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(71) Applicant: **SHIMA SEIKI MFG., LTD.**
Wakayama 641-8511 (JP)

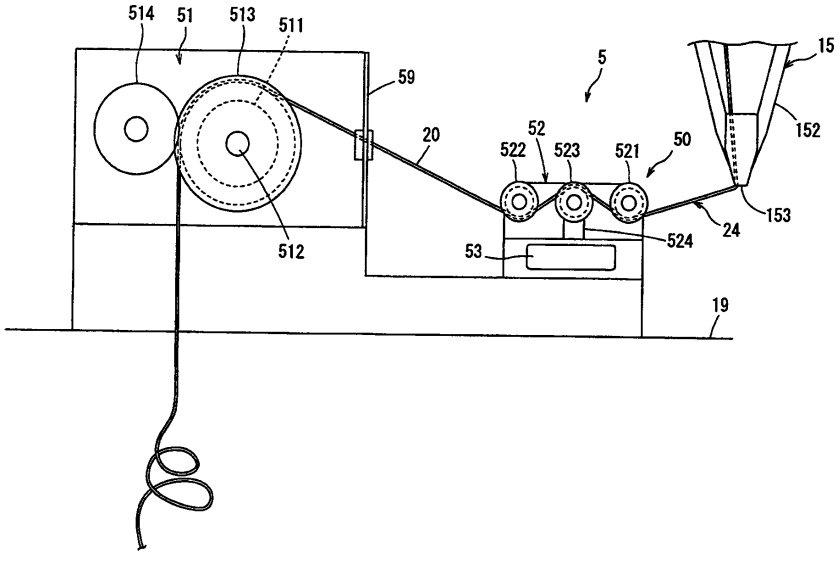
(72) Inventors:
- **NAKAGUCHI, Kazuhito**
  Wakayama 641-8511 (JP)
- **SHIMASAKI, Yoshinori**
  Wakayama 641-8511 (JP)

(74) Representative: **Schmidbauer, Andreas Konrad**
Wagner & Geyer Partnerschaft mbB
Patent- und Rechtsanwälte
Gewürzmühlstrasse 5
80538 München (DE)

(54) TENSION MEASURING DEVICE FOR KNITTING MACHINE AND TENSION MEASURING METHOD

(57) There are provided a tension measuring device for a flat knitting machine and a tension measuring method for the same, with which tension of a yarn can be measured in such a manner that measured tension substantially accurately represents tension of the yarn to be knitted into fabric at a position after the yarn passes through a yarn feeding port so that problems can be prevented from occurring to the fabric due to abnormal tension of the yarn. In a flat knitting machine configured such that a yarn 20 is fed to needles via a feed path 2 with tension being applied to the yarn 20, a yarn drawing-in means 51 draws the yarn 20 being in a ready-for-knitting state, at a position after the yarn 20 passes through a yarn feeding port 153, into a measurement path 24 that is different from the feed path 2 to the needles. Subsequently, a measuring means 52 measures tension of the yarn 20 drawn into the measurement path 24 without performing knitting, and the tension of the yarn 20 measured at a position after the yarn feeding port 153 is displayed on a monitor 53.

Fig. 3



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Description

BACKGROUND OF INVENTION

1. Field of the Invention

[0001] The present invention relates to a tension measuring device for a knitting machine in which a yarn is fed via a feed path from a yarn package to needles with tension being applied to the yarn, the tension measuring device being configured to measure the tension of the yarn accurately.

2. Description of the Related Art

[0002] A known tension measuring device for this type of knitting machine is disposed on a yarn feed path halfway from the yarn package to the needles so as to measure tension of the yarn to which tension is applied on the yarn feed path by using a top tension device, a side tension device, or the like (see Japanese Patent No. 2951068).

[0003] When a yarn supplied via the feed path is knitted into fabric, this tension measuring device measures the tension of the yarn on the feed path before the yarn passes a yarn feeding port.

[0004] In view of an impact on fabric to be knitted, the tension of the yarn during knitting is preferably measured at a position as close as possible to the needles, in other words, at a position after the yarn passes through the yarn feeding port.

[0005] However, since the known tension measuring device measures tension of the yarn before the yarn enters the yarn feeding port, the measured tension may become different from tension of the yarn at a point after the yarn passes through the yarn feeding port and accordingly may not accurately represent the tension of the yarn to be knitted.

[0006] In addition, the yarn is being supplied at a high speed to the needles while tension of the yarn is measured. Accordingly, even if an abnormality occurs to the measured tension of the yarn, the knitting machine has a momentum to continue knitting and may lead to a problem in the knitted fabric.

SUMMARY OF THE INVENTION

[0007] Accordingly, it is an object of the present invention to provide a tension measuring device for a knitting machine that can measure tension of a yarn, while the operation of a yarn feeding port stops, by drawing a ready-for-knitting-state yarn, at a position after the yarn passes through the yarn feeding port, into a measurement path that is different from a feed path to needles and that can thereby provide measured tension that substantially accurately represents tension of the yarn to be knitted into fabric at a position after the yarn feeding port, whereby problems can be prevented from occurring to the fabric due to abnormal tension of the yarn. It is also an object of the present invention to provide a tension measuring method for the above knitting machine.

