



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication: **14.11.2012 Bulletin 2012/46** (51) Int Cl.: **D05B 47/02 (2006.01)**

(21) Application number: **12167081.4**

(22) Date of filing: **08.05.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

- **Kawai, Yasunori**
Kariya-shi, Aichi 448-8650 (JP)
- **Kai, Akihiro**
Kariya-shi, Aichi 448-8650 (JP)
- **Kamatsuka, Akimitsu**
Kariya-shi, Aichi 448-8650 (JP)
- **Yamaoka, Atsuo**
Kariya-shi, Aichi 448-8650 (JP)

(30) Priority: **13.05.2011 JP 2011108329**

(71) Applicant: **AISIN SEIKI KABUSHIKI KAISHA**
Kariya-shi, Aichi 448-8650 (JP)

(74) Representative: **Serjeants LLP**
25 The Crescent
King Street
Leicester, LE1 6RX (GB)

(72) Inventors:
• **Suzuki, Tatsuya**
Kariya-shi, Aichi 448-8650 (JP)

(54) **Sewing machine thread tension apparatus and sewing machine**

(57) Disclosed is a sewing machine thread tension apparatus provided in a sewing machine to adjust a thread tensile force, including: a first thread tension disc; a second thread tension disc facing the first thread tension disc to nip a thread therebetween; a thread tension spring having a resilient force for adjusting the thread tensile force by biasing the second thread tension disc toward the first thread tension disc such that the first and second thread tension discs approaches each other; a movable body movable along a resilient force adjustment direction for adjusting a strength of the resilient force of the thread tensile spring; a rotatable body that is provided rotatably with respect to a rotational center and has a cylindrical portion, a conversion mechanism that moves the movable body along the resilient force adjustment direction in response to rotation, and a plurality of internal teeth formed with a predetermined pitch circle diameter with respect to a rotational center in an inner circumferential wall of the cylindrical portion; and a thread tension dial that is provided rotatably relative to the rotatable body through user's rotation operation, has a plurality of external teeth formed to have a pitch circle diameter D_{out} smaller than a pitch circle diameter D_{in} of the internal teeth of the rotatable body and capable of meshing with the internal teeth of the rotatable body, and rotates the rotatable body in a common direction by transferring rotation to the rotatable body while a torque is reduced by causing the external teeth and the internal teeth to mesh with each other in response to rotation.

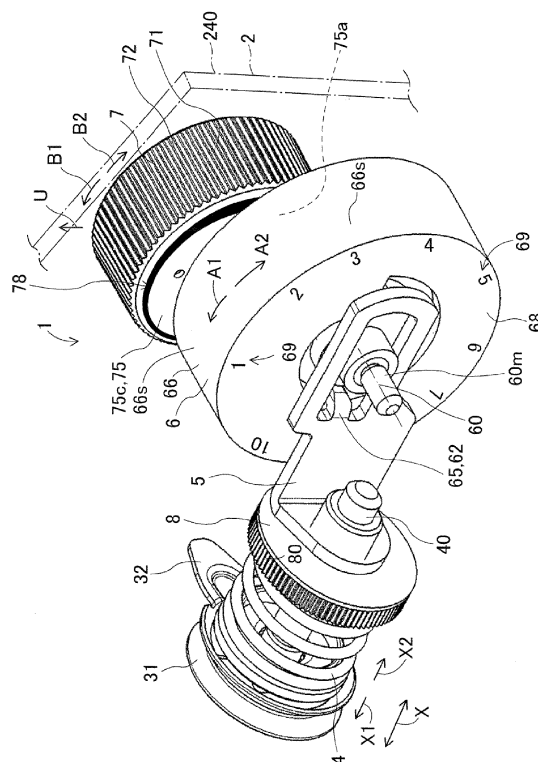


FIG. 1

Description

TECHNICAL FIELD

[0001] This disclosure relates to a sewing machine thread tension apparatus and a sewing machine.

BACKGROUND DISCUSSION

[0002] JP2008-264065A (hereinafter referred to as Reference 1) discloses a sewing machine thread tension apparatus for adjusting a thread tensile force. This apparatus includes a first thread tension disc, a second thread tension disc, a thread tension spring that has a resilient force for adjusting a thread tensile force by biasing the second thread tension disc toward the first thread tension disc, a thread tension dial that adjusts a strength of the resilient force of the thread tension spring, a resilient force adjustment cam provided in the thread tension dial and capable of adjusting the thread tension spring, a transmission plate capable of adjusting the resilient force of the thread tension spring by following the resilient force adjustment cam, and a first adjustment member that is combined with the transmission plate with screws to receive the other end of the thread tension spring.

[0003] In addition, JPH6-154454A (hereinafter referred to as Reference 2) discloses a sewing machine thread tension apparatus for adjusting the thread tensile force. This apparatus includes a thread tension dial that adjusts a tensile force applied to an upper thread and a resilient force adjustment cam formed in the thread tension dial and capable of adjusting the resilient force of the thread tension spring. It is possible to obtain a desired tensile force when a user manually rotates the thread tension dial.

[0004] In order to obtain a desired thread tensile force depending on a sewing object, it is necessary for a user to manually rotate a dial to change the thread tensile force. It is desirable to reduce the thread tensile force when a thickness of the sewing object is thin. It is desirable to increase the thread tensile force when the thickness of the sewing object is thick. In order to increase the thread tensile force, it is desirable to increase a spring constant of the thread tension spring. However, as the spring constant of the thread tension spring increases, a rotation torque of the thread tension dial increases so that a user feels heavy in the rotation operation of the thread tension dial and feels a sense of discomfort in the rotation operation of the thread tension dial. If a diameter of the thread tension dial increases, the sense of discomfort in the rotation operation of the thread tension dial is alleviated. However, there is a limitation in increase of the diameter of the thread tension dial in terms of desirability of the sewing machine.

[0005] Thus, a need exists for a sewing machine thread tension apparatus and a sewing machine capable of finely adjusting the resilient force of the thread tension

spring while the diameter of the thread tension dial is suppressed from increasing even when the spring constant of the thread tension spring increases.

