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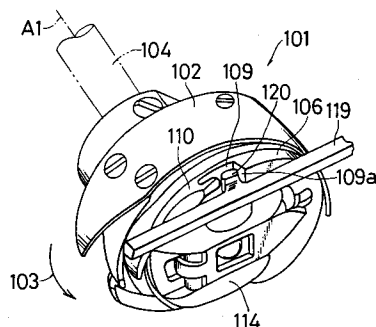
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(54) **Hook assembly and sewing process.**

(57) In rotary hook assemblies (101) and oscillating shuttle hook assemblies (321), a bearing rib (108,325) on a bobbin case basket (106, 311) or at least its surface layer (217, 324) is composed of a synthetic resin such as a liquid crystal polymer, which has such properties that the amount of the rotating frictional force of the slide contact portion, between the surface layer (217, 324) of the bearing rib (108, 325) and the inside circumference layer (326) of the groove shaped bearing raceway (128, 322) where the bearing rib (108, 325) is fitted, is lower in cases without industrial sewing machine oil than in other cases with the industrial sewing machine oil.

By this construction, the hook assembly (101, 321) which has the good durability of the rotating portion without any hook lubrication is realized. Accordingly, the oil stains of threads and sewing materials by hook lubricant is disappeared and the sewing quality enhances.

Fig. 1**EP 0 669 415 A1**

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 The present invention relates to a hook assembly which is incorporated into a lockstich sewing machine or the like as well as to a sewing process utilizing the hook assembly.

2. Description of the Related Art

10 A bobbin case basket assembly which is incorporated into a lockstich sewing machine has a bearing rib formed on its outside circumference, which bearing rib is fitted into a groove shaped bearing raceway formed in the inside circumference of a hook, and only the hook is driven to rotate at a high speed while the bobbin case basket assembly is prevented from rotating downstream in the direction of rotation of the hook by a position finger secured to the body of the sewing machine. Specifically, hooks of industrial sewing
15 machines are driven to rotate at high speeds of about 6,000-10,000 rpm.

Accordingly, a large frictional force is generated due to the sliding contact between the bearing rib and the groove shaped bearing raceway. In cases where the friction between the bearing rib and the groove shaped bearing raceway is high, the position finger is brought into vigorous contact with the side wall of a rotation restraining groove of the bobbin case basket assembly into which the position finger is fitted, and
20 therefore a needle thread cannot pass smoothly through the rotation restraining groove, and it causes a problem that the tension of the needle thread changes undesirably, and that the sewing quality becomes worse, and the durability is also diminished due to the friction between the bearing rib and the groove shaped bearing raceway.

In order to solve this problem, there is a well known construction designed to provide a lubricant
25 between the surface layer, or the outside circumference, of the bearing rib on the bobbin case basket assembly and the inside circumference of the groove shaped bearing raceway in the hook; this construction, however, has the risk of staining the needle thread, bobbin thread, cloth, etc. by the lubricant. Accordingly, another conventional construction includes coating of the bearing rib on the bobbin case basket assembly by a fluorine resin with a low friction coefficient, such as TEFLON (trade name). According
30 to the techniques of the prior art mentioned above, however, since the fluorine resin is sprayed and baked to provide a thin film coating usually around 10-20 μm thick, the durability is poor, and particularly in cases where no oil is fed, there is an additional problem in that the coating readily peels off.

SUMMARY OF THE INVENTION

35 An object of the present invention is to provide a hook assembly, wherein the friction of the rotating section is minimized without lubrication, so that the hook assembly can rotate smoothly and stably at a high speed.

The present invention relates to a hook assembly for a sewing machine comprising a bearing rib
40 formed on the outside circumference of a bobbin case basket and extending circumferentially and a groove shaped bearing raceway for rotating the bobbin case basket, which surrounds the bobbin case basket, extends circumferentially, and fits the bearing rib, characterized in that at least either the bearing rib or at least its surface layer, or the groove shaped bearing raceway or at least its inside circumference layer is composed of a synthetic resin of such type that the rotating frictional force of a slide contact portion
45 between the surface layer of the bearing rib and the inside circumference layer of the groove shaped bearing raceway into which the bearing rib is fitted, is lower in cases where no industrial sewing machine oil is present between said surface layer and said inside circumference layer than in other cases with the industrial sewing machine oil present therebetween.

The present invention further relates to a hook assembly for a sewing machine, characterized in that the
50 hook assembly is a rotary hook assembly, and the hook is a rotary hook.

The present invention further relates to a hook assembly for a sewing machine, characterized in that the hook assembly is an oscillating shuttle hook assembly, and the shuttle hook is an oscillating loop taker.

The present invention further relates to the hook assembly for a sewing machine, characterized in that the synthetic resin is a liquid crystal polymer.

55 The present invention further relates to the hook assembly for a sewing machine, characterized in that the synthetic resin is an aromatic polyimide resin.

The present invention further relates to the hook assembly for a sewing machine, characterized in that the bobbin case basket comprises a cylindrical section for receiving the bobbin, and the bearing rib is an

endless ring fittedly secured to the outside circumference of the cylindrical section.

The present invention further relates to the bobbin case basket assembly for a sewing machine, characterized in that the bearing rib section of a metal bobbin case basket assembly body comprises a bearing rib formed integrally with the synthetic resin-made coating member which covers from the loop-spreading section to the rail end section of the bearing rib section, and the coating member is stripped off the loop-spreading section of the metal bearing rib section upward in the direction of rotation of the hook.

The present invention further relates to a sewing process using the above hook assembly for a sewing machine which is rotated or oscillated, characterized in that at least either the bearing rib or at least its surface layer, or the groove shaped bearing raceway or at least its inside circumference layer is composed of a synthetic resin of such type that the rotating frictional force of a slide contact portion between the surface layer of the bearing rib and the inside circumference layer of the groove shaped bearing raceway into which the bearing rib is fitted, is lower in cases where no industrial sewing machine oil is present between said surface layer and said inside circumference layer than in other cases with the industrial sewing machine oil present therebetween; and sewing is performed without hook lubrication.

According to the present invention, the bearing rib and/or the groove shaped bearing raceway in the hook assembly or at least its surface layer is composed of a synthetic resin such as a liquid crystal polymer, which has such properties that the rotating frictional force of a slide contact portion between the surface layer of the bearing rib and the inside circumference layer of the groove shaped bearing raceway into which the bearing rib is fitted, is lower in cases where no industrial sewing machine oil is present between said surface layer and said inside circumference layer than in other cases with the industrial sewing machine oil present therebetween, and accordingly a sewing machine incorporating such hook assembly can be operated without hook lubrication; because of the low friction between the bearing rib and the groove shaped bearing raceway the frictional heat is negligible and does not cause burning; thus staining of needle thread, bobbin thread, sewing material, etc. by hook lubricants may be prevented.

In addition, since the rotating frictional force between the bearing rib and the groove shaped raceway in the hook assembly may be minimized, the force worked on a bobbin case assembly retaining portion may also be diminished, and therefore a loop of needle thread smoothly passes through the retaining portion without exerting great tension on the loop of needle thread, which can improve sewing quality.

Further, by using a liquid crystal polymer or aromatic polyimide resin according to the present invention, the friction between the surface layer of the bearing rib composed of the liquid crystal polymer or aromatic polyimide resin and the inside circumference of the groove shaped bearing raceway can be reduced, thereby the durability of the hook rotating portion is improved as compared with the cases where teflon or other types of resin are used.

The oil-free type hook assembly of sewing machine according to the present invention, not only consumes no lubricant such as industrial sewing machine oil, and as a result, a structure for feeding a lubricant is not required, which allows not only simpler construction, but also easier maintenance of the machine.

The present invention may also be applied to horizontal rotary hook assemblies, vertical rotary hook assemblies, oscillating shuttle hook assemblies, etc.

According to the present invention, the bearing rib section of the metal bobbin case basket body comprises a bearing rib formed integrally with a synthetic resin-made coating member by, for example, outsert, from the loop-spreading section to the rail end section of the bearing rib section. The coating member and the bearing rib section may be formed into one piece by exertion of great force so that the coating member does not easily peel off from the bearing rib section. The friction between the bearing rib on the bobbin case basket and the groove shaped bearing raceway in the hook may be minimized; therefore, the hook assembly can be driven to rotate in a smooth and stable manner at a high speed. This eliminates the need for hook lubrication, thereby preventing staining of the thread, cloth, etc. by lubricants. Further, since in the loop-spreading section with which the thread is in sliding contact, the coating member is stripped off the metal bearing rib section upstream in the direction of rotation of the hook, the formation of "thread print" is prevented.

Also according to the present invention, since the coating member may be formed of a synthetic resin such as a liquid crystal polymer, aromatic polyimide resin or the like, productivity may be increased because of the ease of processing.

Also according to the present invention, the hook may comprise a main hook body and a slide member. The slide member may be composed of a synthetic resin having a low friction coefficient, and may be formed integrally with the hook body by, for example, insert or outsert molding. Into the groove shaped bearing raceway wherein the slide member is formed in this manner is fitted the bearing rib on the bobbin case basket to lessen the frictional force of the bearing rib and groove shaped bearing raceway, and

therefore, the hook assembly can be driven to rotate stably at a high speed.

BRIEF DESCRIPTION OF THE DRAWINGS

Other and further objects, features, and advantages of the invention will be more explicit from the following detailed description taken with reference to the drawings wherein:

The above-mentioned and other objects, aspects and advantages of the present invention will become more apparent from the following description in detail in connection with the accompanying drawings wherein:

Fig. 1 is a perspective view of a vertical rotary hook assembly 101 according to an embodiment of the present invention;

Fig. 2 is a sectional view showing the overall construction of the vertical rotary hook assembly 101;

Fig. 3 is a fragmentary perspective view of the vertical rotary hook assembly 101;

Fig. 4 is a plane view of a bobbin case basket assembly 106 as seen from the top in Fig. 2;

Fig. 5 is a back view of the bobbin case basket assembly 106 as seen from the left in Fig. 2;

Fig. 6 is a sectional view of the bobbin case basket assembly 106 of the vertical rotary hook assembly 101;

Fig. 7 is an enlarged sectional view taken along the section line VII-VII of Fig. 4;

Fig. 8 is a partially cutaway sectional view of a liquid crystal polymer-made injection-molded piece 28;

Fig. 9 is an enlarged sectional view of a bobbin case basket assembly 106 according to another embodiment of the present invention, taken along the section line VII-VII of Fig. 4;

Fig. 10 is a fragmentary perspective view of a bobbin case basket assembly 71 according to a further embodiment of the present invention;

Fig. 11 is a sectional view showing a fitting groove 73 and its vicinity of the bobbin case basket assembly 71;

Fig. 12 is a perspective view of the bobbin case basket assembly 71 according to the above embodiment of the present invention;

Fig. 13 is a graph showing the torques which work on the position finger of the sewing machine by hook rotation in the experiments performed by the present inventors according to an embodiment of the present invention and a comparison;

Fig. 14 is a graph showing the increase in the clearance (or gap) between the bearing rib on the bobbin case basket and the groove shaped bearing raceway in the hook with lapse of the hook rotating time in the experiments performed by the present inventors according to an embodiment of the present invention and a comparison;

Fig. 15 is a graph showing the sewing quality when polyester filament #50 thread was used in the experiments performed by the present inventors according to an embodiment of the present invention and a comparison;

Fig. 16 is the same graph as Fig. 16, except that polyester spun #60 thread was used;

Fig. 17 is the same graph as Fig. 16 or Fig. 17, except that cotton #120 thread was used;

Fig. 18 is a partially enlarged sectional view of a bearing rib 108, a groove shaped bearing raceway 128 and their vicinity in cases where a slide member 131 is provided according to a further embodiment of the present invention;

Fig. 19 is a simplified perspective view of an oscillating shuttle hook assembly 321 according to another embodiment of the present invention; and

Fig. 20 is a simplified front view of the oscillating shuttle hook assembly 321 as seen from the direction L2 in Fig. 19;

Fig. 21 is an enlarged sectional view in a simplified version taken along the section line XXI-XXI of Fig. 20; and

Fig. 22 is an enlarged sectional view corresponding to Fig. 21 according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Now referring to the drawings, preferred embodiments of the invention are described below.

