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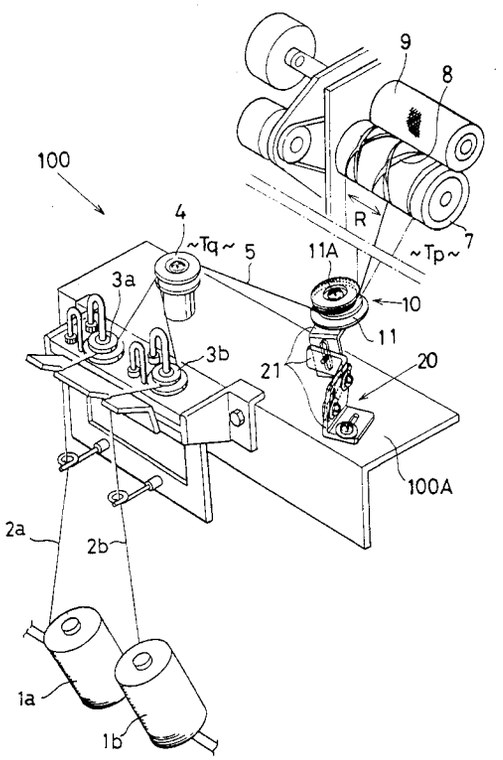
(54) A doubling machine

(57) In a doubling machine having a pulley (11) and a drum (7) having traverse grooves (8) to move a yarn thread (5) traversely therealong so as to supply the yarn thread to a wind-up package (9) by rotating the wind-up package (9), The pulley (11) has a groove (12) V-shaped in cross section, and is rotationally supported around its central axis (11A) so as to guide the yarn thread (5) toward the drum (7). An angle-adjustable member (20) is provided to incline the pulley (11) obliquely against a thread-supply path (Tp, Tq) in which the yarn thread (5) runs via the pulley (11) to the drum (7) so as to bring the yarn thread (5) into contact with inner walls of the groove (12) of the pulley (11). A contact changing member (15a, 15b) is provided to change the condition which brings the yarn thread (5) into contact with the inner wall of the groove (12) when the yarn thread (5) runs out of the pulley (11) from the condition which brings the yarn thread (5) into contact with the inner wall of the groove (12) when the yarn thread (5) is introduced into the pulley (11).

Fig.1



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Description

The invention relates to a doubling machine which provisionally joins a plurality of threads together to feed it to a wind-up package in which a doubled yarn is wound up by moving the yarn thread traversely.

In this type of doubling machine, a drum has been used widely which has travese grooves in order to traversely move a yarn thread to supply it to a wind-up package via several pulleys while rotating the wind-up package.

Upon joining a long-fibrous thread and short-fibrous thread together in which the long-fibrous thread is made of a synthetic fiber such as nylon, polyester or the like, while the short-fibrous thread made of natural fiber such as cotton, wool or the like, the long-fibrous thread is however likely to be overfed so that the long-fibrous thread is separated from the short-fibrous thread. When the separated part of the yarn thread reaches an intersection of traverse grooves of the drum, the yarn thread tends to enter the reversely defined helical groove often causing an unfavourable winding with the yarn threads strayed apart.

The inventor assumes that the cause of the separation of the yarn thread as follows:

In this type of doubling machine as shown in Fig. 10, a metallic roller 51 is generally provided which has a groove to introduce the yarn thread 54 to the drum. Since an inner wall of its groove is plated by chrominum (Cr), a static electricity is induced due to friction between the yarn thread 54 and the metallic roller 51 during the process in which the yarn thread 54 of the long-and short-fibrous threads 52a, 52b united together at a collecting unit 53 runs slidingly through the metallic roller 51. The static electricity tends to attract the the long-fibrous thread 52a to a smooth outer surface of the metallic roller 51 rather than the short-fibrous thread 52b. This causes to temporarily stick the long-fibrous thread 52a to the outer surface of the metallic roller 51 so as to slack the thread 52a at a releasing side of the metallic roller 51.

On the other hand, upon doubling a plurality of the threads which have different elasticity, a flexion is set up in the doubled yarn thread due to a slack yielded by one thread and a contraction given by other thread of the doubled yarn thread to result in the yarn thread being of different length especially when an inappropriate tension is given to the threads to be joined together.

With this in mind, the present invention is made after delving deeper into the behaviour of the yarn thread running through the roller so as to eliminate the above drawbacks.

Therefore, it is a main object of the invention to provide a doubling machine which is capable of effectively preventing the yarn thread from inadvertently entering the reversely defined helical groove so as to avoid an unfavourable winding with the yarn thread strayed aprat when the separated part of the yarn thread reaches an intersection of travese grooves of the drum.

It is another object of the invention to provide a doubling machine which is capable of quickly and smoothly winding up a plurality of yarn threads.

According to the present invention, there is provided a doubling machine including a pulley and a drum having traverse grooves to move a yarn thread traversely therealong so as to supply the yarn thread to a wind-up package by rotating the wind-up package; the pulley having a groove V-shaped in cross section, and is rotationally supported around its central axis so as to guide the yarn thread toward the drum ; an angle-adjustable member provided to incline the pulley obliquely against a thread-supply path in which the yarn thread runs via the pulley to the drum so as to bring the yarn thread into contact with inner walls of the groove of the pulley; and a contact changing member provided to change the condition which brings the yarn thread into contact with the inner wall of the groove when the yarn thread runs out of the pulley from the condition which brings the yarn thread into contact with the inner wall of the groove when the yarn thread is introduced into the pulley.

Such is the structure that the yarn thread invariably slidingly runs along the inner wall of the groove of the pulley before supplied to the drum. Due to the contact changing member provided to change the contact condition of the yarn thread against the pulley when the yarn thread runs out of the pulley from the contact condition of the yarn thread when the yarn thread is introduced into the pulley, the yarn thread are provisionally twisted with different intensity depending on the rotational angle of the pulley. The yarn thread is favourably twisted especially when the threads are made of several thread segments.

As a result, upon winding the doubled yarn thread at high speed, the provisionally twisted yarn thread effectively prevents the yarn thread from unfavourably wound on the traverse drum with one of the threads strayed apart even though one thread is overfed from other thread, or the static electricity is induced between the yarn thread and the pulley to attract the yarn thread to the pulley. This makes it possible to wind the yarn thread with smooth and rapid operation.

Further, the pulley has a flange whose inner wall is continuous from an inner wall of the groove by way of an stepped portion, the inner wall of the groove being inclined such that a distance gradually changing from the center of the groove toward an outer periphery of the flange, and the contact changing member is the flanges provided on both side of the groove to have different diameters.