SUMMARY

[0006] According to an aspect of this disclosure, there is provided a sewing machine thread tension apparatus provided in a sewing machine to adjust a thread tensile force, including: a first thread tension disc; a second thread tension disc facing the first thread tension disc to nip a thread therebetween; a thread tension spring having a resilient force for adjusting the thread tensile force by biasing the second thread tension disc toward the first thread tension disc such that the first and second thread tension discs approaches each other; a movable body movable along a resilient force adjustment direction for adjusting a strength of the resilient force of the thread tensile spring; a rotatable body that is provided rotatably with respect to a rotational center and has a cylindrical portion, a conversion mechanism that moves the movable body along the resilient force adjustment direction in response to rotation, and a plurality of internal teeth formed with a predetermined pitch circle diameter with respect to a rotational center in an inner circumferential wall of the cylindrical portion; and a thread tension dial that is provided rotatably relative to the rotatable body through user's rotation operation, has a plurality of external teeth formed to have a pitch circle diameter D_{out} smaller than a pitch circle diameter D_{in} of the internal teeth of the rotatable body and capable of meshing with the internal teeth of the rotatable body, and rotates the rotatable body in a common direction by transferring rotation to the rotatable body while a torque is reduced by causing the external teeth and the internal teeth to mesh with each other in response to rotation.

[0007] As the rotatable body is rotated, rotation of the rotatable body causes the movable body to move along the resilient force adjustment direction using the conversion mechanism. As a result, the strength of the resilient force of the thread tension spring is adjusted, the force for nipping a thread between the first and second thread tension discs is adjusted, and thus, the thread tensile force is adjusted.

[0008] As a user rotationally operates the thread tension dial, the external teeth are rotated along with the thread tension dial. Then, the internal teeth meshing with the external teeth in the rotatable body are rotated with respect to the rotational center of the rotatable body. Here, the pitch circle diameter D_{out} of the external teeth of the thread tension dial is smaller than the pitch circle diameter D_{in} of the internal teeth of the rotatable body. Therefore, the number of teeth N_{out} of the external teeth is smaller than the number of teeth N_{in} of the internal teeth of the rotatable body. For this reason, a deceleration mechanism is configured when the internal teeth of the rotatable body mesh with the external teeth of the thread tension dial by using the thread tension dial as a driving

source. Therefore, when a user rotationally operates the thread tension dial, it is possible to transfer rotation to the rotatable body while the torque of the thread tension dial is decelerated. If the rotatable body is rotated as described above, rotation of the rotatable body causes the movable body to move along the resilient force adjustment direction using the conversion mechanism. As a result, the strength of the resilient force of the thread tension spring is adjusted, the force for nipping a thread between the first and second thread tension discs is adjusted, and thus, the thread tensile force is adjusted.

[0009] According to this disclosure, since the deceleration mechanism is configured when the external teeth of the thread tension dial mesh with the internal teeth of the rotatable body by using the thread tension dial as a driving source, it is possible to finely adjust the strength of the resilient force of the thread tension spring, the force for nipping a thread between the first and second thread tension discs, and thus, the thread tensile force. In this case, in comparison with a case where the deceleration mechanism is not provided, that is, a case where a user directly rotates the rotatable body, it is possible to efficiently adjust the strength of the resilient force of the thread tension spring.

[0010] However, in order to obtain the thread tensile force ranging from a weak thread tensile force to a strong thread tensile force, it is preferable to use a thread tension spring having a spring constant as high as possible. In addition, if a target workpiece such as a cloth is thick, it is preferable to increase the spring constant of the thread tension spring in order to increase the thread tensile force. However, in this case, a rotational torque of the thread tension dial operated by a user increases. In addition, the strength of the resilient force of the thread tension spring significantly changes just by slightly rotationally operating the thread tension dial, and it is not essentially easy to finely adjust the strength of the resilient force of the thread tension spring. That is, it is not essentially easy to finely adjust the force for nipping a thread between the first and second thread tension discs. Furthermore, it is not essentially easy to finely adjust the thread tensile force. In this regard, according to this disclosure, since the deceleration mechanism is configured when the external teeth of the thread tension dial mesh with the internal teeth of the rotatable body by using the thread tension dial as a driving source, it is possible to finely adjust the strength of the resilient force of the thread tension spring, the force for nipping a thread between the first and second thread tension discs, and thus, the thread tensile force. In this case, even when the spring constant of the thread tension spring is high, it is possible to efficiently adjust the strength of the resilient force of the thread tension spring in comparison with a case where the deceleration mechanism is not provided, that is, a case where a user directly rotates the rotatable body.

[0011] In the sewing machine thread tension apparatus described above, the thread tension dial has an outer cylinder rotationally operated by a user and a gear formed

in an inner cylinder which is provided coaxially to the outer cylinder and has the external teeth. In this case, if a user rotationally operates the thread tension dial, the deceleration mechanism is configured when the external teeth of the thread tension dial mesh with the internal teeth of the rotatable body. Therefore, it is possible to finely adjust the position of the movable body. For this reason, it is advantageous to finely adjust the strength of the resilient force of the thread tension spring, the force for nipping a thread between the first and second thread tension discs, and thus, the thread tensile force.

[0012] In the sewing machine thread tension apparatus described above, a rotational center of the thread tension dial is decentered from a rotational center of the rotatable body, and an axial end face of the outer cylinder of the thread tension dial includes a covered face portion covered by the rotatable body and an exposed face portion exposed from the rotatable body. In this case, since the rotational center of the thread tension dial is decentered from the rotational center of the rotatable body, a user is suppressed from confusing the thread tension dial and the rotatable body in a visual or operation sense. If an indicator for adjusting the strength of the thread tensile force is formed on the axial end face of the thread tension dial, a user can visually recognize the indicator on the exposed face portion of the thread tension dial.

[0013] In the sewing machine thread tension apparatus described above, the axial end face of the thread tension dial has an indicator for indicating a strength of the thread tensile force, and a direction of the indicator for indicating the strength of the thread tensile force is common to a rotational direction of the thread tension dial. The axial end face of the thread tension dial can change from the covered face portion covered by the rotatable body to the exposed face portion exposed from the rotatable body in response to the rotation operation of the thread tension dial by a user. For this reason, if the indicator for indicating the strength of the thread tensile force is formed on the axial end face of the thread tension dial, a user can visually recognize the indicator displayed on the exposed face portion so that a user can visually recognize the strength of the thread tensile force using the indicator. In this case, since the direction of the indicator for indicating the strength of the thread tensile force is common to the rotational direction of the thread tension dial, a user can adjust the strength of the thread tensile force without feeling a sense of discomfort.

