



## Description

### TECHNICAL FIELD

**[0001]** The invention relates to a synthetic yarn splicer.

### BACKGROUND

**[0002]** As a conventional synthetic yarn splicer, for example, one described in Patent Literature 1 (Japanese Unexamined Patent Publication No. H10-17214) is known. In the synthetic yarn splicer described in Patent Literature 1, a starting end and a terminating end of two synthetic yarns are aligned in the opposite directions to be drawn into an air nozzle, both side portions outside the air nozzle of the drawn yarn end are pressed down, the pressed both side portions are moved into the air nozzle, the aligned yarn end is loosened inside the air nozzle, and the yarns are spliced by an air flow inside the air nozzle.

### SUMMARY

**[0003]** The synthetic yarn splicer is used to splice a terminating end of a yarn of one supply bobbin and a starting end of a yarn of the other supply bobbin in, for example, a yarn winding machine for winding synthetic fibers. In the yarn winding machine, the yarn is wound around a bobbin while applying a tension to the yarn to form a package. For that reason, an entangled portion obtained by splicing the yarns by the synthetic yarn splicer is pulled while a tension is applied thereto. In the yarn winding machine, when the entangled portion is unwound during the winding operation, the winding operation must be temporarily stopped and hence the production efficiency is lowered. For that reason, there is a demand for forming an entangled portion having a tensile elongation capable of withstanding a winding tension in the synthetic yarn splicer.

**[0004]** An aspect of the invention is to provide a synthetic yarn splicer capable of suppressing a change in tensile elongation decrease amount while suppressing a decrease in tensile elongation of an entangled portion.

**[0005]** A synthetic yarn splicer according to an aspect of the invention is a synthetic yarn splicer that performs a splicing operation between one yarn and the other yarn formed of synthetic fibers, including: a yarn splicing portion that includes a passage which forms a space through which one yarn and the other yarn are insertable and an injection hole which opens to the passage and injects a fluid; and a pair of clamping mechanisms that is provided at a position interposing the passage of the yarn splicing portion and holds each of one yarn and the other yarn inserted through the space, in which a cross-sectional shape of the passage formed on a plane orthogonal to a penetration direction of the passage is a circular shape, and in which a first line passing through a center of the passage and connecting an inner peripheral surface of

the passage and a second line passing through the center of the passage, connecting the inner peripheral surface of the passage, and orthogonal to the first line are equal to or larger than 4.0 mm and equal to or smaller than 7.0 mm.

**[0006]** In the synthetic yarn splicer according to an aspect of the invention, the first line and the second line are equal to or larger than 4.0 mm and equal to or smaller than 7.0 mm. In the synthetic yarn splicer, since the first line and the second line are set to be equal to or larger than 4.0 mm, it is possible to suppress an influence of a contact with the inner surface of the passage when one yarn and the other yarn are swayed inside the passage by using the clamping mechanism as a fixed point. Further, in the synthetic yarn splicer, when the first line and the second line become larger than 7.0 mm, a fluid hardly acts on one yarn and the other yarn inside the passage and hence the entangled portion is not appropriately formed. Thus, in the synthetic yarn splicer, since the first line and the second line are set to be equal to or larger than 4.0 mm and equal to or smaller than 7.0 mm, the entangled portion can be appropriately formed. As a result, in the synthetic yarn splicer, it is possible to suppress a change in tensile elongation decrease amount while suppressing a decrease in tensile elongation of the entangled portion.

**[0007]** In one embodiment, the injection hole may have a circular shape and a diameter of the injection hole may be equal to or larger than  $\phi 0.8$  mm and equal to or smaller than  $\phi 2.0$  mm. In this configuration, it is possible to suppress a change in tensile elongation decrease amount while suppressing a decrease in tensile elongation of the entangled portion.

**[0008]** In one embodiment, the diameter of the injection hole may be equal to or larger than  $\phi 1.0$  mm and equal to or smaller than  $\phi 1.8$  mm. In this configuration, it is possible to further suppress a change in tensile elongation decrease amount while suppressing a decrease in tensile elongation of the entangled portion.

**[0009]** According to an aspect of the invention, it is possible to suppress a change in tensile elongation decrease amount while suppressing a decrease in tensile elongation of an entangled portion.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0010]**

FIG. 1 is a perspective view illustrating a synthetic yarn splicer according to an embodiment.

FIG. 2 is a view illustrating a yarn splicing mechanism when viewed from above.

FIG. 3 is a side view of the yarn splicing mechanism.

FIG. 4 is a cross-sectional view of a yarn splicing portion.

FIG. 5 is a cross-sectional view taken along a line V-V of FIG. 2.

FIG. 6A is a diagram illustrating an operation of the

yarn splicing mechanism.

FIG. 6B is a diagram illustrating an operation of the yarn splicing mechanism.

FIG. 7A is a diagram showing a tensile elongation measurement result of an entangled portion.

FIG. 7B is a diagram showing a tensile elongation measurement result of an entangled portion.

FIG. 8A is a diagram showing Example and Comparative Example.

FIG. 8B is a diagram showing Example and Comparative Example.

## DETAILED DESCRIPTION

**[0011]** Hereinafter, preferred embodiments of the invention will be described in detail with reference to the accompanying drawings. Furthermore, in the description of the drawings, the same reference numerals will be given to the same or equivalent components and the repetitive description will be omitted.

**[0012]** A synthetic yarn splicer 1 illustrated in FIG. 1 is a device which performs a splicing operation between a yarn end of a first yarn (one yarn) Y1 (see FIG. 6A) formed of synthetic fibers and a yarn end of a second yarn (the other yarn) Y2 (see FIG. 6A) formed of synthetic fibers. The synthetic yarn splicer 1 is used to perform a splicing operation between a terminating end of a yarn of one supply bobbin and a starting end of a yarn of the other supply bobbin, for example, in a yarn winding machine that winds a yarn from a supply bobbin to form a package. In the embodiment, the synthetic yarn splicer 1 is a so-called hand splicer.

**[0013]** The synthetic yarn splicer 1 includes a main body 3 and a yarn splicing mechanism 5. The main body 3 is a casing which accommodates the yarn splicing mechanism 5. The main body 3 includes a first main body portion 3a and a second main body portion 3b. The main body 3 is formed in, for example, a substantially L shape in the side view.

**[0014]** The first main body portion 3a is a portion which is gripped by an operator when the synthetic yarn splicer 1 is used. The first main body portion 3a has, for example, a substantially rectangular parallelepiped shape. The first main body portion 3a is provided with an operation portion 7. The operation portion 7 is a button which is operated when performing a splicing operation in the synthetic yarn splicer 1. In the embodiment, the operation portion 7 is provided at a portion which is located within an operation range of an index finger when the first main body portion 3a is gripped by the operator at the side of one end portion (the side of the second main body portion 3b) of the first main body portion 3a in the longitudinal direction.

**[0015]** The lower end portion of the first main body portion 3a (the other end portion of the longitudinal direction) is provided with a connection portion 9. A tube (not illustrated) supplying compressed air (fluid) (hereinafter, simply referred to as "air") is connected to the connection

portion 9. The first main body portion 3a may accommodate a switch which is operated in synchronization with the operation of the operation portion 7 and components branching compressed air supplied through the connection portion 9.

**[0016]** The second main body portion 3b is provided with the yarn splicing mechanism 5. The second main body portion 3b has, for example, a substantially rectangular parallelepiped shape. The second main body portion 3b is provided at one end portion of the first main body portion 3a. Specifically, the second main body portion 3b is integrally formed with the first main body portion 3a so that a predetermined angle (for example, 90° or less) is formed between the longitudinal direction of the second main body portion 3b and the longitudinal direction of the first main body portion 3a. The second main body portion 3b exposes the yarn splicing mechanism 5. The second main body portion 3b accommodates a driving portion or the like (for example, a cylinder or the like) which drives a first clamping mechanism 20 and a second clamping mechanism 30 to be described later.

**[0017]** As illustrated in FIG. 2 or 3, the yarn splicing mechanism 5 includes a yarn splicing portion 10, the first clamping mechanism 20, and the second clamping mechanism 30. The first clamping mechanism 20 and the second clamping mechanism 30 are provided at a position that interposes a chamber 14 of the yarn splicing portion 10.

**[0018]** As illustrated in FIG. 4, the yarn splicing portion 10 includes a yarn splicing nozzle 12, a chamber (a passage) 14, and an air flow path 16.

