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(54) **RING-TRAVELER DEVICE OF RING TYPE SPINNING MACHINE**

(57) A ring-traveler device with no liquid lubrication of a ring type spinning machine includes a ring 11 and a traveler 12 that is slidable along the ring. The ring-traveler device has a plurality of first recesses 15 and a plurality of second recesses 16 formed in at least one of sliding surfaces of the ring and the traveler. Each first recess has a width between 10 and 100 μm and is formed by an opening edge 15A and an inner surface 15B, Each second recess 16 has a width smaller than each first recess 15. At least one of the second recesses extends across at least one of the opening edges and the inner surfaces of the first recesses.

FIG. 1C

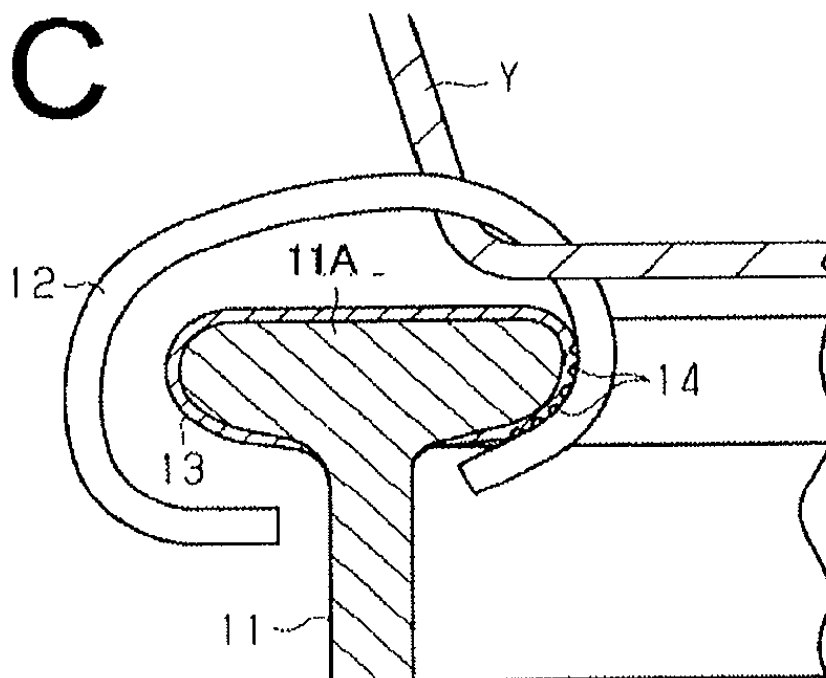
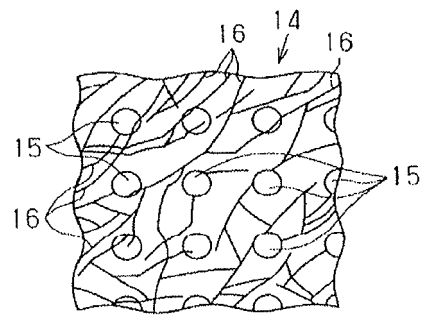


FIG. 2A



Description**BACKGROUND OF THE INVENTION**

[0001] The present invention relates to a ring-traveler system in a ring type spinning machine, more specifically to a ring-traveler system with no liquid lubrication.

[0002] In a ring-traveler system of a ring type spinning machine and a ring twisting machine, there have been proposed various methods of protecting the ring-traveler system from performance deterioration caused by frictional wear and seizure, such as the use of various materials, surface treatment, the modification of shapes and the use of liquid lubrication, thereby to increase the operation speed and prolong the service life of the ring-traveler system. The use of liquid lubrication in the ring-traveler system is relatively inexpensive and effective, but it is limited to wool spinning because it may stain a yarn with oil and require troublesome maintenance.

[0003] Japanese Patent Application Publication no. 2014-29045 discloses a ring-traveler system of a ring type spinning machine in which a recess having a depth between 0.1 and 20 μm and a flat portion having a width between 1 and 250 μm are formed alternately in the surface of the ring that is in sliding contact with the traveler, thus providing reduced friction and increased endurance as compared to commercially available ring-traveler systems. Furthermore, Japanese Patent Application Publication no. 2014-29046 discloses a ring-traveler system that provides the reduced friction and the increased endurance (or prolonged service life) by forming a thin fiber film by fibers separated from a yarn to the surface of the ring on which the traveler slides and allowing such thin fiber film to be utilized for lubrication of the ring-traveler system. In the latter ring-traveler system, 400 or more recesses per centimeter are formed in the sliding surface of the ring. The recesses may be a groove or a dimple.

