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# (54) METHOD AND DEVICE FOR SPLICING YARN

(57) An objective of the present invention is to provide a yarn piecing method and device useful when used for sequentially selectinganyof plural types of yarns different in color or suchlike, and supplying them to a yarn feeding device in a knitting machine.

In the present invention, two yarns Y1 and Y4 to be pieced are accommodated and clamped in a piecing nozzle 21 with their ends arranged to point in the same direction, a jet stream of air is generated in the piecing nozzle and applied to the two yarns to be pieced in the piecing nozzle so as to untwist their end segments before cutting the two yarns to be pieced at their end segments, and the yarns are cut and pieced during or after application of the jet stream of air.

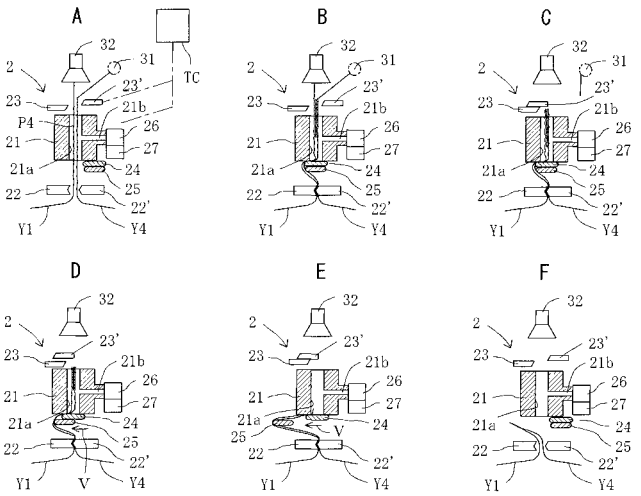


FIG. 10

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## Description

### TECHNICAL FIELD

**[0001]** This invention relates to devices for supplying knitting yarns to yarn feeding devices in knitting machines or suchlike, and particularly to a yarn piecing method and device useful for sequentially selecting any of plural types of yarns different in color or suchlike, and performing yarn piecing upon each supply to a yarn feeding device in a knitting machine.

### BACKGROUND ART

**[0002]** As is well-known, the tendency toward decorative variations resulting from an increase in type of knit has become increasingly remarkable, and therefore there are demands for improvements to knitting machines, in particular, technical improvements in supplying knitting yarns to yarn feeding devices in knitting machines, i.e., such technical improvements as to, in the run-up to supplying knitting yarns to knitting machines, sequentially select and piece yarns of different colors in accordance with previously designed knitting patterns, and automatically supply the pieced yarns to the knitting machines.

**[0003]** In conventionally proposed equipment, a yarn selecting device and a yarn piecing device are provided between plural types of yarn supply packages different in color or suchlike and the knitting machine, a choice yarn selected by the yarn selecting device is automatically pieced with a knitted yarn currently being knitted, thereby achieving knitting of desired colors/patterns. Such equipment has no effective yarn changing device for holding ends of yarns from the plural types of packages, and releasing and introducing only one selected choice yarn into the yarn piecing device, thereby piecing it with the knitted yarn being knitted.

**[0004]** Patent Document 1: Japanese Laid-Open Patent Publication No. 2004-27463 (Abstract, FIGS. 1 to 6) Patent Document 2: Japanese Patent Application No. 2005-25124 (Abstract, FIGS. 1 to 3)

### DISCLOSURE OF THE INVENTION

### PROBLEMS TO BE SOLVED BY THE INVENTION

**[0005]** Therefore, the invention provides a yarn piecing method and device useful when used in conjunction with a yarn changing device in a knitting machine or suchlike, as described above, for sequentially selecting any of plural types of yarns different in color or suchlike, and performing yarn piecing upon each supply to a yarn feeding device in a knitting machine.

### SOLUTION TO THE PROBLEMS

**[0006]** Concretely, the invention to achieve the above objective resides in a yarn piecing method in which two yarns to be pieced are accommodated and clamped in a piecing nozzle with their ends arranged to point in the same direction, a jet stream of air is generated in the piecing nozzle and applied to the two yarns to be pieced in the piecing nozzle so as to untwist their end segments before cutting the two yarns to be pieced at their end segments, and the yarns are cut and pieced during or after application of the jet stream of air.

**[0007]** Furthermore, the subject matter recited in claim 2 based on the invention is directed to the yarn piecing method according to claim 1, in which the two yarns to be pieced are elastic yarns.

**[0008]** Furthermore, the subject matter recited in claim 3 based on the invention is directed to a yarn piecing device comprising: a yarn piecing nozzle with a yarn piecing chamber for accommodating two yarns to be pieced with their ends arranged to point in the same direction, the yarn piecing nozzle including air jetting means for jetting out compressed air from a direction perpendicular to the yarn piecing chamber; clamping means provided on one side of the yarn piecing chamber in the yarn piecing nozzle to grasp the two yarns accommodated in the yarn piecing chamber; cutting means provided on the other side of the yarn piecing chamber in the yarn piecing nozzle to cut the two yarns at their end segments; and timing control means provided for the air jetting means and the cutting means to allow the air j ettingmeans to jet out the compressed air to the two yarns before the two yarns are cut by the cutting means.

### EFFECT OF THE INVENTION

**[0009]** According to the yarn piecing method and device that constitutes the invention, the two yarns to be pieced are accommodated and clamped in the yarn piecing nozzle with their ends arranged to point in the same direction, the jet stream of air is generated in the piecing nozzle and applied to the two yarns to be pieced in the piecing nozzle so as to untwist their end segments before cutting the two yarns to be pieced at their end segments, and the yarns are cut and pieced during or after application of the jet stream of air, so that when the two yarns are cut, they are already about to be entangled by the action of the jet stream of air and therefore it is possible to reliably piece the yarns so as to not cause them to fall out of the yarn piecing nozzle. Furthermore, when the yarns to be pieced are elastic yarns, they are pieced by a jet stream of air before being cut, thereby providing extremely effective action in that it is possible to ensure that the problem of the yarn end segments shrinking and falling out at the time of cutting the yarns is overcome.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0010]** [FIG. 1] FIG. 1 is a schematic side view illustrating an exemplary flat-knitting machine having a yarn piecing device according to the invention mounted there-

in.

[FIG. 2] FIG. 2 is a schematic perspective view illustrating a concrete configuration example of a yarn changing device in a knitting machine or suchlike.
[FIG. 3] FIG. 3 is a schematic perspective view illustrating the details of a substantial portion of a yarn selecting device.
[FIG. 4] FIG. 4 is a schematic perspective view illustrating the details of a substantial portion of the yarn piecing device.
[FIG. 5] FIG. 5 is a diagram illustrating a yarn guiding lever, in which A of FIG. 5 is a schematic front view thereof, B of FIG. 5 is a right side view in A of FIG. 5, and C of FIG. 5 is a cross-sectional view taken along line I-I in B of FIG. 5.
[FIG. 6] FIGS. 6 to 9 are diagrams for describing the operational procedure for yarn selection, in which A-1 and A-2 of FIG. 6 are respectively a front view and a side view illustrating the first stage, and B-1 and B-2 of FIG. 6 are respectively a front view and a side view illustrating the second stage.
[FIG. 7] A-1 and A-2 of FIG. 7 are respectively a front view and a side view illustrating the third stage, and B-1 and B-2 of FIG. 7 are respectively a front view and a side view illustrating the fourth stage.
[FIG. 8] A-1 and A-2 of FIG. 8 are respectively a front view and a side view illustrating the fifth stage, and B-1 and B-2 of FIG. 8 are respectively a front view and a side view illustrating the sixth stage.
[FIG. 9] A-1 and A-2 of FIG. 9 are respectively a front view and a side view illustrating the seventh stage, and B-1 and B-2 of FIG. 9 are respectively a front view and a side view illustrating the eighth stage.
[FIG. 10] A to F of FIG. 10 are cross-sectional side views of the yarn piecing device for describing the operational procedure of the yarn piecing device.
[FIG. 11] FIG. 11 is a perspective view illustrating a portion of the device, including a yarn inserting rotational plate.
[FIG. 12] FIG. 12 is a time chart illustrating operational states of the yarn changing device.
[FIG. 13] FIG. 13 is an explanatory view for describing other exemplary states corresponding to the illustrations in FIG. 7.

DESCRIPTION OF THE REFERENCE CHARACTERS

**[0011]**

| | |
|---|---|
| 1 | yarn selecting device |
| 2 | yarn piecing device |
| 10 | yarn guiding lever |
| 12 | separator |
| 20 | disk guide |
| 21 | piecing nozzle |
| 21a | yarn piecing chamber |
| 21b | nozzle opening |
| 23 | cutting means |
| 26 | air jetting means |
| 27 | magnetic valve |
| 28 | suctioning means |
| 29 | clamping means |
| 29A | first clamper |
| 29B | second clamper |
| 30 | yarn clutching member |
| 31 | yarn holding member |
| 32 | yarn end grasping suctioner |
| 33 | yarn clutching cylinder |
| 34 | yarn holding cylinder |
| TC | timing control means |
| P1 | selecting position |
| P2 | prescribed position |
| P3 | standby position |
| P4 | yarn piecing position |
| Y1 | choice yarn |
| Y4 | knitted yarn |

BEST MODE FOR CARRYING OUT THE INVENTION

**[0012]** Hereinafter, a piecing method and device that constitutes the invention will be described in detail with respect to a concrete embodiment illustrated in the drawings. In the embodiment as described below, the piecing method and device is incorporated in a flat-knitting machine as shown in FIG. 1.

**[0013]** FIG. 1 is a schematic side view illustrating the flat-knitting machine having the piecing method and device according to the invention embodied therein. The flat-knitting machine includes a machine frame 40, and a yarn feeding device 41 incorporated in the machine frame 40 with which a yarn selecting device 1 and a yarn piecing device 2 are combined. The machine frame 40 has, for example, eight knitting yarn packages W1 to W8 provided in its vicinity. These knitting yarn packages W1 to W8 are respectively composed of knitting yarns Y1 to Y8 of different colors. The machine frame 40 includes a needle bed 42 in which a plurality of knitting needles are retractably provided in a row.