**[0019]** The yarn splicing nozzle 12 is a block body which is formed of metal or ceramic. The yarn splicing nozzle 12 is provided with a slit 13. The slit 13 is a portion which introduces a yarn to the chamber 14. An upper portion of the slit 13 is provided with an inclined surface 15. The inclined surface 15 guides a yarn to the slit 13. The inclined surface 15 has a tapered shape which is narrowed from an upper surface 12a of the yarn splicing nozzle 12 toward the slit 13.

**[0020]** The chamber 14 is a passage through which a first yarn Y1 and a second yarn Y2 are inserted. As illustrated in FIG. 5, the chamber 14 penetrates one side surface 12b and the other side surface 12c of the yarn splicing nozzle 12. The chamber 14 forms a space through which the first yarn Y1 and the second yarn Y2 are insertable. As illustrated in FIG. 4, a cross-sectional shape of the chamber 14 formed in a plane orthogonal to the penetration direction of the chamber 14 is a circular shape. A circular shape includes a true circular shape, an oval shape, and the like. In the embodiment, the penetration direction of the chamber 14 is a facing direction of the pair of side surfaces 12b and 12c (see FIG. 5) of the yarn splicing nozzle 12. In the embodiment, the cross-sectional shape of the chamber 14 is a true circular shape.

**[0021]** In the chamber 14, a first line which passes through a center C of the chamber 14 and connects the

inner peripheral surface 14a of the chamber 14 and a second line which passes through the center C of the chamber 14, connects the inner peripheral surface 14a of the chamber 14, and is orthogonal to the first line are equal to or larger than 4.0 mm and equal to or smaller than 7.0 mm. In the embodiment, a cross-sectional shape of the chamber 14 is a true circular shape. For that reason, as illustrated in FIG. 4, the first line and the second line have the same dimension and correspond to the diameter R1 of the chamber 14. In the embodiment, the diameter R1 of the chamber 14 is equal to or larger than  $\phi 4.0$  mm and equal to or smaller than  $\phi 7.0$  mm.

**[0022]** The air flow path 16 circulates air to be supplied to the chamber 14. The air flow path 16 includes an injection hole 16a which opens to the chamber 14. The injection hole 16a communicates the air flow path 16 with the chamber 14. Air is injected from the injection hole 16a to the chamber 14. The diameter R2 of the injection hole 16a is equal to or larger than  $\phi 0.8$  mm and equal to or smaller than  $\phi 2.0$  mm, desirably equal to or larger than  $\phi 1.0$  mm and equal to or smaller than  $\phi 1.8$  mm, and more desirably equal to or larger than  $\phi 1.3$  mm and equal to or smaller than  $\phi 1.6$  mm. The position of the chamber 14 of the injection hole 16a may be appropriately set in response to a design. A connection portion 18 is provided at the upstream side of the air flow path 16 (the opposite side to the injection hole 16a). A supply pipe or the like which supplies air is connected to the connection portion 18.

**[0023]** As illustrated in FIGS. 2 and 3, the first clamping mechanism 20 includes a support portion 22 and a clamping portion 23. The first clamping mechanism 20 clamps a yarn inserted through the chamber 14 of the yarn splicing portion 10.

**[0024]** The support portion 22 has a rectangular parallelepiped shape (prismatic shape). As illustrated in FIG. 5, the support portion 22 includes a pair of facing main surfaces 22a and 22b and a pair of facing side surfaces 22c and 22d. The side surface 22d is a surface which faces the side surface 12b in the yarn splicing nozzle 12.

**[0025]** The support portion 22 holds the clamping portion 23. The support portion 22 is provided to be swingable. Specifically, as illustrated in FIG. 2, a base end portion of the support portion 22 (one end portion of the longitudinal direction) is provided with a shaft 21. The shaft 21 is fixed to a frame (not illustrated) or the like. The support portion 22 swings about the shaft 21. The support portion 22 moves between a second position P2 (see FIG. 6B) in which a front end portion (the other end portion of the longitudinal direction) moves close to the yarn splicing portion 10 and a first position P1 (see FIG. 6A) in which the front end portion moves away from the yarn splicing portion 10 in relation to the second position P2. That is, the first clamping mechanism 20 moves between the first position P1 and the second position P2. The support portion 22 moves by the driving of, for example, a driving portion (not illustrated) such as a cylinder. In the embodiment, as described above, one end

portion of the longitudinal direction provided with the shaft 21 in the support portion 22 will be referred to as a base end portion and the other end portion of the longitudinal direction opposite to the one end portion will be referred to as a front end portion.

**[0026]** The support portion 22 is provided with a concave portion 25. The concave portion 25 is provided at the side of the front end portion of the support portion 22. The concave portion 25 opens to the main surface 22a and the pair of side surfaces 22c and 22d of the support portion 22. The concave portion 25 exposes a part of the clamping portion 23. As illustrated in FIG. 2, the concave portion 25 has a rectangular shape when viewed from the main surface 22a of the support portion 22. As illustrated in FIG. 3, the concave portion 25 has a rectangular shape when viewed from the side surface 22c of the support portion 22.

**[0027]** As illustrated in FIG. 5, the support portion 22 includes a support surface 27a which slidably supports a second clamping member 26 (a first clamping member 24) to be described later in the clamping portion 23. The support surface 27a is provided at a center portion in the facing direction of the pair of side surfaces 22c and 22d of the support portion 22. The support surface 27a has a shape (a semi-circular shape) which is curved in a convex shape downward in response to the shape of the outer peripheral surface of the second clamping member 26 (the first clamping member 24). The support surface 27a extends in the longitudinal direction of the support portion 22.

**[0028]** The support portion 22 includes a first contact surface 27b and a second contact surface 27c at a position interposing the support surface 27a in the facing direction of the pair of side surfaces 22c and 22d (the facing direction of the first clamping mechanism 20 and the second clamping mechanism 30). The first contact surface 27b and the second contact surface 27c constitute a bottom surface of the concave portion 25. The first contact surface 27b is a surface which is able to contact the first yarn Y1 and the second yarn Y2 clamped by the clamping portion 23. A contactable state includes a case in which the first contact surface 27b contacts the first yarn Y1 and the second yarn Y2 clamped by the clamping portion 23 and a case in which the first contact surface 27b does not contact the first yarn Y1 and the second yarn Y2. The second contact surface 27c is a surface which contacts the first yarn Y1 and the second yarn Y2 clamped by the clamping portion 23. As illustrated in FIG. 2, the first contact surface 27b and the second contact surface 27c are provided at a position in which at least the first clamping member 24 and the second clamping member 26 contact.

**[0029]** As illustrated in FIG. 5, the first contact surface 27b is a flat surface which is continuous to one end of the support surface 27a (an end at the side of the side surface 22c). The second contact surface 27c is a flat surface which is continuous to the other end of the support surface 27a (an end at the side of the side surface

22d). That is, respective surfaces are provided in order of the second contact surface 27c, the support surface 27a, and the first contact surface 27b from the yarn splicing portion 10 when viewed from the facing direction of the pair of main surfaces 22a and 22b of the support portion 22. That is, the second contact surface 27c is disposed between the yarn splicing portion 10 and the clamping portion 23. The second contact surface 27c is located at the inside of the facing direction of the first clamping mechanism 20 and the second clamping mechanism 30 facing each other with the yarn splicing portion 10 interposed therebetween and the first contact surface 27b is located at the outside of the facing direction.

**[0030]** The first contact surface 27b is substantially parallel to the main surfaces 22a and 22b. The first contact surface 27b is provided over the support surface 27a and the side surface 22c. The second contact surface 27c is substantially parallel to the main surfaces 22a and 22b. The second contact surface 27c is provided over the support surface 27a and the side surface 22d. The first contact surface 27b and the second contact surface 27c are located at the same position in the facing direction of the pair of main surfaces 22a and 22b of the support portion 22.

**[0031]** As illustrated in FIG. 2, the clamping portion 23 includes the first clamping member 24 and the second clamping member 26. Each of the first clamping member 24 and the second clamping member 26 is formed in a columnar shape. Each of the first clamping member 24 and the second clamping member 26 is formed of, for example, metal such as SUS having abrasion resistance. The diameter of each of the first clamping member 24 and the second clamping member 26 may be appropriately set.

