



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
06.04.2011 Bulletin 2011/14

(51) Int Cl.:
D04B 15/06 (2006.01)

(21) Application number: **09762256.7**

(86) International application number:
PCT/JP2009/002598

(22) Date of filing: **09.06.2009**

(87) International publication number:
WO 2009/150825 (17.12.2009 Gazette 2009/51)

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

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(30) Priority: **13.06.2008 JP 2008155673**

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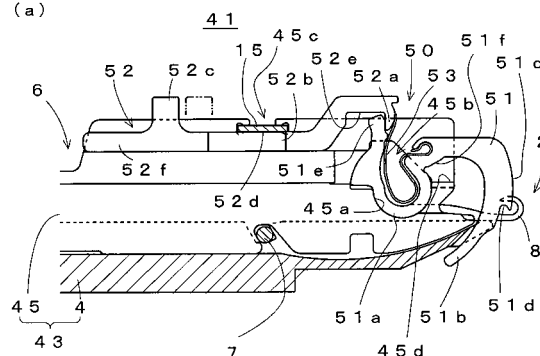
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(54) **WEFT KNITTING MACHINE EQUIPPED WITH MOVABLE SINKER**

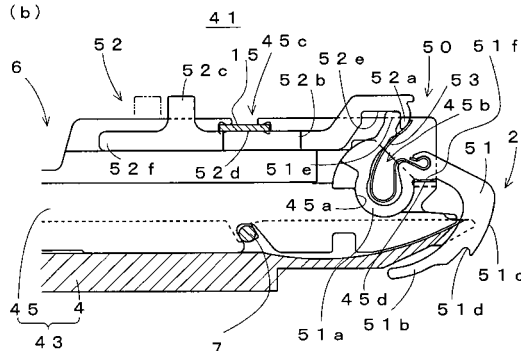
(57) To provide a flatbed knitting machine having a movable sinker that can produce a sufficient pressing force in the closed state with a simple structure.

A movable sinker 50 includes a sinker 51, a sinker jack 52 and a wire spring 53. The wire spring 53 is supported in abutment with a front end portion 52a of the sinker jack 52. On condition that no load is applied to the yarn receiving portion 51d, whether in the opened state of the sinker or in the closed state, the wire spring 53 thrusts the front end portion 52a of the sinker jack 52 from the front side closer to the needle bed gap 2 and also thrusts the front end portion 52a from the back side as well in a sandwiching manner. Even when the sinker 51 increases in stroke in the closed state, the knitted fabric in the needle bed gap 2 can be pressed down by a pressing force nearly equal to that in the opened state.

Fig. 1
(a)



(b)



Description

Technical Field

[0001] The present invention relates to a flatbed knitting machine provided with movable sinkers capable of pressing down a knitted fabric.

Background Art

[0002] In general, a flatbed knitting machine 1 provided with movable sinkers whose schematic construction is shown in Fig. 5 is used (See Patent Citation 1, for example). In the flatbed knitting machine 1, needle beds 3 are arranged in front and back to face each other and define a needle bed gap 2 between them. Each of the needle beds 3 is slanted so that it becomes high in level at a portion thereof closer to the needle bed gap 2 and decreases in level with distance from the needle bed gap 2. For convenience of explanation, only one of the front and back needle beds 3 is shown in a horizontal position.

[0003] The needle bed 3 is formed with needle plates 5 standing upright and spaced at a regular pitch on a strip base 4 extending in a direction perpendicular to the paper surface. A needle groove 6 is formed between adjacent needle plates 5. A wire 7 is extended through between the base 4 and the needle plate 5, for positioning them. A knitting needle 8 is accommodated in the needle groove 6. As to the knitting needle 8, only a hook part of the knitting needle 8 at a front end portion thereof is shown and the remaining part is omitted. In Fig. 5(b), the illustration of the knitting needle 8 is omitted. The knitting needle 8 in the needle groove 6 is capable of sliding shift in a lateral direction, when viewed in the drawing, so as to advance and retract the hook at the front end of the knitting needle 8 into and from the needle bed gap 2. A movable sinker 10 is placed between the adjacent knitting needles 8 and at one lateral side of the needle plate 5 so as to be juxtaposed thereto.

[0004] The movable sinker 10 includes a sinker 11 which is shifted to oscillate between an opened state shown in Fig. 5(a) and a closed state shown in Fig. 5(b). The switching between the opened state and the closed state of the sinker 11 is controlled by a sinker jack 12. The sinker 11 has a working arm 11b in its part extending from a support receiving portion 11a toward the needle bed gap 2. The working arm 11b has a loop forming portion 11c and a yarn receiving portion 11d. A passive arm 11e is also extended from the support receiving portion 11a. A wire spring 13 is accommodated in the interior of the journal portion 11a of the sinker 11. The support receiving portion 11a of the sinker 11 has an outer periphery shaped like a circular arc and is so supported as to be shifted to oscillate via a sinker supporting portion 5a of the needle plate 5. The support receiving portion 11a of the sinker 11 and the wire spring 13 are accommodated in a sinker accommodating portion 5b which is formed by reducing a thickness of the needle plate 5 on a side

thereof near to the needle bed gap 2. The wire spring 13 is shifted in such a manner as to be pivoted about the support receiving portion 11a of the sinker 11, whereby a resilient torque is produced to urge the working arm 11b in the direction of advancing to the needle bed gap 2.

[0005] The sinker jack 12 has a front end portion 12a on the side near to the needle bed gap 2 and has a base portion 12b on the side away from the needle bed gap 2. The base portion 12b is provided with a butt 12c which is driven by a cam mechanism mounted on a carriage which is moved along the needle bed 3 in a direction perpendicular to the paper surface. The base portion 12b is provided, at an intermediate portion thereof, with a split portion 12d extending in a lateral direction when viewed in the drawing. A metal band 15 extending in a direction perpendicular to paper surface is inserted through the split portion 12d. The metal band 15 is extended through a metal band through-hole 5c of the needle plate 5 as well so that when the sinker jack 12 is shifted in the sliding manner, drop of the sinker jack 12 from the needle groove 6 can be restricted. A joint of the sinker jack 12 and the sinker 11 is performed in such a manner that a front end of the passive arm 11e of the sinker 11 is engaged with an engagement portion 12e formed in the vicinity of the front end portion 12a of the sinker jack 12. The engagement portion 12e of the sinker jack 12 has a dimension still larger than that of the front end of the passive arm 11e of the sinker 11, so that the front end of the passive arm 11e is loosely fitted in the engagement portion 12e. This provides the result that when a force applied from the knitting yarn to the yarn receiving portion 11d of the sinker 11 on the side near to the working arm 11b becomes larger than an urging force of the wire spring 13, the sinker 11 is shifted to oscillate in a direction for the working arm 11b to be retreated from the needle bed gap 2 until the front end of the passive arm 11e is brought into contact with the back side of the engagement portion 12e. By this oscillated shifting action, the movable sinker 10 can relax a reactive force exerted on the knitting yarn, to prevent exertion of an excessive pressing force on the knitting yarn.