**[0014]** The machine frame 40 further includes a carrier 43 and a carriage 44, which are capable of moving back and forth, and as the carriage 44 moves, the knitting needles of the needle bed 42 are retractably operated, and the carrier 43 also moves. The eight types of knitting yarns Y1 to Y8 wound on the knitting yarn packages W1 to W8, respectively, are supplied to the yarn selecting device 1, one of which is selected by the yarn selecting device 1 (hereinafter, referred to as a "choice yarn"), and fed to the carrier 43 by the yarn feeding device 41 after being pieced with a knitting yarn being knitted by the yarn piecing device 2 (hereinafter, referred to as a "knitted yarn"), and thereafter it is grasped by the carrier 43, and moved back and forth to be supplied to the needle bed 42, so that a fabric 45 is knitted. The knitting yarns Y1 to Y8 are supplied to the yarn selecting device 1 via a tension-applying top spring 46. Then, the yarn selecting de-

vice 1 and the yarn piecing device 2 change the color of the knitting yarn, Y1 to Y8, that is being knitted in accordance with the pattern of the fabric 45 to be knitted.

**[0015]** The yarn changing device in a knitting machine or suchlike essentially consists of: the yarn selecting device 1 for selecting a yarn between the plural types of yarn supplypackages W1 to W8 different in color or suchlike and the yarn feeding device 41 in the knitting machine; and the yarn piecing device 2 for piecing the choice yarn selected by the yarn selecting device 1 with the knitted yarn being knitted.

**[0016]** The yarn changing device includes suctioning means 28 for collectively suctioning and holding a plurality of yarns, and clamping means 29 for collectively clamping the yarns between the suctioning means 28 and the yarn supply packages W1 to W8, the clamping means 29 consisting of a first clamper 29A and a second clamper 29B disposed in two places along the yarn path and activated selectively.

**[0017]** In the yarn changing device, the first clamper 29A of the clamping means 29 is configured to operate in conjunction with the suctioning means 28, and collectively clamp the yarns in the yarn path during the suctioning operation of the suctioning means 28.

**[0018]** Furthermore, in the yarn changing device, the second clamper 29B of the clamping means 29 includes a yarn holding member 31, which normally has the yarns collectively clamped but releases the clamp when the choice yarn is selected, whereas the first clamper includes a yarn clutching member 30, which normally releases the clamp but clutches the yarns before the yarn holding member 31 is released when the choice yarn is selected, and stops clutching after the start of yarn holding.

**[0019]** FIG. 2 is a schematic perspective view illustrating the yarn selecting device 1, the yarn piecing device 2, etc., in magnification. The yarn selecting device 1 has eight yarn selection plates G1 to G8 in its upper portion. Each of the yarn selection plates G1 to G8 includes a yarn passing ring "g" in its lower portion. The knitting yarns Y1 to Y8 from the knitting yarn packages W1 to W8 pass their respective yarn passing rings "g" of the yarn selection plates G1 to G8, and one of the yarns, the knittedyarn, is fed to the yarn feeding device 41. Theyarnpassing rings "g" are each provided in the form of a loop such that the knitting yarns Y1 to Y8 pass through their respective loops. When changing the type of the knitted yarn, one of the yarn selection plates G1 to G8 that holds a knitting yarn selected for the change is moved inwardly as indicated by the double-dashed chain line inFIG. 2, thereby setting the knitting yarn in a selecting position. These operations will be described in detail below.

**[0020]** The yarn selecting device 1 includes a separator 12 for separately placing the knitted yarn and other knitting yarns. Furthermore, the yarn selecting device 1 includes a yarn guiding lever 10 for guiding the knitting yarn in the selecting position to a yarn piecing position. FIG. 3 is a schematic perspective view illustrating the details of a substantial portion of the yarn selecting device 1, and FIG. 4 is a schematic perspective view illustrating the details of a substantial portion of the yarn piecing device 2.

**[0021]** The yarn selecting device 1 has the yarn clutching member 30, the yarn holding member 31, and a yarn end grasping suctioner 32 provided in the vicinity of the separator 12, as shown in FIGS. 2 and 3. The yarn clutching member 30 is configured to be retractably operated by a yarn clutching cylinder 33, as shown in FIGS. 2 and 3, and it is normally retracted to open the yarn path between the separator 12 and an operating end 33a of the yarn clutching cylinder 33, but when extended, it collectively clamps the yarns between the separator 12 and the operating end 33a of the yarn clutching cylinder 33.

**[0022]** On the other hand, the yarn holding member 31 is configured to be retractably operated by a yarn holding cylinder 34, and it is normally extended to collectively clamp the yarns between the separator 12 and an operating end 34a of the yarn holding cylinder 34, but when retracted for yarn changing, it opens the yarn path between the separator 12 and the operating end 34a of the yarn holding cylinder 34.

**[0023]** The yarn selecting device 1 has the yarnpiecing device 2 combined with its lower portion. The yarn piecing device 2 is a yarn piecing device of a splicer type piecing yarns by blowing a jet of compressed air to the yarns, and is configured to piece two knitting yarns with their end portions arranged to point in the same direction, as shown in FIGS. 2 and 4. The yarn piecing device 2 includes a piecing nozzle 21. The piecing nozzle 21 includes a yarn piecing chamber 21a for accommodating two yarns to be pieced with their end portions arranged to point in the same direction. Furthermore, the piecing nozzle 21 includes air jetting means 26 with a nozzle opening 21b for jetting out a stream of compressed air or suchlike from a direction perpendicular to the yarn piecing chamber 21a, and the air jetting means 26 includes a magnetic valve 27 to be controlled to open/close, thereby controlling the air jet.

**[0024]** The yarn piecing device 2 includes a disk guide 20 for guiding two knitting yarns to the yarn piecing position, and also includes clamping means 22 provided on one side of the yarn piecing chamber 21a for grasping two knitting yarns accommodated in the yarn piecing chamber 21a, and cutting means 23 provided on the other side of the yarn piecing chamber 21a in the yarn piecing nozzle for cutting the two knitting yarns at their end segments. The yarn piecing device 2 is configured to be driven by a drive motor 50. The yarn piecing device 2 has a yarn positioning portion 35 provided in its lower portion for positioning and delivering the knitted yarn to the yarn feeding device 41. The yarn positioning portion 35 has a slit-like notch by which to seize the knitting yarn for positioning.

**[0025]** FIG. 5 is a diagram illustrating the yarn guiding lever, in which A of FIG. 5 is a schematic front view there-

of, B of FIG. 5 is a schematic right side view seen from the right side in A of FIG. 5, and C of FIG. 5 is a cross-sectional view taken along line I-I in B of FIG. 5. The yarn guiding lever 10 has a main body 105 generally provided in the form of an arc, as shown in A of FIG. 5. The yarn guiding lever 10 has a first catching portion 101 provided at one end for catching the choice yarn. The first catching portion 101 is configured in the form of a V-shaped notch, as shown in B of FIG. 5. The yarn guiding lever 10 has a rotational axis 107 provided at the other end, so that it can rotate about the rotational axis 107 in arrow directions II. Furthermore, the yarn guiding lever 10 includes a second catching portion 102 provided roughly at its center for catching the knitted yarn. The second catching portion 102 projects from the main body 105, as shown in B of FIG. 5. The main body 105 has a pair of walls 106 and 106' provided on its opposite sides, as shown in C of FIG. 5, so that the parts 105, 106, and 106' form a U-shaped yarn regulating portion 103. Accordingly, the yarn regulating portion 103 is formed in the shape of U opening outwardly, generally all over the outer circumference of the yarn guiding lever 10. By placing the choice yarn in the yarn regulatingportion 103 , it becomes possible to guide the choice yarn to the yarn piecing position while regulating that knitting yarn in a prescribed position.

**[0026]** Next, the operation of changing the type of the knitting yarn being knitted will be described in detail with reference to the operational procedure shown in FIGS. 6 to 9. FIGS. 6 to 9 are diagrams for describing operations of the yarn selecting device, etc. , the yarn selecting device is operated in the first through eighth stages according to the procedure shown in A and B of FIG. 6, A and B of FIG. 7, A and B of FIG. 8, and A and B of FIG. 9, and in each figure, A-1 and B-1 are schematic front views, while A-2 and B-2 are schematic left side views corresponding to A-1 and B-1, respectively. FIG. 10 is a diagram for describing the operational procedure of the yarn piecing device according to the invention. FIG. 11 is a perspective view illustrating a portion of the device, including the disk guide.

**[0027]** In the yarn selecting device 1, the eight knitting yarns Y1 to Y8 are respectively held by the eight yarn selection plates G1 to G8 during the first stage, as shown in A-1 and A-2 of FIG. 6. The knitted yarn Y4 (indicated by the double-dashed chain line) is placed on the inner side of the separator 12 (the left side in A-2 of FIG. 6). Furthermore, the seven knitting yarns Y1 to Y3 and Y5 to Y8 other than the knitted yarn Y4 are placed on the outer side of the separator 12 (the right side in A-2 of FIG. 6), and held by clamping with the yarn holding member 31. The yarn holding member 31 includes an air solenoid for controlling the flow rate of air, which performs a piston/cylinder operation to grasp/release the knitting yarns. In this state, the knitted yarn Y4 is fed in the top-to-bottom direction to pass the front of the piecing nozzle 21.

**[0028]** Thereafter, a control portion (not shown) provided in the flat-knitting machine sends a yarn change signal based on a previously inputted fabric pattern to the yarn selecting device 1, the yarn piecing device 2, the yarn feeding device 41, etc. In accordance with this signal, the yarn feeding device 41 is suspended to stop moving the knitted yarn Y4, so that the yarn selecting device 1, the yarn piecing device 2, etc., are activated. Then, in the second stage, the yarn selection plate G1 holding the choice yarn Y1 selected for type change (indicated by the dashed line) is driven, as shown in B-1 and B-2 of FIG. 6. The yarn selection plate G1 moves inwardly to set the choice yarn Y1 in the selecting position P1. Afterwards, the yarn guiding lever 10 is rotated in an arrow direction III (normal rotation).