**[0032]** The first clamping member 24 and the second clamping member 26 are disposed at the support portion 22 so that respective end surfaces face each other. Specifically, the first clamping member 24 is disposed at the side of the front end portion of the support portion 22 and the second clamping member 26 is disposed at the side of the base end portion of the support portion 22 in relation to the first clamping member 24. The first clamping mechanism 20 holds a yarn by clamping the yarn between the end surface of the first clamping member 24 and the end surface of the second clamping member 26 in the clamping portion 23.

**[0033]** A part of the first clamping member 24 is accommodated in the support portion 22 and a part of the first clamping member 24 is exposed in the concave portion 25 of the support portion 22. The first clamping member 24 may be fixed to the support portion 22 and may be provided to be movable (slidable on the support surface 27a) in the facing direction of the first clamping member 24 and the second clamping member 26 (hereinafter, simply referred to as the "facing direction").

**[0034]** A part of the second clamping member 26 is accommodated in the support portion 22 and a part of the second clamping member 26 is exposed in the con-

cave portion 25 of the support portion 22. The second clamping member 26 is movably provided in the support portion 22. The second clamping member 26 moves in the facing direction. The second clamping member 26 is biased toward the first clamping member 24 by a biasing member (not illustrated) such as a spring. That is, the end surfaces of the second clamping member 26 and the first clamping member 24 are in contact with each other by a biasing force of a biasing member in a state in which a force other than the biasing member is not applied to the second clamping member 26.

**[0035]** The second clamping member 26 moves in synchronization with the movement of the support portion 22. The second clamping member 26 moves in a direction moving away from the first clamping member 24 by the movement of the support portion 22 from the second position P2 (see FIG. 6B) to the first position P1 (see FIG. 6A). Specifically, the second clamping member 26 can be pressed down in a direction opposite to the biasing direction of the biasing member by a cam mechanism (not illustrated) or the like when the support portion 22 moves from the second position P2 to the first position P1. Accordingly, a gap (space) is formed between the first clamping member 24 and the second clamping member 26 in the clamping portion 23. Furthermore, the movement of the second clamping member 26 may not be synchronized with the movement of the support portion 22.

**[0036]** As illustrated in FIGS. 2 and 3, the second clamping mechanism 30 includes a support portion 32 and a clamping portion 33. The second clamping mechanism 30 clamps a yarn inserted through the chamber 14 of the yarn splicing portion 10.

**[0037]** The support portion 32 has a rectangular parallelepiped shape (prismatic shape). As illustrated in FIG. 5, the support portion 32 includes a pair of facing main surfaces 32a and 32b and a pair of facing side surfaces 32c and 32d. The side surface 32d is a surface which faces the side surface 12c of the yarn splicing nozzle 12.

**[0038]** The support portion 32 holds the clamping portion 33. The support portion 32 is provided to be swingable. Specifically, as illustrated in FIG. 2, a base end portion of the support portion 32 (one end portion of the longitudinal direction) is provided with a shaft 31. The shaft 31 is fixed to a frame (not illustrated) or the like. The support portion 32 swings about the shaft 31. The support portion 32 moves between a second position P2 (see FIG. 6B) in which a front end portion (the other end portion of the longitudinal direction) moves close to the yarn splicing portion 10 and a first position P1 (see FIG. 6A) in which the front end portion moves away from the yarn splicing portion 10 in relation to the second position P2. That is, the first clamping mechanism 20 moves between the first position P1 and the second position P2. The support portion 32 moves by the driving of, for example, a driving portion (not illustrated) such as a cylinder. The driving portion may be the same as the driving portion that drives the support portion 22 or may be sep-

arately provided. In the embodiment, as described above, one end portion of the longitudinal direction provided with the shaft 31 in the support portion 32 will be referred to as a base end portion and the other end portion of the longitudinal direction opposite to the one end portion will be referred to as a front end portion.

**[0039]** The support portion 32 is provided with a concave portion 35. The concave portion 35 is provided at the side of the front end portion of the support portion 32. The concave portion 35 opens to the main surface 32a and the pair of side surfaces 32c and 32d of the support portion 32. The concave portion 35 exposes a part of the clamping portion 33. As illustrated in FIG. 2, the concave portion 35 has a rectangular shape when viewed from the main surface 32a of the support portion 32. The concave portion 35 has a rectangular shape when viewed from the side surfaces 32c and 32d of the support portion 32.

**[0040]** As illustrated in FIG. 5, the support portion 32 includes a support surface 37a which slidably supports the second clamping member 36 (the first clamping member 34) to be described later in the clamping portion 33. The support surface 37a is provided at a center portion of the facing direction of the pair of side surfaces 32c and 32d of the support portion 32. The support surface 37a has a shape (a semi-circular shape) which is curved in a convex shape downward in response to the shape of the outer peripheral surface of the second clamping member 36 (the first clamping member 34). The support surface 37a extends in the longitudinal direction of the support portion 32.

**[0041]** The support portion 32 includes a first contact surface 37b and a second contact surface 37c at a position interposing the support surface 37a in the facing direction of the pair of side surfaces 32c and 32d. The first contact surface 37b and the second contact surface 37c constitute a bottom surface of the concave portion 35. The first contact surface 37b is a surface which is able to contact the first yarn Y1 and the second yarn Y2 clamped by the clamping portion 33. The second contact surface 37c is a surface which contacts the first yarn Y1 and the second yarn Y2 clamped by the clamping portion 33. As illustrated in FIG 2, the first contact surface 37b and the second contact surface 37c are provided at a position in which at least the first clamping member 34 and the second clamping member 36 contact.

**[0042]** As illustrated in FIG. 5, the first contact surface 37b is a flat surface which is continuous to one end of the support surface 37a (an end at the side of the side surface 32c). The second contact surface 37c is a flat surface which is continuous to the other end of the support surface 37a (an end at the side of the side surface 32d). That is, respective surfaces are provided in order of the second contact surface 37c, the support surface 37a, and the first contact surface 37b from the yarn splicing portion 10 when viewed from the facing direction of the pair of main surfaces 32a and 32b of the support portion 32. That is, the second contact surface 37c is

disposed between the yarn splicing portion 10 and the clamping portion 33. The second contact surface 37c is located at the inside of the facing direction of the first clamping mechanism 20 and the second clamping mechanism 30 facing each other with the yarn splicing portion 10 interposed therebetween and the first contact surface 37b is located at the outside of the facing direction.

**[0043]** The first contact surface 37b is substantially parallel to the main surfaces 32a and 32b. The first contact surface 37b is provided over the support surface 37a and the side surface 32c. The second contact surface 37c is substantially parallel to the main surfaces 32a and 32b. The second contact surface 37c is provided over the support surface 37a and the side surface 32d. The first contact surface 37b and the second contact surface 37c are located at the same position in the facing direction of the pair of main surfaces 32a and 32b of the support portion 32.

**[0044]** As illustrated in FIG. 2, the clamping portion 33 includes the first clamping member 34 and the second clamping member 36. Each of the first clamping member 34 and the second clamping member 36 is formed in a columnar shape. Each of the first clamping member 34 and the second clamping member 36 is formed of, for example, metal such as SUS having abrasion resistance. The diameter of each of the first clamping member 34 and the second clamping member 36 may be appropriately set.

**[0045]** The first clamping member 34 and the second clamping member 36 are disposed at the support portion 32 so that respective end surfaces face each other. Specifically, the first clamping member 34 is disposed at the side of the front end portion of the support portion 32 and the second clamping member 36 is disposed at the side of the base end portion of the support portion 32 in relation to the first clamping member 34. The second clamping mechanism 30 holds a yarn by clamping the yarn between the end surface of the first clamping member 34 and the end surface of the second clamping member 36 in the clamping portion 33.

**[0046]** A part of the first clamping member 34 is accommodated in the support portion 32 and a part of the first clamping member 34 is exposed in the concave portion 35 of the support portion 32. The first clamping member 34 may be fixed to the support portion 32 and may be provided to be movable in the facing direction of the first clamping member 34 and the second clamping member 36 (to be slidable on the support surface 37a).

**[0047]** A part of the second clamping member 36 is accommodated in the support portion 32 and a part of the second clamping member 36 is exposed in the concave portion 35 of the support portion 32. The second clamping member 36 is movably provided in the support portion 32. The second clamping member 36 moves in the facing direction. The second clamping member 36 is biased toward the first clamping member 34 by a biasing member (not illustrated) such as a spring. That is, the end surfaces of the second clamping member 36 and the

first clamping member 34 contact each other by a biasing force of a biasing member in a state in which a force other than the biasing member is not applied to the second clamping member 36.