[0008] To achieve the above objects, a tension measuring device according to the present invention requires a knitting machine configured such that a yarn that is fed via a feed path from a yarn package to needles with tension being applied to the yarn is guided by a yarn feeding port on the feed path and thereby fed to the needles. A tension measuring device body is disposed near the yarn feeding port. The tension measuring device body draws the yarn, at a position after the yarn passes through the yarn feeding port, into a measurement path that is different from the feed path to the needles and thereby measures tension of the yarn. The tension measuring device body includes a yarn drawing-in means that draws the yarn being in a ready-for-knitting state into the measurement path at the position after the yarn passes through the yarn feeding port. The tension measuring device body also includes a measuring means that is disposed on the measurement path at a position between the yarn feeding port and the yarn drawing-in means and that measures tension of the yarn drawn, without performing knitting, into the measurement path by the yarn drawing-in means. The tension measuring device body further includes a display means that displays the tension of the yarn measured by the measuring means on the measurement path. Here, "a ready-for-knitting state" means a state in which the yarn can be knitted into fabric once the yarn is guided to the needles after passing through the yarn feeding port.

[0009] The feed path is provided with tension imparting means that apply tension to the yarn. In addition, the display means may display the measured tension of the yarn on the measurement path in such a manner that the measured tension is comparable with a predetermined target tension of the yarn after the yarn passes through the yarn feeding port and that the measured tension is brought closer to the target tension by adjusting the tension imparting means.

[0010] Yarn speed of the yarn on the measurement path may be changeable in accordance with a change in yarn speed on the feed path at a position after the yarn passes through the yarn feeding port when a drawing direction of the yarn is switched.

[0011] The tension measuring device body may be detachably disposed near the yarn feeding port of the knitting machine.

[0012] To achieve the above objects, a tension measuring method according to the present invention requires a knitting machine configured such that a yarn that is fed via a feed path from a yarn package to needles with tension being applied to the yarn is guided by a yarn feeding port on the feed path and thereby fed to the needles. The yarn in the ready-for-knitting state is drawn, at a position after the yarn passes through the yarn feeding port, into a measurement path that is different from the feed path to the needles. Subsequently, tension of the yarn drawn

into the measurement path without performing knitting is measured, and the tension of the yarn measured at a position after the yarn feeding port is displayed.

[0013] The yarn in the ready-for-knitting state is drawn into a measurement path at the position after passing through the yarn feeding port, and tension of the yarn is measured. Accordingly, the measured tension substantially accurately represents tension of the yarn that can be knitted into fabric at a position after the yarn feeding port on the feed path. Especially in the case of intarsia knitting in which fabric is knitted by using a plurality of yarns fed from yarn packages via separate yarn feed paths having different path lengths, the tension of each yarn can be measured accurately at a position after the yarn feeding port for each one of the yarn feed paths. Moreover, the tension of the yarn that varies depending on the amount of knitted fabric (the amount of yarn) even on the same yarn feed path, and this tension can also be grasped accurately.

[0014] While the operation of the yarn feeding port stops, tension is measured by drawing the yarn, at a position after the yarn passes through the yarn feeding port, into the measurement path that is different from the yarn feed path to the needles. Accordingly, it is not necessary to knit fabric by using the needles during the measurement of tension of the yarn. Problems occurring to the fabric due to abnormal tension can be prevented by checking the tension of the yarn before knitting.

[0015] The display means displays the measured tension of the yarn on the measurement path in such a manner that the measured tension is comparable with a predetermined target tension and the measured tension can be brought closer to the target tension by adjusting tension imparting means. With this display function, the measured tension can be accurately brought closer to the target tension by adjusting the tension imparting means.

[0016] Tension of the yarn corresponding to the yarn speed that varies on the feed path can be measured easily on the measurement path by changing yarn speed on the measurement path in accordance with a change in yarn speed on the feed path at a position after the yarn passes through the yarn feeding port when a drawing direction of the yarn on the yarn feed path is switched.

[0017] The tension measuring device body is detachably mounted on a knitting machine near the yarn feeding port. In other words, the tension measuring device body can be mounted on other knitting machines near the yarn feeding port thereof, which enables tension of a yarn to be measured accurately on the yarn feed path for other knitting machines by using a single tension measuring device.

[0018] In addition, the yarn in the ready-for-knitting state is drawn, at a position after the yarn passes through the yarn feeding port, into the measurement path that is different from the feed path to the needles, and the tension of the yarn drawn into the measurement path without performing knitting is displayed. Thus, there can be provided a tension measuring method with which the measured tension can substantially accurately represent the tension of the yarn to be knitted into fabric at a position after the yarn feeding port, whereby problems can be prevented from occurring to the fabric before knitting due to abnormal tension of the yarn on the feed path.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 is a configuration diagram schematically illustrating a flat knitting machine equipped with a tension measuring device according to an embodiment of the invention;

Fig. 2 is a configuration diagram schematically illustrating a yarn feed path of the flat knitting machine of Fig. 1; and

Fig. 3 is a configuration diagram schematically illustrating the tension measuring device of Fig. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] An embodiment of the present invention will be described with reference to the drawings.

[0021] Fig. 1 is a configuration diagram schematically illustrating a yarn feed path of a flat knitting machine equipped with a tension measuring device according to an embodiment of the invention, and Fig. 2 is a configuration diagram schematically illustrating the same feed path of the flat knitting machine of Fig. 1.