With the contact condition of the yarn thread against the pulley when the yarn thread runs out of the pulley from the contact condition of the yarn thread when the yarn thread is introduced into the pulley, it is possible to uniformly twist the threads due to the difference of the twisting momentum between the condition in which the yarn thread runs out of the pulley and the condition in

which the yarn thread is introduced into the pulley. This makes it possible to smoothly wind the yarn thread at high speed.

Furthermore, the contact changing member is a plurality of protuberances provided on the inner walls of the groove of the pulley.

With the rotational movement of the pulley, the threads are provisionally twisted lightly in which the yarn thread encounters the protuberances, thus changes the twisting degree substantially depending on the portion of the yarn thread. Particularly when the threads are made of several thread segments, these thread segments are entangled each other when the yarn thread encounters the protuberances, and thereby twisting the threads all the more tightly. This prevents the provisionally twisted yarn thread from straying apart when the yarn thread passes the pulley, and thus prevents the yarn thread from being wound up with the yarn thread strayed apart. This apparently leads to smoothly winding up the yarn thread at high speed.

Stillfurther, the contact changing member is a plurality of cut-out portions provided on the inner walls of the groove of the pulley.

With the rotational movement of the pulley, the threads are provisionally twisted lightly in which the yarn thread encounters the cut-out portions, thus changes the twisting degree substantially depending on the portion of the yarn thread. Particularly when the threads are made of several thread segments, these thread segments are entangled each other when the yarn thread encounters the cut-out portions, and thereby twisting the threads all the more tightly as a whole. This prevents the provisionally twisted yarn thread from straying apart when the yarn thread passes the pulley, and thus prevents the yarn thread from being wound up by the wind-up package with the yarn thread strayed apart. This apparently renders the winding up operation smooth at high speed.

Moreover, the angle-adjustable member is an assemble of a plurality of angular plates which inclines the pulley obliquely against the thread-supply path (Tp, Tq), while at the same time, adjusting the tension of the yarn thread within the thread-supply path.

With the angular plates thus combined, it is possible to adjust the tension of the yarn threads introduced to the pulley and run out of the pulley depending on the yarn thread which is to be wound up by the wind-up package.

When twisting several threads which have different elasticity, it is possible to adjust the tension individually by using the pulley to each of the threads, and thereby favourably twisting the threads of different expansion without inviting the flexion to the doubled yarn thread.

Furthermore, on an outer surface of the drum, a honing or blast treatment is provided which is a step prior to an aventurine plating treatment.

With the treatment thus provided on the drum, it is possible to reduce the friction between the drum and the wind-up package as opposed to the case in which the drum is chormized when the drum is rotationally driven while pressing against the wind-up package. This prevents the fibrous remnents from sticking to the outer surface of the drum, thus preventing the doubled yarn thread from wound up with the yarn thread strayed apart when winding up the doubled yarn thread at high speed.

Stillfurther, the pulley is made of a wear-resistant ceramic material such as alumina, zirconia and titania. The pulley may be made of semi-ceramic material such as, for example, boronic titanium. With the use of the ceramic material, it is possible to reduce the friction between the yarn thread and the inner walls of the pulley along which the yarn thread slides. This makes it possible to reduce the static electricity between the yarn thread and the inner walls of the pulley, thus positively tangles the threads by provisionally twisting them. By using the ceramic material to the axis, it is possible to put a durable oiless bearing into a practical use.

In order that the invention may be more clearly understood, the following description is given by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a main part of a doubling machine according to a first embodiment of the invention;

Figure 2 is a side elevational view of a pulley located at a support guide;

Figure 2a is a side elevational view of a pulley located at a support guide when flanges of different diameter are used;

Figure 3a is a longitudinal cross sectional view of the pulley;

Figure 3b is a longitudinal cross sectional view of the pulley taken along the lines A-A of Figure 3a;

Figure 3c is a longitudinal cross sectional view of the pulley taken along the lines B-B of Figure 3a;

Figure 4 is an enlarged view of the pulley and its perimeter;

Figure 5 is an enlarged perspective view of the pulley and its perimeter depicted to show a thread-supply path toward the pulley and out of the pulley;

Figure 6 is a perspective view of a pulley of a doubling machine according to a second embodiment of the invention;

Figure 7 is a perspective view of a pulley of a doubling machine according to a third embodiment of the invention;

Figure 8 is a perspective view of a doubling machine according to a fourth embodiment of the invention;

Figure 9 is a perspective view of a doubling machine according to a fifth embodiment of the invention; and

Figure 10 is a schematic view of a metallic roller and its perimeter to show how an overfeed of a thread occurs in a prior art machine.

Referring to Figure 1 which shows a main portion of a doubling machine 100, threads 2a, 2b are emanated from respective thread-supply path packages 1a, 1b by way of tension pulleys 3a, 3b.

The threads 2a, 2b which run through the respective tension pulleys 3a, 3b are united together at a guide roller 4 to form a yarn thread 5. From the guide roller 4, the yarn thread 5 is introduced to a drum 7 by way of a support guide 10.

On an outer surface 7a of the drum 7, a honing or blast (shot peening) treatment is provided which is a step prior to an aventurine plating. The outer surface 7a of the drum 7 has a closed-ended traverse groove 8, and adapted to rotate by a drive unit (not shown). Against the drum 7, a wind-up package 9 is pressed in the manner to circumscribe with the drum 7 by means of a cradle arm (not shown). The wind-up package 9 is designed to rotate in combination with the rotational movement of the drum 7.

The support guide 10 serves as a fulcrum to introduce the yarn thread 5 emanatd from the guide roller 4 to the drum 7. The support guide 10 includes a pulley 11 made of alumina as an insulating ceramic material. The pulley 11 is in free wheeling relationship with a steel axis 11A by way of a roller type bearing (not shown). The steel axis 11A is secured to a frame 100A of the doubling machine 100 by way of an assemble of an angular plate assemble 21 of an angle-adjustable member 20.

An outer periphery of the pulley 11 has a groove 12 which is generally V-shaped in cross section as shown in Figure 2. The wheel 11 has flanges 15a, 15b whose inner walls are continuous from inner walls of the groove 12 by way of stepped portions 14a, 14b which are provided between an outer periphery 13a of the inner wall of the flange 15a and a cam-like outer periphery 13b of the inner wall of the flange 15b. In this instance, the flange 15a is diametrically greater than the stepped portion 14a, and the flange 15b is diametrically greater than the flange 15a.