[0014] According to another aspect of this disclosure, there is provided a sewing machine including a sewing machine thread tension apparatus for adjusting a thread tensile force, the sewing machine thread tension apparatus including: a first thread tension disc; a second thread tension disc facing the first thread tension disc to nip a thread therebetween; a thread tension spring having a resilient force for adjusting the thread tensile force by biasing the second thread tension disc toward the first thread tension disc such that the first and second thread tension discs approaches each other; a movable body

movable along a resilient force adjustment direction for adjusting a strength of the resilient force of the thread tensile spring; a rotatable body that is provided rotatably with respect to a rotational center and has a cylindrical portion, a conversion mechanism that moves the movable body along the resilient force adjustment direction in response to rotation, and a plurality of internal teeth formed with a predetermined pitch circle diameter with respect to a rotational center in an inner circumferential wall of the cylindrical portion; and a thread tension dial that is provided rotatably relative to the rotatable body through user's rotation operation, has a plurality of external teeth formed to have a pitch circle diameter D_{out} smaller than a pitch circle diameter D_{in} of the internal teeth of the rotatable body and capable of meshing with the internal teeth of the rotatable body, and rotates the rotatable body in a common direction by transferring rotation to the rotatable body while a torque is reduced by causing the external teeth and the internal teeth to mesh with each other in response to rotation.

[0015] In this configuration, it is possible to obtain the same effects as those of the aforementioned aspect. That is, since a deceleration mechanism is configured when a user rotationally operates the thread tension dial, and the external teeth of the thread tension dial mesh with the internal teeth of the rotatable body by using the thread tension dial as a driving source, it is possible to finely adjust the strength of the resilient force of the thread tension spring, the force for nipping a thread between the first and second thread tension discs, and thus, the thread tensile force. In this case, even when the spring constant of the thread tension spring is high, it is possible to efficiently adjust the strength of the resilient force of the thread tension spring in comparison with a case where the deceleration mechanism is not provided, that is, a case where a user directly rotates the rotatable body.

[0016] According to this disclosure, since the deceleration mechanism is configured when a user rotationally operates the thread tension dial, and the external teeth of the thread tension dial mesh with the internal teeth of the rotatable body, it is possible to finely adjust the position of the movable body, the strength of the resilient force of the thread tension spring, and thus, the strength of the thread tensile force. Since the deceleration mechanism is provided in this manner, it is possible to efficiently adjust the strength of the resilient force of the thread tension spring even when the spring constant of the thread tension spring is high in comparison with a case where the deceleration mechanism is not provided, that is, a case where a user directly rotates the rotatable body. In addition, it is possible to reduce a torque for rotationally operating the thread tension dial and suppress a user from feeling heavy in the thread tension dial.

[0017] According to this disclosure, it is possible to suppress a torque for rotationally operating the thread tension dial even when the spring constant of the thread tension spring is high in comparison with a case where the deceleration mechanism is not provide, that is, a case

where a user directly rotates the rotatable body. Therefore, it is possible to efficiently adjust the strength of the resilient force of the thread tension spring.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The foregoing and additional features and characteristics of this disclosure will become more apparent from the following detailed description considered with the reference to the accompanying drawings, wherein:

[0019] Fig. 1 is a perspective view illustrating a thread tension apparatus;

[0020] Fig. 2 is a diagram illustrating a state that the internal teeth of a rotatable body of a thread tension apparatus and external teeth of a thread tension dial mesh with each other;

[0021] Fig. 3 is a diagram schematically illustrating a conversion mechanism of the rotatable body; and

[0022] Fig. 4 is a front view illustrating a sewing machine having a thread tension apparatus as an application.

DETAILED DESCRIPTION

[0023] The first and second thread tension discs are used to adjust a thread tensile force by nipping a thread therebetween. A thread tension spring has a resilient force for adjusting the thread tensile force by biasing the second thread tension disc toward the first thread tension disc such that the first and second thread tension discs approaches each other. The movable body is movable along a resilient force adjustment direction for adjusting a strength of the resilient force of the thread tension spring. The rotatable body is provided rotatably with respect to the rotational center and has a conversion mechanism for moving the movable body along the resilient force adjustment direction in response to rotation. The rotatable body includes a cylindrical portion having the conversion mechanism and a plurality of internal teeth formed to have a predetermined pitch circle diameter with respect to the rotational center in the inner circumferential wall of the cylindrical portion. The thread tension dial is provided rotatably for the rotatable body through user's rotation operation and has a plurality of external teeth formed to have a pitch circle diameter D_{out} smaller than the pitch circle diameter D_{in} of the internal teeth of the rotatable body and be capable of meshing with the internal teeth of the rotatable body. Since the external teeth and the internal teeth mesh with each other, as a user rotationally operates the thread tension dial, rotation is transferred to the rotatable body to rotate the rotatable body in a direction common to that of the thread tension dial while the rotational speed of the thread tension dial is decelerated.

Embodiments

[0024] Hereinafter, embodiments of this disclosure will

be described with reference to Figs. 1 to 3. As illustrated in Fig. 1, the sewing machine thread tension apparatus 1 is used to adjust the thread tensile force and is held in a bracket 240 (only partially illustrated) installed in the sewing machine main body 2. The sewing machine thread tension apparatus 1 includes a first thread tension disc 31, a second thread tension disc 32 that faces the first thread tension disc 31 to nip a thread therebetween, a thread tension spring 4 formed of a coil spring provided nearly coaxially in the outer circumferential side of the shaft 40, a movable body 5, a rotatable body 6, and a thread tension dial 7.