[0022] As illustrated in Figs. 1 and 2, a flat knitting machine 1 includes front and rear needle beds 11 (only one bed is illustrated) that oppose each other with a knitting zone 10 provided therebetween so as to form an inverse-V shape. A carriage 12 is disposed so as to face the front and rear needle beds 11 and to straddle yarn guiding rails 14. The carriage 12 is moved reciprocally by a servomotor (not illustrated) in a longitudinal direction (in the right-left direction in Fig. 1) of the needle beds 11.

[0023] More specifically, a plurality of yarn guiding rails 14 (only one rail is illustrated in Fig. 1) are laid parallel to the longitudinal direction of the needle beds 11 above the knitting zone 10. The yarn guiding rails 14 movably support respective yarn carriers 15, 16 that feed yarns 20. Two tracks on which each of the yarn carriers 15, 16 run are formed on each of the yarn guiding rails 14. The yarn carriers 15, 16 respectively include bases 151, 161, yarn feeding arms 152, 162 that extend downward from corresponding bases 151, 161, yarn feeding ports 153, 163 that are formed at bottom ends of corresponding yarn feeding arms 152, 162 and that guide yarns 20 to needles (not illustrated). Many needles are arranged in a row along each needle bed 11, and systems mounted on the carriage 12, such as a needle selection mechanism and a cam mechanism, cause the needles to perform stitching selectively.

[0024] The carriage 12 has yarn-carrier entraining

pins. The carriage 12 entrains the yarn carriers 15, 16 by causing the yarn-carrier entraining pins to engage recesses of respective yarn carriers 15, 16. Yarn packages 17 are installed on a yarn stand bench 18 of the flat knitting machine 1. Yarns 20 from yarn packages 17 are fed to corresponding yarn feeding ports 153, 163 of the yarn carriers 15, 16 via individual yarn feed paths 2.

[0025] Fabric 22 is knitted by repeating the process in which each needle having a hook at the end thereof is caused to advance into the knitting zone 10, to hook the yarn 20 fed from each of the yarn feeding port 153, 163, and to draw the yarn 20 into a needle bed 11 and thereby cause a previously formed stitch to knock over on the yarn 20. The carriage 12 entrains a single one or a plurality of yarn carriers 15, 16 for knitting the fabric 22. Knitting of the fabric 22 is controlled in accordance with knitting data prepared in advance, and the knitted fabric 22 is drawn downward from the knitting zone 10 as the knitting proceeds. The carriage 12 and the needles are operated automatically. Strokes of movement of the carriage 12 are optimized on the basis of the knitting data.

[0026] The yarn carriers 15, 16 are on standby outside the width of the fabric 22 near a fabric side end 221. The moving direction of the carriage 12 is reversed at positions outside the width of the fabric 22 by reversing the rotational direction of the servomotor (not illustrated).

[0027] A plurality of top tension devices 3, which serve as tension imparting means, are disposed in a top region of the flat knitting machine 1 at positions halfway on respective yarn feed paths 2. Each of the top tension devices 3 includes a tensioning disk 31, a support arm 32 that has a base portion for supporting the tensioning disk 31 and that protrudes frontward, and a yarn guide 33 disposed at the end of the support arm 32. A yarn 20 is fed upward from a yarn package 17 and passes through the tensioning disk 31 of the top tension device 3. The yarn 20 subsequently passes through the yarn guide 33 at the end of the support arm 32 and is guided downward. When the yarn 20 passes through the tensioning disk 31, tension is thereby applied to the yarn 20. The tensioning disk 31 has an adjustment handle 34, and the load applied to the tensioning disk 31 is adjusted by using the adjustment handle 34. The tension applied to the yarn 20 is thereby adjusted.

[0028] A plurality of side tension devices 4, which serve as tension imparting means for respective yarn feed paths 2, are disposed at right and left sides of the yarn stand bench 18. Each of the side tension devices 4 includes a supporting member 41 that is pivotally fixed to the right or the left side of the yarn stand bench 18. Each side tension device 4 includes a side tension arm 42 of which the top end is attached to the supporting member 41 and also includes a yarn guide 43 disposed at the end (bottom end) of the side tension arm 42. The supporting member 41 is configured to be adjustable for the load of pivotal movement of the side tension arm 42 relative to the yarn stand bench 18. Each yarn 20, which is guided downward from the top tension device 3, passes through the yarn guide 43 at the end of the side tension arm 42. The yarn 20 is further guided in the right or the left direction toward the inside of the knitting machine. At this time, tension is applied to the yarn 20 due to the load of pivotal movement of the side tension arm 42 at the supporting member 41 and due to bending of the side tension arm 42. An adjustment dial (not illustrated) is provided at the supporting member 41. By using the adjustment dial, the load of pivotal movement of the side tension arm 42 is adjusted and the tension applied to the yarn 20 is thereby changed.

