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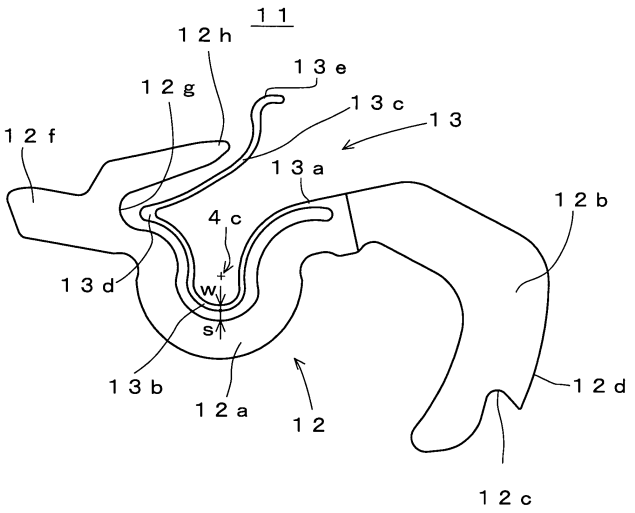
(54) MOVABLE SINKER AND WEFT KNITTING MACHINE

(57) To provide a movable sinker and a flat knitting machine that can be manufactured at a low cost even when a torque spring portion is integrated to a sinker portion, can eliminate individual variations, and can shorten manufacturing work hours. From the intermediate section between a support part 12a and an arm part 12b of a sinker portion 12 of a movable sinker 11, a torque spring portion 13 is extended in the direction opposite to the arm part 12b. Following the extending part 13a, a roundabout part 13b is formed to take roundabout course to a virtual center of a circle 4c on the inner circumferential side of the support part 12a. Following the roundabout part 13b, an idle end part 13c that runs parallel to the extending part 13a is formed. Between the roundabout part 13b and the idle end part 13c, a projection part 13d that projects outwards in the radial direction is provided to add the line length of the torque spring. By the addition of the line length, the relationship between sufficient amount of displacement and the load can be obtained for the sinker even manufactured from punching out process by a press machine.

Fig.1 (a)



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Description

Technical Field

[0001] The present invention relates to a movable sinker that presses a knitted fabric by spring energized motion and to a flat knitting machine.

Background Art

[0002] Conventionally, a flat knitting machine is provided with sinkers along a needle bed gap at a head end of a needle bed and each sinker has functions to form sinker loops in plain knitting or to assist in clearing and knocking-over needle loops. By making the sinker movable, multiple tucks, pintucks, flechage knitting, and other knitting which are difficult to be knitted by a fixed sinker are able to be carried out easily. By energizing movable sinkers by springs, appropriate tension is constantly worked on knitted loops, and knitted fabrics of high quality and high hand value can be knitted.

[0003] Fig. 5(a) shows a configuration of a movable sinker device 1 that presses a knitted fabric with a movable sinker energized by spring (for example, see patent document 1). The movable sinker device 1 has a sinker member 2 and a wire spring 3 combined and arranged in the vicinity of the head end on a needle bed gap 5 side of a needle plate 4. Needle plates 4 are disposed at a regular interval in the direction perpendicular to the paper surface of the drawing. Between needle plates 4, a needle groove in which a knitting needle is accommodated is formed. The sinker member 2 is in a form of plates and is formed into an illustrated shape. The needle plate 4 has a cutout portion 4a in which the wall thickness of one side surface at the upper part of the head end is reduced. In the cutout portion 4a, the sinker member 2 has a practically inverted Ω-letter shape part housed, including a support part 2a. To the needle plate 4, a concave portion to support sinker 4b is formed on the bottom part of the cutout portion 4a. The concave portion to support sinker 4b supports the support part 2a of the sinker member 2 at the circular arc surface. The outer circumference of the support part 2a fits into the concave portion to support sinker 4b. The sinker member 2 can make rocking displacement centering around a virtual center of a circle of a circular arc on the inner circumferential side of the sinker supporting concave portion 4b and an arm portion 2b that extends from the support part 2a advances to and reverses from the needle bed gap 5 in accord with rocking displacement. In the vicinity of the head end of the arm part 2b, a yarn catching part 2c that presses the knitting yarn of a knitted fabric drooping from the knitting needle to the needle bed gap is formed. At an intermediate of the arm part 2b in which the diameter from the center of a circle 4c is maximized, a front fringe part 2d which catches the knitting yarn to form a sinker loop when the knitting yarn is drawn in by a knitting needle in plain knitting, is provided. The arm part 2b has the thickness reduced on the side not in contact with the cutout portion 4a of the needle plate 4 so that the front edge part 2d becomes the center between adjacent knitting needles.

[0004] The wire spring 3 has a base end part 3a elastically latched to a spring hold part 2e provided where the arm part 2b is extended from the inverted Ω-letter shape part of the sinker member 2. The wire spring 3 has a practically U-letter shape except the base end part 3a. The U-letter shape portion bends along the inner circumference of the support part 2a of the sinker member 2 and has a roundabout part 3b that takes roundabout course around the center of a circle 4c, and an idle end part 3c that extends in parallel to the base end part 3a from the roundabout part 3b. The vicinity of the head end of the idle end part 3c comes in contact with a press part 4d on the upper side of the cutout portion 4a of the needle plate 4. Under the state shown in the drawing, the wire spring 3 is pressed in such a manner that the idle end part 3c is brought closer to the base end part 3a side than under the free state, and to the sinker member 2, clockwise torque is applied centering around the center of a circle 4c. When torque in the reverse direction based on the tension of a knitting yarn caught on the yarn catching part 2c increases, the sinker member 2 makes rocking displacement counterclockwise and the tension of the knitting yarn is relaxed.

[0005] In the movable sinker device 1 shown in Fig. 5 (a), the sinker member 2 and the wire spring 3 are two separate elements. The sinker member 2 is manufactured by punching out a metal sheet by press. The wire spring 3 is manufactured by bending a metal wire rod with a square cross-section. On the other hand, a sinker integrated with a spring is proposed (for example, see patent document 2). The sinker disclosed in Fig. 4 and others of patent document 2 is used for circular knitting machines and is practically linear, and a spring element is formed at the side opposite to a head that carries out knitting operation. In patent document 1, too, it is stipulated in the vicinity of the end of the embodiment column that "it is needless to say that the sinker plate may be formed by spring steel and an energizing means may be formed by its elasticity."

[0006] Fig. 5(b) shows an assumed configuration when the sinker member 2 and the wire spring 3 are integrated by the movable sinker device 1 as shown in Fig. 5(a). The sinker member 2 is manufactured by punching out process with a press machine, therefore it is possible to think manufacturing the torque spring portion by punching out simultaneously with the sinker portion when the torque spring portion 6 is integrated to the sinker portion. That is, it is expected that the torque spring portion 6 is extended to the support part 2a side as an extending part 6a from a section at which the spring hold part 2e is provided in Fig. 5(a), and together with a roundabout part 6b and an idle end part 6c, so that the torque spring portion 6 forms a practically U-letter shape. However, in order to enable mass-production by press-punching out, a clearance s greater than a predetermined

standard is required between the outer circumference of the torque spring portion 6 and the inner circumference of the inverted Ω-letter shape portion, and a width w of the torque spring portion 6 greater than a predetermined standard is required, too.

