to the leading end side (i.e., to the left side in the figure). On the other hand, at the left end face of the nozzle 2 on the side opposite to the flange portion 2a, an outlet 12a is formed to eject the yarn 31 having been introduced into the yarn path 10. The yarn ejecting part 12 is formed so that the internal diameter thereof increases toward the outlet 12a. The diameter-decreasing yarn introducing part 11 and the diameter-increasing yarn ejecting part 12 are, for example, tapered in shape or horn-shaped such that the degree of widening (curvature) at the peripheral part is larger than that of the tapered shape. For example, in the present embodiment, the yarn introducing part 11 is horn-shaped whereas the yarn ejecting part 12 is tapered.

[0025] At an axially central part of the nozzle 2 is formed an air injection hole 14 (fluid injection hole) which is open to an air introducing part 13 of the yarn path 10. While FIG. 4(a) shows only one air injection hole 14, in reality a plurality of (three for example) air injection holes 14 are provided at equal intervals along the circumference of the nozzle 2. The air injection hole 14 extends to incline toward the leading end side (left side) of the yarn path 10 with respect to the radial directions of the nozzle 2 (i.e., the directions orthogonal to the yarn path 10), with the result that strong leftward airflow is generated when air is ejected into the yarn path 10.

[0026] Now, the nozzle holder 3 will be described. As shown in FIG. 1 to FIG. 3, the nozzle holder 3 is rectangular parallele piped and slightly long in the vertical direction. In the upper part of this nozzle holder 3, an attaching hole 20 is formed to horizontally penetrate the nozzle holder 3. To this attaching hole 20, the above-described nozzle 2 is inserted. In this regard, the diameter of the attaching hole 20 is arranged to be smaller than the outer diameter of the flange portion 2a of the nozzle 2. With this arrangement, while the left end portion of the nozzle 2 is inserted into and attached to the attaching hole 20 from the right opening, the flange portion 2a provided at the right end portion of the nozzle 2 contacts the right side of the nozzle holder 3 without being inserted into the attaching hole 20, with the result that the nozzle 2 is positioned with respect to the nozzle holder 3. Furthermore, as shown in FIG. 1, to the nozzle holder 3 is attached a regulator 22 that prevents the nozzle 2 inserted into the attaching hole 20 from jutting out rightward.

[0027] Inside the nozzle holder 3 is formed a vertically-extending air supply hole 21. This air supply hole 21 is connected to an unillustrated air supply source. When the nozzle 2 is attached to the attaching hole 20 of the nozzle holder 3, the air injection hole 14 formed in the nozzle 2 is connected to the air supply hole 21 and the air supplied from the air supply hole 21 is ejected from the air injection hole 14 to the yarn path 10.

[0028] Now, the collision body 4 will be described. As shown in FIG. 3 and FIG. 4, the collision body 4 is a substantially disc-shaped member and is made of a hard material such as metal and ceramics. This collision body 4 opposes, over a small gap, the left end face of the nozzle 2 attached to the nozzle holder 3 (i,e., the leading end face of the yarn ejecting part 12 on which face the outlet 12a is formed).

[0029] In the right face of the collision body 4 which face opposes the left end face of the nozzle 2, a concave portion 4a is formed at a central part to oppose the outlet 12a. The inner surface of this concave portion 4a is arranged to be circular-arc-shaped in a cross section taken at the plane including the central axis of the nozzle 2. Furthermore, the concave portion 4a is surrounded by a flat portion 4b which has a flat surface in parallel to the leading end face of the yarn ejecting part 12.

[0030] While the arrangement to support the collision body 4 to oppose the outlet 12a of the nozzle 2 is not limited to any particular arrangement, the present embodiment employs the following arrangement as an example. First of all, as shown in FIG. 1, an attaching base member 23 is fixed to the lower left side of the nozzle holder 3 by a bolt or the like, and a lower part of a block-shaped holder 24 is connected to the attaching base member 23 to be rotatable along the vertical surface. Furthermore, to the holder 24 is fixed an end of a connection rod 25, whereas the other end of the connection rod 25 is fixed to the collision body 4. According to this arrangement, as indicated by two-dot chain lines in

FIG. 3, when the holder 24 is rotated with respect to the attaching base member 23, the collision body 4 is rotated together with the holder 24. The collision body 4 is movable between the position where the collision body 4 opposes the outlet 12a of the nozzle holder (i.e., the position indicated by the full lines) and the retracted position where the collision body 4 is distant from the outlet 12a (i.e., the position indicated by the two-dot chain lines). With this, the yarn is easily introduced into the nozzle 2 by moving the collision body 4 to the retracted position.

[0031] To stabilize the running of the yarn 31 after being ejected from the yarn ejecting part 12 of the nozzle 2, a yarn guide is preferably provided on the downstream of the nozzle 2. In this regard, the tension of the yarn on the nozzle downstream side is varied in accordance with the position of the yarn guide with respect to the nozzle 2. For this reason, when a yarn guide is provided independently of the yarn processing device 1, it is necessary to conduct a tiresome operation to suitably adjust the tension of the yarn, that is, an operation to adjust the position of the yarn guide with respect to the yarn processing device 1 (i.e., the nozzle 2) after the yarn processing device is installed.