[0006] The wire spring 13 is supported at one end by a basal end of the working arm 11b of the sinker 11 and at the other end by a spring stopper 5d arranged in the vicinity of the front end of the needle plate 5. The resilient force of the wire spring 13 becomes large in the opened state and becomes small in the closed state. In the opened state, a large resilient force of the wire spring 13 acts so that the engagement portion 12e of the sinker jack 12 is pulled in the direction to the needle bed gap 2 through the passive arm 11e of the sinker 11. In order to hold the sinker jack 12 in the position where the sinker jack 12 is drawn away from the needle bed gap 2 against this pulling force, so as to maintain the opened state of the sinker 11, the sinker jack 12 is provided with a lug 12f. The lug 12f can be retained by a wire 16 extending through the wire through-hole 5e of the needle plate 5.

[0007] Figs. 6 and 7 show a sectional side view and a

side view showing respectively a construction of the base 4 and a construction of the needle plate 5 combined to form the needle bed 3 of Fig. 5. The base 4 has a needle plate insertion groove 4a to insert the needle plate 5 and has a surface as a bottom surface 4b of the needle groove 4a. The base 4 has, at a front end thereof, a sinker groove 4c for receiving the working arm 11b of the sinker 11.

[0008] Fig. 8 shows a side view for a construction of a combined state of the sinker 11 and the wire spring 13 of Fig. 5. A roundabout portion 13a of the wire spring 13 is accommodated in the interior of the support receiving portion 11a of the sinker 11. An urging portion 13b formed by one end of the wire spring 13 exerts a torque on a portion of the support receiving portion 11a from which the working arm 11b is extended. A support portion 13c of the wire spring 13 is a free end. Alternatively, a corresponding portion to the urging portion 13b of the wire spring 13 may be formed by being extended from the sinker 11 and the corresponding portion to the sinker 11 and a corresponding portion to the wire spring 13 may be formed integrally (See Patent Citation 2, for example). It is to be noted however that in the corresponding member to the sinker 11 of Patent Citation 2, the corresponding portion to the working arm 11e is formed by being extended laterally and is driven vertically by a presser provided on the carriage.

[0009] Fig. 9 shows a side view for a construction of the sinker jack 12 of Fig. 5. The engagement portion 12e of the sinker jack 12 is shifted in the lateral direction as viewed in the drawing by a driving force exerted on the butt 12c.

[0010] Fig. 10 shows a schematic construction of a drive mechanism used in the flatbed knitting machine 1 of Fig. 5. The knitting needle 8 of Fig. 5 is driven by a needle actuating cam mechanism 20. The needle actuating cam mechanism 20 is mounted on a carriage 21 which moves in reciprocation to a direction perpendicular to paper surface of Fig. 5 along the needle bed 3. A solenoid 22 is arranged on at least one side with respect to the moving direction of the carriage 21. The carriage 21 is provided with a needle selection mechanism 23 for selectively driving the knitting needle 8 by the needle actuating cam mechanism 20.

[0011] The needle actuating cam mechanism 20 guides a butt of the knitting needle 8 with a cam including a center cam 25, a stitch cam 26, and a bridge cam 27 so as to trace e.g. a guide trajectory 28a in accordance with the moving direction of the carriage 21. An illustrated guide trajectory 20a is traced when a knit knitting motion is imparted to the knitting needle 8. The guiding path 20a can be switched by the cam mechanism 20 so that a variety of knitting motions can be imparted to the knitting needle 8 in accordance to multiple needle selection modes by the needle selection mechanism 23. In the case where a compound needle having a slider is used as the knitting needle 8, a slider cam 28 for the slider is used to guide the butt of the slider so as to trace the guide trajectory 28a.

[0012] The switching between the opened state and the closed state of the movable sinker 10 of Fig. 5 is driven by a sinker actuating cam mechanism 30. The sinker actuating cam mechanism 30 includes a moving cam 31, oscillating cams 32, 33, and a rest cam 34 and guides the butt 12c of the sinker jack 12 so that a guiding trajectory 30a can be traced. The moving cam 31 is moved downstream with respect to the moving direction of the carriage 21 by a reaction force produced when the butt 12c is driven. When a knitting yarn is received by the hook of the knitting needle 8 in the needle bed gap 2, the sinker 11 is driven in the open direction by the moving cam 31 so that the working arm 11b can be retreated from the needle bed gap 2 to prevent from trouble on feeding of the knitting yarn. The oscillating cams 32, 33 are so associated that only a portion of the carriage 21 on the upstream side with respect to the moving direction of the carriage 21 can be actuated. When the carriage 21 is moved leftwards as viewed in the drawing, the oscillating cam 32 draws the sinker jack 12 to retreat the working arm 11b of the sinker 11 from the needle bed gap 2 before the butt of the knitting needle 8 is so guided as to be advanced into the needle bed gap 2 by the center cam 25. When the sinker 11 is retreated from the needle bed gap 2, a distance between the urging portion 13b and the support portion 13c of the wire spring 13 is narrowed and a resilient force of the wire spring is increased. Immediately after drawing the sinker jack 12, the oscillating cam 32 stops the drawing of the sinker jack 12, so that, as a result, the working arm 11b is urged by the increased resilient force and is advanced into the needle bed gap 2 again to press down the knitting yarn reliably by the yarn receiving portion 11d. In order to retain the lug 12f of the sinker jack 12 by the wire spring 16 so as to maintain the opened state of the sinker jack, as shown in Fig. 5(a), the rest cam 34 is actuated by the solenoid 22 to retreat the sinker jack 12.

