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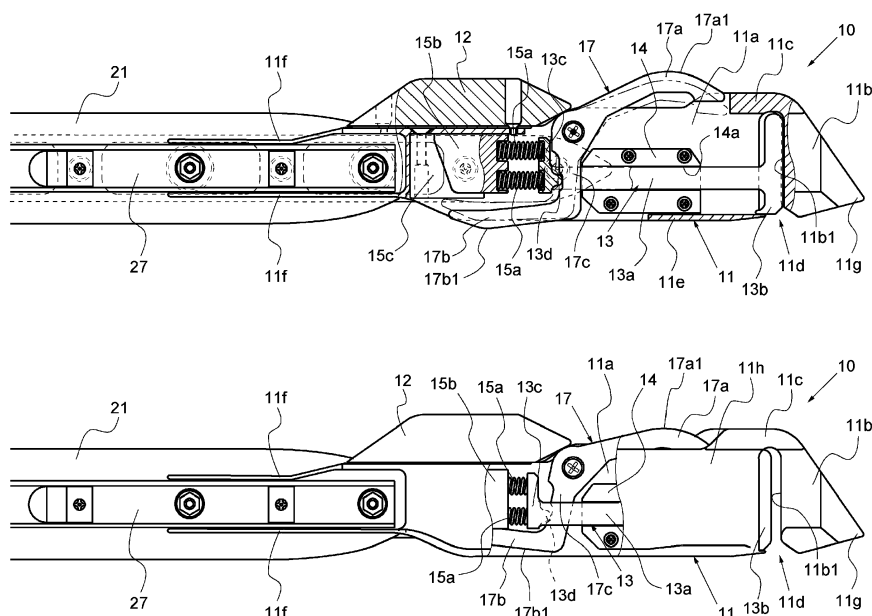
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(54) **WEFT INSERTION DEVICE FOR RAPIER LOOM**

(57) A weft insertion device (1) for a rapier loom includes a yarn guide mechanism (50) including a holding device (51) that holds a tip portion of the flat yarn (Y) and that guides the flat yarn (Y) from a position above a movement path (P) of the rapier head (10, 10') to a position below the movement path (P) with respect to an up-down direction, the yarn guide mechanism (50) displacing, independently or in cooperation with the rapier head (10,

10'), the flat yarn (Y) in a direction parallel to a width direction of the rapier head (10, 10'). Immediately before weft insertion is started, the flat yarn (Y) is guided into a yarn inlet portion (11d, 11d') of the rapier head (10, 10') while the flat yarn (Y) is displaced by the yarn guide mechanism (50) in the width direction of the rapier head (10, 10').

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a weft insertion device for a rapier loom that performs weaving by using a tape-shaped flat yarn as a weft. In particular, the present invention relates to a single-rapier weft insertion device with which a rapier head, whose standby position is set on a side opposite to a weft supply side, advances toward the weft supply side, grips the flat yarn on the weft supply side, and inserts the flat yarn as a weft while retreating.

2. Description of the Related Art

[0002] In order to enable weaving by using a tape-shaped flat yarn as a weft, a rapier loom having a weft insertion device that is capable of performing weft insertion by using such a flat yarn is known to date. When inserting a flat yarn as a weft, it is necessary that weft insertion be performed so that twisting or the like of the flat yarn does not occur. Examples of a weft insertion device for realizing such weft insertion include a weft insertion device disclosed in Japanese Unexamined Patent Application Publication No. 2012-046835 (Patent Document 1) (hereinafter, referred to as "the existing device").

[0003] The existing device is a single-rapier weft insertion device with which a rapier head, whose standby position is set on the side opposite to the weft supply side, is advanced toward the weft supply side, the rapier head grips a weft on the weft supply side, and the weft (flat yarn) is inserted while the rapier retreats. A rapier loom including such a single-rapier weft insertion device is called a "single-rapier loom".

[0004] In the existing device, the rapier head includes a yarn gripping mechanism for holding the flat yarn in a state in which the flat yarn is gripped at a leading end portion thereof. In order to prevent occurrence of twisting or the like of the flat yarn during weft insertion as described above, the yarn gripping mechanism is structured to grip the flat yarn in a state in which the width direction of the flat yarn coincides with a horizontal direction and the warp direction (of the loom). Because the rapier head reciprocates in a horizontal direction that is perpendicular to the warp direction, the longitudinal direction of the rapier head coincides with the reciprocating direction of the rapier head. A direction (width direction) perpendicular to the longitudinal direction of the rapier head coincides with the width direction of the flat yarn in a state in which the rapier head grips the flat yarn.

[0005] To be more specific, regarding the yarn gripping mechanism of the existing device, the yarn gripping mechanism is structured to grip the flat yarn between a pair of gripping surfaces that face each other in the lon-

gitudinal direction. Therefore, the gripping mechanism includes a first gripping portion and a second gripping portion each of which has a gripping surface. In the yarn gripping mechanism, the first gripping portion is displaceable in the rapier head in the longitudinal direction. The yarn gripping mechanism is structured so that the first gripping portion is driven to be displaced in the longitudinal direction when gripping the flat yarn.

[0006] With the existing device, a flat yarn that is pulled out from a weft supply package (bobbin) is guided by a yarn guide mechanism in the up-down direction (to be precise, diagonally from a position above the movement path of the rapier head to a position below the movement path with respect to the up-down direction) at a predetermined position in the warp direction (a position that coincides with a position where the rapier head reciprocates) that is near the most advanced position of the rapier head in the reciprocating direction of the rapier head, in an orientation such that the width direction thereof coincides with the horizontal direction and the warp direction. With the existing device, a portion of the flat yarn guided by the guide mechanism in the up-down direction is gripped by the yarn gripping mechanism of the rapier head as described above in a state in which the orientation is maintained.

[0007] In order to grip a flat yarn between a pair of gripping surfaces, it is naturally necessary a flat yarn be disposed between the gripping surfaces. With the existing device, the flat yarn is disposed between the first gripping portion and the second gripping portion when the rapier head has moved to the most advanced position. However, with the existing device, the flat yarn is guided by the yarn guide mechanism at the predetermined position described above. Therefore, the existing device is structured so that, in order to prevent interference of the flat yarn and the second gripping portion while the rapier head advances, the second gripping portion is swung to be displaced to a position outside of an area where the flat yarn is present in the width direction before the rapier head reaches the most advanced position.

[0008] To be more specific, the existing device is structured so that the first gripping portion is displaced rearward in the longitudinal direction (in the retreating direction of the rapier head) before the rapier head reaches the most advanced position, and the second gripping portion is swung to be displaced as described above while the first gripping portion is displaced rearward. Moreover, the existing device is structured so that, the second gripping portion is swung to be displaced so as to be returned to the original position in the width direction at the time when the rapier head reaches the most advanced position and the flat yarn is disposed between the first gripping portion and the second gripping portion with respect to the longitudinal direction; and then, the first gripping portion is displaced forward in the longitudinal direction while the rapier head retreats. Due to the displacements of the first and second gripping portions, with the existing device, the flat yarn is gripped by the first gripping portion

and the second gripping portion.

[0009] As described above, the existing device is structured so that, regarding the first gripping portion and the second gripping portion for gripping the flat yarn, the first gripping portion is displaced in the longitudinal direction and the second gripping portion is swung to be displaced in the width direction when gripping the flat yarn. Thus, the existing device has a complex structure for gripping the flat yarn and performs a complex operation for holding the flat yarn. With the rapier loom, weft insertion is performed a plurality of times per second, and the rapier head reciprocates over the weaving width for each weft insertion. That is, the rapier head is reciprocated at high speed for each weft insertion. Accordingly, the aforementioned complex structure of the rapier head is not preferable, because the complex structure may negatively affect the high-speed reciprocating motion of the rapier head. Moreover, the complex operation for gripping may lead to a failure in gripping the flat yarn.

SUMMARY OF THE INVENTION

[0010] The present invention relates to a weft insertion device for a rapier loom for inserting a flat yarn as a weft as described above, and an object of the present invention is to provide a weft insertion device in which the structure of a rapier head and an operation for gripping the flat yarn are not complex.

[0011] As described above, the present invention is based on a weft insertion device for a rapier loom that performs weaving by using a tape-shaped flat yarn as a weft, the weft insertion device being a single-rapier weft insertion device with which a rapier head, whose standby position is set on a side opposite to a weft supply side, advances toward the weft supply side, grips the flat yarn on the weft supply side, and inserts the flat yarn as a weft while retreating. In addition, the present invention has the following features in the weft insertion device on which the present invention is based.

[0012] The weft insertion device includes, in addition to the rapier head, a yarn guide mechanism that includes a holding device that holds a tip portion of the flat yarn supplied from a weft supply package on the weft supply side and that guides the flat yarn from a position above a movement path of the rapier head to a position below the movement path with respect to an up-down direction, the yarn guide mechanism displacing, independently or in cooperation with the rapier head, the flat yarn in a direction parallel to a width direction of the rapier head. The rapier head includes a head body that includes a yarn inlet portion, into which the flat yarn is guided, in a leading end portion thereof, a yarn gripping member that is displaceable in the yarn inlet portion in a longitudinal direction of the rapier head, an operated member that is displaceable in the head body in the longitudinal direction and that is coupled to the yarn gripping member, and an operation lever that is operated by engaging with openers on the weft supply side and the side opposite to the weft

supply side and that displaces the operated member in the longitudinal direction. The yarn inlet portion of the head body is defined by inner side surfaces of the head body that form an angular U-shape in plan view so as to be open toward one side in the width direction and in the up-down direction. In the rapier head, one inner side surface of the inner side surfaces that define the yarn inlet portion, the one inner side surface facing in a retreating direction of the rapier head, functions as one of a pair of gripping surfaces for gripping the flat yarn, and a surface of the yarn gripping member that faces the one of the gripping surfaces functions as the other of the gripping surfaces. In the weft insertion device, immediately before weft insertion is started, the flat yarn is guided into the yarn inlet portion while the flat yarn is displaced by the yarn guide mechanism in the width direction.

[0013] In the weft insertion device according to the present invention, the rapier head may be structured so that the operation lever is swingable in the width direction relative to the head body and the operated member is displaced in the longitudinal direction by a swinging operation of the operation lever due to engagement of the operation lever with the openers; and the operation lever may include a first engagement portion that engages with the opener on the weft supply side and a second engagement portion that engages with the opener on the side opposite to the weft supply side, the first engagement portion and the second engagement portion protrude from the head body in the width direction in a state in which the first engagement portion and the second engagement portion are not engaged with the corresponding openers, and the first engagement portion and the second engagement portion engage with the corresponding openers at side surfaces thereof.

[0014] In the weft insertion device according to the present invention, in which the rapier head and the operation lever are structured as described above, the operation lever may have the first engagement portion at a position closer to one end thereof than a swing center thereof and may have the second engagement portion at a position closer to the other end thereof than the swing center, the second engagement portion may be located in the retreating direction from the first engagement portion with respect to the longitudinal direction, and, with respect to the width direction, the first engagement portion may protrude toward one side relative to the head body and the second engagement portion may protrude toward the other side relative to the head body.

[0015] In the weft insertion device according to the present invention, regarding the pair of gripping portions (gripping surfaces), which constitute parts of the rapier head that grip the flat yarn, one inner side surface of the inner side surfaces of the head body that define the yarn inlet portion, the one inner side surface facing in the retreating direction of the rapier head, functions as one of the pair of gripping surfaces (one of the gripping surfaces). Accordingly, a part of the head body in which the one of the gripping surfaces is formed corresponds to

one of the pair of gripping portions (one of the gripping portions). In the rapier head, a surface of the yarn gripping member that faces the one of the gripping surfaces functions as the other of the pair of gripping surfaces (the other of the gripping surfaces). Accordingly, the yarn gripping member, which has the other of the gripping surfaces, corresponds to the other of the pair of gripping portions (the other of the gripping portions). In addition, the rapier head is structured so that only the other of the pair of gripping portions is driven to be displaced in the longitudinal direction, in other words, the one of the gripping portions is a part of the head body that is not displaced relative to the rapier head.

[0016] Accordingly, the structure of the rapier head is simpler than the structure of the existing device described above, and the structure of the rapier head is less likely to negatively affect the reciprocating motion of the rapier head at high speed. Moreover, because the motion of the rapier head for gripping the flat yarn is only the displacement of the other of the gripping portions, which is a simple motion, failure in gripping the flat yarn is less likely to occur. Thus, with the weft insertion device according to the present invention, insertion of a flat yarn as a weft is stably performed.

[0017] In the weft insertion device according to the present invention, when the rapier head is structured so that the operation lever, having the first engagement portion and the second engagement portion, is swingable in the width direction relative to the head body and the operation lever is swung to be displaced as the first engagement portion and the second engagement portion engage with the corresponding openers at side surfaces thereof, problems, such as warp breakage, which may occur due to engagement of a part of the rapier head with the openers, can be prevented as far as possible.

[0018] To be specific, in the existing device, the first gripping portion is attached to a slidable gripping piece, and an operation protrusion is formed so as to protrude upward relative to the slidable gripping piece. Moreover, the existing device has a pressing portion (corresponding to the opener described above) that is fixedly disposed on the weft supply side and that is capable of engaging with the operation protrusion while the rapier head advances. However, in the existing device, the pressing portion is disposed, with respect to the width direction, at a position that is the same as a position where the rapier head reciprocates. In addition, the existing device is structured so that, while the rapier head advances, the operation protrusion and the pressing portion engage with each other and the operation protrusion is pressed by the pressing portion rearward relatively, and thereby the first gripping portion is displaced rearward as described above.

[0019] As described above, the existing device is structured so that, while the rapier head advances, the operation protrusion of the rapier head and the pressing portion on the weft supply side collide with each other at surfaces thereof facing each other in the direction in

which the rapier head reciprocates. Therefore, in the existing device, due to the collision, a force generated by the collision is entirely applied to the rapier head as a force directed rearward (a force in a direction opposite to the advancing direction of the rapier head). In a case of a bar rapier, whose driving member for reciprocating the rapier head is a bar member, even if such a force is applied to the rapier head, negative effect on weft insertion is small. However, in a case of a band rapier, whose driving member for reciprocating the rapier head is a band member (rapier band), as a result of such a force being applied to the rapier head, buckling of the rapier band, to which the rapier head is attached, may occur, and, accordingly, an irregular position of the rapier head and irregular movement of the rapier head may occur. If the irregular movement of the rapier head occurs, the rapier head may interfere with the warp when the rapier head retreats (during weft insertion), and a problem such as warp breakage may occur.

[0020] Moreover, there is a problem in that, when the rapier head, which moves at high speed, collides head-on with the pressing portion at a part thereof, the rapier head may break due to the impact of the collision.

[0021] In contrast, in the weft insertion device according to the present invention, by structuring the operation lever as described above and by appropriately setting the angle of the surface (engagement surface) of each of the engagement portions that engage a corresponding one of the openers, a force that is applied to the operation lever (rapier head) due to the engagement of the operation lever with the opener can be divided into a component in the width direction (for swinging the operation lever) and a component in a direction opposite to the advancing direction of the rapier head. Thus, the force applied to the rapier head (head body) in the direction opposite to the advancing direction is smaller than that of the existing device structured as described above. By structuring the weft insertion device so that the opener is displaced toward the rapier head (operation lever) from a side at the time when the rapier head reaches a position where the rapier head grips the flat yarn (the most advanced position), a force in the direction opposite to the advancing direction is not applied to the rapier head. Accordingly, with the weft insertion device according to the present invention structured as described above, occurrence of warp breakage due to an irregular position of the rapier head and breakage of the rapier head can be prevented as far as possible.

[0022] In the weft insertion device according to the present invention, regarding the operation lever, in the case where the first engagement portion is located closer to one end of the operation lever than the swing center of the operation lever and the second engagement portion is located closer to the other end of the operation lever than the swing center, the second engagement portion is located in the retreating direction from the first engagement portion with respect to the longitudinal direction, and, with respect to the width direction, the first

engagement portion protrudes toward one side relative to the head body and the second engagement portion protrudes toward the other side relative to the head body, the length of the selvage (feathered selvage) protruding from the end of the fabric on the side opposite to the weft supply side can be reduced.

[0023] To be specific, the length of the feathered selvage on the side opposite to the weft supply side depends on the time when the rapier head (the yarn gripping mechanism) releases the flat yarn when the rapier head has retreated to the side opposite to the weft supply side. That is, if the flat yarn is released earlier, the length of the feathered selvage is shorter, and, if the flat yarn is released later, the length of the feathered selvage is longer. Releasing of the flat yarn is performed when the operation lever of the rapier head engages with the opener on the side opposite to the weft supply side while the rapier head retreats (during weft insertion). Accordingly, in order to reduce the length of the feathered selvage, with respect to the weaving-width direction, it is necessary to dispose the opener on the side opposite to the weft supply side at a position that is as near as possible to the selvage of the fabric on the side opposite to the weft supply side. However, in a loom, a slay for supporting the reed and the like are present beyond a region in which the fabric is present with respect to the weaving-width direction, and the slay extends to a position further outward than the selvage on the side opposite to the weft supply side relative to the fabric. Therefore, the opener is disposed so as to be separated from the region in which the slay is present relative to the selvage on the side opposite to the weft supply side so that the opener or a portion for supporting the opener does not interfere with the slay.

[0024] On the weft supply side, a cutter device for cutting the flat yarn and the like are disposed near the selvage. Therefore, the opener on the weft supply side and the yarn guide mechanism are disposed further outward than a region in which the cutter device and the like are present with respect to the weaving-width direction relative to the fabric. However, because the length of a part of the flat yarn closer to the tip portion than a portion gripped by the rapier head increases as the distance between the position of the yarn guide mechanism and the cutter device increases, the yarn guide mechanism is disposed as near as possible to the cutter device. The position of the opener on the weft supply side is determined in accordance with the position of the yarn guide mechanism.

[0025] Thus, the operation lever is structured so that the position of the first engagement portion, which engages with the opener on the weft supply side, is nearer to the leading end of the rapier head. If, for example, with a structure such that the operation lever is swung to be operated as the first engagement portion engages with the opener also on the side opposite to the weft supply side, when the rapier head retreats, the swinging operation of the operation lever (releasing of the flat yarn) is

not performed until the first engagement portion, which is located as described above, reaches the position of the opener on the side opposite to the weft supply side. Therefore, with this structure, the feathered selvage on the side opposite to the weft supply side is long.