Fig. 1 is a perspective view of a vertical rotary hook assembly 101 having an horizontal rotation axis A1 according to an embodiment of the present invention. Fig. 2 is a sectional view showing the overall construction of the vertical rotary hook assembly 101 according to the embodiment. Fig. 3 is a fragmentary perspective view of the rotary hook assembly 101. Hook 102 is constructed in such a manner that a shaft

104 which is driven to rotate about a horizontal rotation axis A1 in the direction indicated by the arrow 103 is fixed with a bolt 105, and it is driven to rotate about the same axis of A1 of the shaft 104. The hook 102 constructed in this manner receives a bobbin case basket assembly 106.

Referring to Fig. 4 showing the plane view as seen from the top in Fig. 2, Fig. 5 showing the back view and Fig. 6 showing the longitudinal section, the bobbin case basket 106 comprises a cylindrical section 107, a bearing rib 108 formed on the outside circumference of the cylindrical section 107, a flange section 110 having a bobbin case basket rotation stop recess 109 formed at one end of the cylindrical section 107 at the side of the open end of the bobbin case basket (the right portion in Fig. 4), and a bottom 111 called a "bridge", which extends diametrically toward the other end of the cylindrical section 107. On the bottom 111, a stud 112 stands and extends coaxially with the cylindrical section 107 toward the open end of the bobbin case basket, and on the stud 112 a bobbin 113 and a bobbin case 114 are engaged.

In the rotation stop recess 109 of the bobbin case basket 106 formed on the flange section 110, a protrusion 120 of the position finger 119 secured to a sewing machine body (not shown) is engaged with a gap in order to prevent the rotation of the bobbin case basket 106 during the rotation of the hook. The gap is around 0.7mm in both axial and radial directions, and it is necessary for a needle thread to go through. In the cylindrical section 107 is formed a needle dropping hole 121 through which a needle 122 is reciprocated along the axis A2, in synchronization with the rotation of the hook. Needle thread 123 which has passed through the needle 122 is seized by a hook point 124 formed on the hook 102, and goes around the bobbin case basket 106 to form a seam. The bobbin case basket 106 is chiefly made of steel.

The hook 102 comprises a cylindrical section 125 to which the hook point 124 is formed, a base section 126 formed integrally with the cylindrical section 125 into which the shaft 104 is inserted, and a hook gib 127 secured with a screw (not shown) to the end of the cylindrical section 125 at the side of the open end. In the inside circumference of the cylindrical section 125 is formed a groove shaped bearing raceway 128 into which a bearing rib 108 is fitted. The hook 102 is chiefly made of steel.

Fig. 6 is a sectional view of the bobbin case basket 106. The bearing rib 108 is formed around a cylindrical section 107 of the bobbin case basket 106. The bearing rib comprises a basic rib section 216 and a coating member 217.

In this embodiment, the coating member 217 is not provided on the loop-spreading section 18; nonetheless, the loop-spreading section 18 may be covered with the coating member 217 according to another embodiment of the present invention. The rail end section 19 may or may not be coated according to a further embodiment.

The main body of the bobbin case basket 106 may be formed of steel or a metal such as stainless steel, a synthetic resin, an inorganic material such as ceramic, or the like.

Fig. 7 is an enlarged sectional view of the bearing rib 108 and its vicinity of the bobbin case basket shown in Fig. 6. The main body 204a and the basic bearing rib section 216 of the bobbin case basket 106 are made of steel, and a coating member 217 comprising a liquid crystal polymer with 0.3-0.5mm thickness t is formed integrally by, for example, outsert molding, on the outer surface 216a of the bearing rib section 216. Since the coating member 217 is formed to have a sufficient thickness in this manner, the durability is improved and dislocation is also prevented because a part of the coating member 217 is fitted in a groove 220 formed in the bearing rib section 216.

An explanation will now be given regarding the details of the liquid crystal polymer used for formation of the coating member 217. Since the above polymer comprising bar-like rigid components in the polymer backbone has a great intermolecular force due to the rigid backbone components, and crystallizes with a high orientation when molded, its thermal resistance is so excellent that it does not deform even at increased temperatures due to the friction created by the high-speed rotation of the hook 102, because of its very high thermal deformation temperature. In addition, since the liquid crystal polymer comprises a rigid molecular chain, and is highly orientated in the direction of its flow when molded, it has high strength and a high elastic coefficient, while since the molecular chain is stretched to the maximum degree in the direction of the orientation, little further stretching can be expected even upon exertion of tension, and thus excellent creep characteristics are produced. In addition, the linear expansion coefficient is extremely low, and particularly the linear expansion coefficient in the direction of flow is as low as about 1×10^{-5} cm/cm/°C. This linear expansion coefficient is lower than those of other synthetic resins by one order of magnitude, and this enables it to provide the same dimension stability as metals. Because of this stability, the dimensions change little even with changes in season-dependent ambient temperature and humidity. Further, since liquid crystal polymers have outstanding weatherability, they may be used for a long time. It is also to be noted that because of the low degree of their phase change, which is attributable to similar structures in their molten and solidified states, the volumes of liquid crystal polymers change only a little even when solidified.

Fig. 8 is a partially cutaway sectional view of a liquid crystal polymer-made injection-molded piece 28 which is the coating member 217. The liquid crystal polymer comprises an outer skin layer 29 with the molecular chains highly orientated in the direction of flow, an inner skin layer 30 and a poorly orientated core layer 31. The thickness of the skin layers 29 and 30 are almost constantly 0.3-0.2 mm regardless of the thickness of the molded articles. The liquid crystal polymer is plasticated by heating and forced into a sealable mold which is then sealed, and the polymer is cooled to a solid and then removed from the opened mold. Since the liquid crystal polymer may be molded into a coating member in this way, the processing is easy and the productivity is improved.

Since the respective skin layers 29 and 30 are highly orientated in the direction of flow, the liquid crystal polymers have excellent mechanical properties, including high strength and high elastic coefficients. This ease of orientation, however, tends to create an isotropy, and a reinforcing agent is preferably introduced into the rigid backbone so as to diminish the anisotropy. The ease of orientation also tends to produce fibrils peeled off from the respective skins 29 and 30. The macrofibril 32 is 5 μm , the fibril 33 is 0.5 μm , and the microfibril 27 is 0.05 μm . Since the liquid crystal polymers have a multi-layer structure comprising the outer skin layer 29, inner skin layer 30, core layer 31, etc., their vibration damping properties are outstanding in spite of their high elastic coefficients.

By using the liquid crystal polymers, the wear of the surfaces of the bearing rib 108 and the groove shaped bearing raceway 128 is minimal even after high-speed sewing operation without hook lubrication for an extended period of time, and the durability is exceptionally increased. In addition, according to another embodiment the coating member 217 is stripped off the loop-spreading section 18 of the steel-made bearing rib section 216, along which the thread passes, and thus the formation of "thread print" is prevented. Further, because of the frictional characteristic of the liquid crystal polymers, the contact stress in the direction of rotation 103 of the hook 102 between the side wall 109a of the recess 109 upstream and the position finger 120 (119) is minimized. Accordingly, the needle thread can pass through during its travel between the ends 109a and the position finger 120 at constant tension, and the sewing quality is improved.

Fig. 9 is an enlarged sectional view of a bobbin case basket 106 according to another embodiment of the present invention, taken along the section line VII-VII of Fig. 4. The bobbin case basket main body 204a and the bearing rib section 236 with a hole 238 are made of steel, and on the outer surface 236a of the bearing rib section 236 there is provided a liquid crystal polymer-composed coating member 217 having a thickness t of 0.3-0.5 mm, formed integrally therewith, wherein a part of the liquid crystal polymer extends through and fills the hole 238. By providing the hole 238 in the bearing rib section 236 and filling the hole 238 with the liquid crystal polymer, displacement of the coating member 217 is prevented more reliably.

Fig. 10 is a fragmentary perspective view of a bobbin case basket 71 according to a further embodiment of the present invention, for a vertical rotary hook assembly. The bobbin case basket 71 basically comprises a bobbin case basket main body 72 and a built-in bearing rib member 74 secured to a fitting groove 73 formed in the outside circumference of the bobbin case basket main body 72.

Fig. 11 is a sectional view showing a fitting groove 73 and its vicinity. The built-in bearing rib member 74 is fitted in the fitting groove 73. This bearing rib member 74 comprises a bearing rib 79 and fitting protrusions 80 jutting inward in its radial direction. In the fitting groove 73, fitting holes 91 are formed, which correspond to the protrusions 80. The plurality of protrusions 80 and the fitting hole 91 are formed circumferentially and spaced, integrally with the bearing rib 79.

Fig. 12 is a perspective view showing the state of the assembled bobbin case basket 71. A bearing rib member 74 is fitted in the bobbin case basket main body 72 in a secured manner.

The bearing rib member 74 is composed of a synthetic material which is a synthetic resin such as a liquid crystal polymer, aromatic polyimide resin or the like, and the endless annular bearing rib 79 has an elastic force, by which the bearing rib of the bearing rib member 74 may be forced, for fitting, into the cylindrical section 75 of the bobbin case basket main body 72 as indicated by the reference number 89 (Fig. 11). Here, the fitting protrusion 80 is fitted properly and elastically, in fitting holes 91. In this way the bearing rib 79 is secured to the bobbin case basket main body 72 in a detachable manner so that a worn one may be replaced.

The bearing rib member 74 may be secured to the bobbin case basket main body 72 so as to prevent removal for its replacement. The inner surface configuration of the fitting holes 91 are almost identical to the outer surface configuration of the fitting protrusion 80, and this fitting protrusion 80 is properly fitted in the fitting holes 91 for fixation, as mentioned above. Although the bearing rib member 74 is formed as an endless ring according to the foregoing embodiment, it may consist only of the bearing rib 79 which is roughly C-shaped.