[0029] An advancing roller 44 is provided on each yarn feed path 2 between the top tension device 3 and the side tension device 4. The yarn 20 is wound one time around the advancing roller 44. The advancing roller 44, which applies a driving force to the yarn 20, feeds the yarn 20 from each yarn package 17 to the side tension device 4 via the top tension device 3. The advancing roller 44 serves to reduce resistance in yarn feeding and thereby make the feeding smooth until the yarn 20 reaches each of the yarn carriers 15, 16. The yarn carriers 15, 16 are entrained by the carriage 12 and slidably move along respective yarn guiding rails 14 in the right-left direction. When the yarn carriers 15, 16 entrained by the carriage 12 slide in the right-left direction, each yarn carrier is switched between a pull direction and a push direction. The pull direction is the direction in which the yarn 20 is drawn from the yarn feeding port 153, 163 in the same direction as the direction in which the yarn 20 is guided from the side tension device 4. The push direction is the direction in which the yarn 20 is drawn from the yarn feeding port 153, 163 in the direction opposite to the direction in which the yarn 20 is guided from the side tension device 4.

[0030] Fig. 3 is a configuration diagram schematically illustrating the tension measuring device of Fig. 2. As illustrated in Fig. 3, a tension measuring device body 50 of a tension measuring device 5 is disposed near the yarn feeding port 153 of the yarn carrier 15. While the operation of the yarn feeding port 153 stops, the tension measuring device 5 draws the yarn 20 into a measurement path 24, which is different from the yarn feed path 2 to the needles, at a position after the yarn 20 passes through the yarn feeding port 153, and thus measures the tension of the yarn 20. The tension measuring device body 50 includes a frame-shaped housing 59 and a magnet (not illustrated) disposed at the bottom surface of the housing 59. The tension measuring device body 50 is detachably mounted on a metallic support bench 19 of the flat knitting machine 1. Accordingly, the tension measuring device body 50 can be mounted on other flat knitting machines at a position near the yarn feeding port thereof, which enables the tension of a yarn to be measured accurately on the yarn feed path for other flat knitting machines by using a single tension measuring device body 50. Note that in the present embodiment, the housing 59 of the tension measuring device body 50 is detachably mounted on the support bench 19 of the flat

knitting machine 1. However, the tension measuring device body may be provided integrally, without being detachable, on the support bench of a flat knitting machine.

[0031] The tension measuring device body 50 includes a yarn drawing-in means 51 that draws the yarn 20 in the ready-for-knitting state into the measurement path 24 at a position on the yarn feed path 2 from the yarn feeding port 153 to the needles. The yarn drawing-in means 51 includes a yarn drawing-in motor 511, a yarn drawing-in pulley 513 that is joined to an output shaft 512 of the yarn drawing-in motor 511 so as to rotate together, and an idler pulley 514 that is passively driven by the yarn drawing-in pulley 513 with the yarn 20 nipped therebetween. In this case, the speed of the yarn 20 drawn by the yarn drawing-in means 51 along the measurement path 24 is set at the same speed as that of the yarn 20 guided by the yarn carrier 15 entrained by carriage 12 to the needles at a position after the yarn 20 passes through the yarn feeding port 153.

[0032] The tension measuring device body 50 also includes a measuring means 52 disposed on the measurement path 24 between the yarn feeding port 153 and the yarn drawing-in means 51. The measuring means 52 has two guide rollers 521, 522 that guide the yarn 20 drawn into the measurement path 24, a tension detection roller 523 disposed between two guide rollers 521, 522, and a load cell 524 that supports the tension detection roller 523. The measuring means 52 is configured such that the load cell 524 measures, via the tension detection roller 523, the tension of the yarn 20 that is drawn into the measurement path 24 by the yarn drawing-in means 51.

[0033] The tension measuring device body 50 further includes a monitor 53 that serves as a display means for displaying tension measured by the load cell 524. The monitor 53 displays the measured tension of the yarn 20 on the measurement path 24, in other words, the tension of the yarn 20 measured at a position after the yarn 20 passes through the yarn feeding port 153. The measured tension is displayed on the monitor 53 in such a manner that the measured tension is comparable with a predetermined target tension for the yarn 20 on the yarn feed path 2 to the needles. The measured tension displayed is utilized for adjusting the tension acting on the yarn 20 at a position after the yarn feeding port 153 on the yarn feed path 2, by adjusting the top tension device 3 and the side tension device 4, so as to bring the measured tension closer to the target tension. In this case, the target tension of the yarn 20 at a position after the yarn feeding port 153 on the yarn feed path 2 is set in advance in accordance with the type of flat knitting machine. The target tension need not be an ideal value but may be a value with which knitting can be performed without causing problems.

[0034] The yarn speed on the yarn feed path 2 changes when the direction of drawing the yarn 20 from the yarn feeding portion 153 to the needles is switched. In other words, the yarn speed on the yarn feed path 2 changes when movement of the yarn carrier 15, which is entrained by the carriage 12, is switched and the direction of drawing the yarn 20 from the yarn feeding port 153 is switched between the push direction and the pull direction. To simulate this change, the speed of the yarn 20 on the measurement path 24 is changed accordingly. The yarn speed, which changes when the direction of drawing the yarn 20 is switched between the push direction and the pull direction, is predetermined in accordance with a pitch of stitches in the course direction thereof, a loop length of each stitch to be knitted, knitting speed of fabric 22, and the gauge of the flat knitting machine 1. The yarn speeds when the yarn 20 is drawn in the push direction and in the pull direction are preset depending on the type of flat knitting machine 1.