Patent Citation 1: Pamphlet of International Publication No. 05/012613

Patent Citation 2: Pamphlet of International Publication No. 08/018185

Disclosure of the Invention

Technical Problem

[0013] In the movable sinker 10 shown in Fig. 5, the torque of the wire spring 13 to urge the working arm 11b of the sinker 11 in the direction of the needle bed gap 2 increases to a maximum value in the opened state and decreases to a minimum value in the closed state. The force to press down the knitted fabric in the needle bed gap 2 by the yarn receiving portion 11d decreases to a minimum value in the closed state. When an increased pressing force is tried to be obtained in the closed state, there is a possibility that the torque of the wire spring 13 may excessively increase beyond its strength limit in the

opened state.

[0014] The flatbed knitting machine 1 can allow a larger stitch loop to be formed by a half-gauge knitting and the like. However, as the stitch loop increases in size, the working arm 11b advanced to the needle bed gap 2 in the closed state of the sinker 11 increases in advancing stroke and, as a result, it becomes difficult to generate a proper torque from the wire spring 13. When a sufficient pressing force is tried to be produced in the closed state in which the advancing stroke of the sinker 11 is increased, there is a possibility that the torque may increase excessively in the opened state so that the wire spring 13 may be broken. Although such an excess increase of the torque can be relaxed by increasing a central diameter of the roundabout portion 13a of the wire spring 13, or by winding the roundabout portion 13a spirally an increased number of times, the movable sinker 10 increases in size or complicates in structure.

[0015] It is an object of the present invention to provide a flatbed knitting machine having a movable sinker that can produce a sufficient pressing force in the closed state with a simple structure.

Technical Solution

[0016] The present invention provides a flatbed knitting machine having movable sinkers, in which a number of sinkers are arranged in an oscillating capable manner on a front end side of a needle bed confronting a needle bed gap which is an area where a knitted fabric is knitted, each sinker having a working arm extending to a direction of the needle bed gap in the shape of a curve and a passive arm provided on the side away from the needle bed gap, and the sinker can be switched between its closed state in which a knitted fabric in a needle bed gap is pressed down by a yarn receiving portion provided at a location on the side closer to a front end of the working arm and its opened state in which the yarn receiving portion is away from the needle bed gap by shifting a front end portion of a sinker driving member that acts on the passive arm in a direction closer to the needle bed gap and in a direction away from there, and is urged by a torque spring in a direction in which the yarn receiving portion moves closer to the needle bed gap at least in the closed state,

wherein the torque spring is disposed between the sinker and the sinker driving member, and is supported in such a manner that at one end thereof by the working arm of the sinker and at the other end thereof by the front end portion of the sinker driving member.

[0017] In the present invention, the torque spring is connected to the sinker at a portion thereof to be supported by the working arm, so as to be integrated with the sinker.

[0018] In the present invention, the torque spring is connected to the sinker driving member at a portion thereof to be supported by the front end portion, so as to be integrated with the sinker driving member.

Advantageous Effects

[0019] According to the present invention, the sinker driving member, which is shifted to allow the sinker to switch between the closed state and the opened state, supports by its front end portion the other end of the torque spring whose one end is supported by the working arm of the sinker. In the closed state of the sinker in which the front end portion of the sinker driving member comes closer to the needle bed gap, the torque spring can be pressed in a direction for the working arm of the sinker to be advanced into the needle bed gap. Even when the sinker increases in stroke from its opened state to its closed state, a pressing force exerted by the yarn receiving portion of the working arm in the closed state can be reinforced by a thrust force exerted on the torque spring pressed by the sinker driving member, to obtain a sufficient pressing force. If the thrust force by the sinker driving member is not given, stress of the torque spring is reduced, the stress of the torque spring is increased to obtain a sufficient pressing force in the closed state, then there is a possibility that an excessive stress may be generated in the opened state so that the torque spring may be broken. This possible problem can be avoided by the simple construction that the sinker driving member is urged at a front end portion thereof by the other end of the torque spring, even when the sinker is increased in stroke when the sinker is advanced to the needle bed gap, a sufficient pressing force exerted on the knitting yarn can be secured.

[0020] According to the present invention, the sinker and the torque spring may be integrated so that the movable sinker can be decreased in number of components to facilitate the assembly.

[0021] According to the present invention, the sinker driving member and the torque spring may be integrated so that the movable sinker can be decreased in number of components to facilitate the assembly.

Brief description of Drawings

[0022]

[Fig.1] Fig. 1 is a partial and sectional side view showing a schematic configuration of a flatbed knitting machine 41 of an embodiment of the present invention.

[Fig.2] Fig. 2 shows a side view and a bottom view showing a construction of a sinker jack 52 of Fig. 1.

[Fig.3] Fig. 3 is a side view showing a configuration of a sinker 51 and a configuration of a wire spring 53 of Fig. 1.

[Fig.4] Fig. 4 is a side view showing a construction of a needle plate 45 of Fig. 1.

[Fig.5] Fig. 5 is a sectional side view showing a schematic construction of a conventional flatbed knitting machine 1.

[Fig.6] Fig. 6 is a sectional side view showing a con-

struction of a base 4 of Fig. 5.

[Fig.7] Fig. 7 is a sectional side view showing a construction of a needle plate 5 of Fig. 5.

[Fig.8] Fig. 8 is a side view showing a construction of a sinker 11 and a construction of a wire spring 13 of Fig. 5.

[Fig.9] Fig. 9 is a side view showing a construction of a sinker jack 12 of Fig. 5.

[Fig.10] Fig. 10 is a plan view showing a schematic construction of a driving mechanism used in the flat-bed knitting machine 1 of Fig. 5.

Explanation of References

[0023]

2	Needle bed gap
6	Needle groove
8	Knitting needle
43	Needle bed
45	Needle plate
50	Movable sinker
51	Sinker
52	Sinker jack
53	Wire spring

Best Mode for Carrying Out the Invention

[0024] Figs. 1-4 show constructions related to an embodiment of the present invention. Corresponding parts, when presented in the preceding explanation, are labeled the same reference characters used in the preceding explanation throughout the drawings, for avoidance of redundancy of explanation.