[0004] The reduced friction and the increased endurance (or prolonging service life) may be achieved by the ring-traveler systems of the above-cited Publications, as compared with a commercially available ring-traveler system. However, there has been a demand for further improvement of the service life of the ring-traveler system through reduction of the friction.

[0005] The present invention, which has been made in light of the above-mentioned problem, is directed to providing a ring-traveler system of a ring type spinning machine that utilizes a thin fiber film formed by fibers separated from a yarn and deposited on the sliding surface of the ring, for an increase in the friction reducing effect and in the endurance (prolonging service life) of the ring-traveler system.

SUMMARY OF THE INVENTION

[0006] In accordance with an aspect of the present invention, there is provided a ring-traveler device of a ring type spinning machine with no liquid lubrication including a ring and a traveler that is slidable along the ring. The ring-traveler device has a plurality of first recesses and a plurality of second recesses formed in at least one of sliding surfaces of the ring and the traveler. Each first recess has a width between 10 and 100 μm and is formed by an opening edge and an inner surface. Each second recess has a width smaller than each first recess. At least one of the second recesses extends across at least one of the opening edges and the inner surfaces of the first recesses.

[0007] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The invention together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1A is a perspective view of a ring of a ring-traveler system according to an embodiment of the present invention;

Fig. 1B is an enlarged fragmentary view of the ring of Fig. 1A;

Fig. 1C is a schematic view showing a relationship between the ring and its associated traveler;

Fig. 2A is a microscopic view of a friction reduction portion;

Fig. 2B is an enlarged microscopic view of the low friction portion of Fig. 2A;

Fig. 3 is a chart showing a service life of travelers;

Figs. 4A and 4B are schematic views of large-sized recesses in travelers of ring-traveler devices according to other embodiments of the present invention, respectively;

Fig. 5 is a cross-sectional fragmentary view showing a ring and a traveler of a ring-traveler device according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0009] The following will describe a ring-traveler device of a ring spinning machine according to an embodiment of the present invention with reference to Figs. 1 to 3. Referring to Figs. 1A, 1B and 1C, the ring-traveler device includes a ring 11 and a traveler 12 that is slidable along the ring 11. The ring 11 has a flange 11A having a T-shape in cross-section and the traveler 12 has a C-shape in cross-section. The ring 11 is made of a bearing steel, and the flange 11A of the ring 11 has a hard chromium plating layer 13 having a thickness of 10 to 20 μm , as shown in Figs. 1B and 1C.

[0010] As shown in Fig. 1C, the hard chromium plating layer 13 includes a low friction portion 14 that forms a part of the inner peripheral surface of the flange 11A of the ring 11 in contact with which the traveler 12 slides, as shown in Fig. 1C.

[0011] As shown in Figs 2A and 2B, the low friction portion 14 has a plurality of first recesses 15 each having an opening edge 15A and an inner surface 15B and a plurality of second recesses 16. The second recesses 16 are formed so as to extend across at least one of the opening edge 15A and the inner surface 15B of the first recess 15 and have a width smaller than the first recess 15.

[0012] The first recess 15 has a shape of a circular dimple and a width between 10 and 100 μm , more preferably between 15 and 40 μm , and the depth of the circular dimple should preferably be 5 μm or less. In the present embodiment of the invention, the circular dimple refers to a spherical concave having a circular opening and a spherical concave surface. In other words, the first recess 15 is formed by a generally curved surface.

[0013] The second recess 16 is provided in the form of a groove and about 700 to 1,000 second recesses 16 are formed per centimeter. Specifically, the grooves are formed by micro-cracks of random lengths and extending in random directions in the surface of the hard chromium plating layer 13. According to Japanese Industrial Standards, H8615 refers to an industrial chromium plating layer having 250 or more micro-cracks per centimeter. The number of cracks in the surface of the hard chromium plating layer 13 of the present embodiment is increased by surface treatment.

