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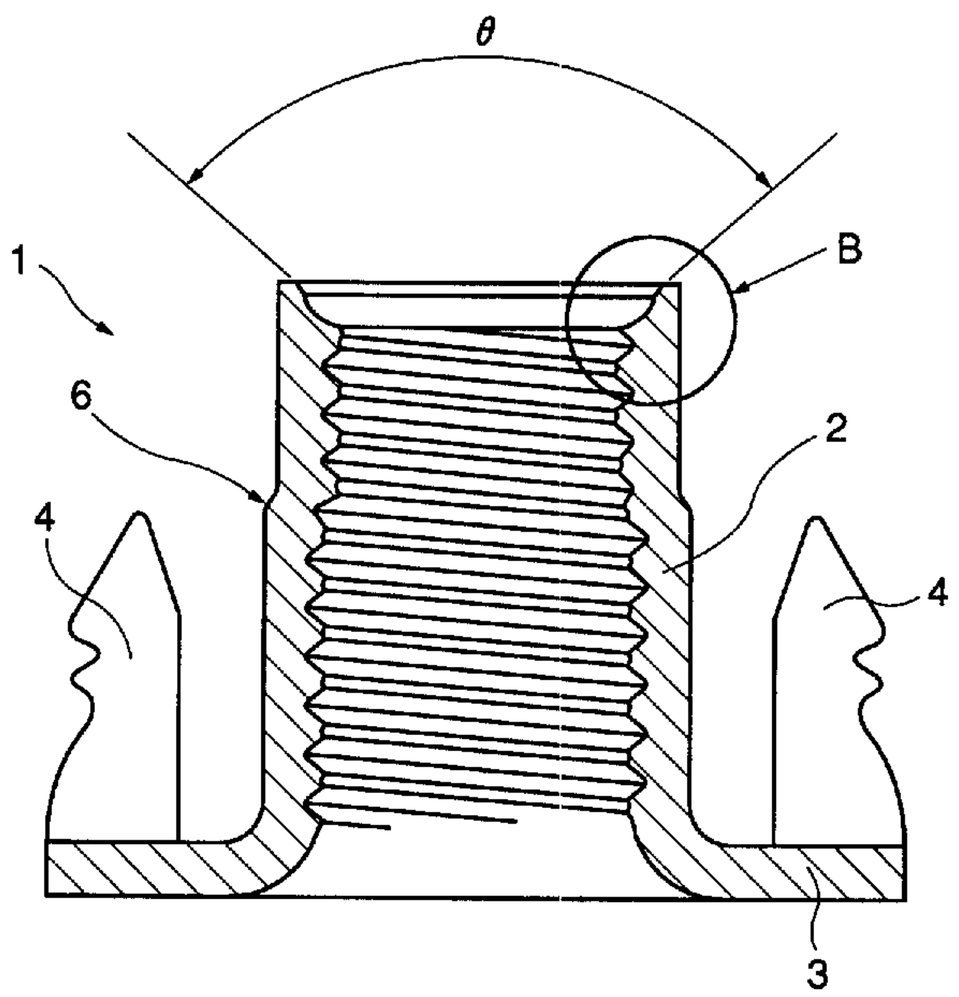
(54) **ECROU ET PRODUIT INTERMEDIAIRE CONNEXE**
(54) **NUT AND INTERMEDIATE PRODUCT THEREFOR**



(57) A nut consists of integral metal material and has a female screw formed in a screw hole opening substantially perpendicularly to an end surface of one end with a rolled tap, while a lead thread defining an opening end of the screw hole for the end surface has such a shape that a concave bent portion and a linear tapered portion are continuously combined along the overall periphery. It is possible to provide a nut having a female screw formed with a rolled tap causing no cross-thread when engaging with a bolt due to the aforementioned shape of the lead thread.

ABSTRACT OF THE DISCLOSURE

A nut consists of integral metal material and has a female screw formed in a screw hole opening substantially perpendicularly to an end surface of one end with a rolled tap, while a lead thread defining an opening end of the screw hole for the end surface has such a shape that a concave bent portion and a linear tapered portion are continuously combined along the overall periphery. It is possible to provide a nut having a female screw formed with a rolled tap causing no cross-thread when engaging with a bolt due to the aforementioned shape of the lead thread.

TITLE OF THE INVENTION

Nut and Intermediate Product Therefor

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a nut and an intermediate product therefor, and more particularly, it relates to the structures of a nut having a lead thread shape suitable for internal threading with a rolled tap and an intermediate product therefor.

Description of the Prior Art

In general, a nut is internally threaded with the so-called cutting tap 52 shown in Figs. 13A and 13B. In this internal threading with the cutting tap 52, the inner peripheral surface of a prepared hole of an unthreaded intermediate product 51 for a nut is cut to form roots of a female screw while discharging chips through grooves 52a of the cutting tap 52 shown in Fig. 13A. In such internal threading with the cutting tap 52, the crest diameter of the worked female screw coincides with the inner diameter d of the unthreaded prepared hole and hence the accuracy of the female screw shape can be relatively readily ensured. However, parts of the chips tend to remain in the worked female screw to bite into a male screw engaging with the female screw and disadvantageously hinder proper fastening.

In order to solve such a problem, a nut is increasingly internally threaded with a rolled tap causing no chips. Figs. 14A and 14B show a rolled tap 53 threading an intermediate product 51 for a nut. In such internal threading with a rolled tap 53, a female screw is formed not by cutting but by plastic working. In other words, the inner peripheral surface of a prepared hole of the intermediate product 51 for a nut is depressed for forming roots of the female screw while the material extruded from the depressed portions is raised to form crests. The crest diameter of the worked female screw is smaller than the inner diameter d of the prepared hole of the unthreaded intermediate product 51.

However, such conventional internal threading of the nut with a rolled tap has the following problem:

In general, an internally threaded screw hole of a nut is provided on its opening end with a tapered lead thread, called a countersink in general, in order to guide the forward end of a bolt engaging with the nut or facilitating discharge of chips resulting from internal threading with a tap. Fig. 15A shows an unthreaded intermediate product 131 for a nut provided with a lead thread 31a having such a shape, to be internally threaded with a rolled tap 53 from the side of the lead thread 31a. As a consequence of internal threading with the rolled tap 53, a nut 31 provided with a female screw having a concave portion in each thread is formed as shown in Fig. 15B. When the rolled tap 53 is screwed into the intermediate product 131 from the side of the lead thread 31a, the material is plastically deformed along thick arrows appearing in Fig. 16, showing a part enclosed with a circle A in Fig. 15B in an enlarged manner, in the vicinity of the lead thread 31a. Thus, roots of the rolled tap 53 cannot be completely filled up with the material but crests of the threads of the formed female screw are disadvantageously depressed. In particular, the root of the rolled tap 53 for forming a thread 31b adjacent to the lead thread 31a cannot be sufficiently filled up with the material in general due to the tapered shape of the lead thread 31a. Thus, the thread 31b is lower in height and large in depression than the remaining threads.

When a bolt 32 is to engage with the nut 31 internally threaded with the rolled tap 53 in the aforementioned manner from the side of the lead thread 31a as shown in Fig. 17A, a thread on the forward end of the bolt 32 hits against the depression on the crest of the thread 31b of the nut 31 adjacent to the lead thread 31a to cause the so-called cross-thread, as shown in a part enclosed with a circle A in Fig. 17B. Consequently, the bolt 32 incorrectly engages with the nut 31, to result in an improper fastening state.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a nut having a lead thread shape causing no cross-thread in engagement with a bolt also when internally threaded with a rolled tap.

In order to attain the aforementioned object, a nut according to a

first aspect of the present invention consists of integral metal material and has a female screw formed in a screw hole opening substantially perpendicularly to an end surface of one end, and a lead thread defining an opening end of the screw hole for the end surface has a concavely depressed shape along the overall periphery.

In a preferred embodiment, the lead thread includes a concave bent portion in an arbitrary longitudinal section including the central axis of the screw hole. The lead thread preferably has such a shape that the concave bent portion is continuously combined with a linear tapered portion, and in this case, the concave bent portion further preferably starts from the inner peripheral side of the opening end to be continuous with the linear tapered portion on an outer prescribed position.