**[0048]** The second clamping member 36 moves in synchronization with the movement of the support portion 32. The second clamping member 36 moves in a direction moving away from the first clamping member 34 by the movement of the support portion 32 from a second position P2 (see FIG. 6B) to a first position P1 (see FIG. 6A). Specifically, the second clamping member 36 is pressed down in a direction opposite to the biasing direction of the biasing member by a cam mechanism (not illustrated) or the like when the support portion 32 moves from the second position P2 to the first position P1. Accordingly, a gap (space) is formed between the first clamping member 34 and the second clamping member 36 in the clamping portion 33. Furthermore, the movement of the second clamping member 36 may not be synchronized with the movement of the support portion 32.

**[0049]** Subsequently, a method of forming an entangled portion using the synthetic yarn splicer 1 (a splicing method) will be described.

**[0050]** First, as illustrated in FIG. 6A, the first yarn Y1 and the second yarn Y2 are set on the synthetic yarn splicer 1. Specifically, the first yarn Y1 and the second yarn Y2 are located in the chamber 14 through the slit 13 of the yarn splicing portion 10 and are disposed on the first clamping mechanism 20 and the second clamping mechanism 30 located at the first position P1. More specifically, the first yarn Y1 and the second yarn Y2 are disposed between the first clamping member 24 and the second clamping member 26 of the first clamping mechanism 20 and are disposed between the first clamping member 34 and the second clamping member 36 of the second clamping mechanism 30. Accordingly, the first yarn Y1 and the second yarn Y2 are placed on the first contact surface 27b and the second contact surface 27c of the first clamping mechanism 20 and are placed on the first contact surface 37b and the second contact surface 37c of the second clamping mechanism 30.

**[0051]** When the first yarn Y1 and the second yarn Y2 are set on the synthetic yarn splicer 1, the operation portion 7 is operated (pressed down). Accordingly, in the synthetic yarn splicer 1, the driving portion is operated so that the first clamping mechanism 20 and the second clamping mechanism 30 are operated.

**[0052]** Specifically, the first yarn Y1 and the second yarn Y2 are clamped by the first clamping member 24 and the second clamping member 26 of the first clamping mechanism 20. Further, the first yarn Y1 and the second yarn Y2 are clamped by the first clamping member 34 and the second clamping member 36 of the second clamping mechanism 30. Then, as illustrated in FIG. 6B, the first clamping mechanism 20 and the second clamping mechanism 30 move from the first position P1 to the second position P2. Accordingly, as illustrated in FIG. 7,

the first yarn Y1 and the second yarn Y2 are held between the clamping portion 23 and the clamping portion 33 in a loosened state. Further, the first yarn Y1 and the second yarn Y2 are held while contacting at least the second contact surface 27c and the second contact surface 37c.

**[0053]** Further, when the operation portion 7 is operated, air is injected from the injection hole 16a to the chamber 14 through the air flow path 16. Accordingly, the first yarn Y1 and the second yarn Y2 located inside the chamber 14 are spliced by the action of air to form an entangled portion.

**[0054]** Subsequently, the operation of the operation portion 7 is cancelled. Accordingly, in the synthetic yarn splicer 1, the injection of air from the injection hole 16a to the chamber 14 is stopped and the first clamping mechanism 20 and the second clamping mechanism 30 are operated.

**[0055]** Specifically, as illustrated in FIG. 6A, the first clamping mechanism 20 and the second clamping mechanism 30 move from the second position P2 to the first position P1. In accordance with this operation, the second clamping member 26 of the first clamping mechanism 20 moves in a direction moving away from the first clamping member 24 and the clamping of the first yarn Y1 and the second yarn Y2 by the first clamping member 24 and the second clamping member 26 is cancelled. Also similarly to the second clamping mechanism 30, the second clamping member 36 moves in a direction moving away from the first clamping member 34 and the clamping of the first yarn Y1 and the second yarn Y2 by the first clamping member 34 and the second clamping member 36 is cancelled. Furthermore, the clamping of the first yarn Y1 and the second yarn Y2 by the first clamping member 24 and the second clamping member 26 may be cancelled after the first clamping mechanism 20 moves from the second position P2 to the first position P1. Similarly, the clamping of the first yarn Y1 and the second yarn Y2 by the first clamping member 34 and the second clamping member 36 may be cancelled after the second clamping mechanism 30 moves from the second position P2 to the first position P1. With the above-described configuration, the splicing of the first yarn Y1 and the second yarn Y2 by the synthetic yarn splicer 1 is completed. Accordingly, the first yarn Y1 and the second yarn Y2 become one yarn.

**[0056]** Subsequently, an operation and an effect of the synthetic yarn splicer 1 according to the embodiment will be described.

**[0057]** In the synthetic yarn splicer 1, when the first yarn Y1 and the second yarn Y2 are swayed in the chamber 14 by using the clamping portions 23 and 33 as fixed points by the injection of air in a case in which the diameter R1 of the chamber 14 is smaller than  $\phi 4.0$  mm, the yarns easily contact the inner peripheral surface 14a of the chamber 14. In this way, when a ratio in which the first yarn Y1 and the second yarn Y2 contact the inner peripheral surface 14a of the chamber 14 increases, an influence of a friction due to a contact becomes notice-

able. Accordingly, there is concern that an entangled portion is not appropriately formed since the first yarn Y1 and the second yarn Y2 are damaged. Further, in the synthetic yarn splicer, since air hardly acts on the first yarn Y1 and the second yarn Y2 inside the chamber 14 when the diameter R1 of the chamber 14 becomes larger than  $\phi 7.0$  mm, an entangled portion is not appropriately formed. As a result, there is a possibility that the tensile elongation of the entangled portion decreases.

**[0058]** In contrast, in the synthetic yarn splicer 1 according to the embodiment, the diameter R1 of the chamber 14 is equal to or larger than  $\phi 4.0$  mm and equal to or smaller than  $\phi 7.0$  mm. Accordingly, in the synthetic yarn splicer, it is possible to suppress an influence due to the contact with the inner peripheral surface 14a of the chamber 14 and to appropriately apply air to the first yarn Y1 and the second yarn Y2 when the first yarn Y1 and the second yarn Y2 are swayed inside the chamber 14. Thus, in the synthetic yarn splicer 1, the entangled portion can be appropriately formed. As a result, in the synthetic yarn splicer 1, it is possible to suppress a change in tensile elongation decrease amount while suppressing a decrease in tensile elongation of the entangled portion.

**[0059]** FIGS. 7A and 7B show a tensile elongation measurement result of an entangled portion when the entangled portion is formed by changing a combination of the diameter R1 of the chamber 14 and the diameter R2 of the injection hole 16a in the synthetic yarn splicer 1 according to the embodiment. In the measurement, TENSORAPID4 (trade name) manufactured by USTER was used. FIG. 7A shows a result when the pressure of air injected from the injection hole 16a is set to 4 kgf/cm<sup>2</sup>. FIG. 7B shows a result when the pressure of air injected from the injection hole 16a is set to 5 kgf/cm<sup>2</sup>. The yarn is a pre-oriented yarn (POY). The yarn corresponding to a measurement object is 88dtex-72f. The tensile elongation of the yarn without the entangled portion used for the measurement of FIG. 7A was 132.3 (%). The tensile elongation of the yarn without the entangled portion used for the measurement of FIG. 7B was 131.1 (%).

**[0060]** As shown in FIGS. 7A and 7B, a result was obtained such that the tensile elongation decrease amount was relatively small when the diameter R2 of the injection hole 16a was equal to or larger than  $\phi 0.8$  mm and equal to or smaller than 2.0 mm and the diameter R1 of the chamber 14 was equal to or larger than  $\phi 4.0$  mm and equal to or smaller than 7.0 mm. As shown in FIG. 7A, a result was obtained such that the tensile elongation decrease amount was relatively small when the air pressure was 4 kgf/cm<sup>2</sup>, particularly, when the diameter R1 of the chamber 14 was  $\phi 5.5$  mm,  $\phi 6.0$  mm, and  $\phi 7.0$  mm. As shown in FIG. 7B, a result was obtained such that the tensile elongation decrease amount was relatively small when the air pressure was 5 kgf/cm<sup>2</sup>, particularly, when the diameter R1 of the chamber 14 is  $\phi 6.0$  mm and  $\phi 7.0$  mm. As described above, in the synthetic yarn splicer 1, it was found that a decrease in tensile elongation of the entangled portion could be suppressed when the diam-

eter R1 of the chamber 14 was set to be equal to or larger than  $\phi 4.0$  mm and equal to or smaller than  $\phi 7.0$  mm.