[0014] A known electrolytic etching is used as a method to increase the micro-cracks in the surface of the hard chromium plating layer 13 in the present embodiment, and the number of micro-cracks is variable depending on the duration of electrolytic etching. Micro-cracks in the surface of the hard chromium plating layer 13 before the electrolytic etching were not clearly visible, but the recognizable micro-cracks were increased after the electrolytic etching.

[0015] For counting the number of micro-cracks, a microscope picture of the surface of the hard chromium plating layer 13 was taken and a straight line was drawn on the picture. The number of micro-cracks was determined by counting the micro-cracks that extend across the straight line of one centimeter length. The micro-cracks include a recessed dimple, as well as the recessed groove. The straight line may be drawn arbitrarily because the micro-cracks have random lengths and extend in random directions.

[0016] The first recesses 15 were formed after the formation of the second recesses 16. An ultrashort pulse laser beam such as a femtosecond pulse laser beam was irradiated to the surface of the hard chromium plating layer 13 at locations where the first recesses 15 were to be formed.

[0017] The following will describe the operation of the ring-traveler device having the above-described configuration. In spinning operation of the spinning machine, a yarn Y delivered from a draft part (not shown) and passing through the traveler 12, as shown in Fig. 1C, is wound on a bobbin (not shown) that is rotated at a high speed. The maximum rotation speed of the spindle of the spinning machine is about 25,000 rpm during normal spinning operation of the spinning machine, and the traveler 12 slides on the flange 11A of the ring 11 while being subjected to the winding tension of the yarn Y. Although the sliding position of the traveler 12 is slightly varied according to its moving speed, the traveler 12 moves in sliding contact with the inner lower surface of the flange 11A, as shown in Fig. 1C.

[0018] In general, metal-to-metal sliding contact without lubricant causes severe wear. In the case of the ring-traveler device, it may be considered that the ring and the traveler in sliding contact with each other are susceptible to seizure and severe wear in a few minutes to a few hours. In actuality, however, the wear of the ring-traveler device is unexpectedly, considerably low. In a cotton spinning machine, for example, the traveler is usually replaced with a new one at an interval of one to two weeks. It is considered that the unexpectedly longer serviceable life of the traveler is due to the tribological boundary lubrication. Further analysis showed that a cellulose film was formed on the surface of the ring 11 on which the traveler 12 slides and such cellulose film provided the lubrication effect. The cellulose in the film may be thought to be formed from fibers that are separated from a yarn passing through the traveler during spinning operation and caught between the ring and the traveler.

[0019] In the ring-traveler device of the present embodiment, the low friction portion 14 of the ring 11 has on the surface thereof on which the traveler slides 700 to 1,000 second recesses 16 per centimeter and first recesses 15 having a

diameter between 10 and 100 μm and a depth of 5 μm or less.

[0020] While the traveler 12 is sliding in contact with the low friction portion 14 of the ring 11, some fibers enter and are held securely at intersections between the second recesses 16 and the opening edges 15A of the first recesses 15. With such fibers located in a scattered manner and serving as the point of formation of cellulose film or thin fiber film, some fibers or cellulose separated from a yarn passing through the traveler are deposited thereby to form the thin fiber film (fiber coating) and the strength of such fiber film is increased.

[0021] Because part of the second recess 16 extends in the inner surface 15B of the first recess 15, part of fibers in the first recess 15 are caught in the second recess 16. The fibers present inside the first recess 15 are less exposed to the influence of the sliding movement of the traveler 12 than the fibers present on the flat surface outside the first recess 15, so that the fibers in the first recess 15 remain inside the first recess 15 for a longer period of time. If the thin fiber film on the flat surface outside the first recess 15 is separated by any causes, part of the fibers inside the first recess 15 is supplied to the flat surface for quick recovery of the thin fiber film. In the ring-traveler system according to the embodiment, some fibers separated from a yarn Y passing through the traveler 12 are deposited on the sliding surface of the ring 11 thereby to form a thin fiber film that provides friction reduction effect and increases the durability and hence the serviceable life of the traveler 12 without using lubricant.

[0022] For evaluation of the friction reducing effect, four different rings 11 were provided, each having circular first recesses 15 in the low friction portion 14 that were formed after the formation of 700 to 1,000 micro-cracks (second recesses 16) per centimeter. The circular first recesses 15 of the four rings 11 had substantially the same depth, but different diameters of circles described by the opening edges 15A of the respective first recess 15. Additionally, the four rings 11 had different area ratios, which refer to the ratio in percentage of open area of the first recesses 15 to the area of sliding surfaces between the traveler 12 and the ring 11. Without running-in operation, spinning test using the four rings 11 (Samples 1, 2, 3 and 4 shown in Table 1) was conducted under actual operation condition of the maximum rotation speed 20,000 rpm.