[0007] Fig. 6 shows a general tendency of the relationship between the amount of displacement and the load in the movable sinker device 1 shown in Figs. 5. In the configuration shown in Fig. 5(a) in which the sinker member 2 and the wire spring 3 are two separate elements, as shown in the solid line, the relationship between the amount of displacement and the load falls within the working load range for properly pressing the knitting yarn. As shown in Fig. 5(b), to assume a case in which the torque spring portion 6 is integrated, the clearance s and the width w must be increased from the case of separate elements. When the clearance s increases, the wire length of torque spring portion 6 becomes shorter than the wire spring 3. If the wire length is shortened in the event that the torque spring portion 6 bears bending deformation with the overall wire length, the bending load shared at each portion thereof increases. When the width w increases, the cross-sectional secondary moment of the torque spring portion 6 becomes larger than the cross-sectional secondary moment of the wire spring 3, and large bending force is required for the same bending deformation. As a result, as shown by the chain double-dashed line, the load for the amount of displacement shifts to a larger side and may possibly deviate from the working load range. In addition, the load may exceed the spring material strength limit and the torque spring portion 6 may be destroyed.

Patent document 1: Japanese Examined Patent Application Publication No. 5-83657
Patent document 2: Japanese Unexamined Patent Application Publication No. 2001-303407

Disclosure of Invention

Technical Problem

[0008] As shown in Fig. 5(a), when the sinker member 2 and the wire spring 3 are two separate elements, machining and assembling processes increase, manufacturing work hours increase, and the manufacturing cost increases. The wire spring 3 is difficult to be formed and have large variations in shapes and spring characteristics. In particular, in the event that it is difficult to latch the base end part 3a to the spring hold part 2e by the elastic force only, fixing in conjunction with brazing is used, too. However, in the event that the wire spring 3 collapse or tilted at the time of brazing, variations in the relationship between the amount of displacement and load increases as shown in Fig. 6. In the event that latching of the wire spring 3 at the spring hold part 2e is insufficient, the sinker member 2 and the wire spring 3 are apt to be separated. For example, at the time of maintenance of a flat knitting machine, the movable sinker device 1 may be removed from the needle bed. When the movable sinker device is removed, if the sinker member 2 and the wire spring 3 are separated, reassembling must be conducted.

[0009] As shown in Fig. 5(b), if it is possible to integrally form the torque spring portion 6 to the sinker member 2, it is expected that the problem at the time of using two separate elements of the sinker member and the wire spring could be solved. However, manufacturing the torque spring portion 6 by simultaneously punching out together with the sinker member 2 by press-working shortens the line length as a spring due to restrictions of the clearance s and cannot reduce thickness as the cross section of bend due to restrictions of width w. Consequently, as shown by the chain double-dashed line in Fig. 6, it becomes difficult to keep the relationship between the amount of displacement and load within an appropriate working load range. Even though there are working methods that can narrow the clearance s and width w such as wire cut, adopting such working methods lowers the mass-productivity as compared to press-working and increases the working cost.

[0010] It is an object of the present invention to provide a movable sinker and a flat knitting machine that can be manufactured at low cost even when a torque spring portion is integrated into a sinker portion, can eliminate individual variations, and can shorten manufacturing working hours.

Technical Solution

[0011] The present invention provides a movable sinker having a sinker portion of which being provided with a support part and an arm part, the support part supports the sinker portion in such a manner as to enable rocking displacement by a circular-arc-shape guide part around a center of the circular-arc, the guide part being provided on a needle bed in the vicinity of a needle bed gap, and the arm part is advanced into the needle bed gap and presses down a knitted fabric downwards with a head end side of the arm part by energizing of a torque spring, which works on the support part, wherein
the movable sinker further having a torque spring portion, which is formed integral with the sinker portion to work as the torque spring and is provided with;
an extending part bifurcating out from the arm part side and extending to the support part side,
a roundabout part being connected to the extending part and taking a roundabout route in the periphery of the center of the circle,
a projection part being connected to the roundabout part and projecting outwards in the radial direction, and
a idle end part being connected to the project part and taking a parallel course to the extending part.

[0012] The movable sinker in accordance with the present invention,
the sinker portion has practically an Ω-letter shape,

the support part is formed in such a manner as to have a predetermined width at the middle of the Ω-letter shape and between the circular-arc-shape outer circumference and the circular-arc-shape inner circumference,
the roundabout part of the torque spring portion is formed inside the support part, and
the project part is formed outside the support part.

[0013] The movable sinker in accordance with the present invention,
the support part of the sinker portion is supported by a sinker supporting concave part formed a little to the head end of a needle plate disposed at predetermined intervals on the needle bed, and
the idle end part of the torque spring portion has a protrusion that comes in contact with a press part provided on the needle plate side.

[0014] The sinker portion in accordance with the present invention,
the sinker portion has the minimum size of clearance between the torque spring portion and the sinker portion set within a range from 70% to 100% of the thickness and the minimum size of width of the torque spring portion set within a range from 40% to 60% of the thickness, respectively, and is manufactured by a fine blanking process..

[0015] Furthermore, the present invention is a flat knitting machine that is equipped with the movable sinker according to either one of the foregoing paragraphs.

Advantageous Effects

[0016] According to the present invention, the torque spring portion formed integrally to the sinker portion has a practically U-letter shape equivalent to the separate torque spring with the extending part, roundabout part, and idle end part. Between the roundabout part and the idle end part of the torque spring portion, a projection part that projects outwards in the radial direction is formed, and it becomes possible to extend the sinker with an extra line length added as a wire spring and it is possible to conduct appropriate spring energization as a movable sinker. Even when the torque spring portion is integrated to the sinker portion, the clearance and width of the torque spring portion can be increased, and it is possible to manufacture the sinker portion at low cost by punching out working with a press machine, to eliminate individual variations, and to shorten manufacturing working hours.

[0017] In addition, according to the present invention, the projection part that adds the extra line length of the torque spring portion is formed outside the support part of the sinker portion, and therefore, even if the inner circumference of the sinker portion is formed with a predetermined clearance from the outer circumference of the projection part, the strength of the support part of the sinker member does not have to be lowered.

[0018] In addition, according to the present invention, the support part of the sinker portion is supported by the concave portion to support sinker formed a little to the head end of the needle plate, and therefore, even if the torque spring portion is integrated into the sinker portion, it is able to be used in the same manner as in the case in which the torque spring is separate from the sinker portion. The idle end part of the torque spring portion has a project part that comes in contact with a press part provided on the needle plate side, and therefore, it is possible to stabilize the motion by specifying the position at which the idle end part comes in contact with the press part.

[0019] In addition, according to the present invention, the sinker portion integrated to the torque spring portion is manufactured by fine-blanking process with setting the minimum size of a clearance between the torque spring portion and the sinker portion to 70 to 100% of the thickness and the minimum size of the width of the torque spring portion to 40 to 60%, respectively. It becomes possible to align the characteristics as a torque spring portion by high-precision punching-out working and to achieve reduction in the comprehensive manufacturing cost.

[0020] Furthermore, according to the present invention, the sinker portion and the torque spring portion of the movable sinker are integrated to reduce variations in characteristics of the movable sinker device used in a large quantity for a flat knitting machine. Therefore, knitted fabrics produced can be stabilized and a higher quality can be achieved.