[0025] Fig. 1 shows a schematic construction of a flat-bed knitting machine 41 of an embodiment of the present invention. Figs. 1(a) and 1(b) show the opened state and the closed state respectively presented as sectioned side views in the same manner as in Fig. 5. In the flatbed knitting machine 41, a needle bed 43 is formed with needle plates 45 juxtaposed on a base 4. A movable sinker 50 includes a sinker 51, a sinker jack 52 and a wire spring 53. Although the needle plate 45 has a sinker support portion 45a and a sinker accommodating portion 45b corresponding to the sinker support portion 5a and the sinker accommodating portion 5b of the needle plate 5 of Fig. 5, respectively, it does not have any corresponding construction to that of the spring stopper 5d. The wire spring 53 is not supported by the needle plate 45 at a corresponding part thereof to the spring stopper 5d, but is supported in abutment with a front end portion 52a of the sinker jack 52. In other words, the wire spring 53 is supported at one end thereof by a base end portion of the working arm 51b of the sinker 51 and is supported at the other end by a front end portion 52a of the sinker jack 52 which is a sinker driving member.

[0026] Therefore, on condition that no load is applied to the yarn receiving portion 51d, whether in the opened

state of the sinker or in the closed state, the other end of the wire spring 53, whose one end is supported by a front end portion of the working arm 51b of the sinker 51, thrusts the front end portion 52a of the sinker jack 52 from the front side closer to the needle bed gap 2 by the reaction force of the wire spring supported and also thrusts the front end portion 52a from the back side as well through the passive arm 51e of the sinker 51 in a sandwiching manner. Even when the sinker 51 increases in stroke in the closed state shown in Fig. 1(b), the knitted fabric in the needle bed gap 2 can be pressed down by a pressing force nearly equal to that in the opened state.

[0027] The sinker 51 is basically the same as the sinker 11 of Fig. 5 and has a support receiving portion 51a, a working arm 51b, a loop forming portion 51c, a yarn receiving portion 51d, and a passive arm 51e. A curved portion 52b, a butt 52c, and an engagement portion 52e of a sinker jack 52 of Fig. 1 correspond to the base portion 12b, the butt 12c, and the engagement portion 12e of the sinker jack 12 shown in Fig. 5, respectively. In connection with the sinker jack 52, however, it is a flat upper surface 52d of the curved portion 52b that is equivalent to the split portion 12d through which the metal band 15 extends. In addition, the sinker jack 52 does not have any specific structure to be retained by the wire 16 which is equivalent to the lug 12f of the sinker jack 12, but is simply provided with a tail portion 52f which contacts with side walls of the needle groove 6 to provide an increased sliding resistance, so as to be simplified in structure.

[0028] In the closed state shown in Fig. 1(b), the free end of the wire spring 53, which abuts with and is supported by the front end portion 52a of the sinker jack 52, comes closer to the needle bed gap 2, so the wire spring 53 is not reduced in resilient force. Consequently, even when the sinker 51 is moved until its slant portion 51f is abutted with the sinker stopper 45d of the needle plate 45, so as to be increased in stroke, a sufficient pressing force can be exerted on the knitted fabric.

[0029] Fig. 2 shows a construction of the sinker jack 52 of Fig. 1. Fig. 2(a) and Fig. 2(b) show the construction presented as a side view and the construction presented as a bottom view, respectively. The sinker jack 52 is provided with the tail portion 52f and thereby is simplified in structure in the neighborhood of the lug 12f of the sinker jack 12 shown in Fig. 9. Since the wire spring 53 is not flexed so much even in the opened state of the sinker 51, its reaction force is not increased excessively. Accordingly, even the same level of a resistance that offers to the sliding movement of the tail portion 52f along the needle groove 6 is enough to maintain the opened state, without providing the lug. Therefore, the wire 16 of Fig. 5 is omitted in Fig. 1. In relation to the metal band 15, the construction equivalent to the split portion 12d of the sinker jack 12 is omitted by simply imposing restriction on the curved portion 52b of the sinker jack 52 by the upper surface 52d of the sinker jack 52. The sinker jack 12 may be cannibalized.

[0030] Fig. 3 shows a side view showing a construction

of the sinker 51 combined with the wire spring 53 of Fig. 1. As to the wire spring 53, a roundabout portion 53a and an urging portion 53b correspond to the roundabout portion 13a and the urging portion 13b of wire spring 13 of Fig. 8, respectively. It should be noted, however, that a support portion 53c of the wire spring 53, or a free end of the same, is smaller in bend than the support portion 13c of the wire spring 13 and extends upwards along the passive arm 51e. In the opened state of the sinker 51 as mentioned above, the support portion 53c is moved leftwards together with the front end 52a of the sinker jack 52 of Fig. 2. Therefore, even when the sinker 51 is opened and the urging portion 53b is moved leftwards, since the wire spring 53 is not bent too much, no excessive resilient force is generated.

[0031] Fig. 4 shows a side view showing a construction of the needle plate 45 of Fig. 1. The needle plate 45 has basically the same construction as that of the needle plate 5 shown in Fig. 7, including a sinker supporting portion 45a, a sinker accommodating portion 45b, and a metal band through-hole 45c, except that it does not include the spring stopper 5a and the wire through-hole 5e.

[0032] By simply putting the free end of the wire spring 53 into abutment with the front end portion 52a of the sinker jack 52, as shown in Fig. 1, the spring force to urge the working arm 51b to advance to the needle bed gap 2 can be reduced in the opened state (a) in which the urging force of the spring exerted on the working arm 51b of the sinker 51 is not normally needed. Even when the sinker jack 52 is rested in the opened state, since the spring force to draw the sinker jack 52 in the direction of the needle bed gap 2 is reduced, the rested state of the sinker jack 52 can be maintained by the same level of resistance that offers to the sliding movement of the bending portion 52f along the needle groove 6.

[0033] Even in the closed state of the sinker 51 as shown in Fig. 1(b), the support portion 53c of the wire spring 53 receives a urging force from the front end portion 52a of the sinker jack 52, so that the sinker 51 can be pressed down by the urging portion 53b to adequately press down the knitted fabric in the needle bed gap 2. Since the pressing force can be increased by simply advancing the sinker jack 52 in the direction of the needle bed gap 2, the cam mechanism for driving the sinker jack 52 does not require any specific arrangements like the oscillating cams 32, 33 included in the sinker actuating cam mechanism 30 of Fig. 10, thus providing a simplified structure.