[Table 1]

Sample no.	Diameter of Hole(μm)	Area Ratio (%)	Depth (μm)
Sample 1	10	8.7	4
Sample 2	15	11	4
Sample 3	20	6.4	4
Sample 4	20	12.6	4

[0023] For comparison with the above four Samples, additional samples including a commercially available ring (Sample 6), a ring only having 700 to 1,000 micro-cracks per centimeter (Sample 5) and a ring only having first recesses 15 (Sample 7), were tested under the same condition to look into the replacement life.

[0024] It is noted that travelers are usually replaced with new ones when travelers of a predetermined percentage are found to need to be replaced, to avoid bad influence on spinning operation, and the period of time before replacement is called replacement life. The test result is shown in Fig. 3.

[0025] Referring to in Fig. 3, the replacement life of Sample 6 was 10 days, and the replacement lives of Sample 5 and Sample 7 were 14 and 12 days, respectively, which were about 1.4 and 1.2 times greater than Sample 6, respectively.

[0026] On the other hand, the replacement lives of Samples 1, 2, 3, 4 were 20, 30, 25, 26 days, respectively, which account for 2 to 3 times greater than Sample 6.

[0027] Compared with Sample 6, the replacement lives of Sample 5 and Sample 7 were increased by 4 and 2 days, respectively, and the overall expected effect of combining the micro-cracks and the first recess 15 were an increase of life of 6 days. Of Samples 1 to 4 according to the present embodiment, however, Sample 1 showed the least increase of replacement life, or 10 days, and Sample 2 showed the most increase, or 20 days, thus providing a synergetic effect due to the formation of micro-cracks and the first recesses 15.

[0028] If the diameter of the first recess 15 is not large enough, it becomes hard for fibers to enter into the first recess 15. If the diameter of the first recess 15 is too large, it becomes hard for fibers to remain in the flat surface portion. Therefore, it is desirable that first recess 15 should have a diameter of at least 10 μm . More specifically, it is preferable that the first recess 15 is a circular dimple with a diameter between 15 and 20 μm and a depth of 5 μm or less, and the area ratio of the first recesses 15 to the area of the sliding surfaces is between 6 and 13 percent.

[0029] The present embodiment will offer the following effects.

- (1) The ring-traveler device of a ring spinning machine has in the sliding surface of the ring 11 thereof on which the traveler 12 slides with no liquid lubricant during the spinning operation a plurality of the first recesses 15 each having

a width between 10 and 100 μm and a plurality of second recesses 16 each having a width smaller than that of the first recess 15, and the second recesses 16 are formed so as to extend across at least one of the opening edge 15A and the inner surface 15B of the first recess 15. With such ring-traveler device, a thin fiber film is formed on the sliding surface of the ring 11 from fibers that are separated from a yarn Y and utilized for lubrication of the sliding surfaces of the ring 11 and traveler 12. As compared with the conventional ring-traveler device, friction reducing effect is achieved without using liquid lubrication and durability (or service life) of the ring-traveler device is improved.

(2) The second recesses 16 are formed by micro-cracks. Such structure of the second recesses 16 allows fibers in the second recesses 16 to be kept caught securely by the second recess 16 and a thin fiber film of greater strength is formed, with the result that the friction reducing effect due to the fiber film is improved greatly, as compared with a case in which the second recess 16 is formed by a groove or dimple.

(3) The first recess 15 is formed by a dimple. Although the first recess 15 may be formed by a groove, the dimple may be formed more easily. In addition, the opening edges 15A of the dimples as the first recess 15 provide a greater total length than the grooves as the first recess 15, provided that the aforementioned area ratio is the same in the above two cases. Furthermore, the formation of dimple is advantageous in that the second recesses 16 may be formed so as to extend across the opening edge 15A of the first recess 15 more easily.

[0030] The present invention is not limited to the above-described embodiment, but it may be modified in various manners, as exemplified below.