Brief Description of Drawings

[0021]

[Fig.1] Figs. 1 are side views showing configuration of movable sinkers 11 as one embodiment of the present invention.
[Fig.2] Figs. 2 are side views showing main components to be combined when the movable sinkers 11 shown in Figs. 1 are used for a flat knitting machine.
[Fig.3] Fig. 3 is a partial side cross-sectional view schematically showing configuration of a flat knitting machine 20 to which the movable sinkers 11 of Figs. 1 are mounted.
[Fig.4] Figs.4 are side cross-sectional views schematically showing configuration of movable sinker devices 25 that use the movable sinker 11 shown in Figs. 1.
[Fig.5] Figs. 5 are partial side views showing configuration of conventional movable sinker devices 1.
[Fig.6] Fig. 6 is a graph showing simplified relationship between an amount of displacement and load in the movable sinker device 1 of Fig. 5.

Explanation of Reference

[0022]

4 Needle plate

5 Needle bed gap
11 Movable sinker
12 Sinker portion
12a Support part
12b Arm part
12g Deficiency part
13 Torque spring portion
13a Extending part
13b Roundabout part
13c Idle end part
13d Projection part
13e Protrusion
15 Knitting needle
18 Spacer
20 Flat knitting machine
21 Needle bed
25 Movable sinker device

Best Mode for Carrying Out the Invention

[0023] Figs.1 show configuration of movable sinkers 11 as embodiment s of the present invention. Hereinafter in Figs.1 through Figs.4, the same reference characters designate ones that correspond to the ones explained in advance in Figs.5 and redundant explanations are omitted.

[0024] Fig.1(a) shows the movable sinker 11 for a flat knitting machine to which knitting needles are disposed at a rate of 7G (gauge), that is, 7 knitting needles per 25.4 mm (1 inch), while Fig. 1(b) shows a movable sinkerll for a 12G flat knitting machine, respectively. Each movable sinker 11 has a sinker portion 12 and a torque spring portion 13 formed integrally by press punching-out working of fine-blanking process from a metal sheet material. The sheet thickness of an inverted Ω-letter portion that includes a support part 12a of the sinker portion 12 and the torque spring portion 13 is, for example, 0.7 mm for 7G and 0.55 mm for 12G. In such cases, the sheet thickness of an arm part 12b of the sinker portion 12 is 0.49 mm for 7G and 0.38 mm for 12G. This is because the sheet thickness of the arm part 12b of the movable sinker 11 is reduced in such a manner that the arm part 12b is located at the center of intervals between adjacent knitting needles as in the case of the arm 2b of the sinker member 2. The sheet thickness and the arm-part sheet thickness are larger for 7G with a smaller gauge value.

[0025] The sinker portion 12 has a supporting part 12a whose outer circumference is a circular arc and an arm part 12b that extends from the supporting part 12a to one side as in the case of the sinker member 2 shown in Fig. 5(a). In the arm part 12b, a yarn hold part 12c and front fringe part 12d same as the yarn hold part 2c and the front fringe part 2d of the arm part 2b of the sinker member 2 are formed, respectively. Since the 12G flat knitting machine uses thinner knitting yarns than those for the 7G flat knitting machine, the concave section of the yarn hold part 12c is smaller than that for 12G shown in Fig. 1(b). Except the difference in the yarn hold part 12c and the difference shown in Table 1, the movable sinkers 11 have nearly equivalent configuration for 7G and for 12G. Now, the parts which have equivalent configuration will be described as follows.

[0026] From the intermediate section between the supporting part 12a and the arm part 12b of the sinker portion 12 of the movable sinker 11, a torque spring portion 13 is extended in the direction opposite to the arm part 12b. This intermediate section corresponds to a position where a spring hold part 2e is provided in the sinker member 2 shown in Fig. 5(a). The sinker portion 12 forms a practically inverted Ω-letter shape with this intermediate section, the supporting part 12a, and furthermore a protruding section in the direction opposite to the arm part 12b on the left side of the drawing. The protruding section in the direction opposite to the arm part 12b is subject to the action of a cam mounted to a carriage of a flat knitting machine and becomes a cam work part 12f for forcibly evacuating the arm part 12b from the needle bed gap. To the torque spring portion 13, a roundabout part 13b that takes a roundabout course around a virtual center of a circle 4c is formed on the inner circumferential side of the supporting part 12a following the extending part 13a that continues into a bifurcating section from the sinker portion 12. In the torque spring portion 13, an idle end part 13c that runs parallel to the extending part 13a is formed following the roundabout part 13b. The extending part 13a, the roundabout part 13b, and the idle end part 13c form a practically U-letter shape, and achieve to form a nearly equivalent shape that excludes a base end part 3a of a wire spring 3 of the movable sinker device 1 shown in Fig.5(a).

[0027] However, with this kind of U-letter shape only, the torque spring portion is equivalent to a torque spring portion 6 shown in Fig.5(b), and the line length becomes short. Therefore, as shown in the chain double-dashed line in Fig.7, it is unable to obtain the relationship between the sufficient amount of displacement and the load by punching-out working by press. In the torque spring portion 13 of the movable sinker 11, in order to add a line length, a projection part 13d that projects to the left side of the drawing, that is, to outwards in the radial direction is provided between the roundabout part 13b and the idle end part 13c. A concave section which serves as the deficiency part 12g is formed on the sinker portion 12 side so that a clearance can be secured even if the projection part 13d is provided. It is the outside of the supporting part 12a of the sinker portion 12 that the deficiency part 12g is provided. The upper section of the deficiency part 12g becomes a touch part 12h being pressed from upward so that the supporting part 12a is not floated.

[0028] The movable sinkers 11 in which the sinker portion 12 and the torque spring portion 13 are integrated as shown in Figs.1, can be suitably manufactured by a press punching-out method called fine-blanking (FB). In fine-blanking, the material is plastic-worked while a punched-out portion is restricted by dies with a small clearance. The restriction requires values not less than

the minimum sizes corresponding to the sheet thickness for a clearance s, between the inner circumferential side of the Ω-letter shape portion of the sinker portion 12 and the outer circumferential side of the torque spring portion 13, and for a width w of the torque spring portion 13. Incidentally, in order to extend the line length as the torque spring portion 13 while the clearance s is secured for the touch part 12h of the sinker portion 12, the idle end part 13c has a shape that bends inwards in the radial direction as the torque spring portion 13, and a protrusion 13e that protrudes outwards in the radial direction is formed in the vicinity of the head end. After punching out, finish-working is carried out if required and heat treatment is conducted, too.

[0029] As described above, let the sheet thickness of the movable sinker 11 for 7G be 0.7 mm; then, assume the minimum sizes of the clearance s and the width w be, for example, 0.55 mm and 0.32 mm. Let the sheet thickness be used for the reference; then, they are 79% and 46% of the sheet thickness, respectively. In the same manner, let the sheet thickness of the movable sinker 11 for 12G be 0.55 mm; then, the minimum sizes of the clearance s and the width w can be made into 0.5 mm and 0.3 mm, which are 91% and 55% of the sheet thickness, respectively. In this way, it is preferable to set the minimum size of the clearance s within a range from 70% to 100% of the sheet thickness and the minimum size of the width w within a range from 40% to 60% of the sheet thickness, respectively.