[0025] The first thread tension disc 31 is fixed to the sewing machine main body 2. The second thread tension disc 32 is provided to face the first thread tension disc 31 to nip a thread between the first and second thread tension disc 31 and 32. The thread tension spring 4 biases the second thread tension disc 32 in the arrow direction X1 toward the first thread tension disc 31 such that the second thread tension disc 32 approaches the first thread tension disc 31. In this manner, the thread tensile force is adjusted. A thread tension nut 8 having a fingering concave-convex portion 80 in its outer circumference is interposed between the thread tension spring 4 and the movable body 5. The resilient force of the thread tension spring 4 which is an industrial product may have a slight deviation. For this reason, a manufacturer or the like can adjust the resilient force of the thread tension spring 4 by rotating the thread tension nut 8 around its shaft center during a shipment and the like.

[0026] The movable body 5 serving as a thread tension plate is movable along the resilient force adjustment direction (arrow direction X) for adjusting the strength of the resilient force of the thread tension spring 4. As illustrated in Fig. 1, the rotatable body 6 is provided rotatably in a circumferential direction (arrow directions A1 and A2) with respect to the shaft 60m serving as a first rotational center 60. The rotatable body 6 has a conversion mechanism 62 for moving the movable body 5 in the resilient force adjustment direction (arrow direction X) in response to the rotation. As the rotatable body 6 is rotated along its circumferential direction (arrow directions A1 and A2), the rotation of the rotatable body 6 causes the movable body 5 to move along the resilient force adjustment direction (arrow direction X) by means of the conversion mechanism 62. As a result, the strength of the resilient force of the thread tension spring 4 is adjusted, a force for nipping a thread between the first and second thread tension discs 31 and 32 is adjusted, and furthermore, the thread tensile force of the upper thread is adjusted.

[0027] Description will be made further. As illustrated in Fig. 3, the conversion mechanism 62 includes a cam trench 63 formed to have a winding shape from one end 63e to the other end 63f with respect to the first rotational center 60 of the rotatable body 6 and a follower 65 guided relatively along the cam trench 63. Since the follower 65 is integrated with the movable body 5, it can be displaced

in the arrow direction X along with the movable body 5, but is not rotated. As illustrated in Fig. 3, the cam trench 63 is formed in a vortex shape with respect to the first rotational center 60 such that a distance L between the first rotational center 60 and the cam trench 63 increases gradually from one end 63e to the other end 63f. Here, as illustrated in Fig. 3, a distance L1 is set between one end 63e of the diameter inner side of the cam trench 63 and the first rotational center 60. A distance L2 is set between the other end 63f of the diameter outer side of the cam trench 63 and the rotational center (L2>L1). As the rotatable body 6 is rotated in one direction (arrow direction A1) with respect to the first rotational center 60, the cam trench 63 is rotated in the same direction as that of the rotatable body 6 with respect to the first rotational center 60. Therefore, the follower 65 is engaged with and guided by the cam trench 63 so as to move in the arrow direction X1. This causes the movable body 5 to move in the arrow direction X1. As a result, the thread tension spring 4 is compressed in the arrow direction X1, and the resilient force of the thread tension spring 4 increases, so that the contact pressure between the first and second thread tension discs 31 and 32 increases, and the thread tensile force of the upper thread increases.

[0028] On the contrary, as recognized from Fig. 3, as the rotatable body 6 is rotated in the other direction (arrow direction A2) with respect to the first rotational center 60, the cam trench 63 is rotated with respect to the first rotational center 60 in the same direction along with the rotatable body 6. Therefore, the follower 65 is engaged with and guided by the cam trench 63 to move in the arrow direction X2. For this reason, the movable body 5 moves in the arrow direction X2 by virtue of the resilient force of the thread tension spring 4. In this case, the thread tension spring 4 is stretched in the arrow direction X2 due to its own resilient force. As a result, the resilient force of the thread tension spring 4 is reduced, and the contact pressure between the first and second thread tension discs 31 and 32 is reduced, so that the thread tensile force of the upper thread is reduced.

[0029] According to the present embodiment, as illustrated in Fig. 2, the rotatable body 6 includes a cylindrical portion 66 having an outer circumferential surface 66s and a plurality of internal teeth 67 arranged side by side in the circumferential direction in the inner circumferential wall of the cylindrical portion 66. As illustrated in Fig. 2, the internal teeth 67 are formed across the entire circumference of the inner circumferential portion of the cylindrical portion 66 such that it makes a single revolution with respect to the first rotational center 60 of the rotatable body 6. As illustrated in Fig. 2, a pitch circle diameter of the internal teeth 67 is denoted by Din. The pitch circle diameter Din of the internal teeth 67 is larger than the outer diameter DA of the thread tension dial 7 in consideration of a deceleration ratio and the like. However, this disclosure is not limited thereto.

[0030] The thread tension dial 7 is rotatable with respect to the second rotational center 70 of the shaft 70m

through user's rotation operation and is held in a bracket 240 of the sewing machine main body 2 that holds the entire thread tension apparatus 1 (see Fig. 1). The thread tension dial 7 includes an outer cylinder 72 having a concave-convex portion 72 extensibly provided in the circumferential direction (arrow directions B1 and B2) for frictional engagement of a fingertip and the like, a gear 74 formed in the inner cylinder 73 coaxially provided in the outer cylinder 72, and an axial end face 75 for connecting the inner cylinder 73 and the outer cylinder 72 (see Fig. 1). As illustrated in Fig. 2, the gear 74 has a plurality of external teeth 77 capable of meshing with the internal teeth 67 of the rotatable body 6. The pitch circle diameter D_{out} of the external teeth 77 of the gear 74 is smaller than the pitch circle diameter D_{in} of the internal teeth 67 of the rotatable body 6 ($D_{out} < D_{in}$) for deceleration.

[0031] As recognized from Fig. 2, since the external teeth 77 and the internal teeth 67 mesh with each other, as a user rotationally operates the thread tension dial 7 in its circumferential direction, rotation is transferred to the rotatable body 6, and the rotatable body 6 is rotated in a direction common to that of the thread tension dial 7 while the rotational speed of the thread tension dial 7 is decelerated. Therefore, as recognized from Figs. 1 and 2, when the thread tension dial 7 is rotationally operated in the arrow direction B1, the rotatable body 6 is rotated in the arrow direction A1 which is common to the rotational direction (arrow direction B1) of the thread tension dial 7. In addition, when the thread tension dial 7 is rotationally operated in the arrow direction B2, the rotatable body 6 is rotated in the arrow direction A2 which is common to the rotational direction (arrow direction B2) of the thread tension dial 7.