[0032] In consideration of this point, as shown in FIG. 1 and FIG. 2, the present embodiment is arranged so that a yarn guide 26 for guiding the yarn ejected from the nozzle 2 is attached to the attaching base member 23 fixed to the nozzle holder 3, via an attaching member 27. That is to say, the yarn guide 26 is further attached to the nozzle holder 3 having the nozzle 2 and the collision body 4, and the nozzle 2, the collision body 4, and the yarn guide 26 are integrated. The yarn introduced into the nozzle 2 from the right side in FIG. 1 and ejected from the yarn ejecting part 12 passes through the yarn guide on the viewer side in FIG. 1 (on the right side in FIG. 2) and is then guided upward. Because the yarn guide 26 is integrated with the nozzle holder 3 as described above, the position of the yarn guide 26 is automatically determined when the yarn processing device 1 is installed at a predetermined position, and it is therefore unnecessary to adjust the position of the yarn guide 26 with respect to the nozzle 2.

[0033] Now, effects of the yarn processing device 1 of the present embodiment in the loftiness-imparting process will be described. To begin with, as shown in FIG. 1 to FIG. 3, through the inlet 11a of the yarn introducing part 11 of the nozzle 2, a yarn 31 constituted by filaments made of synthetic resin or the like is introduced, and the yarn 31 is guided to the air introducing part 13. In the meanwhile, to the air introducing part 13, air supplied from an unillustrated air supply source is ejected from the air injection hole 14.

[0034] The air ejected into the air introducing part 13 is discharged from the yarn ejecting part 12, and collides the collision body 4 which is provided to oppose the outlet 12a. By this airflow, the yarn 31 is ejected through the gap between the collision body 4 and the yarn ejecting part 12. At this stage, the filaments constituting the yarn 31 are unwound on account of strong airflow in the yarn ejecting part 12, and loops and entanglements are formed as each filament severely vibrates. As such, loftiness is imparted to the yarn 31.

[0035] In connection with the above, as discussed earlier, in the yarn processing device 1 of the present embodiment the concave portion 4a is formed on the surface of the collision body 4 which surface opposes the outlet 12a. For this reason, a large space is provided between the yarn ejecting part 12 of the nozzle 2 and the collision body 4, and this facilitates the generation of turbulence of airflow. Because the generation of loops and entanglements in the filaments ejected from the yarn ejecting part 12 is accelerated on account of the turbulence of airflow, the yarn processing capability is improved. When the processing capability of the yarn processing device 1 is improved, the quality of produced yarns is unchanged or improved even if the processing is conducted at a higher yarn speed, and hence the productivity is improved and an amount of air required to produce a unit length of yarn is reduced.

[0036] According to the present embodiment, the concave portion 4a of the collision body 4 is formed to have a curved surface which is circular-arc-shaped in cross section. As the concave portion 4a has such a curved surface, the air ejected from the yarn ejecting part 12 along with the yarn flows in the space in the concave portion 4a along the inner surface thereof. This restrains the air from being locally stagnant, and the formation of loops and entanglements on the filaments is further facilitated. The concave portion 4a which is circular-arc-shaped in cross section is deepest at the central part (where the central axis of the nozzle 2 passes through), and the yarn ejected from the yarn ejecting part 12 converges on and collides the deepest part of the concave portion 4a. Because the yarn intensively collides a part of the collision body 4, the subsequent yarn processing (the formation of loops and entanglements) is stably carried out, and hence the yarn processing capability is improved.

[0037] In addition to the above, according to the present embodiment, the concave portion 4a and the flat portion 4b surrounding the concave portion are formed at the opposing part of the collision body 4 which part opposes the outlet 12a. The yarn processing is stable in this case, because, as compared to a case where the entirety of the opposing part of the collision body 4 is formed to have a concave shape and the edge (outer periphery) is sharp (as in a later-described modification shown in FIG. 5(e)), processing variation of the shape of the edge (outer periphery) of the opposing part of the collision body 4 is restrained, and the formation of cracks is restrained. Provided that the outer diameter of the collision body 4 is D, the diameter of the concave portion 4a is d, and the width of the flat portion 4b is t, the equation $D=d+2t$ holds true. In this regard, the width t of the flat portion 4b preferably falls within the range of $0 \leq t \leq 5$(mm).

[0038] As illustrated by examples below, it will be evident that many modifications may be made to the embodiment described, while remaining within the scope of the invention.

[0039] 1] The concave part of the collision body 4 opposing the outlet 12a of the nozzle 2 may not be circular-arc-

shaped in cross section as in the embodiment above. For example, as shown in FIG. 5, the cross section of the concave portion 4a may be (a) partial elliptical, (b) U-shaped, (c) trapezoidal, or (d) conical, for example.

[0040] In FIGs. 5 (a) to 5(d), the partial elliptical concave portion 4a shown in FIG. 5(a) is, in the same manner as the circular-arc-shaped concave portion of the embodiment above (see FIG. 4), has a curved inner surface. The air flows along the inner surface and hardly locally stagnant, and hence the formation of loops and entanglements on the filaments is facilitated. Furthermore, in cases of the partial elliptical shape in FIG. 5(a) and the conical shape in FIG. 5(d), because the central part is the deepest part, the yarn intensively collides the deepest part of the collision body 4, and hence the subsequent yarn processing is stably carried out.

[0041] In addition to the above, while the embodiment above is arranged so that, as shown in FIG. 4, the concave portion 4a is formed only at a part of the surface of the collision body 4 which surface is on the outlet 12a side and the concave portion 4a is surrounded by the flat portion 4b, the entirety of the surface of the collision body 4 on the outlet 12a side may be a concave portion 4a as shown in FIG. 5(e).

[0042] 2] The nozzle 2 may be shaped differently from the shape of the embodiment above shown in FIG. 4 (a). For example, as shown in FIG. 6 (a), the yarn introducing part 11 is tapered whereas the yarn ejecting part 12 is horn-shaped. Alternatively, as shown in FIG. 6 (b), the yarn introducing part 11 may have a straight shape with constant diameter.