[0030] Fig. 2 shows main components combined when the movable sinker 11 shown in one of Figs. 1 is used for a flat knitting machine. The movable sinker 11 is housed in the cutout portion 4a formed by reducing wall thickness on the head end side of the needle plate 4 placed side by side on the needle bed of the flat knitting machine, same as the sinker members 2 shown in Figs. 5. On the bottom of the cutout portion 4a, a concave portion to support sinker 4b, which has a circular arc shape inner circumferential face, is formed, and the support part 12a of the sinker portion 12 is fitted into the concave portion to support sinker 4b. The virtual center of a circle 4c of a circular arc of the concave portion to support sinker 4b serves as the center of rocking displacement of the movable sinker 11. At the top of the cutout portion 4a with reduced wall thickness, the press part 4d that comes in contact with the protrusion 13d of the torque spring portion 13 is formed.

[0031] In the needle groove between needle plates 4, a knitting needle 15 is housed. The knitting needle 15 is configured by a combination of, for example, a needle body 16 and a needle jack 17. To the needle jack 17, for example, a select jack for selecting the needle is combined. The needle body 16 is, for example, a latch needle that opens and closes a hook 16a at the head end by a latch 16b, and has a blade 16c for loop transfer in the needle shank portion. To the needle jack 17, a butt 17a, which is subject to the action of a cam mechanism for knitting drive mounted to the carriage of the flat knitting machine, is formed.

[0032] The movable sinker 11 shown in one of Figs. 1 is mounted inside the cutout portion 4a of the needle plate 4 that forms a needle groove in which a knitting needle 15 is housed. Therefore, above the knitting needle 15, a space is generated in the needle groove. Into this space, a spacer 18 is inserted. As described later, the upper part of the movable sinker 11 is used in a condition being sandwiched between the spacer 18 and the cutout portion 4a of the needle plate 4.

[0033] Fig. 3 schematically shows a configuration of a flat knitting machine 20 to which the movable sinker 11 is mounted. The needle plates 4 are placed side by side on a needle bed 21 of the flat knitting machine 20 with intervals provided in the direction perpendicular to the paper surface. As described above, the portion except the support part12a, the arm part 12b, and a cam work part 12f of the sinker portion 12 of the movable sinker 11, as well as the upper part such as the idle end part 13c of the torque spring portion 13 are sandwiched between the cutout portion 4a of the needle plate 4 and a spacer 18. At the upper center of the cutout portion 4a, a hedge plate 22 penetrates in the direction perpendicular to the paper surface. The arm part 12b of the sinker portion 12 protrudes to the needle bed gap 5 side. Due to rocking displacement at the support part 12a, the arm part 12b carries out swing displacement that advances and reverses with respect to the needle bed gap 5. The protrusion 13e in the vicinity of the head end of the idle end part 13c of the torque spring portion 13 is pressed by the press part 4d of the needle plate 4 and the arm part 12b is energized by the clockwise torque of the drawing. With this torque, the yarn catching part 12c presses the knitting yarn of the knitted fabric downwards of the needle bed gap 5. However, when the resistance based on the tension of knitting yarn becomes greater than the pressing force by spring energization, the yarn catching part 12c reverses from the needle bed gap 5 and does not unnecessarily press the knitting yarn. Pressing the cam work part 12f by the cam mounted to the carriage can force the arm part 12b to reverse from the needle bed gap 5. Incidentally, in the flat knitting machine 20, in general, needle beds 21 of the similar configuration face each other with the needle bed gap 5 in-between and each needle bed 21 tilts in such a manner that the needle bed gap 5 side rises. Consequently, the vertical direction at the needle bed gap 5 is not the vertical direction with the needle plate 4 side set as the top and the needle bed 21 side set as the bottom on the paper surface but is tilted so that the lower left is set to the bottom and the upper right is set to the top with respect to the paper surface that conforms to this vertical direction.

[0034] Figs. 4 schematically show configurations of movable sinker devices 25 that use the movable sinker 11 for 7G shown in Fig. 1(a). Fig. 4(a) shows the lower-limit state in which the yarn catching part 12c presses the knitting yarn downwards of the needle bed gap 5, while Fig. 4(b) shows the upper-limit state. In the upper-

limit state, the yarn catching part 12c is pushed up by the knitting yarn or the arm part 12b is forcibly pushed up by pressing pressure to the cam work part 12f. The movable sinker 11 can carries out rocking displacement between the lower-limit state shown in Fig. 4(a) and the upper-limit state shown in Fig. 4(b). This rocking displacement is carried out centering around the virtual center of a circle 4c of a circular arc with the outer circumference of the support part 12a of the sinker portion 12 supported by the concave portion to support sinker 4b of the needle plate 4 and by the guidance of the circular-arc-shape inner circumferential surface. During the rocking displacement, the touch part 12h of the end section of the sinker portion 12 comes in contact with the bottom surface of the hedge plate 22 at any part in the vicinity of the head end so that the support part 12a does not drift away from the concave portion to support sinker 4b. At the idle end part 13c of the torque spring portion 13, the part of the protrusion 13e that protrudes outwards in the radial direction comes in contact with the press part 4d of the needle plate 4. The part of the protrusion 13e comes in contact at a position a little nearer to the needle bed gap 5 than to the hedge plate 22.

[0035] As shown in Fig. 5(a), in the event that the wire spring 3 is separate from the sinker member 2, and the base end part 3a of the wire spring 3 is elastically held by the spring hold part 2e of the sinker member 2, the spring hold part 2e occupies a comparatively large space and has little room to deform the idle end part 3c side that runs parallel. In the movable sinker 11, the sinker portion 12 and the torque spring portion 13 are integrated. Thus, there is no need to provide the spring hold part 2e like the sinker member 2 and a space can be provided below the idle end part 13c. Consequently, even if the protrusion 13e that protrudes outwards in the radial direction is provided, the head end of the idle end part 13c and the like are able to be prevented from coming in contact with the sinker portion 12 side. The top of the protrusion 13e is a convex curve with a comparatively small curvature radius and stably comes in point-contact with the press part 4d of the needle plate 4, and can smoothly move along the surface of the press part 4a.

[0036] Incidentally, in the movable sinker 11 shown in one of Figs. 1, the sheet thickness of the arm part 12b is reduced to vary from other parts but, functions as a movable sinker device can be fulfilled equivalently even if the whole arm part is made into the same sheet thickness. In addition, the concave portion to support sinker 4b that supports the support part 12a of the movable sinker 11 is provided to the needle plate 4, but it may be provided to the needle bed 21. The cam work part 12f is formed in such a manner that the sinker portion 12 is subject to the counterclockwise torque by the pressing action but it may be formed not in the lateral direction as illustrated but in the longitudinal direction so that the sinker portion 12 is subject to the similar torque by the pull-in action in the direction opposite to the needle bed gap 5. In this way, it is needless to say that any change or modification may be made to the present invention if such change or modification does not depart from the spirit and scope of the present invention.