[0032] That is, according to the present embodiment, as recognized from Fig. 2, if a user rotationally operates the thread tension dial 7 in the arrow direction B1 with respect to the second rotational center 70, the external teeth 77 of the gear of the thread tension dial 7 are rotated in synchronization, and the internal teeth 67 meshing with the external teeth 77 are rotated in the arrow direction A1 with respect to the first rotational center 60 of the rotatable body 6. As a result, the movable body 5 and the thread tension nut 8 move in the arrow direction X1 to displace the thread tension spring 4 in the same direction, and the second thread tension disc 32 approaches the first thread tension disc 31 to strengthen the thread tensile force of the upper thread.

[0033] In addition, as a user rotationally operates the thread tension dial 7 in the arrow direction B2 around the second rotational center 70, the external teeth 77 of the gear of the thread tension dial 7 is rotated in synchronization so that the internal teeth 67 meshing with the external teeth 77 is rotated in the arrow direction A2 with respect to the first rotational center 60 of the rotatable body 6. As a result, the movable body 5 and the thread tension nut move in the arrow direction X2 to displace the thread tension spring 4 in the same direction, and the

second thread tension disc 32 is separated from the first thread tension disc 31 to weaken the thread tensile force.

[0034] Here, as recognized from Fig. 2, the pitch circle diameter D_{out} of the external teeth 77 of the thread tension dial 7 is smaller than the pitch circle diameter D_{in} of the internal teeth 67 of the rotatable body 6 ($D_{out} < D_{in}$). Therefore, the number of teeth N_{out} of the external teeth 77 is smaller than the number of teeth N_{in} of the internal teeth 67 of the rotatable body 6 ($N_{out} < N_{in}$). For this reason, when a user rotationally operates the thread tension dial 7, the external teeth 77 of the thread tension dial 7 and the internal teeth 67 of the rotatable body 6 mesh with each other, so that a deceleration mechanism 79 is formed to transfer rotation of the thread tension dial 7 to the rotatable body 6 with a decelerated rotational speed. Therefore, when a user rotationally operates the thread tension dial 7, rotation of the thread tension dial 7 can be transferred to the rotatable body 6 while the rotational speed is decelerated. In addition, since the deceleration mechanism is provided, it is possible to suppress a user from feeling heavy in the rotation operation of the thread tension dial 7.

[0035] Here, according to the present embodiment, if a user directly rotationally operates the rotatable body 6, the rotatable body 6 exhibits a function of coarsely adjusting the thread tensile force. If a user directly rotationally operates the thread tension dial 7, the thread tension dial 7 exhibits a function of finely adjusting the thread tensile force. Here, in the adjustment of the thread tensile force, the rotational direction of the rotatable body 6 is common to the rotational direction of the thread tension dial 7. Therefore, even when a user confuses the rotatable body 6 and the thread tension dial 7 and erroneously operates them, there is only a difference in the coarse adjustment or the fine adjustment of the thread tensile force, and there is no difference in the direction for adjusting the strength of the thread tensile force. Therefore, it is possible to achieve convenient operation.

[0036] As described above, as the rotatable body 6 is rotated, rotation of the rotatable body 6 causes the movable body 5 to move in the resilient force adjustment direction (arrow directions X1 and X2) using the conversion mechanism 62, along with the rotation. As a result, it is possible to adjust the strength of the resilient force of the thread tension spring 4, the force for nipping a thread between the first and second thread tension discs 31 and 32, and thus, the thread tensile force. According to the present embodiment, the deceleration mechanism 79 is formed when the external teeth 77 of the thread tension dial 7 mesh with the internal teeth 67 of the rotatable body 6. For this reason, it is possible to finely adjust the strength of the resilient force of the thread tension spring 4, the force for nipping a thread between the first and second thread tension discs 31 and 32, and thus, the thread tensile force. In this case, in comparison with a case where the deceleration mechanism 79 is not provided, that is, a case where a user directly rotates the rotatable body 6, it is possible to rotate the rotatable body

6 with a reduced torque. Therefore, it is possible to easily move the movable body 5 with high precision and finely adjust the thread tensile force by efficiently adjusting the strength of the resilient force.

[0037] In addition, as illustrated in Fig. 2, an outer diameter DA of the outer cylinder 72 of the thread tension dial 7 is set to be larger than the pitch circle diameter Dout of the external teeth 77 in the gear 74 of the thread tension dial 7. In this case, the rotational distance of the external teeth 77 of the gear 74 is reduced relative to the rotational distance when a user rotates the outer cylinder 72 of the thread tension dial 7 in the circumferential direction. In this meaning, it is possible to form the deceleration mechanism for finely adjusting the thread tensile force.

[0038] On the other hand, in order to obtain a strong thread tensile force from a weak thread tensile force, it is preferable to use a thread tension spring 4 having a high rigidity with a high spring constant. In addition, if a target workpiece such as a cloth is thick, it is preferable to harden the thread tension spring 4 by increasing the spring constant of the thread tension spring 4 in order to increase the thread tensile force. However, if the spring constant of the thread tension spring 4 is high, a rotational torque of the thread tension dial tends to excessively increase so that a user may feel heavy in the rotation operation of the thread tension dial 7, thereby causing a sense of discomfort. In addition, the strength of the resilient force of the thread tension spring 4 sensitively and significantly changes just by rotationally operating the thread tension dial, and it is not essentially easy to finely adjust the strength of the resilient force of the thread tension spring 4. Furthermore, it is not essentially easy to finely adjust the thread tensile force. Moreover, in order to finely adjust the thread tension spring 4 while increasing the spring constant, it is necessary to increase a stroke of the movable body 5 in the arrow direction X. However, a size of the movable body 5 in the arrow direction X significantly increases so that there is a disadvantage in that a design of the sewing machine is degraded.

[0039] In this regard, according to the present embodiment, when the thread tension dial 7 is rotationally operated by a user, and when the external teeth 77 of the thread tension dial 7 mesh with the internal teeth 67 of the rotatable body 6, the deceleration mechanism 79 is formed to transfer rotation of the thread tension dial 7 to the rotatable body 6 with a decelerated rotational speed. Therefore, even when the spring constant of the thread tension spring 4 increases, it is possible to reduce a torque for rotationally operating the thread tension dial 7 by a user, suppress a user from feeling heavy in the rotation operation of the thread tension dial 7, and easily finely adjust the strength of the resilient force of the thread tension spring 4. Therefore, it is possible to finely adjust a force for nipping a thread between the first and second thread tension discs 31 and 32 and thus, the thread tensile force.