[0026] In contrast, by structuring the operation lever so as to additionally have the second engagement portion as described above, when the rapier head retreats, the operation of releasing of the flat yarn is performed before the first engagement portion reaches the position of the opener on the side opposite to the weft supply side, and therefore the length of the feathered selvage on the side opposite to the weft supply side can be reduced. Note that an increase in the length of the feathered selvage leads to excessive consumption of the flat yarn used as a weft. In a case where the flat yarn is a yarn composed of carbon fiber, the yarn is expensive, and such excessive consumption is not preferable in view of fabric production cost. In contrast, by reducing the length of the feathered selvage as described above, fabric production cost can be reduced as far as possible.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

Fig. 1 shows partially sectional plan views of a rapier head of a weft insertion device according to an embodiment of the present invention;

Fig. 2 is a perspective view of the rapier head of the weft insertion device according to the embodiment of the present invention;

Figs. 3A and 3B illustrate an opening operation, on the weft supply side, of a gripping mechanism of the rapier head of the weft insertion device according to the embodiment of the present invention;

Figs. 4A and 4B illustrate an opening operation, on the side opposite to the weft supply side, of the gripping mechanism of the rapier head of the weft insertion device according to the embodiment of the present invention;

Fig. 5 is a front view of a yarn supply mechanism, including a yarn guide mechanism, of the weft insertion device according to the embodiment of the present invention;

Fig. 6 is a front view of the yarn supply mechanism, including the yarn guide mechanism, of the weft insertion device according to the embodiment of the present invention;

Fig. 7 is a front view of a holding device the yarn guide mechanism of the weft insertion device according to the embodiment of the present invention;

Fig. 8 illustrates an operation of a yarn supply mechanism, including the yarn guide mechanism, of the weft insertion device according to the embodiment of the present invention;

Fig. 9 illustrates an operation of the yarn supply mechanism, including the yarn guide mechanism, of

the weft insertion device according to the embodiment of the present invention;

Fig. 10 is a schematic plan view illustrating a region near a weft insertion device for a rapier loom to which the weft insertion device according to the present invention is applied;

Figs. 11A to 11D are plan views of a rapier head of a weft insertion device according to another embodiment of the present invention;

Fig. 12 shows partially sectional plan views of a main part of a rapier head of a weft insertion device according to a modification of the embodiment of the present invention; and

Fig. 13 shows partially sectional plan views of a main part of a rapier head of a weft insertion device according to another modification of the embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] Hereinafter, referring to Figs. 1 to 10, a weft insertion device for a rapier loom according to an embodiment of the present invention will be described.

[0029] Fig. 10 schematically illustrates a single-rapier loom on which the present invention is based. The single-rapier loom is a rapier loom that performs weft insertion by using a single rapier head 10. In the present embodiment, a weft insertion device 1, which includes the rapier head 10, is a band-rapier weft insertion device that uses a band (rapier band) as a driving member that is used to reciprocally drive (reciprocate) the rapier head 10. Accordingly, the weft insertion device 1 includes a driving device in addition to the rapier head 10. The driving device includes a rapier band 21, to which the rapier head 10 is attached, and a band wheel 23, on which the rapier band 21 is looped and which rotates the rapier band 21 in normal and reverse directions in a predetermined angular range so as to reciprocate the rapier band 21. With the weft insertion device 1, the band wheel 23 is rotated, and thereby the rapier head 10 is reciprocated via the rapier band 21. Fig. 10 illustrates a state in which a reed R is located at the most retreated position. As shown in Fig. 10, a movement position where the rapier head 10 moves by being reciprocated as described above is set near the most retreated position of the reed R with respect to the front-back direction of the loom (the direction in which the warp T extends).

[0030] The weft insertion device 1 includes a yarn supply mechanism 25 for supplying the weft Y to the rapier head 10 during weft insertion. The weft Y used in the present invention is a flat yarn that has a tape-like and that is made of, for example, carbon fiber. In the weft insertion device 1, the driving device and the like are disposed so that a standby position of the rapier head 10, where the rapier head 10 is disposed in a period other than a weft insertion period, is set on a side opposite to the weft supply side, on which the yarn supply mechanism 25 is disposed, with respect to the weaving-width

direction.

[0031] With the weft insertion device 1, in a weft insertion period, when the reed R is located at the most retreated position, the rapier head 10 is driven to advance, and the rapier head 10 moves toward the weft supply side in a shed formed by the warp T. Then, when the rapier head 10 reaches the position of the yarn supply mechanism 25 on the weft supply side, the weft (flat yarn) Y is supplied to the rapier head 10. Subsequently, the rapier head 10 grips the supplied flat yarn Y, and the rapier head 10 is driven to retreat toward the aforementioned standby position while gripping the flat yarn Y. Thus, the flat yarn Y is inserted into the shed of the warp T (weft insertion is performed), the flat yarn Y is beaten by the reed R, and thereby a fabric is formed.

[0032] Figs. 1 and 2 illustrate the rapier head 10 according to the present embodiment of the present invention. The rapier head 10 is mainly composed of a head body 11. The head body 11 is fixed to the rapier band 21 via an attachment member 27, and thereby the rapier head 10 is attached to the rapier band 21. The head body 11 has a thin-plate-shaped base portion 11a and a head portion 11b that tapers toward an extreme end 11g. The head body 11 is integrally formed by coupling the base portion 11a and the head portion 11b via a coupling portion 11c so as to be separated from each other in the longitudinal direction of the rapier head 10.

[0033] Accordingly, the head body 11 has a space portion 11d between the base portion 11a and the head portion 11b. One side of the space portion 11d in the width direction of the rapier head 10 (a direction perpendicular to the longitudinal direction in plan view) is closed by the coupling portion 11c. That is, the head body 11 has the space portion 11d in an end portion thereof including the head portion 11b; and the space portion 11d is defined by three inner side surfaces, which are an end surface 11b1 of the head portion 11b facing the base portion 11a, a side surface of the base portion 11a facing the head portion 11b, and a side surface of the coupling portion 11c facing the inside of the head body 11. The space portion 11d is, in the end portion, open toward one side in the width direction and in the up-down direction, and has an angular U-shape in plan view. The space portion 11d functions as a yarn inlet portion of the head body 11 into which the flat yarn Y is guided as described below.

[0034] In the head body 11, the head portion 11b has a shape such that the head portion 11b tapers toward the extreme end 11g in the width direction and in the thickness (height) direction of the rapier head 10 and the extreme end 11g is located on a side opposite to the coupling portion 11c relative to the center with respect to the width direction. The head body 11 has a side wall 11e and a pair of side walls 11f that extend upward from the base portion 11a. The side wall 11e is formed in a front portion of the base portion 11a (on the head portion 11b side with respect to the longitudinal direction) on a side opposite to the coupling portion 11c side with respect to the width direction. The side walls 11f are formed in a

rear portion of the base portion 11a (on a side opposite to the head portion 11b side with respect to the longitudinal direction, hereinafter simply referred to as the "rear side") so as to face each other in the width direction. These side walls 11e and 11f are also integrally formed with the base portion 11a. The side walls 11f are coupled to each other via a rib, and the attachment member 27 described above fixes the head body 11 to the rapier band 21 in a region surrounded by the pair of side walls 11f and the rib. Moreover, a guide portion 12, for restricting the position of the rapier head 10 on the side opposite to the weft supply side as described below, is attached to one of outer side surfaces of the pair of side walls 11f.

[0035] The rapier head 10 has a yarn catch 13 for gripping the flat yarn Y, which has been guided into the yarn inlet portion 11d of the head body 11, in cooperation with the head portion 11b. The yarn catch 13 is displaceable in the head body 11 in the longitudinal direction. Therefore, the rapier head 10 has a guide body 14 for guiding displacement of the yarn catch 13.

[0036] The guide body 14 is a block-shaped member and has a rectangular guide groove 14a for guiding displacement of the yarn catch 13. The guide body 14 is fixed to the base portion 11a of the head body 11 with a plurality of screw members in a state in which the extension direction of the guide groove 14a coincides with the longitudinal direction.

[0037] The yarn catch 13 has a guide portion 13a that is guided by the guide groove 14a of the guide body 14. The guide portion 13a has a plate-like shape. The guide portion 13a has a rectangular shape when viewed in the thickness direction thereof. The dimension of the guide portion 13a in the longitudinal direction, which is the direction of the long sides, is sufficiently larger than the dimension of the guide portion 13a in the transversal direction, which is the direction of the short sides. The groove width of the guide groove 14a of the guide body 14 is substantially the same as the dimension of the guide portion 13a of the yarn catch 13 in the transversal direction so that the guide groove 14a can guide displacement of the yarn catch 13 in the longitudinal direction.

[0038] The yarn catch 13 has a gripping portion 13b for gripping the flat yarn Y and a receiving portion 13c for receiving an urging force for gripping the flat yarn Y. The gripping portion 13b is located at one end of the guide portion 13a in the longitudinal direction, and the receiving portion 13c is located at the other end of the guide portion 13a. The yarn catch 13 is a member in which the guide portion 13a, the gripping portion 13b, and the receiving portion 13c are integrally formed.

[0039] As viewed in the thickness direction, the receiving portion 13c of the yarn catch 13 protrudes from the guide portion 13a toward one side with respect to the transversal direction. Accordingly, when viewed in the thickness direction, the guide portion 13a and the receiving portion 13c of the yarn catch 13 have a substantially L-shape. Moreover, the receiving portion 13c has a dimension that is larger than that of the guide portion 13a

with respect to the thickness direction. One side of the receiving portion 13c is flush with the guide portion 13a, and the other side of the receiving portion 13c protrudes from the guide portion 13a.

[0040] The gripping portion 13b has a dimension that is the same as that of the guide portion 13a with respect to the thickness direction, and protrudes toward both sides from the guide portion 13a with respect to the transversal direction. The dimension of the gripping portion 13b in the longitudinal direction is substantially the same as the dimension of the guide portion 13a in the transversal direction. The dimension of the gripping portion 13b in the transversal direction is substantially the same as the dimension of one of the inner side surfaces (the end surface 11b1), which defines the yarn inlet portion 11d of the head portion 11b of the head body 11, in the width direction.

[0041] Moreover, the yarn catch 13 has an engagement portion 13d between the guide portion 13a and the receiving portion 13c. To be more specific, the yarn catch 13 has the engagement portion 13d that protrudes toward the guide portion 13a from a part of the receiving portion 13c protruding from the guide portion 13a with respect to the thickness direction within a region of the guide portion 13a in the transversal direction. The protruding end of the engagement portion 13d has an arc-shaped surface. In the yarn catch 13, the engagement portion 13d is also integrally formed with the guide portion 13a and the receiving portion 13c.

[0042] The guide portion 13a of the yarn catch 13 is loosely fitted in the guide groove 14a of the guide body 14 so that the yarn catch 13 is displaceable in the head body 11 in the longitudinal direction. In this state, the yarn catch 13 is in an orientation such that the gripping portion 13b is located closer to the head portion 11b than the guide body 14 with respect to the longitudinal direction and the engagement portion 13d is located closer to the base portion 11a than the guide portion 13a with respect to the thickness direction. In this state, the yarn catch 13 is disposed in such a way that the position of the gripping portion 13b coincides with the position the end surface 11b1 of the head portion 11b with respect to the width direction (the gripping portion 13b completely faces the end surface 11b1 of the head portion 11b). In other words, the guide body 14 is disposed, with respect to the width direction, at the position such that the guide body 14 can guide the guide portion 13a of the yarn catch 13.

[0043] Regarding the structure of the yarn catch 13, the gripping portion 13b functions as a portion that grips the flat yarn Y in cooperation with the head portion 11b of the head body 11 as described below. Accordingly, the gripping portion 13b corresponds to a yarn gripping member in the present invention. A combination of the guide portion 13a and the receiving portion 13c, which has an L-shape as described above, is a portion that is displaceable in the head body 11 in the longitudinal direction and that is coupled to the yarn gripping member. Accordingly, the combination of the guide portion 13a

and the receiving portion 13c corresponds to an operated member in the present invention. That is, in the present embodiment, a yarn gripping member and an operated member in the present invention are integrally formed and included in a single member (the yarn catch 13). The engagement portion 13d is a part of the operated member.

[0044] The rapier head 10 includes spring members for urging the yarn catch 13, which is disposed in the head body 11 as described above, toward the head portion 11b of the head body 11 with respect to the longitudinal direction. To be more specific, in the head body 11, a spring receiving member 15b is disposed on the base portion 11a at a position separated from the guide body 14 toward the rear side with respect to the longitudinal direction. The spring receiving member 15b is attached to the head body 11 via a holder 15c, which is fixed to one of the pair of side walls 11f of the head body 11, with a screw member. In the head body 11, compression springs 15a (in the example shown in the figures, two compression springs 15a) are disposed between the spring receiving member 15b and the receiving portion 13c of the yarn catch 13, which is disposed as described above.

[0045] With this structure, in the rapier head 10, the receiving portion 13c of the yarn catch 13 receives spring forces of the compression springs 15a, and the yarn catch 13 is urged toward the head portion 11b in the head body 11. Accordingly, in the rapier head 10, the gripping portion 13b of the yarn catch 13 is in a state (pressed-contact state) in which the gripping portion 13b (to be more specific, an end surface 13b1 of the gripping portion 13b facing the head portion 11b) is pressed against the end surface 11b1 of the head portion 11b, unless a force toward the rear side is not applied to the yarn catch 13.

[0046] With the rapier head 10, the flat yarn Y, which has been guided into the yarn inlet portion 11d, is gripped by the gripping portion 13b of the yarn catch 13 in the press-contact state and the head portion 11b of the head body 11. Accordingly, in the rapier head 10, the gripping portion 13b and the head portion 11b constitute a gripping mechanism for gripping the flat yarn Y, and the end surface 13b1 of the gripping portion 13b and the end surface 11b1 of the head portion 11b correspond to a pair of gripping surfaces in the present invention. That is, regarding the pair of gripping surfaces of the rapier head 10 according to the present embodiment, the end surface 13b1 of the gripping portion 13b of the yarn catch 13 functions as one of the gripping surfaces, and the end surface 11b1 of the head portion 11b of the head body 11 functions as the other of the gripping surfaces.

[0047] In the structure illustrated in the figures, the spring receiving member 15b and the receiving portion 13c of the yarn catch 13 have holes for receiving parts of the compression springs 15a. A groove is formed in the end surface 11b1 of the head portion 11b so that the head portion 11b can slightly receive a part of the end surface 13b1 of the gripping portion 13b of the yarn catch

13 in a state in which the gripping portion 13b is pressed against the head portion 11b as described above. The end surface 11b1 of the head portion 11b, which faces the base portion 11a of the head body 11 as described above, is a surface that faces in the retreating direction of the reciprocating motion of the rapier head 10. That is, the end surface 11b1 is an inner side surface that is one of the inner side surfaces defining the yarn inlet portion 11d as described above and that faces in the retreating direction of the rapier head 10.

[0048] The rapier head 10 includes an operation lever 17 for displacing the yarn catch 13 (the guide portion 13a and the receiving portion 13c as an operated member), which is disposed in the head body 11 in the state described above. As with general rapier looms, the single-rapier loom on which the present invention is based has an opener for operating the gripping mechanism of the rapier head 10 (for opening the gripping mechanism) on each of the weft supply side and the side opposite to the weft supply side (the details of the opener will be described below). In addition, the operation lever 17 of the rapier head 10 according to the present embodiment has a first engagement portion 17a on the weft supply side, which engages with the opener on the weft supply side to open the gripping mechanism (to displace the yarn catch 13 (the gripping portion 13b)); and, independently from the first engagement portion 17a, a second engagement portion 17b on the side opposite to the weft supply side, which engages with the opener on the side opposite to the weft supply side to open the gripping mechanism. To be specific, the operation lever 17 is structured as follows.

[0049] The operation lever 17 is provided in the rapier head 10 in such a way that operation lever 18 is swingable in the width direction relative to the head body 11. The operation lever 17 has a support portion 17c that is supported by the base portion 11a of the head body 11. The support portion 17c has a shape (substantially rectangular shape) a part of which is cut out when viewed in the thickness direction. The dimension of the support portion 17c, which has the substantially rectangular shape, in the long-side direction is substantially the same as the dimension of a part of the base portion 11a that supports the operation lever 17 (the support portion 17c) in the width direction.

[0050] The operation lever 17 has the first engagement portion 17a and the second engagement portion 17b as described above. When the operation lever 17 is viewed in the thickness direction, the first engagement portion 17a extends, with respect to the long-side direction and a direction (a short-side direction) perpendicular to the long-side direction, in the short-side direction from one end portion of the support portion 17c in the long-side direction. When the operation lever 17 is viewed in the thickness direction, the second engagement portion 17b extends from the other end portion of the support portion 17c in the short-side direction toward a side opposite to the first engagement portion 17a. Accordingly, the oper-

ation lever 17 has a substantially Z-shape in plan view. The first engagement portion 17a of the operation lever 17 has a shape such that the first engagement portion 17a is curved at a middle portion thereof and extends in a direction at an obtuse angle slightly larger than a right angle relative to the support portion 17c. The second engagement portion 17b of the operation lever 17 also extends in a direction at an obtuse angle slightly larger than a right angle relative to the support portion 17c.

[0051] The operation lever 17 is rotatably supported by the head body 11 (the base portion 11a) at one end portion of the support portion 17c in the long-side direction. Thus, the operation lever 17 is disposed on the head body 11 so as to be swingable in the width direction. The operation lever 17 is supported by the head body 11 in such a way that the first engagement portion 17a is located on the head portion 11b side of the head body 11 relative to the support portion 17c and the second engagement portion 17b is located on the rear side relative to the support portion 17c. As a result, in the rapier head 10, the first engagement portion 17a and the second engagement portion 17b of the operation lever 17 are located at different positions with respect to the longitudinal direction, and the second engagement portion 17b is located on the rear side (the retreating direction when the rapier head 10 is reciprocated) relative to the first engagement portion 17a.

[0052] The support position where the operation lever 17 is supported on the base portion 11a (the swing center of the operation lever 17) is set at a position on the rear side relative to the guide body 14 and near the guide body 14 with respect to the longitudinal direction. The support position is set at a position, with respect to the width direction, such that the position of the support portion 17c substantially coincides with the position of the base portion 11a (the support portion 17c and the base portion 11a substantially completely overlap in plan view), when the operation lever 17 is in a state in which the long-side direction substantially coincides with the width direction.