**[0029]** Subsequently, in the third stage, the yarn guiding lever 10 is rotated to allow its first catching portion 101 to catch the choice yarn Y1 in the selecting position P1, as shown in A-1 and A-2 of FIG. 7. The choice yarn Y1 is placed in the yarn regulating portion 103 of the yarn guiding lever 10, and thus guided downwardly while being regulated in the prescribed position P2. The second catching portion 102 of the yarn guiding lever 10 projects higher than the separator 12, and moves along an arc-like upper edge 12a of the separator 12. The state shown in A-1 of FIG. 7 is at the moment when the secondcatchingportion 102 contacts and catches the knitted yarn Y4. In this state, a portion of the choice yarn Y1 and the knitted yarn Y4 are placed on the inner side of the separator 12.

**[0030]** Furthermore, in the fourth stage, the yarn guiding lever 10 is further rotated toplace the first catching portion 101 in the lowest position lower than the piecing nozzle 21, as shown in B-1 and B-2 of FIG. 7. Accordingly, the choice yarn Y1 is slid and guided while being caught by the first catching portion 101. The choice yarn Y1 is further slid and conducted on the yarn regulating portion 103 while being regulated in the prescribed position P2 by the yarn regulating portion 103 of the yarn guiding lever 10, and then guided to the front of the piecing nozzle 21. As such, the choice yarn Y1 is guided while being regulated in the prescribed position P2 by the yarn regulating portion 103, and therefore it is possible to move the choice yarn Y1 to the front of the piecing nozzle 21 without entanglement with the knitted yarn Y4 and other knitting yarns such as Y2 and Y3.

**[0031]** In the state shown inA-1 andA-2 of FIG. 7, as described above, the second catching portion 102 contacts and catches the knitted yarn Y4, and in that state, the yarn guiding lever 10 is further rotated (see B-1 and B-2 of FIG. 7). As a result, the knitted yarn Y4 is conducted while being caught by the second catching portion 102, moving from the inner side to the outer side of the separator 12. Specifically, the knitted yarn Y4 moves to a standby position P3 where the knitting yarns Y1 to Y3 and Y5 to Y8 (the knitting yarns other than the yarn being knitted) are on standby.

**[0032]** Afterwards, in the fifth stage, the yarn clutching member 30 is driven to clamp the knitting yarns Y2 to Y8 other than the choice yarn Y1 placed on the inner side of the separator 12, as shown in A-1 and A-2 of FIG. 8.

Thereafter, the yarn end grasping suctioner 32 starts suctioning before the yarn holding member 31 is driven to release the yarn ends. As a result, the yarn end grasping suctioner 32 grasps the ends of the knitting yarns Y1 to Y3 and Y5 to Y8. The yarn clutching member 30 is configured to grasp/release the knitting yarns in accordance with the piston/cylinder operation of the air solenoid. The yarn clutching member 30 is provided because the suction power of the yarn end grasping suctioner 32 is not enough to reliably hold the ends of the knitting yarns Y2 to Y8 due to tension applied by the repelling force of the top spring 46 provided in the flat-knitting machine, as shown in FIG. 1.

**[0033]** Then, in the sixth stage, a yarn inserting portion 20a included in the disk guide 20 presses the choice yarn Y1 guided to the front of the piecing nozzle 21, and the knitted yarn Y4, thereby inserting them into the yarn piecing chamber 21a of the piecing nozzle 21, as shown in B-1 and B-2 of FIG. 8. As a result, the choice yarn Y1 and the knitted yarn Y4 are placed in a yarn piecing position P4.

**[0034]** The rotational drive of the drive motor 50 causes rotational drive of a first drive gear 51 and a second drive gear 52, as shown in FIG. 11. The first drive gear 51 is connected to a link mechanism (not shown) for allowing the yarn piecing device 2 to perform a series of operations to be described later. The second drive gear 52 drives the disk guide 20. The second drive gear 52 allows a first driven gear 53 to engage with a second driven gear 54, thereby rotationally driving the disk guide 20 attached to the second driven gear 54. The disk guide 20 includes a notchedportion having the hook-like yarn inserting portion 20a provided on one side. The disk guide 20 is rotated in an arrow direction IV to move the choice yarn Y1 and the knitted yarn Y4, which are hooked and caught by the yarn inserting portion 20a, so that the yarns are pressed into the yarn piecing chamber 21a of the piecing nozzle 21.

**[0035]** At the same time, the yarn piecing device 2 is activated, as shown in FIG. 10. The yarn piecing device 2 is an air splicer provided with the piecing nozzle 21 to jet out compressed air for yarn piecing. The piecing nozzle 21 includes the yarn piecing chamber 21a for accommodating two knitting yarns. Furthermore, the piecing nozzle 21 includes the air jetting means 26 for jetting out compressed air toward the yarn piecing chamber 21a. In addition, the nozzle opening 21b is provided so as to extend from the air jetting means 26 in the direction perpendicular to the yarn piecing chamber 21a. The air jetting means 26 is configured to control the air jet by opening/closing the magnetic valve 27.

**[0036]** The piecing nozzle 21 has provided on one side with the clamping means 22 for grasping two knitting yarns accommodated in the yarn piecing chamber 21a and placed in the yarn piecing position P4, and on the other side with the cutter 23 for cutting the two knitting yarns at their end segments, thereby adjusting their lengths. Furthermore, the piecing nozzle 21 is provided on one side with a nozzle cover 24 for closing one side of the yarn piecing chamber 21a, and a yarn pullout lever 25 for pulling out the yarns while adjusting the length to be pieced. The piecing nozzle 21, the clampingmeans 22, the cutter 23, the nozzle cover 24, and the yarn pullout lever 25 are configured so as to be driven in conjunction with one another by the link mechanism (not shown) connected to the first drive gear 51.

**[0037]** The choice yarn Y1 and the knitted yarn Y4 are suctioned and grasped by the yarn end grasping suctioner 32 with their ends arranged to point in the same direction, as shown in A of FIG. 10, and they are inserted into the yarn piecing chamber 21a of the piecing nozzle 21 so as to be placed in the yarn piecing position P4. Then, the choice yarn Y1 and the knitted yarn Y4 are grasped by the clamping means 22, and the nozzle cover 24 and the yarn pullout lever 25 move to the position to close the yarnpiecing chamber 21a, as shown in B of FIG. 10. The invention comprises two configurations, in one of which, before cutting two yarns to be pieced at their end segments, a jet stream of air is generated in the piecing nozzle 21 and applied to the two yarns to be pieced in the piecing nozzle 21 to untwist the end segments of the yarns, the yarns are cut with the jet stream of air being applied thereto, and further air is jetted out to complete yarn piecing, while in the other, a jet stream of air is generated in the piecing nozzle 21 and applied to two yarns to be pieced in the piecing nozzle 21 to untwist the end segments of the yarns, and then the yarns are cut after the jet stream of air is temporarily stopped, so that yarn piecing is completed when the yarns are cut.

**[0038]** According to the former configuration, for example, in the stage shown in B of FIG. 10, the air jetting means 26 is activated to blow compressed air to the choice yarn Y1 and the kitted yarn Y4 via the nozzle opening 21b to untwist the endportion of each knitted yarn. Thereafter, the cutter 23 is activated to cut the choice yarn Y1 and the knitted yarn Y4 at their end segments by a predetermined length, as shown in C of FIG. 10. The remaining end segment of the choice yarn Y1 is suctioned by the yarn end grasping suctioner 32. In the invention, timing control means TC can be provided for the air jetting means 26 and the cutting means 23 in order to allow the air jetting means to jet out the jet stream of air to the two yarns before they are cut by the cutting means 23. The timing control means TC is operated to control the timing of generating the jet stream of air by the air jetting means 26 and the timing of activating the cutting means 23, thereby making it possible to apply both the former and latter configurations such that one of them can be suitably selected and implemented.

**[0039]** After the state shown in C of FIG. 10, the yarn pullout lever 25 slightly moves in an arrow direction V to adjust the length of the joint between the choice yarn Y1 and the knitted yarn Y4, as shown in D of FIG. 10. In the state in E of FIG. 10, the yarn pullout lever 25 is further moved in the arrow direction V to pull out the choice yarn Y1 and the knitted yarn Y4 from the yarn piecing chamber

21a (see F of FIG. 10). Fibers at the untwisted yarn ends are entwined when passing near the compressed air outlet of the yarn piecing chamber 21a, thereby piecing the choice yarn Y1 with the knitted yarn Y4. When the entwined portions are pulled out from the yarn piecing chamber 21a, the choice yarn Y1 and the knitted yarn Y4 are pressed by the nozzle cover 24 to prevent shrinkage of the entwined portions, thereby rendering the joint resistant to the formation of lumps.

**[0040]** Then, the choice yarn Y1 and the knitted yarn Y4 are completely pulled out from the yarn piecing chamber 21a, and thereafter the clamping means 22 is released so that the cutter 23, the nozzle cover 24, and the yarn pullout lever 25 return to their original positions, thereby completing the yarn piecing, as shown in F of FIG. 10. Note that in the case where the yarns to be pieced are stretchable elastic yarns, if air is jetted out to the yarns being clamped (B of FIG. 10), the elastic yarns might be entwined and pieced thereafter almost at the same time when they are cut (C of FIG. 10). In such a case, yarn piecing is possible even if the pullout lever 25 remains inactive.

**[0041]** Afterwards, in the seventh stage, the yarn holding member 31 of the yarn selecting device 1 grasps the knitting yarns Y2 to Y8 other than the choice yarn Y1, as shown in A-1 and A-2 of FIG. 9. Then, the yarn clutching member 30 releases the knitting yarns Y2 to Y8, and at the same time, the yarn end grasping suctioner 32 stops suctioning. Furthermore, in the eighth stage, the yarn guiding lever 10 is rotated back (reversed) to its original state, as shown in B-1 and B-2 of FIG. 9. Thereafter, the yarn selection plate G returns to its original position, and the yarn feeding device 41 is activated with the choice yarn Y1 positioned on the inner side of the separator 12, so that the choice yarn Y1 is fed to the flat-knitting machine.

**[0042]** FIG. 12 is a time chart illustrating operational states of the above-described main components. After the yarn guide arm 10 is normally rotated, the drive motor 50 is rotated one revolution (0° to 360°), as shown in FIG. 12. The one revolution of the drive motor 50 causes the disk guide 20 to rotate one revolution, and drives the clamping means 22, the cutter 23, the nozzle cover 24, the yarn pullout lever 25, etc. , so that the yarn piecing operation is performed in a series from its start to completion.