[0043] 3] While in the embodiment above the collision body 4 is arranged to be movable (rotatable) with respect to the nozzle holder 3, the collision body 4 may be fixed with respect to the nozzle holder 3.

Examples

[0044] Now, specific examples of the present invention will be illustrated in comparison with comparative examples.

(1) Specifications of Nozzles and Collision Bodies

[0045] The specifications of four types of nozzles used in examples and comparative examples are shown in Table 1, whereas the specifications of six types of collision bodies used in examples and comparative examples are shown in Table 2. Combinations of these nozzles and collision bodies are shown in FIG. 7.

[0046]

[Table 1]

NOZZLE NUMBER	NOZZLE SHAPE		DIAMETER OF OUTLET K (mm)	AIR INJECTION HOLE (mm)
	YARN INTRODUCING PART	YARN EJECTING PART		
NO.1	HORN-SHAPED	TAPERED	6	0.5
NO.2	HORN-SHAPED	TAPERED	6	0.6
NO.3	TAPERED	HORN-SHAPED	13	0.6
NO.4	TAPERED	HORN-SHAPED	13	0.75

[0047]

[Table 2]

NAME OF COLLISION BODY	SHAPE	DETAILS
Cup(11mm)	CONCAVE	DIAMETER OF CONCAVE PORTION(d) = 11mm, DEPTH OF CONCAVE PORTION(h) = 0.8mm
Cup(20mm)	CONCAVE	DIAMETER OF CONCAVE PORTION(d) = 20mm, DEPTH OF CONCAVE PORTION(h) = 3.0mm
Cup(24mm)	CONCAVE	DIAMETER OF CONCAVE PORTION(d) = 24mm, DEPTH OF CONCAVE PORTION(h) = 4.5mm
Ball(6mm)	SPHERICAL	DIAMETER 6mm
Ball(13mm)	SPHERICAL	DIAMETER 13mm

(continued)

NAME OF COLLISION BODY	SHAPE	DETAILS
Plate	PLANAR	-

[0048] The nozzle No.1 and the nozzle No.2 in Table 1 are nozzles shown in the left column (1) in FIG. 7. On the other hand, the nozzle No.3 and the nozzle No.4 in Table 2 are nozzles shown in the right column (2) in FIG. 7. In this connection, as shown in Table 1, the nozzle No.1 is different from the nozzle No.2 in the diameter of the air injection hole, i.e., they are slightly different from each other in the thickness range of the yarn (the nozzle No.1 is for narrow yarns whereas the nozzle No.2 is for thick yarns). The same applies to the nozzle No.3 and the nozzle No.4.

[0049] In addition to the above, as shown in Table 2, there are six types of collision bodies in total, i.e., three types of collision bodies (Cups) in each of which the part of the nozzle opposing the outlet is arranged to be concave are used in the examples corresponding to the present invention, whereas two types of spherical collision bodies (Balls) and a single type of a planar collision body (Plate) are used in comparative examples. In FIG. 7, (a) and (e) are spherical collision bodies 13mm in diameter, (b) and (f) are spherical collision bodies 6mm in diameter, (c) and (g) are planar collision bodies, and (d) and (h) are concave collision bodies of the present invention. All of the six types of the collision bodies are made of ceramics.

(2) Comparison of processing capabilities resulting from different shapes of collision bodies

[0050] How the processing capability of the yarn processing device varies when the shape of the collision body is different was examined. That is to say, the nozzles in Table 1 were combined with the collision bodies of Table 2, and experiments were conducted with different materials of the yarn and different thickness of the yarn, and the yarn tension on the nozzle downstream side (discharging side) was measured in each case.

[0051] It is noted that the experiments were done by core-and effect processing in which a core yarn and an effect yarn were supplied to a nozzle at different supply rates and processed. Furthermore, the yarn speed (discharging side yarn speed) on the nozzle downstream side were changed in four stages, and the yarn tension (in units of gr) was measured on the premise that the overfeed amount (the excess percentage of the amount of yarn supplied to the nozzle (i.e., supply side yarn speed) as compared to the amount of discharge yarn (discharging side yarn speed)) of each of the core yarn and the effect yarn was constant. The results of measurement of the yarn tensions on the discharging side when the thickness of polyester yarn (PET) was 150 denier, 300 denier, 600 denier, and 750 denier are shown in Table 3 to Table 6. Furthermore, the result of measurement of the yarn tension on the discharging side when the thickness of nylon yarn (PA6) was 140 denier is shown in Table 7. In Table 3 to Table 7, a nozzle suitable for the thickness of the yarn was appropriately selected from the four types of nozzles shown in Table 1.

[0052]

[Table 3]

(YARN TYPE)MATERIAL:PET, YARN THICKNESS:75d/72f × 2=150d (a) NOZZLE NUMBER.1 (gr)				
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)			
	350	400	450	500
Cup(11mm)	7.2	7	6.8	6.8
Ball(6mm)	7	6.8	6.2	6
Ball(13mm)	6	5.2	5	4.8
Plate	7	7	6.6	6.2
(b) NOZZLE NUMBER.2 (gr)				
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)			
	350	400	450	500
Cup(11mm)	9	8.8	8.2	8

(continued)

(b) NOZZLE NUMBER.2				(gr)
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)			
	350	400	450	500
Ball(6mm)	7.8	7.6	7.5	7.2
Ball(13mm)	7.6	7.5	7.2	7
Plate	8.5	8.2	8	7.6
(c) NOZZLE NUMBER.3				(gr)
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)			
	350	400	450	500
Cup(11mm)	8	7.6	7.5	7.5
Ball(6mm)	7	6.8	6.5	6.2
Ball(13mm)	7.8	7.2	7	6.8
Plate	7.8	7.4	7	6.8