[0034] The wire spring 53 may be varied in shape, as long as it can generate a torque for allowing the sinker 51 to be shifted to oscillate. According to Patent Citation 2, for example, the torque spring is varied in shape from the wire spring 53 so that it can be adapted to integration with the sinker. The torque spring may be adapted not only to the integration with the sinker but also to the integration with the sinker driving member such as the sinker jack. Such integration can provide a reduced number of components of the movable sinker and thus can pro-

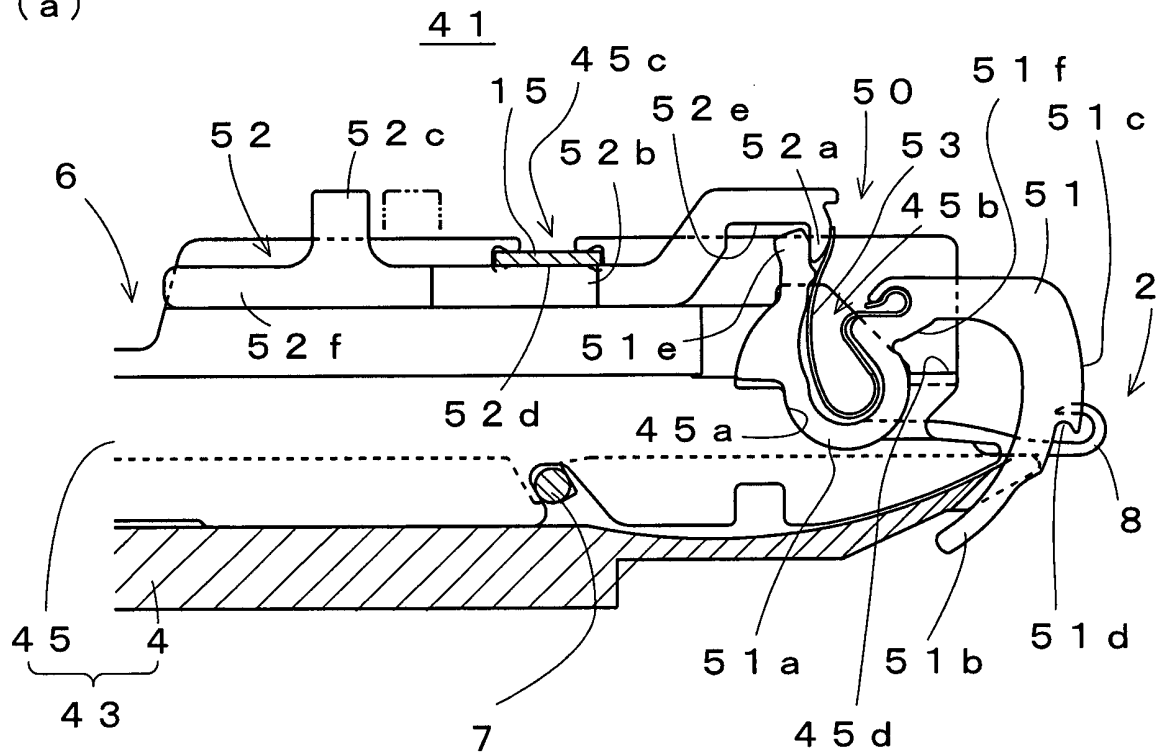
vide a reduced number of assembly processes.

Claims

1. A flatbed knitting machine having movable sinkers, in which a number of sinkers are arranged in a oscillating capable manner on a front end side of a needle bed confronting a needle bed gap which is an area where a knitted fabric is knitted, each sinker having a working arm extending to a direction of the needle bed gap in the shape of a curve and a passive arm provided on the side away from the needle bed gap, and the sinker can be switched between its closed state in which a knitted fabric in a needle bed gap is pressed down by a yarn receiving portion provided at a location on the side closer to a front end of the working arm and its opened state in which the yarn receiving portion is away from the needle bed gap by shifting a front end portion of a sinker driving member that acts on the passive arm in a direction closer to the needle bed gap and in a direction away from there, and is urged by a torque spring in a direction in which the yarn receiving portion moves closer to the needle bed gap at least in the closed state, wherein the torque spring is disposed between the sinker and the sinker driving member, and is supported in such a manner that at one end thereof by the working arm of the sinker and at the other end thereof by the front end portion of the sinker driving member.
2. The flatbed knitting machine having the movable sinkers according to claim 1, wherein the torque spring is connected to the sinker at a portion thereof to be supported by the working arm, so as to be integrated with the sinker.
3. The flatbed knitting machine having the movable sinkers according to claim 1 or 2, wherein the torque spring is connected to the sinker driving member at a portion thereof to be supported by the front end portion, so as to be integrated with the sinker driving member.

Fig. 1

(a)



(b)