[0040] For this reason, according to the present embodiment, even when the spring constant of the thread tension spring 4 is high, it is possible to efficiently adjust the strength of the resilient force of the thread tension spring 4 in comparison with a case where the deceleration mechanism 79 is not provided, that is, a case where a user directly rotates the rotatable body 6. In this manner, since there is no influence even when the spring constant of the thread tension spring 4 is high, it is possible to miniaturize a size of the thread tension spring 4 in the axial direction and the like while the spring constant of the thread tension spring 4 increases. Naturally, when a user desires to coarsely adjust the thread tensile force, a user may directly rotationally operate the rotatable body 6.

[0041] According to the present embodiment, as illustrated in Fig. 1, the thread tension dial 7 has an axial end face 75 in the rotatable body 6 side as a connector for connecting the outer cylinder 72 and the inner cylinder 73. As recognized from Fig. 2, the thread tension dial 7 is provided such that the second rotational center 70 is decentered to the upper side (arrow direction U side) from the first rotational center 60 of the rotatable body 6. In addition, the axial end face 75 of the outer cylinder 72 of the thread tension dial 7 includes a covered face portion 75a covered by the rotatable body 6 and an exposed face portion 75c exposed from the rotatable body 6. In this manner, while the thread tension dial 7 and the rotatable body 6 neighbor to each other, the thread tension dial 7 is decentered from the first rotational center 60 of the rotatable body 6. Therefore, a user can visually distinguish between the thread tension dial 7 and the rotatable body 6, and it is possible to suppress a user from confusingly operating the thread tension dial 7 and the rotatable body 6. Particularly, since the thread tension dial 7 is decentered to the upper side (arrow direction U side), it is possible to obtain an advantage in that a user can easily operate the thread tension dial 7.

[0042] In addition, according to the present embodiment, as illustrated in Fig. 1, the axial end face 68 of the rotatable body 6 is externally exposed, and the indicator 69 is provided to indicate a strength for coarsely adjusting the thread tensile force of the upper thread. Using the indicator 69, a user can recognize the strength for coarsely adjusting the thread tensile force. In addition, a direction of the indicator 69 for indicating the strength of the thread tensile force is common to a rotation operation direction of the rotatable body 6. That is, if the rotatable body 6 is rotationally operated in the arrow direction A1 to increase the thread tensile force, the indicator 69 indicates the strong thread tensile force. For this reason, a user can rotationally operate the rotatable body 6 for coarsely adjusting the tensile force without feeling a sense of discomfort.

[0043] In addition, according to the present embodiment, as illustrated in Fig. 1, the axial end face 75 of the thread tension dial 7 is provided with the indicator 78 for indicating the strength for finely adjusting the thread ten-

sile force of the upper thread. A user can visually recognize the indicator 78 for the fine adjustment on the exposed face portion 75c. That is, as a user rotationally operates the thread tension dial 7, the axial end face 75 of the thread tension dial 7 can change from the covered face portion 75a covered by the rotatable body 6 to the exposed face portion 75c exposed from the rotatable body 6. For this reason, using the indicator 78 that is formed in the axial end face 75 of the thread tension dial 7 and indicates the strength for finely adjusting the thread tensile force, a user can easily recognize the strength for finely adjusting the thread tensile force. In addition, the rotation operation direction of the indicator 78 for indicating the strength of the thread tensile force is common to the rotation operation direction of the thread tension dial 7. That is, if the thread tension dial 7 is rotationally operated in the arrow direction B1 to increase the thread tensile force, the indicator 78 indicates the strong thread tensile force. For this reason, a user can operate the thread tension dial 7 for finely adjusting the tensile force without feeling a sense of discomfort. Furthermore, even when a user confusingly performs the rotation operation of the thread tension dial 7 and the rotation operation of the rotatable body 6, it is possible to suppress a significant failure caused by the confusion because a direction where the indicators 69 and 78 indicate the strength of the thread tensile force is common to the rotational directions of the thread tension dial 7 and the rotatable body 6.

[0044] According to the present embodiment, as recognized from Fig. 1, the axial end face 68 of the rotatable body 6 and the axial end face 75 of the thread tension dial 7 are recognized by a user while they are exposed in the same direction. Therefore, the indicator 69 formed on the axial end face 68 for coarsely indicating the thread tensile force and the indicator 78 formed on the axial end face 75 for finely indicating the thread tensile force are exposed in the same direction, so that they are easily recognized by a user.

(Application)

[0045] Fig. 4 illustrates an application. The sewing machine main body 2 of the sewing machine includes a bed portion 22, a vertical arm portion 23 upward extending from one end of the bed portion 22, a horizontal arm portion 24 horizontally extending from a top portion of the vertical arm portion 23, a needle bar 25 for installing a needle, and a presser lifting lever 26 for operating vertical movement of a presser bar. The bracket 240 of the horizontal arm portion 24 is provided with the thread tension apparatus 1 operated by a user to adjust the tensile force of the upper thread.

(Other Embodiments)

[0046] Although the conversion mechanism 62 for converting the rotational motion of the rotatable body 6 into

the linear motion of the movable body 5 uses the cam trench 63, according to the embodiments described above, this disclosure is not limited thereto. For example, any other types of cams such as a cylindrical cam may be used if it can change the rotational motion of the rotatable body 6 into the linear motion of the movable body 5. Although the thread tension dial 7 is decentered upward (arrow direction U side), it may protrude to a user side directly facing the sewing machine. While embodiments of this disclosure have been described hereinbefore with reference to the accompanying drawings, they are not intended to limit this disclosure, and various modifications or variations can be made without departing from the spirit and scope of this disclosure.