According to the present invention, the bearing rib of the bobbin case basket or at least its surface layer is made of a liquid crystal polymer or aromatic polyimide resin as demonstrated in the foregoing

embodiments, and with this design, the low torque rotation of the hook due to the reduced friction coefficient between the bearing rib and the groove shaped bearing raceway which is an object of the present invention may be accomplished. The use of the liquid crystal polymer or aromatic polyimide resin produces the following three important effects a, b and c:

- 5 (a) It is possible to drive the hook assembly with rotating resistance between the hook and the bobbin case assembly, and particularly the rotating resistance is lower in the case of sewing without hook lubrication as compared with the sewing with hook lubrication. In other words, the rotating resistance may be reduced by using the oil-free type;
- 10 (b) Applying oil-free type, however, the increases in the clearance or gap between the bearing rib and groove shaped bearing raceway of the hook is extremely small as compared with cases of using another synthetic resin, for example, a fluororesin such as TEFLON (trade name), and thus the durability is exceptionally excellent; and
- 15 (c) Applying the oil-free type, the frequency of occurrence of incidental looping and thread breakage is desirably low as compared with cases of using oil-feed types, such as all steel-made hook assembly, and there is no oil stain of the thread, sewing material by hook lubricants. Accordingly, better sewing quality is realized.

It is apparent from Fig. 13 which shows the results of experiments performed by the present inventors, since the bearing rib or at least the surface layer thereof is composed of a liquid crystal polymer, the friction coefficient between the surface layer and the groove shaped bearing raceway of the hook is
20 lowered.

Lines L1 and L2 in Fig. 13 represent the rotating performance of the hook assembly of the constructions shown in Fig. 10 through Fig. 12 wherein the bobbin case main body 72 is made of steel, and the bearing rib member 74 composed of TEFLON (trade name), a fluororesin, is mounted thereon.

25 TABLE 1

Fig. 13	SURFACE LAYER OF BEARING RIB	OIL
L1	Fluororesin	Not fed.
L2	Fluororesin	Fed.
L3	Liquid crystal polymer	Not fed.
L4	Liquid crystal polymer	Fed.
L5	Steel	Fed.

35 In the case of the rotational speed of the hook 102 is 4,000-7,000 rpm, it will be understood, as is clearly indicated by Line L1, that fluororesins cannot be used without hook lubrication. In the cases represented by Line L2 where a fluororesin is used and with hook lubrication although the torque from the rotation of the hook 102 is greatly reduced, the hook lubricant may present the serious problem of the oil stain of the thread, and sewing material.

40 In the case of using conventional vertical rotary hook assemblies whose bobbin case baskets and hooks are made of steel, as indicated by Line L5 in Fig. 13, even if there is hook lubrication, the force exerted on the bobbin case basket 71 due to the rotation of the hook 102 is excessively increased, and as a result the contact stress between the bobbin case basket stop recess 109 and the position finger 120 is increased correspondingly, and it causes in turn an increase in tension of the needle thread passage between the
45 contact sections, resulting in poor sewing quality.

In vertical rotary hook assemblies according to the present invention, the bobbin case basket main body 72 is made of steel, and the bearing rib member 74 is composed of a liquid crystal polymer. It has been proved that according to the oil-free construction, as indicated by Line L3, even under the condition of the high-speed rotation without hook lubrication, machines, the contact stress between the bobbin case basket stop recess 109 and the position finger 120 is lower than in the cases with hook lubrication, and it is also desirably lower than the cases of a conventional oil-feed type of steel-made vertical rotary hook assembly, shown by Line L5.
50

It has been proved that the hook lubricant the above vertical rotary hook assembly equipped with a bearing rib member composed of such a liquid crystal polymer causes increases in the contact stress, as indicated by Line L4. Accordingly, in the present invention it will be easily understood that the torque may be desirably lowered without hook lubrication.
55

Since the bearing rib or at least its surface layer is made of a liquid crystal polymer, the clearance or gap between the bearing rib member 74 and the groove shaped bearing raceway of the hook is kept almost

constant, thus minimizing the wear. It is apparent from Fig. 14 which shows the results of experiments performed by the present inventors.

TABLE 2

Fig. 14	DIRECTION OF CLEARANCE	SURFACE LAYER OF BEARING RIB	OIL
L11	Axial	Fluororesin	Not fed.
L12	Radial	Fluororesin	Not fed.
L13	Axial	Liquid crystal polymer	Not fed.
L14	Radial	Liquid crystal polymer	Not fed.
L15	Axial	Steel	Fed.
L16	Radial	Steel	Fed.

In the constructions shown in Fig. 14, the hook 102 is made of steel, and the bobbin case basket main body 72 is also made of steel. Lines L13 and L14 represent the construction wherein the liquid crystal polymer-made bearing rib member 74 is fixed. In the construction shown in Fig. 14, the hook 102 rotates at a rotational speed of 6,500 rpm. In the oil-free constructions represented by Lines L11 and L12 where the bearing rib member is made of a fluororesin, the increases in the clearance increase rapidly in a relatively short sewing time, and it cannot be used for the vertical rotary hook assemblies. On the other hand, according to the constructions represented by Lines L13 and L14 where the bearing rib member 74 is made of a liquid crystal polymer, and the hook rotates without hook lubrication and the increases in the clearance are very small, and almost constant, and the performance is similar to that of the conventional construction represented by Line L15 wherein both the bobbin case basket and hook are made of steel, and rotates with hook lubrication. However, it is well known that the conventional steel-made rotary hook assemblies cannot be used for high-speed rotation without feeding oil because of over-heating. It has been proved by the above results that in the case of using a bobbin case basket at least the surface layer of which is coated with a liquid crystal polymer as in the constructions represented by Lines L13 and L14, even without feeding oil, the durability of the rotating portion of the hook assembly is better.

In addition, it is apparent that the use of the bobbin case basket with the bearing rib member 74 at least the surface layer of which is composed of a liquid crystal polymer diminishes the frequency of occurrence of sewing rejects due to incidental looping or thread breakage, and improves sewing quality, as is evident from Fig. 15 through Fig. 17 which show the results of experiments performed by the present inventors.

TABLE 3

DRAWINGS	SURFACE LAYER OF BEARING RIB	OIL THREADS
Fig. 15	(1) Liquid crystal polymer (2) Liquid crystal polymer (3) Steel	Not fed. TETRON #50 Polyester Filament Fed. Fed.
Fig. 16	(1) Liquid crystal polymer (2) Liquid crystal polymer (3) Steel	Not fed. Polyester Spun #60 Fed. Fed.
Fig. 17	(1) Liquid crystal polymer (2) Liquid crystal polymer (3) Steel	Not fed. Cotton #120 Fed. Fed.

It will be understood that particularly the oil-free construction using a liquid crystal polymer greatly improves sewing quality. In Fig. 15 through Fig. 17, the hook rotates at a rotational speed of 6,000 r.p.m.

In Fig. 15 through Fig. 17, the bobbin case assembly with a bearing rib whose surface layer is composed of a liquid crystal polymer comprises a steel-made bobbin case basket main body 72 and a liquid crystal polymer-made bearing rib member 74. The entirety of the bobbin case basket is made of steel in cases where the bearing rib is specified to have a steel-made surface layer. In these experiments, the hooks were made of steel. In the experiments with hook lubrication industrial machine oil was used. These results clearly demonstrate that, regardless of the kind of the needle and bobbin threads, the frequency of

occurrence of sewing rejects due to incidental looping or thread breakage is lowered in the case of the embodiments which utilize bobbin case basket with the rib made of using liquid crystal polymers, and particularly the frequency of occurrence of such rejects is made lower in the case without hook lubrication, and sewing quality is improved.

5 It will be understood that since at least the surface layer of the bearing rib is composed of a liquid crystal polymer, the above effects a, b and c are realized.

Also, all the embodiments of Fig. 1 through Fig. 10 produced the same experimental results as in Fig. 15 through Fig. 17, and these results prove the excellent construction of the present invention.

10 Similar preferable results were obtained in experiments similar to those above, but using only an aromatic polyimide resin instead of the liquid crystal polymer.

According to another embodiment of the present invention, all the components of the bobbin case assembly may be made of synthetic resins such as liquid crystal polymers or aromatic polyimide resins, which possess the properties mentioned above. In this case, the strength of the bobbin case basket main body is weaker as compared with other embodiments. Also any other synthetic resin, not limited to liquid crystal polymers and aromatic polyimide resins, may be used as far as it has the above properties.

15 Fig. 18 is a partially enlarged sectional view of a bearing rib 108, a groove shaped bearing raceway 128 and their vicinity according to a further embodiment of the present invention. In the embodiment shown therein, a recess groove 130 is formed in the inside circumference of the hook 102, and a U-shaped section slide member 131 having 0.3-0.5mm thickness is fixed in this recess groove 130.

20 The slide member 131 is composed of a synthetic resin such as a liquid crystal polymer, aromatic polyimide resin or the like, of the same type as used in the foregoing embodiments. Also in this case the same improvement as in the case of other embodiments can be seen.

The present invention may be also extended for horizontal rotary hook assemblies.

Also, the hook and bobbin case basket may be prepared from the same materials for the bearing rib.

25 Fig. 19 is a perspective view in a simplified version of an oscillating shuttle hook assembly 321 according to a further embodiment of the present invention. Fig. 20 is a front view in a simplified version of a portion of the oscillating shuttle hook assembly 321. The oscillating shuttle hook assembly 321 is constructed such that a loop-seizing member 310 provided in a fixed position is supported by fitting an oscillating loop taker 311 thereinto in a manner capable of oscillating with respect to the axis of rotation A2.

30 A bobbin case 313 is mounted over a stud 312 of the oscillating loop taker 311. The bobbin case 313 houses a bobbin wound by bobbin thread 318. In Fig. 19, the loop-seizing member 310 is omitted for the clear understanding of the drawing. A driver 314 is driven by an oscillating shaft 315 to rotate half a turn in each of alternating directions as indicated by arrows D1 and D2, while a needle 316 is reciprocated up and down in linkage with the movement of the oscillating shaft 315.

35 A position finger 317 is formed integrally with the bobbin case 313, and is fitted into a fitting recess of a bobbin case presser member secured to a machine body integrally with a machine bed and a throat plate 328. This construction prevents rotation of the bobbin case 313. In Fig. 20 the driver 314 is not shown.

Fig. 21 is an enlarged sectional view in a simplified version of a portion of the oscillating shuttle hook assembly 321, taken along the section line XXI-XXI of Fig. 20. The loop-seizing member 310 is constructed such that a shuttlerace ring 320 is detachably mounted on a shuttlerace body 319 with the aid of a set claw 341 which can be angularly displaced by manual operation. The shuttlerace body 319 and the shuttlerace ring 320, together, form a bearing raceway 322. A bearing rib 325 is constructed such that a surface layer 324 having a U-shape in cross section is secured to the outside circumference of a protrusion 323 circumferentially extending from the oscillating loop taker 311. As in the foregoing embodiments, the surface layer 324 is made of a synthetic resin such as a liquid crystal polymer, aromatic polyimide resin or the like. The loop-seizing member 310 and the oscillating loop taker 311 (parts other than the surface layer 324) may both be made of steel.