[0035] For example, in the case of plain knitting, the speed (m/s) of the yarn 20 when the yarn 20 is drawn in the push direction may be obtained from the following equation: yarn speed (m/s) = ((loop length of a stitch - pitch of stitches)/pitch of stitches) $\times$ knitting speed of fabric 22. More specifically, the yarn speed (m/s) for gauge 14G of the flat knitting machine 1 when the yarn 20 is drawn in the push direction is ((6.0 - 1.814)/1.814) $\times$ 1.0 $\approx$ 2.3 m/s, in which the pitch of stitches in the course direction is 1.814, the loop length of a stitch is 6.0, and the speed of knitting fabric 22 is 1.0 (m/s).

[0036] On the other hand, the speed (m/s) of the yarn 20 when the yarn 20 is drawn in the pull direction may be obtained from the following equation: yarn speed (m/s) = ((loop length of a stitch + pitch of stitches)/pitch of stitches) $\times$ knitting speed of fabric 22. More specifically, the yarn speed (m/s) for gauge 14G of the flat knitting machine 1 when the yarn 20 is drawn in the pull direction is ((6.0 + 1.814)/1.814) $\times$ 1.0 $\approx$ 4.3 m/s, in which the pitch of stitches in the course direction is 1.814, the loop length of a stitch is 6.0, and the speed of knitting fabric 22 is 1.0 (m/s).

[0037] Moreover, the rotation rate of the yarn drawing-in motor 511 can be obtained from the relationship between the rotation rate and the yarn speed on the basis of the speeds of the yarn 20 when the yarn 20 is drawn in the push direction and in the pull direction. For example, in the case of a yarn speed of 2.3 m/s when the yarn 20 is drawn in the push direction, the rotation rate of the yarn drawing-in pulley 513 is about 1400 rpm, whereas in the case of a yarn speed of 4.3 m/s when the yarn 20 is drawn in the pull direction, the rotation rate of the yarn drawing-in pulley 513 is about 2550 rpm, which can be obtained from the relationship between the rotation rate and the yarn speed.

[0038] Next, the following describes an example method of measuring the tension of the yarn 20 by using the tension measuring device body 50 at a position after the yarn 20 passes through the yarn feeding port 153.

[0039] First, a yarn 20 in the ready-for-knitting state, which is fed from the yarn packages 17 to the yarn feeding port 153 of the yarn carrier 15 via the top tension device 3 and the side tension device 4, is drawn at a position

after the yarn feeding port 153 of the yarn carrier 15 into the measurement path 24 that is different from the yarn feed path 2 to the needles.

[0040] Next, the yarn 20 drawn into the measurement path 24 without performing knitting is placed and nipped between the yarn drawing-in pulley 513 and the idler pulley 514. Subsequently, the yarn drawing-in motor 511 is actuated to rotate the yarn drawing-in pulley 513 together with the idler pulley 514 so as to draw the ready-for-knitting-state yarn 20 into the measurement path 24, without performing knitting, from the yarn feed path 2 that leads to the needles.

[0041] When the yarn speed on the measurement path 24 is set so as to simulate the yarn speed on the yarn feed path 2, which varies when the drawing direction of the yarn 20 is switched between the push direction and the pull direction at a position after the yarn feeding port 153, the yarn speed on the measurement path 24 is simply set in accordance with preset values, such as the pitch of stitches in the course direction, the loop length of a stitch to be knitted, the knitting speed of the fabric 22, and the gauge of the flat knitting machine 1. More specifically, the rotation rates of the yarn drawing-in pulley 513 are set in relation to corresponding yarn speeds of the yarn 20 that is drawn in the push direction and in the pull direction. The yarn speeds can be thereby simulated easily even if the ratio between the yarn speeds in the push drawing direction and in the pull drawing direction of the yarn 2 varies depending on a combination of the loop length per stitch and the knitting speed. Thus, the tension corresponding to the yarn speed that varies on the yarn feed path 2 can be measured easily even on the measurement path 24.

[0042] Subsequently, the tension of the yarn 20 that is drawn, without performing knitting, into the measurement path 24 at the point after the yarn 20 passes through the yarn feeding port 153 is measured by using the load cell 524 of the measuring means 52. Thus, the tension of the yarn 20 can be measured at a position after the yarn feeding port 153 as accurately as the case of measuring the tension of the ready-for-knitting-state yarn 20 on the yarn feed path 2. Especially in the case of intarsia knitting in which fabric 22 is knitted by using a plurality of yarns 20 fed from different yarn packages 17 via separate yarn feed paths 2 having different path lengths, the tension of each yarn 20 can be measured accurately at a position after the yarn feeding port 153 for each one of the yarn feed paths 2. Moreover, even if the yarn feed path 2 is the same, the tension of the yarn 20 varies depending on the amount of knitted fabric 22, and this tension also can be grasped accurately. Furthermore, while the operation of the yarn feeding port 153 stops, tension is measured at a position after the yarn 20 passes through the yarn feeding port 153 by drawing the yarn 20 into the measurement path 24 that is different from the yarn feed path 2 to the needles, and accordingly, it is not necessary to knit the fabric 22 during the measurement of tension of the yarn 20. Problems caused by abnormal tension values can be prevented from occurring to the fabric 22 by checking the tension of the yarn 20 before knitting.