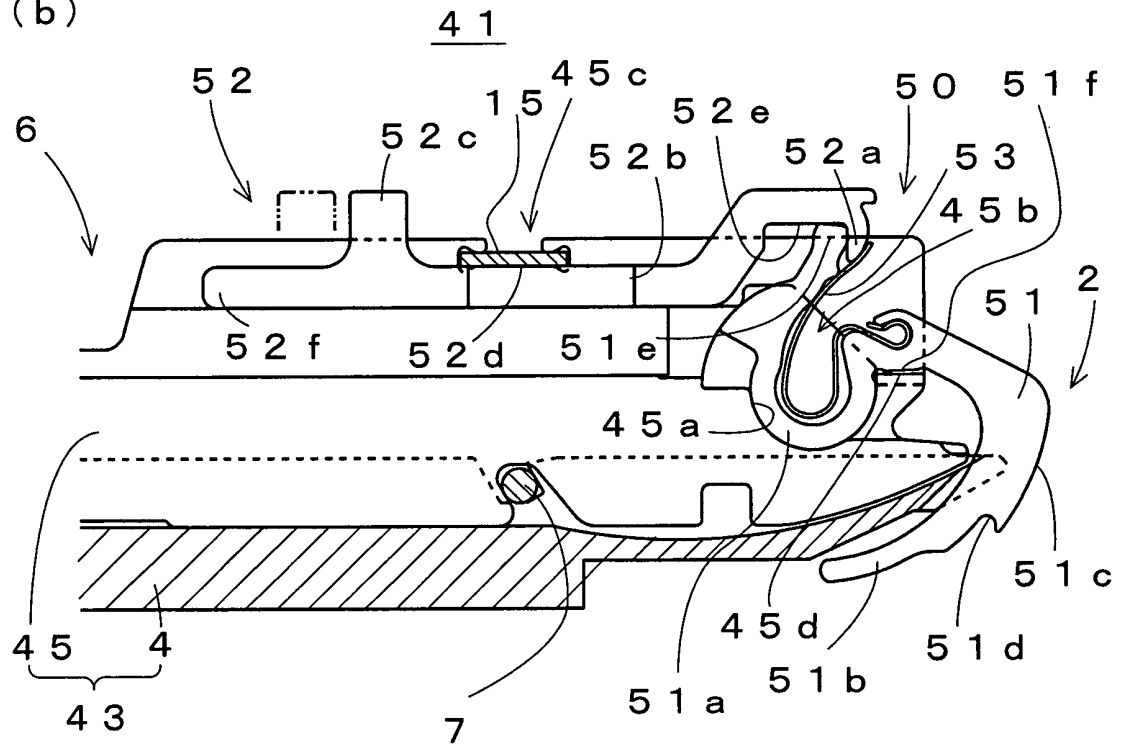
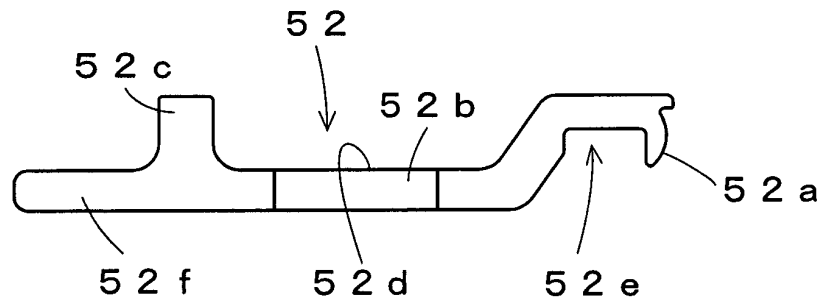


Fig. 2

(a)



(b)

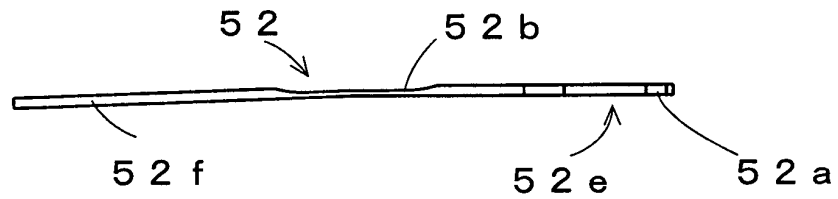


Fig. 3

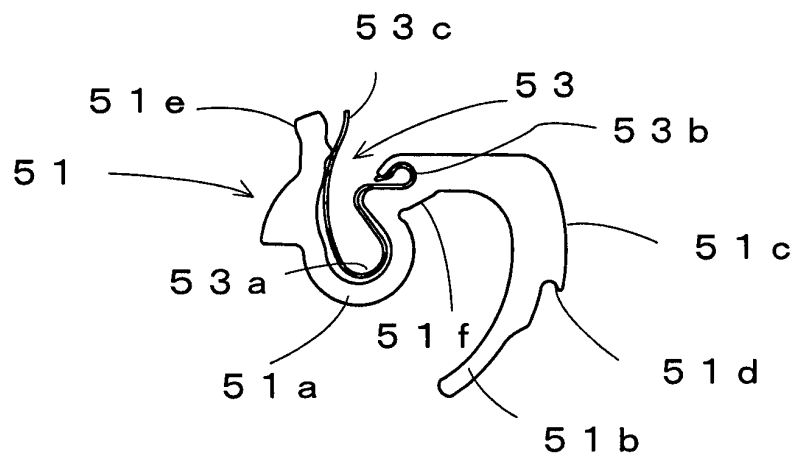


Fig. 4

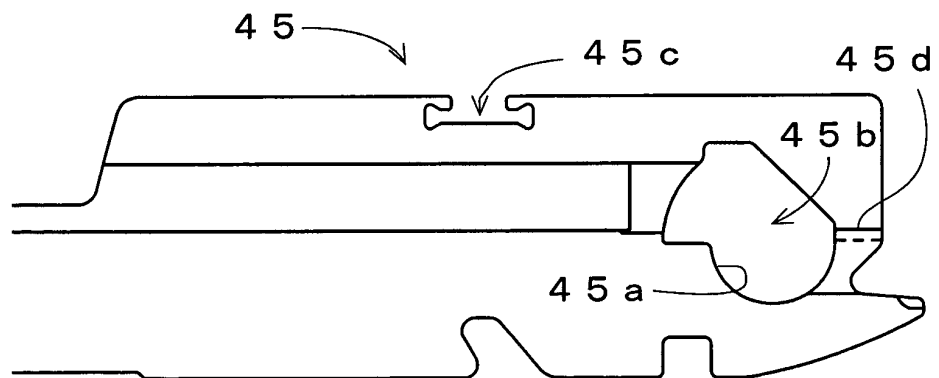


Fig. 5
(a)