A nut according to a second aspect of the present invention comprises a shaft portion and a flange portion outwardly extending from a first end of the shaft portion, consisting of integral metal material. The shaft portion is in the form of a hollow cylinder, has a portion slated for caulking in a second end opposite to the first end and is formed with a female screw on the inner peripheral surface excluding the portion slated for caulking. The portion slated for caulking has an inner diameter larger than that of the portion formed with the female screw, and a lead thread defining an end of the portion of the shaft portion formed with the female screw adjacent to the portion slated for caulking has a concavely depressed shape along the overall periphery. In this nut, the present invention is applied to the so-called rivet type tee nut having a predeterminate caulked portion, and the shape of the portion formed with the female screw is common to the nut according to the first aspect of the present invention.

The present invention includes an unthreaded intermediate product for a nut consisting of integral metal material and having a screw hole, opening substantially perpendicularly to an end surface of one end, slated for internal threading with a rolled tap at least in a prescribed region, and a lead thread defining an end of the prescribed region of the screw hole slated for internal threading has a concavely depressed shape along the overall periphery.

The nut according to the first or second aspect of the present invention is formed by working a female screw in the screw hole of such an intermediate product for a nut with a rolled tap. In the intermediate product for a nut according to the present invention, the concavely depressed shape of the lead thread is preferably so formed that the crest of a thread of the female screw adjacent to the lead thread has no concave groove but a convex shape. Consequently, no concave groove is formed on the crest of the thread of the female screw adjacent to the lead thread when the intermediate product is threaded with the rolled tap, whereby it is possible to prevent such an inconvenient phenomenon that a thread on the forward end of a bolt engaging with the nut hits against the thread of the female screw to cause cross-thread. Further, the nut maintains such a characteristic of the countersink that the diameter of the lead thread enlarges toward the opening end, whereby the female screw can be worked without damaging the function of the countersink facilitating discharge of chips resulting from internal threading with the tap.

The concavely depressed portion of the lead thread is shaped as a concave bent portion, not to damage another function of the conventional tapered countersink properly guiding the forward end of the bolt engaging with the nut for automatically aligning the central axes of the nut and the bolt. Even if the bolt for engagement is inserted into the nut in a slightly inclined state, the central axes of the nut and the bolt are automatically aligned due to the guiding function of the lead thread, so that the nut and the bolt properly engage with each other.

The nut according to the present invention is also applicable to the so-called rivet type tee nut in which a predeterminate caulked portion of a shaft portion has an inner diameter larger than a first inner diameter and a uniform outer diameter substantially identical to a first outer diameter or another rivet type tee nut in which a predeterminate caulked portion of a shaft portion has an inner diameter larger than a first inner diameter and an outer diameter larger than a first outer diameter.

Further, the nut according to the present invention is also applicable to the so-called rivet type tee nut in which a predeterminate caulked

portion of a shaft portion has an inner diameter larger than that of a portion formed with a female screw and is formed to be smaller in thickness than the portion formed with the female screw, or another rivet type tee nut in which a predeterminate caulked portion of a shaft portion has an inner diameter larger than that of a portion formed with a female screw and an outer diameter larger than that of the portion formed with the female screw, for example.

When applying the nut according to the present invention to a tee nut, the shaft portion preferably has a step portion in the region formed with the female screw, so that a region closer to the flange portion with reference to the step portion has a shape larger in inner and outer diameters than a region on an end opposite to the flange portion. The nut having such a step portion is formed by internally threading an intermediate product for a nut having a step portion with a rolled tap or the like. When the shaft portion of the unthreaded intermediate product for a nut has such a step portion, allowance for working accuracy can be attained by working only the screw hole of the prescribed region including the lead thread in the female screw forming region into a shape maintaining necessary accuracy while rendering the remaining region slightly larger in inner diameter than the prescribed region so that a female screw shape defined in a standard such as JIS can be accurately formed. It can be said that such a step portion is effective also for working the lead thread in the present invention in high accuracy.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A illustrates a central longitudinal section of a nut according to a first embodiment of the present invention, and Fig. 1B is a partially enlarged sectional view showing a part enclosed with a circle B in Fig. 1A in an enlarged manner;

Fig. 2 is a perspective view showing the nut appearing in Figs. 1A

and 1B carried along a feed track;

Fig. 3A is a sectional view showing an intermediate product for the nut according to the first embodiment of the present invention to be internally threaded with a rolled tap, and Fig. 3B is a sectional view showing the intermediate product in the process of internal threading with the rolled tap;

Fig. 4 is a partially enlarged sectional view showing a part enclosed with a circle B in Fig. 3B, for illustrating flow of material caused by plastic deformation in the process of internal threading on the intermediate product for the nut according to the first embodiment of the present invention with the rolled tap;

Fig. 5A is a sectional view showing the nut according to the first embodiment of the present invention to engage with a bolt, and Fig. 5B is a sectional view showing such a state that a thread on the forward end of the bolt starts to engage with a portion of a female screw of the nut adjacent to a lead thread;

Fig. 6A is a sectional view showing a state of working a concave bent portion of the lead thread with a punch having a prescribed shape in a press step of molding the intermediate product for the nut according to the first embodiment of the present invention, and Fig. 6B is a sectional view showing a state of forming a linear tapered portion with another punch after working the concave bent portion of the lead thread;

Fig. 7A illustrates a central longitudinal section of a nut according to a second embodiment of the present invention, and Fig. 7B is a partially enlarged sectional view showing a part enclosed with a circle C in Fig. 7A in an enlarged manner;

Fig. 8A illustrates a central longitudinal section of an unthreaded intermediate product for the nut according to the second embodiment of the present invention, and Fig. 8B is a partially enlarged sectional view showing a part enclosed with a circle C in Fig. 8A in an enlarged manner;

Fig. 9A illustrates a central longitudinal section of a nut according to a third embodiment of the present invention, and Fig. 9B is a partially enlarged sectional view showing a part enclosed with a circle D in Fig. 9A

in an enlarged manner;

Fig. 10A illustrates a central longitudinal section of an unthreaded intermediate product for the nut according to the third embodiment of the present invention, and Fig. 10B is a partially enlarged sectional view showing a part enclosed with a circle D in Fig. 10A in an enlarged manner;

Fig. 11A is a partially enlarged sectional view showing a part, close to a lead thread, in a central longitudinal section of an unthreaded intermediate product for a nut according to a fourth embodiment of the present invention in an enlarged manner, and Fig. 11B is a partially enlarged sectional view showing the part close to the lead thread of the intermediate product shown in Fig. 11A formed with a female screw in a screw hole with a rolled tap;

Fig. 12A is a partially enlarged sectional view showing a part, close to a lead thread, in a central longitudinal section of an unthreaded intermediate product for a nut according to a fifth embodiment of the present invention in an enlarged manner, and Fig. 12B is a partially enlarged sectional view showing the part close to the lead thread of the intermediate product shown in Fig. 12A formed with a female screw in a screw hole with a rolled tap;

Fig. 13A is an explanatory diagram showing internal threading with a cutting tap, and Fig. 13B is an explanatory diagram showing the shape of an insert of the cutting tap in plane;

Fig. 14A is an explanatory diagram showing internal threading with a rolled tap, and Fig. 14B is an explanatory diagram showing the shape of an insert of the rolled tap in plane;

Fig. 15A is a sectional view showing an intermediate product for a conventional nut to be internally threaded with a rolled tap, and Fig. 15B is a sectional view showing the intermediate product in the process of internal threading with the rolled tap;

Fig. 16 is a partially enlarged sectional view showing a part enclosed with a circle A in Fig. 15B for illustrating flow of material caused by plastic deformation in the process of internal threading on the intermediate product for the conventional nut with the rolled tap; and

Fig. 17A is a sectional view showing the conventional nut for engaging with a bolt, and Fig. 17B is a sectional view showing the so-called cross-thread caused by a thread on the forward end of the bolt hitting a concave portion of a first thread of the female screw when the forward end of the bolt starts to engage with a portion of the female screw of the nut adjacent to a lead thread.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention are now described with reference to the drawings.

(First Embodiment)

A first embodiment of the present invention is now described with reference to Figs. 1A to 6B. In the first embodiment, the present invention is applied to the so-called hopper feed tee nut provided with a flange portion 3 having pawls 4 on an end of a hollow cylindrical shaft portion 2, which can be automatically fed along feed tracks 50 as shown in Fig. 2. The feature of this nut 1 resides in the shape of a lead thread 5 thereof, i.e., the shape of a starting end of a female screw forming portion on the upper end of the shaft portion 2 shown in Fig. 1A. As most clearly understood from Fig. 1B showing a part enclosed with a circle B in Fig. 1A in an enlarged manner, the lead thread 5 includes a concave bent portion 5a on the inner peripheral side and a tapered portion 5b continuous with the bent portion 5a on the outer peripheral side. The concave bent portion 5a is generally set in a substantially arcuate shape.