Claims

1. A movable sinker having a sinker portion of which being provided with a support part and an arm part, the support part supports the sinker portion in such a manner as to enable rocking displacement by a circular-arc-shape guide part around a center of the circular-arc, the guide part being provided on a needle bed in the vicinity of a needle bed gap, and the arm part is advanced into the needle bed gap and presses down a knitted fabric downwards with a head end side of the arm part by energizing of a torque spring, which works on the support part, wherein
the movable sinker further having a torque spring portion, which is formed integral with the sinker portion to work as the torque spring and is provided with;
an extending part bifurcating out from the arm part side and extending to the support part side,
a roundabout part being connected to the extending part and taking a roundabout route in the periphery of the center of the circle,
a projection part being connected to the roundabout part and projecting outwards in the radial direction, and
a idle end part being connected to the project part and taking a parallel course to the extending part.

2. The movable sinker according to claim 1,
wherein the sinker portion has practically an Ω-letter shape,
the support part is formed in such a manner as to have a predetermined width at the middle of the Ω-letter shape and between the circular-arc-shape outer circumference and the circular-arc-shape inner circumference,
the roundabout part of the torque spring portion is formed inside the support part, and
the project part is formed outside the support part.

3. The movable sinker according to claim 1 or claim 2, wherein the support part of the sinker portion is supported by a sinker supporting concave part formed a little to the head end of a needle plate disposed at predetermined intervals on the needle bed, and
the idle end part of the torque spring portion has a protrusion that comes in contact with a press part provided on the needle plate side.

4. The movable sinker according to any one of claims 1 - 3,
wherein the sinker portion has the minimum size of clearance between the torque spring portion and the

sinker portion set within a range from 70% to 100% of the thickness and the minimum size of width of the torque spring portion set within a range from 40% to 60% of the thickness, respectively, and is manufactured by a fine blanking process.

5. A flat knitting machine, comprising the movable sinker according to any one of claims 1 - 4.

[Figs.1]

Fig.1(a)

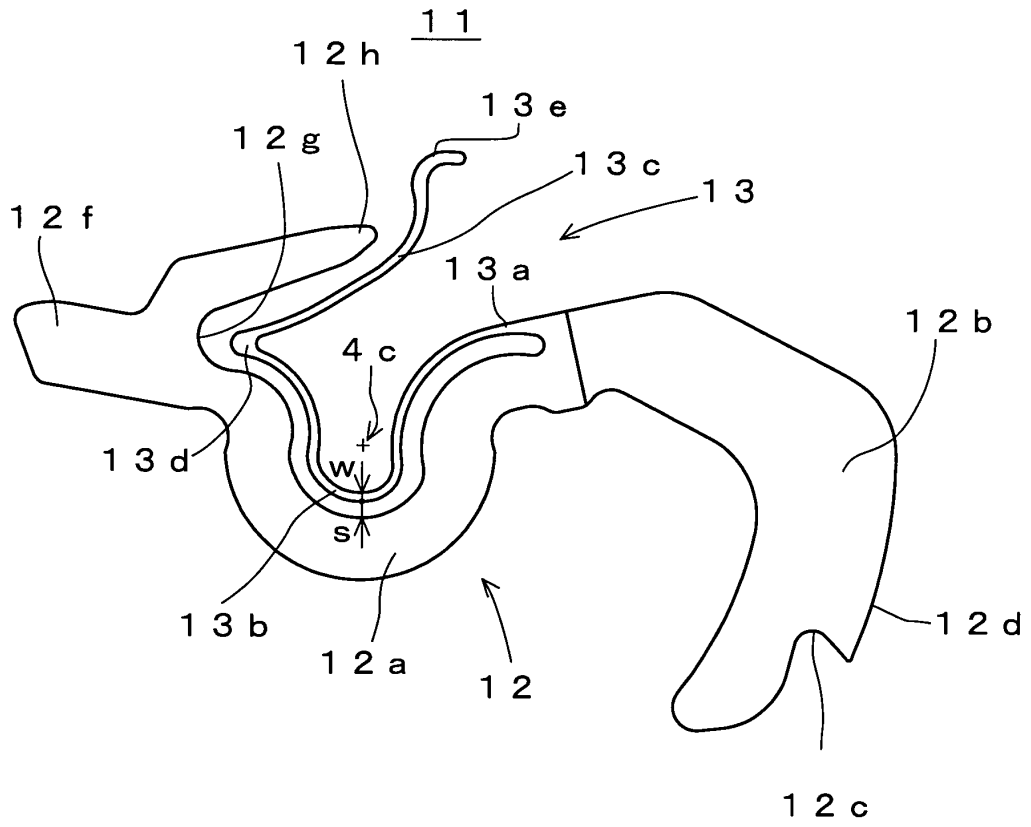
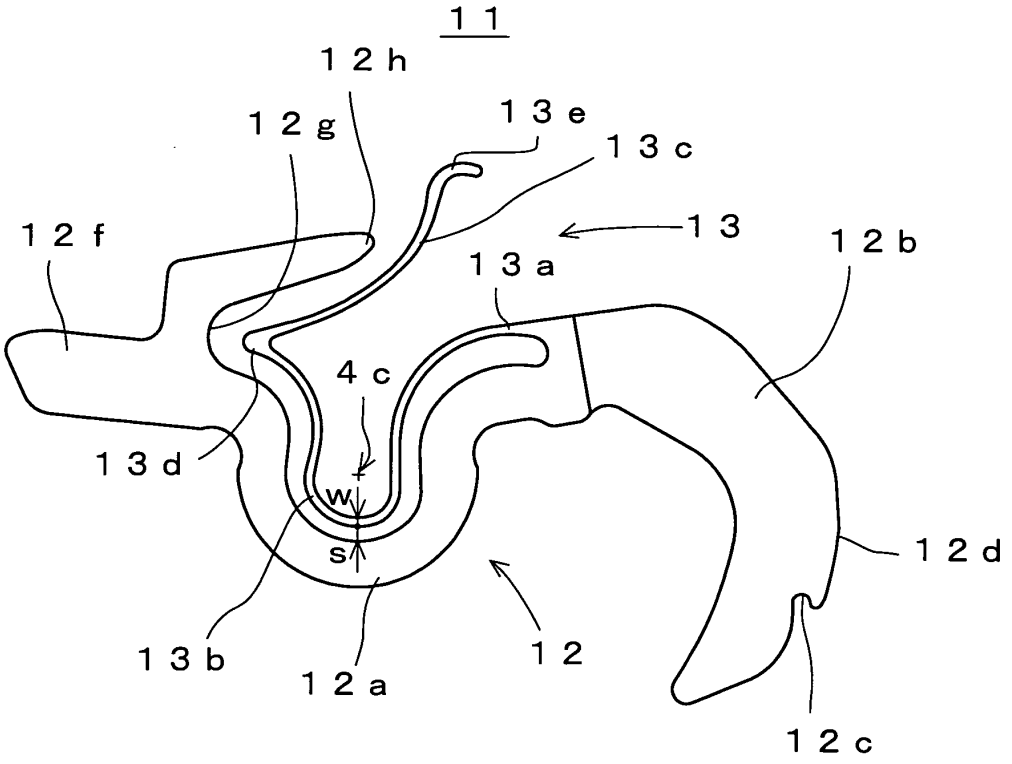
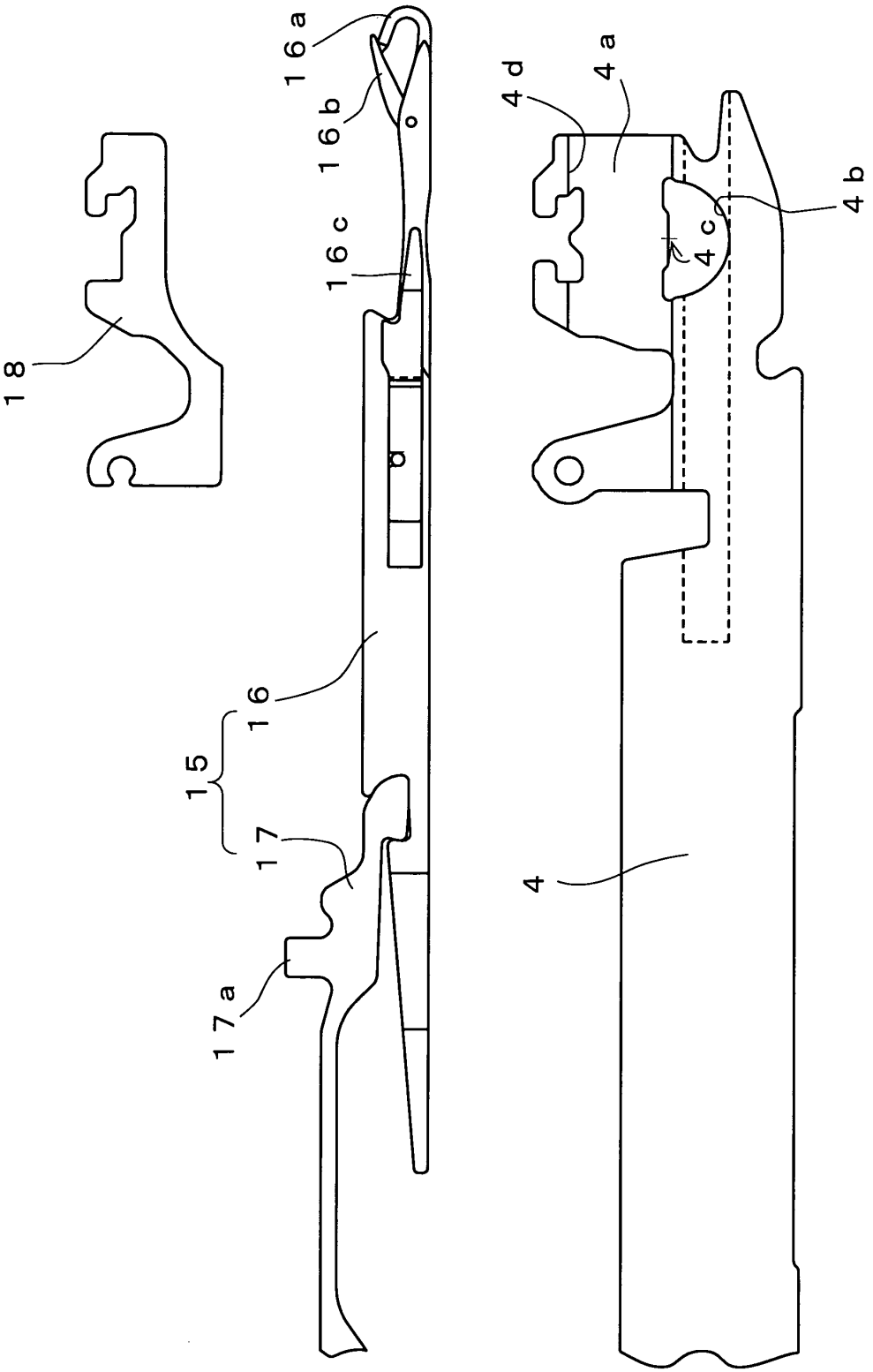