[0043] The tension of the yarn 20 measured by the load cell 524 at a position after the yarn feeding port 153 is displayed on the monitor 53. The measured tension displayed on the monitor 53 is made comparable with the target tension of the yarn 20 at a position after the yarn feeding port 153 on the yarn feed path 2. Thus, the tension of the yarn 20 on the yarn feed path 2 can be brought closer to the target tension by adjusting the load of the tensioning disk 31 using the adjustment handle 34 of the top tension device 3 and by adjusting the load of pivotal movement of the side tension arm 42 relative to the yarn stand bench 18 by manipulating the supporting member 41 of the side tension device 4.

[0044] Note that the present invention is not limited to the embodiment described above but may include various forms of modification. For example, in the above embodiment, the measured tension displayed on the monitor 53 is made comparable with the target tension of the yarn 20 at a position after the yarn feeding port 153 on the yarn feed path 2, which is utilized to bring the measured tension closer to the target tension by adjusting the top tension device 3 and the side tension device 4. However, it may be sufficient to display measured tension of the yarn that is drawn into the measurement path at a position after the yarn feeding port. Measured tension displayed on the monitor closely represents the state of knitting, and accordingly, adjusting the tension of the yarn 20 so as to bring it closer to the target tension is not always necessary. By using the measured tension displayed on the monitor, the difference between yarn feeding ports of the same knitting machine or the difference between separate knitting machines can be distinguished. Moreover, with the measured tension displayed on the monitor, the tension of the yarn along the yarn feed path can be adjusted accurately on the basis of tension measurement without relying on intuition.

[0045] In the above embodiment, the advancing roller 44 that applies tension to the yarn 20 is provided on the yarn feed path 2. However, a feeding device may be disposed on the yarn feed path 2 and may apply tension to the yarn and also measure the amount of yarn feeding.

[0046] In addition, in the above embodiment, the tension measuring device 5 is applied to the flat knitting machine 1 by way of example. However, the tension measuring device may be applied to other knitting machines, such as a warp knitting machine and a circular knitting machine.

[0047] Moreover, in the above embodiment, the top tension device 3 and the side tension device 4 are described as examples of tension imparting means. However, the tension imparting means is not limited to these devices.

[0048] Furthermore, in the above embodiment, the tension measuring device body 50 is detachably mounted on the support bench 19 of the flat knitting machine 1 by using the magnet disposed at the bottom surface of the

housing 59. However, a recess may be provided on the support bench of a flat knitting machine, and the tension measuring device body may be detachably mounted on the support bench by fitting the housing of the tension measuring device body 50 into the recess. Alternatively, the tension measuring device body may be detachably mounted on the support bench of the flat knitting machine by using locking members.

Claims

1. A tension measuring device (5) for a knitting machine (1) configured such that a yarn (20) that is fed via a feed path (2) from a yarn package (17) to needles with tension being applied to the yarn (20) is guided by a yarn feeding port (153) on the feed path (2) and thereby fed to the needles, the tension measuring device (5) comprising:
a tension measuring device body (50) that is disposed near the yarn feeding port (153) and that draws the yarn (20), at a position after the yarn (20) passes through the yarn feeding port (153), into a measurement path (24) that is different from the feed path (2) to the needles, the tension measuring device body (50) thereby measuring tension of the yarn (20), the tension measuring device body (50) including

a yarn drawing-in means (51) that draws the yarn (20) being in a ready-for-knitting state into the measurement path (24) at the position after the yarn (20) passes through the yarn feeding port (153),
a measuring means (52) that is disposed on the measurement path (24) at a position between the yarn feeding port (153) and the yarn drawing-in means (51) and that measures tension of the yarn (20) drawn, without performing knitting, into the measurement path (24) by the yarn drawing-in means (51), and
a display means (53) that displays the tension of the yarn (20) measured by the measuring means (52) on the measurement path (24).

2. The tension measuring device (5) for the knitting machine (1) according to Claim 1, wherein
the feed path (2) is provided with tension imparting means (3, 4) that apply tension to the yarn (20), and
the display means (53) displays the measured tension of the yarn (20) on the measurement path (24) in such a manner that the measured tension is comparable with a predetermined target tension of the yarn (20) after the yarn (20) passes through the yarn feeding port (153) and that the measured tension is brought closer to the target tension by adjusting the tension imparting means (3, 4).

3. The tension measuring device (5) for the knitting machine (1) according to Claim 1 or 2, wherein
yarn speed of the yarn (20) on the measurement path (24) is changeable in accordance with a change in yarn speed on the feed path (2) at the position after the yarn (20) passes through the yarn feeding port (153) when a drawing direction of the yarn (20) is switched.

4. The tension measuring device (5) for the knitting machine (1) according to any one of Claims 1 to 3, wherein
the tension measuring device body (50) is detachably disposed near the yarn feeding port (153) of the knitting machine (1).