40 Fig. 22 shows a still further embodiment of the present invention. In this embodiment, similar to those described in Fig. 19 through Fig. 21, same reference numerals are used to describe corresponding parts. In this oscillating shuttle hook assembly 321, a surface layer 326 is formed on the inside circumference of the bearing raceway 322 to which the bearing ring 325 of the oscillating loop taker 311 is fittedly secured. In the same manner as in the foregoing embodiments, the surface layer 326 is made of a synthetic resin such as a liquid crystal polymer, aromatic polyimide resin or the like. The oscillating loop taker 311 and the loop-seizing member 310 (parts other than the surface layer 326) may both be made of steel. The surface layer 326 is comprised of a surface portion 331 having a L-letter shape in cross section secured to the shuttlerace body 319 and a planar surface portion 332 secured to the shuttlerace ring 320.

55 In the embodiments shown in Fig. 19 through Fig. 21, and Fig. 22, the provision of the surface layer 324 and the surface layer 326 lowers the frictional force between the loop-seizing member 310 and the oscillating

loop taker 311. Accordingly, cloth and thread are free from staining by hook lubricants such as industrial sewing machine oil.

The present invention may be carried out in various forms without departing from the spirit and the essential characteristics thereof. Accordingly, the foregoing embodiments are mere illustrations thereof from every point of view, whereas the scope of the present invention is described in the claims, and is not limited to any of the details of description. It should be noted that all variations and modifications falling within the scope of equivalence of the claims are embraced by the present invention.

Claims

1. A hook assembly (101, 321) for a sewing machine comprising a bearing rib (108, 325) formed on the outside circumference of a bobbin case basket (106, 311) and extending circumferentially and a groove shaped bearing raceway (128, 322) for rotating the bobbin case basket (106, 311), which surrounds the bobbin case basket (106, 311), extends circumferentially, and fits the bearing rib, characterized in that at least either the bearing rib (108, 325) or at least the surface layer thereof (217, 324), or the groove shaped bearing raceway (128, 322) or at least the inside circumference layer thereof (326) is composed of a synthetic resin of such type that the rotating frictional force of a slide contact portion between the surface layer (217, 324) of the bearing rib (108, 325) and the inside circumference layer (326) of the groove shaped bearing raceway (128, 322), is lower in cases where no industrial sewing machine oil is present between said surface layer (217, 324) and said inside circumference layer (326) than in other cases with the industrial sewing machine oil present therebetween.
2. The hook assembly (101, 321) as claimed in claim 1, characterized in that the hook assembly is a rotary hook assembly (101) and the hook is a rotary hook.
3. The hook assembly (101, 321) as claimed in claim 1, characterized in that the hook assembly is an oscillating shuttle hook assembly (321) and the shuttle hook is a oscillating loop taker.
4. The hook assembly (101, 321) as claimed in any of claims 1-3, characterized in that the synthetic resin is a liquid crystal polymer.
5. The hook assembly (101, 321) as claimed in any of claims 1-3, characterized in that the synthetic resin is an aromatic polyimide resin.
6. The hook assembly (101, 321) as claimed in any of claims 1-3, characterized in that the bobbin case basket (106, 311) comprises a cylindrical section (107) for receiving a bobbin, and the bearing rib (108, 325) is an endless ring fittedly secured to the outside circumference of the cylindrical section (107).
7. The hook assembly (101, 321) as claimed in any of claims 1-3, characterized in that the bearing rib (108, 325) section of a metal bobbin case basket assembly body (72) comprises a bearing rib (108, 325) formed integrally with the synthetic resin-made coating member (217) which covers from the loop-spreading section (18) to the rail end section (19) of the bearing rib section (108), and the coating member (217) is stripped off the loop-spreading section (18) of the metal bearing rib section (108) upward in the direction of rotation of the hook.
8. A sewing process comprising:
 - using a hook assembly for a sewing machine which is rotated or oscillated, said hook assembly comprising a bearing rib (108, 325) formed on the outside circumference of a bobbin case basket (106, 311) and extending circumferentially and a groove shaped bearing raceway (128, 322) for rotating the bobbin case basket (106, 311), which surrounds the bobbin case basket (106, 311), extends circumferentially, and fits the bearing rib, characterized in that at least either the bearing rib (108, 325) or at least the surface layer thereof (217, 324), or the groove shaped bearing raceway (128, 322) or at least the inside circumference layer thereof (326) is composed of a synthetic resin of such type that the rotating frictional force of a slide contact portion between the surface layer (217, 324) of the bearing rib (108, 325) and the inside circumference layer (326) of the groove shaped bearing raceway (128, 322), is lower in cases where no industrial sewing machine oil is present between said surface layer (217, 324) and said inside circumference layer (326) than in other cases with the industrial sewing machine oil present therebetween;

and performing sewing without hook lubrication.