In order to form a female screw in the nut 1 having the aforementioned structure, a rolled tap 53 is screwed into an unthreaded intermediate product 101 for the nut 1 shown in Fig. 3A from the side of the upper end thereof, i.e., the side of the lead thread 5. A lead thread 105 of the intermediate product 101 for the nut 1 includes a substantially arcuate concave bent portion 105a provided on the inner periphery of the upper end of a hollow cylindrical shaft portion 102 in an arbitrary longitudinal section including the central axis of the shaft portion 102 and a linear tapered portion 105b continuous with the concave bent portion 105a on the outer peripheral side.

The lead thread 105 has the aforementioned shape so that the shaft portion 2 of the nut 1 is provided with a female screw having a sectional shape shown in Fig. 3B when internal threading with the rolled tap 53 is completed. Fig. 4 illustrates a part enclosed with a circle B in Fig. 3B in an enlarged manner, to show flow of material caused by plastic deformation when the intermediate product 101 shown in Fig. 3A is internally threaded to obtain the nut 1 shown in Fig. 3B. As shown by thick arrows in Fig. 3B, the inner periphery of the shaft portion 102 is depressed due to formation of the female screw so that the material fills up spaces for defining threads to cause this flow.

The intermediate product 101 for the nut 1 according to this embodiment corresponds to that prepared by substantially arcuately depressing the region close to the inner peripheral end of the lead thread 31a of the intermediate product 131 for the conventional nut shown in Fig. 15A, formed by only a linear tapered portion, thereby forming the concave bent portion 105a. The lead thread 105 of the intermediate product 101 has the concave bent portion 105a so that no concave part is formed on a thread 2a of the female screw adjacent to the lead thread 5 of the completed nut 1 dissimilarly to the corresponding thread 31b of the intermediate product 131 for the conventional nut. In other words, the amount of depression of the concave bent portion 105a of the lead thread 105 of the intermediate product 101 and the ratios of the concave bent portion 105a and the linear tapered portion 105b are previously set so that no concave portion is formed on the thread 2a of the female screw adjacent to the lead thread 105.

The linear tapered portions 5b and 105b are left on the outer peripheral ends of the lead threads 5 and 105 for smoothly guiding the forward end of the rolled tap 53 into a screw hole for internally threading the intermediate product 101 or guiding the forward end of a bolt for engaging with the nut 1 formed with the female screw into the screw hole. When the concave bent portion 105a must be largely formed, however, the concave bent portion 105a may be provided along the overall region of the lead thread 105 of the intermediate product 101 for the nut 1 with no linear

tapered portion 105b. The angle of the linear tapered portions 5b and 105b, i.e., the angle denoted by θ in Fig. 1, is preferably set at 118° to 120° slightly smaller than the angle formed by the forward end of the rolled tap 53.

When a bolt 3 is inserted in the nut 1 according to the embodiment formed in the aforementioned manner as shown in Figs. 5A and 5B, a thread on the forward end of the bolt 3 reliably engages with a first root 2b of the female screw without hitting against the thread 2a of the female screw having no concave part. Even if threads other than the thread 2a of the female screw adjacent to the lead thread 5 have concave parts, therefore, crests of a male screw of the bolt 3 slide along the roots of the female screw of the nut 1 to be prevented from hitting against the concave parts, i.e., from cross-thread.

Further, such a characteristic of the countersink is maintained that the diameter of the lead thread enlarges toward the opening end, whereby the female screw can be worked without damaging a function of the countersink facilitating discharge of chips resulting from internal threading with a tap. In addition, the lead thread 5 is shaped to define a substantially arcuate concave bent portion, not to damage another function of the conventional tapered countersink properly guiding the forward end of the bolt for engaging with the nut and automatically aligning the central axes of the nut and the bolt. Even if the bolt is inserted into the nut 1 in a slightly inclined state, the central axes of the nut 1 and the bolt are automatically aligned due to the guiding function of the lead thread 5, so that the nut 1 and the bolt properly engage with each other.

The lead thread 105 of the intermediate product 101 for the nut 1 according to this embodiment can be readily formed through a press molding step by first molding the concave bent portion 105a with a punch 54 shown in Fig. 6A and thereafter molding the linear tapered portion 105b with a punch 55 shown in Fig. 6B, for example.

While the nut 1 according to this embodiment has a structure obtained by applying the present invention to a full screw type hopper feed tee nut, the present invention is also applicable to a lead thread shape of a

nut, such as a standard hexagon nut, other than the tee nut for similarly enabling internal threading causing no cross-thread by working with a rolled tap, as a matter of course.

Further, the shaft portions 2 and 101 of the nut 1 according to this embodiment and the intermediate product 101 therefor have step portions 6 and 106 having different inner and outer diameters, so that regions closer to the flange portion 3 with reference to the step portions 6 and 106 have shapes larger in inner and outer diameters than regions on ends opposite to the flange portion 3. The unthreaded intermediate product 101 for the nut 1 has such a step portion 106 so that a female screw shape defined in a standard such as JIS can be accurately formed. In the screw hole of the shaft portion 102, only a prescribed region, including the lead thread 105, of a region slated for internal threading can be worked in necessary accuracy while the remaining region can be slightly larger in inner diameter to attain allowance in working accuracy. It can be said that formation of the step portion 106 is also effective for working the lead threads 5 and 105 according to this embodiment in high accuracy.

(Second Embodiment)

The structure of a nut 11 according to a second embodiment of the present invention is now described with reference to Figs. 7A to 8B. Referring to Figs. 7A to 8B, components similar to those of the nut 1 according to the first embodiment are denoted by the same reference numerals, and redundant description is not repeated.

In this embodiment, the present invention is applied to the so-called rivet type tee nut already proposed by the inventor in U.S. Patent No. 5,348,432. As shown in Fig. 7A, a hollow cylindrical shaft portion 12 of the nut 11 according to this embodiment includes a female screw forming portion 12a as well as a predeterminate caulked portion 12b having a smaller thickness, dissimilarly to the nut 1 according to the first embodiment. The predeterminate caulked portion 12b has an inner diameter larger than that of the female screw forming portion 12a and an outer diameter substantially identical to that of the female screw forming portion 12a. As shown in Fig. 7B, the nut 11 is provided on an end portion

of the female screw forming portion 12a adjacent to the predeterminate caulked portion 12b with a lead thread 15, which is formed by a substantially arcuate concave bent portion 15a and a linear tapered portion 15b in an arbitrary longitudinal section including the central axis of the shaft portion 12, similarly to the first embodiment.

For the nut 11 having the aforementioned structure, a rolled tap 53 is screwed into an unthreaded intermediate product 111 from the side of the upper end of the nut 11, i.e., the side of the lead thread 15 as shown in Fig. 8A, for forming a female screw. As shown in Fig. 8B, a lead thread 115 of the intermediate product 111 for the nut 11 includes a substantially arcuate concave bent portion 115a provided on the inner peripheral side of the upper end of a hollow cylindrical shaft portion 112 and a linear tapered portion 115b continuous with the concave bent portion 115a on the outer peripheral side in an arbitrary longitudinal section including the central axis of the shaft portion 112.

With the lead thread 115 having the aforementioned shape, the intermediate product 111 is internally threaded with the rolled tap 53 in a mode basically similar to that described with reference to Figs. 3A, 3B and 4 in the first embodiment. The concave bent portion 115a of the lead thread 115 of the intermediate product 111 is worked into a predetermined proper shape so that the crest of a thread of the female screw adjacent to the lead thread 15 has no concave groove when the intermediate product 111 is completely internally threaded with the rolled tap 53. Consequently, when a bolt engages with the nut 11 from the side of the lead thread 15, the nut 11 is prevented from cross-thread in a similar manner to the above description of the first embodiment with reference to Figs. 5A and 5B.

The intermediate product 111 for the nut 11 according to this embodiment can be relatively readily formed without remarkably increasing the manufacturing cost by including a molding step with a punch described in relation to the first embodiment with reference to Figs. 6A and 6B in the process of a progressive press molding step already proposed by the inventor in U.S. Patent No. 5,503,596.

The shaft portions 12 and 112 of the nut 11 according to this embodiment and the intermediate product 111 therefor are provided with step portions 16 and 116 having different inner and outer diameters, so that regions closer to the flange portion 3 with reference to the step portions 6 and 106 have shapes larger in inner and outer diameters than regions on ends opposite to the flange portion 3. The object and effect of the step portions 16 and 116 are similar to those of the step portions 6 and 106 in the first embodiment, while it can be said that the step portions 16 and 116 are more effective for the nut 11 according to this embodiment requiring higher working accuracy due to the predeterminate caulked portion 12b having a relatively small thickness.