**[0061]** Subsequently, an effect of the synthetic yarn splicer 1 will be described on the basis of Examples and Comparative Examples. FIGS. 8A and 8B show a tensile elongation decrease amount (%) from a reference value in Examples and Comparative Examples when the tensile elongation measurement value of the synthetic fiber without the entangled portion is used as the reference value. In the measurement, TENSORAPID4 (trade name) manufactured by USTER was used. Examples show a result of the yarn provided with the entangled portion when the diameter R1 of the chamber 14 is set to  $\phi 6.0$  mm in the synthetic yarn splicer 1 according to the embodiment. Comparative Examples show a result of the yarn provided with the entangled portion when the diameter R1 of the chamber 14 is set to  $\phi 3.5$  mm. The yarn is a pre-oriented yarn. The yarn corresponding to a measurement object is 88dtex-48f-CD (cationic dyeable yarn). The pressure of the air injected from the injection hole 16a was set to 3.5 kgf/cm<sup>2</sup>. "A", "B", "C", and "D" show a repeated test result in the same condition.

(Example 1 and Comparative Example 1)

**[0062]** In Example 1 and Comparative Example 1, the diameter R2 of the injection hole 16a was set to  $\phi 1.3$  mm. In Example 1, the tensile elongation decrease amount [%] from the reference value was -3.5% in "A", -2.1% in "B", -2.3% in "C", and -0.7% in "D". In Example 1, a difference between a minimum value and a maximum value of a decrease amount was 2.8%.

**[0063]** In Comparative Example 1, the tensile elongation decrease amount [%] from the reference value was -7.6% in "A", -5.3% in "B", -14.9% in "C", and -12.8% in "D". In Comparative Example 1, a difference between a minimum value and a maximum value of a decrease amount was 9.6%.

(Example 2 and Comparative Example 2)

**[0064]** In Example 2 and Comparative Example 2, the diameter R2 of the injection hole 16a was set to  $\phi 1.6$  mm. In Example 2, the tensile elongation decrease amount [%] from the reference value was -8.5% in "A", -12.4% in "B", -12.3% in "C", and -8.8% in "D". In Example 2, a difference between a minimum value and a maximum value of a decrease amount was 3.9%.

**[0065]** In Comparative Example 2, the tensile elongation decrease amount [%] from the reference value was -10.5% in "A", -8.4% in "B", -16.6% in "C", and -9.6% in "D". In Comparative Example 2, a difference between a minimum value and a maximum value of a decrease amount was 8.2%.

**[0066]** As described above, when the diameter R1 of the chamber 14 is set to  $\phi 6.0$  mm, there is a tendency that the tensile elongation decrease amount is small as compared with the case of  $\phi 3.5$  mm. Further, in Examples



1 and 2, a difference between a minimum value and a maximum value of a decrease amount of "A" to "D" is smaller than that of Comparative Examples 1 and 2. For that reason, it was found that a change in tensile elongation decrease amount was small in the synthetic yarn splicer 1. Thus, since it is possible to stably form the entangled portion in the synthetic yarn splicer 1, it was found that a change in tensile elongation decrease amount could be suppressed while suppressing a decrease in tensile elongation of the entangled portion.

**[0067]** In the synthetic yarn splicer 1 according to the embodiment, the injection hole 16a of the yarn splicing portion 10 has a circular shape. The diameter R2 of the injection hole 16a is equal to or larger than  $\phi 0.8$  mm and equal to or smaller than  $\phi 2.0$  mm. In this configuration, as shown in FIGS. 7A and 7B, it is possible to suppress a change in tensile elongation decrease amount while suppressing a decrease in tensile elongation of the entangled portion.

**[0068]** Although the embodiment of the invention has been described, the invention is not essentially limited to the above-described embodiment and can be modified into various forms without departing from the gist thereof.

**[0069]** In the above-described embodiment, a shape illustrated in FIG. 1 has been described as the shape of the main body 3. However, the shape of the main body 3 is not limited to the shape illustrated in FIG. 1.

**[0070]** In the above-described embodiment, an example of an embodiment in which the first clamping members 24 and 34 and the second clamping members 26 and 36 are formed in a columnar shape, that is, the cross-sections of the first clamping members 24 and 34 and the second clamping members 26 and 36 are formed in a circular shape has been described. However, the first clamping member and the second clamping member are not limited to the columnar shape as long as the yarn can be clamped, but may be formed in various shapes (for example, prismatic shapes or the like).

**[0071]** In the above-described embodiment, an example of an embodiment in which the support portions 22 and 32 swing about the shafts 21 and 31 to move to the first position P1 and the second position P2 has been described. However, the support portions 22 and 32 may move in a direction moving close to each other and moving away from each other, for example, in a substantially parallel state.

**[0072]** In the above-described embodiment, an example of an embodiment in which the cross-sectional shape of the chamber 14 is a true circular shape has been described. However, the cross-sectional shape of the chamber 14 may be an oval shape. In this case, each of the first line passing through the center C of the chamber 14 and connecting the inner peripheral surface 14a of the chamber 14 and the second line passing through the center C of the chamber 14, connecting the inner peripheral surface 14a of the chamber 14, and orthogonal to the first line may be equal to or larger than 4.0 mm and equal to or smaller than 7.0 mm. That is, long and short

axes of the oval chamber 14 may be equal to or larger than 4.0 mm and equal to or smaller than 7.0 mm.

**[0073]** In the above-described embodiment, an example of an embodiment in which the first yarn Y1 and the second yarn Y2 are disposed on the first clamping mechanism 20 and the second clamping mechanism 30 located at the first position P1, the first clamping mechanism 20 and the second clamping mechanism 30 are moved from the first position P1 to the second position P2, and air is injected from the injection hole 16a to the chamber 14 to form an entangled portion has been described. However, a method of forming the entangled portion by using the synthetic yarn splicer 1 is not limited thereto.

**[0074]** For example, the first yarn Y1 and the second yarn Y2 are disposed on the first clamping mechanism 20 and the second clamping mechanism 30 located at the second position P2, the first clamping mechanism 20 and the second clamping mechanism 30 are moved from the second position P2 to the first position P1, the first clamping mechanism 20 and the second clamping mechanism 30 are moved from the first position P1 to the second position P2, and air is injected from the injection hole 16a to the chamber 14 to form an entangled portion.

**[0075]** In the above-described embodiment, an example of an embodiment in which the synthetic yarn splicer 1 is a hand splicer used while being gripped by an operator has been described. However, the synthetic yarn splicer may be provided in an apparatus or the like.

## REFERENCE SIGNS LIST

**[0076]** 1... SYNTHETIC YARN SPLICER, 10...YARN SPLICING PORTION, 14... CHAMBER (PASSAGE), 14a...INNER PERIPHERAL SURFACE, 16a...INJECTION HOLE, 20...FIRST CLAMPING MECHANISM, 30... SECOND CLAMPING MECHANISM, C...CENTER, R1...DIAMETER (FIRST LINE, SECOND LINE), R2...DIAMETER, Y1...FIRST YARN (ONE YARN), Y2...SECOND YARN (OTHER YARN).