[0053] Regarding the positional relationship between the operation lever 17 and the yarn catch 13, which is disposed as described above, in the head body 11, the positional relationship is such that, with respect to the up-down direction, the operation lever 17 is located below the guide portion 13a of the yarn catch 13 and at the same height as the engagement portion 13d. The positional relationship is such that, with respect to the longitudinal direction, the engagement portion 13d of the yarn catch 13 is located on the rear side relative to the support portion 17c of the operation lever 17.

[0054] Due to the support position of the operation lever 17 and the positional relationship between and the operation lever 17 and the yarn catch 13, in the head portion 11b, the support portion 17c of the operation lever 17 is located between the guide body 14 and the engagement portion 13d of the yarn catch 13 with respect to the longitudinal direction.

[0055] As described above, the support portion 17c of the operation lever 17 has a rectangular shape a part of which is cut out. To be specific, a portion of the support portion 17c in the longitudinal direction that faces the engagement portion 13d and a surrounding portion are slightly cut out in a substantially arc shape. Accordingly, the dimension of the portion of the support portion 17c in the short-side direction is slightly smaller than that of the remaining portion.

[0056] As described above, the yarn catch 13 receives urging forces of the compression springs 15a toward the head portion 11b. In a normal state of the rapier head 10 in which the operation lever 17 is not engaged with the opener, the gripping portion 13b is pressed against the head portion 11b of the head body 11. That is, in the normal state, the position of the yarn catch 13 in the longitudinal direction is held by the compression springs 15a (the urging forces) at a position where the gripping portion 13b is pressed against the head portion 11b. Accordingly, the position of the engagement portion 13d with respect to the longitudinal direction is also held by the urging forces at a position corresponding to the position of the yarn catch 13. In this state, the position of the engagement portion 13d in the longitudinal direction is separated from the guide body 14 by a distance that is substantially the same as (slightly larger than) the dimension of the cutout portion of the support portion 17c of the operation lever 17 in the short-side direction.

[0057] Accordingly, rotation of the operation lever 17, which is rotatably supported as described above, is restrained by the engagement portion 13d, whose position in the longitudinal direction is held by the urging forces, and the guide body 14, which is fixedly disposed in the head body 11 (the base portion 11a). In this state, the long-side direction of the support portion 17c of the operation lever 17 substantially coincides with the width direction. Accordingly, a part of each of the first engagement portion 17a and the second engagement portion 17b of the operation lever 17, which has an obtuse angle slightly larger than a right angle relative to the support portion 17c as described above, protrudes from the head body 11 (the base portion 11a) in the width direction.

[0058] In the rapier head 10 structured as described above, a cover member 11h is attached to the base portion 11a of the head body 11. The cover member 11h covers members that are disposed on the base portion 11a in plan view in a region extending from the rib to the yarn inlet portion 11d in the longitudinal direction. Accordingly, in the rapier head 10, the guide body 14, the spring receiving member 15b, the compression springs 15a, the guide portion 13a and the receiving portion 13c of the yarn catch 13, a part of the operation lever 17, and the like are disposed in a space between the base portion 11a and the cover member 11h in the up-down direction.

[0059] Next, referring also to Figs. 3A to 4B, an operation of opening the gripping mechanism (displacing the yarn catch 13) (hereinafter, referred to as "the opening operation") on each of the weft supply side and the side

opposite to the weft supply side will be described.

[0060] Figs. 3A and 3B illustrate the opening operation on the weft supply side. Figs. 3A and 3B illustrate states in which the rapier head 10 has reached the most advanced position, after the rapier head 10 has been driven to advance from the standby position toward the weft supply side and has moved in the shed of the warp T. The most advanced position corresponds to the position of the yarn supply mechanism 25 on the weft supply side shown in Fig. 10. The rapier head 10 is reciprocated as described above and thereby moves in a direction parallel to the weaving-width direction. That is, in the weft insertion device 1, the rapier head 10 is reciprocated in a direction such that the longitudinal direction thereof coincides with the weaving-width direction. Accordingly, the width direction of the rapier head 10 coincides with the front-back direction of the loom (the direction in which the warp T extends).

[0061] The yarn supply mechanism 25 includes an opener 31 on the weft supply side as illustrated in the figures. The opener 31 is disposed, with respect to the up-down direction and the weaving-width direction, at a position such that the opener 31 can face the first engagement portion 17a of the operation lever 17 in the front-back direction in a state in which the rapier head 10 has reached the most advanced position. That is, the opener 31 is disposed at a position, with respect to the up-down direction, at the same height as the operation lever 17 (the first engagement portion 17a) of the rapier head 10 on the loom so that the position of the opener 31 overlaps the position of the first engagement portion 17a in a state in which the rapier head 10 has reached the most advanced position. In the weft insertion device 1 according to the present embodiment, the opener 31 on the weft supply side can be moved closer to or away from the operation lever 17 in a state in which the rapier head 10 has reached the most advanced position.

[0062] To be specific, the yarn supply mechanism 25 includes a support lever 33 that supports the opener 31. The support lever 33 is supported by a frame (not shown) of the loom via appropriate support means or the like. The support lever 33 is swingable in a horizontal plane around a support point 33a at substantially the center in the longitudinal direction thereof. The opener 31 is attached to one end portion of the support lever 33 relative to the support point 33a. The opener 31, which is attached to the support lever 33 in this way, is disposed so that the opener 31 can face the operation lever 17 of the rapier head 10 in the front-back direction as described above. To be more specific, the opener 31 is disposed so that a side surface of the opener 31 facing the movement position of the rapier head 10 can face a side surface 17a1 of the first engagement portion 17a (an outer side surface that intersects the width direction, hereinafter referred to as "the first engagement surface").

[0063] The support lever 33 is coupled to a drive mechanism (not shown), for swinging the support lever 33, at the other end portion relative to the support point 33a.

The driving mechanism swings the support lever 33 so that the opener 31 attached to the support lever 33 is displaced between the following two positions: an operating position, which is set as an engagement position where the opener 31 engages with the first engagement portion 17a of the operation lever 17 of the rapier head 10; and a non-operating position, which is a position separated from the first engagement portion 17a with respect to the front-back direction. Thus, the opener 31 can be moved closer to or away from the operation lever 17 (the first engagement portion 17a) by using the support lever 33, which is swingable, and the driving mechanism that swings the support lever 33. The opener 31 is located at the non-operating position when the opening operation is not performed.

[0064] When performing weft insertion, the rapier head 10 is driven to advance to be in a state in which the rapier head 10 is at the most advanced position (hereinafter, also referred to as "the most advanced state"). As illustrated in Fig. 3A, at the time when the rapier head 10 has reached the most advanced position, the opener 31 is located at the non-operating position and faces the first engagement surface 17a1 of the first engagement portion 17a of the operation lever 17 of the rapier head 10. In this state, the support lever 33 is driven to swing by the driving mechanism. Thus, the opener 31 becomes displaced from the non-operating position toward the operating position, that is, displaced toward (approaches) the first engagement portion 17a in the front-back direction and becomes engaged with the first engagement surface 17a1 of the first engagement portion 17a. When the opener 31 has been displaced to the operating position, the first engagement portion 17a is pressed by the opener 31 toward the inside of the rapier head 10, and the operation lever 17 swings in the clockwise direction in Figs. 3A and 3B. As a result, as illustrated in Fig. 3B, the operation lever 17 swings by a predetermined amount.

[0065] When the opener 31 engages with the operation lever 17 as described above, the rapier head 10 receives a force in the front-back direction from the opener 31. Therefore, the yarn supply mechanism 25 according to the present embodiment includes a first restricting member 35 for preventing (restricting) displacement of the rapier head 10 in the front-back direction by receiving the force. The first restricting member 35 is disposed at a position, with respect to the front-back direction, on a side of the rapier head 10 opposite to the side on which the opener 31 is located, such that the first restricting member 35 is located adjacent to a side portion of the rapier head 10 in the most advanced state. The first restricting member 35 is disposed at a position, with respect to the weaving-width direction, such that the first restricting member 35 faces the side wall 11e of the head body 11 of the rapier head 10 in the most advanced state in the front-back direction. Accordingly, even when the rapier head 10 receives the aforementioned force from the opener 31, because the force is received by the first re-

stricting member 35 via the side wall 11e of the head body 11, displacement of the rapier head 10 in the front-back direction is restricted by the first restricting member 35.

[0066] When the opener 31 engages with the first engagement portion 17a and the operation lever 17 is swung as described above, in accordance with the swing of the operation lever 17, the support portion 17c of the operation lever 17, which is rotatably supported by the head body 11 as described above, rotates around the support position toward the rear side in the longitudinal direction. Thus, the yarn catch 13, which includes the engagement portion 13d facing the support portion 17c at a position adjacent to the support portion 17c with respect to the longitudinal direction, is pressed by the support portion 17c at the engagement portion 13d, and becomes displaced toward the rear side against the urging forces of the compression springs 15a. As a result, the gripping portion 13b, which has been pressed against the head portion 11b of the head body 11, becomes displaced toward the rear side, and a space is formed in the yarn inlet portion 11d between the head portion 11b and the gripping portion 13b. That is, the gripping mechanism of the rapier head 10 is opened (the opening operation is finished).

[0067] Figs. 4A and 4B illustrate the opening operation on the side opposite to the weft supply side. Fig. 4A illustrates a state in which the rapier head 10 is located at a position immediately in front of the standby position after the rapier head 10 has moved in the shed of the warp T by being driven to retreat from the most advanced position toward the standby position on the side opposite to the weft supply side. Fig. 4B illustrates a state in which the rapier head 10 has reached the standby position by being driven further rearward from the state shown in Fig. 4A (a state in which the rapier head 10 is located at the standby position, hereinafter, also referred to as "the standby state").

[0068] In the weft insertion device 1, an opener 41 on the side opposite to the weft supply side illustrated in the figures is fixedly disposed at the standby position on the side opposite to the weft supply side. To be more specific, the weft insertion device 1 includes a band guide 29 that guides movement of the rapier band 21 on the side opposite to the weft supply side. The band guide 29 is fixed to the frame of the loom on the side opposite to the weft supply side. The opener 41 is attached to the band guide 29. The opener 41 has a substantially rectangular shape, in plan view, such that the length thereof (dimension in the long-side direction of the rectangular shape) is sufficiently larger than the width thereof (dimension in the short-side direction of the rectangular shape). The opener 41 is disposed in an orientation such that the long-side direction thereof coincides with the weaving-width direction.

[0069] The opener 41 is disposed at a position, with respect to the up-down direction, at the same height as the second engagement portion 17b of the operation lever

17 of the rapier head 10. The opener 41 is disposed at a position, with respect to the front-back direction, such that an inner side surface 41a (a side surface adjacent to the movement position of the rapier head 10) is adjacent to the head body 11 (the side wall 11e) of the rapier head 10.

[0070] The opener 41 is disposed, with respect to the weaving-width direction, in such a way that an end surface 41b adjacent to the warp T is located at a position where the second engagement portion 17b of the operation lever 17 reaches before the rapier head 10, which is driven to retreat as described above, reaches the standby position.

[0071] As illustrated in the figures, in the present embodiment, when the rapier head 10 is in the standby state, the end surface 41b is located at substantially the same position as the extreme end 11g of the rapier head 10 with respect to the weaving-width direction. The opener 41 has a length such that the opener 41 extends to a position behind (in the retreating direction of the rapier head 10) the position of the second engagement portion 17b of the rapier head 10 in the standby state. Accordingly, when the rapier head 10 is in the standby state, the opener 41 is present, with respect to the weaving-width direction, in a region in which a part of the rapier head 10 from the extreme end 11g to a position on the rear side relative to the second engagement portion 17b is present. In the present embodiment, the rapier head 10 and the opener 41 are in a positional relationship such that, with respect to the weaving-width direction, the second engagement portion 17b of the rapier head 10 is located at substantially the central portion of the opener 41 in a state in which the rapier head 10 is located at the standby position.

[0072] With the structure and the position of the opener 41, when the rapier head 10 is driven to retreat and reaches the side opposite to the weft supply side, a side surface (an outer side surface that intersects the width direction, hereinafter, referred to as "a second engagement surface 17b1") of the second engagement portion 17b of the operation lever 17 of the rapier head 10 engages with the opener 41 (the inner side surface 41a).

[0073] Apart of the inner side surface 41a of the opener 41 on the warp T side is inclined outward. That is, the outer side surface of the opener 41 is flat along the entirety thereof, and the width of the end surface 41b is smaller than the width of the central portion. The width of the end surface 41b of the opener 41 is such that, at the time when the second engagement portion 17b of the rapier head 10 that is driven to retreat reaches the position of the opener 41, the second engagement portion 17b, which protrudes from the head body 11 of the rapier head 10 as described above, engages with an inclined surface 41a' of the inner side surface 41a without colliding with the end surface 41b.

[0074] Thus, while the rapier head 10 is retreating, at the time when the second engagement portion 17b reaches the position of the opener 41, as illustrated in

Fig. 4A, the second engagement surface 17b1 of the second engagement portion 17b first engages with the inclined surface 41a' of the inner side surface 41a of the opener 41 (to be more specific, a part of the inclined surface 41a' adjacent to the end surface 41b). Subsequently, while the rapier head 10 is retreated further from the time of the first engagement, the second engagement surface 17b1 becomes displaced along the inclined surface 41a'. Accordingly, the engagement point between the second engagement portion 17b (the second engagement surface 17b1) and the side surface 41a (the inclined surface 41a') becomes displaced toward the head body 11 of the rapier head 10 with respect to the front-back direction. That is, while the rapier head 10 is retreated, in the rapier head 10, the second engagement portion 17b of the operation lever 17 becomes displaced toward the head body 11 with respect to the width direction. Thus, the inclined surface 41a' of the opener 41 functions as a cam surface that displaces the second engagement portion 17b toward the head body 11 in accordance with displacement thereof relative to the rapier head 10 in the weaving-width direction.

[0075] Due to the displacement of the second engagement portion 17b, in the rapier head 10, the operation lever 17 swings in the clockwise direction in Figs. 4A and 4B. When the rapier head 10 retreats to a position such that the engagement point reaches the flat portion of the inner side surface 41a of the opener 41 (excluding the inclined surface 41a'), as illustrated in Fig. 4B, substantially the entirety of the second engagement portion 17b enters the inside of the head body 11 (the space between the base portion 11a and the cover member 11h), and the operation lever 17 is swung by a predetermined amount. When the operation lever 17 is swung in this way, as with the weft supply side described above, the gripping mechanism of the rapier head 10 is opened.

[0076] With the rapier head 10, the displacement amount of the yarn catch 13 toward the rear side (the opening amount when opening the gripping mechanism) is determined in accordance with the swing amount of the operation lever 17. In the present embodiment, the swing amount of the operation lever 17 due to engagement of the opener 41 with the operation lever 17 (the second engagement portion 17b) on the side opposite to the weft supply side is set smaller than the swing amount of the operation lever 17 (the first engagement portion 17a) due to engagement of the opener 31 and the operation lever 17 on the weft supply side.

[0077] Also on the side opposite to the weft supply side, a second restricting member 43 is disposed. The second restricting member 43 restricts displacement of the rapier head 10 in the front-back direction due to a force in the front-back direction that is applied to the rapier head 10 when the operation lever 17 (the second engagement surface 17b1 of the second engagement portion 17b) engages with the opener 41. The second restricting member 43 has a shape similar to that of the opener 41, faces the opener 41 in the front-back direction, and is

disposed at substantially the same position as the opener 41 with respect to the weaving-width direction. The second restricting member 43 is disposed in such a way that, with respect to the front-back direction, the position of an inner side surface thereof (a surface facing the opener 41) substantially coincides with the position the outermost surface (outer side surface) of the guide portion 12 of the rapier head 10 in the width direction.

[0078] Moreover, in the rapier head 10, the outer side surface of the guide portion 12 extends to a position on the rear side relative the second engagement portion 17b of the operation lever 17 with respect to the longitudinal direction. Accordingly, when the rapier head 10 retreats to a position such that the second engagement portion 17b engages with the opener 41 as described above, the outer side surface of the guide portion 12 contacts the inner side surface of the second restricting member 43. Thus, when the operation lever 17 (the second engagement portion 17b) engages with the opener 41, even if a force in the front-back direction is applied to the rapier head 10 as described above, the force is received by the second restricting member 43, and therefore displacement of the rapier head 10 in the front-back direction is restricted by the second restricting member 43.

[0079] In the state in which the operation lever 17 has swung by a predetermined amount due to engagement of the second engagement portion 17b and the opener 41 as described above, with respect to the width direction, the entirety of the first engagement portion 17a is located inside the rapier head 10 relative to the outer side surface of the guide portion 12. That is, in the rapier head 10, the guide portion 12 has a size such that the guide portion 12 can be in such a state. As described above, in the rapier head 10, the second engagement portion 17b is located on the rear side relative to the first engagement portion 17a with respect to the longitudinal direction. Accordingly, the weft insertion device 1 is structured so that, while the rapier head 10 moves rearward to the standby position, the first engagement portion 17a and the second restricting member 43 do not interfere with each other.

[0080] Next, referring to Figs. 5 to 9B, a structure for supplying the flat yarn Y, which is a weft, to the rapier head 10 (for guiding the flat yarn Y into the yarn inlet portion 11d of the rapier head 10) when the rapier head 10 is in the most advanced state and operational effects of the structure will be described.

[0081] The yarn supply mechanism 25 includes a yarn guide mechanism 50 for guiding the flat yarn Y into the yarn inlet portion 11d of the rapier head 10. The yarn guide mechanism 50 guides the flat yarn Y, which is supplied from yarn supply means (not shown) including a weft supply package, as follows: with respect to the weaving-width direction, the flat yarn Y is guided at the position of the yarn inlet portion 11d (hereinafter, also referred to as "the yarn supply position") when the rapier head 10 is in the most advanced state; and with respect to the up-down direction, the flat yarn Y is guided from a position above the movement path of the rapier head 10 (shown

by an alternate long and short dash line P in Figs. 5 and 6) to a position below the movement path.