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Fig. 1

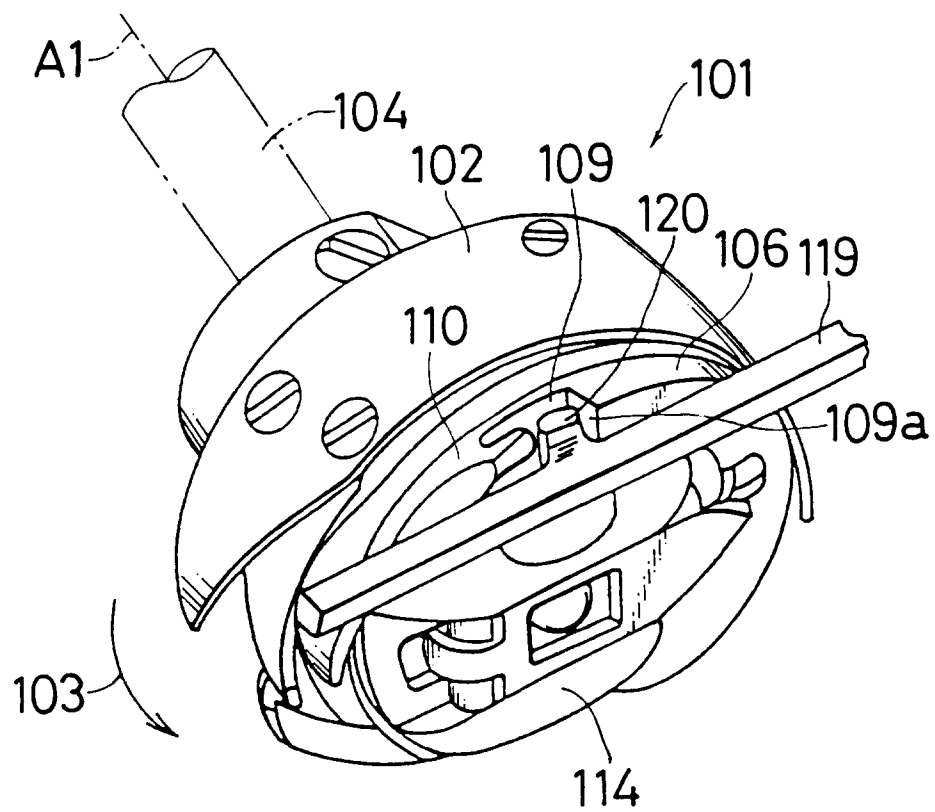


Fig. 2

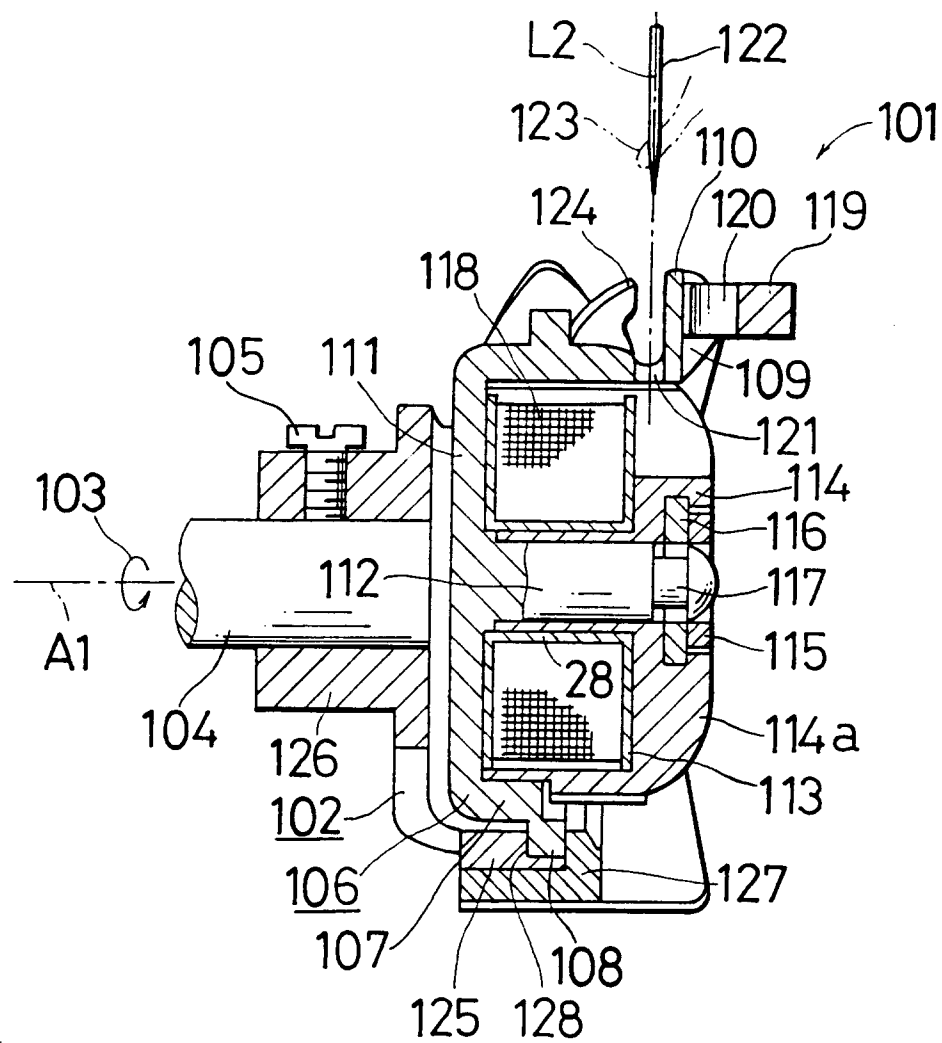


Fig. 3

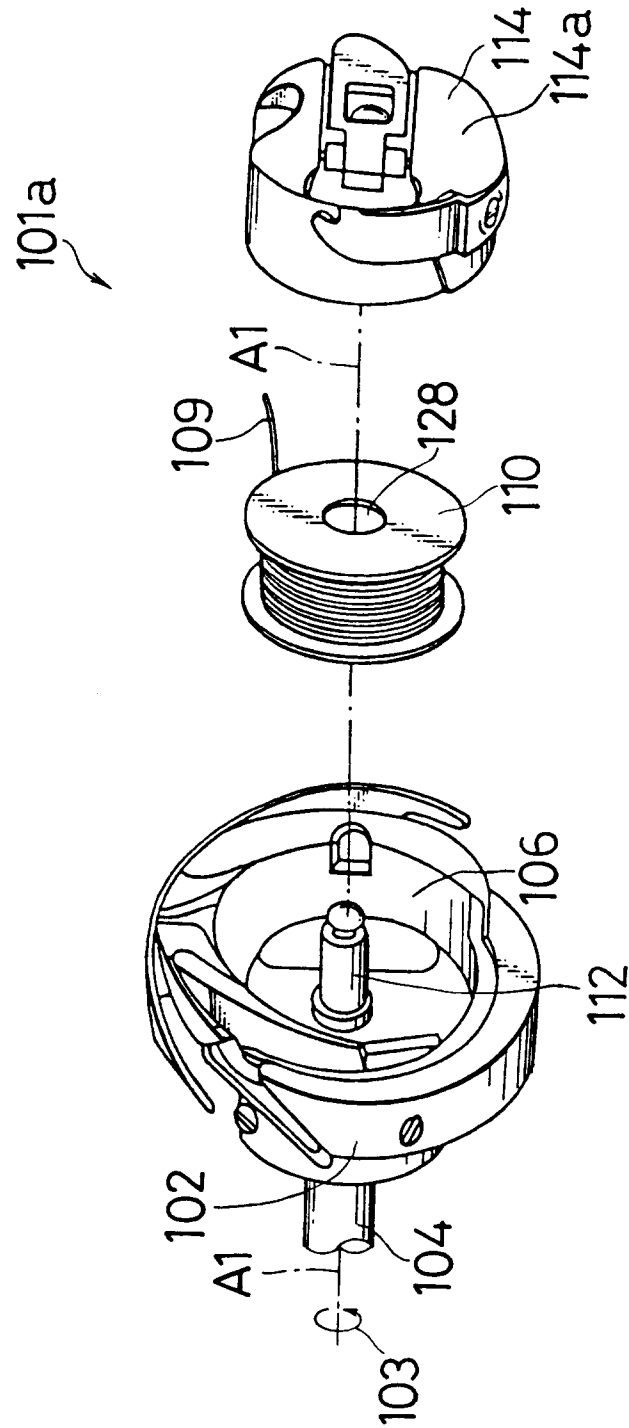


Fig. 4

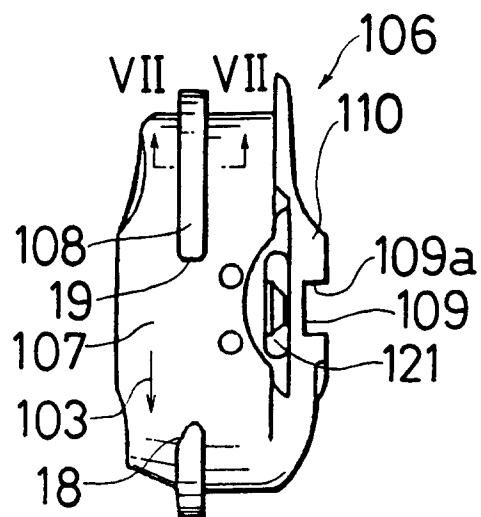


Fig. 5

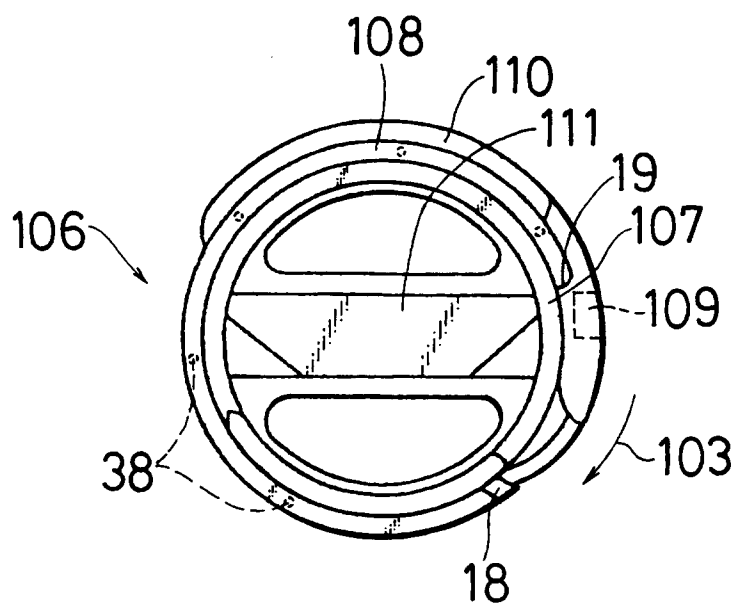


Fig. 6

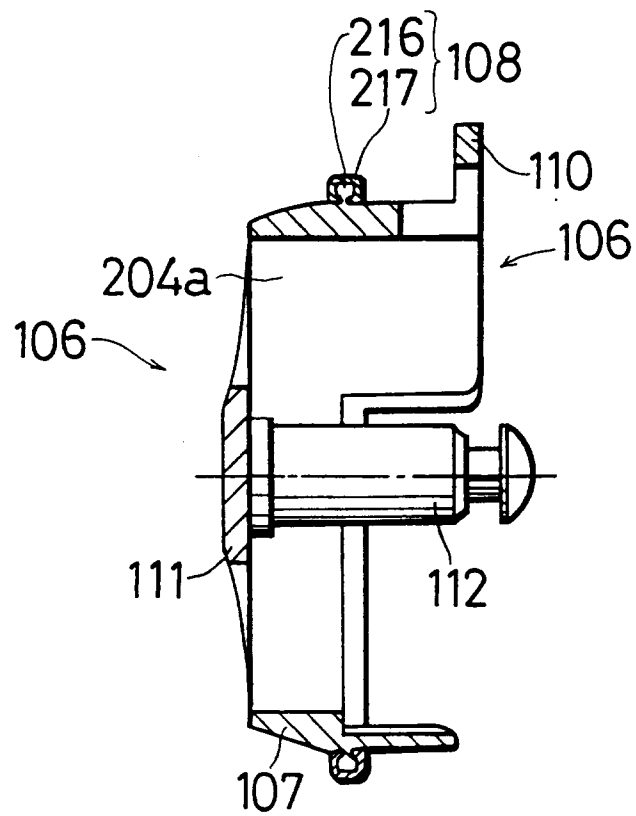


Fig. 7

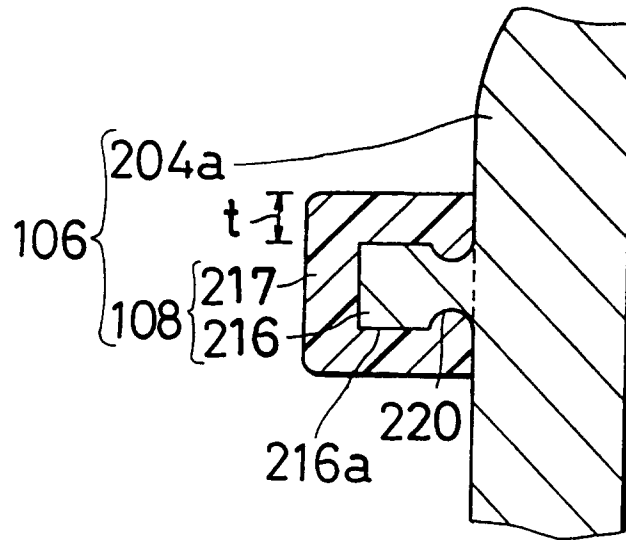