## Claims

1. A synthetic yarn splicer (1) that performs a splicing operation between one yarn (Y1) and the other yarn (Y2) formed of synthetic fibers, comprising:

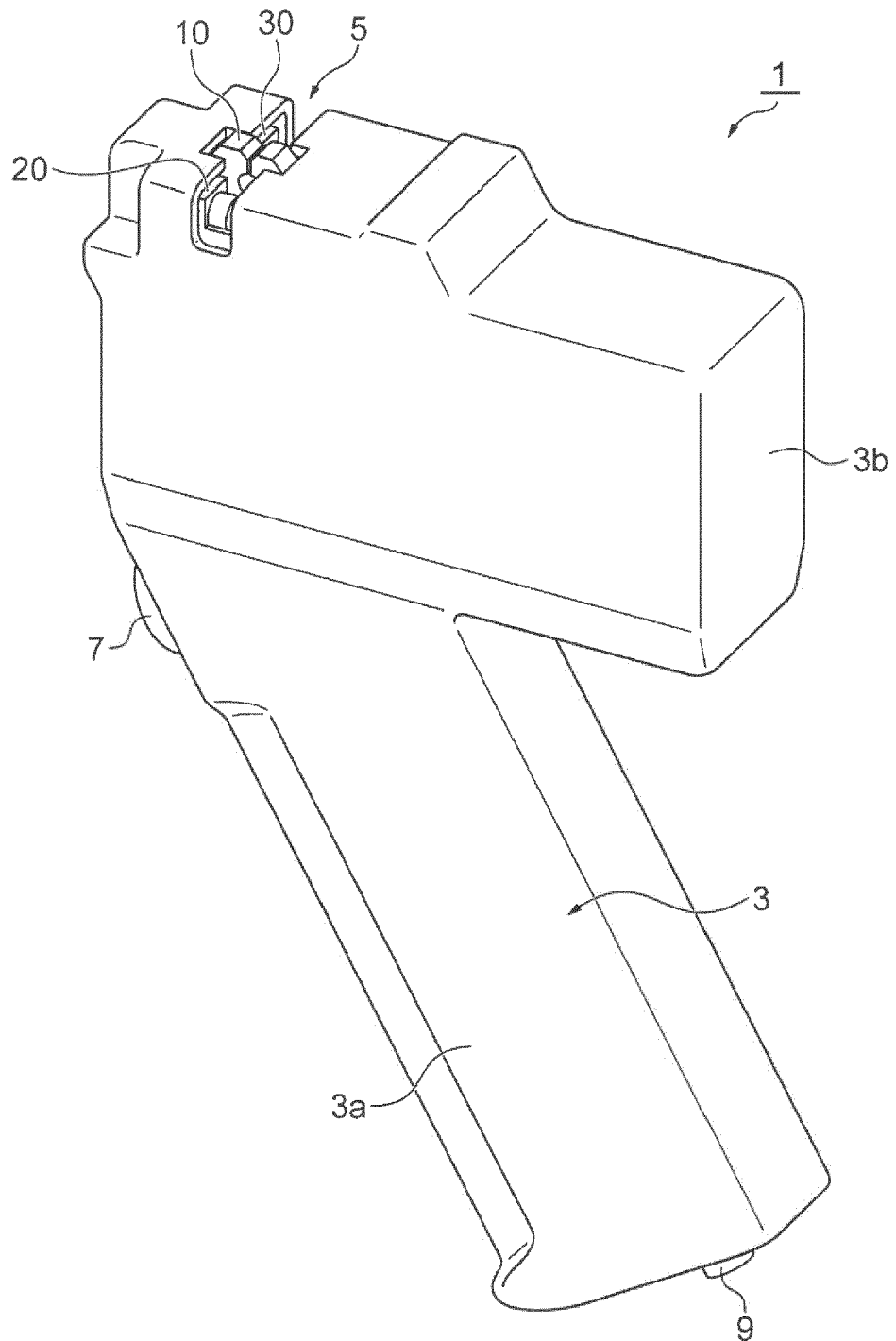
a yarn splicing portion (10) that includes a passage (14) which forms a space through which one yarn (Y1) and the other yarn (Y2) are insertable and an injection hole (16a) which opens to the passage (14) and injects a fluid; and a pair of clamping mechanisms (20,30) that is provided at a position interposing the passage (14) of the yarn splicing portion (10) and holds each of one yarn (Y1) and the other yarn (Y2) inserted through the space, wherein a cross-sectional shape of the passage

(14) formed on a plane orthogonal to a penetration direction of the passage (14) is a circular shape, and

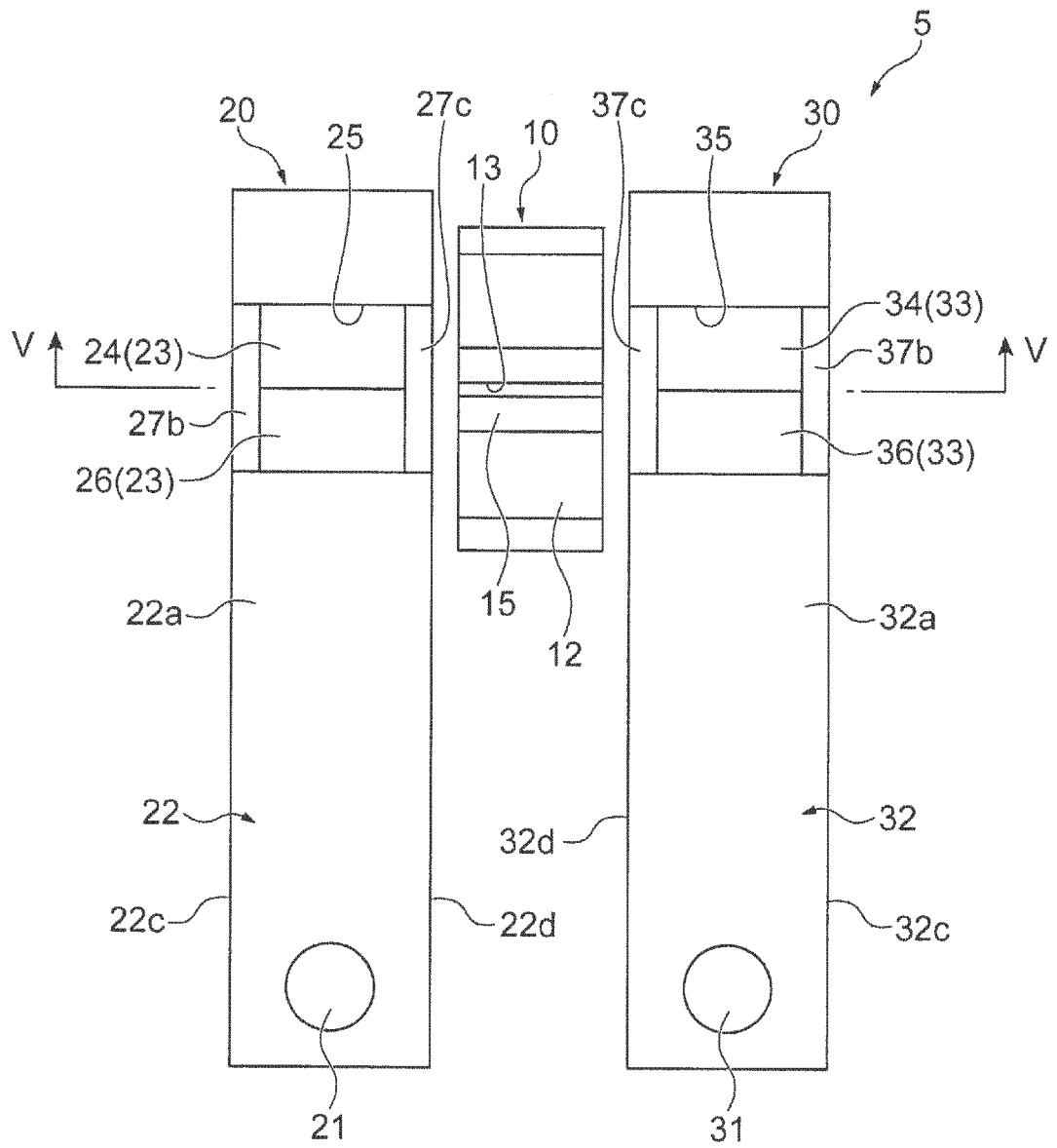
wherein a first line passing through a center (C) of the passage (14) and connecting an inner peripheral surface (14a) of the passage (14) and a second line passing through the center (C) of the passage (14), connecting the inner peripheral surface (14a) of the passage (14), and orthogonal to the first line are equal to or larger than 4.0 mm and equal to or smaller than 7.0 mm.

2. The synthetic yarn splicer (1) according to claim 1, wherein the injection hole (16a) has a circular shape, and wherein a diameter (R2) of the injection hole (16a) is equal to or larger than  $\phi 0.8$  mm and equal to or smaller than  $\phi 2.0$  mm.
3. The synthetic yarn splicer (1) according to claim 2, wherein the diameter (R2) of the injection hole (16a) is equal to or larger than  $\phi 1.0$  mm and equal to or smaller than  $\phi 1.8$  mm.