[0053]

[Table 4]

(YARN TYPE)MATERIAL:PET, YARN THICKNESS:150d/48f × 2=300d (a) NOZZLE NUMBER.1				(gr)
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)			
	350	400	450	500
Cup(11mm)	9	8.3	7.7	7.2
Ball(6mm)	8.2	8	6.5	6
Ball(13mm)	7.6	7	6.2	6
Plate	8	7.8	7.2	6.6
(b) NOZZLE NUMBER.2				(gr)
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)			
	350	400	450	500
Cup(11mm)	12.2	11.6	11	10.2
Ball(6mm)	8	7	6	5.2
Ball(13mm)	7.2	6.2	5.6	5
Plate	10	9	8.2	7.2

(continued)

(c) NOZZLE NUMBER.3 (gr)				
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)			
	350	400	450	500
Cup(11mm)	10	10	9.5	8.7
Ball(6mm)	9	8.2	8	7.8
Ball(13mm)	9.6	8.5	8	7.2
Plate	9.2	8.4	8	7.6

[0054]

[Table 5]

(YARN TYPE)MATERIAL:PET, YARN THICKNESS:150d/48f × 4=600d (a) NOZZLE NUMBER.2 (gr)				
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)			
	350	400	450	500
Cup(11mm)	16.2	15.1	13.2	12
Ball(6mm)	11	10	9	8
Ball(13mm)	10	8	7	6.5
Plate	16.1	15.1	13	11
(b) NOZZLE NUMBER.4 (gr)				
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)			
	350	400	450	500
Cup(11mm)	15	14.5	14	13
Ball(6mm)	10	9	8	7
Ball(13mm)	10.5	10	9	8
Plate	11	10	9.5	9

[0055]

[Table 6]

(YARN TYPE)MATERIAL:PET, YARN THICKNESS:150d/48f × 5=750d (a) NOZZLE NUMBER.2 (gr)				
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)			
	350	400	450	500
Cup(11mm)	13	12	11.5	11
Ball(6mm)	12	11	10	9
Ball(13mm)	11.5	11	9.5	8.5
Plate	12	11	10	9

(continued)

(b) NOZZLE NUMBER.4 (gr)				
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)			
	350	400	450	500
Cup(11mm)	18.5	18	17.5	17
Ball(6mm)	12	11	10	9
Ball(13mm)	12.5	12	11	10
Plate	12.5	12	10.5	10

[0056]

[Table 7]

(YARN TYPE)MATERIAL:PA6, YARN THICKNESS:70d/48f × 2=140d (a) NOZZLE NUMBER.2 (gr)					
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)				
	300	350	400	450	500
Cup(11mm)	6.5	6.4	6.3	6	5.8
Ball(6mm)	5.5	5.4	5.3	5.2	5
Ball(13mm)	5	4.9	4.8	4.6	4.4
Plate	6	5.8	5.3	5.2	5
(b) NOZZLE NUMBER.3 (gr)					
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)				
	300	350	400	450	500
Cup(11mm)	6.3	6.2	6	5.8	5.5
Ball(6mm)	5	4.8	4.4	4.2	4
Ball(13mm)	5.1	5.1	5	4.9	4.8
Plate	6	5.8	5.2	5	4.9

[0057] It has been known that the formation of entanglements on a yarn is typically enhanced as the yarn tension on the discharging side is increased. In other words, the quality of processing is improved as the yarn tension on the discharging side is increased. In this regard, as shown in Table 3 to Table 7, irrespective of the material of the yarn, the thickness of the yarn, and the type of the nozzle, the yarn tension on the discharging side was high in case where a concave collision body (Cup) of the present invention was used, as compared to the cases (comparative examples) where spherical collision bodies (Balls) and a planer collision body (Plate) were used. In short, when a concave collision body was used, the yarn processing capability of the yarn processing device was significantly improved.

[0058] Furthermore, as shown in Table 3 to Table 7, the yarn processing capability is typically improved when the yarn speed is low, because the yarn tension on the discharging side is high. In this regard, when a spherical or planar collision body is used, the yarn speed must be decreased to achieve a certain level of processing quality (i.e., a certain level of yarn tension) . On the other hand, when the concave collision body of the present invention is used, yarns having the same or improved quality as those produced by spherical or planer collision bodies are produced at a higher yarn speed, and hence the productivity is improved.

[0059] For example, according to Table 5, while in the spherical collision bodies (Balls) and the planer collision body (Plate) the tension of 11g was achieved only after the yarn speed was decreased to low 350m/min, in the concave collision body (Cup) the tension was still higher than 11g even if the yarn speed was increased to 500m/min, and hence the quality in the case of the concave collision body was as good as or higher than the quality achieved by the low-speed

processing by using the spherical and planar collision bodies.

(3) Diameter of concave portion of concave collision body

[0060] The yarn processing capabilities of the concave collision body were examined with different concave portion diameters (d in FIG. 7). In the experiments, three types of collision bodies with the diameters of the concave portions of 11mm, 20mm, and 24mm shown in Table 2 and the planar collision body of the comparative example were used, and the thickness of the yarn were changed. The yarn tensions of yarns that were made of PET and were 150 denier, 300 denier, and 600 denier in thickness were measured on the discharging side. The results are shown in Table 8 to Table 10.