Fig. 8

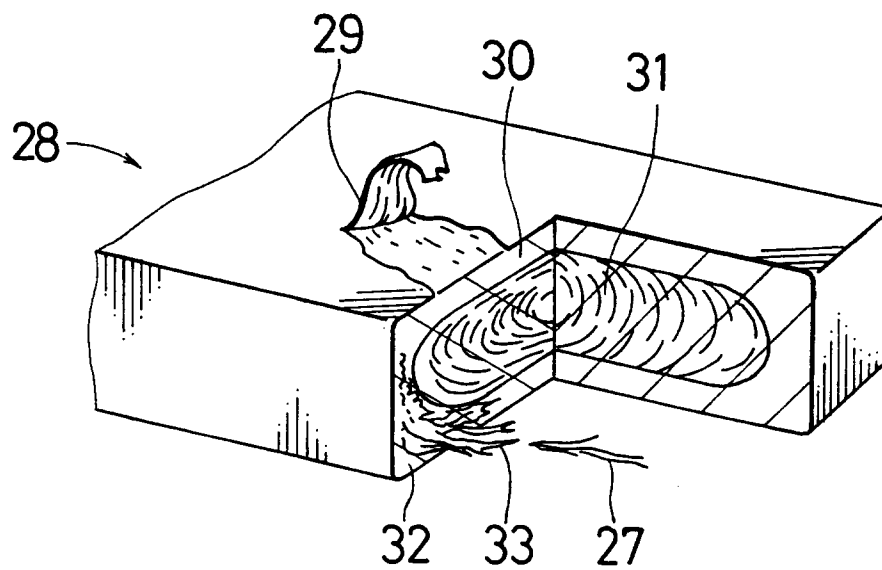


Fig. 9

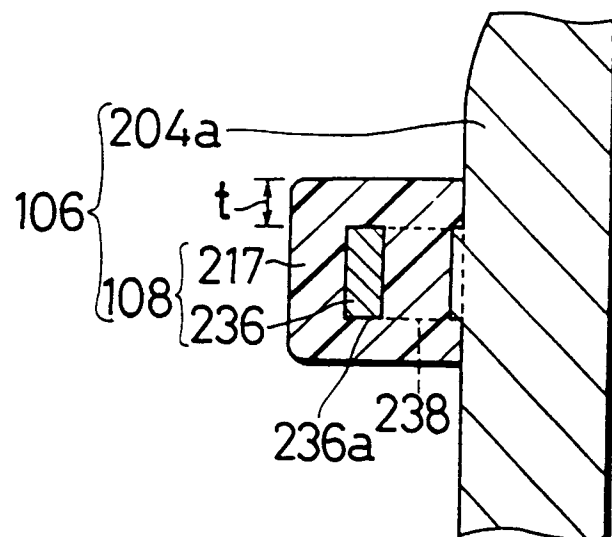


Fig. 10

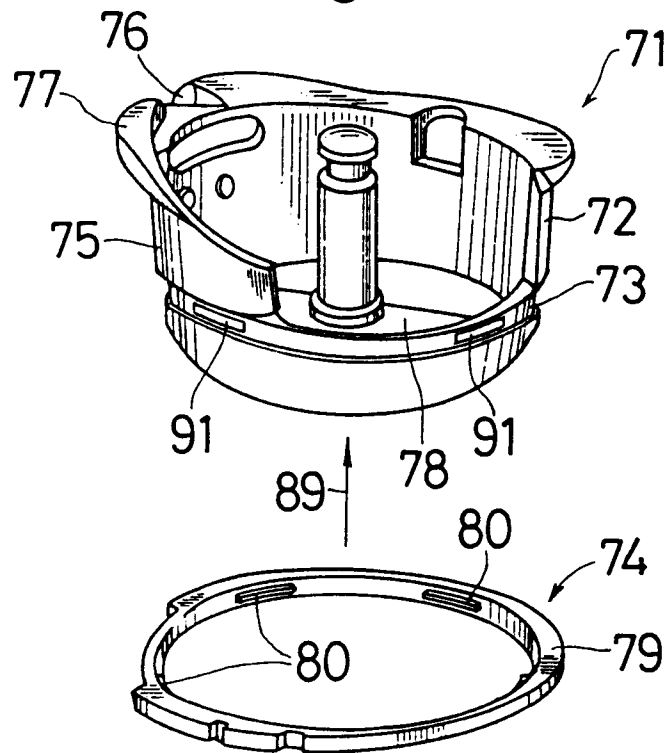


Fig. 11

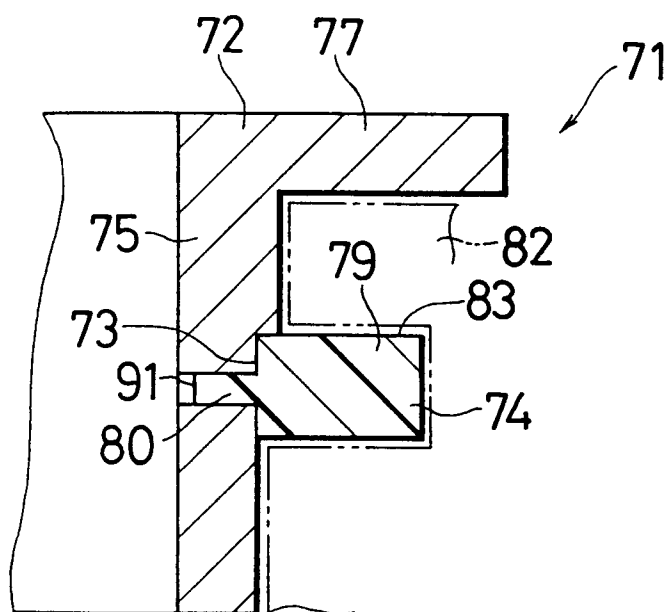


Fig. 12

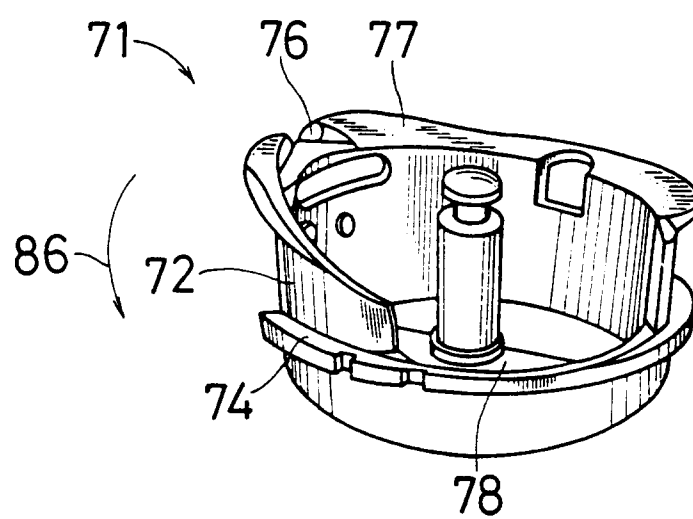


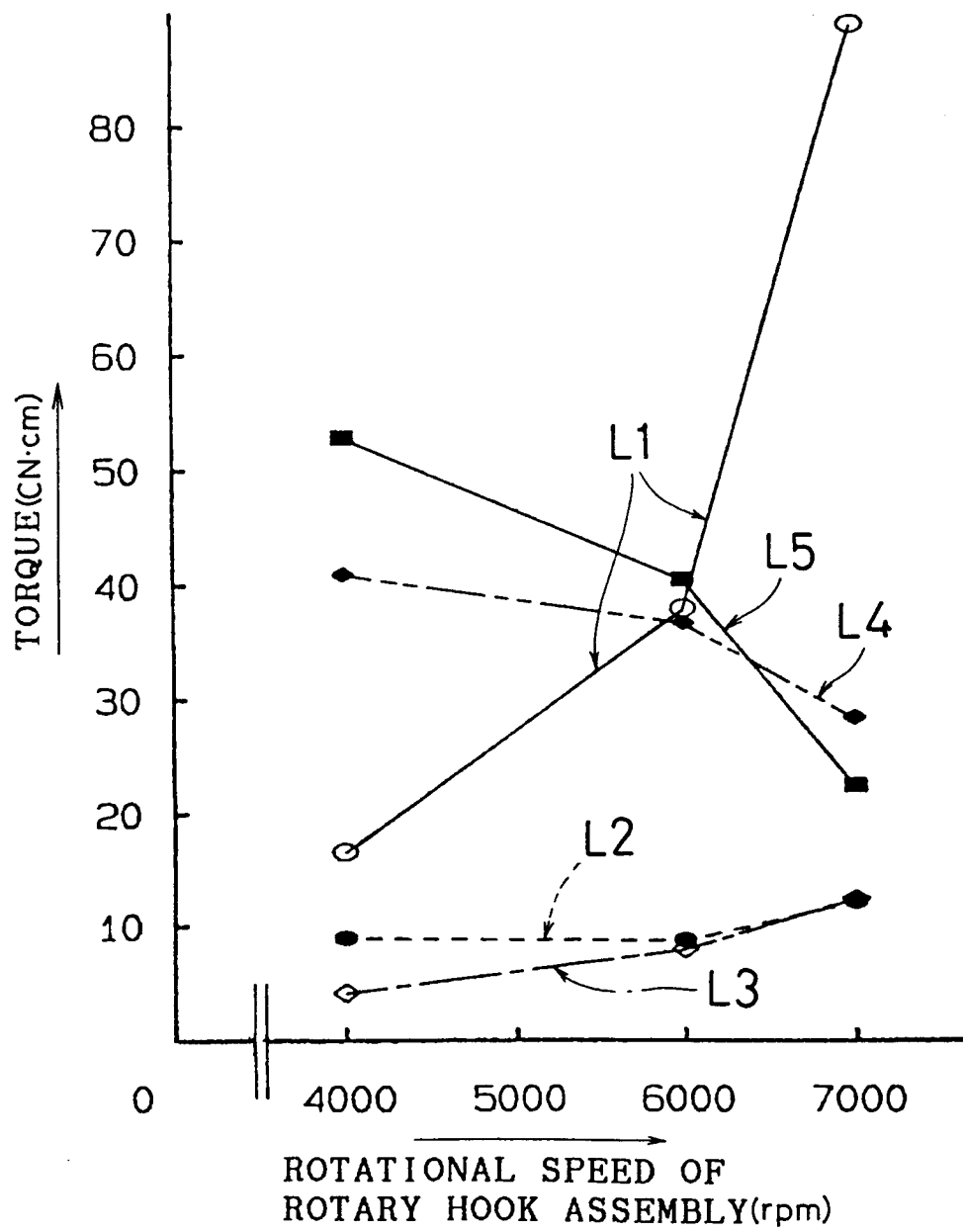
Fig.13

Fig. 14

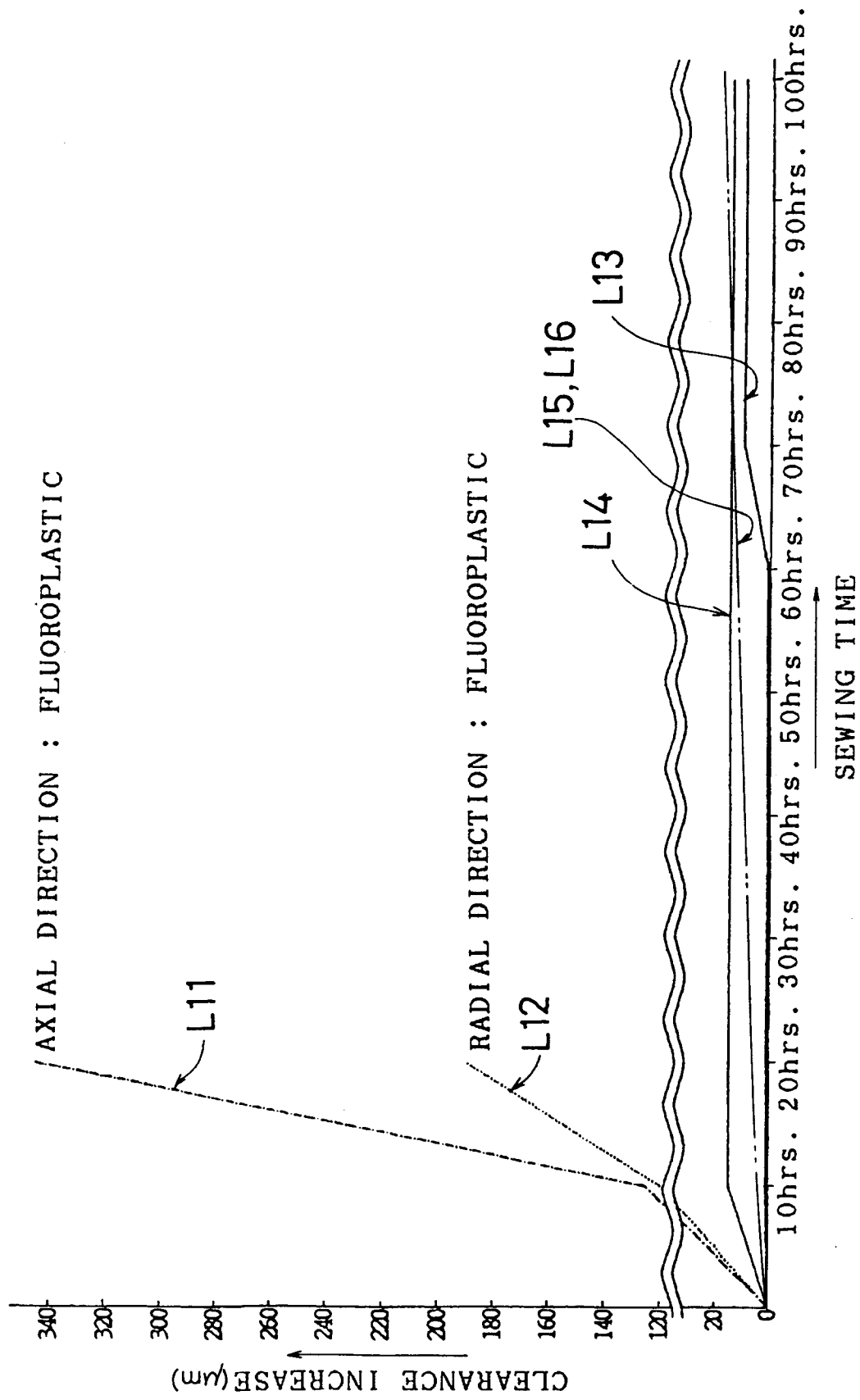


Fig.15(1)