Claims

1. A sewing machine thread tension apparatus provided in a sewing machine to adjust a thread tensile force, comprising:

a first thread tension disc;
 a second thread tension disc facing the first thread tension disc to nip a thread therebetween;
 a thread tension spring having a resilient force for adjusting the thread tensile force by biasing the second thread tension disc toward the first thread tension disc such that the first and second thread tension discs approaches each other;
 a movable body movable along a resilient force adjustment direction for adjusting a strength of the resilient force of the thread tensile spring;
 a rotatable body that is provided rotatably with respect to a rotational center and has a cylindrical portion, a conversion mechanism that moves the movable body along the resilient force adjustment direction in response to rotation, and a plurality of internal teeth formed with a predetermined pitch circle diameter with respect to a rotational center in an inner circumferential wall of the cylindrical portion; and
 a thread tension dial that is provided rotatably relative to the rotatable body through user's rotation operation, has a plurality of external teeth formed to have a pitch circle diameter D_{out} smaller than a pitch circle diameter D_{in} of the internal teeth of the rotatable body and capable of meshing with the internal teeth of the rotatable body, and rotates the rotatable body in a common direction by transferring rotation to the rotatable body while a torque is reduced by causing the external teeth and the internal teeth to mesh with each other in response to rotation.

2. The sewing machine thread tension apparatus according to claim 1, wherein the thread tension dial

has an outer cylinder rotationally operated by a user and a gear formed in an inner cylinder which is provided coaxially to the outer cylinder and has the external teeth.

5

3. The sewing machine thread tension apparatus according to claim 1 or 2, wherein a rotational center of the thread tension dial is decentered from a rotational center of the rotatable body, and an axial end face of the thread tension dial includes a covered face portion covered by the rotatable body and an exposed face portion exposed from the rotatable body. 10
4. The sewing machine thread tension apparatus according to claim 3, wherein the axial end face of the thread tension dial has an indicator for indicating a strength of the thread tensile force, and a direction of the indicator for indicating the strength of the thread tensile force is common to a rotational direction of the thread tension dial. 15 20
5. The sewing machine comprising the sewing machine thread tension apparatus according to any of claims 1 to 4. 25