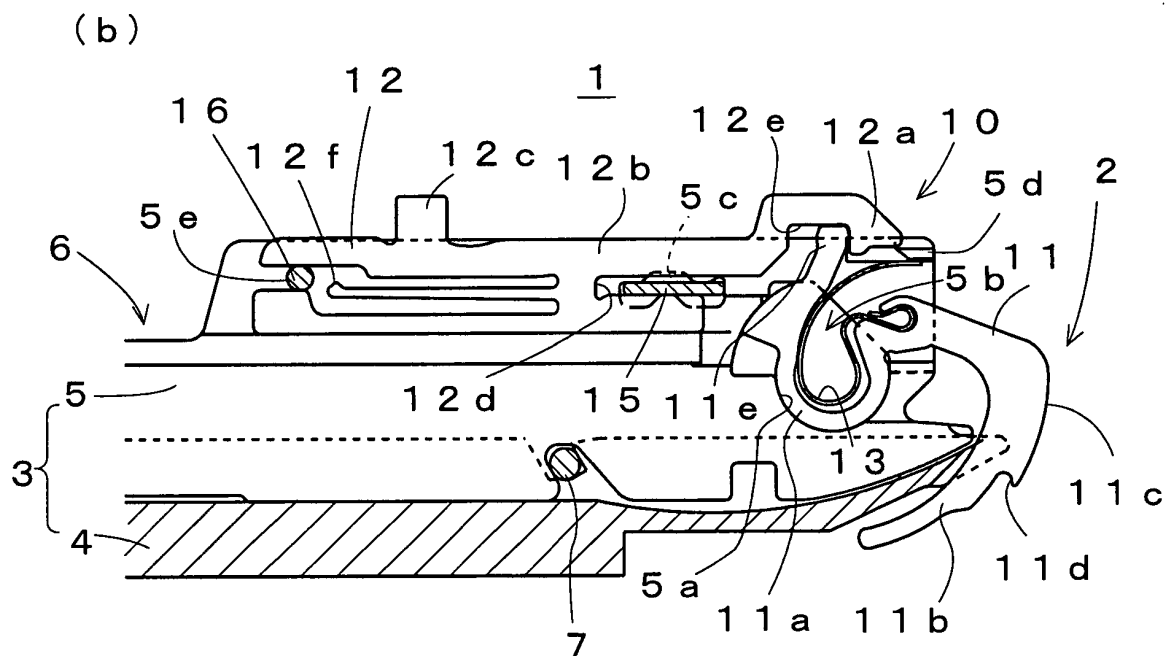
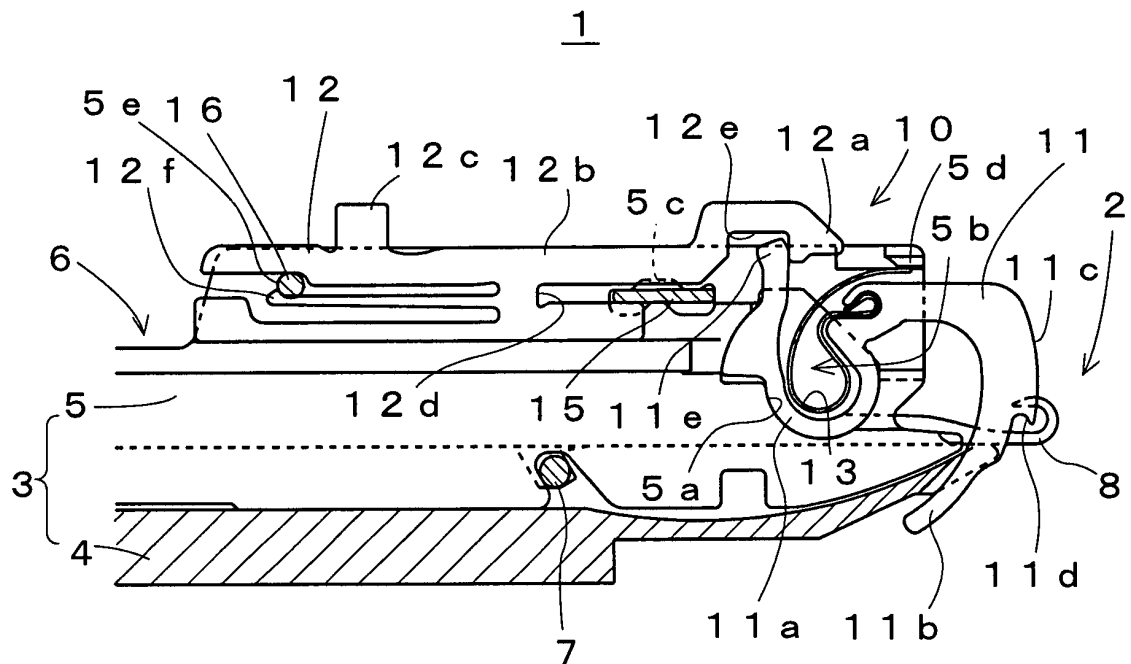