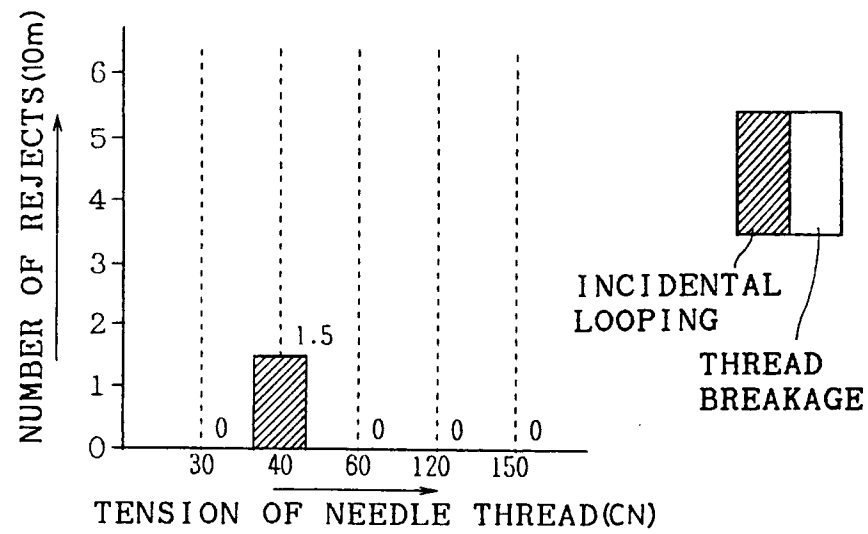


Fig.15(2)

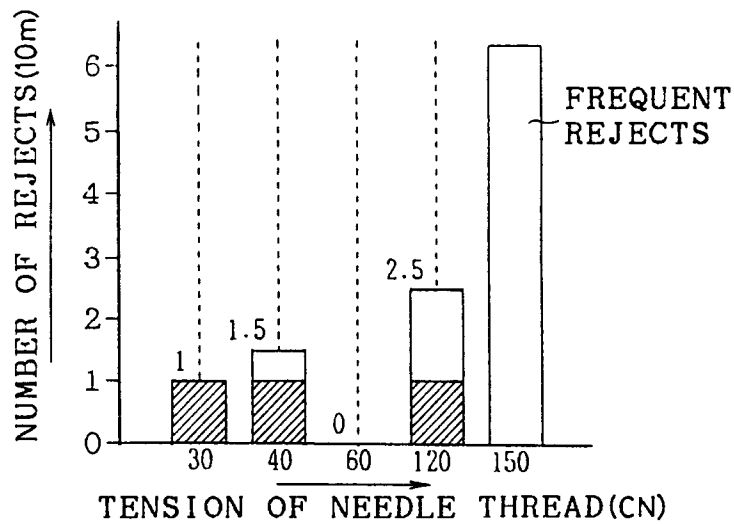


Fig.15(3)

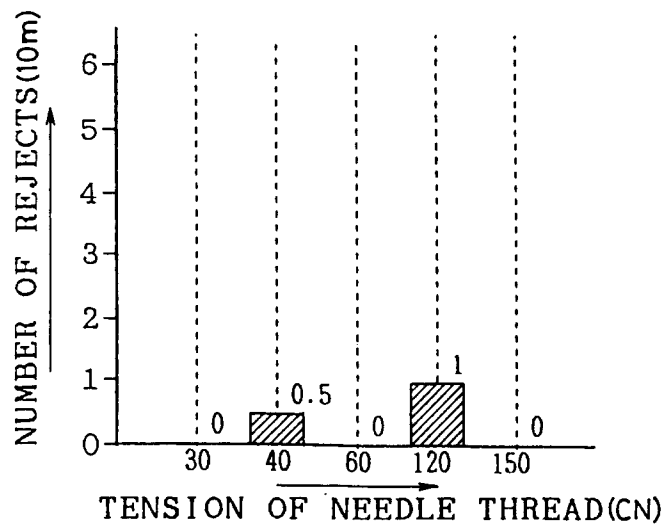


Fig.16(1)

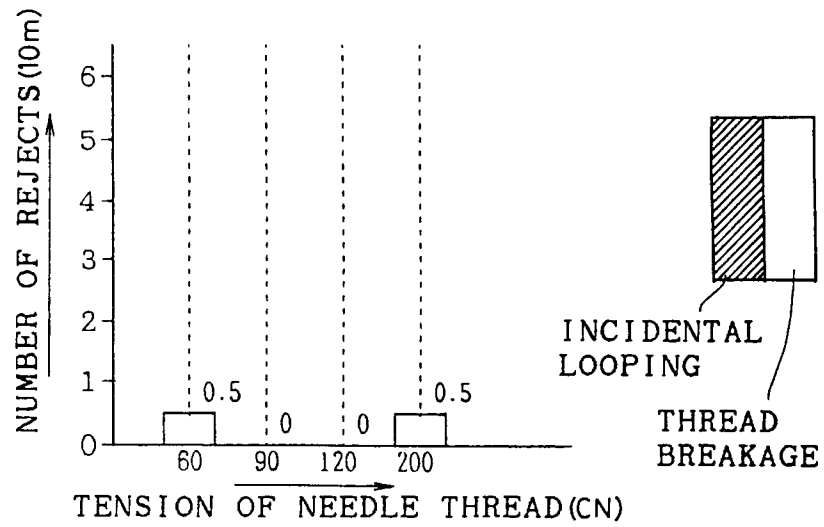


Fig.16(2)

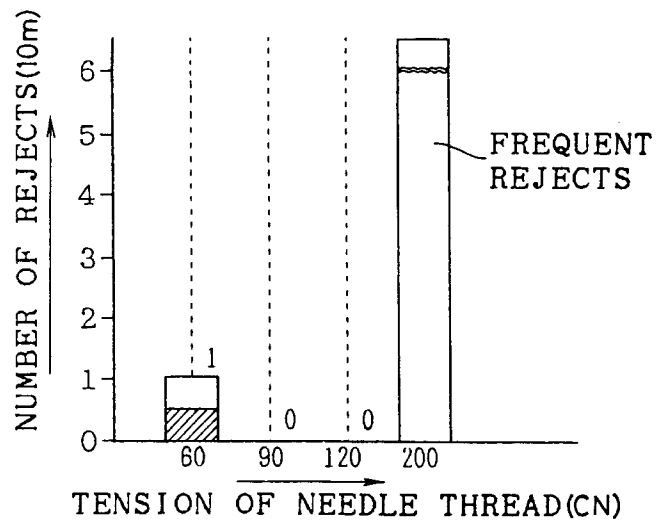


Fig.16(3)

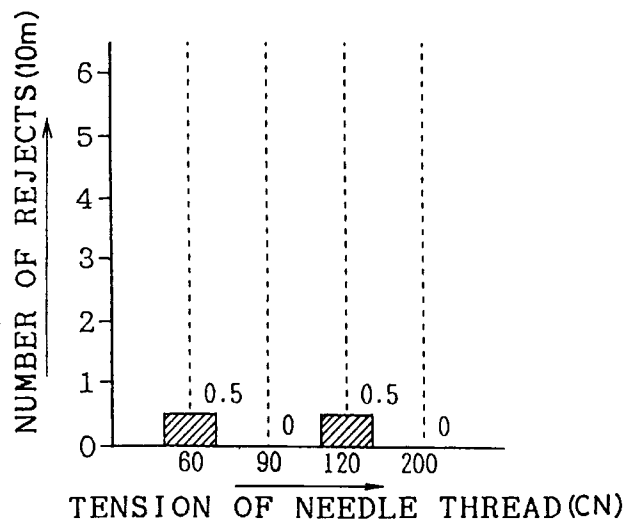


Fig.17(1)

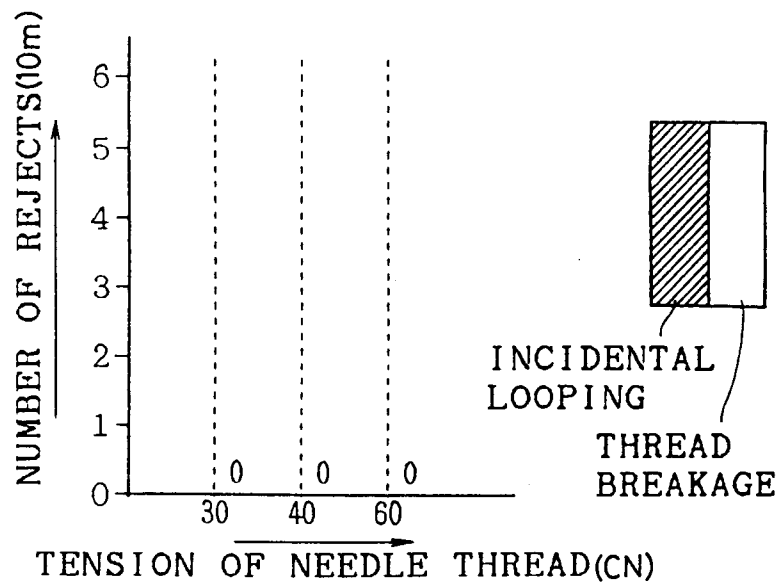


Fig.17(2)

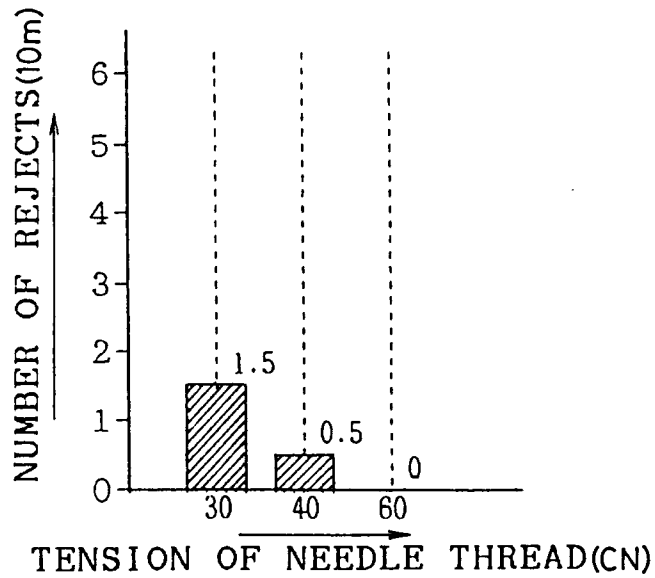


Fig.17(3)