5. A tension measuring method for a knitting machine (1) configured such that a yarn (20) that is fed via a feed path (2) from a yarn package (17) to needles with tension being applied to the yarn (20) is guided by a yarn feeding port (153) on the feed path (2) and thereby fed to the needles, the tension measuring method comprising:

drawing the yarn (20) being in a ready-for-knitting state, at a position after the yarn (20) passes through the yarn feeding port (153), into a measurement path (24) that is different from the feed path (2) to the needles;
measuring tension of the yarn (20) that is drawn into the measurement path (24) without performing knitting; and
displaying the tension of the yarn (20) measured at a position after the yarn (20) passes through the yarn feeding port (153).

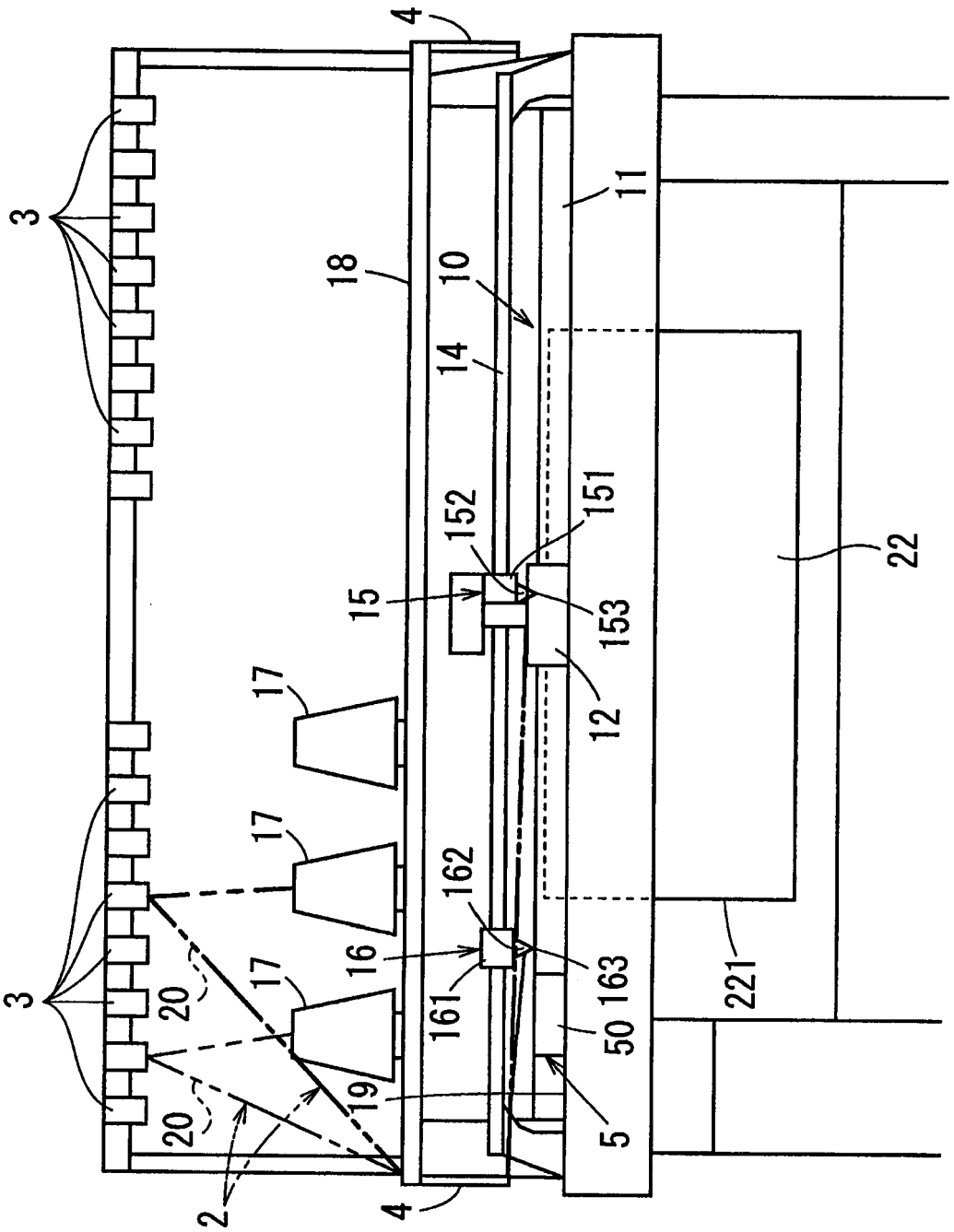
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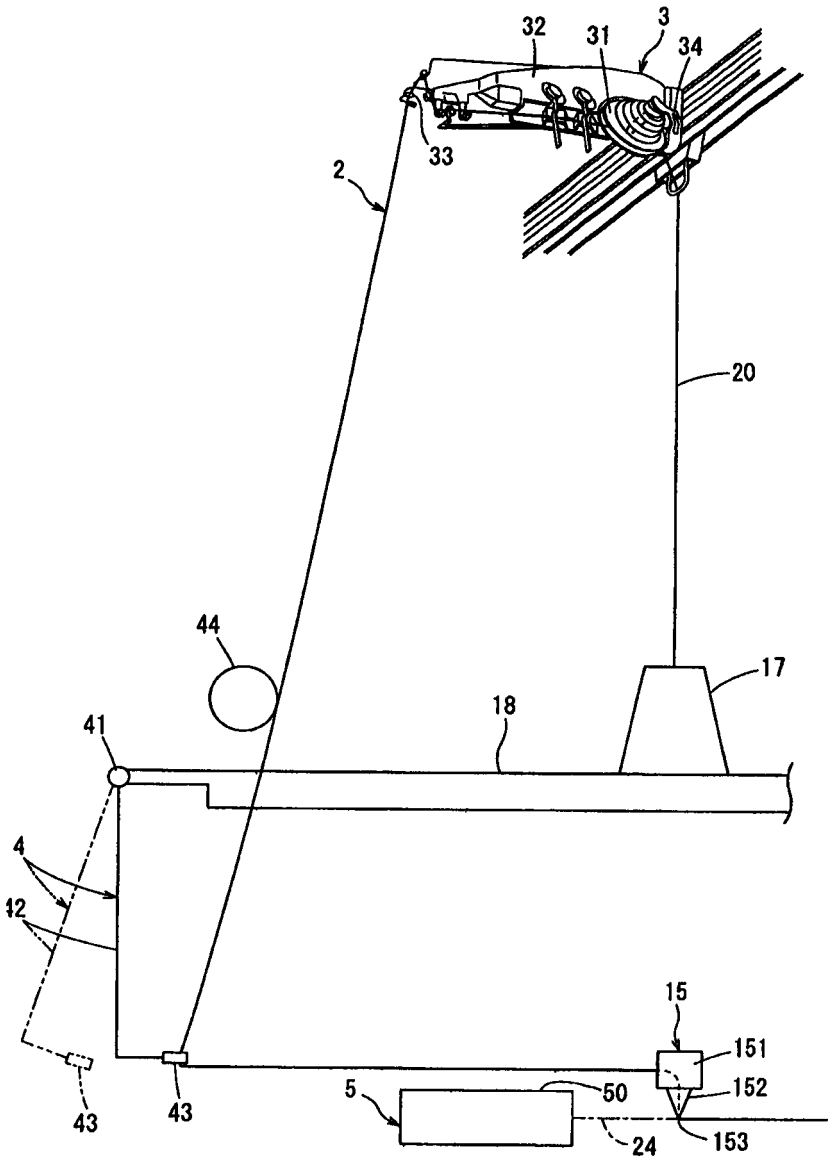
Fig. 1