(Third Embodiment)

The structure of a nut 21 according to a third embodiment of the present invention is now described with reference to Figs. 9A to 10B. Referring to Figs. 9A to 10B, components similar to those of the nut 1 according to the first embodiment are denoted by the same reference numerals, and redundant description is not repeated.

In this embodiment, the present invention is applied to a nut described in U.S. Patent No. 5,618,144. While the nut 21 according to this embodiment is the so-called rivet type tee nut similarly to the nut 11 according to the second embodiment, the shape of a predeterminate caulked portion 22b thereof is different from that of the nut 11. As shown in Fig. 9A, the predeterminate caulked portion 22b of the nut 21 according to this embodiment has an inner diameter larger than that of a female screw forming portion 22a and an outer diameter larger than that of the female screw forming portion 22a. As shown in Fig. 9B, the nut 21 is provided on an end of the female screw forming portion 22a adjacent to the predeterminate caulked portion 22b with a lead thread 25, which is formed by a substantially arcuate concave bent portion 25a and a linear tapered portion 25b in an arbitrary longitudinal section including the central axis of a shaft portion 22, similarly to the first and second embodiments.

For the nut 21 having the aforementioned structure, a rolled tap 53 is screwed into an unthreaded intermediate product 121 from the side of

the upper end of the nut 21, i.e., the side of the lead thread 25 as shown in Fig. 10A, for forming a female screw. A lead thread 125 of the intermediate product 121 for the nut 21 includes a substantially arcuate concave bent portion 125a provided on the inner peripheral side of the upper end of a hollow cylindrical shaft portion 122 and a linear tapered portion 125b continuous with the concave bent portion 125a on the outer peripheral side in an arbitrary longitudinal section including the central axis of the shaft portion 122, as shown in Fig. 10B.

With the lead thread 125 having the aforementioned shape, the intermediate product 121 is internally threaded with the rolled tap 53 also in a mode basically similar to that described with reference to Figs. 3A, 3B and 4 in the first embodiment. The concave bent portion 125a of the lead thread 125 of the intermediate product 121 is worked into a predetermined proper shape so that the crest of a thread of the female screw adjacent to the lead thread 25 has no concave groove when the intermediate product 121 is completely internally threaded with the rolled tap 53. Consequently, when a bolt engages with the nut 21 from the side of the lead thread 25, the nut 21 is prevented from cross-thread in a similar manner to the above description of the first embodiment with reference to Figs. 5A and 5B.

The shaft portions 22 and 122 of the nut 21 according to this embodiment and the intermediate product 121 therefor are also provided with step portions 26 and 126 having different inner and outer diameters, so that regions closer to a flange portion 3 with reference to the step portions 26 and 126 have shapes larger in inner and outer diameters than regions on ends opposite to the flange portion 3. The object and effect of the step portions 26 and 126 are similar to those of the step portions 6 and 106 in the first embodiment or the step portions 16 and 116 in the second embodiment.

(Fourth Embodiment)

The structure of an intermediate product 141 for a nut 41 according to a fourth embodiment of the present invention and that of the nut 41 prepared by internally threading the intermediate product 141 with a

rolled tap are now described with reference to Figs. 11A and 11B.

As shown in Fig. 11A, a lead thread 145 provided in the vicinity of the forward end of a shaft portion 142 of the intermediate product 141 for the nut 41 according to this embodiment includes a concave depressed portion 145a having a bottom substantially horizontal along the overall periphery and a peripheral side perpendicular thereto and a linear tapered portion 145b continuous with the concave depressed portion 145a on the outer peripheral side. A female screw is formed in a screw hole of the intermediate product 141 with a rolled tap, to obtain the nut 41 according to this embodiment having the structure shown in Fig. 11B. A lead thread 45 in the vicinity of the forward end of a shaft portion 42 of the nut 41 according to this embodiment includes a concave depressed portion 45a having a bottom substantially horizontal along the overall periphery and a peripheral side perpendicular thereto and a linear tapered portion 45b continuous with the concave depressed portion 45a on the outer peripheral side.

Also when forming the concave depressed portion 145a of the lead thread 145 of the intermediate product 141 so that a corner part is substantially right-angled, the crest of a thread 42a, adjacent to the lead thread 45, of the female screw formed with the rolled tap can be convexly formed to include no concave groove, as shown in Fig. 11B. Thus, it is possible to prevent cross-thread caused by a thread of a bolt hitting against a concave groove of the crest of the thread of the nut 41. Further, the female screw can be worked without damaging still another function of the countersink facilitating discharge of chips resulting from internal threading with the tap.

(Fifth Embodiment)

The structure of an intermediate product 151 for a nut 51 according to a fifth embodiment of the present invention and that of the nut 51 prepared by internally threading the intermediate product 151 with a rolled tap are now described with reference to Figs. 12A and 12B. This embodiment corresponds to a nut prepared by replacing the lead thread of the rivet type nut according to the second embodiment shown in Figs. 7A to

8B with a lead thread having a shape similar to that in the fourth embodiment.

As shown in Fig. 12A, a lead thread 155 defining an end, closer to a portion 152b slated for caulking, of a portion 152a slated for formation of a female screw in a shaft portion 152 of the intermediate product 151 for the nut 51 according to the present invention includes a concave depressed portion 155a having a bottom substantially horizontal along the overall periphery and a peripheral side perpendicular thereto and a linear tapered portion 155b continuous with the concave depressed portion 155a on the outer peripheral side. A female screw is formed in a screw hole of the intermediate product 151 with a rolled tap, to obtain the nut 51 according to this embodiment having the structure shown in Fig. 12B. A lead thread 55 of the nut 51 according to this embodiment includes a concave depressed portion 55a having a bottom substantially horizontal along the overall periphery and a peripheral side perpendicular thereto and a linear tapered portion 55b continuous with the concave depressed portion 55a on the outer peripheral side.

Also when forming the concave depressed portion 155a of the lead thread 155 of the intermediate product 151 so that a corner portion is substantially right-angled, the crest of a thread 52a, adjacent to the lead thread 55, of the female screw formed with the rolled tap can be convexly formed to include no concave groove, as shown in Fig. 12B. Thus, it is possible to prevent cross-thread caused by a thread of a bolt hitting against a concave groove of the crest of the thread of the nut 51. Further, the female screw can be worked without damaging the function of the countersink facilitating discharge of chips resulting from internal threading with the tap.

While the lead thread has the linear tapered portion continuous only on the outer peripheral side of the concavely depressed portion in each of the aforementioned embodiments, a linear tapered portion continuous with the inner peripheral side of the concave depressed portion may be further provided on the inner peripheral end of the lead thread.

Although the present invention has been described and illustrated in

detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

WHAT IS CLAIMED IS:

1. A nut consisting of integral metal material and having a female screw formed in a screw hole opening substantially perpendicularly to an end surface of one end with a rolled tap, wherein

a lead thread defining an opening end of said screw hole for said end surface has a concavely depressed shape along the overall periphery.

2. The nut in accordance with claim 1, wherein said lead thread has a concave bent portion in an arbitrary longitudinal section including the central axis of said screw hole.

3. The nut in accordance with claim 2, wherein said lead thread has such a shape that said concave bent portion and a linear tapered portion are continuously combined in an arbitrary longitudinal section including the central axis of said screw hole.

4. The nut in accordance with claim 3, wherein said concave bent portion starts from the inner peripheral side of said lead thread to be continuous with said linear tapered portion on an outer prescribed position.

5. The nut in accordance with claim 1, wherein said female screw is formed on the inner peripheral surface of a hollow cylindrical shaft portion, and said nut further comprises a flange portion radially outwardly extending from said shaft portion on another end opposite to said end.

6. The nut in accordance with claim 5, wherein said shaft portion has a step portion in a region formed with said female screw so that a region closer to said flange portion with reference to said step portion has a shape larger in inner and outer diameters than a region on an end opposite to said flange portion.

7. A nut comprising a shaft portion and a flange portion outwardly

extending from a first end of said shaft portion, consisting of integral metal material, wherein

said shaft portion is in the form of a hollow cylinder and has a portion slated for caulking in a second end opposite to said first end while a female screw is formed on the inner peripheral surface excluding said portion slated for caulking with a rolled tap,

said portion slated for caulking has an inner diameter larger than that of a portion formed with said female screw, and

a lead thread defining an end, adjacent to said portion slated for caulking, of said portion of said shaft portion formed with said female screw has a concavely depressed shape along the overall periphery.