In addition to a bottom 12a of the groove 12 being annular in configuration, both the cam-like outer peripheries 13a, 13b of the inner walls of the flanges 15a, 15b are circular. Although the bottom 12 of the groove 12 is concentric with the rotational axis IIa of the wheel 11, both the outer peripheries 13a, 13b of the inner walls of the flanges 15a, 15b are eccentric with the rotational axis IIa of the pulley 11 as shown in Figures 3a and 3c.

The eccentric direction of the center 16a of the cam-like outer periphery 13a is different from that of the center 16b of the cam-like outer periphery 13b. The eccentric direction of the center 16a is in 150-degree offset relationship with that of the center 16b when defined in terms of the rotational angle as shown in Figure 3b. That is to say, the center 16a is out of point symmetry from the the center 16b by 30 degrees. The eccentricities M of the centers 16a, 16b from the rotational axis 11a are the same in somuch as the cam-like outer peripheries 13a, 13b are within outer limits of the flanges 15a, 15b.

Such is the structure that the distance between the bottom 12a of the groove 12 and the cam-like outer peripheries 13a, 13b gradually changes depending on the rotational angle of the pulley 11. For this reason, the inclination of the inner walls 12x, 12y of the groove 12 gradually changes depending on the specified position of the cam-like outer peripheries 13a, 13b according to the rotational angle of the pulley 11 as shown in Figure 3b.

As shown in Fig. 4, screws 22, 22 is used to connect the angular plates 21, 21 of the angle-adjustable member 20. With an alteration of a relative angle formed by the angular plates 21, 21 by loosening the screws 22, 22, it is possible to change the angle of the steel axis 11A so as to incline the pulley 11 against a thread-supply path (Tq, Tp) as described hereinafter.

In the support guide 10, the steel axis 11A of the pulley 11 is not perpendicular to a thread-supply path (Tq) which is formed by the yarn thread 5 supplied from the guide roller 4 as also shown in Figure 4. The steel axis 11A is instead oblique across the thread-supply path (Tq) so that the yarn thread 5 invariably slides on the cam-like outer periphery 13a of the flange 15a or the inner wall 12x of the groove 12 before running through the bottom 12a of the groove 12.

Further, the steel axis 11A of the wheel 11 is not perpendicular to a thread-supply path (Tp) which is formed by the yarn thread 5 supplied from the wheel 11 to the drum 7. The steel axis 11A is instead oblique across the thread-supply path (Tp) so that the yarn thread 5 invariably slides on the cam-like outer periphery 13b of the flange 15b or the inner wall 12y of the groove 12 before running out of the pulley 11.

The yarn thread 5 run out of the pulley 11 enters the traverse groove 8 of the drum 7, and axially moves in the direction of a double-headed arrow R within certain angular limits. Between the guide roller 4 and the tension pulleys 3a, 3b, a detection unit (not shown) is provided to detect whether or not the threads 2a, 2b are accidentally disconnected. Between the guide roller 4 and the pulley 11 of the support guide 10, a yarn cutter is provided although it is not shown.

In the doubling machine 100, the threads 2a, 2b running through the tension pulleys 3a, 3b are united together by the guide roller 4 so as to form the yarn thread 5 when running through the guide roller 4. During the process in which the yarn thread 5 passes through the pulley 11, the yarn thread 5 slides on the cam-like outer periphery 13a of the flange 15a or the inner wall 12x of the groove 12 so as temporarily twistd before reaching the bottom 12a of the pulley 11. Then, the yarn thread 5 slides on the cam-like outer periphery 13b of the flange 15b or the inner wall 12y of the groove 12 so as temporarily twisted before running into the drum 7.

In this situation, the running of the yarn thread 5 facilitates the smooth rotation of the pulley 11 since the inner walls 12x, 12y of the V-shaped groove 12 are

roughened because the pulley 11 is made of the ceramic material. Facilitating the smooth rotation of the pulley 11 leads to yielding a minimum friction between the yarn thread 5 and the pulley 11 so as to reduce the occurrence of the static electricity. With the reduced static electricity and provisional twist of the yarn threads 2a, 2b, it is possible to prevent one of the theads 2a, 2b from sticking to the bottom 12a of the groove 12, thus avoiding the other thread from being overfed at the feeding side of the pulley 11.

From the reason that the distance between the bottom 12a of the groove 12 and the cam-like outer peripheries 13a, 13b gradually changes depending on the rotational agnle of the pulley 11, the twisting degree of the yarn thread 5 changes depending on the position in which the yarn thread 5 slides on the inner walls 12x, 12y of the groove 12 so as to induce variations in the twisting intensity. This enables to provisionally twisting the the yarn thread 5 effectively so as to strongly unite the threads 2a, 2b together.

In the case in which the yarn threads 2a, 2b are in turn of long-and short-fiber threads by way of illustration, and the static electricity appears between the yarn thread 5 and the pulley 11 due to the friction therebetween, it is possible to prevent one of the theads 2a, 2b from sticking to the bottom 12a of the groove 12, thus avoiding the other thread from being overfed at the feeding side of the pulley 11.

As a result, the yarn thread 5 enters the traverse groove 8 of the drum 7 with the threads 2a, 2b tightly united, thus preventing the yarn thread 5 from inadvertently entering the reversely defined helical groove 8 of the drum 7 so as to avoid an unfavourable winding with the yarn threads strayed apart when the separated part of the yarn thread 5 reaches an intersection of the travese groove 8 on the drum 7.

With the honing or blast (shot peening) treatment provided on the outer surface of the drum 7, it is possible to reduce the friction between the drum 7 and the wind-up package 9 as opposed to the case in which the drum is chromized when the drum 7 is rotationally driven while pressing against the wind-up package 9. This prevents the fibrous remnents from sticking to the outer surface of the drum 7, thus preventing the doubled yarn thread from wound up with the yarn threads strayed apart when winding up the doubled yarn thread at high speed.

In particular, when using a yarn thread (Spandex) which is rich in expansion and high in frictional resistance, it is possible to winding up the yarn thread at high speed. When using the yarn thread (Spandex), it is possible to wind up at the speed of 700 m/s which is twice the prior speed of 350 m/s.

It is to be observed that the pulley 11 may be made from zirconia or titania (TiO_2) instead of alumina (Al_2O_3), otherwise the wheel 11 may be made by baking wear-resistant ceramic powder of titanic boron (TiB_2).

It is to be appreciated that the stepped portion of the pulley 11 may be made into elliptic configuration instead of circular configuration insomuch as the pulley 11 can smoothly rotate without let and hindrance.