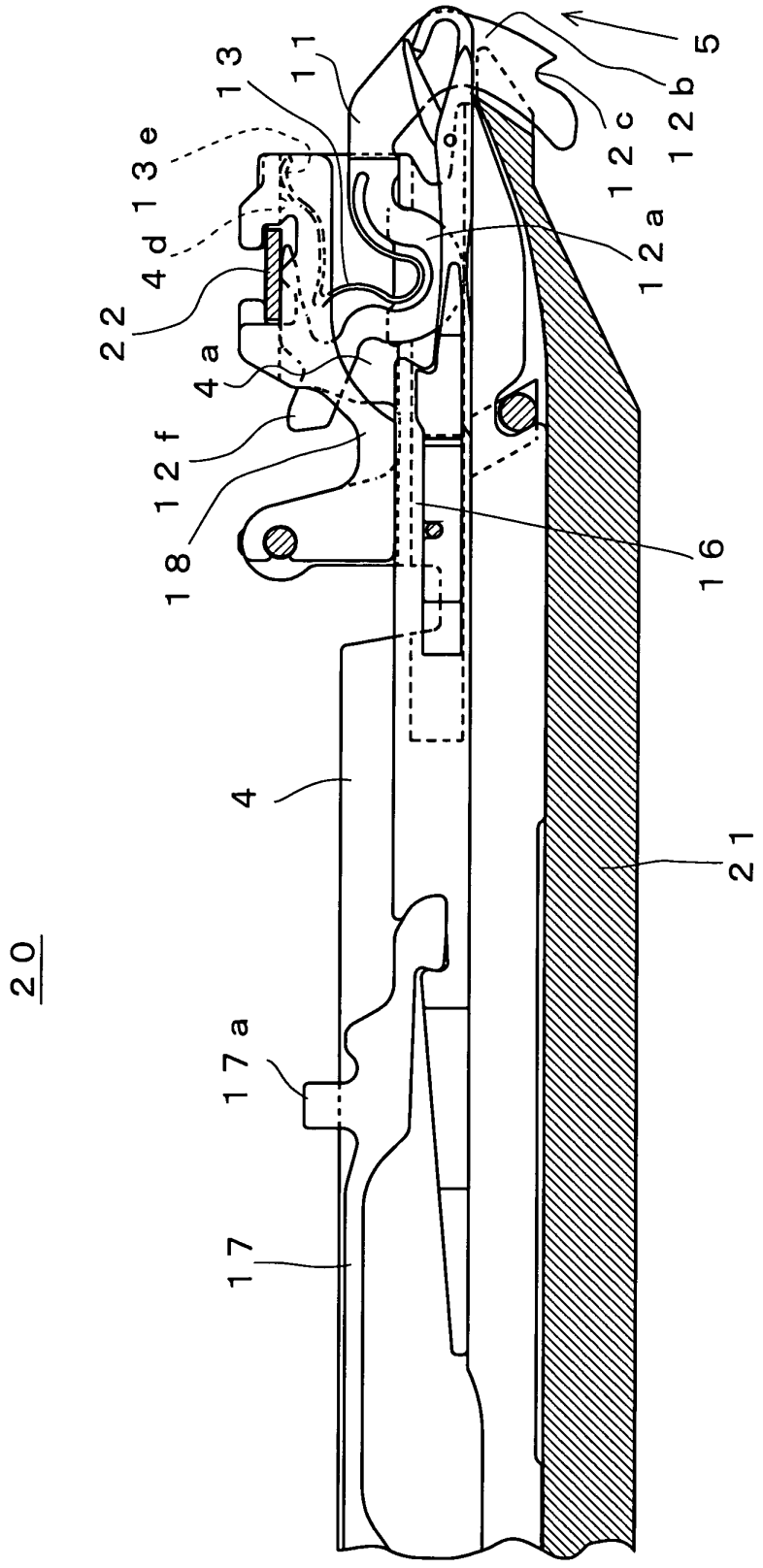
Fig.1(b)