8. The nut in accordance with claim 7, wherein said lead thread has a concave bent portion in an arbitrary longitudinal section including the central axis of a screw hole.

9. The nut in accordance with claim 8, wherein said lead thread has such a shape that said concave bent portion and a linear tapered portion are continuously combined in an arbitrary longitudinal section including the central axis of said screw hole.

10. The nut in accordance with claim 9, wherein said concave bent portion starts from the inner peripheral side of said lead thread to be continuous with said linear tapered portion on an outer prescribed position.

11. The nut in accordance with claim 7, wherein said portion of said shaft portion slated for caulking has an inner diameter larger than that of said portion formed with said female screw and is formed to be smaller in thickness than said portion formed with said female screw.

12. The nut in accordance with claim 7, wherein said portion of said shaft portion slated for caulking has an inner diameter larger than that of said portion formed with said female screw and an outer diameter larger

than that of said portion formed with said female screw.

13. The nut in accordance with claim 7, wherein said shaft portion has a step portion in a region formed with said female screw so that a region closer to said flange portion with reference to said step portion has a shape larger in inner and outer diameters than a region on an end opposite to said flange portion.

14. A nut consisting of integral metal material and having a female screw formed on a prescribed region of a screw hole opening substantially perpendicularly to an end surface of one end with a rolled tap, wherein

the crest of at least a thread, among threads of said female screw, close to a starting end of said female screw on a side first engaging with a bolt has a convex shape with no concave groove.

15. An intermediate product for a nut, not yet formed with a female screw, consisting of integral metal material and having a screw hole opening substantially perpendicularly to an end surface of one end and slated for formation of a female screw with a rolled tap at least in a prescribed region, wherein

a lead thread defining an end of said prescribed region of said screw hole slated for formation of a female screw has a concavely depressed shape along the overall periphery.

16. The intermediate product for a nut in accordance with claim 15, wherein said shape of said lead thread concavely depressed along the overall periphery is so set that the crest of a thread of a female screw adjacent to said lead thread has a convex shape with no concave groove after a female screw is formed in said screw hole with a rolled tap.

17. The intermediate product for a nut in accordance with claim 15, comprising a hollow cylindrical shaft portion formed therethrough with said screw hole and a flange portion radially outwardly extending from said

shaft portion on an end of said shaft portion.

18. The intermediate product for a nut in accordance with claim 15, further comprising a region slated for caulking having an inner diameter larger than said prescribed region slated for formation of a female screw over an end of said shaft portion opposite to said flange portion and said lead thread.

19. The intermediate product for a nut in accordance with claim 17, wherein said shaft portion has a step portion in said region slated for formation of a female screw so that a region closer to said flange portion with reference to said step portion has a shape larger in inner and outer diameters than a region on an end opposite to said flange portion.