Fig. 2



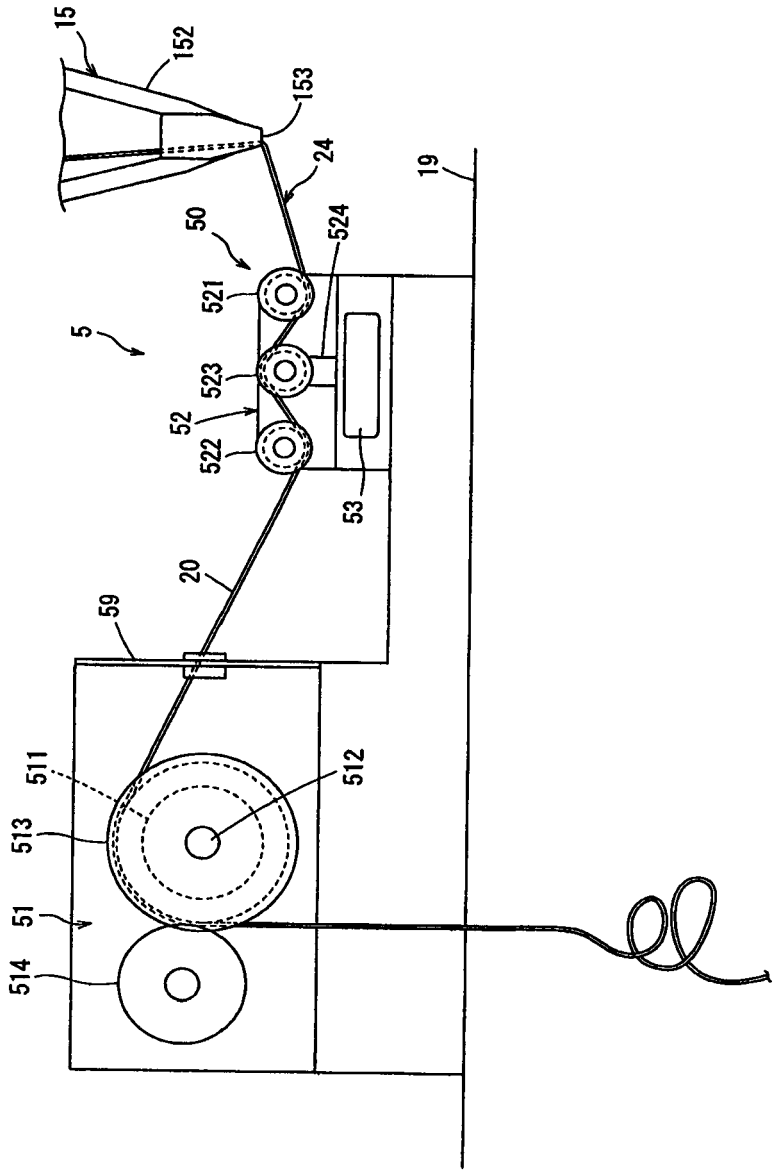


Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 19 17 3120

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	16 July 2019	Messai, Sonia

CATEGORY OF CITED DOCUMENTS

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