**[0043]** In this embodiment, first, the first catching portion 101 catches the choice yarn Y1 in the selectingposition P1, and then the second catching portion 102 catches the knitted yarn Y4 , so that the knitted yarn Y4 is moved from the inner side to the outer side of the separator 12, as shown in FIG. 7.

However, for example, when the knittedyarn (theknitting yarn being knitted) is the knitting yarn Y1, and the choice yarn (the knitting yarn selected for change) is the knitting yarn Y4, the choice yarn Y4, rather than the second catching portion 102, catches the knitted yarn Y1 and moves it from the inner side to the outer side of the separator 12, as shown in the illustrations in FIG. 13 (each showing the state in its corresponding illustration inFIG. 7). Specifically, the first catching portion 101 is rotated while catching the choice yarn Y4, so that the choice yarn Y4 moves while being placed astride the outer side and the inner side of the separator 12, as shown in A-1 and A-2 of FIG. 13. As a result, the knitted yarn Y1 crosses the choice yarn Y4, and therefore it contacts and catches the choice yarn Y4 before it is caught by the second catching portion 102. In this state, the yarn guiding lever 10 is further rotated so that the choice yarn Y4 moves the knitted yarn Y1 from the inner side to the outer side of the separator 12, as shown in B-1 and B-2 of FIG. 13.

**[0044]** That is, when the choice yarn crosses the knitted yarn after being caught by the first catching portion 101, the choice yarn, rather than the second catching portion 102, catches the knitted yarn and moves it to the standby position P3. On the other hand, when the choice yarn does not cross the knitted yarn after being caught by the first catching portion 101, the second catching portion 102 catches the knitted yarn and moves it to the standby position P3.

**[0045]** While the foregoing embodiment has been described with respect to the flat-knitting machine, the yarn changing device according to the present invention can also be mounted in textile machinery such as an automatic winder for piecing yarns selected from among plural types of yarns.

## Claims

1. A yarn piecing method, **characterized in that** two yarns to be pieced are accommodated and clamped in a piecing nozzle with their ends arranged to point in the same direction, a jet stream of air is generated in the piecing nozzle and applied to the two yarns to be pieced in the piecing nozzle so as to untwist their end segments before cutting the two yarns to be pieced at their end segments, and the yarns are cut and pieced during or after application of the jet stream of air.

2. The yarn piecing method according to claim 1, **characterized in that** the two yarns to be pieced are elastic yarns.

3. A yarn piecing device, **characterized by** comprising: a yarn piecing nozzle with a yarn piecing chamber for accommodating two yarns to be pieced with their ends arranged to point in the same direction, the yarn piecing nozzle including air jetting means for jetting out compressed air from a direction perpendicular to the yarn piecing chamber; clamping means provided on one side of the yarn piecing chamber in the yarn piecing nozzle to grasp the two yarns accommodated in the yarn piecing chamber; cutting means provided on the other side of the yarn

piecing chamber in the yarn piecing nozzle to cut the two yarns at their end segments; and timing control means provided for the air jetting means and the cuttingmeans to allow the air j ettingmeans to jet out the compressed air to the two yarns before the two yarns are cut by the cutting means.

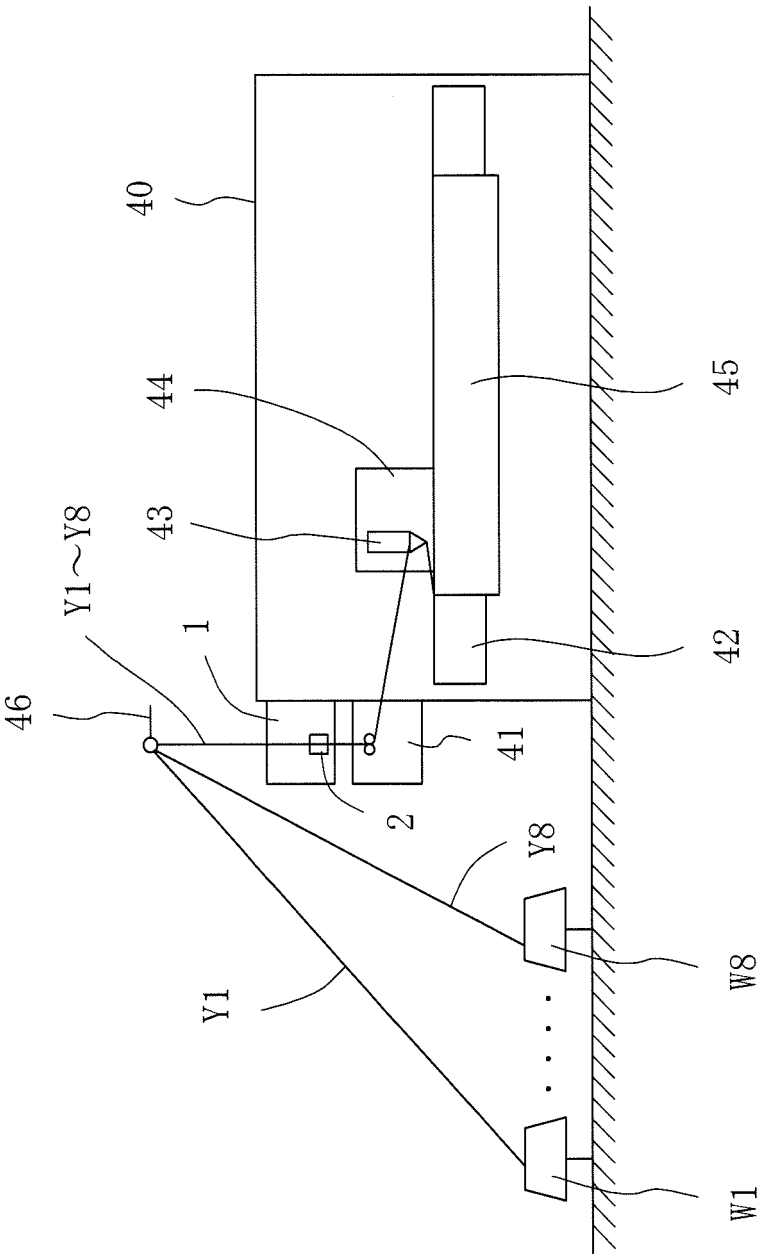


FIG. 1

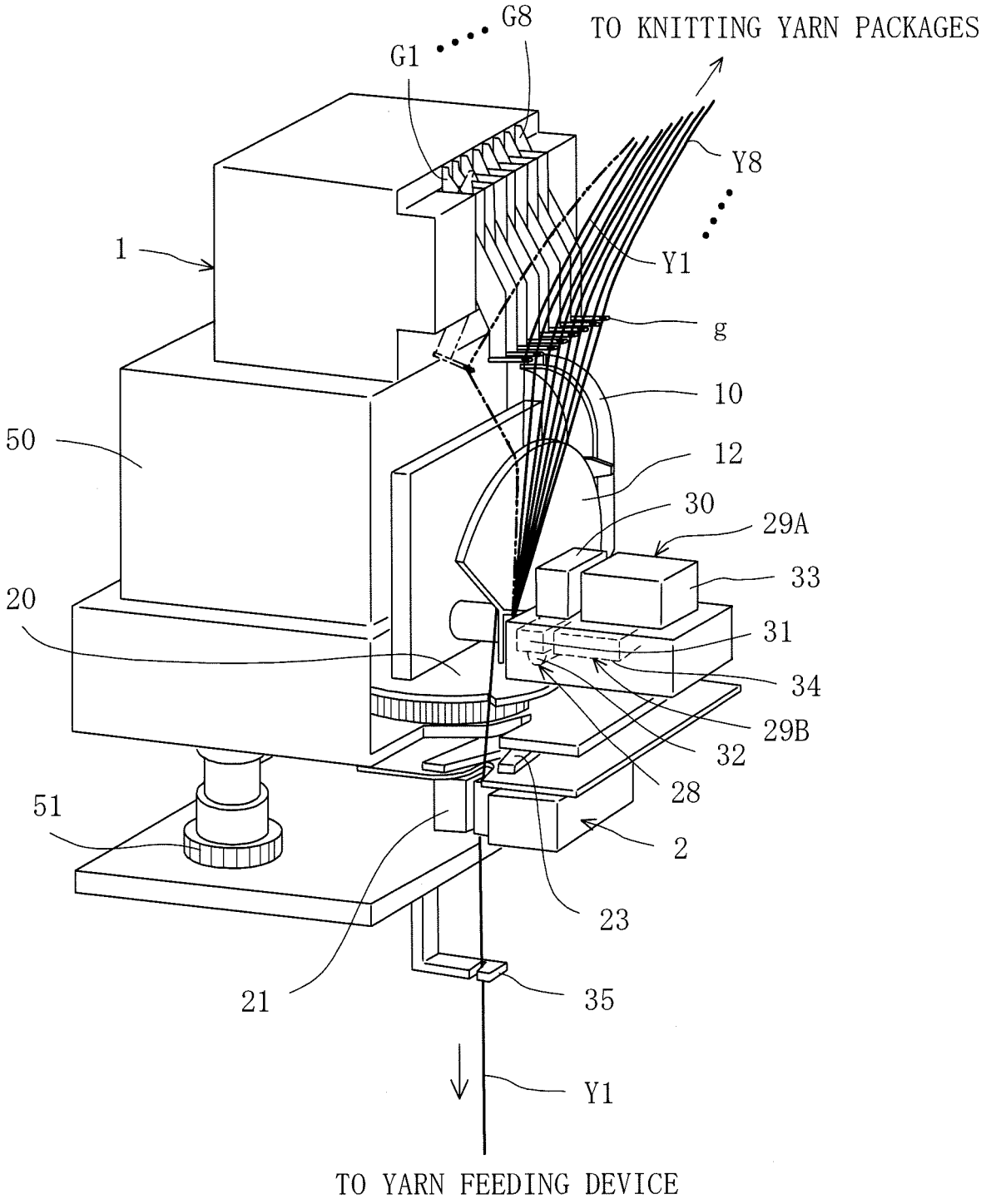
G8
G1
TO KNITTING YARN PACKAGES
Y8
1
Y1
g
10
50
12
30
29A
33
20
31
34
29B
32
28
51
2
23
21
35
Y1
TO YARN FEEDING DEVICE