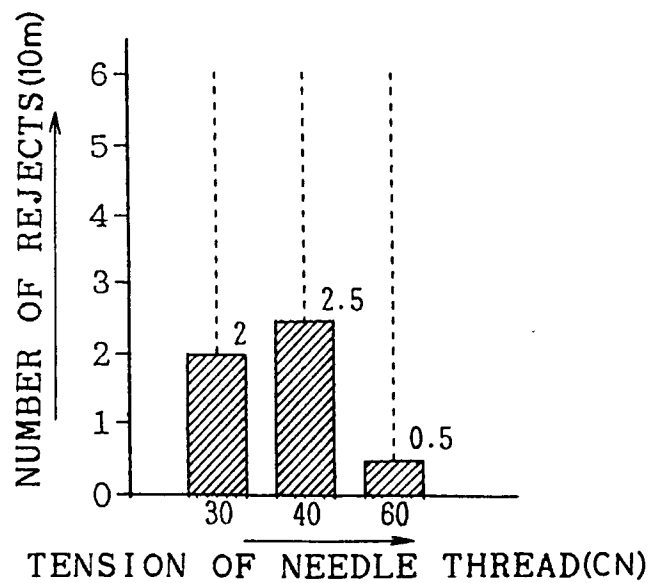


Fig. 18

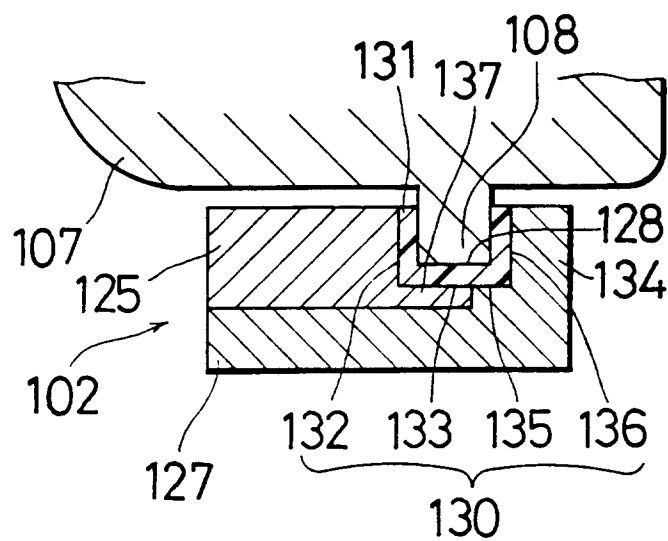


Fig. 19

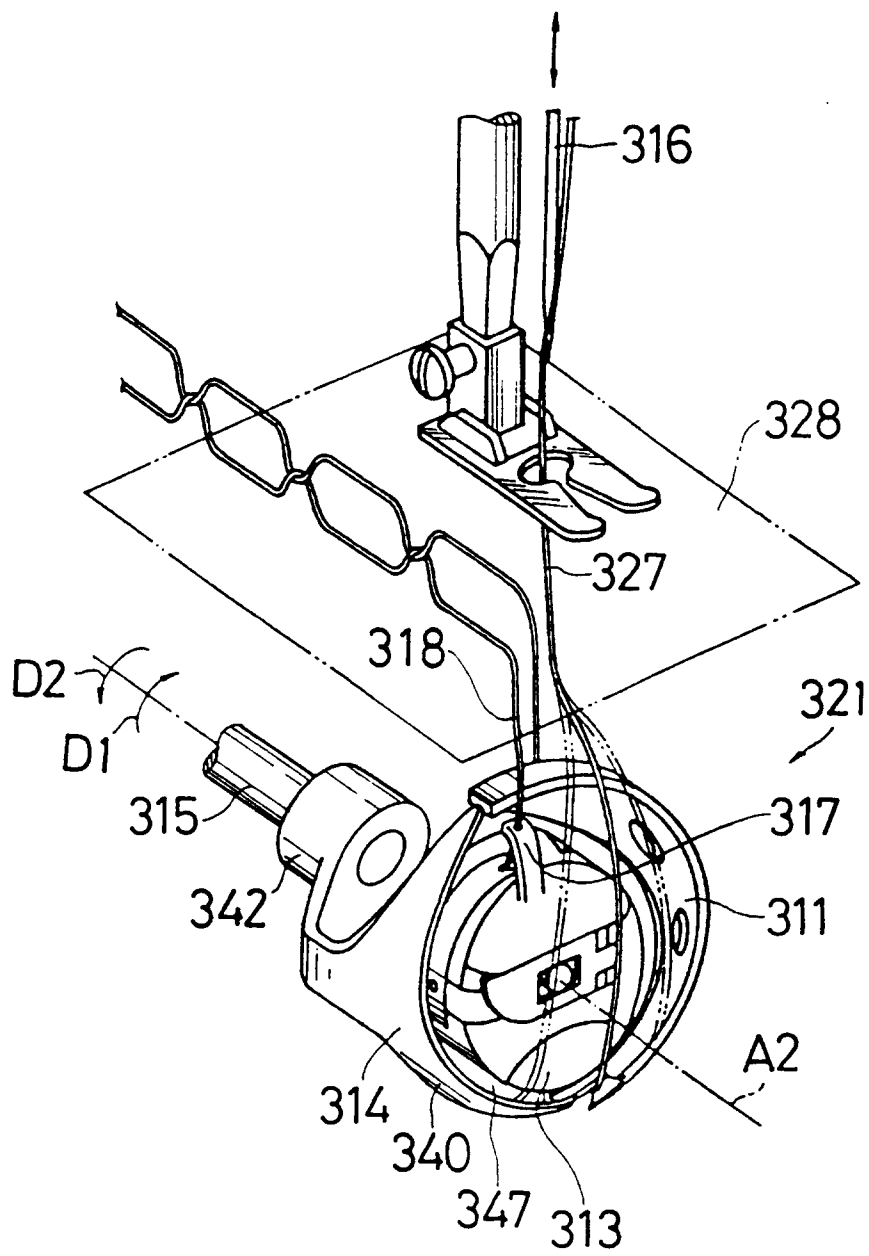


Fig. 20

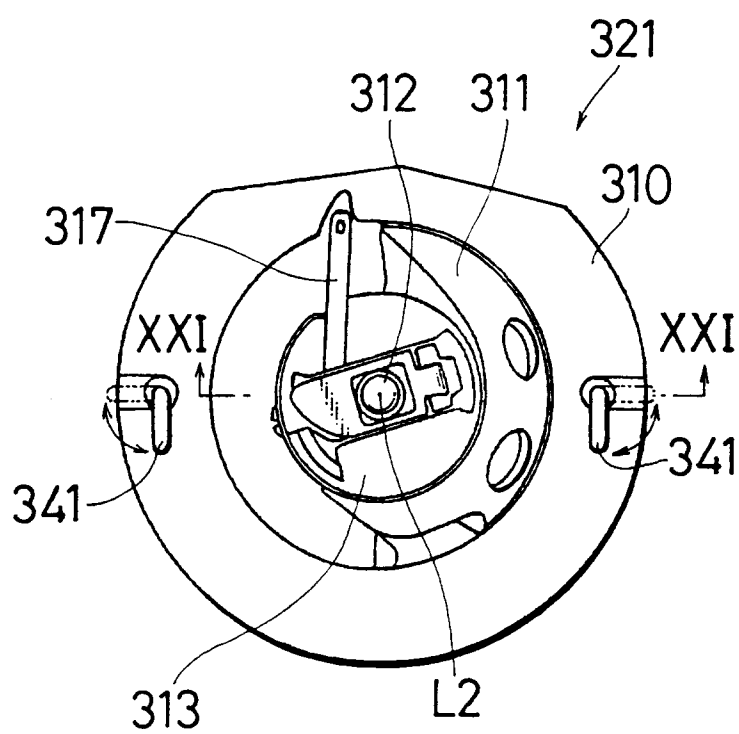


Fig. 21

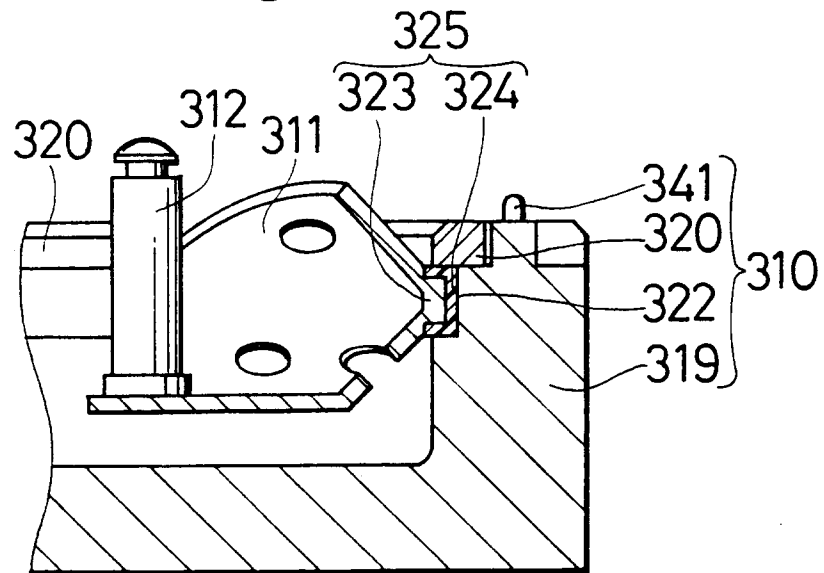
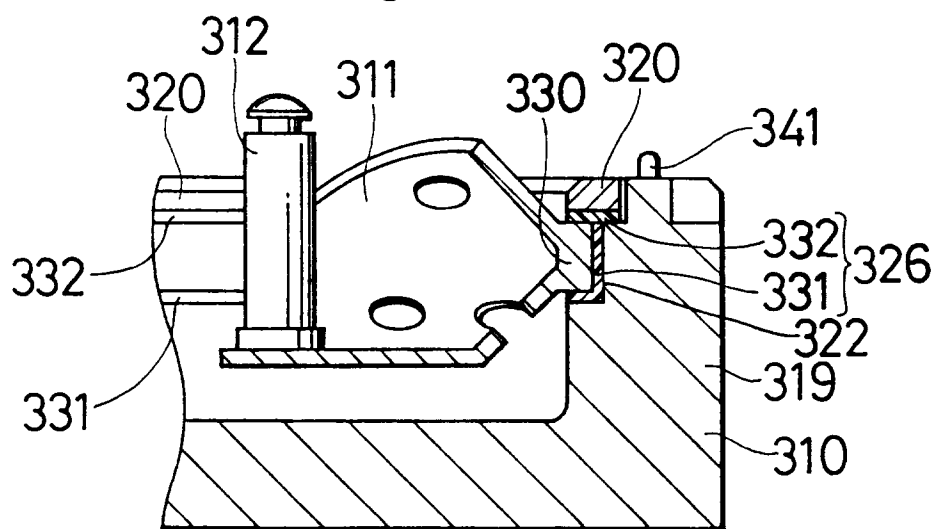


Fig. 22





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 20 0450

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	FR-A-1 116 991 (PHOENIX NÄHMASCHINEN A.G. BAER & REMPEL) * the whole document * ---	1,2,5,8	D05B57/14
X	FR-E-67 797 (PHOENIX NÄHMASCHINEN A.G. BAER & REMPEL) * the whole document * ---	1,2,5,6,8	
X	US-A-4 660 487 (MARUZEN SEWING MACHINE CO. LTD.) * column 1, line 31 - line 52; figures * ---	1,2,8	
X	US-A-2 851 978 (HUSQVARNA VAPENFABRIKS AKTIEBOLAG) * column 2, line 40 - line 48; figures 13,14 * ---	1,2,8	
A	US-A-2 348 718 (S.A. BETHUNE ET AL) -----		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			D05B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 31 May 1995	Examiner Courrier, G
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	