[0082] To be more specific, the yarn guide mechanism 50 includes a holding device 51 that holds the flat yarn Y at a position below the movement path P, a guide member 53 that guides the flat yarn Y at a position above the movement path P, a guide device 55 that guides the flat yarn Y toward the holding device 51, and a fluid-pressure cylinder 57 (such as an air cylinder) as driving means that switches the holding device 51 between a holding state and a non-holding state.

[0083] The holding device 51 includes a holding body that receives the flat yarn Y from above and holds a tip portion of the flat yarn Y. The holding body is structured like a clip as a whole and includes a holding member 51a on the base side, which serves as a holding base when holding the flat yarn Y, and a holding member 51b on the movable side, which is rotationally operated when holding the flat yarn Y. The holding members 51a and 51b are mainly composed of base portions 51a1 and 51b1, each of which has a substantially pyramidal shape, and have holding portions 51a2 and 51b2 at ends of the base portions 51a1 and 51b1 in the longitudinal direction.

[0084] In the holding members 51a and 51b, the holding portions 51a2 and 51b2 have dimensions larger than those of the base portions 51a1 and 51b1 with respect to the width direction of the holding members 51a and 51b, and are respectively continuous with the base portions 51a1 and 51b1 at middle parts thereof. Accordingly, the holding members 51a and 51b each have a T-shape when viewed in the thickness direction thereof. In addition, the holding members 51a and 51b are coupled to each other via a pivot shaft 51c at attachment portions 51a3 and 51b3, which are formed at substantially the middle part of the base portions 51a1 and 51b1 in the longitudinal direction. In the state in which the holding members 51a and 51b are coupled to each other in this way, the holding members 51a and 51b face each other in the thickness direction, and the positions of the holding portions 51a2 and 51b2 coincide with each other in the longitudinal direction of the base portions 51a1 and 51b1.

[0085] Moreover, the holding body includes compression springs 51d (in the example shown in the figures, two compression springs 51d) that are interposed between the base portions 51a1 and 51b1 at a position on a side of the attachment portions 51a3 and 51b3 opposite to a side on which the holding portions 51a2 and 51b2 are disposed with respect to the longitudinal direction of the base portions 51a1 and 51b1. In the holding body, the holding portions 51a2 and 51b2 of the holding members 51a and 51b are pressed against each other by the spring forces of the compression springs 51d.

[0086] The holding device 51 includes a support mechanism 51e for supporting the holding body (the holding member 51a on the base side) on the loom. Fig. 7 illustrates an example of the support mechanism 51e. AS illustrated in the figure, the support mechanism 51e includes a support plate 51e1 to which the holding member

51a on the base side is attached. The holding member 51a on the base side is attached to the support plate 51e1 at a side surface of the base portion 51a1 opposite to a side surface facing the holding member 51b on the movable side.

[0087] The support mechanism 51e includes a bracket 51e3 that supports the support plate 51e1. The support plate 51e1 is formed by bending a plate material into an L-shape. The holding member 51a on the base side can be attached to an inner side surface of a part of the support plate 51e1 closer to one end portion than the bent portion. The bracket 51e3 has an elongated plate-like shape. The support plate 51e1 is attached to the bracket 51e3 at an outer surface closer to the other end portion than the bent portion. In the state in which the support plate 51e1 is attached to the bracket 51e3, the holding member 51a is attached to the support plate 51e1 so that the longitudinal direction of the bracket 51e3 coincides with the longitudinal direction of the base portion 51a1 of the holding member 51a attached to the support plate 51e1. A part of the support plate 51e1 adjacent to the one end portion extends further than a part of the support plate 51e1 adjacent to the other end portion in the longitudinal direction of the bracket 51e3.

[0088] The support mechanism 51e includes a guide mechanism, such as an LM guide, composed of a rail 51e6 and a block 51e5, whose displacement is guided by the rail 51e6. The rail 51e6 is supported by the frame of the loom via appropriate support means or the like. The rail 51e6 is fixedly disposed at a position that is below the movement path P in the up-down direction and that is at the yarn supply position in the weaving-width direction so as to extend in the front-back direction. The bracket 51e3, to which the support plate 51e1 is attached as described above, is attached to an upper part of the block 51e5 of the guide mechanism in an orientation such that the longitudinal direction thereof coincides with the up-down direction.

[0089] Thus, the holding member 51a on the base side, which is attached to the support plate 51e1 as described above, and the holding member 51b on the movable side, which is coupled to the holding member 51a, are disposed on the loom in a state in which the holding member 51a is supported by the support mechanism 51e in a state in which the longitudinal direction of the base portions 51a1 and 51b1 coincides with in the up-down direction. In the guide mechanism of the support mechanism 51e, the block 51e5 is allowed to be displaced in the extension direction of the rail 51e6, that is, in the front-back direction, but is not allowed to be displaced in other directions. Accordingly, the position of the holding member 51a (the holding member 51b), which is supported by the block 51e5 via the bracket 51e3 and the support plate 51e1, is fixed with respect to the weaving-width direction.

[0090] In the state in which the holding members 51a and 51b are disposed on the loom, the holding members 51a and 51b are located below the movement path P as

described above. Due to the position of the support mechanism 51e (the rail 51e6) on the loom and the positional relationship between the holding member 51a on the base side and the support mechanism 51e (the rail 51e6) in a state in which the holding member 51a is attached to the support plate 51e1, the holding member 51a, which is provided on the loom as described above, is disposed in such a way that a surface of the holding portion 51a2 facing the holding member 51b on the movable side with respect to the weaving-width direction is located at the yarn supply position. Accordingly, a holding section 51h of the holding device 51, which is formed as the holding portions 51a2 and 51b2 of the holding members 51a and 51b are pressed against each other, are also located at the yarn supply position with respect to the weaving-width direction. Because the support mechanism 51e is supported by the frame of the loom via the guide mechanism described above, the holding members 51a and 51b are displaceable on the loom in the front-back direction.

[0091] The support mechanism 51e is coupled to a driving mechanism (not shown) for displacing the support mechanism 51e in the front-back direction and for displacing the holding members 51a and 51b in the front-back direction. Therefore, the support mechanism 51e includes a coupling member 51e7, and the coupling member 51e7 is attached to the bracket 51e3. The support mechanism 51e is coupled to the driving mechanism via the coupling member 51e7. The support mechanism 51e is (the holding members 51a and 51b are) driven to be displaced by the driving mechanism at a predetermined timing during a weft insertion period.

[0092] The yarn guide mechanism 50 includes the guide member 53, which guides the flat yarn Y as described above, and the guide member 53 is also supported by the support mechanism 51e. To be specific, the guide member 53 is a roller-like (shaft-like) member and is supported by the support plate 51e1 of the support mechanism 51e via an attachment plate 53a and a support arm 53b. The attachment plate 53a is formed by bending a plate material into an L-shape. The attachment plate 53a is attached to an outer surface of the one end portion of the support plate 51e1 at a part thereof closer to one end than the bent portion. In the state in which the attachment plate 53a is attached to the support plate 51e1, a part of the attachment plate 53a closer to the other end portion than the bent portion is located above the other end portion of the support plate 51e1 on the loom.

[0093] The support arm 53b is an elongated plate-shaped member and is attached to the attachment plate 53a at one end portion thereof in the longitudinal direction in such a way that the support arm 53b extends upward from the other end portion of the attachment plate 53a on the loom. The guide member 53 is supported only at the other end portion of the support arm 53b. In the state in which the guide member 53 is supported, the guide member 53 is located above the movement path P with respect to the up-down direction. That is, the support arm

53b has a length such that the guide member 53 is disposed at such a position. The guide member 53 is disposed, with respect to the weaving-width direction, on a side opposite to the side on which the reed R is disposed relative the holding portion 51a2 of the holding member 51a on the base side.

[0094] As described above, the guide member 53 is supported by the support mechanism 51e, which supports the holding members 51a and 51b. Accordingly, while the holding members 51a and 51b are driven to be displaced in the front-back direction as described above, the guide member 53 is displaced in the front-back direction in the same way. The holding members 51a and 51b and the guide member 53 are driven to be displaced, with respect to the front-back direction, between the following two positions: a reference position, which is a position overlapping the movement position of the rapier head 10; and a retreated position, which is separated from the movement position toward the cloth fell side.

The holding members 51a and 51b and the guide member 53 are usually disposed at the reference position. During a period from the time when the rapier head 10 is started to be driven to advance for weft insertion to the time when the rapier head 10 reaches the most advanced position, the holding members 51a and 51b and the guide member 53 are located the retreated position. When the rapier head 10 reaches the most advanced position and the flat yarn Y is guided into the yarn inlet portion 11d, the holding members 51a and 51b and the guide member 53 are displaced toward the reference position.

[0095] The yarn guide mechanism 50 further includes the fluid-pressure cylinder 57 as described above. The fluid-pressure cylinder 57 switches the holding device 51 between a holding state and a non-holding state. To be more specific, the fluid-pressure cylinder 57 switches the holding section 51h of the holding device 51 between a holding state, in which the holding portions 51a2 and 51b2 of the holding members 51a and 51b are pressed against each other, and a non-holding state, in which the holding portions 51a2 and 51b2 are separated from each other and the holding section 51h is opened.

[0096] The fluid-pressure cylinder 57 is fixed to the frame of the loom via appropriate support means or the like. The fluid-pressure cylinder 57 is disposed in such a way that a pressing body 57b, which is attached to an end of a piston rod 57a, faces, in weaving-width direction, the base portion 51b1 of the holding member 51b on the movable side at the reference position with respect to the front-back direction. The fluid-pressure cylinder 57 faces, with respect to the up-down direction, an end portion (lower end portion) of the base portion 51b1 on a side opposite to the holding portion 51b2 side in the longitudinal direction thereof. Moreover, the fluid-pressure cylinder 57 is disposed in such a way that, with respect to the weaving-width direction, the pressing body 57b is separated from the holding member 51b when the fluid-pressure cylinder 57 is activated (when the piston rod 57a is retreated) and the pressing body 57b presses the

lower end portion of the holding member 51b by a predetermined amount when the fluid-pressure cylinder 57 is deactivated (when the fluid-pressure cylinder 57 is advanced).

[0097] Accordingly, when the fluid-pressure cylinder 57 is activated, the lower end portion of the holding member 51b on the movable side is pressed as described above and becomes displaced against the spring forces of the compression springs 51d, and, as a result, the holding member 51b rotates around the pivot shaft 51c, which couples the holding members 51a and 51b, in a direction such that the holding portion 51b2 separates from the holding member 51a. Thus, the holding portion 51a2 of the holding member 51a on the base side and the holding portion 51b2 of the holding member 51b on the movable side, which have been pressed against each other as described above (as shown in Fig. 5) are separated from each other (as shown in Fig. 6), and the holding section 51h is opened.

[0098] The yarn guide mechanism 50 further includes the guide device 55, which guides the flat yarn Y toward the holding device 51, as described above. As illustrated in the figures, the guide device 55 has a guide plate 55a, which is formed by bending a thin plate by substantially a right angle at two positions.

[0099] Regarding the position of the guide plate 55a, the guide plate 55a is disposed, with respect to the weaving-width direction, in such a way that an end portion, which is closer to one end (end portion) than the bent portion, is, as a whole, at substantially the same position as the holding section 51h of the holding device 51. The guide plate 55a is disposed, with respect to the front-back direction, so as to be located at substantially the same position as the position of the holding section 51h (the holding portions 51a2 and 51b2) when the holding device 51 is located at the reference position. The guide plate 55a is disposed in such a way that an end edge 55a1 (an end edge on a side opposite to the bent portion side) of the end portion thereof extends horizontally at the lowest position. The width of the guide plate 55a (the dimension of the end edge 55a1 in the extension direction) is substantially the same as the dimension of the holding portions 51a2 and 51b2 in the width direction of the holding members 51a and 51b.

[0100] The guide plate 55a is supported in such a way that the guide plate 55a is attached to a bracket 55b at the position described above. The bracket 55b is attached, above the holding device 51 (to be specific, the holding member 51a on the base side), to a support portion (not shown) that is fixedly disposed so as to extend in the up-down direction on the loom so as to be displaceable in the up-down direction, via, for example, a guide mechanism (not shown) that is similar to the guide mechanism of the support mechanism 51e of the holding device 51. Accordingly, the guide plate 55a is displaceable in the up-down direction at the aforementioned position on the loom.

[0101] The bracket 55b is coupled to a driving mechanism (not shown) for displacing the guide plate 55a in the up-down direction.

The guide plate 55a is driven to be displaced by the driving mechanism in the up-down direction. The guide plate 55a is driven to be displaced, with respect to the up-down direction, so that the guide plate 55a is displaced between the following two positions: an elevated position, where the guide plate 55a (the end edge 55a1) is located above the guide member 53; and a lowered position, where the end edge 55a1 of the guide plate 55a is located below the holding portion 51a2 of the holding member 51a of the holding device 51. When the guide plate 55a is in a standby state, which is not an operating state in which guiding of the flat yarn Y to the holding device 51 is performed, the guide plate 55a is disposed at the upper standby position. When the guide plate 55a is in the operating state, the guide plate 55a is driven to be displaced toward the guide position.

[0102] Operational effects of the weft insertion device 1 structured as described above, in particular, operational effects of the yarn guide mechanism 50 is as follows.

[0103] Fig. 5 illustrates a state when weft insertion has been finished. The flat yarn Y supplied from the yarn supply means (weft supply package) is deflected toward the movement path P by the guide member 53, and is pulled out in the weaving-width direction toward the side opposite to the weft supply side. The weft insertion device 1 includes a cutting device 26 for cutting the flat yarn Y, which has been inserted as a weft, between the yarn guide mechanism 50 and the reed R in the weaving-width direction. The cutting device 26 illustrated in the figures is a cutting device that cuts the flat yarn Y while clamping the flat yarn Y. The cutting device 26 includes a cutting mechanism including a fixed blade 26a1 and a movable blade 26a2 and a clamping mechanism including a fixed clamping body 26b1 and a movable clamping body 26b2. The cutting device 26 is structured so that the movable blade 26a2 and the movable clamping body 26b2 are displaced together in the up-down direction. When the movable blade 26a2 and the movable clamping body 26b2 are not performing a cutting operation of cutting the flat yarn Y, the movable blade 26a2 and the movable clamping body 26b2 are disposed at positions that are separated upward from the fixed blade 26a1 and the fixed clamping body 26b1.

[0104] When weft insertion is finished, at a predetermined timing after finishing the weft insertion and before the next weft insertion is started, the movable blade 26a2 and the movable clamping body 26b2 of the cutting device 26 are driven, and the flat yarn Y is cut at the position of the cutting device 26. Thus, the flat yarn Y connected to the yarn supply means is cut off from the flat yarn Y that has been inserted as a weft. In this state, the tip portion of the flat yarn Y on the yarn supply means side is clamped by the fixed clamping body 26b1 and the movable clamping body 26b2 and held at the position.

[0105] In this state, as illustrated in Fig. 6, the fluid-pressure cylinder 57 is activated, and the holding section 51h of the holding device 51 is opened (the holding por-

tion 51a2 and the holding portion 51b2 are separated from each other). Moreover, in the guide device 55, the guide plate 55a (the bracket 55b), which is located at the elevated position, is driven to be displaced downward toward the lowered position. Thus, the guide plate 55a, which is located above the flat yarn Y extending toward the yarn supply means, first engages with the flat yarn Y at the end edge 55a1. Before the guide plate 55a engages with the flat yarn Y, the movable clamping body 26b2 of the cutting device 26 is driven upward, and the flat yarn Y, which has been clamped by the fixed clamping body 26b1 and the movable clamping body 26b2, is released.

[0106] As the guide plate 55a moves further downward from the time when the guide plate 55a engages with the flat yarn Y, the guide plate 55a guides the flat yarn Y downward while rubbing the flat yarn Y with the end edge 55a1. When the guide plate 55a reaches the lowered position, as illustrated in Fig. 6, the tip portion of the flat yarn Y is inserted into the holding section 51h of the holding device 51, which is opened (between the holding portion 51a2 and the holding portion 51b2). In this state, the guide plate 55a is driven to be displaced toward the elevated position, and the fluid-pressure cylinder 57 is deactivated. Thus, in the holding device 51, the holding member 51b on the movable side is rotated by the spring forces of the compression springs 51d so that the holding portion 51b2 is displaced toward the holding member 51a on the base side (the holding portion 51a2), and the flat yarn Y is clamped and held by the holding portion 51a2 and the holding portion 51b2.

[0107] In this state, the flat yarn Y is guided (deflected) by the guide member 53, which is located above the movement path P and extends to a position below the guide member 53, and the tip portion of the flat yarn Y is held by the holding members 51a and 51b, which are disposed below the movement path P. That is, with the yarn guide mechanism 50 (the holding device 51), after weft insertion is finished and the flat yarn Y is cut by the cutting device 26 as described above, the flat yarn Y is guided from a position above the movement path P to a position below the movement path P in the up-down direction. In this state, the holding members 51a and 51b of the holding device 51 and the guide member 53 are located, with respect to the front-back direction, at the reference position that overlaps the movement position of the rapier head 10 where the flat yarn Y is inserted as a weft.

[0108] When the flat yarn Y, which has been inserted as a weft, is beaten by the reed R and the next shed of the warp T is formed, the rapier head 10 is started to be driven to advance for the next weft insertion. Accordingly, in the yarn guide mechanism 50, the support mechanism 51e of the holding device 51 is driven to be displaced so that the holding members 51a and 51b and the guide member 53, which are located at the reference position as described above, are displaced toward the retreated position in the front-back direction. Thus, as illustrated in

Fig. 8, the holding members 51a and 51b and the guide member 53 are located at the retreated position, which is separated from the movement position of the rapier head 10 toward the cloth fell side in the front-back direction. At this time, the opener 31 on the weft supply side is located at the non-operating position as the support lever 33 is driven as described above.

[0109] When the rapier head 10 is driven to advance as described above and reaches the most advanced position, the rapier head 10 is located, in plan view, between the holding members 51a and 51b and the guide member 53 (and the flat yarn Y, which is guided in the up-down direction so as to extend between the guide member 53 and the holding members 51a and 51b) and the opener 31. In this state, as described above, the first engagement portion 17a of the operation lever 17 of the rapier head 10 (the first engagement surface 17a1) and the opener 31 face each other in the front-back direction, and the position of the yarn inlet portion 11d of the rapier head 10 and the position of the holding section 51h of the holding device 51 substantially coincide with each other in the weaving-width direction.