It is also to be appreciated that the eccentricity M of one cam-like outer periphery of the flange may be different from that of the other cam-like outer periphery of the flange insomuch as the wheel can slide the yarn thread on it without let and hindrance.

It is still to be observed that the eccentric direction of the center 16a is may be within (180 A 10)-degree offset relationship with that of the center 16b when defined in terms of the rotational angle, in which the provisional twisting timing when running into the pulley is substantially opposite to the provisional twisting timing when running out of the pulley.

It is to be observed that the centers 16a, 16b of the stepped portions 14a, 14b may be in concentric relationship with the center of the bottom 12a of the groove 12 with the flanges 15a, 15b having different diameter (D_1, D_2) as shown in Figure 2a. With the flanges 15a, 15b provided diametrically different, diameters of the stepped portions 14a, 14b become different so that one of the opposed inner walls 12, 12 is dimensionally greater than the other. There arises a twisting difference between the yarn thread portion sliding on the larger inner wall and the yarn thread portion sliding on the smaller inner wall. Due to the twisting difference thus arisen, the yarn thread 5 is provisionally twisted to an anticipated degree. In this instance, the diametrical difference between the flanges 15a, 15b can be altered arbitrarily without limitation. However, upon determining the diametrical difference between the flanges 15a, 15b, it is preferable to make the diameter (D_2) of the flange 15a smaller by 5 ~ 30 % than the diameter (D_1) of the flange 15b.

Figure 5 shows a modification form of the first embodiment of the invention in which two angular plates 21, 21 are connected each other as the angle-adjustable member 20. When the thread-supply path is limited, the simple type of the angular plates 21, 21 can be used. The threads 2a, 2b may be adapted to run through two guide rollers after running through the tension pulleys 3a, 3b, and the threads 2a, 2b may be united together at one of two guide rollers. The guide rollers may be made of the ceramic material.

Figure 6 shows a second embodiment of the invention in which a general pulley 110 is used which has a groove 111 V-shaped in cross section. Inner walls 112 of the groove 111 have a plurality of protuberances 113. When the yarn thread encounters the protuberances 113 at the side of feeding it to the pulley 110 and at the side of running out of the pulley 110, the yarn thread is temporarily hooked by the protuberances 113. There arises a difference in the twisting momentum between the yarn thread portion hooked by the protuberances 113 and the yarn thread portion sliding on the inner walls 112 of the groove 111. This is all the more effective by dispersing the protuberances 113 so that the yarn thread portions may not encounter the protuberances

113 concurrently at the side of feeding it to the pulley 110 and at the side of running out of the pulley 110. The number of the protuberances 113 may be provided two or more on each of the inner walls 112 of the groove 111.

Figure 7 shows a third embodiment of the invention in which a general pulley 120 is used which has a groove 121 V-shaped in cross section. Inner walls 122 of the groove 121 sporadically milled to have a plurality of cut-out portions 123 which has substantially flat surface. The cut-out portions 123 may be formed into recesses.

When the yarn thread encounters the cut-out portions 123 at the side of feeding it to the pulley 120 and at the side of running out of the pulley 120, the yarn thread is temporarily freed from the contact against the inner walls 122 of the groove 121. There arises a difference in the twisting momentum between the yarn thread portion freed from the contact against the inner walls 122 and the yarn thread portion sliding on the inner walls 112 of the groove 111. This is all the more effective by dispersing the cut-out portions 123 so that the yarn thread portions may not encounter the cut-out portions 123 concurrently at the side of feeding it to the pulley 110 and at the side of running out of the pulley 110. The number of the cut-out portions 123 may be provided two or more on each of the inner walls 122 of the groove 121.

Figure 6 shows a fourth embodiment of the invention in which a pair of guide rollers 4a, 4b are provided to introduce the threads 2a, 2b upwardly. On the frame 100A of the doubling machine 100, an upright bracket 100a is provided whose upper end has an upper guide roller 6. Between the upper end and lower end of the upright bracket 100a, an intermediate guide roller 6a is provided. On the frame 100A, the support guide 100 is placed which includes the pulley 11 in the same manner as described in the first embodiment of the invention. A yarn cutter 6A is suspended between intermediate guide roller 6a and the support guide 100.

Fig. 9 shows a fifth embodiment of the invention in which the yarn cutter 6A serves to unite the threads 2a, 2b together which are introduced from the tension pulleys 3a, 3b. The threads 2a, 2b are united together by running them through a guide slit 6B of the yarn cutter 6A, and forming the yarn thread 5 which runs through the pulley 11 of the support guide 100.

In the fourth and fifth embodiment of the invention, the general pulleys 110, 120 may be used instead of the pulley 11.

The positional relationship among the threads, the yarn thread and the pulley of the support guide can be altered insomuch as the axis of the support guide may be inclined such that the yarn thread slidingly runs along the inner wall of the pulley or the inner wall of the flange.

It is to be appreciated that instead of uniting the threads each made of the long fibrous segments and short fibrous segments, a single thread may be wound up by a cylindrical package. Otherwise, three threads may be united together.

As understood from the foregoing description, it is possible to prevent the overfeed of the thread due to the static electricity and the friction, thus enables to provisinally twist the threads favourably and wound up without the threads strayed apart.

It is also to be appreciated that the yarn thread may be wound up by a spool in lieu of the doubling machine.

It is further to be noted that instead of the ball bearing, the ceramic pulley may be rotationally supported directly by the axis 11A to form an oilless bearing structure. Instead of the traversely grooved drum, a cylindrical wind-up drum may be used which is driven discretely by a traverse mechanism.

Claims

1. A doubling machine including a pulley (11) and a drum (7) having traverse grooves (8) to move a yarn thread (5) traversely therealong so as to supply the yarn thread to a wind-up package (9) by rotating the wind-up package (9); characterised in that

   the pulley (11) has a groove (12) V-shaped in cross section, and is rotationally supported around its central axis (11A) so as to guide the yarn thread (5) toward the drum (7);
   an angle-adjustable member (20) is provided to incline the pulley (11) obliquely against a thread-supply path (Tp, Tq) in which the yarn thread (5) runs via the pulley (11) to the drum (7) so as to bring the yarn thread (5) into contact with inner walls of the groove (12) of the pulley (11); and
   a contact changing member (15a, 15b) is provided to change the condition which brings the yarn thread (5) into contact with the inner wall of the groove (12) when the yarn thread (5) runs out of the pulley (11) from the condition which brings the yarn thread (5) into contact with the inner wall of the groove (12) when the yarn thread (5) is introduced into the pulley (11).