[0061]

[Table 8]

(YARN TYPE)MATERIAL:PET, YARN THICKNESS:75d/72f × 2=150d (a) NOZZLE NUMBER.1 (K=6mm) (gr)					
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)				RATIO ε (=K/d)
	350	400	450	500	
Cup(11mm)	7.2	7	6.8	6.8	0.55
Cup(20mm)	8	7.6	7	7	0.3
Cup(24mm)	7.8	7.2	6.6	6.5	0.25
Plate	7	7	6.6	6.2	-
(b) NOZZLE NUMBER.2(K=6mm) (gr)					
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)				RATIO ε (=K/d)
	350	400	450	500	
Cup(11mm)	9	8.8	8.2	8	0.55
Cup(20mm)	9	9	8.9	8.3	0.3
Cup(24mm)	8.5	8.5	8.2	8	0.25
Plate	8.5	8.2	8	7.6	-

[0062]

[Table 9]

(YARN TYPE)MATERIAL:PET, YARN THICKNESS:150d/48f × 2=300d (a) NOZZLE NUMBER.2(K=6mm) (gr)					
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)				RATIO ε (=K/d)
	350	400	450	500	
Cup(11mm)	12.2	11.6	11	10.2	0.55
Cup(20mm)	12.3	11.8	11	10.3	0.3
Cup(24mm)	12.4	11.8	11.1	10.3	0.25
Plate	10	9	8.2	7.1	-

[0063]

[Table 10]

(YARN TYPE)MATERIAL:PET, YARN THICKNESS:150d/48f × 4=600d (a) NOZZLE NUMBER.2(K=6mm) (gr)					
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)				RATIO ε (=K/d)
	350	400	450	500	
Cup(11mm)	16.2	15.1	13.2	12	0.55
Cup(20mm)	16.5	15.3	14.2	13.1	0.3
Cup(24mm)	16.9	15.3	14.5	13.1	0.25
Plate	16.1	15.1	13	11	-
(b) NOZZLE NUMBER.3(K=13mm) (gr)					
TYPE OF COLLISION BODY	DISCHARGING SIDE YARN SPEED(m/min)				RATIO ε (=K/d)
	350	400	450	500	
Cup(11mm)	15.2	13.3	12	11	1.18
Cup(20mm)	15.2	14.1	13	11.7	0.65
Cup(24mm)	15.1	14.1	12	11	0.54
Plate	13.2	12.2	10.4	9.2	-

[0064] As shown in Table 8 to Table 10, irrespective of the thickness of the yarn and the type of the nozzle, the yarn tension was high as compared to the case of the planar collision body when the diameter of the concave portion fell within the range of 11mm to 24mm, and the processing capability was improved.

[0065] It is noted that the improvement in the processing capability seems not conspicuous when the concave portion of the collision body is extremely larger than or smaller than the diameter of the opposing outlet. In this regard, Table 8 to Table 10 show non-dimensional parameters each of which is the ratio between the diameter of the outlet of the nozzle (K) and the diameter of the concave portion of the collision body (d) (ε=K/d). This indicates that the processing capability is good at least when ε is between 0.25 and 1.18.

Sequence Listing

[0066]

1 YARN PROCESSING DEVICE
2 NOZZLE
3 NOZZLE HOLDER
4 COLLISION BODY
4a CONCAVE PORTION
4b FLAT PORTION
10 YARN PATH
11a INLET
12 YARN EJECTING PART
12a OUTLET
14 AIR INJECTION HOLE
26 YARN GUIDE
31 YARN

Claims

1. A yarn processing device comprising:

a nozzle including a yarn path constituted by a yarn introducing part and a yarn ejecting part and a fluid injection hole configured to eject fluid into the yarn path; and
a collision body having a surface which opposes, over a gap,
a leading end face of the yarn ejecting part on which face an outlet is formed,
on the surface of the collision body which surface opposes the leading end face of the yarn ejecting part, an opposing part opposing the outlet being formed to have a concave shape.

2. The yarn processing device according to claim 1, wherein, an inner surface of the concave opposing part of the collision body is formed by a curved surface.

3. The yarn processing device according to claim 1 or 2, wherein, the opposing part of the collision body is formed to be deepest at a central part.

4. The yarn processing device according to claim 1, wherein, the opposing part of the collision body is circular-arc-shaped or partial-elliptical-shaped in cross section.

5. The yarn processing device according to any one of claims 1 to 4, wherein, on the opposing part of the collision body, a concave portion and a flat portion, which is in parallel to the leading end face of the yarn ejecting part including the outlet and surrounds the concave portion, are formed.

6. The yarn processing device according to any one of claims 1 to 5, further comprising:

a nozzle holder that holds the nozzle,
the collision body being attached to the nozzle holder, and
the nozzle holder being provided with a yarn guide which is configured to guide a yarn having passed through a gap between the yarn ejecting part of the nozzle and the collision body.