[0110] In this state, first, the support lever 33 is driven to swing and the opener 31 is displaced toward the operating position; and, as illustrated in the upper part of Fig. 9, the opener 31 engages with the operation lever 17 of the rapier head 10 (the first engagement surface 17a1 of the first engagement portion 17a). Thus, in the rapier head 10, the opening operation is performed, and the gripping mechanism is opened as described above. The yarn inlet portion 11d, which is formed as a space portion in the rapier head 10 (the head body 11), is closed to the outside when the gripping portion 13b of the yarn catch 13 is pressed against the head portion 11b of the head body 11 (when the gripping mechanism is closed). When the gripping mechanism of the rapier head 10 is opened as described above (when the opening operation is performed), the yarn inlet portion 11d is opened to the outside.

[0111] Then, in the state in which the gripping mechanism of the rapier head 10 (the yarn inlet portion 11d) is opened, in the holding device 51 of the yarn guide mechanism 50, the support mechanism 51e is driven to be displaced so that the holding members 51a and 51b and the guide member 53 are displaced toward the reference position with respect to the front-back direction. Accordingly, in the yarn guide mechanism 50, a portion of the flat yarn Y guided in the up-down direction as described above is displaced to a position that overlaps the rapier head 10 in the front-back direction. Thus, the portion of the flat yarn Y (to be precise, a part of the portion located at the same height as the rapier head 10 in the up-down direction) is guided into the yarn inlet portion 11d of the rapier head 10 that is opened as described above. Fig. 9 illustrates a state in which the flat yarn Y is guided into the yarn inlet portion 11d in this way.

[0112] When the flat yarn Y is guided into the yarn inlet portion 11d of the rapier head 10 in this way, the support

lever 33 is driven to swing in a direction opposite to the aforementioned direction and the opener 31 is displaced toward the non-operating position, and the opener 31 is separated from the operation lever 17 of the rapier head 10 (the first engagement portion 17a) again. Thus, in the rapier head 10, the gripping portion 13b of the yarn catch 13 is pressed against the head portion 11b of the head body 11 again, and the flat yarn Y is gripped by the gripping portion 13b and the head portion 11b of the gripping mechanism.

[0113] In the yarn guide mechanism 50, the fluid-pressure cylinder 57 is activated again, and the holding section 51h of the holding device 51 is opened (the holding portion 51a2 and the holding portion 51b2 are separated from each other). Thus, the flat yarn Y, the tip portion of which has been held by the holding members 51a and 51b of the holding device 51, is released from the holding device 51.

[0114] After the flat yarn Y has been released from the holding device 51, the rapier head 10 is started to be driven to retreat, and the rapier head 10, which is holding the flat yarn Y with the gripping mechanism as described above, starts moving rearward toward the standby position. Thus, the tip portion of the flat yarn Y is pulled out from the inside of the holding section 51h of the holding device 51 (between the holding portion 51a2 and the holding portion 51b2), a portion of the flat yarn T connected to the yarn supply means is pulled out into the shed of the warp T as the rapier head 10 moves rearward, and thereby weft insertion is performed. When the tip portion of the flat yarn Y is pulled out from the holding section 51h, the fluid-pressure cylinder 57 is deactivated, the holding device 51 returns to a state before holding the flat yarn Y (before the tip portion of the flat yarn Y is inserted) again to prepare for the next weft insertion.

[0115] When the rapier head 10 is driven to retreat and reaches a position near the standby position, in the rapier head 10, the second engagement surface 17b1 of the second engagement portion 17b of the operation lever 17 engages with the opener 41 on the side opposite to the weft supply side, and the operation lever 17 is released from the gripping mechanism. Thus, the flat yarn Y is released from a state in which the leading end portion thereof is gripped by the rapier head 10. Subsequently, when the rapier head 10 moves back to the standby position, one weft insertion is complete.

[0116] As heretofore described, in the present embodiment, the weft insertion device 1 is based on a structure such that the flat yarn Y is guided into the yarn inlet portion 11d of the rapier head 10 in such a way that the flat yarn Y, which is guided at a position that overlaps the movement position of the rapier head 10 on the weft supply side with respect to the front-back direction, and the leading end portion of the rapier head 10 do not interfere with each other while the rapier head 10 advances toward the most advanced position. In order to realize guiding of the flat yarn Y into the yarn inlet portion 11d in such a way, in contrast to the existing device, the weft insertion device

1 has a structure such that the flat yarn Y is actively displaced so as to avoid the movement position of the rapier head 10. That is, the weft insertion device 1 includes the yarn guide mechanism 50 for realizing such an active displacement of the flat yarn Y.

[0117] Accordingly, with the structure of the weft insertion device 1, it is not necessary that the rapier head is structured so that one of the gripping portions is driven to be displaced as in the existing device, and therefore the structure of the rapier head 10 can be made simpler than that of the existing device. Thus, the rapier head 10 can be reciprocated stably at high speed, and a failure of the rapier head 10 in gripping the flat yarn Y can be reduced as far as possible. Here, the term "the existing device" refers to the device described above, in which a portion of a rapier head including one of a pair of gripping surfaces (one of gripping portions closer to the leading end of the rapier head than the yarn inlet portion) is displaceable and the one of the gripping portions is driven to be displaced while the rapier head advances.

[0118] The weft insertion device 1 according to the present embodiment is, as described above, a band-rapier weft insertion device that uses the rapier band 21 as a member for reciprocating the rapier head 10. Such a band-rapier weft insertion device is more general than a bar-rapier weft insertion device that uses a bar as the drive member, because a structure for reciprocating the rapier head, including the drive member, has a smaller size. In addition, the weft insertion device 1 is structured, as described above, so that the first engagement portion 17a and the second engagement portion 17b of the operation lever 17 engage with the openers 31 and 41 at side surfaces thereof (the first engagement surface 17a1 and the second engagement surface 17b1). In particular, in the present embodiment, the opener 31, which engages with the operation lever 17 when the rapier head 10 at the most advanced position farthest from the driving device, is structured so as to be displaced as described above and engage with the first engagement portion 17a.

[0119] With this structure, even when the rapier head 10 (the operation lever 17) and the opener 31 engage with each other during the opening operation that is performed before insertion of the flat yarn Y as a weft (insertion into the shed of the warp T) in one weft insertion period, buckling of the rapier band 21 does not occur due to the engagement. Accordingly, when inserting the flat yarn Y as a weft after the opening operation, problems, such as an irregular position of the rapier head 10, do not occur, and weft insertion is stably performed.

[0120] The rapier head 10 of the weft insertion device 1 according to the present embodiment is structured so that the operation lever 17, which is operated for the opening operation, includes the first engagement portion 17a, which engages with the opener 31 on the weft supply side, and the second engagement portion 17b, which engages with the opener 41 on the side opposite to the weft supply side; and the second engagement portion 17b is located on the rear side relative to the first engagement

portion 17a with respect to the longitudinal direction of the rapier head 10. With this structure, it is possible to make the timing with which the operation lever 17 engages with the opener 41 on the side opposite to the weft supply side earlier than in a case where, for example, a part of the operation lever that engages with the opener on the weft supply side engages also with the opener on the side opposite to the weft supply side. That is, with this structure, it is possible to shorten the period from the time when the rapier head 10 moves out of the shed of the warp T on the side opposite to the weft supply side to the time when the next opening operation is started. Thus, the length of a feathered selvage of a woven fabric on the side opposite to the weft supply side can be made as short as possible.

[0121] Moreover, as described above, the weft insertion device 1 according to the present embodiment is structured so that the swing amount of the operation lever 17 in the opening operation performed on the side opposite to the weft supply side is smaller than that in the opening operation performed on the weft supply side, that is, so that the opening amount of the gripping mechanism of the rapier head 10 on the side opposite to the weft supply side is smaller than that on the weft supply side. Regarding this structure, on the weft supply side, because the flat yarn Y is guided into the yarn inlet portion 11d that is opened by the opening operation, it is preferable that the opening amount be larger in order to reduce failure in guiding the flat yarn Y. On the other hand, on the side opposite to the weft supply side, because it is only necessary that the flat yarn Y can be released from the gripping mechanism of the rapier head 10, the opening amount need not be large and may be small. Therefore, in the weft insertion device 1 according to the present embodiment, a structure for swinging the operation lever 17 on the weft supply side is set as described above.

[0122] For example, if the opening amount on the side opposite to the weft supply side is to be increased in the structure according to the present embodiment, the rapier head 10 needs to be structured so that the second engagement portion of the operation lever 17 protrudes in the width direction from the head body 11 by a distance larger than that of the second engagement portion 17b according to the present embodiment (in a state in which the second engagement portion is not engaged with the opener on the side opposite to the weft supply side). In this case, in order that the opener on the side opposite to the weft supply side can engage with the second engagement portion, which protrudes by a large distance in this way, the opener on the side opposite to the weft supply side needs to be formed so that the inclined surface of the inner side surface is large in the front-back direction and long in the weaving-width direction, compared with the opener 41 according to the present embodiment. In this case, the standby position is set at a position that is separated by a distance larger than that of the aforementioned position according to the present

embodiment. As a result, the driving amount until the rapier head 10 reaches the standby position increases, and, due to the increase in the driving amount, it takes a longer time before one weft insertion is complete. In contrast, with the structure according to the present embodiment, the drive amount can be made as small as possible, and the time before one weft insertion is complete can be made as short as possible.

[0123] Heretofore, the weft insertion device according to an embodiment of the present invention the present invention (hereinafter, referred to as "the embodiment") has been described. However, the present invention is not limited to the embodiment, and may be realized in other embodiments (modifications) as described below.

(1) Regarding the yarn guide mechanism, in the embodiment, the yarn guide mechanism 50 includes the holding device 51 that holds the flat yarn Y below the movement path P, and a structure of the holding device 51 for holding the flat yarn Y (hereinafter, referred to as "the holding structure") is composed of the holding member 51a on the base side and the holding member 51b on the movable side as described above. The yarn guide mechanism 50 according to the embodiment includes the fluid-pressure cylinder 57, which is driving means for actively switching the holding device 51 between the holding state and the non-holding state.

[0124] However, even in the case where the holding device of the yarn guide mechanism (the holding structure) is structured as in the embodiment, in the present invention, a yarn guide mechanism need not have the driving means (fluid-pressure cylinder) as in the embodiment. That is, in the yarn guide mechanism according to the embodiment, the fluid-pressure cylinder 57 may be omitted.

[0125] To be specific, in the embodiment, the holding structure is structured so that the holding portion 51b2 of the holding member 51 b on the movable side is pressed against the holding portion 51a2 of the holding member 51a on the base side by the compression springs 51d. The driving means is a device that displaces the holding portion 51b2 (the holding member 51b) so that the holding portion 51b2 separates from the holding portion 51a2 in order to facilitate insertion of the flat yarn Y into the space (the holding section 51h) between the holding portions 51a2 and 51b2. In addition, insertion of the flat yarn Y into the space between the holding portions 51a2 and 51b2 is performed by displacing the guide plate 55a of the guide device 55 downward to the space between the holding portions 51a2 and 51b2 as described above. However, when inserting the flat yarn Y into the space between the holding portions 51a2 and 51b2 while guiding the flat yarn Y by using the guide plate 55a in this way, it is not necessary to actively open the holding section 51h with the driving means as described above. Instead, it is possible to insert the flat yarn Y by moving the

guide plate 55a downward and pressing the guide plate 55a into the space between the holding portions 51a2 and 51b2, because the holding portion 51b2 is displaced by the pressing force. Accordingly, in the yarn guide mechanism, the driving means (the fluid-pressure cylinder 57 in the embodiment) for the holding device may be omitted.

(2) Regarding the holding device of the yarn guide mechanism, the holding structure of the holding device 51 according to the embodiment is such that the two holding members 51a and 51b hold the flat yarn Y. However, the holding device of the yarn guide mechanism according to the present invention is not limited to a device having a holding structure that mechanically holds the flat yarn Y in this way. For example, the holding device may have a holding structure that holds the flat yarn Y by using a suctioning airflow, such as a suction pipe. The holding device may have a holding structure having a combination of elastic members, such as a pair of plate springs. Also in these cases, as describe above in (1), the driving means of the weft insertion device (yarn guide mechanism) is omitted.

(3) Regarding the yarn guide mechanism, in the embodiment, the holding structure (the holding section 51h) of the holding device 51 is displaceable in the front-back direction, and a driving mechanism for displacing the holding structure is included in the yarn guide mechanism. The yarn hold mechanism is structured so that, in order to prevent interference between the leading end portion of the rapier head 10 and the flat yarn Y when the rapier head 10 advances toward the most advanced position, before the rapier head 10 reaches the most advanced position, the yarn hold mechanism displaces the holding structure and the guide member 53, which guides a portion of the flat yarn Y in the up-down direction in cooperation with the holding structure and which is supported by the holding device 51, in the front-back direction. That is, the weft insertion device according to the embodiment is structured so that a portion of the flat yarn Y guided by a yarn guide mechanism in the up-down direction is actively displaced the front-back direction due to the displacement of the holding structure and the guide member of the yarn guide mechanism before the rapier head 10 reaches the most advanced position.

[0126] However, in the weft insertion device according to the present invention, the yarn guide mechanism is not limited to the mechanism described above with which the holding structure and the guide member, which guide the flat yarn Y in the up-down direction, are displaced in the front-back direction. Instead, the holding structure and the guide member may be fixedly disposed at a predetermined position (the reference position) in the front-back direction. In this case, the flat yarn Y is guided into

the yarn inlet portion of the rapier head is performed by corporation of guiding of the flat yarn Y in the up-down direction by the yarn guide mechanism and the reciprocating motion of the rapier head 10. To be specific, Figs. 11A to 11D illustrate an example of such a structure.

[0127] A rapier head 10' in the example illustrated in Figs. 11A to 11D differs from the rapier head 10 according to the embodiment in that a head portion 11b' is formed so that an extreme end 11g' is within a range of a coupling portion 11c' with respect to the width direction, that is, the extreme end 11g' is located, in the width direction, closer to the coupling portion 11c' than the yarn inlet portion 11d' (on a side of the yarn inlet portion 11d' opposite to the opening in the front-back direction). Although not illustrated, with respect to the front-back direction, the holding structure and the guide member of the yarn guide mechanism are fixedly disposed at the reference position as described above. Accordingly, the flat yarn Y is guided in the up-down direction at the position. In Figs. 11A to 11D, Y' represents a part of a portion (hereinafter, referred to as "the guided portion") of the flat yarn Y guided in the up-down direction as described above, the part being located at the same height as the rapier head 10' in the guided portion.

[0128] With the structure illustrated in Figs. 11A to 11D, when the rapier head 10' is driven to advance and reaches a position near the most advanced position, as shown in Fig. 11A, an inclined surface at the leading end of the rapier head 10', which is inclined from the extreme end 11g' of the head portion 11b' toward the yarn inlet portion 11d', engages with the part Y' of the flat yarn Y. After the engagement, as the rapier head 10' further advances, as illustrated in Fig. 11B, the flat yarn Y (the part Y') is guided by the inclined surface of the rapier head 10', is displaced toward the rear side in the weaving-width direction relative to the rapier head 10', and is displaced toward the cloth fell side in the front-back direction (the direction parallel to the width direction).

[0129] As described above, the positions of the holding structure and the guide member of the yarn guide mechanism in the front-back direction are fixed. Therefore, as the part Y' of the guided portion of the flat yarn Y, which engages with the rapier head 10', is displaced as described above, the guided portion is bent at the engaging part Y' in front view.

[0130] Subsequently, as the rapier head 10' advances further, the flat yarn Y (the part Y') is further displaced as described above, and the flat yarn Y (the part Y') moves over a side edge of the head portion 11b' of the rapier head 10' opposite to the coupling portion in the width direction. Fig. 11C illustrates a state immediately before the flat yarn Y moves over the side edge. When the part Y' moves over the side edge of the head portion 11b' in this way, the guided portion of the flat yarn Y tries to return to the original state from the state in which the flat yarn Y is bent as described above due to the tension thereof, and thereby the part Y' is displaced in a direction away from the cloth fell in the front-back direction. As a

result, the flat yarn Y (the part Y') is guided into the yarn inlet portion 11d' of the rapier head 10'.

[0131] As described above, in the example illustrated in Figs. 11A to 11D, the weft insertion device is structured so that, by cooperation of guiding of the flat yarn Y in the up-down direction by the yarn guide mechanism, the structure of the rapier head 10', and the advance of the rapier head 10', the flat yarn Y is displaced in the front-back direction while the rapier head 10' advances to the most advanced position, and the flat yarn Y is guided into the yarn inlet portion 11d' of the rapier head 10' after the displacement.

[0132] In the case where the weft insertion device is structured as described above, the guided portion of the flat yarn Y is bent while being guided by the inclined surface of the head portion 11b' of the rapier head 10' as described above. When the guide portion is bent, the tension of the guided portion increases. Therefore, in the case where the weft insertion device is structured as described above, in order to prevent the tension of the guided portion of the flat yarn Y from increasing excessively, it is preferable that the holding device of the yarn guide mechanism be structured so that the holding structure thereof holds the flat yarn Y by using suction airflow as described above.

(4) Regarding the yarn gripping member and the operated member of the rapier head, in the embodiment, the rapier head 10 has the yarn catch 13, the gripping portion 13b of the yarn catch 13 corresponds to a yarn gripping member, and a combination of the guide portion 13a and the receiving portion 13c corresponds to an operated member. That is, in the structure according to the embodiment, the yarn gripping member and the operated member are integrally formed, and each of the yarn gripping member and the operated member is a part of a single member (the yarn catch 13).

[0133] However, in the weft insertion device according to the present invention, the rapier head is not limited to a head in which the yarn gripping member and the operated member are integrally formed as in the embodiment. The rapier head may be a head in which a yarn gripping member and an operated member are formed independently from each other, the yarn gripping member is disposed in a head body so as to be displaceable in the longitudinal direction of the rapier head, and an operated member may be provided in such a way that the operated member is coupled to the yarn gripping member so as to displace the yarn gripping member in the longitudinal direction.

[0134] Fig. 12 illustrates a specific example of the structure. In the structure illustrated in Fig. 12, regarding the head body of the rapier head, elements of the head body are basically the same as those of the head body 11 according to the embodiment except for portions related to this modification, and are denoted by the same

reference numerals.