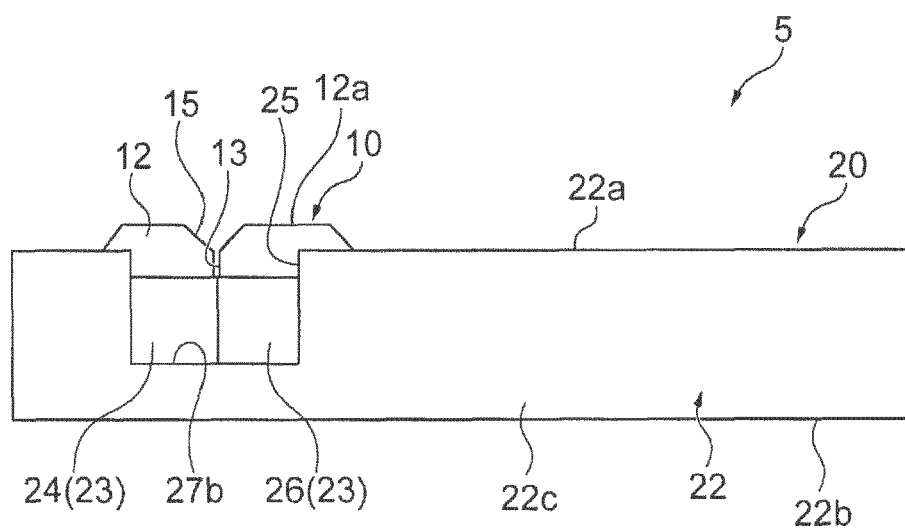
**Fig.1**



**Fig.2**



**Fig.3**



**Fig.4**

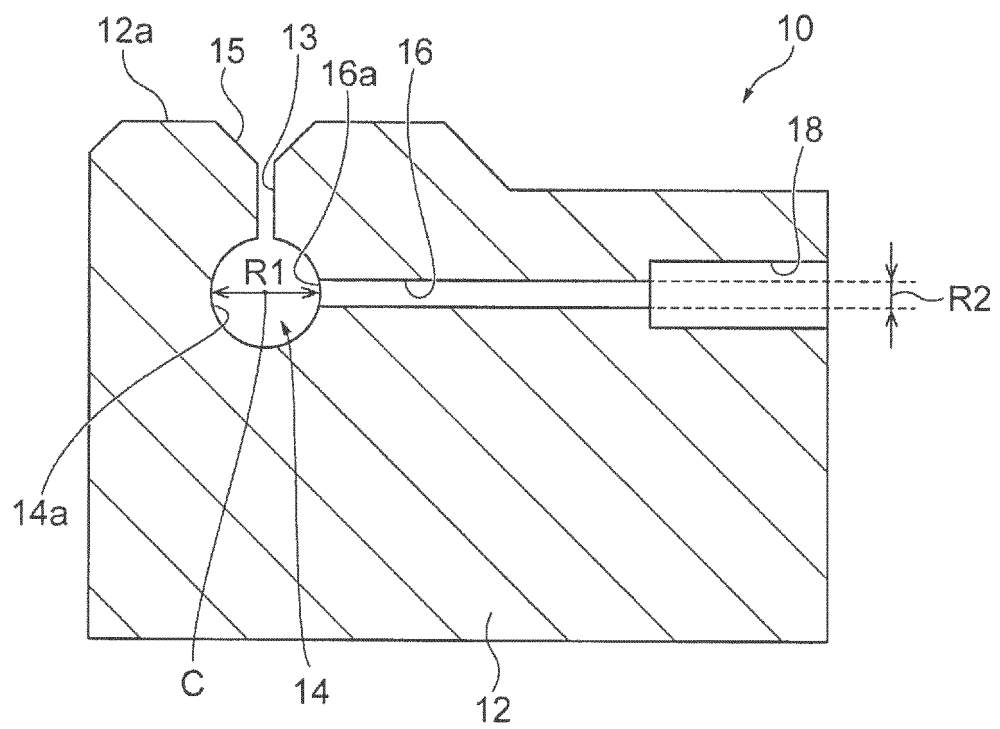
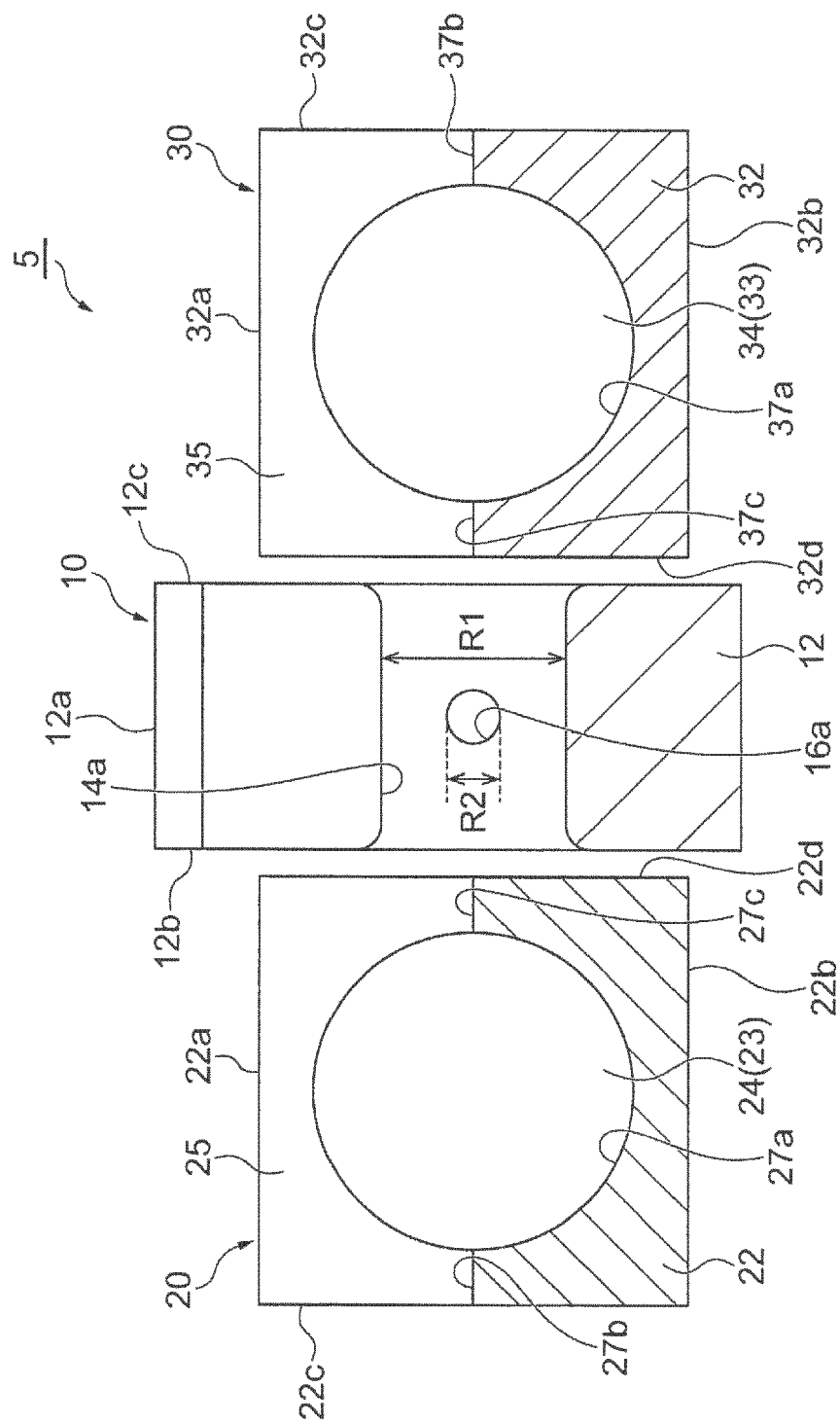
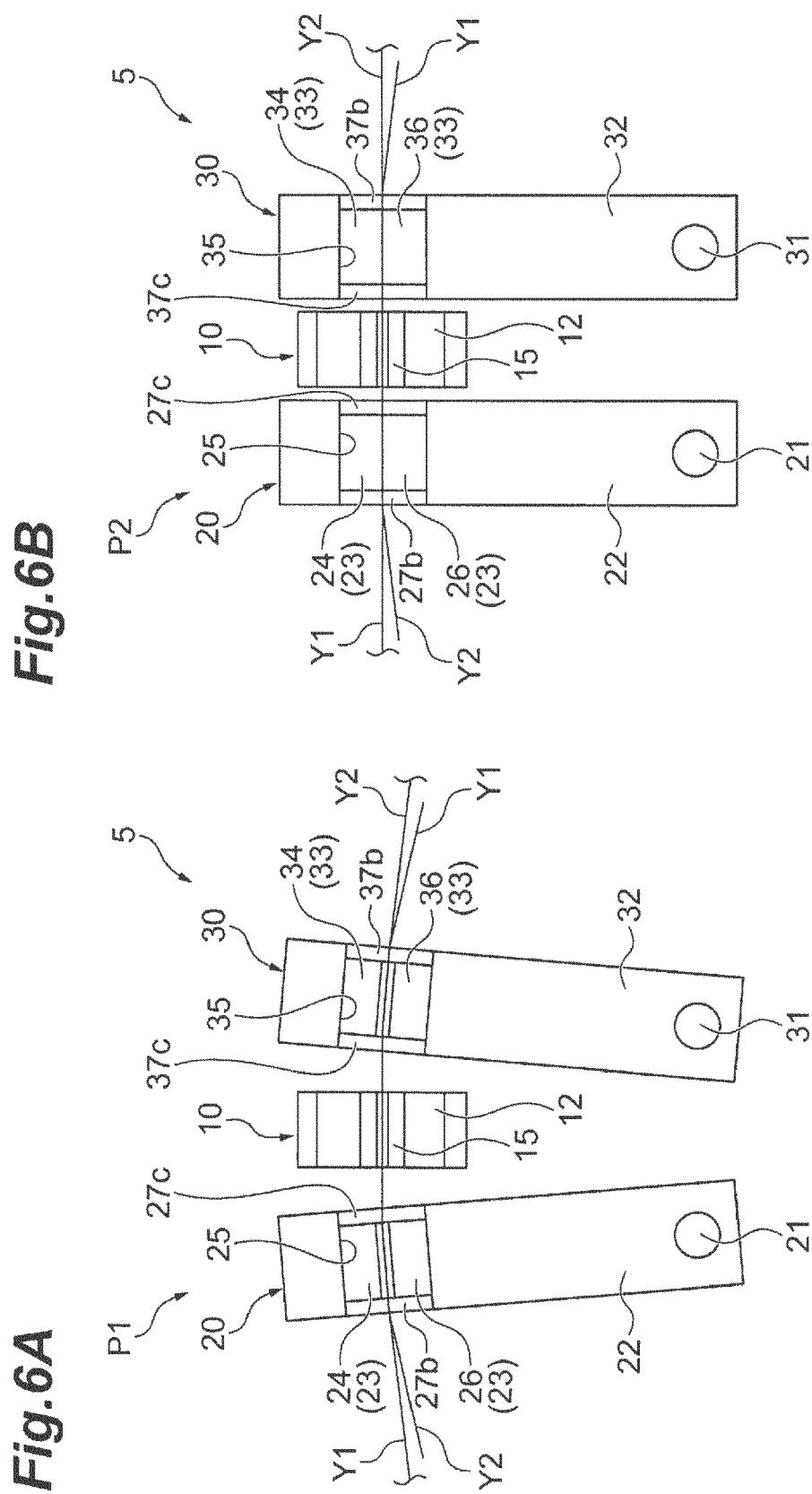