30

35

40

45

50

55

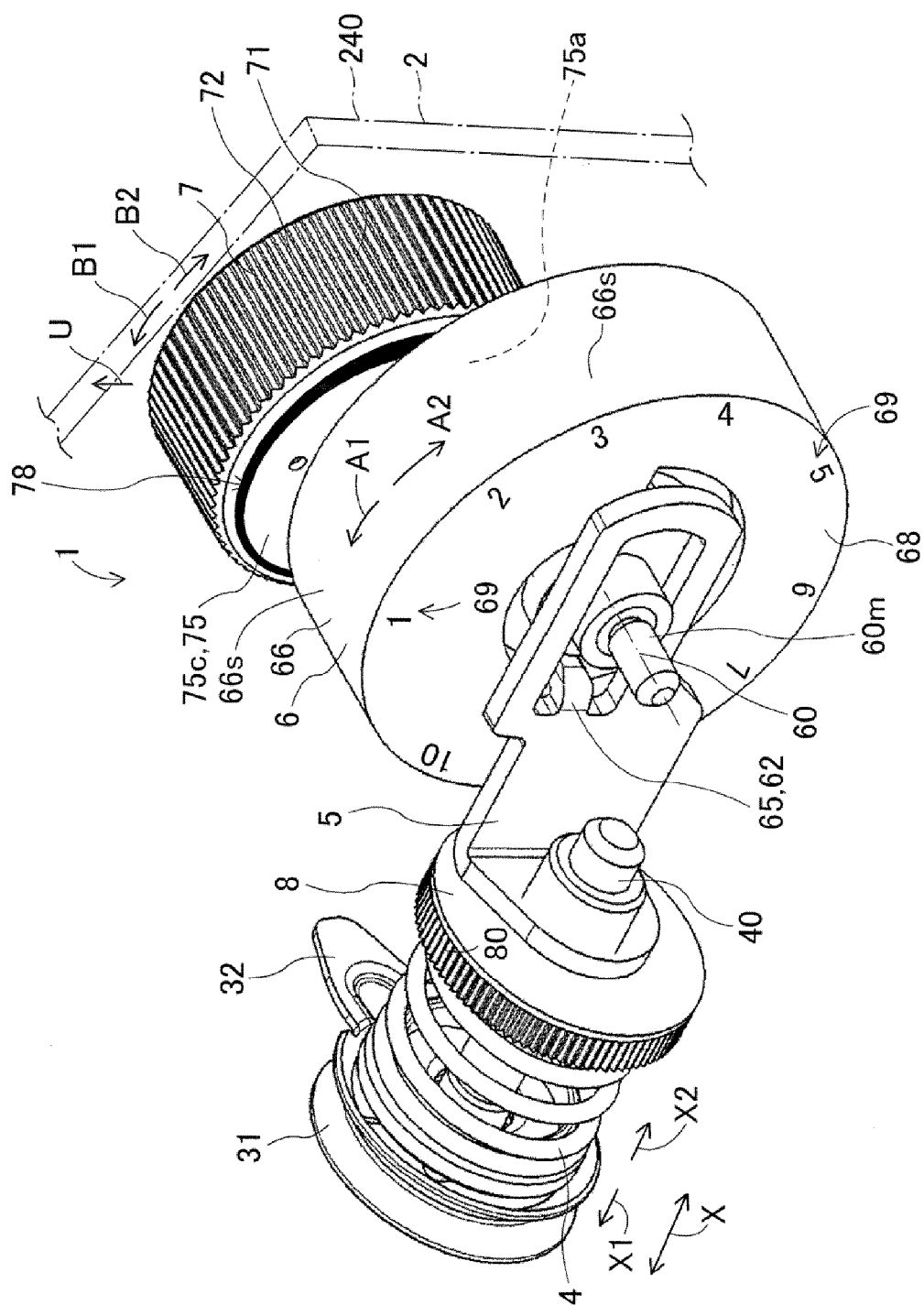


FIG. 1

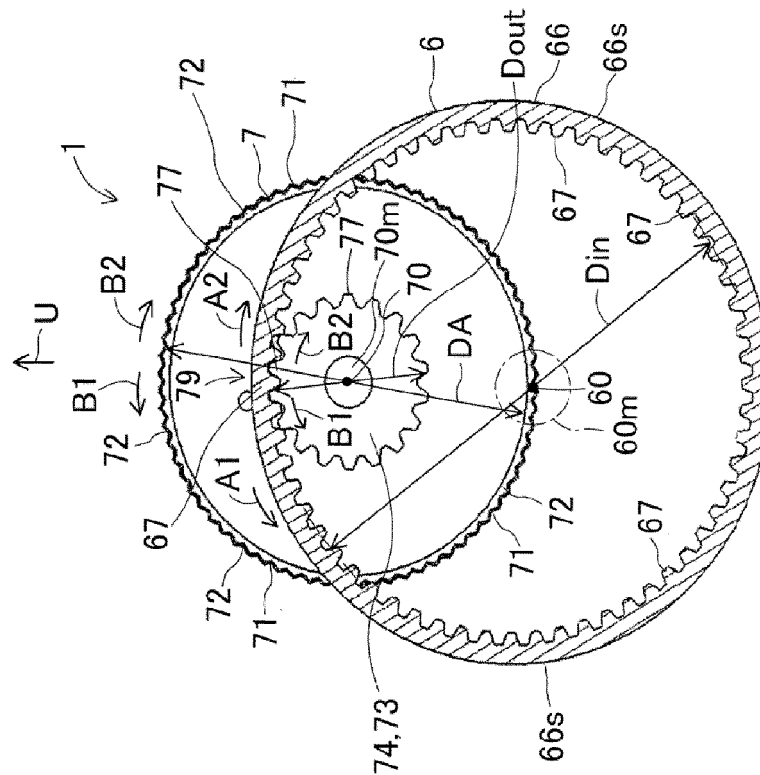


FIG. 2

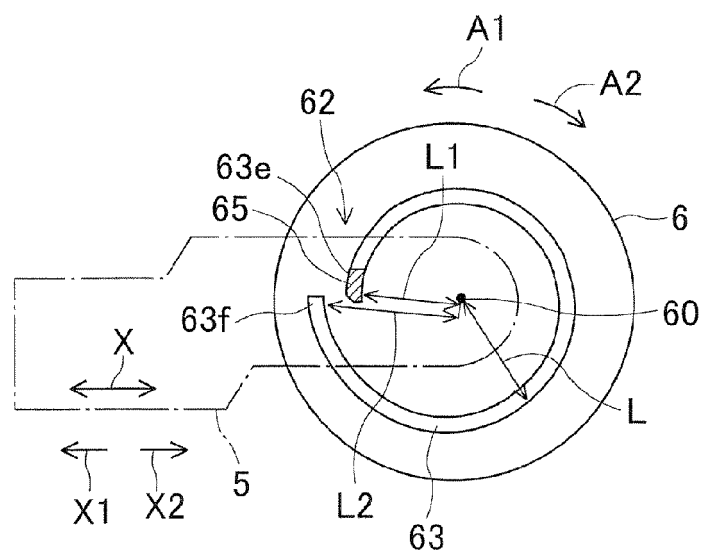


FIG. 3

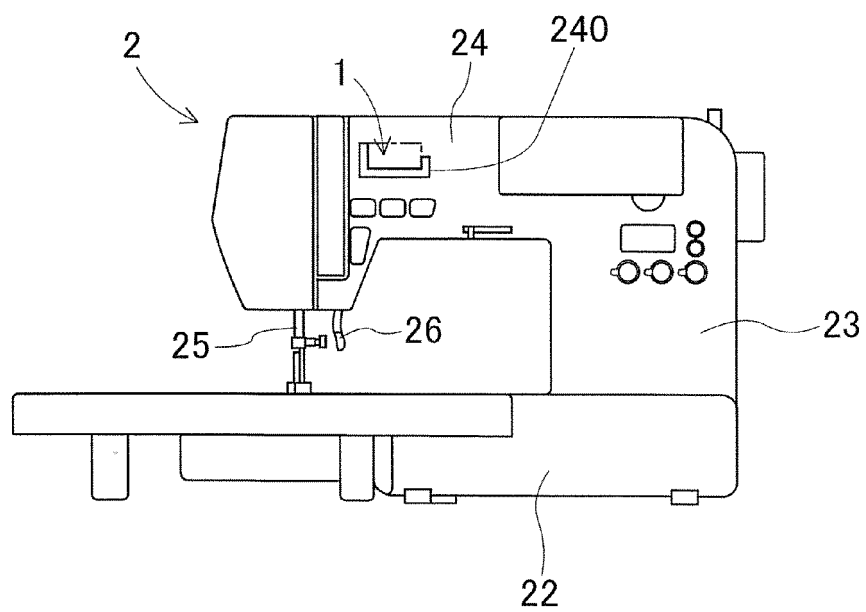


FIG. 4



EUROPEAN SEARCH REPORT

Application Number
EP 12 16 7081

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 6 957 616 B1 (CHANG TSENG HSIEN [TW]) 25 October 2005 (2005-10-25) * column 2, line 4 - column 4, line 14; figures 1-8 *	1-5	INV. D05B47/02
A,D	JP 6 154454 A (HAPPY IND) 3 June 1994 (1994-06-03) * abstract; figure 1- *	1-5	
A	US 3 366 083 A (KETTERER STANLEY J ET AL) 30 January 1968 (1968-01-30) * column 2, line 31 - column 4, line 29; figures 1-4 *	1-5	
A	JP 2001 327784 A (JANOME SEWING MACHINE CO LTD) 27 November 2001 (2001-11-27) * abstract; figures 1-9 *	1-5	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			D05B
Place of search		Date of completion of the search	Examiner
Munich		10 September 2012	Herry-Martin, D
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1
EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 16 7081

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

10-09-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6957616 B1	25-10-2005	DE 102005058236 A1 US 6957616 B1	14-06-2006 25-10-2005
JP 6154454 A	03-06-1994	JP 3314093 B2 JP 6154454 A	12-08-2002 03-06-1994
US 3366083 A	30-01-1968	CH 462602 A DE 1685016 A1 GB 1113720 A US 3366083 A	15-09-1968 12-08-1971 15-05-1968 30-01-1968
JP 2001327784 A	27-11-2001	JP 4789079 B2 JP 2001327784 A	05-10-2011 27-11-2001

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2008264065 A [0002]