[0135] Regarding the structure illustrated in Fig. 12, a yarn gripping member 18a is a plate-shaped member that is formed in a shape similar to the gripping portion 13b according to the embodiment. However, the yarn gripping member 18a is formed in such a way that the dimension of one end portion thereof in the thickness direction is smaller than those of other portions. That is, the yarn gripping member 18a has a small-thickness portion (a thin portion 18a1) in the one end portion. The yarn gripping member 18a is supported in such a way that the thin portion 18a1 is coupled to the coupling portion 11c of the head body 11 via a pivot shaft 18c. A recess 11c1 is formed in the coupling portion 11c, and the thin portion 18a1 of the yarn gripping member 18a is contained in the recess 11c1. With this structure, the yarn gripping member 18a is swingable in the yarn inlet portion 11d of the head body 11 between a position where a side surface thereof facing the head portion 11b contacts the end surface 11b1 of the head portion 11b and a position where the side surface is separated from the end surface 11b1.

[0136] An operated member 18b is formed basically similar to the combination of the guide portion 13a and the receiving portion 13c of the yarn catch 13 according to the embodiment. The operated member 18b is displaceable in the longitudinal direction of the rapier head while being guided by the guide body 14 and is constantly urged toward the head portion 11b (toward the yarn gripping member 18a) by a compression spring. The dimension, in the thickness direction, of an end portion of the operated member 18b adjacent to the yarn gripping member 18a is smaller than those of other portions. That is, the operated member 18b has a small-thickness portion (a thin portion 18b1) adjacent to the yarn gripping member 18a. A coupling pin 18b2 is attached to the thin portion 18b1 of the operated member 18b so as to extend in the thickness direction.

[0137] A slot 18a2 is formed in a part of the yarn gripping member 18a coupled to the operated member 18b. Moreover, a part of the yarn gripping member 18a including the slot 18a2 is formed as a thin portion having a small dimension in the thickness direction. In addition, the yarn gripping member 18a and the operated member 18b are coupled to each other by inserting the coupling pin 18b2, which is attached to the thin portion 18b1 of the operated member 18b, into the slot 18a2 of the yarn gripping member 18a.

[0138] With this structure, because the operated member 18b is urged toward the head portion 11b by the compression spring, in a normal state, the side surface of the yarn gripping member 18a is pressed against the end surface 11b1 of the head portion 11b by an urging force applied via the coupling pin 18b2. When the operation lever 17 engages with the opener and thereby the operated member 18b is displaced toward the rear side, in accordance with the displacement, the yarn gripping member 18a swings around the pivot shaft 18c so that a

part thereof coupled to the operated member 18b is displaced toward the rear side. Thus, the side surface of the yarn gripping member 18a separates from the end surface 11b1 of the head portion 11b, and the yarn inlet portion 11d is opened.

[0139] In this example, the yarn gripping member is swung to be displaced by the operated member as described above. In this case, because the displacement direction of the yarn gripping member includes a component in the longitudinal direction, the side surface of the yarn gripping member is separated from the end surface 11b1 of the head portion 11b in the longitudinal direction. Thus, in the present invention, a yarn gripping member that is "displaceable in the longitudinal direction of the rapier head" is not limited to the yarn gripping member according to the embodiment, which is displaceable parallel to the longitudinal direction. The yarn gripping member may be displaceable in a direction including a component in the longitudinal direction, and may be swung to be displaced as in this example.

(5) Regarding the operation lever of the rapier head, in the embodiment, the operation lever 17 has a substantially Z-shape as a whole as described above. To be specific, the operation lever 17 includes the support portion 17c supported by the head body 11, a portion (the first portion 17a) extending in the short-side direction from one end portion of the support portion 17c in the long-side direction, and a portion (the second portion 17b) extending toward the opposite side in the short-side direction from the other end portion of the support portion 17c in the long-side direction. The first portion 17a functions as a first engagement portion, and the second portion 17b functions as a second engagement portion.

[0140] However, an operation lever of the rapier head of the weft insertion device according to the present invention is not limited to the operation lever structured as in the embodiment. For example, the operation lever may be an operation lever 17' illustrated in Fig. 13, in which the second portion is omitted and which only includes the support portion 17c' and the first portion 17a' described above. With this structure, on the weft supply side, in the same way as in the embodiment, the operation lever 17' is swung when the first portion 17a' engages with the opener 31 on the yarn supply side, and, also on the side opposite to the weft supply side, the operation lever 17' is swung when the first portion 17a' engages with the opener 41 on the side opposite to the weft supply side. Accordingly, with this structure, the first portion 17a' functions as the first engagement portion as in the embodiment and also functions as the second engagement portion.

[0141] As is also the case the example shown in Fig. 13, in the embodiment, the weft insertion device is structured so that the swing amount of the operation lever when the operation lever engages with the opener (the

opening amount of the gripping mechanism) on the side opposite to the weft supply side is smaller than that on the weft supply side. However, a weft insertion device according to the present invention need not be structured in this way, and may be structured so that the swing amount on the side opposite to the weft supply side is the same as the swing amount on the weft supply side.

(6) Regarding the openers for swinging the operation lever, in the embodiment, the opener 31 on the weft supply side is disposed so that the opener 31 can move closer to or away from the operation lever of the rapier head that has reached the most advanced position, and the opener 41 on the side opposite to the weft supply side is fixedly disposed at a position, with respect to the front-back direction, such that the opener 41 can engage with the operation lever of the rapier head.

[0142] However, in the weft insertion device according to the present invention, the opener on the weft supply side may be, as with the opener on the side opposite to the weft supply side according to the embodiment, fixedly disposed at a position such that the opener can engage with the operation lever of the rapier head with respect to the front-back direction. In the case where the rapier head is structured as in the embodiment, the operation lever engages with the fixedly-disposed opener at an outer side surface thereof that forms an acute angle relative to the advancing direction of the rapier head. Accordingly, with such a structure, compared with the existing structure such that the opener and the operation portion of the rapier head engage with each other at a surface perpendicular to the advancing direction of the rapier head, a force applied to the rapier head in a direction opposite to the advancing direction at the time of the engagement is small. Thus, with this structure, because buckling of the rapier band is less likely to occur (in particular, buckling is almost unlikely to occur when the rotation speed of the loom is low), even when the opener on the weft supply side is fixedly disposed as described above, a problem is not likely to occur.

[0143] In the embodiment, the opener on the side opposite to the weft supply side is fixedly disposed as described above. However, as with the opener on the weft supply side according to the embodiment, the opener on the side opposite to the weft supply side may be disposed so that that the opener can move closer to or away from the operation lever of the rapier head in the front-back direction. In addition, by using an appropriate driving mechanism, the opener may be driven to be displaced toward the rapier head (operation lever) when the operation lever of the rapier head, which is retreating toward the standby position, reaches a region where the opener is present with respect to the weaving-width direction.

(7) In the embodiment, the weft insertion device is a band-*rapier* weft insertion device that uses a band

member as a driving member that reciprocates the rapier head. However, the present invention can be applied to a bar-*rapier* weft insertion device that uses a bar member as the driving member.

[0144] The present invention is not limited to any of the embodiments described above and may be modified in various ways within the spirit and scope of the present invention.

Claims

1. A weft insertion device (1) for a rapier loom that performs weaving by using a tape-shaped flat yarn (Y) as a weft, the weft insertion device (1) being a single-*rapier* weft insertion device with which a rapier head (10, 10'), whose standby position is set on a side opposite to a weft supply side, advances toward the weft supply side, grips the flat yarn (Y) on the weft supply side, and inserts the flat yarn (Y) as a weft while retreating, the weft insertion device (1) comprising:

a yarn guide mechanism (50) that includes a holding device (51) that holds a tip portion of the flat yarn (Y) supplied from a weft supply package on the weft supply side and that guides the flat yarn (Y) from a position above a movement path (P) of the rapier head (10, 10') to a position below the movement path (P) with respect to an up-down direction, the yarn guide mechanism (50) displacing, independently or in cooperation with the rapier head (10, 10'), the flat yarn (Y) in a direction parallel to a width direction of the rapier head (10, 10'),

wherein the rapier head (10, 10') includes a head body (11) that includes a yarn inlet portion (11d, 11d'), into which the flat yarn (Y) is guided, in a leading end portion thereof, a yarn gripping member (13b) that is displaceable in the yarn inlet portion (11d, 11d') in a longitudinal direction of the rapier head (10, 10'), an operated member that is displaceable in the head body (11) in the longitudinal direction and that is coupled to the yarn gripping member (13b), and an operation lever (17) that is operated by engaging with openers (31, 41) that are provided on the weft supply side and the side opposite to the weft supply side and that displaces the operated member in the longitudinal direction, wherein the yarn inlet portion (11d, 11d') is defined by inner side surfaces of the head body (11) that form an angular U-shape in plan view so as to be open toward one side in the width direction and in the up-down direction, wherein one inner side surface (11b1) of the inner side surfaces that define the yarn inlet por-

tion (11d, 11d'), the one inner side surface (11b1) facing in a retreating direction of the rapier head (10, 10'), functions as one of a pair of gripping surfaces for gripping the flat yarn (Y), and a surface (13b1) of the yarn gripping member (13b) that faces the one of the gripping surfaces functions as the other of the gripping surfaces, and

wherein, immediately before weft insertion is started, the flat yarn (Y) is guided into the yarn inlet portion (11d, 11d') while the flat yarn (Y) is displaced by the yarn guide mechanism (50) in the width direction.

2. The weft insertion device (1) for a rapier loom according to Claim 1, wherein the rapier head (10, 10') is structured so that the operation lever (17) is swingable in the width direction relative to the head body (11) and the operated member is displaced in the longitudinal direction by a swinging operation of the operation lever (17) due to engagement of the operation lever (17) with the openers (31, 41), and wherein the operation lever (17) includes a first engagement portion (17a) that engages with the opener (31) on the weft supply side and a second engagement portion (17b) that engages with the opener (41) on the side opposite to the weft supply side, the first engagement portion (17a) and the second engagement portion (17b) protrude from the head body (11) in the width direction in a state in which the first engagement portion (17a) and the second engagement portion (17b) are not engaged with the corresponding openers (31, 41), and the first engagement portion (17a) and the second engagement portion (17b) engage with the corresponding openers (31, 41) at side surfaces thereof.
3. The weft insertion device (1) for a rapier loom according to Claim 2, wherein the operation lever (17) has the first engagement portion (17a) at a position closer to one end thereof than a swing center thereof and has the second engagement portion (17b) at a position closer to the other end thereof than the swing center, the second engagement portion (17b) is located in the retreating direction from the first engagement portion (17a) with respect to the longitudinal direction, and, with respect to the width direction, the first engagement portion (17a) protrudes toward one side relative to the head body (11) and the second engagement portion (17b) protrudes toward the other side relative to the head body (11).

FIG. 1

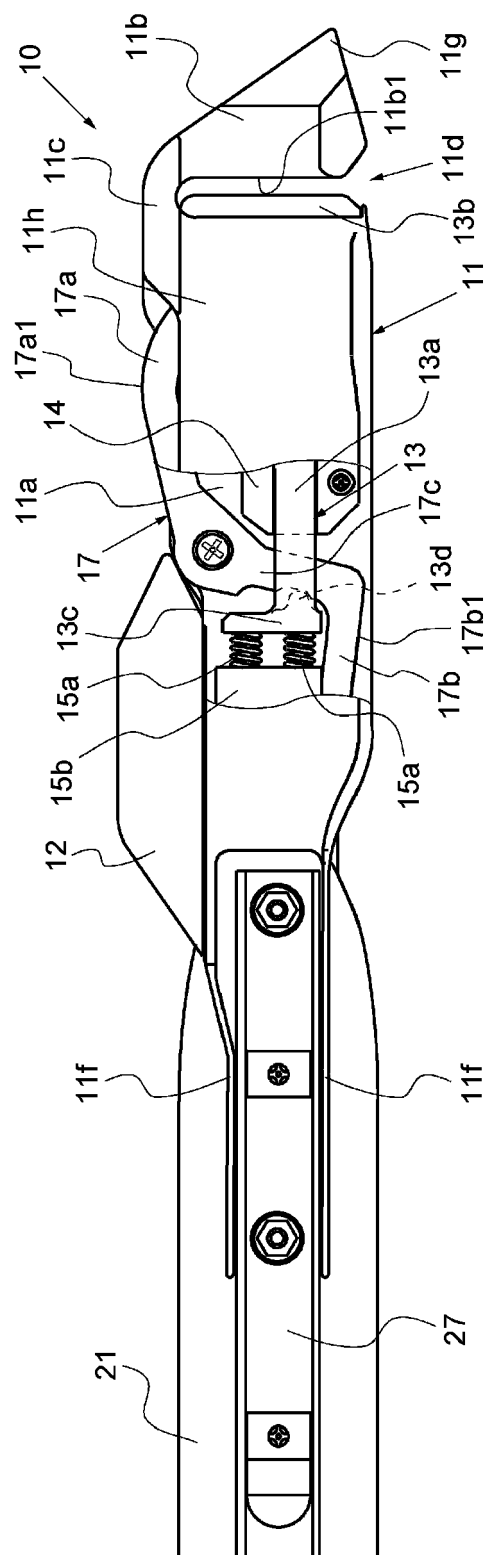
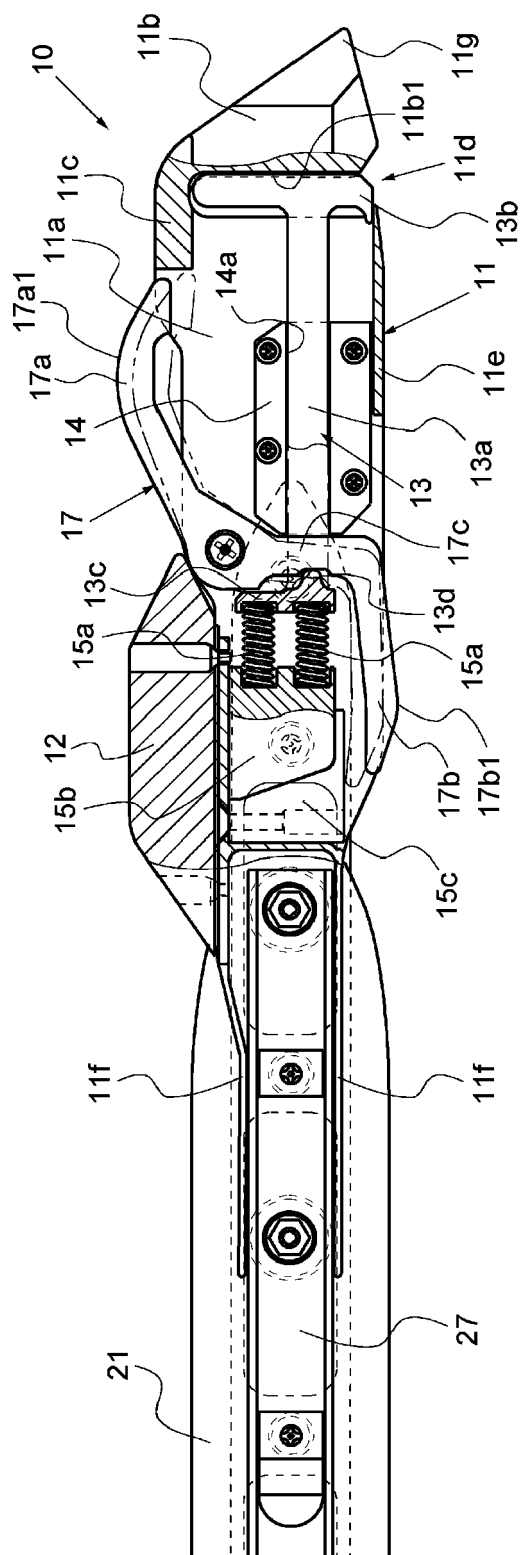