2. A doubling machine according to claim 1, wherein the pulley (11) has flanges (15a, 15b) whose inner walls are continuous from an inner wall of the groove (12) by way of a stepped portion (14a, 14b), and the contact changing member is the flanges (15a, 15b) provided on both sides of the groove (12) and which have different diameters.

3. A doubling machine according to claim 1, wherein the contact changing member is a plurality of protuberances (113) provided on the inner walls of the groove (12) of the pulley (11).

4. A doubling machine according to claim 1, wherein the contact changing member is a plurality of cut-out portions (123) provided on the inner walls of the

groove (12) of the pulley (11).

5. A doubling machine according to any of claims 1 to 4, wherein the angle-adjustable member (20) is an assembly of a plurality of angular plates which inclines the pulley (11) obliquely against the thread-supply path (Tp, Tq), while at the same time, adjusting the tension of the yarn thread (5) within the thread-supply path (Tp, tq).

6. A doubling machine according to any of claims 1 to 5, wherein a honing or blast treatment has been performed on an outer surface of the drum (7).

7. A doubling machine according to any of claims 1 to 6, wherein the pulley (11) is made of a wear-resistant ceramic material.

Fig.1

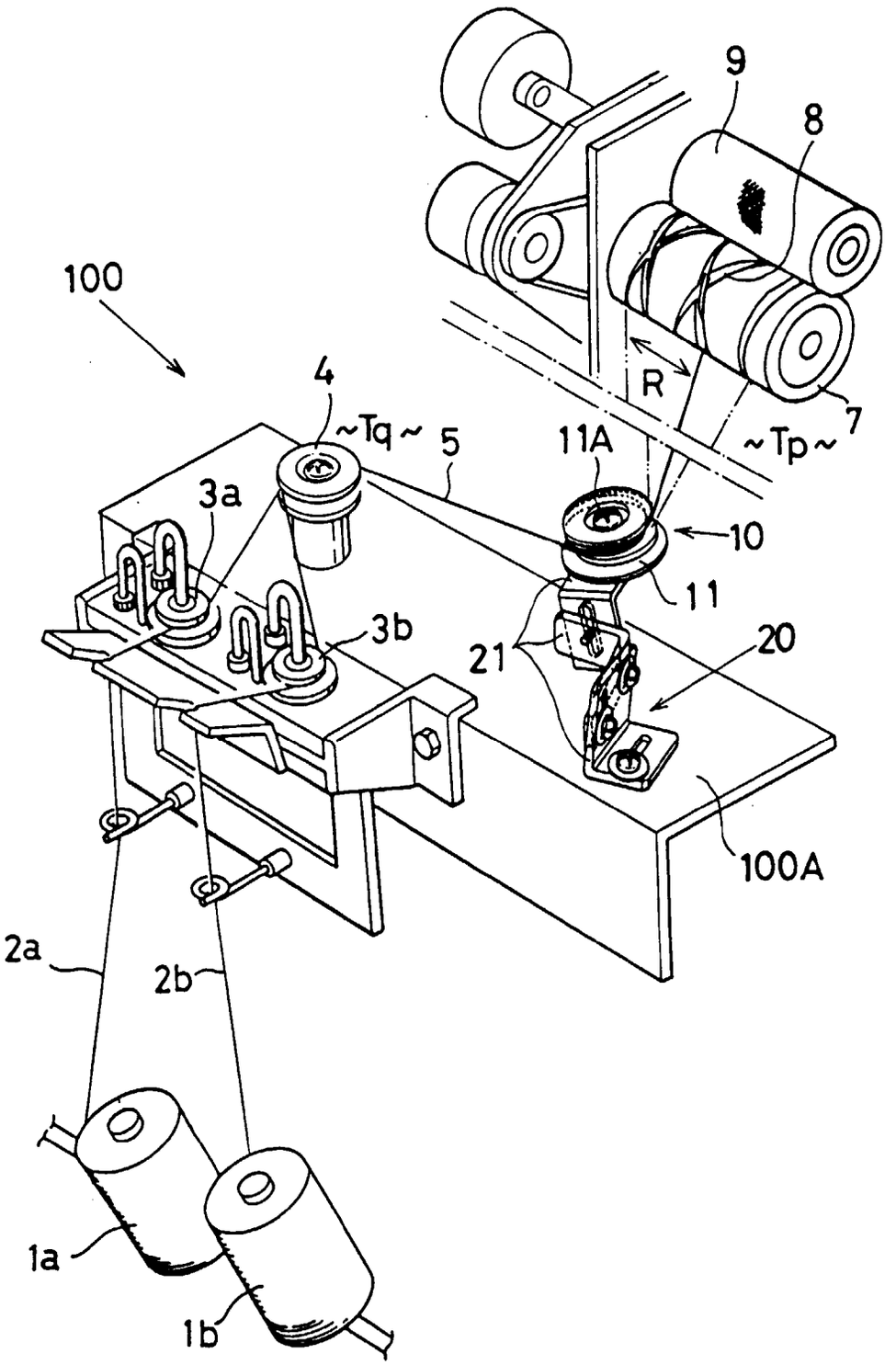

Fig.2

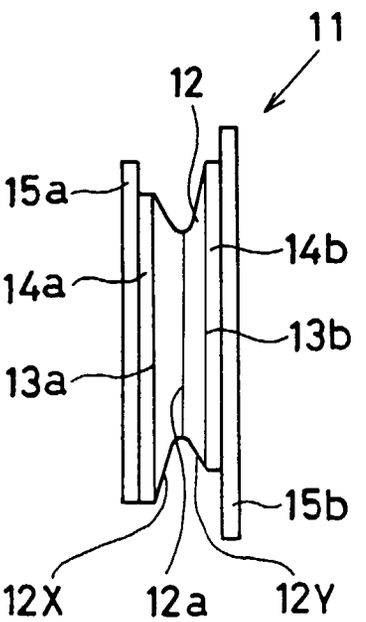

Fig.2a