20. Each and every novel feature or novel combination of features herein disclosed.

R. WILLIAM WRAY & ASSOCIATES

BOX 2760 - STATION D

OTTAWA, CANADA K1P 5W8

PATENT AGENT FOR THE APPLICANT

FIG. 1A

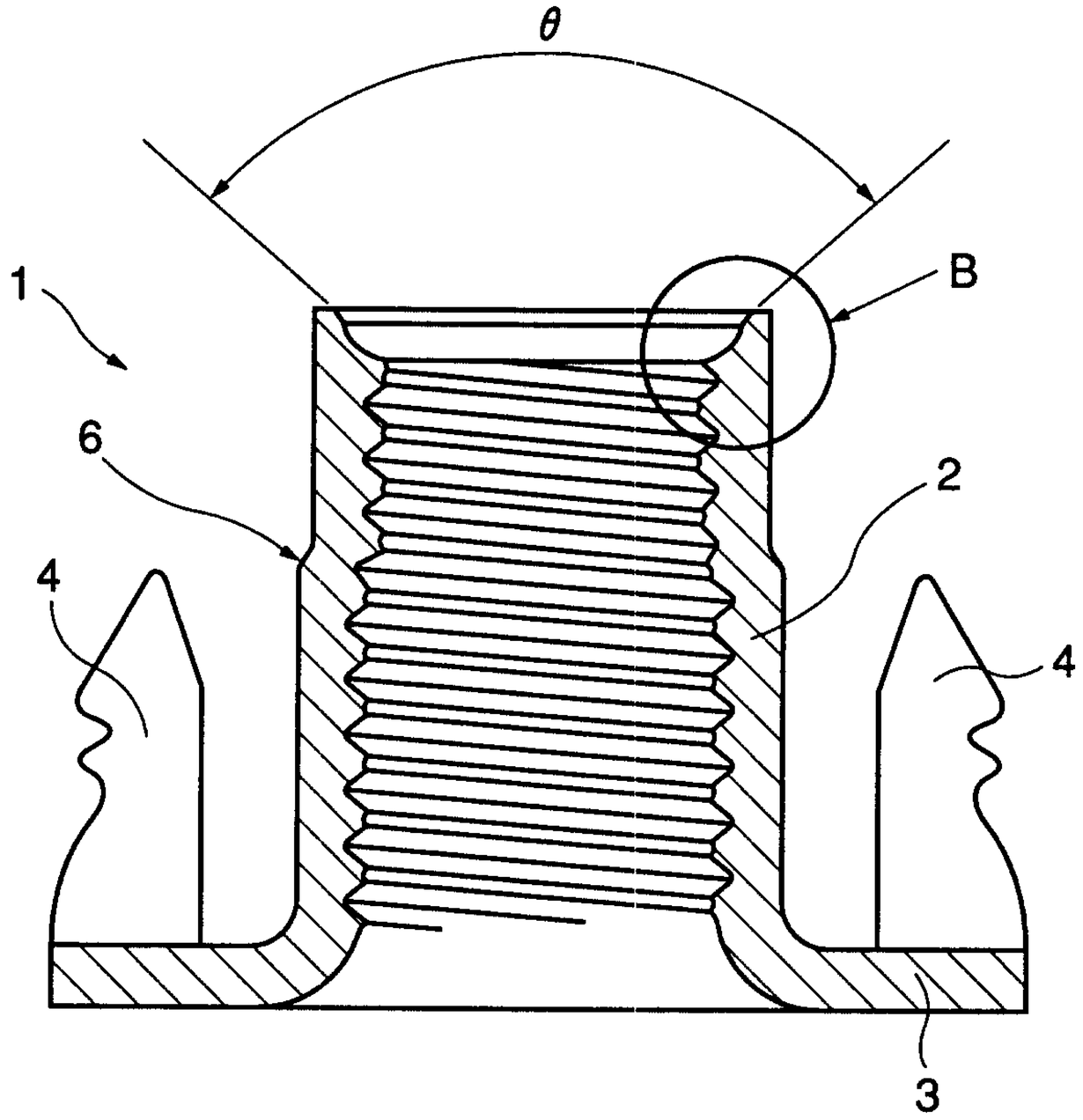


FIG. 1B

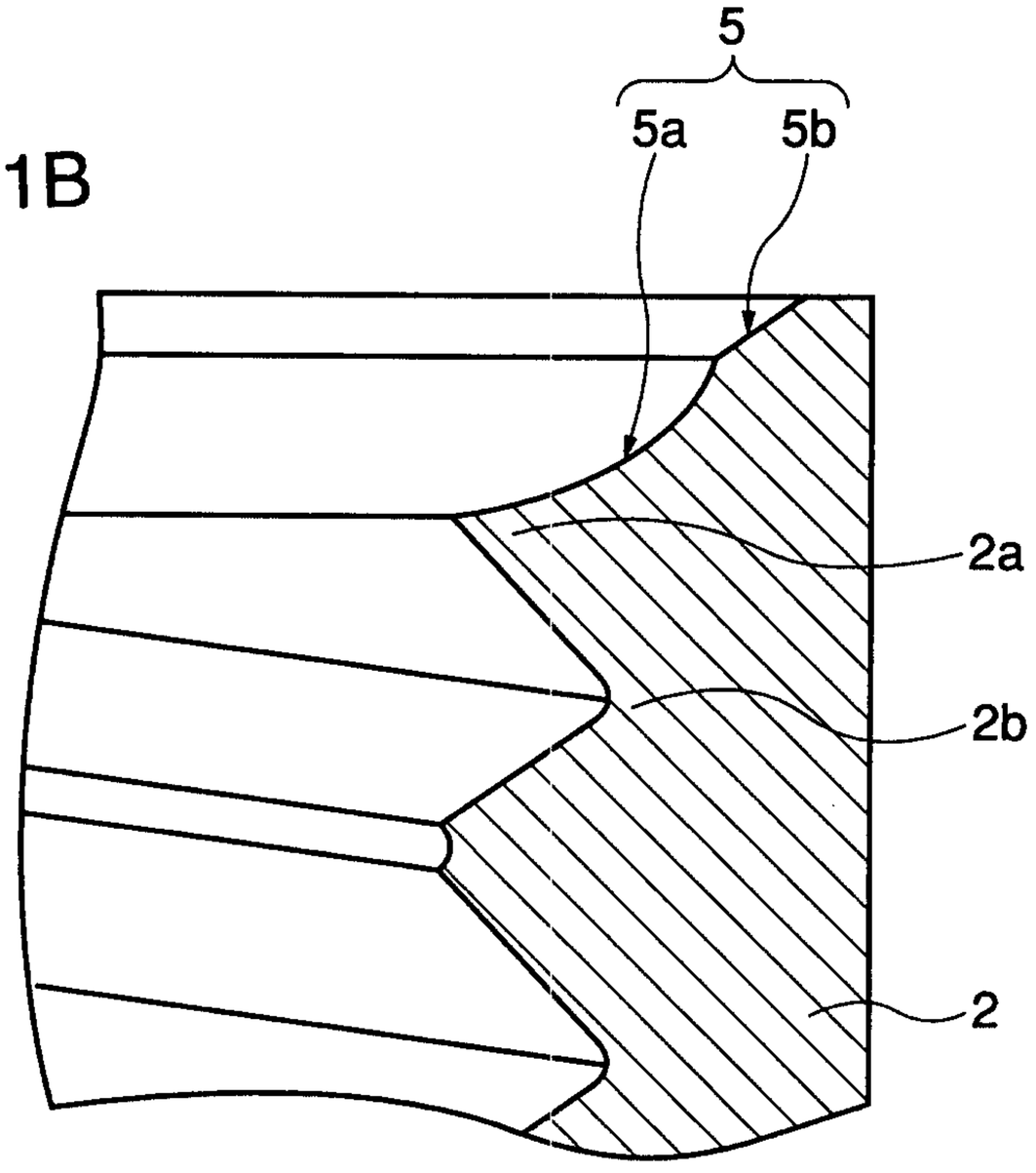


FIG. 2

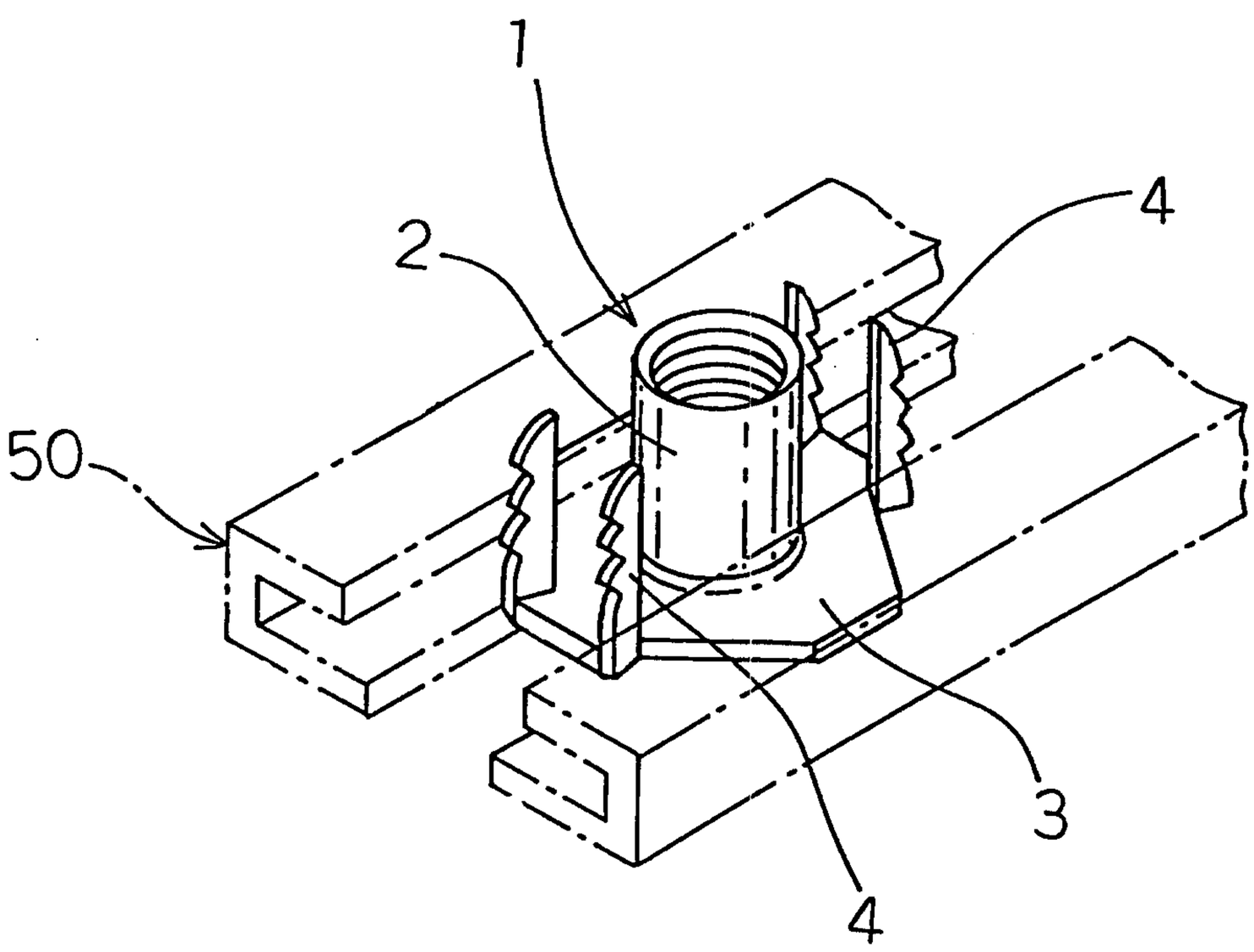


FIG. 3A

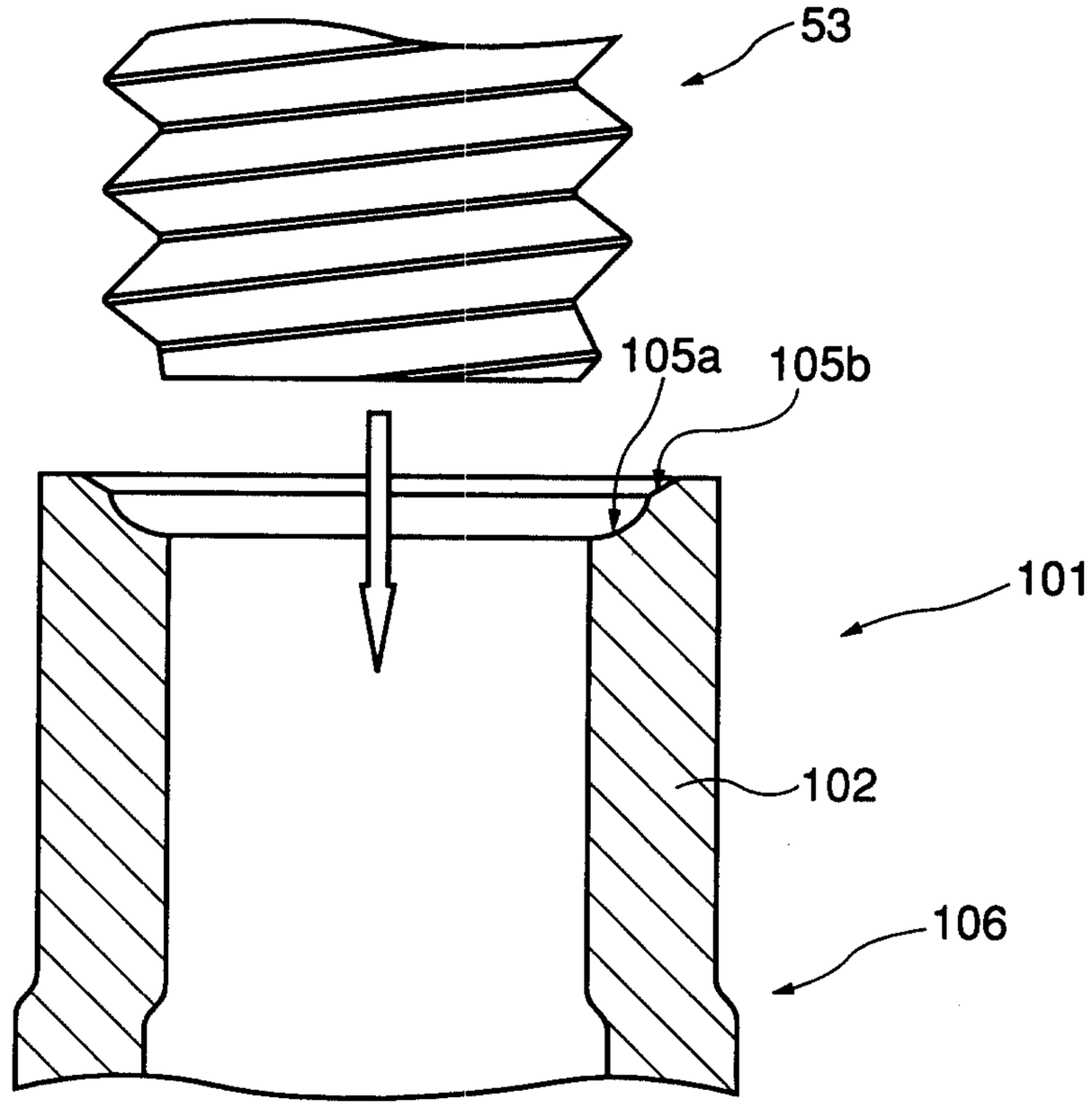


FIG. 3B