[Fig.2]



[Fig.3]



[Figs.4]

Fig.4(a)

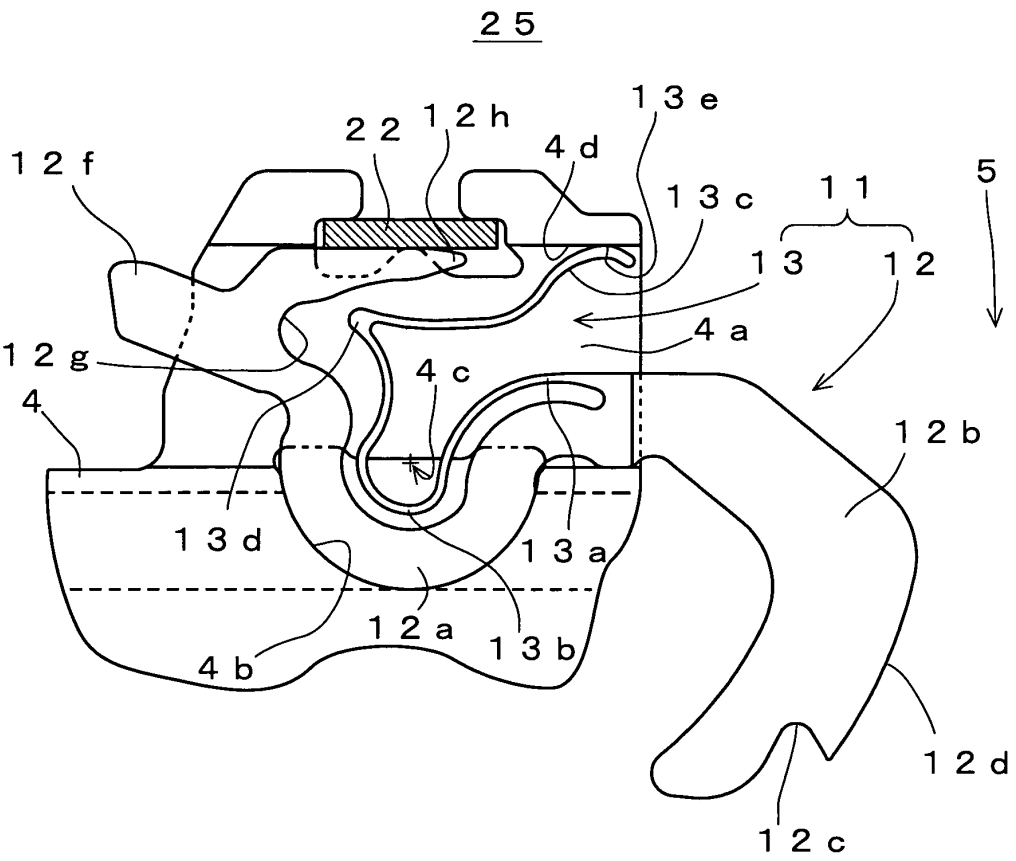
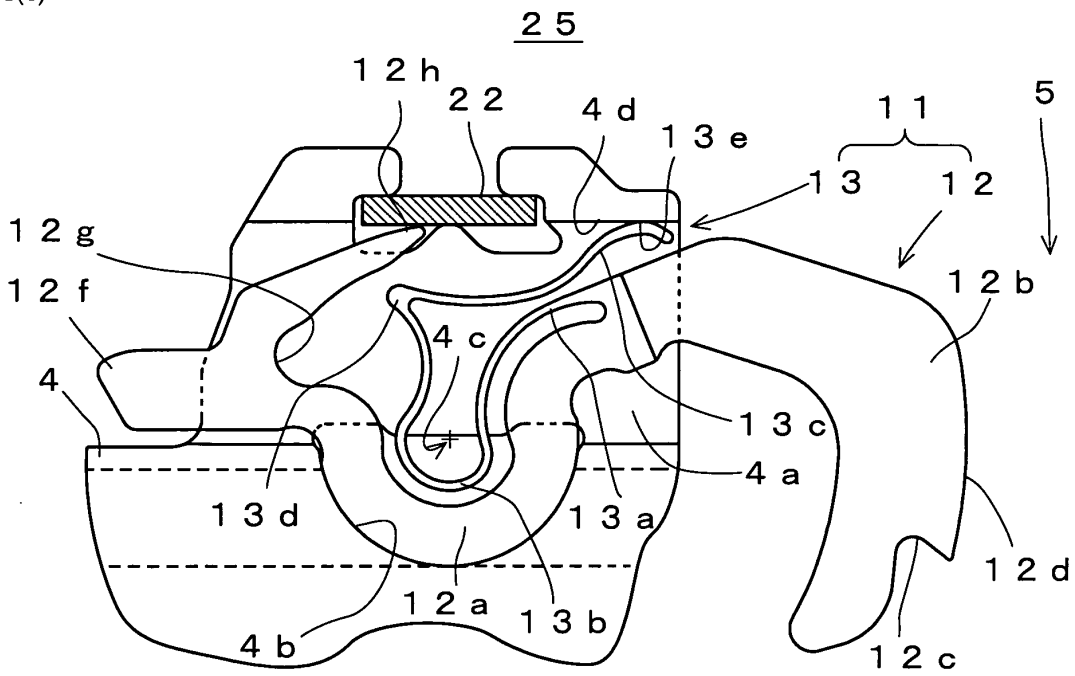


Fig.4(b)



[Figs.5]

Fig.5(a)