[0031] The shape of the opening of the dimple as the first recess 15 is not limited to a circular shape, but it may be, for example, an oval shape as shown in Fig. 4A or an ellipse shape as shown in Fig. 4B, or a polygonal shape. For the sake of illustration, the second recess 16 is omitted in the drawing in the Figs 4A and 4B.

[0032] The first recesses 15 may include dimples having various shapes of openings or various sizes.

[0033] The first recesses 15 may be formed not only by a dimple, but also by a groove, or a mixture of groove and dimple.

[0034] The first recess 15 need not necessarily be formed by a continuous curved surface, but it may include a distinguishable bottom surface and side wall surface. For example, the first recess 15 may be formed having a side wall surface that extends perpendicularly to a flat bottom surface.

[0035] The first recesses 15 may not necessarily be spaced at a regular interval (uniform distance between two adjacent first recesses 15)

[0036] An electrolytic etching to form micro-cracks may take place after the formation of the first recess 15.

[0037] The flange 11A of the ring 11 of the ring-traveler device need not be T-shaped in cross-section. For example, the flange 11A may be formed inclined in cross-section, as shown in Fig. 4. In this case, the traveler 12 should be formed so as to match the inclined flange 11A.

[0038] The first recess 15 need not be formed by irradiating ultra-short pulse laser such as a femtosecond pulse laser, high-output picosecond pulse laser or nanosecond pulse laser. For example, the first recess 15 may be formed by micro etching or short peening.

[0039] The low friction portion 14 may be formed in the traveler 12 instead of the ring 11 of the ring-traveler device. In this case, however, the surface area of the friction reduction portion is significantly decreased. Therefore, it is preferable to form the low friction portion 14 in the ring 11.

[0040] At least one of the second recesses 16 may be formed to extend across at least one of the opening edges 15A and the inner surfaces 15B of the first recesses 15.

[0041] The ring-traveler device is applicable to any spinning machine having a ring such as a ring twisting machine.

[0042] A ring-traveler device of a ring type spinning machine with no liquid lubrication includes a ring and a traveler that is slidable along the ring. The ring-traveler device has a plurality of first recesses and a plurality of second recesses formed in at least one of sliding surfaces of the ring and the traveler. Each first recess has a width between 10 and 100 μm and is formed by an opening edge and an inner surface. Each second recess has a width smaller than each first recess. At least one of the second recesses extends across at least one of the opening edges and the inner surfaces of the first recesses.

Claims

1. A ring-traveler device of a ring type spinning machine with no liquid lubrication comprising a ring (11); and a traveler (12) slidable along the ring (11);
characterized in that
a plurality of first recesses (15) and a plurality of second recesses (16) are formed in at least one of sliding surfaces

of the ring (11) and the traveler (12),

wherein each first recess (15) has a width between 10 and 100 μm and is formed by an opening edge (15A) and an inner surface (15B),

wherein each second recess (16) has a width smaller than each first recess (15), and

wherein at least one of the second recesses (16) extends across at least one of the opening edges (15A) and the inner surfaces (15B) of the first recesses (15).

2. The ring-traveler device according to claim 1, **characterized in that** each second recess (16) is a micro-crack.

3. The ring-traveler device according to claim 1 or 2, **characterized in that** each first recess (15) is a dimple.

4. The ring-traveler device according to any one of claims 1 to 3, **characterized in that** each first recess (15) is a circular dimple with a diameter between 15 and 20 μm and a depth of 5 μm or less, and an area ratio of open area of the first recesses (15) to area of the sliding surfaces is between 6 and 13 percent.