FIG.1

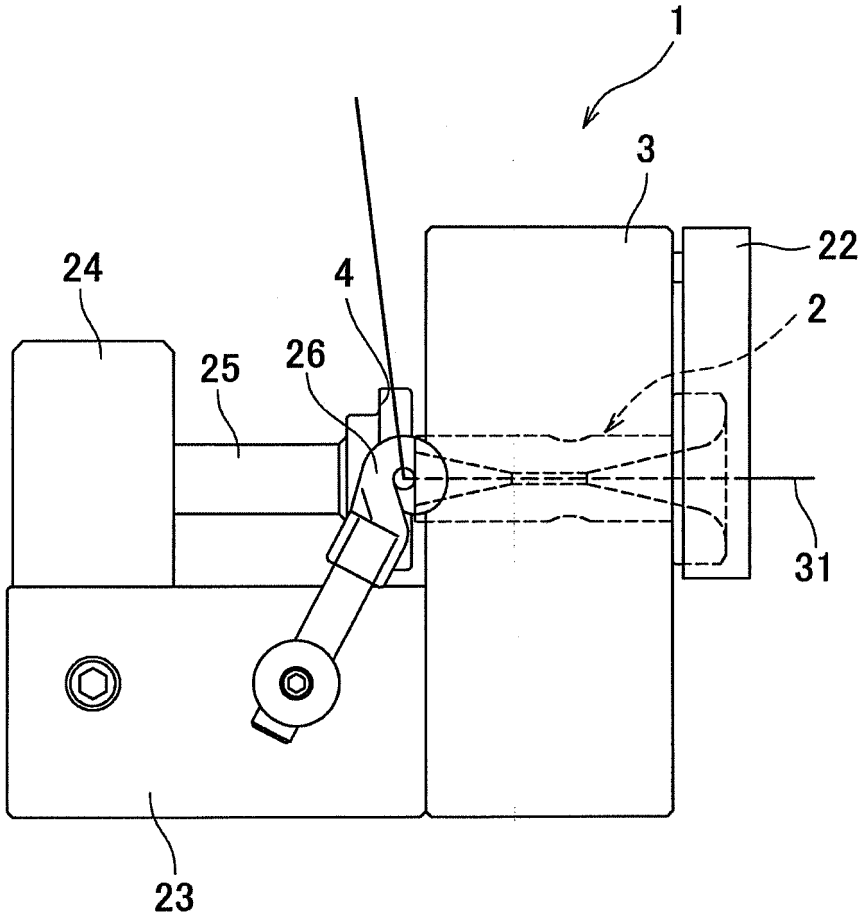


FIG.2

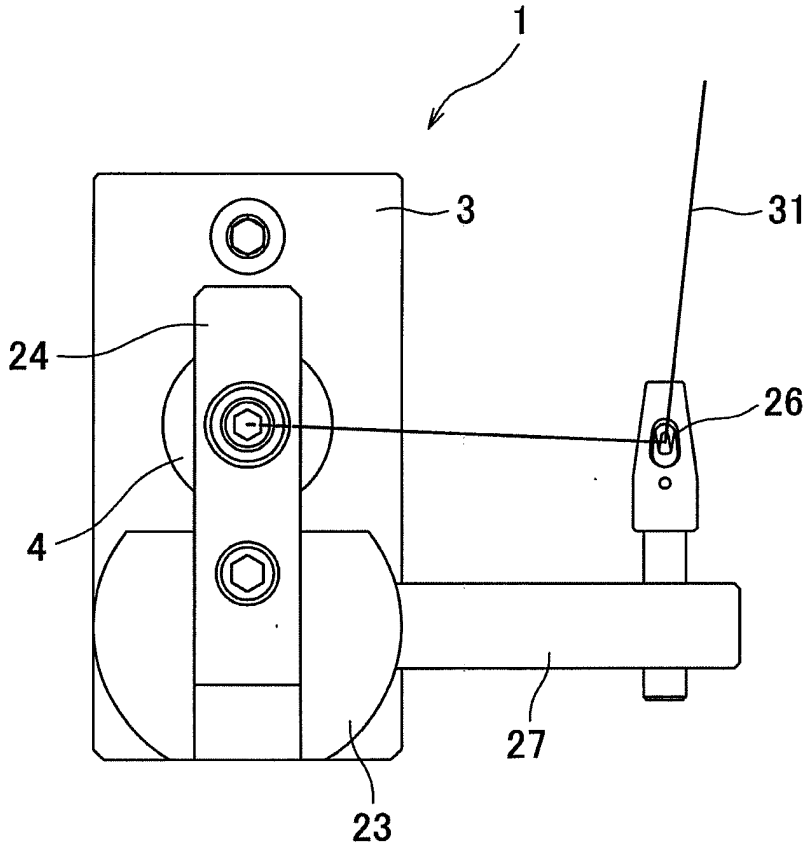


FIG.3

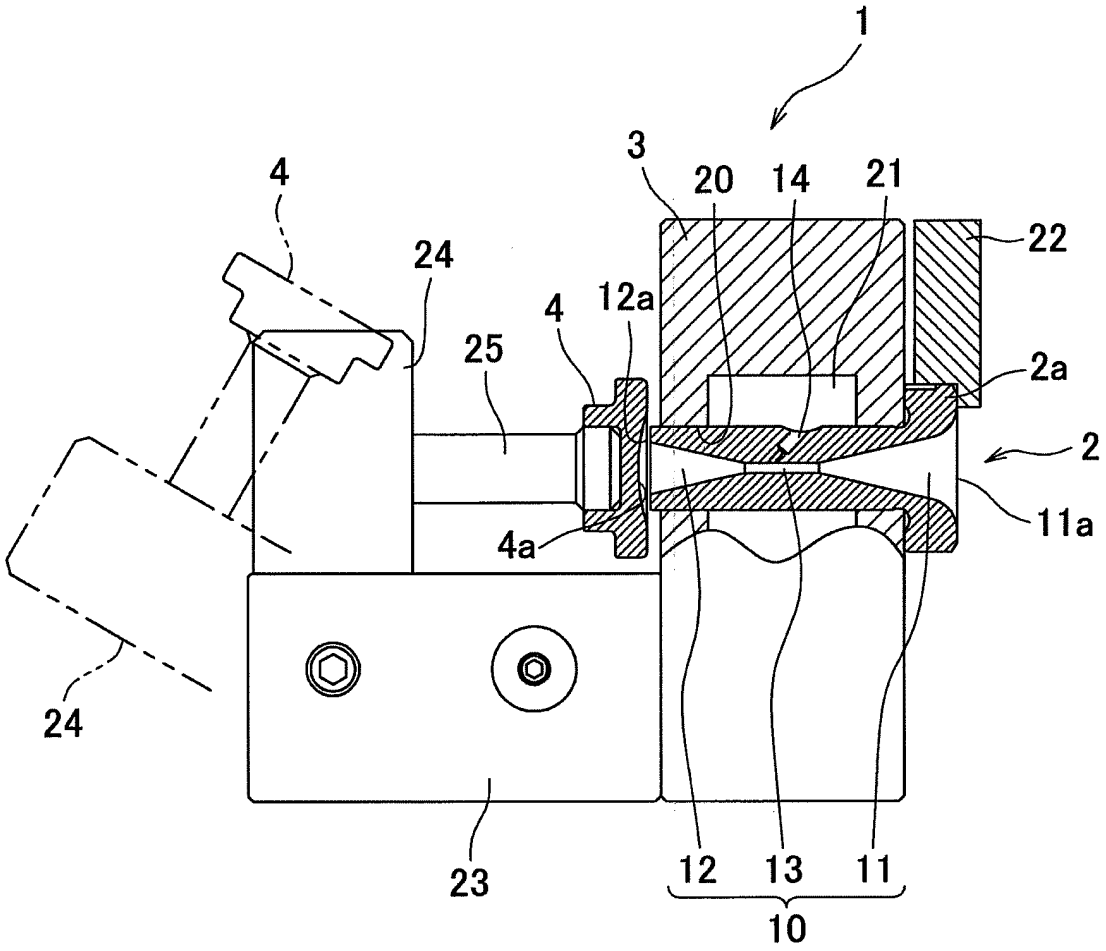


FIG.4(a)

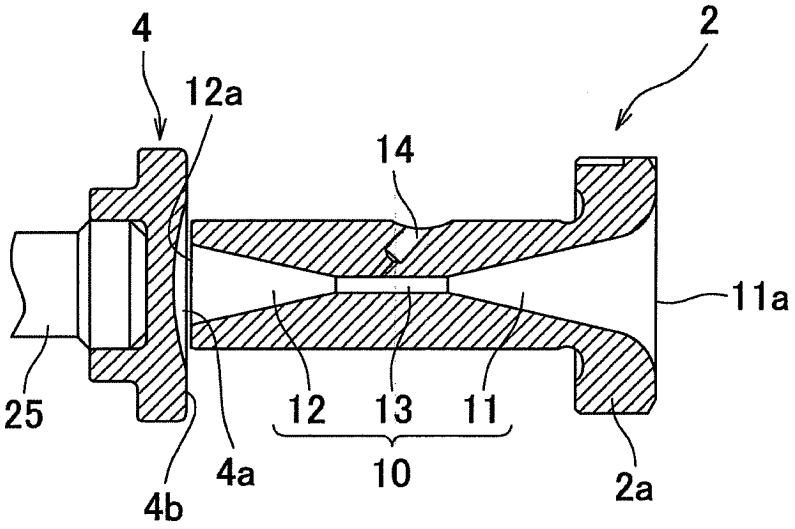


FIG.4(b)

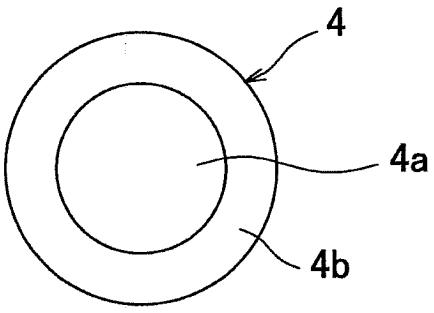


FIG.5(a)