FIG. 2

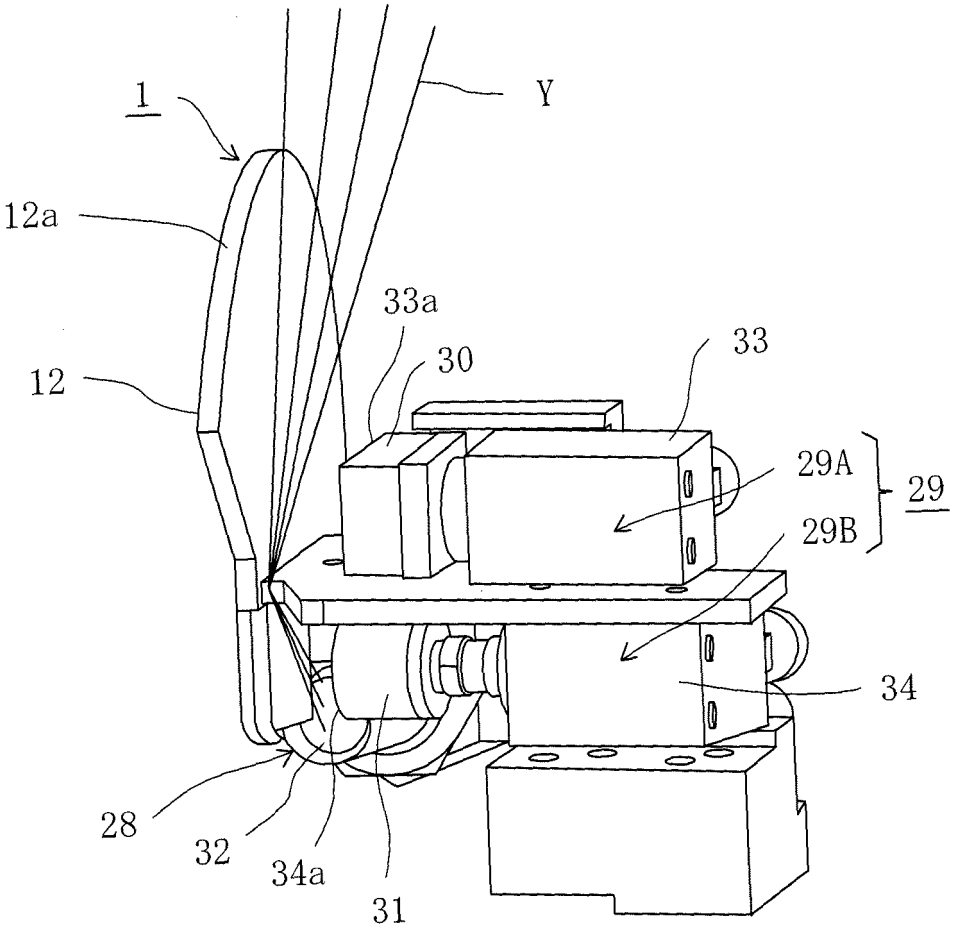


FIG. 3

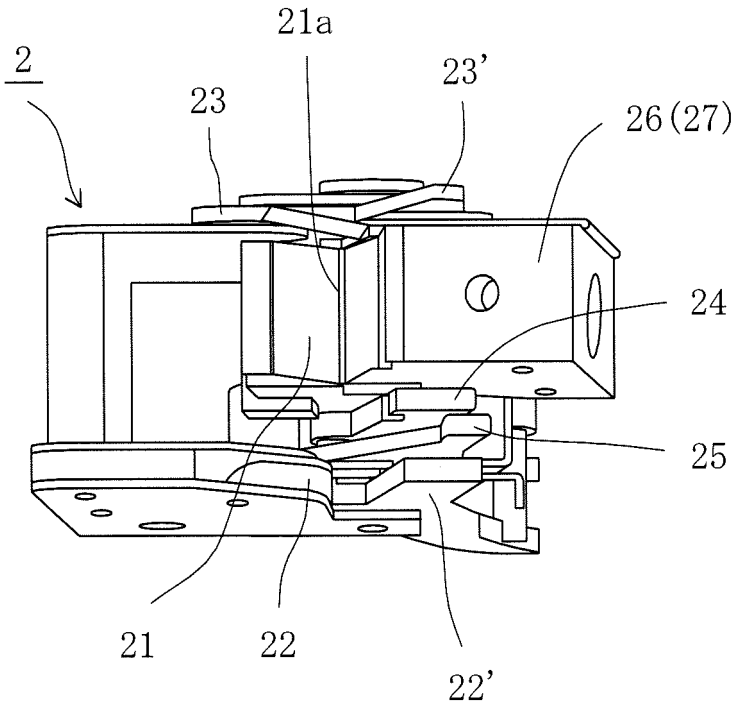


FIG. 4

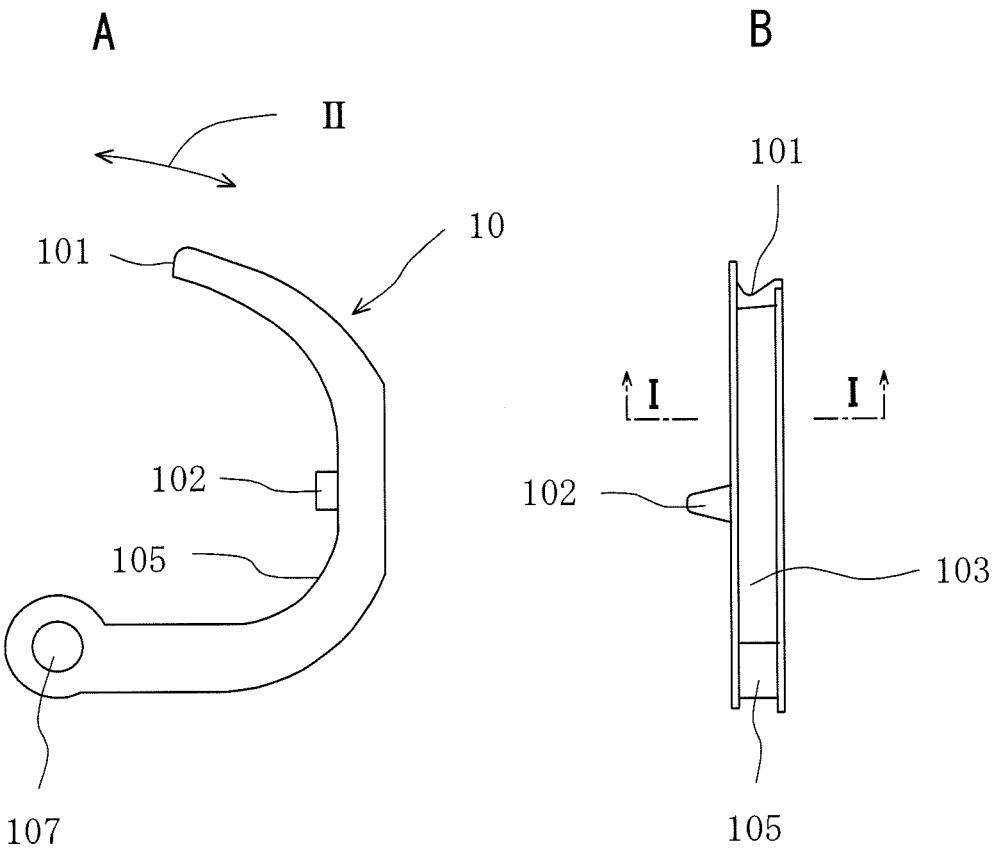


FIG. 5

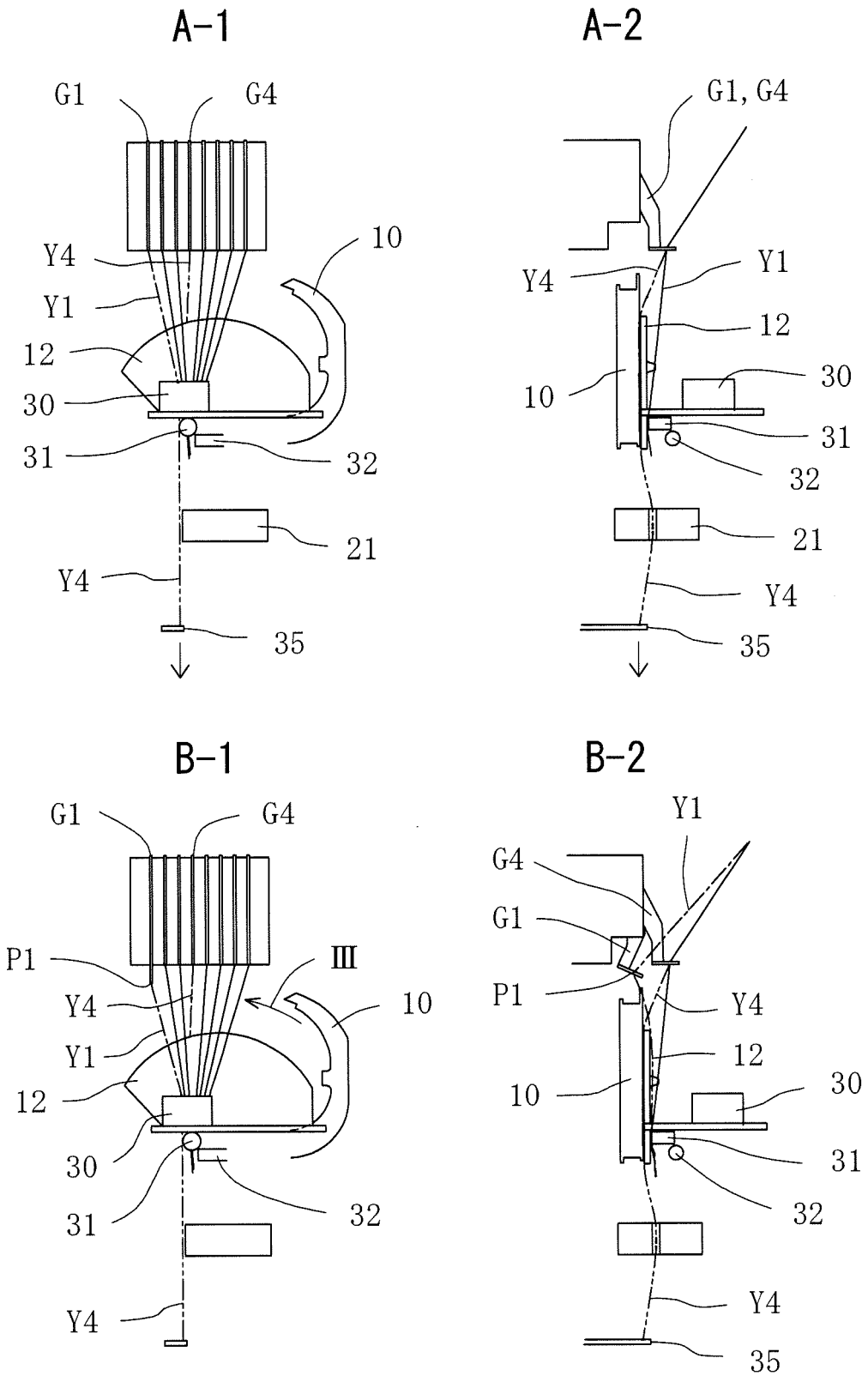
A-1
G1
G4
10
Y4
Y1
12
30
31
32
21
Y4
35
A-2
G1, G4
Y4
Y1
12
10
30
31
32
21
Y4
35
B-1
G1
G4
P1
III
10
Y4
Y1
12
30
31
32
Y4
B-2
Y1
G4
G1
P1
Y4
12
10
30
31
32
Y4
35