Fig. 6

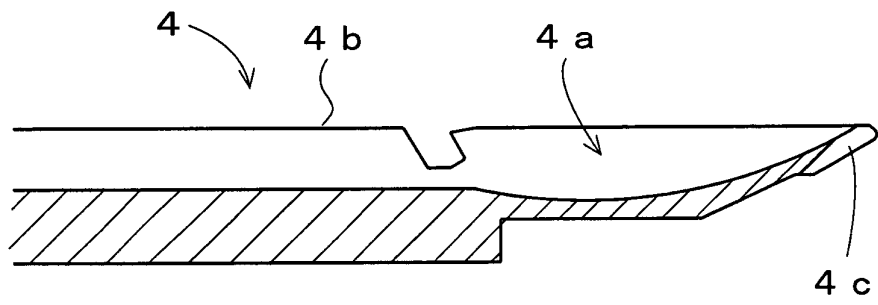


Fig. 7

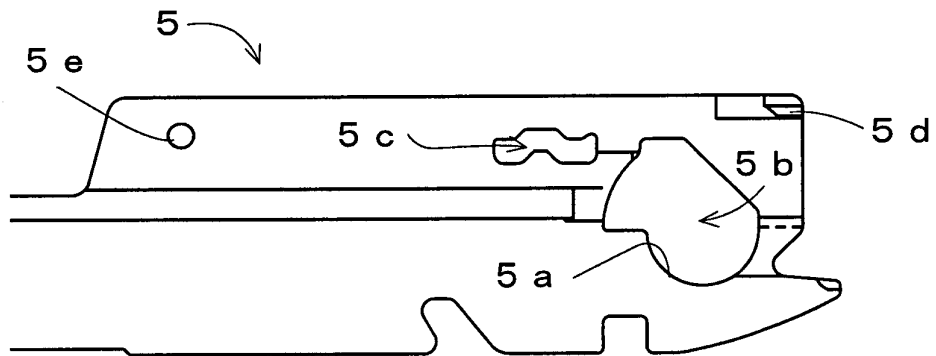


Fig. 8

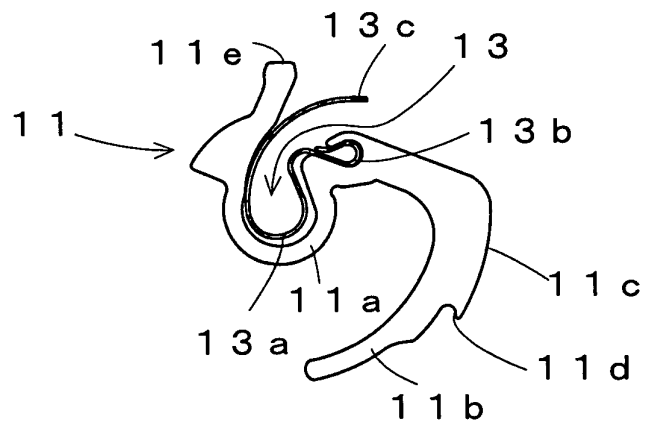


Fig. 9

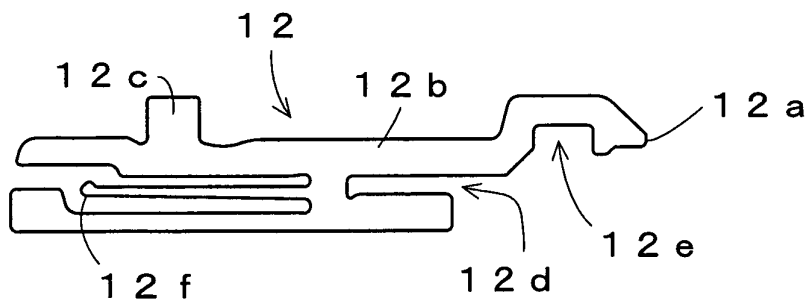
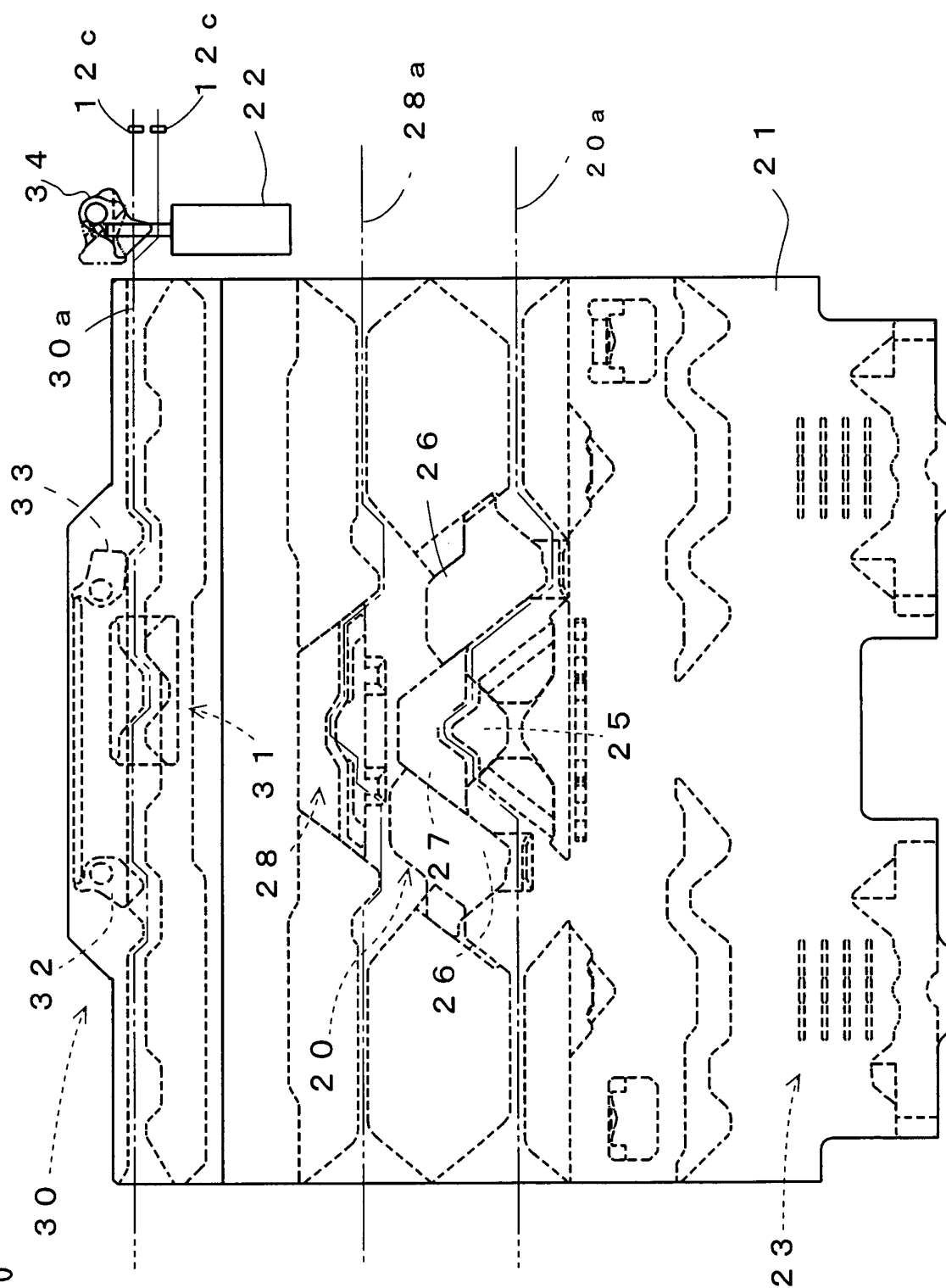


Fig. 10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/002598

A. CLASSIFICATION OF SUBJECT MATTER D04B15/06 (2006.01) i		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) D04B15/06		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009 Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 11-81103 A (H.Stoll GmbH & Co.), 26 March, 1999 (26.03.99), Par. No. [0009]; Figs. 1 to 3 & US 6092396 A & EP 884412 A2 & DE 19725073 A & ES 2202693 T	1-3
A	WO 2005/12613 A1 (Shima Seiki Mfg., Ltd.), 10 February, 2005 (10.02.05), & JP 2005-48335 A & JP 2005-48336 A & JP 2005-48338 A & US 2006/0243001 A1 & EP 1655398 A1 & KR 10-2006-0054366 A & CN 1833060 A	1-3
A	WO 2008/18185 A1 (Shima Seiki Mfg., Ltd.), 14 February, 2008 (14.02.08), & EP 2050849 A	1-3
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 25 June, 2009 (25.06.09)		Date of mailing of the international search report 14 July, 2009 (14.07.09)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/002598

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 3-504991 A (Universal Maschinenfabrik Dr. Rudolf Schieber GmbH & Co. KG.), 31 October, 1991 (31.10.91), & EP 347011 A1 & WO 1989/012708 A1 & DE 3917934 A & DE 3917934 A1	1-3

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REFERENCES CITED IN THE DESCRIPTION

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