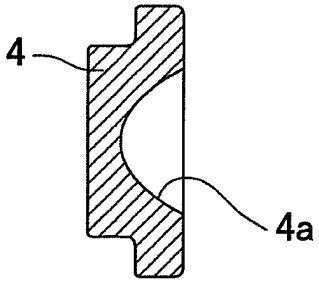


FIG.5(b)

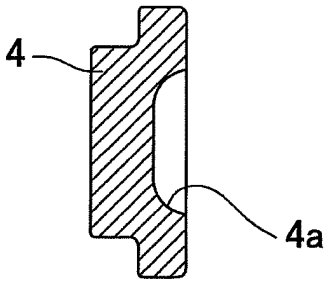


FIG.5(c)

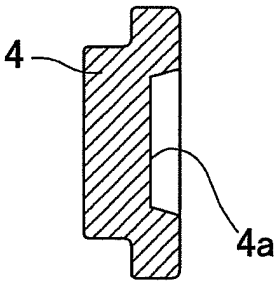


FIG.5(d)

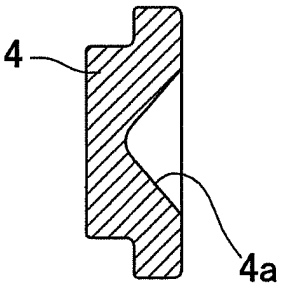


FIG.5(e)

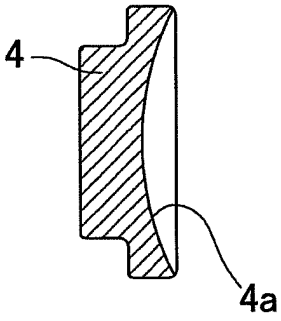


FIG.6(a)