FIG. 6

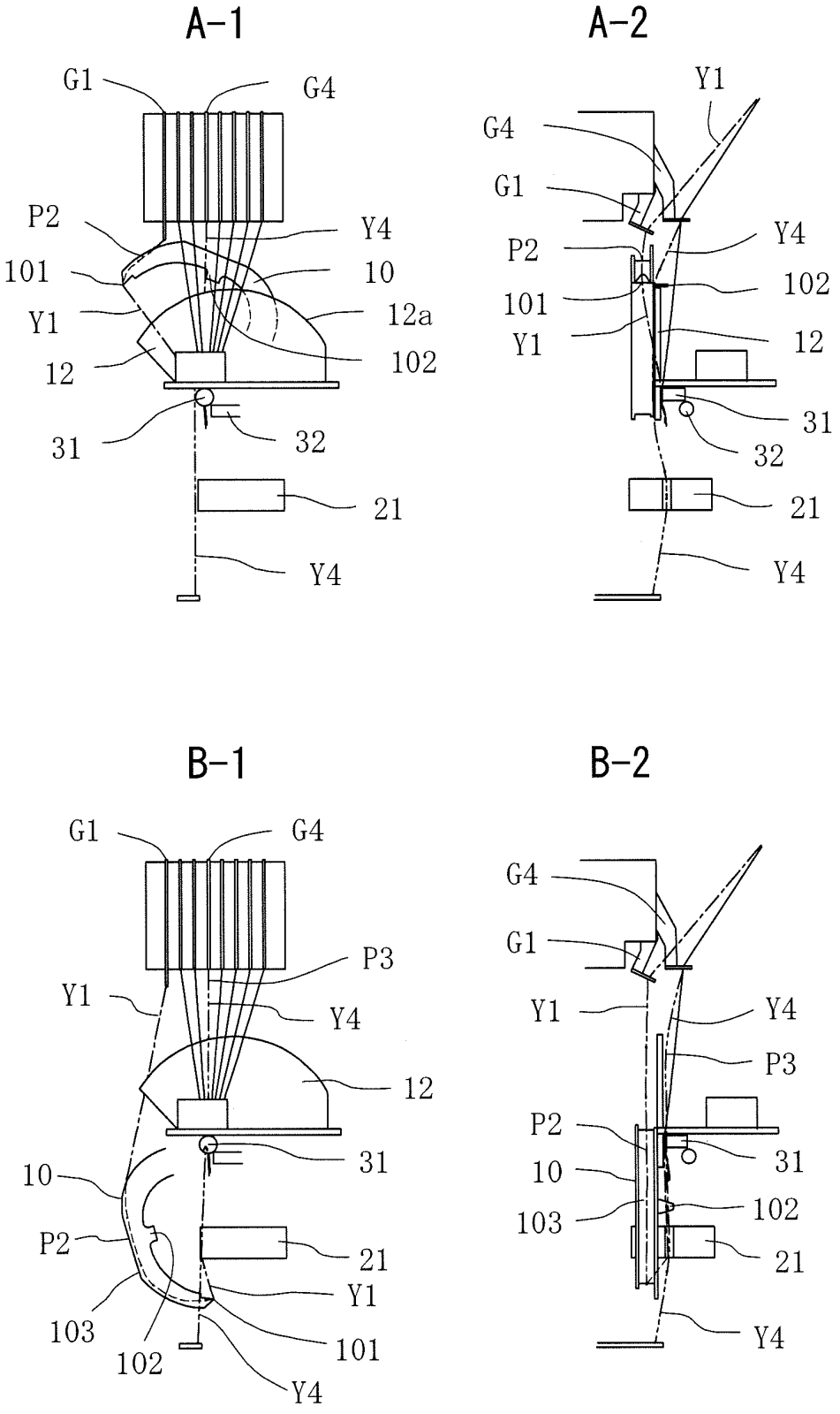
A-1
G1
G4
P2
Y4
101
10
Y1
12a
12
102
31
32
21
Y4
A-2
Y1
G4
G1
Y4
P2
102
101
12
Y1
31
32
21
Y4
B-1
G1
G4
P3
Y1
Y4
12
31
10
P2
21
Y1
103
102
101
Y4
B-2
G4
G1
Y1
Y4
P3
P2
31
10
103
102
21
Y4

FIG. 7

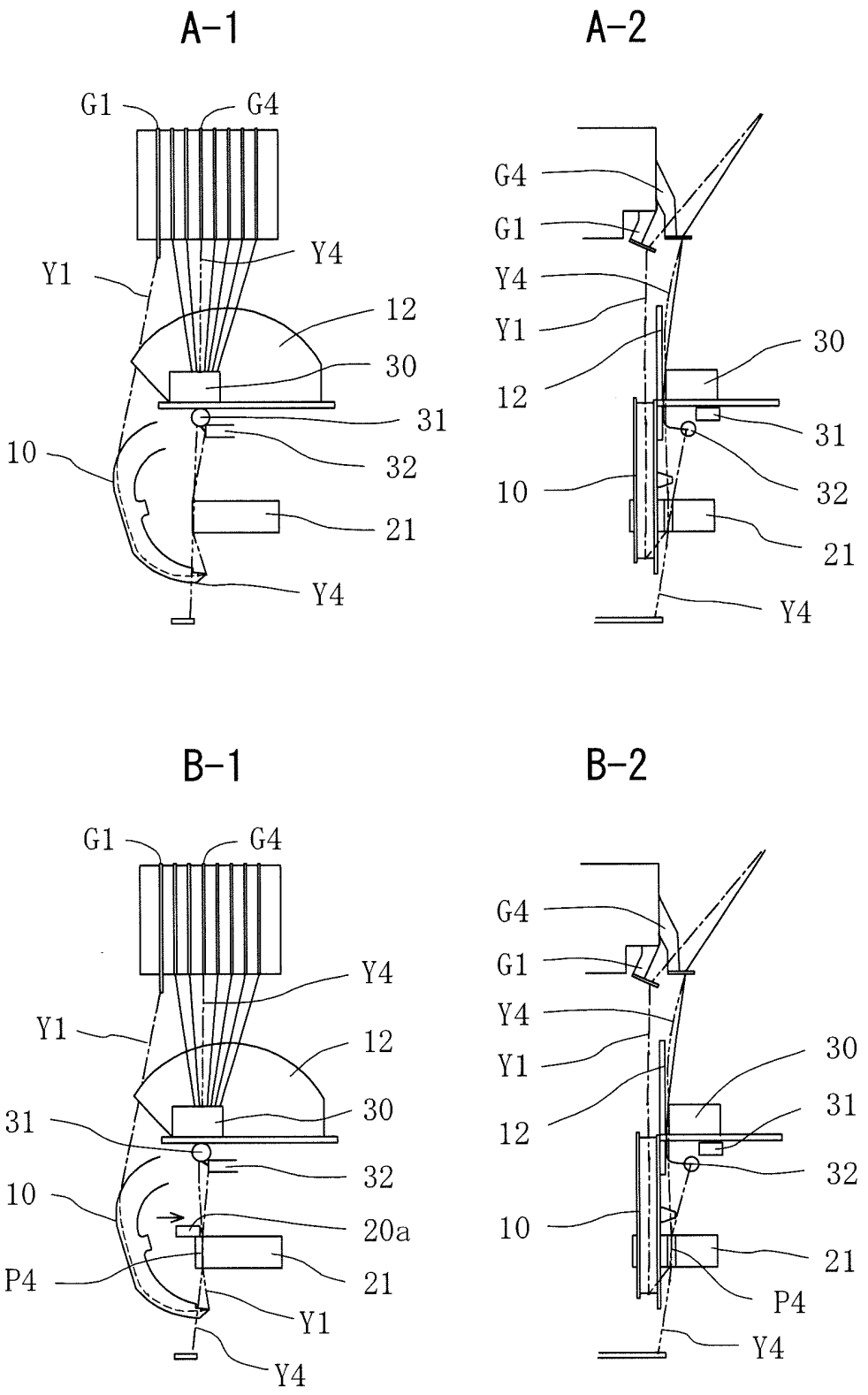
A-1
G1
G4
Y1
Y4
12
30
31
32
10
21
Y4
A-2
G4
G1
Y4
Y1
12
30
31
32
10
21
Y4
B-1
G1
G4
Y4
Y1
12
31
30
32
10
20a
P4
21
Y1
Y4
B-2
G4
G1
Y4
Y1
12
30
31
32
10
21
P4
Y4