Fig. 5







**Fig.7A**

|                                       |            | CHAMBER DIAMETER R1 [mm] |            |            |            |            |            |            |  |
|---------------------------------------|------------|--------------------------|------------|------------|------------|------------|------------|------------|--|
|                                       |            | $\phi$ 3.0               | $\phi$ 3.5 | $\phi$ 4.0 | $\phi$ 4.5 | $\phi$ 5.5 | $\phi$ 6.0 | $\phi$ 7.0 |  |
| INJECTION HOLE<br>DIAMETER R2<br>[mm] | $\phi$ 0.8 | 127.2%                   | 124.7%     | 127.9%     | —          | —          | 126.1%     | —          |  |
|                                       | $\phi$ 1.0 | 127.9%                   | 126.8%     | 125.3%     | —          | —          | 127.1%     | 127.2%     |  |
|                                       | $\phi$ 1.3 | 124.9%                   | 124.8%     | —          | 123.5%     | 128.4%     | 125.9%     | 128.4%     |  |
|                                       | $\phi$ 1.6 | —                        | 129.5%     | 127.9%     | —          | 127.3%     | 127.2%     | 127.6%     |  |
|                                       | $\phi$ 1.8 | —                        | —          | 125.3%     | —          | —          | 128.9%     | 126.5%     |  |
|                                       | $\phi$ 2.0 | —                        | —          | —          | —          | —          | 127.9%     | 130.0%     |  |

**Fig.7B**

|                                       |            | CHAMBER DIAMETER R1 [mm] |            |            |            |            |            |            |  |
|---------------------------------------|------------|--------------------------|------------|------------|------------|------------|------------|------------|--|
|                                       |            | $\phi$ 3.0               | $\phi$ 3.5 | $\phi$ 4.0 | $\phi$ 4.5 | $\phi$ 5.5 | $\phi$ 6.0 | $\phi$ 7.0 |  |
| INJECTION HOLE<br>DIAMETER R2<br>[mm] | $\phi$ 0.8 | —                        | 118.2%     | 123.7%     | —          | —          | 127.2%     | —          |  |
|                                       | $\phi$ 1.0 | —                        | 120.0%     | 121.5%     | —          | —          | 126.5%     | 127.6%     |  |
|                                       | $\phi$ 1.3 | —                        | 123.6%     | —          | 122.3%     | 123.9%     | 127.8%     | 127.3%     |  |
|                                       | $\phi$ 1.6 | —                        | 120.8%     | 123.0%     | —          | 126.8%     | 127.5%     | 127.9%     |  |
|                                       | $\phi$ 1.8 | —                        | —          | 126.4%     | —          | —          | 128.7%     | 126.6%     |  |
|                                       | $\phi$ 2.0 | —                        | —          | —          | —          | —          | 128.6%     | 126.4%     |  |

**Fig.8A**

## EXAMPLE 1

|                        | REFERENCE | A     | B     | C     | D     |
|------------------------|-----------|-------|-------|-------|-------|
| TENSILE ELONGATION [%] | 135.3     | 131.8 | 133.2 | 133.0 | 134.6 |
| DECREASE AMOUNT [%]    | -         | -3.5  | -2.1  | -2.3  | -0.7  |

DIFFERENCE BETWEEN MAXIMUM VALUE AND  
MINIMUM VALUE OF DECREASE AMOUNT 2.8 [%]

## COMPARATIVE EXAMPLE 1

|                        | REFERENCE | A     | B     | C     | D     |
|------------------------|-----------|-------|-------|-------|-------|
| TENSILE ELONGATION [%] | 135.3     | 127.7 | 129.9 | 120.4 | 122.5 |
| DECREASE AMOUNT [%]    | -         | -7.6  | -5.3  | -14.9 | -12.8 |

DIFFERENCE BETWEEN MAXIMUM VALUE AND  
MINIMUM VALUE OF DECREASE AMOUNT 9.6 [%]

**Fig.8B**

## EXAMPLE 2

|                        | REFERENCE | A     | B     | C     | D     |
|------------------------|-----------|-------|-------|-------|-------|
| TENSILE ELONGATION [%] | 135.3     | 126.8 | 122.9 | 123.0 | 126.5 |
| DECREASE AMOUNT [%]    | -         | -8.5  | -12.4 | -12.3 | -8.8  |

DIFFERENCE BETWEEN MAXIMUM VALUE AND  
MINIMUM VALUE OF DECREASE AMOUNT 3.9 [%]

## COMPARATIVE EXAMPLE 2

|                        | REFERENCE | A     | B     | C     | D     |
|------------------------|-----------|-------|-------|-------|-------|
| TENSILE ELONGATION [%] | 135.3     | 124.7 | 126.8 | 118.7 | 125.7 |
| DECREASE AMOUNT [%]    | -         | -10.5 | -8.4  | -16.6 | -9.6  |

DIFFERENCE BETWEEN MAXIMUM VALUE AND  
MINIMUM VALUE OF DECREASE AMOUNT 8.2 [%]



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Application Number  
EP 19 16 7718

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