FIG. 1A

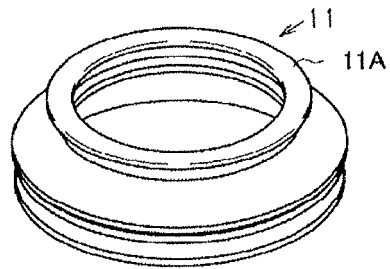


FIG. 1B

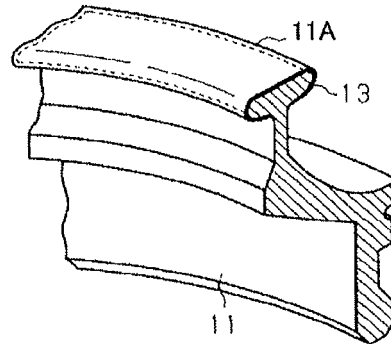


FIG. 1C

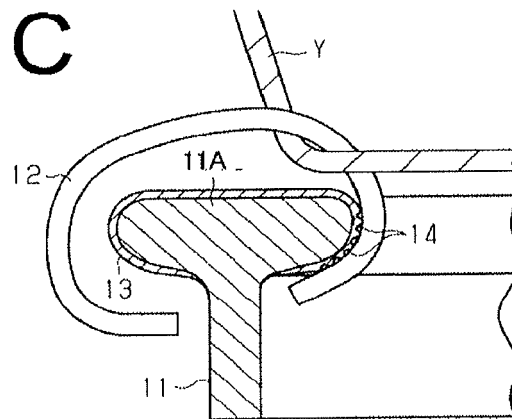


FIG. 2A

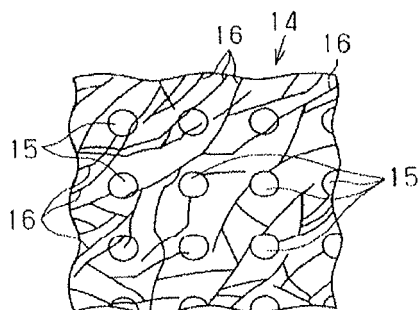


FIG. 2B

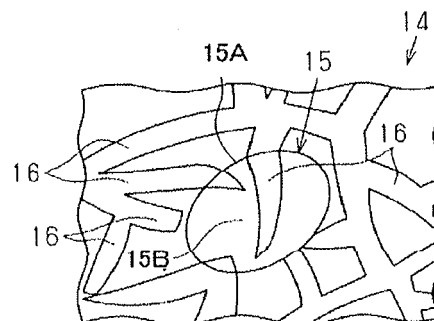


FIG. 3

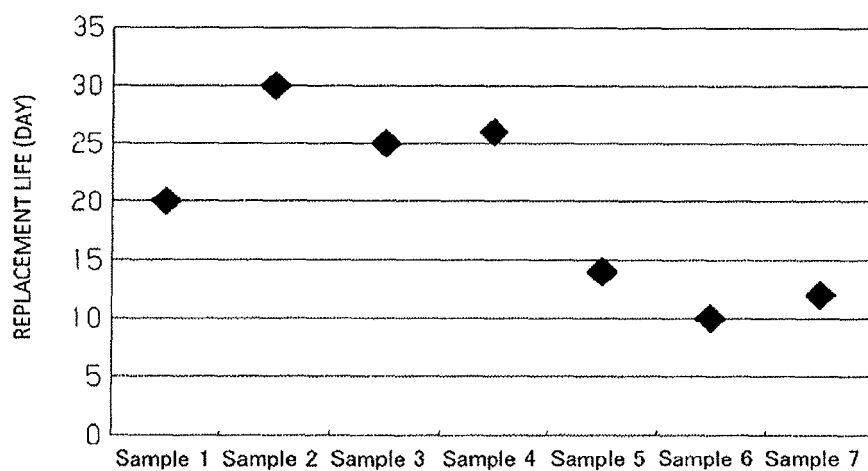


FIG. 4A

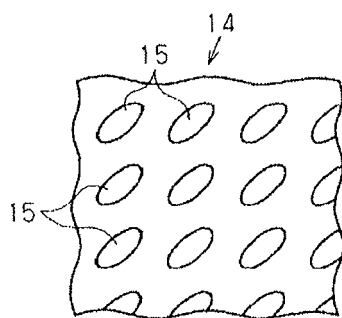


FIG. 4B

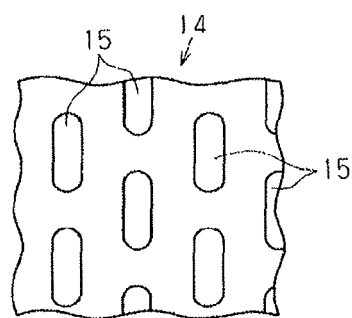
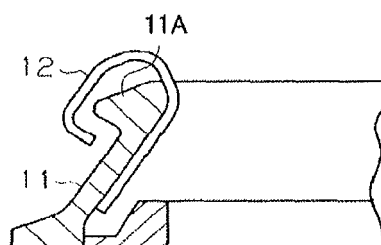


FIG. 5





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EP 15 18 8499

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CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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