FIG. 8

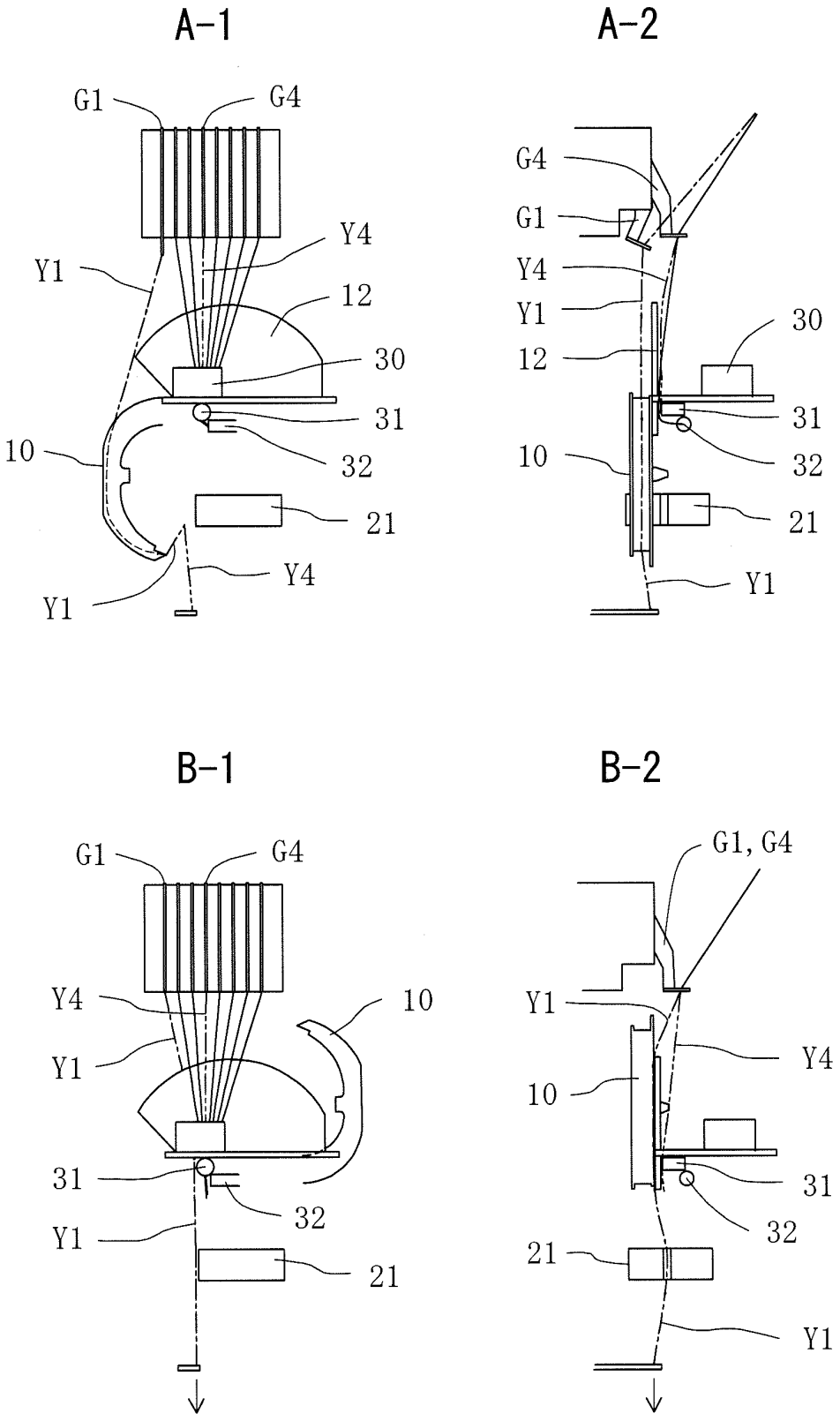
A-1
G1
G4
Y4
Y1
12
30
31
32
10
21
Y4
Y1
A-2
G4
G1
Y4
Y1
12
30
31
32
10
21
Y1
B-1
G1
G4
Y4
Y1
10
31
32
Y1
21
B-2
G1, G4
Y1
Y4
10
31
32
21
Y1