FIG. 2

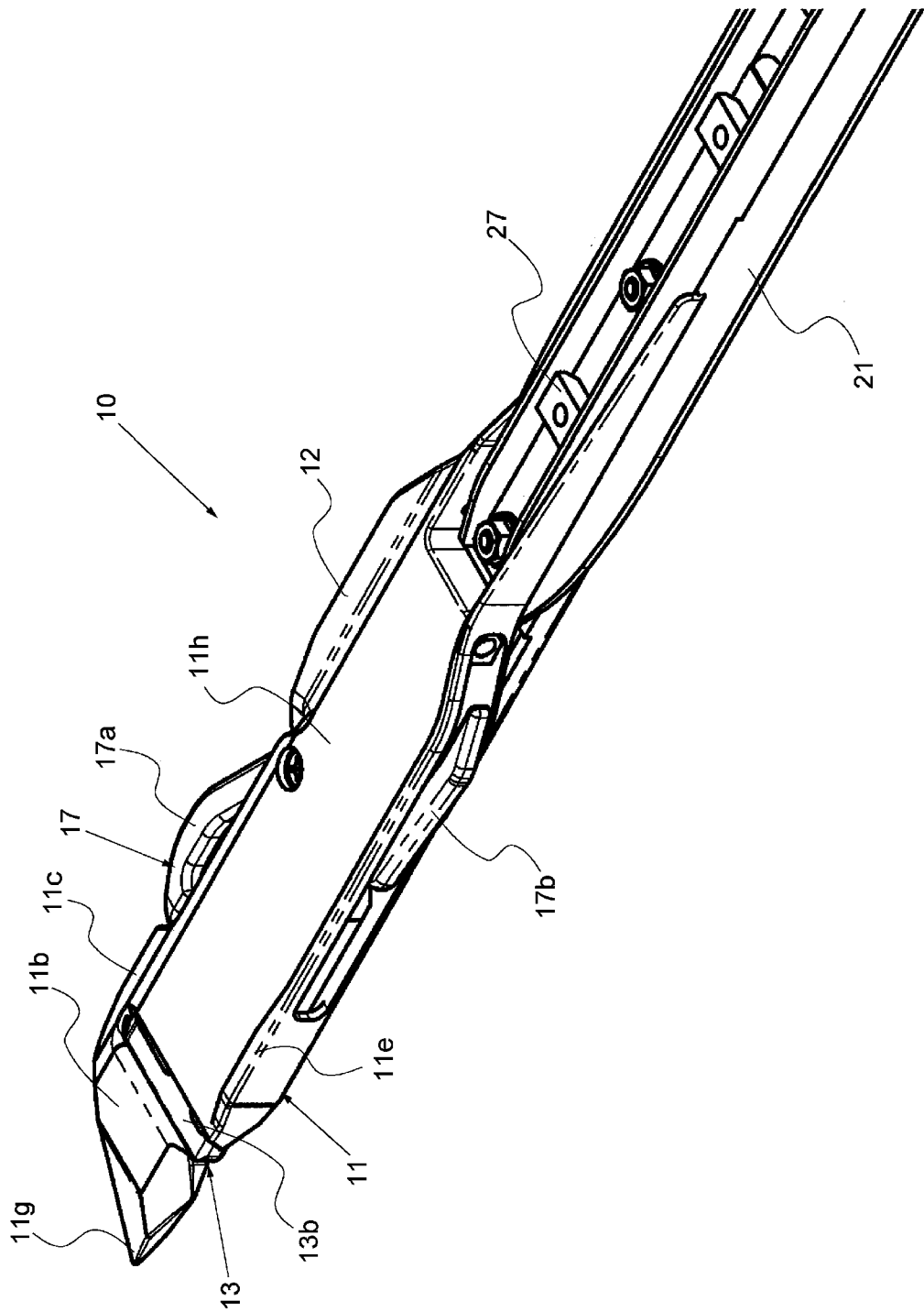


FIG. 3A

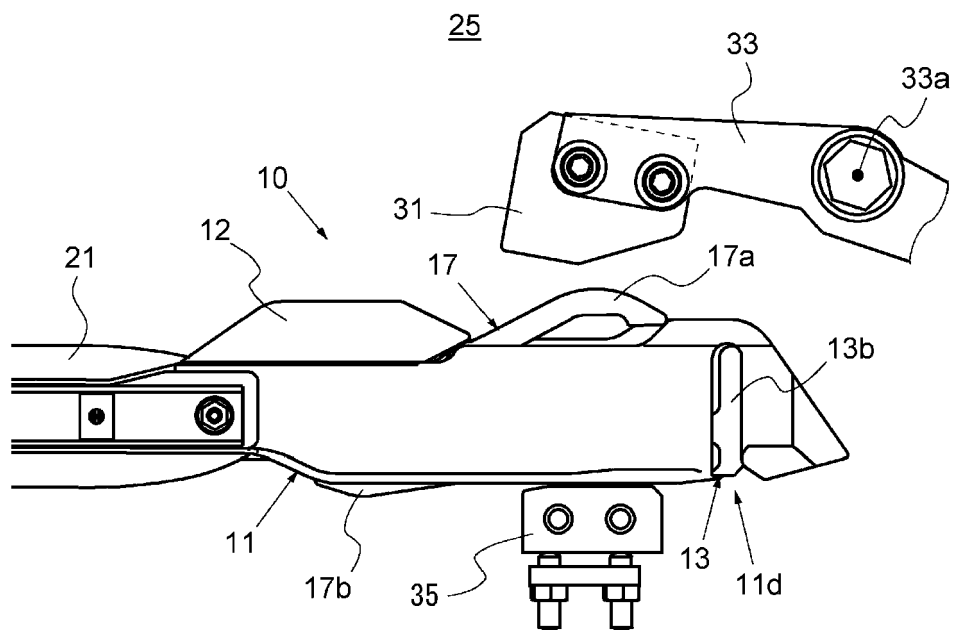
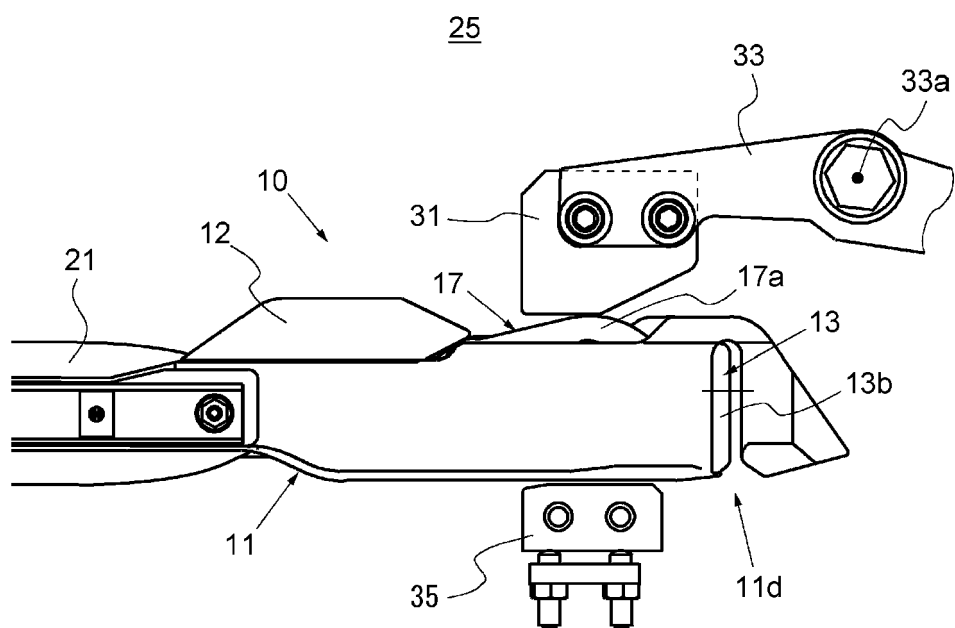


FIG. 3B



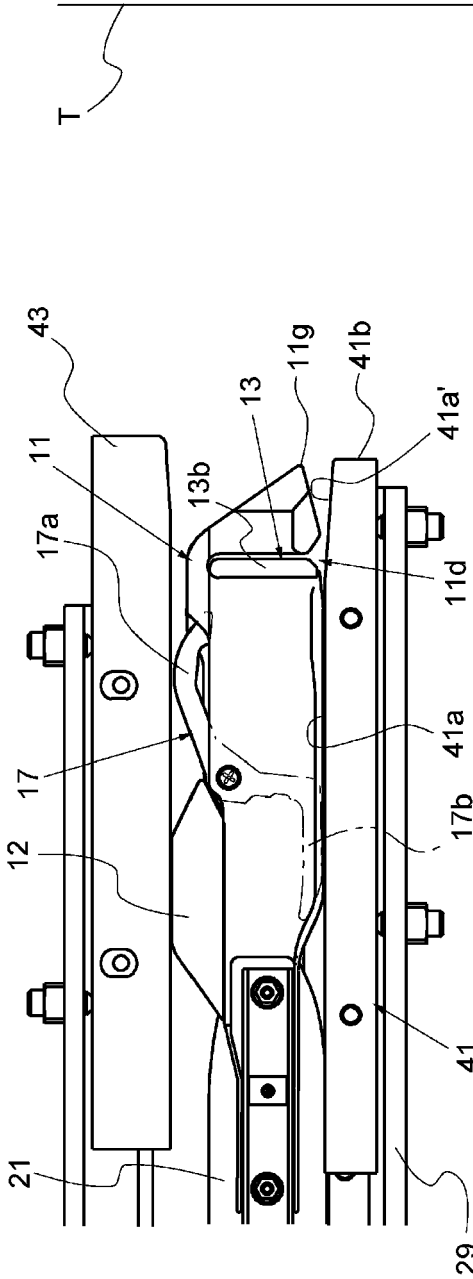
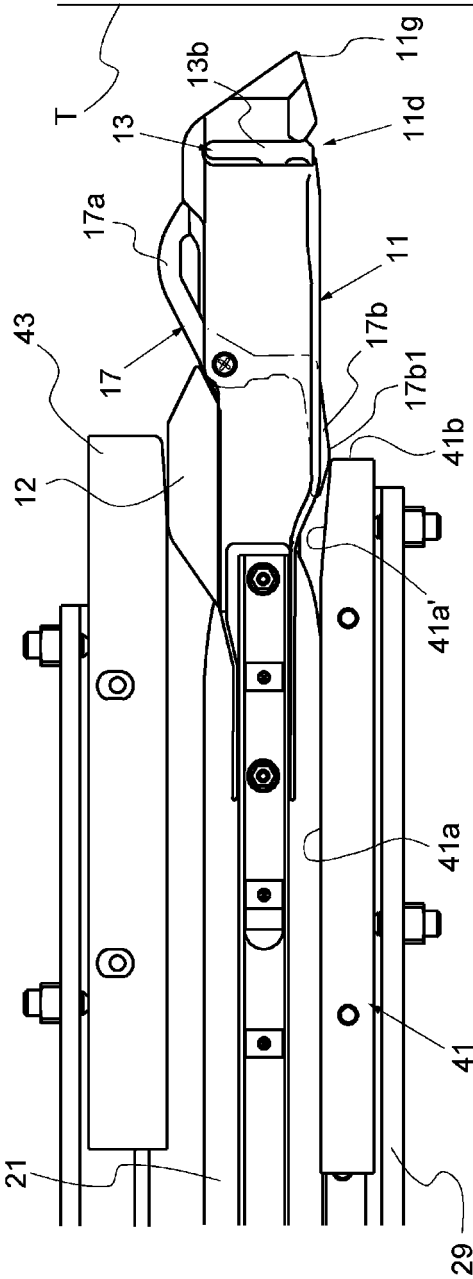