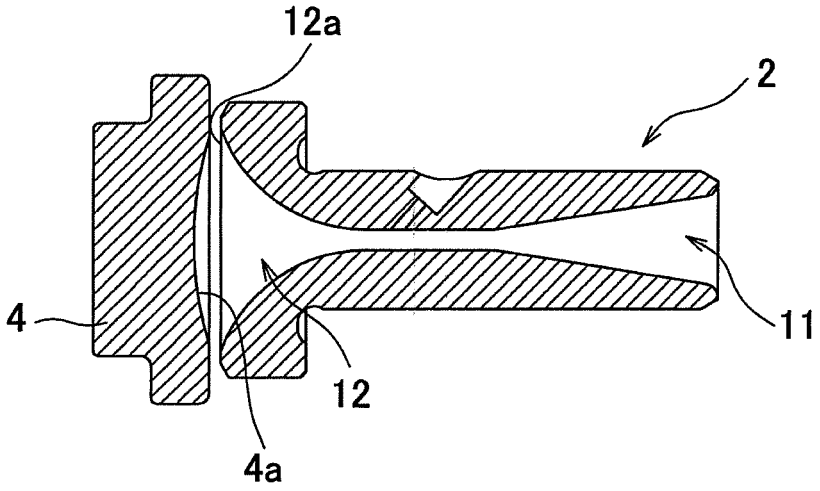
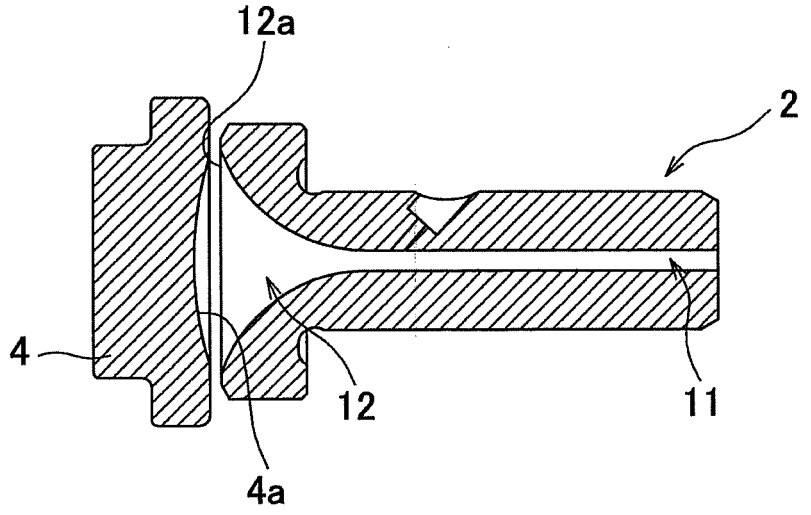


FIG.6(b)



(1)

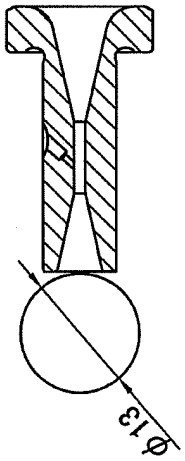


FIG.7(a)

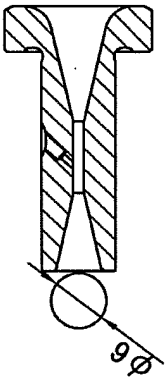


FIG.7(b)

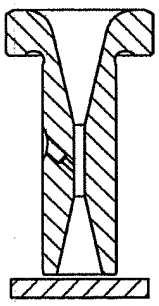


FIG.7(c)

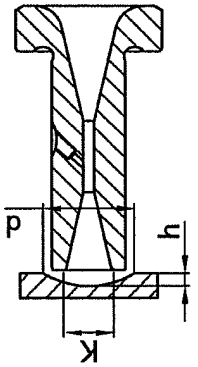


FIG.7(d)

(2)

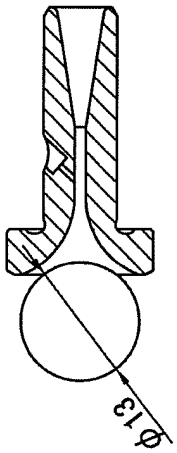


FIG.7(e)

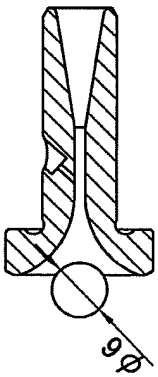


FIG.7(f)

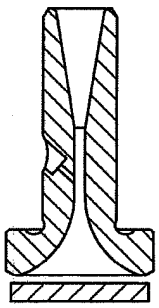


FIG.7(g)

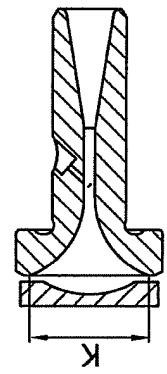


FIG.7(h)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/070376

A. CLASSIFICATION OF SUBJECT MATTER
D02J1/08(2006.01)i, *D02J1/02*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D02G1/00-3/48, D02J1/00-13/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011
Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2000-514509 A (Heberlein Fiber Technology AG.), 31 October 2000 (31.10.2000), claims; page 17, line 15 to page 18, line 11; fig. 8, 8a & US 6088892 A claims; column 9, line 56 to column 10, line 34; fig. 8, 8a & JP 9-310241 A & GB 2310219 A & GB 9702679 A & EP 880611 A1 & WO 1997/030200 A1 & DE 19605675 A & DE 59704244 D & BR 9707431 A & RU 2142029 C & TR 9801567 T & ES 2160923 T & TW 476821 B & TW 477838 B & TW 517108 B & CN 1211293 A	1-4,6 5

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
04 November, 2011 (04.11.11)	15 November, 2011 (15.11.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/070376

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2001-140137 A (Unitika Ltd.), 22 May 2001 (22.05.2001), claims; drawings (Family: none)	1-6

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2000514509 PCT **[0005]**
- JP 2000303280 A **[0005]**