FIG. 9

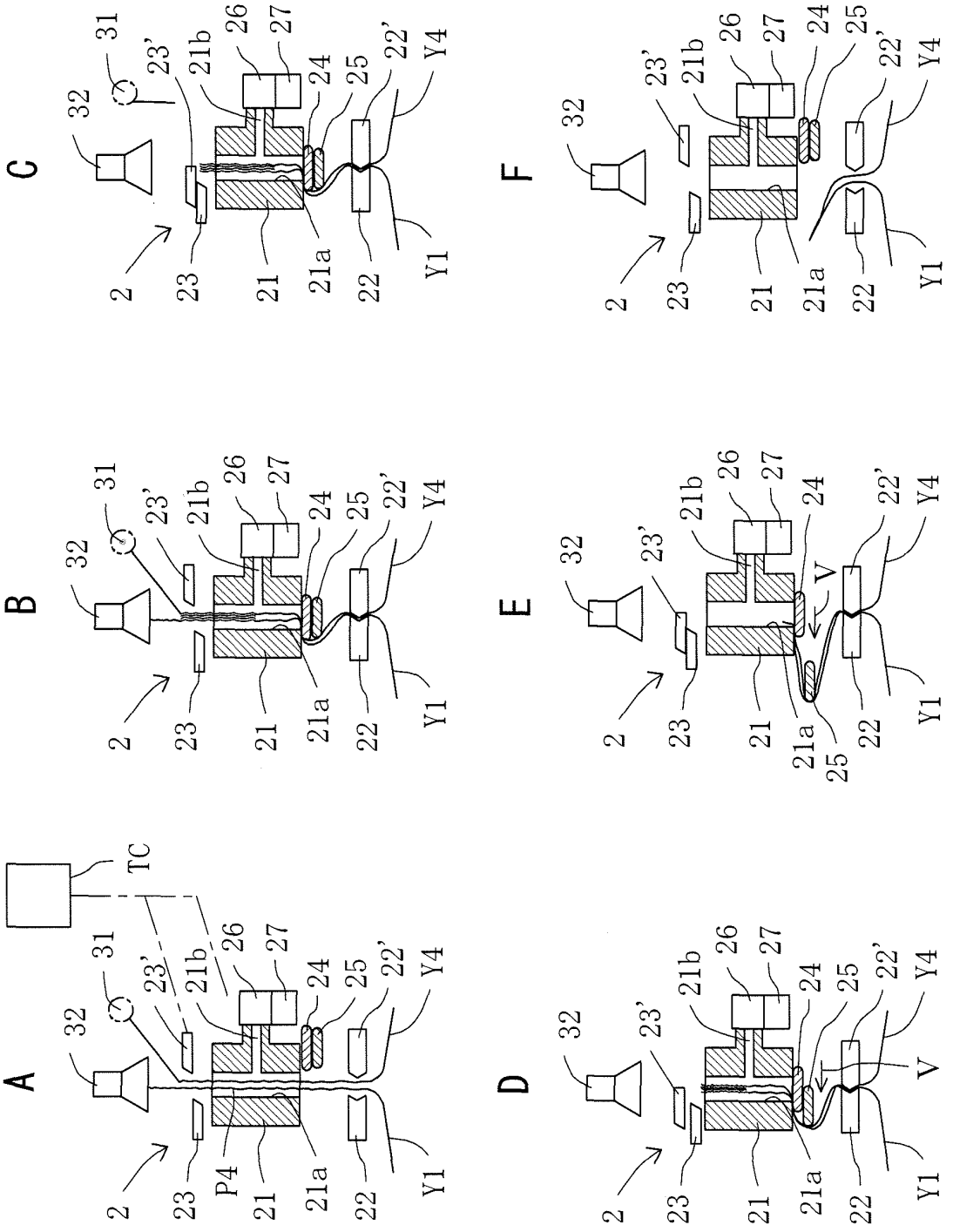


FIG. 10

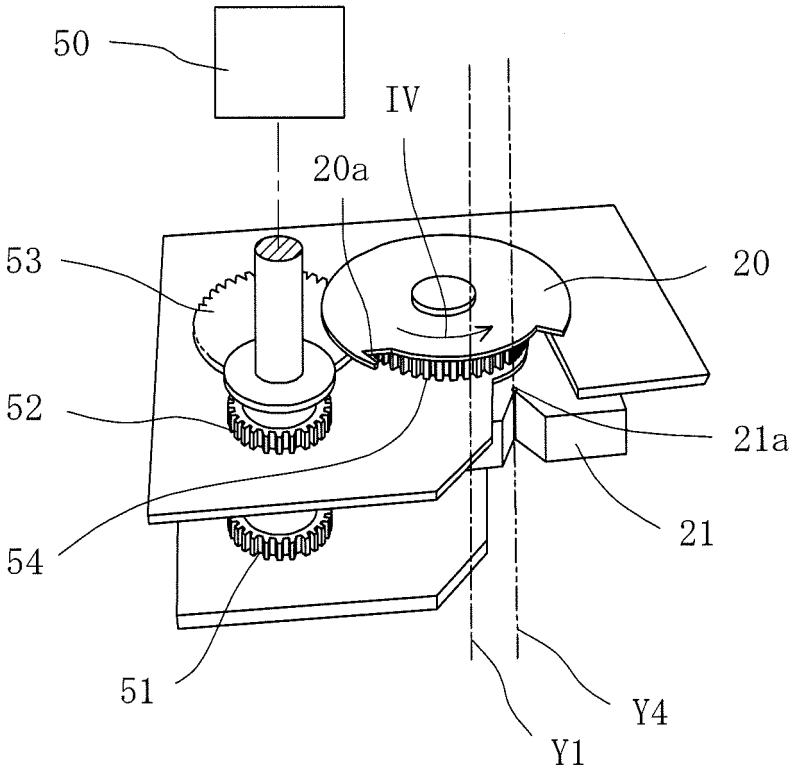


FIG. 11

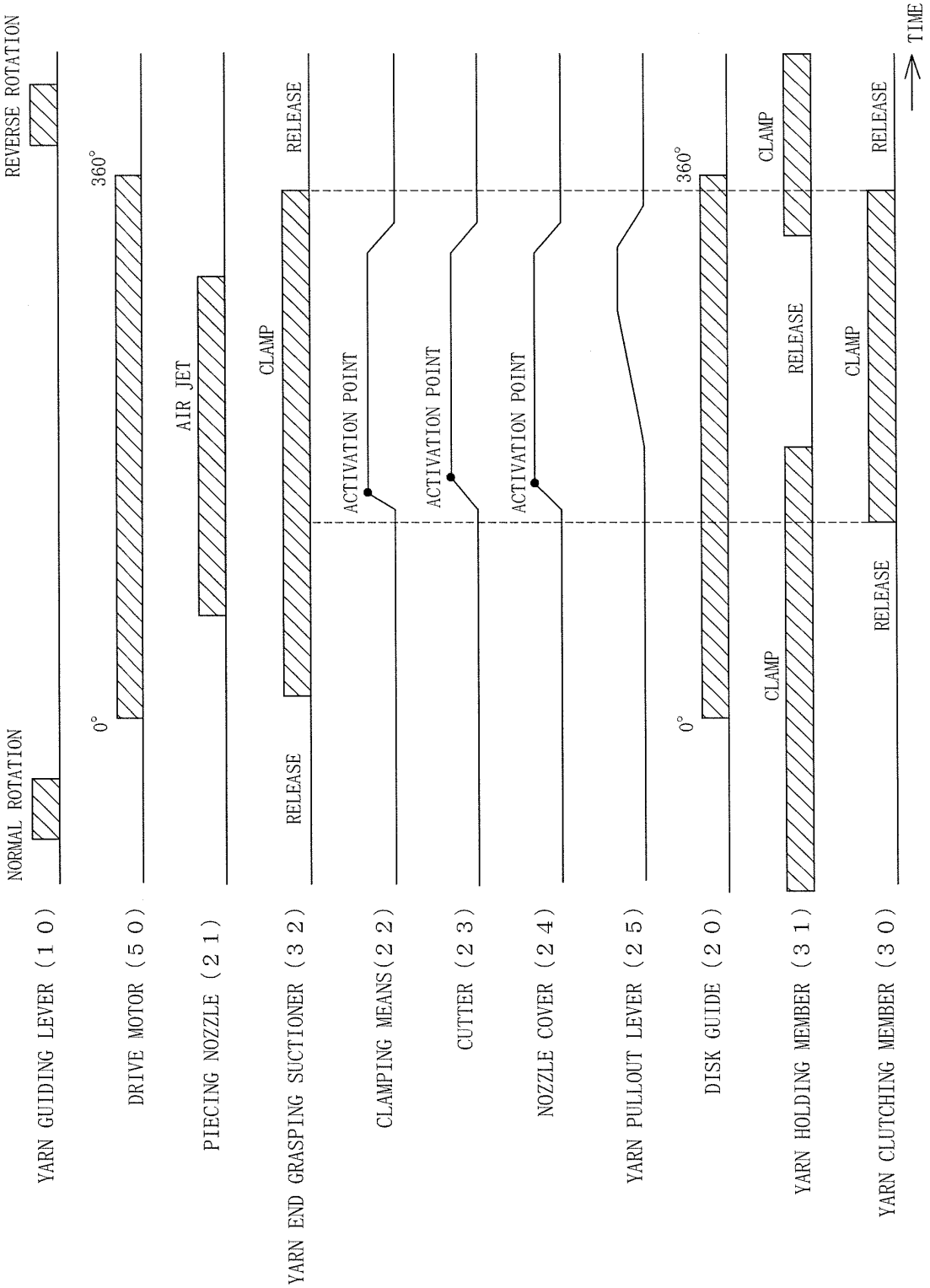
NORMAL ROTATION
REVERSE ROTATION
YARN GUIDING LEVER (10)
0°
360°
DRIVE MOTOR (50)
AIR JET
PIECING NOZZLE (21)
CLAMP
RELEASE
RELEASE
YARN END GRASPING SUCTIONER (32)
ACTIVATION POINT
CLAMPING MEANS(22)
ACTIVATION POINT
CUTTER (23)
ACTIVATION POINT
NOZZLE COVER (24)
YARN PULLOUT LEVER (25)
0°
360°
DISK GUIDE (20)
CLAMP
RELEASE
CLAMP
YARN HOLDING MEMBER (31)
CLAMP
RELEASE
RELEASE
YARN CLUTCHING MEMBER (30)
TIME

FIG. 12

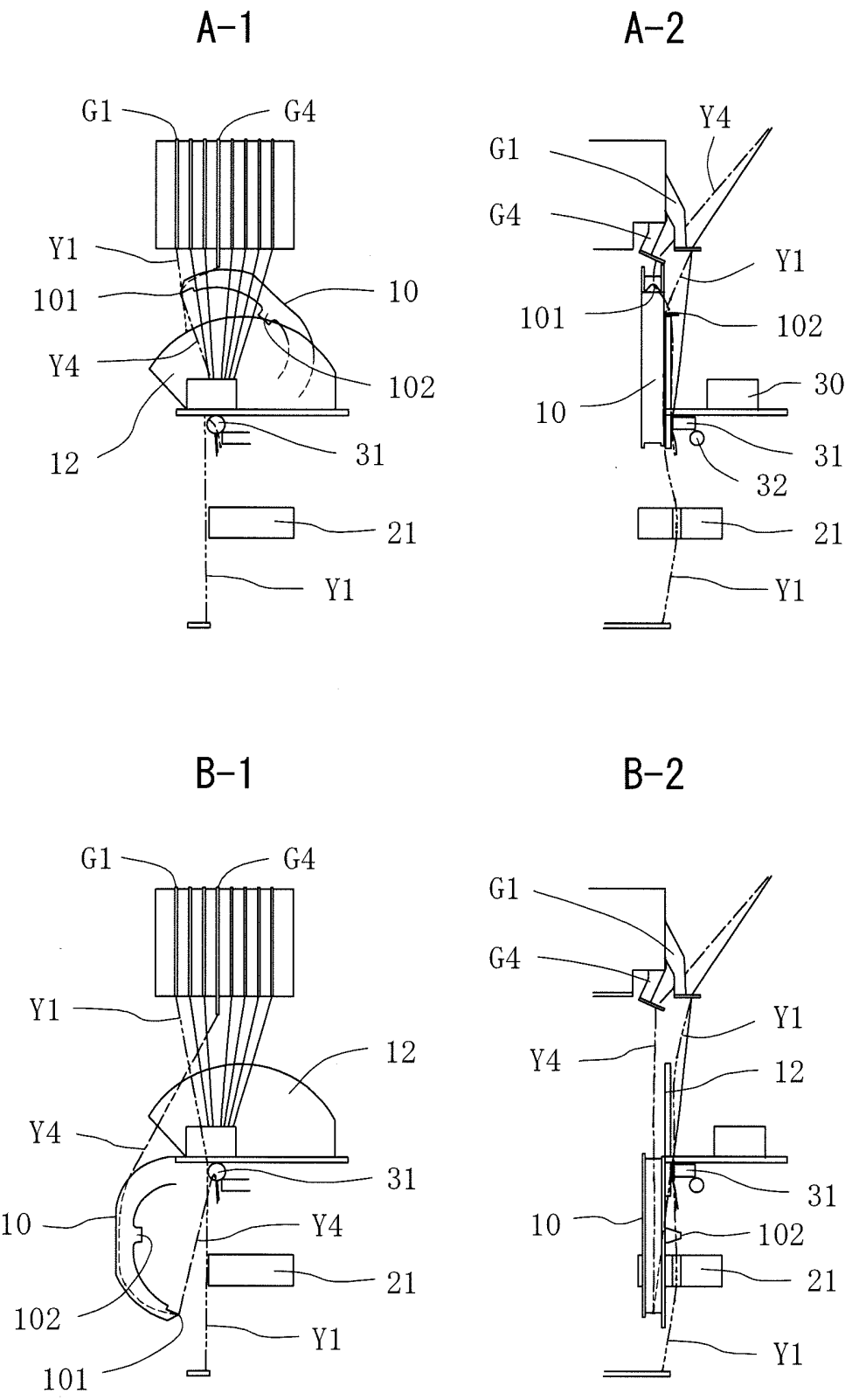
A-1
G1
G4
Y1
101
10
Y4
102
12
31
21
Y1
A-2
Y4
G1
G4
Y1
101
102
30
10
31
32
21
Y1
B-1
G1
G4
Y1
12
Y4
31
10
Y4
21
102
Y1
101
B-2
G1
G4
Y1
Y4
12
31
10
102
21
Y1

FIG. 13

**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/JP2006/319126

A. CLASSIFICATION OF SUBJECT MATTER
*D04B15/56*(2006.01)i, *B65H69/06*(2006.01)i, *D01H15/00*(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)
D04B15/56-15/64, B65H69/04-69/06, D01H15/00

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 1996-2006
Kokai Jitsuyo Shinan Koho 1971-2006 Toroku Jitsuyo Shinan Koho 1994-2006

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. |
|---|---|---|
| P,X | JP 2006-52485 A (Murata Machinery Ltd.), 23 February, 2006 (23.02.06), Par. Nos. [0021], [0022], [0033]; Fig. 4 (Family: none) | 1-3 |
| A | JP 2004-27463 A (Murata Machinery Ltd.), 29 January, 2004 (29.01.04), Par. Nos. [0025], [0027]; Figs. 4, 6 & CN 1456721 A | 1-3 |
| A | JP 2005-314104 A (Murata Machinery Ltd.), 10 November, 2005 (10.11.05), Par. Nos. [0019], [0027] to [0029] & EP 1584595 A1 & CH 1676698 A | 1-3 |

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

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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 23 October, 2006 (23.10.06) | 31 October, 2006 (31.10.06) |
| Name and mailing address of the ISA/ Japanese Patent Office<br>Facsimile No. | Authorized officer<br>Telephone No. |

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**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/JP2006/319126

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 2001-199637 A (Murata Machinery Ltd.), 24 July, 2001 (24.07.01), Par. No. [0005] & EP 1118570 A2 & DE 60009437 T & TW 509220 Y | 2 |

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## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- JP 2004027463 A **[0004]**
- JP 2005025124 A **[0004]**