FIG. 5

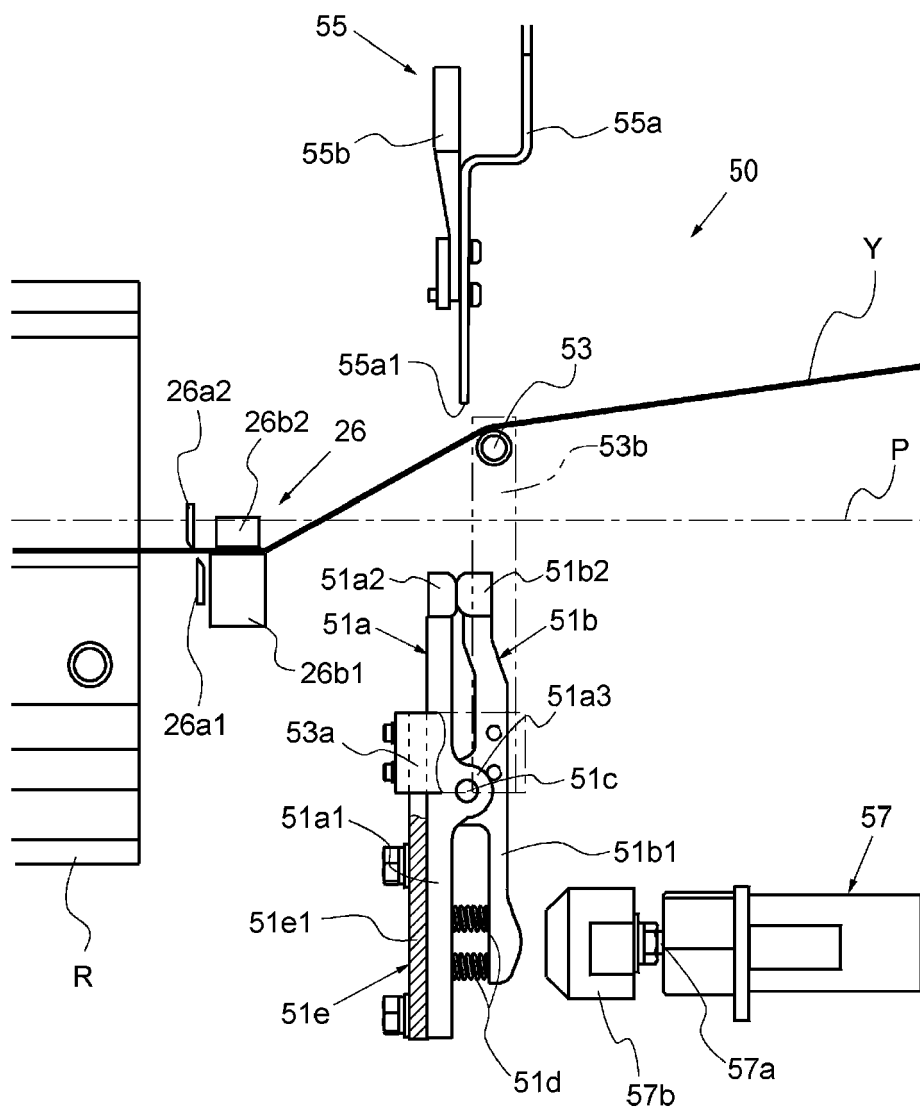


FIG. 6

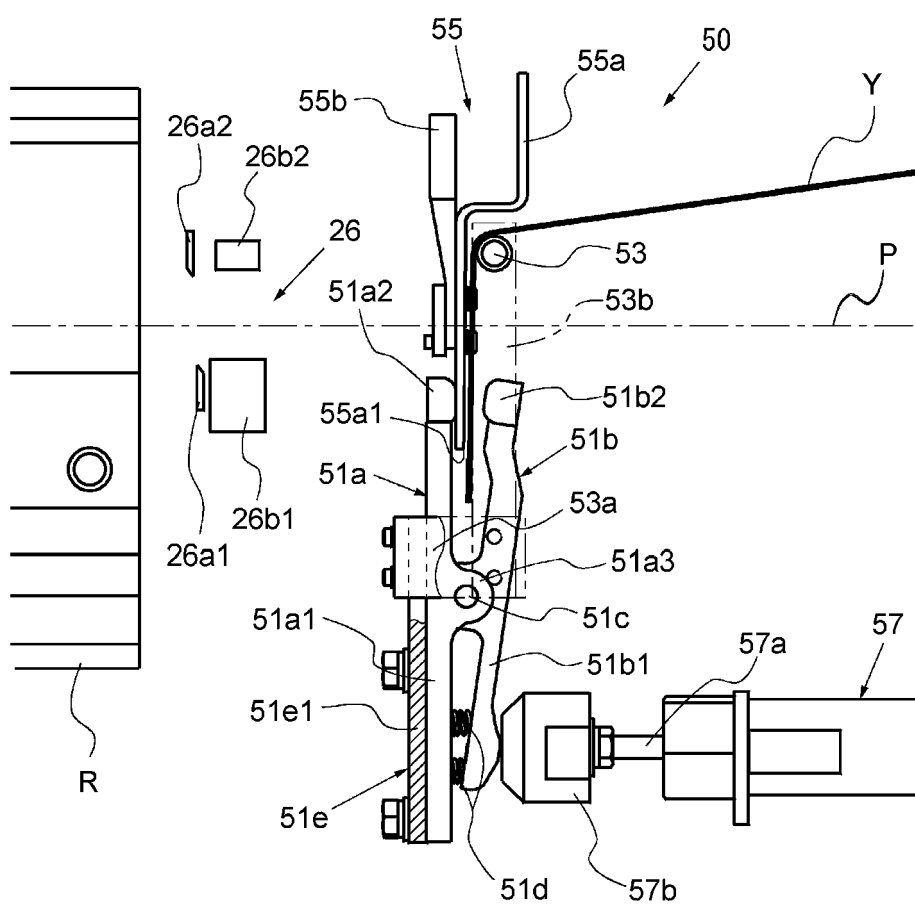


FIG. 7

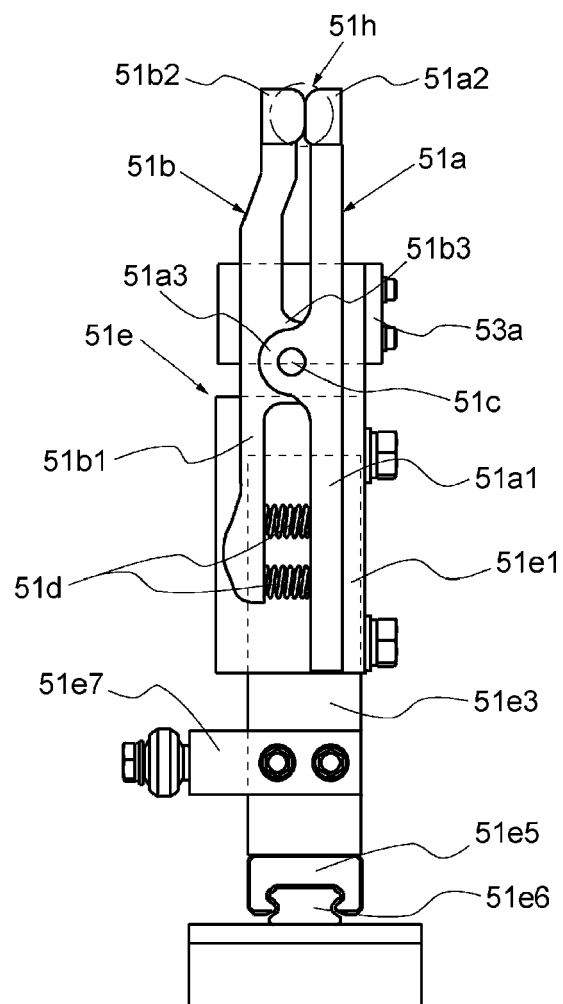


FIG. 8

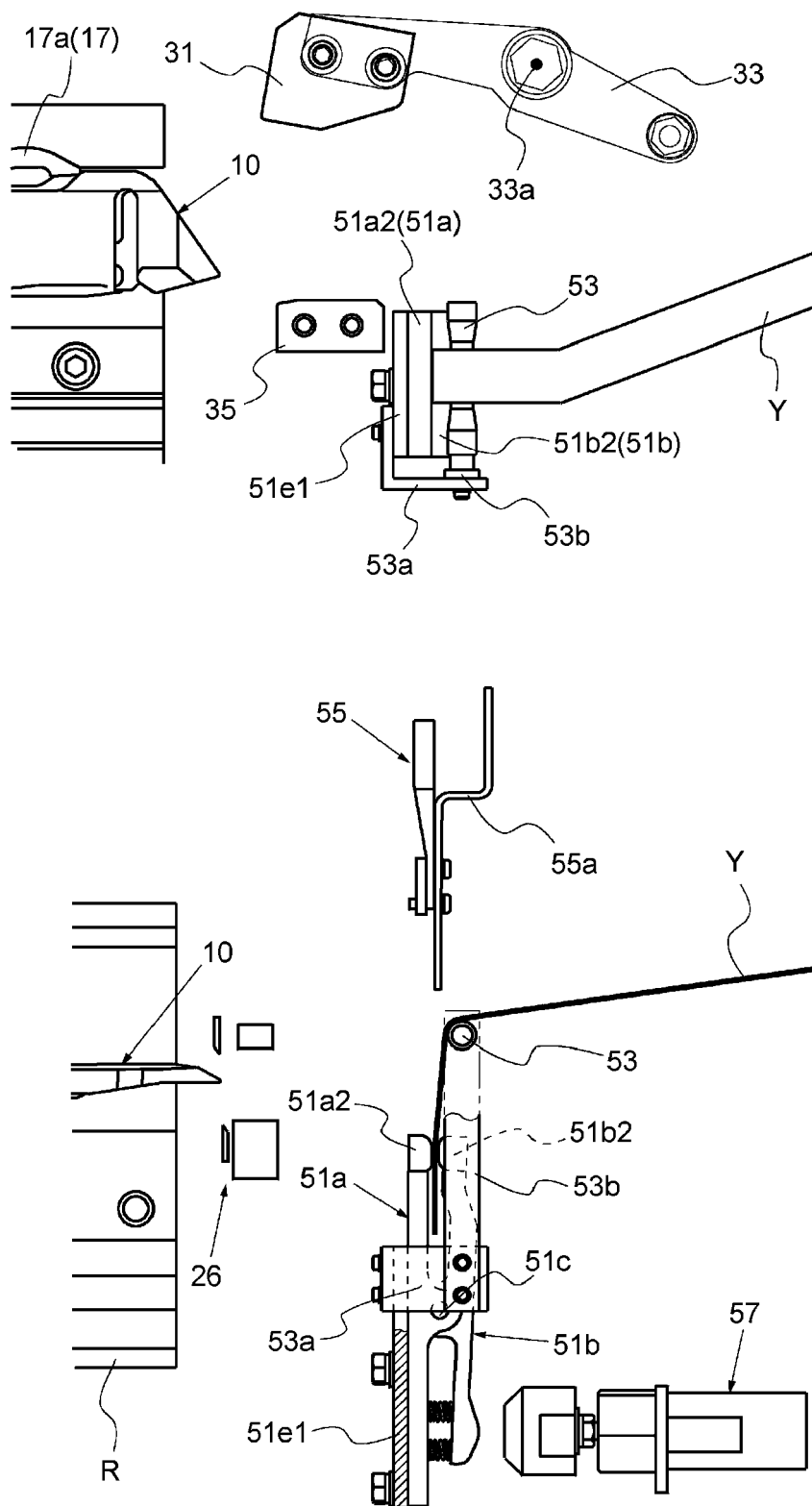


FIG. 9

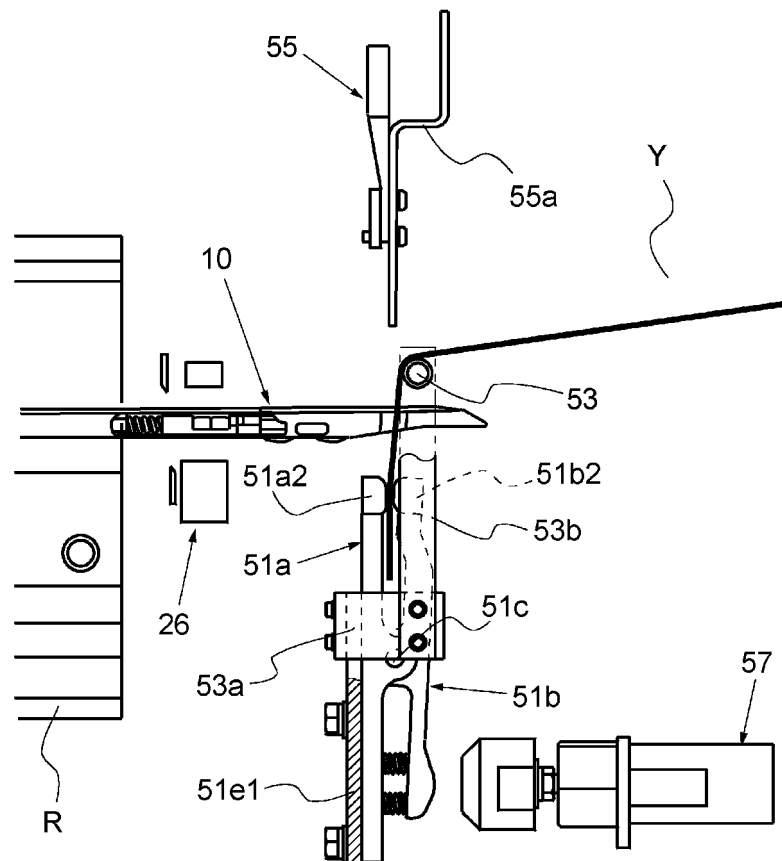
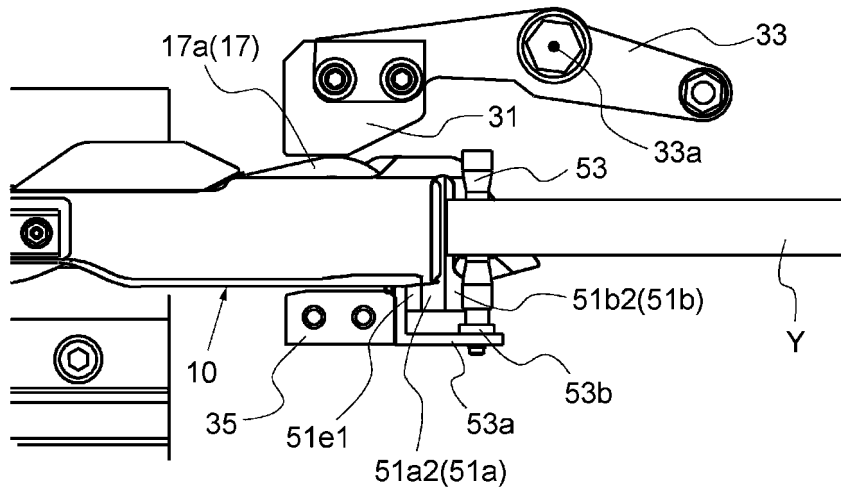


FIG. 10

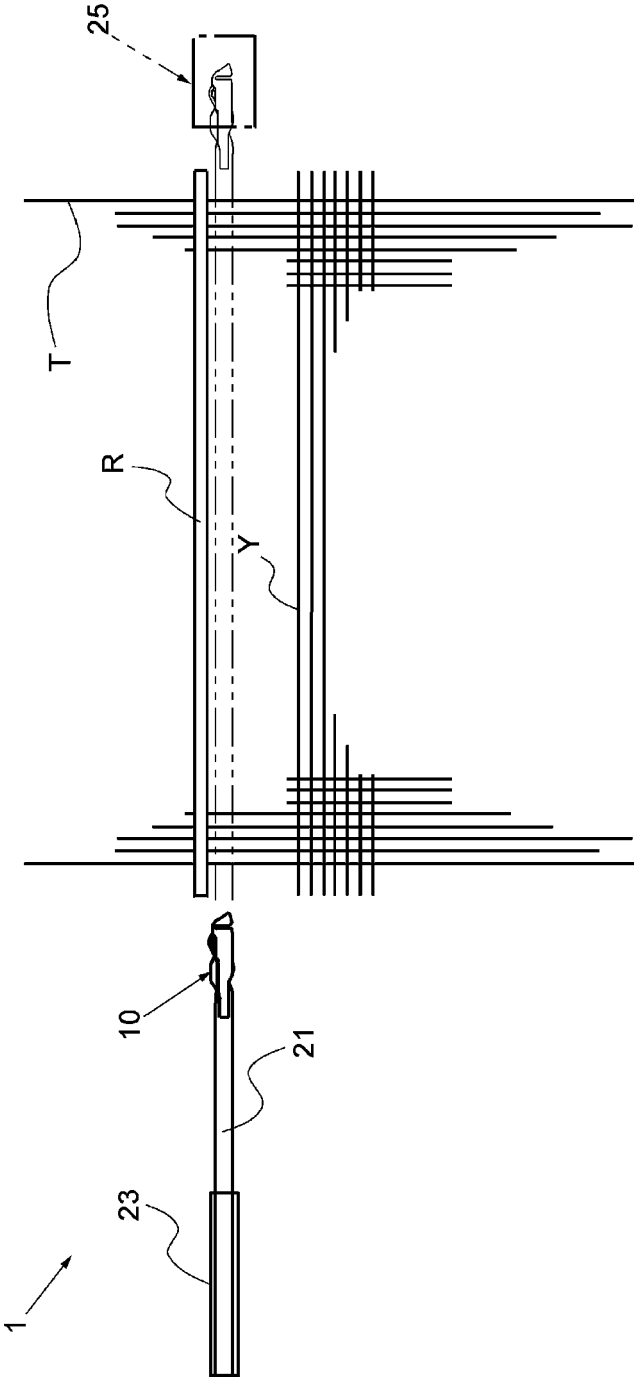


FIG. 11A

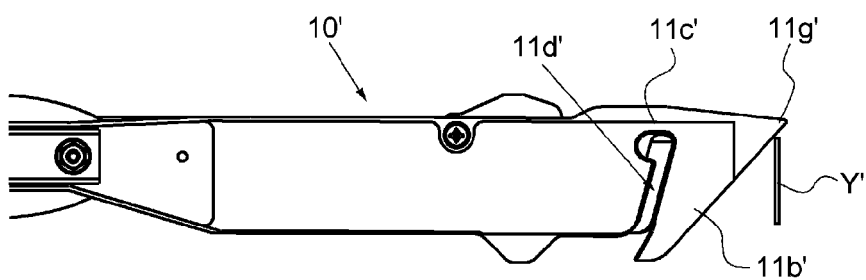


FIG. 11B

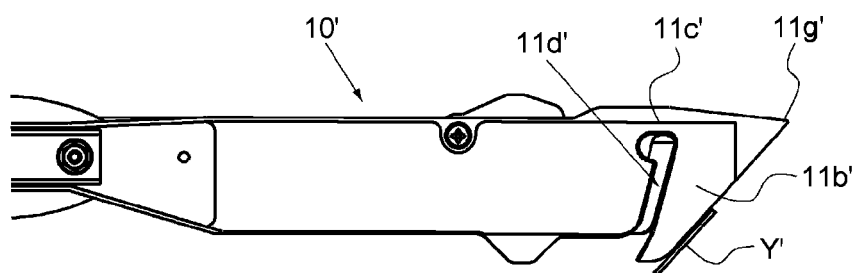


FIG. 11C

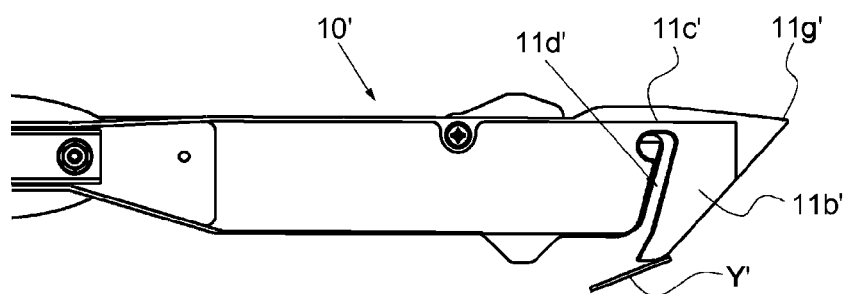


FIG. 11D

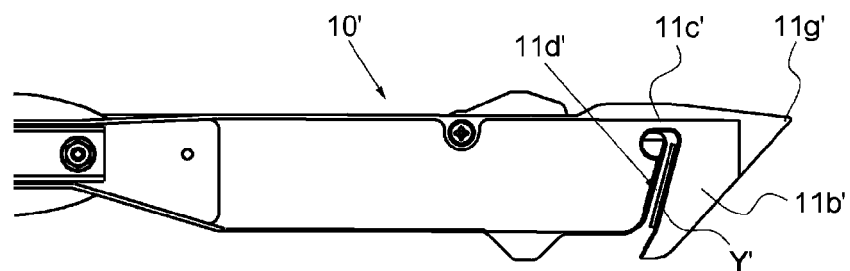


FIG. 12

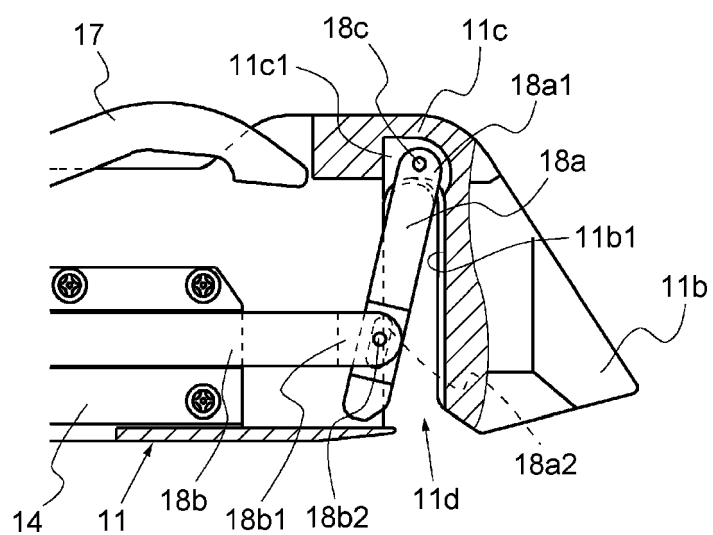
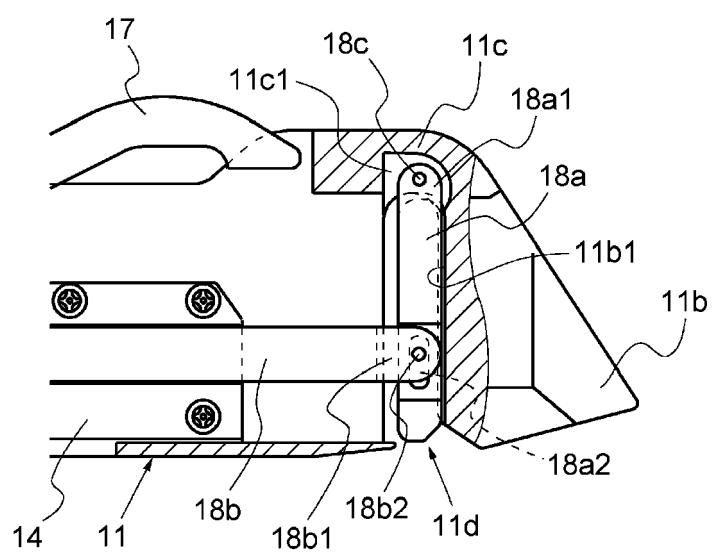
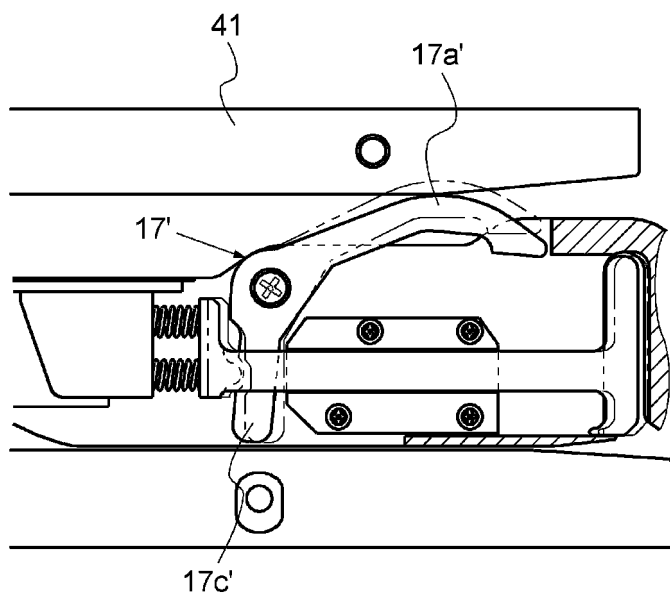
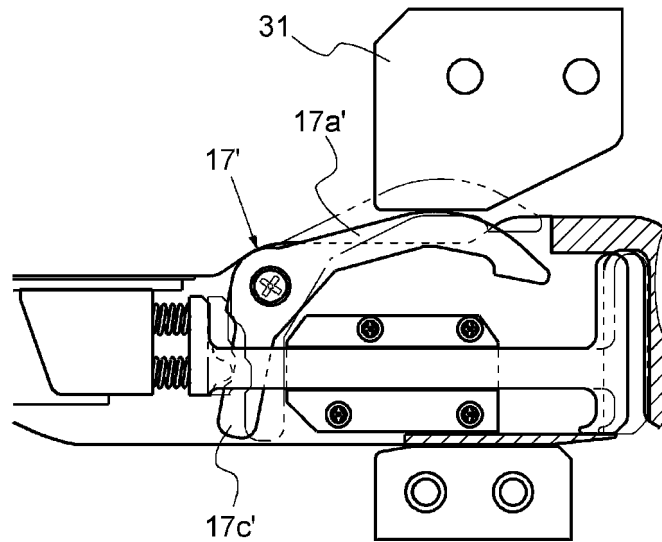


FIG. 13





EUROPEAN SEARCH REPORT

 Application Number
 EP 18 19 0371

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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	EP 0 756 027 A1 (TORAY INDUSTRIES [JP]) 29 January 1997 (1997-01-29) * abstract * * figures 2,5-8 * * pages 2,12-14 *	1-3	INV. D03D47/23
A,D	JP 2012 046835 A (TOYOSU MACHINERY CORP) 8 March 2012 (2012-03-08) * abstract * * claim 1 * * figures 1,5,6,7A,7B,7C * * paragraphs [0001], [0002], [0010] - [0012], [0018] - [0024], [0026] *	1-3	
			TECHNICAL FIELDS SEARCHED (IPC)
			D03D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 8 February 2019	Examiner Heinzelmann, Eric
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			

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 EPO FORM 1503 03/02 (P04C01)

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

EP 18 19 0371

5 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
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08-02-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0756027 A1	29-01-1997	CN 1153541 A	02-07-1997
		EP 0756027 A1	29-01-1997
		EP 1944398 A2	16-07-2008
		KR 100444086 B1	06-11-2004
		US 5783278 A	21-07-1998
		WO 9627701 A1	12-09-1996

JP 2012046835 A	08-03-2012	NONE	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2012046835 A [0002]