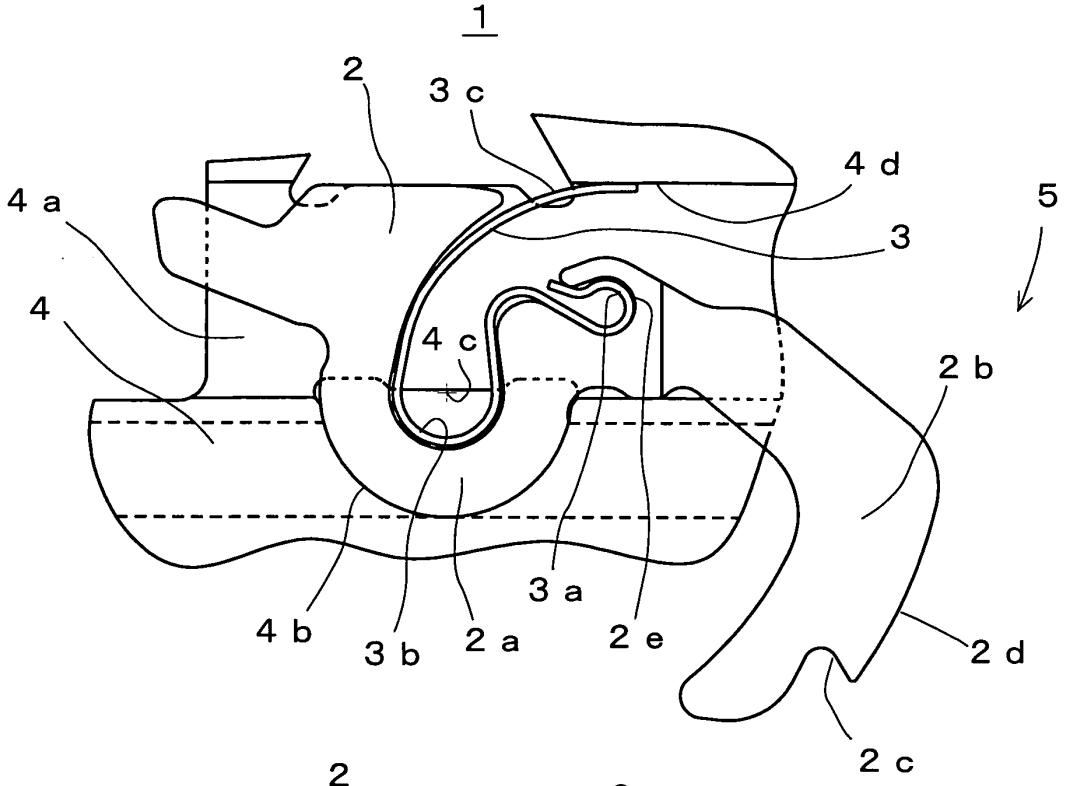
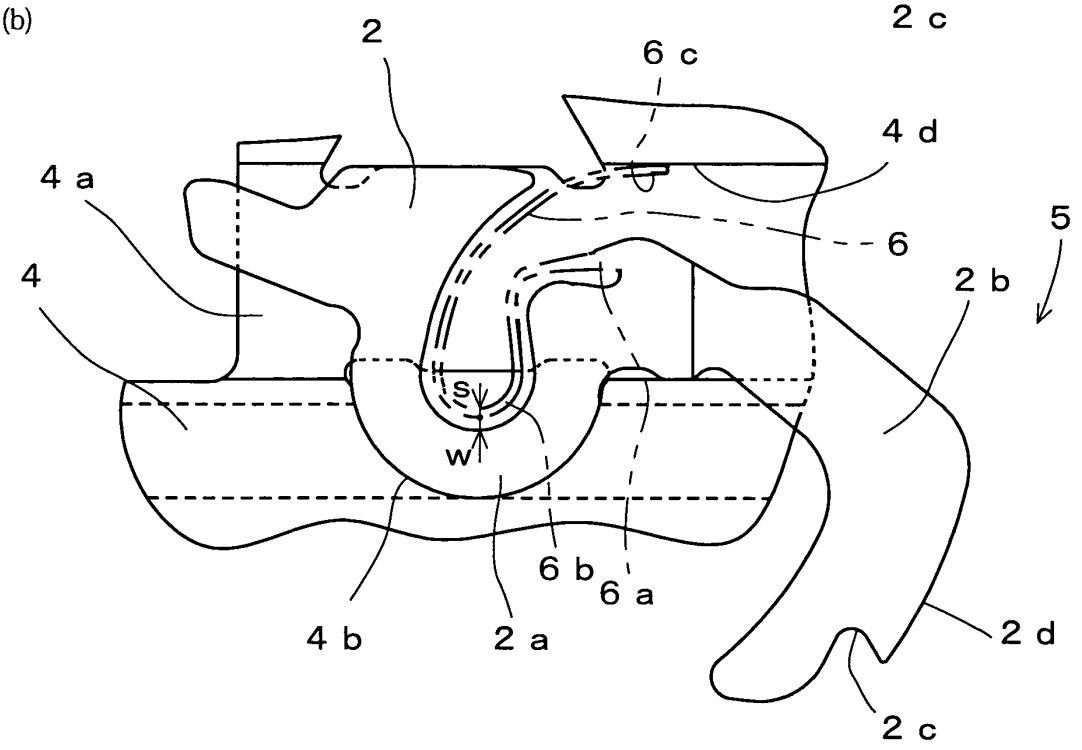
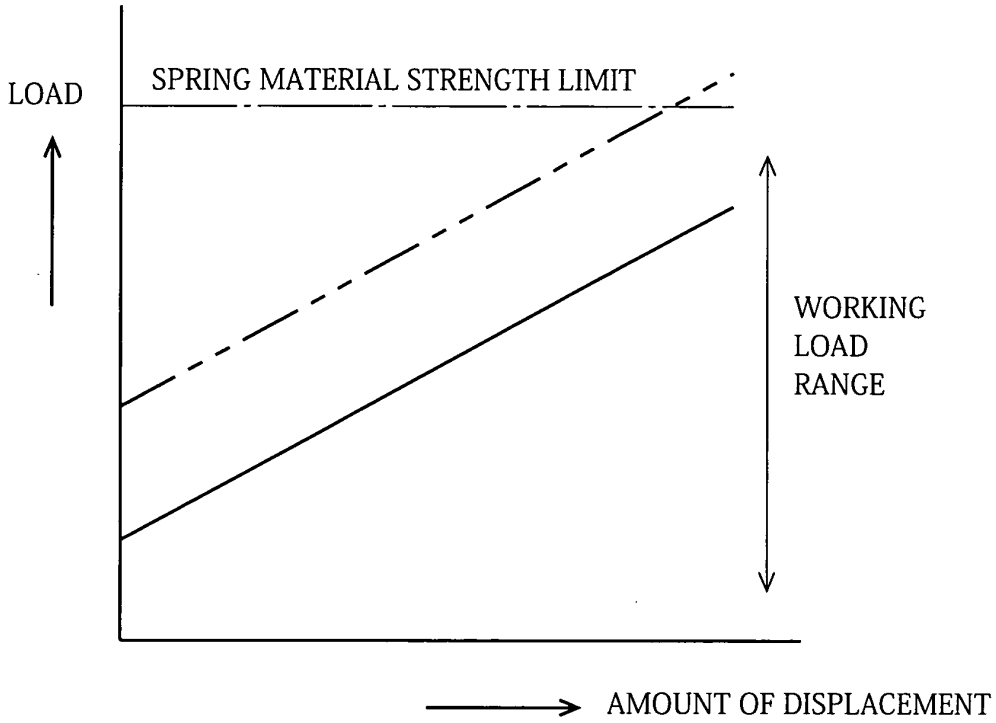


Fig.5(b)



[Fig.6]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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/000875

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 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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.
A	JP 3333304 B2 (Shima Seiki Mfg., Ltd.), 15 October, 2002 (15.10.02), & EP 672769 B1	1-5
A	JP 5-83657 B2 (Shima Seiki Mfg., Ltd.), 29 November, 1993 (29.11.93), & US 5134865 A & EP 435690 B1 & KR 123800 B1	1-5
A	JP 3-504991 A (Universal Maschinenfabrik Dr. Rudolf Schieber GmbH & Co. KG.), 31 October, 1991 (31.10.91), & DE 3917934 A & EP 347011 A & WO 89/012708 A	1-5

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Date of the actual completion of the international search	Date of mailing of the international search report
22 August, 2007 (22.08.07)	04 September, 2007 (04.09.07)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/000875

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 3026192 B2 (H.Stoll GmbH & Co.), 27 March, 2000 (27.03.00), & DE 19725073 A1 & US 6092396 A & EP 884412 B1	1-5
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- JP 5083657 A **[0007]**
- JP 2001303407 A **[0007]**