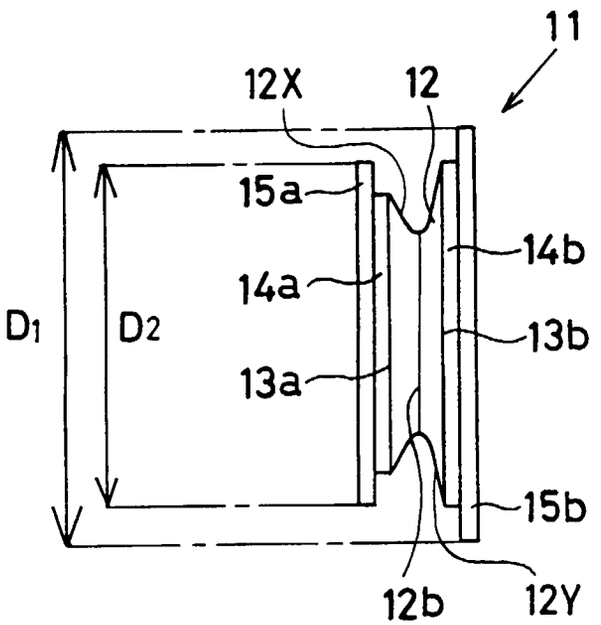

Fig.3c

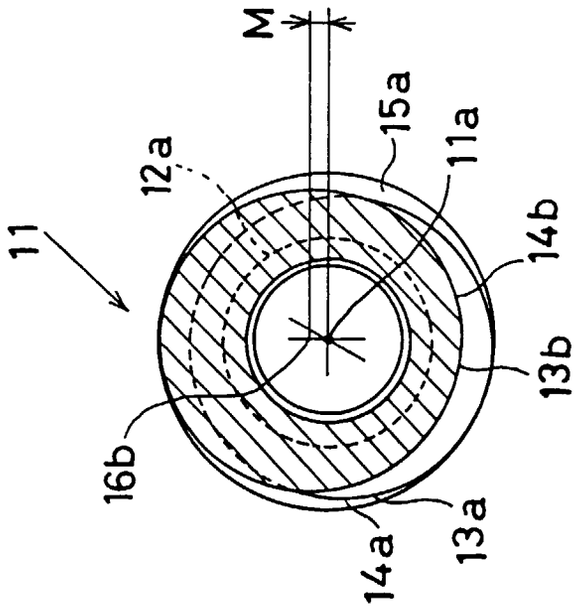

Fig.3b

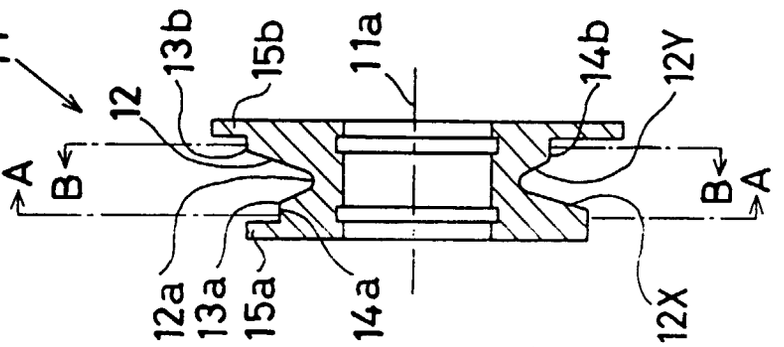

Fig.3a

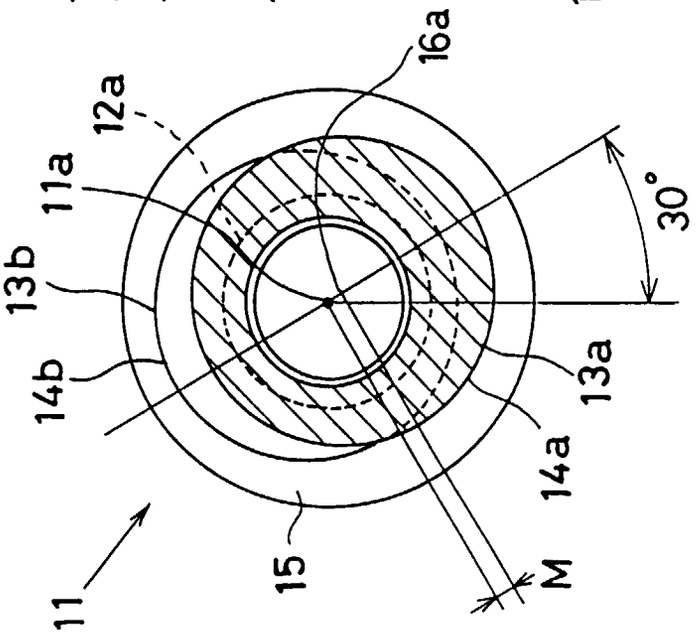

Fig.4

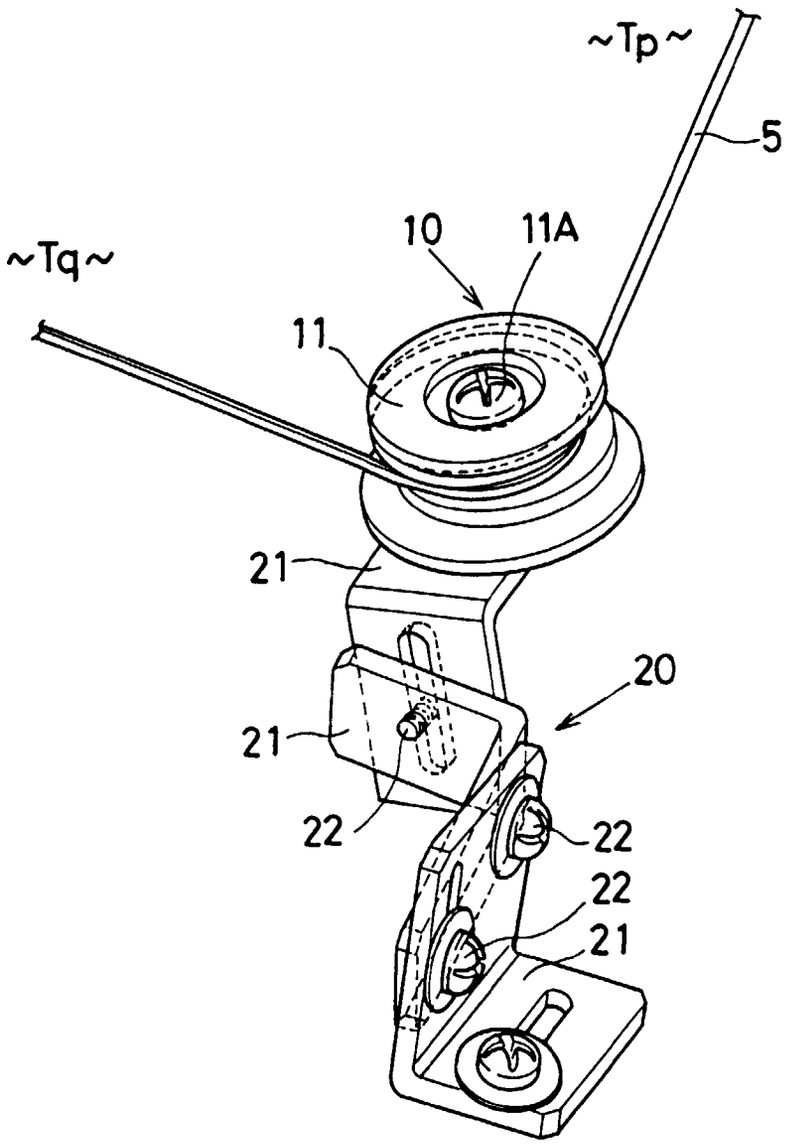

Fig.5

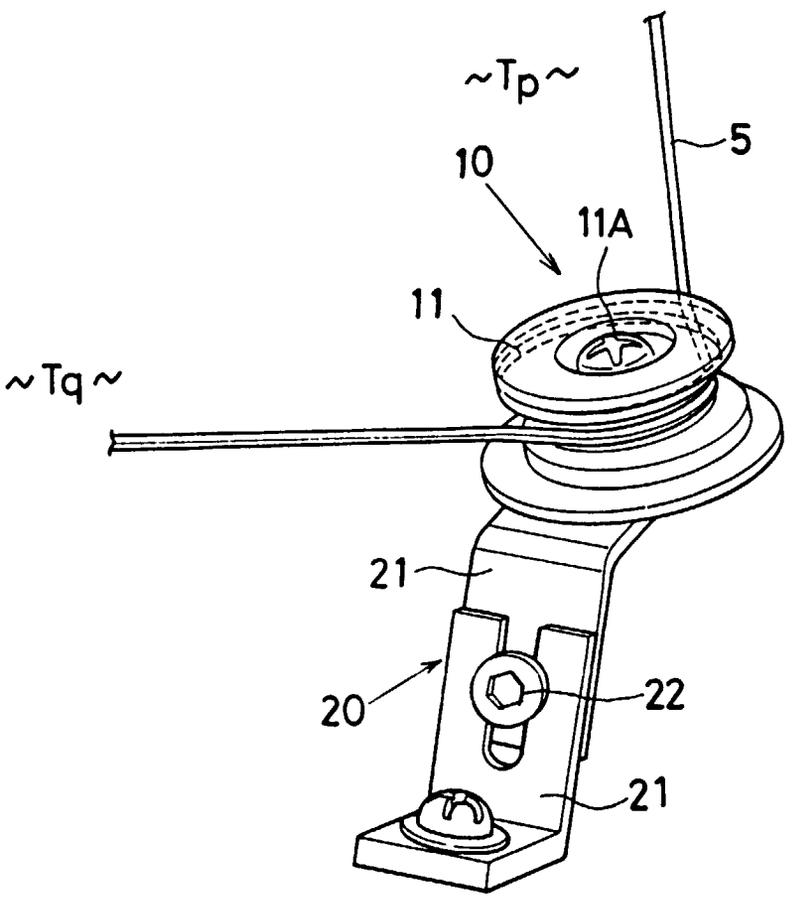

Fig.6

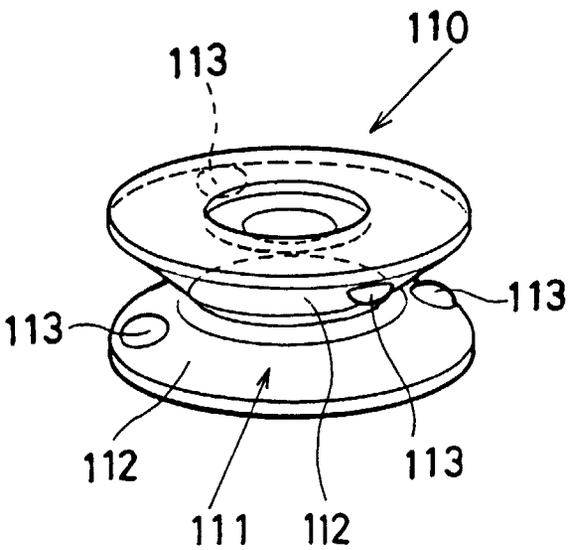

Fig. 7

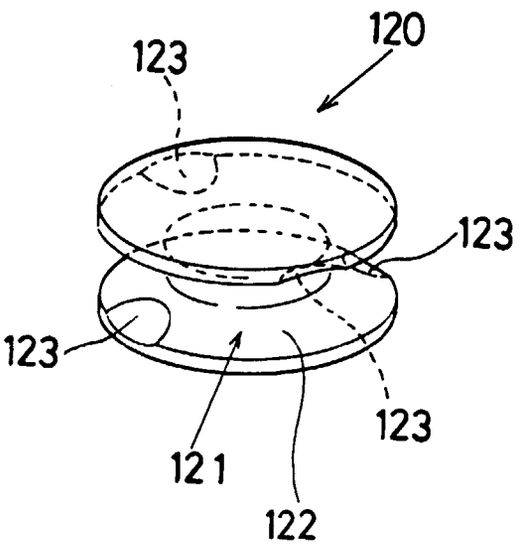

Fig.8

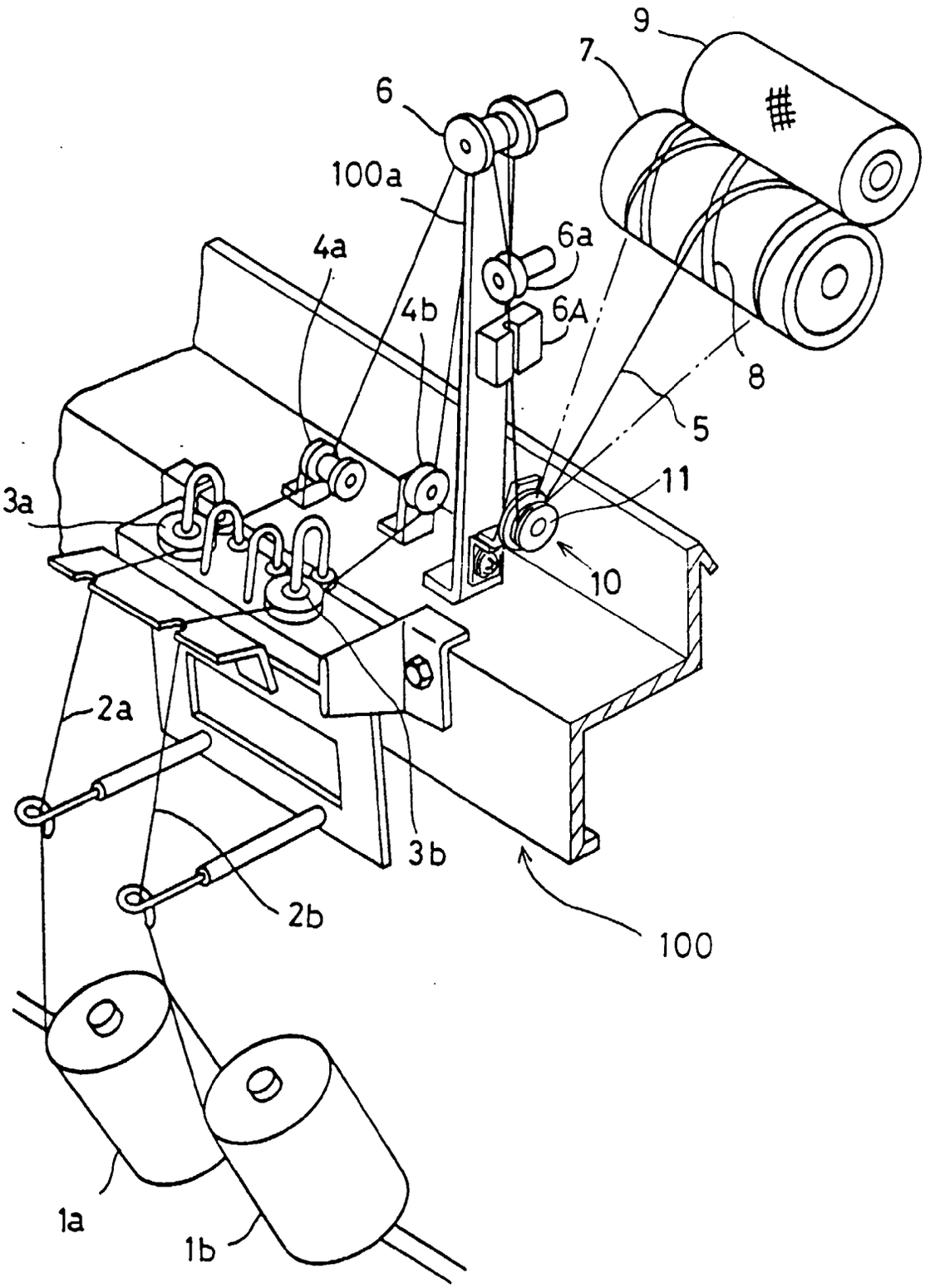

Fig.9

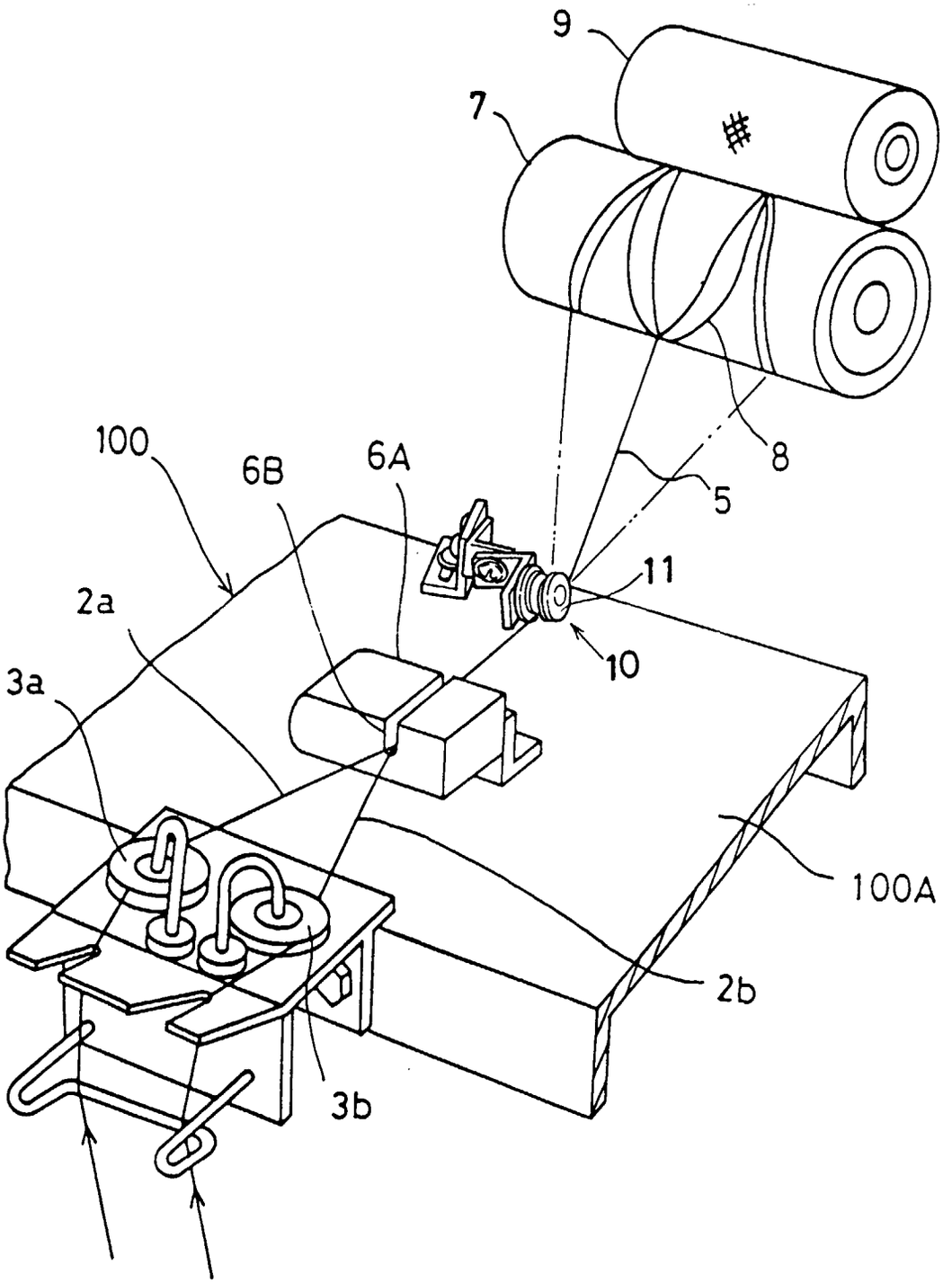

Fig.10