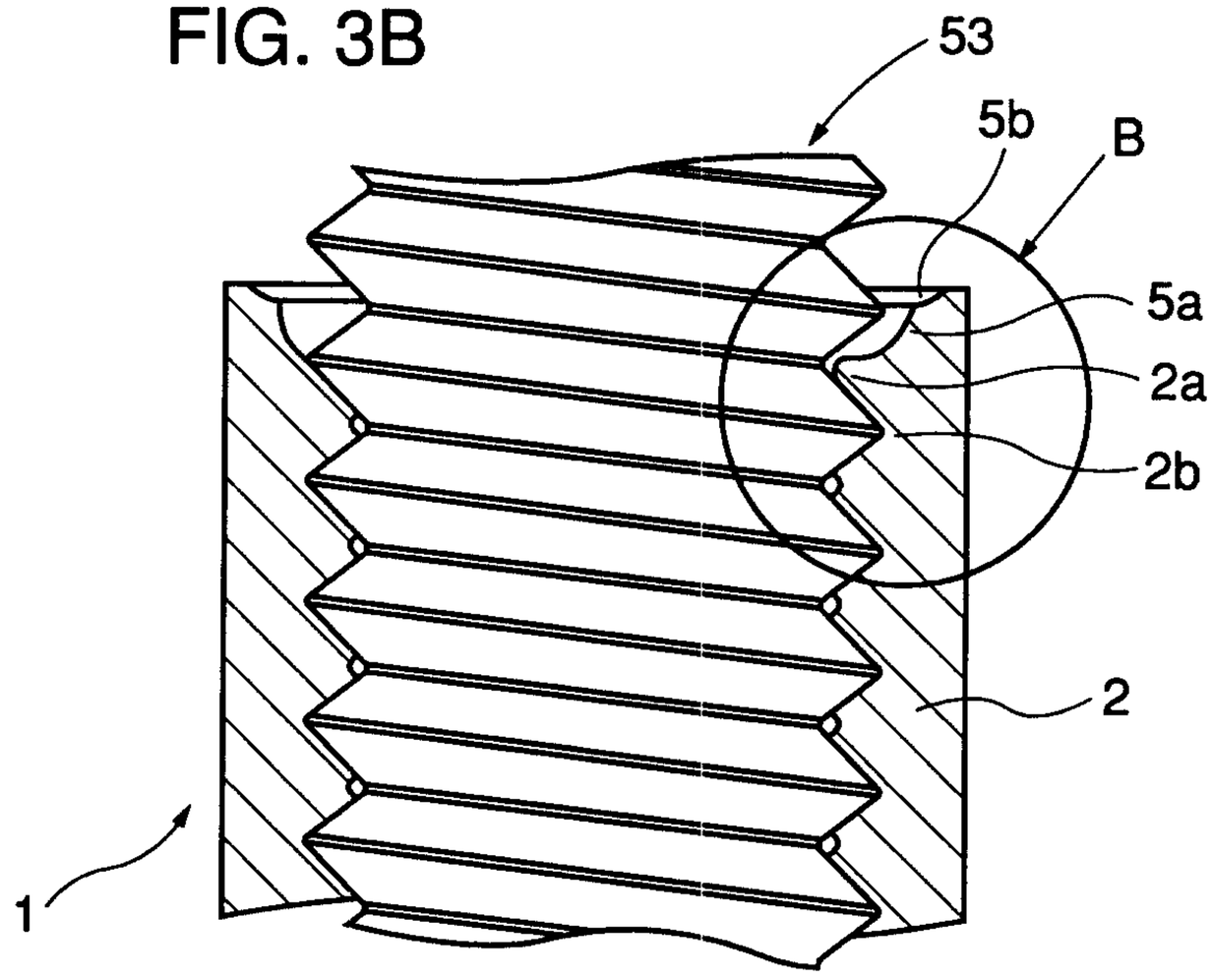


FIG. 4

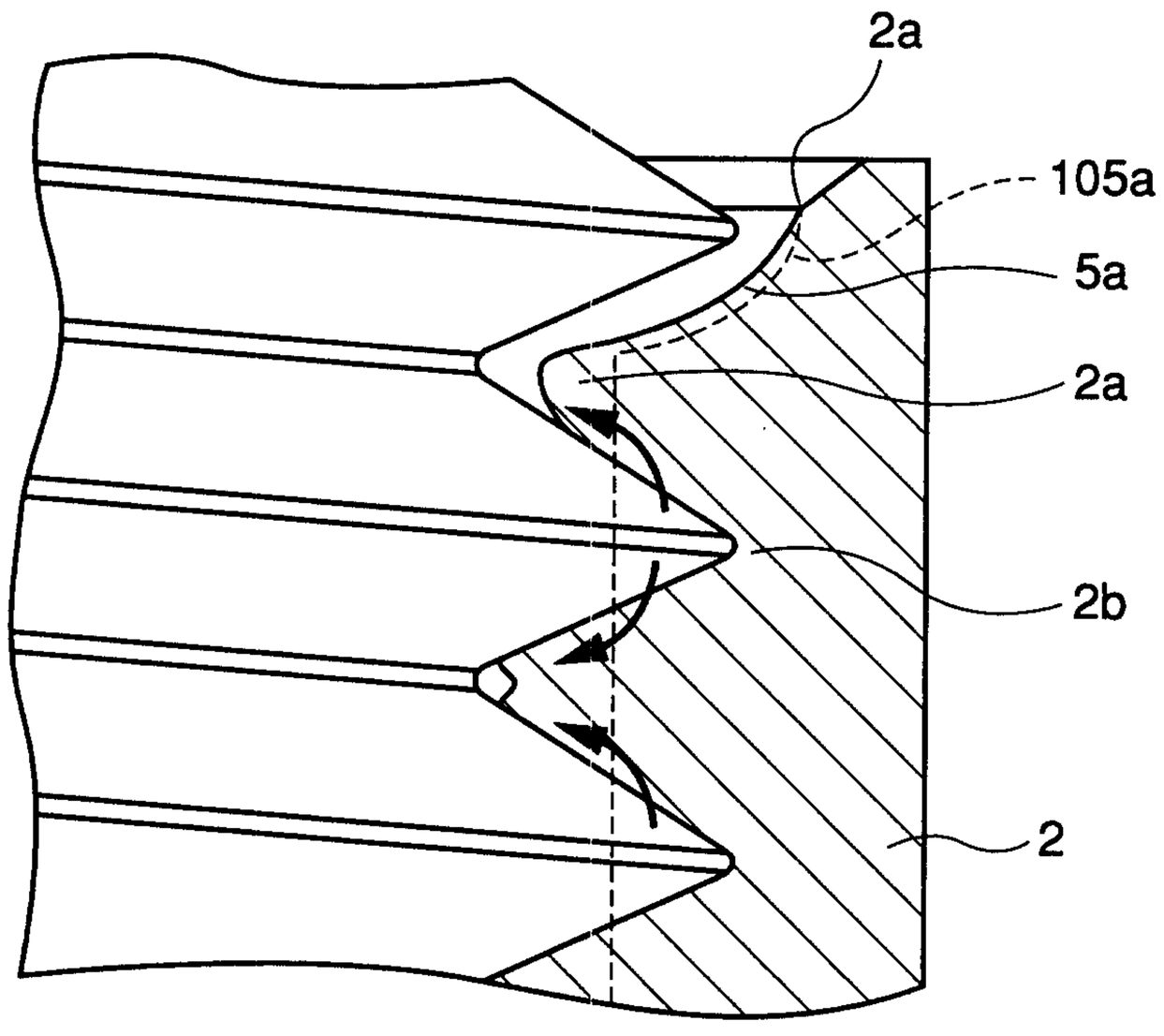


FIG. 5A

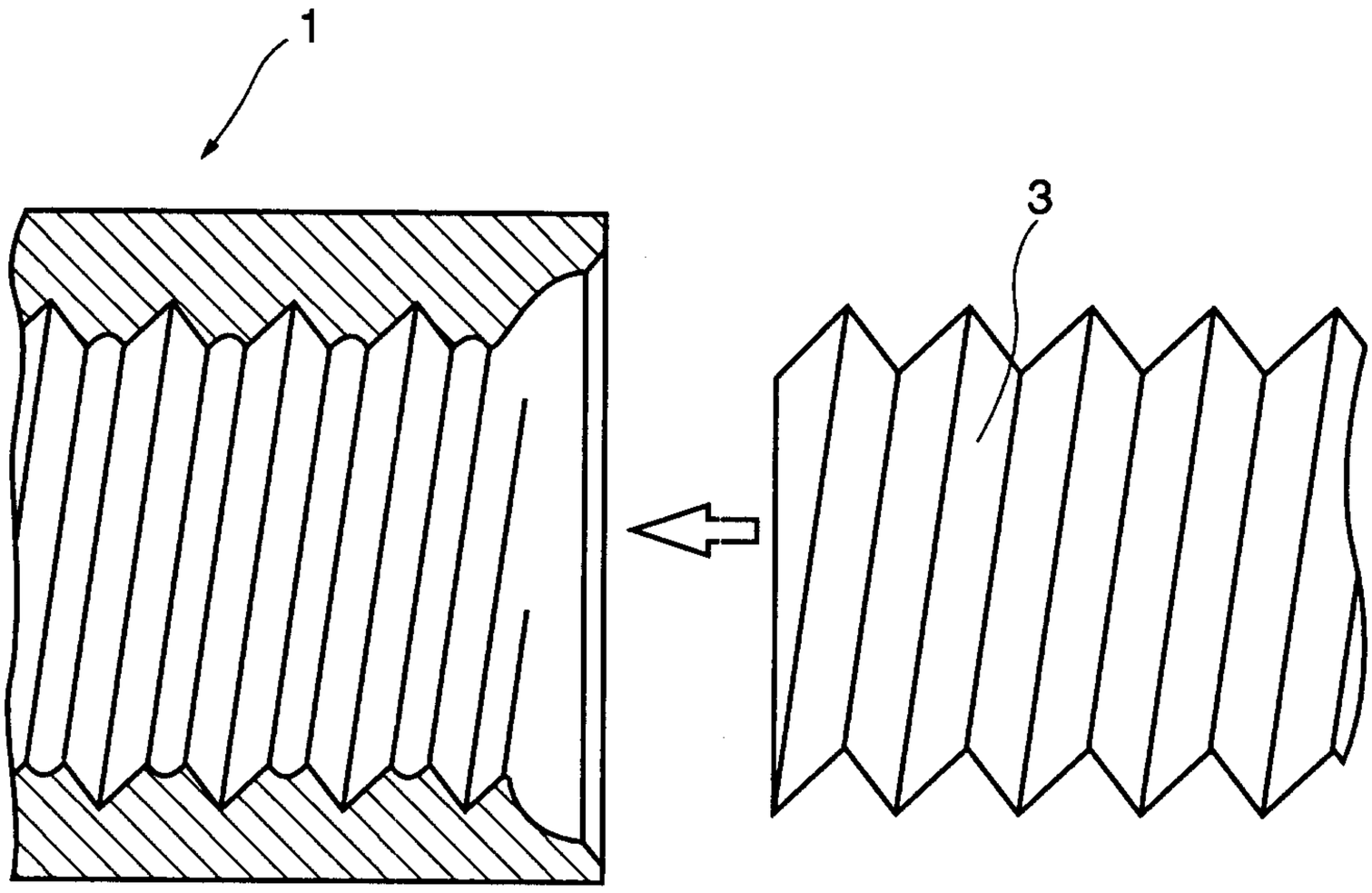


FIG. 5B

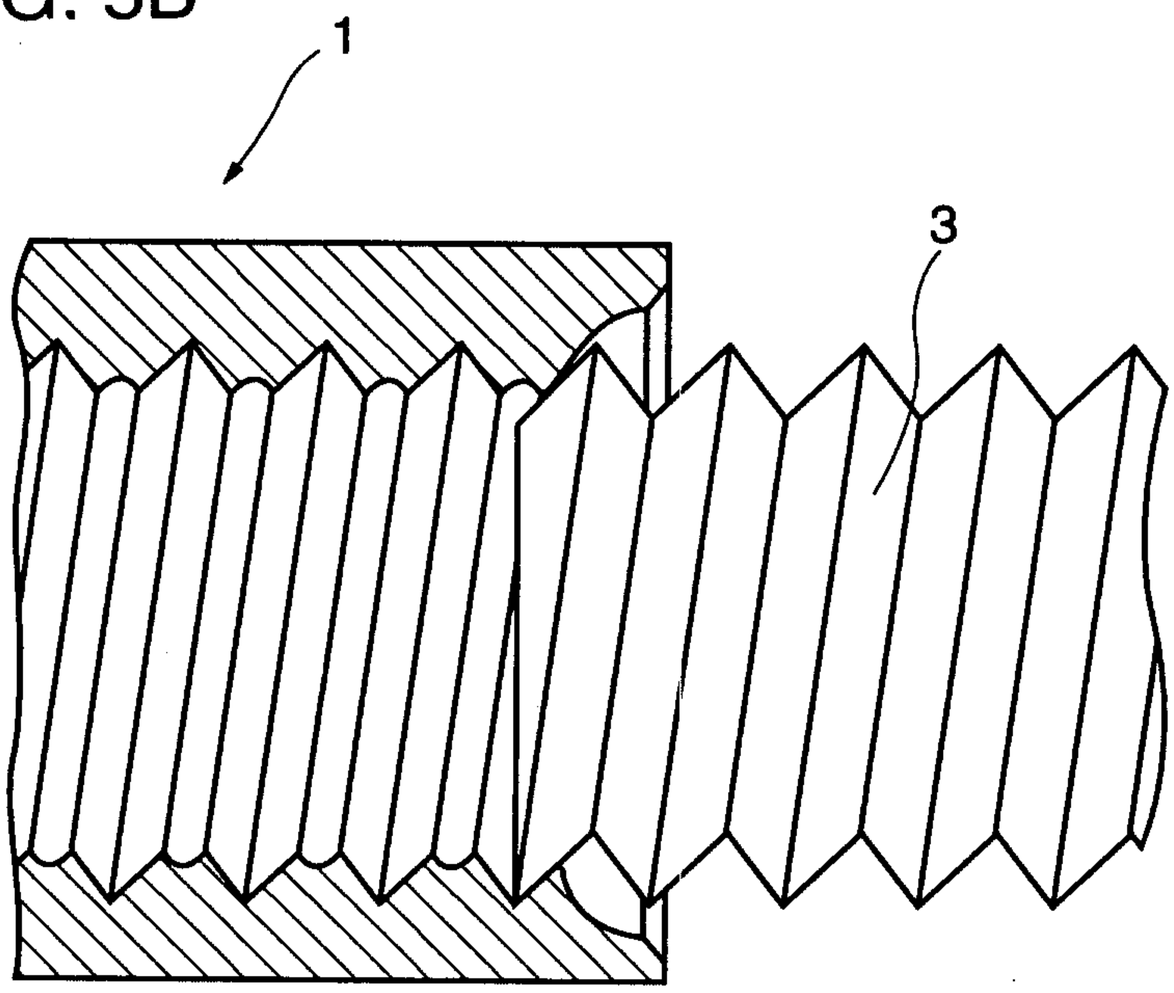


FIG. 6A

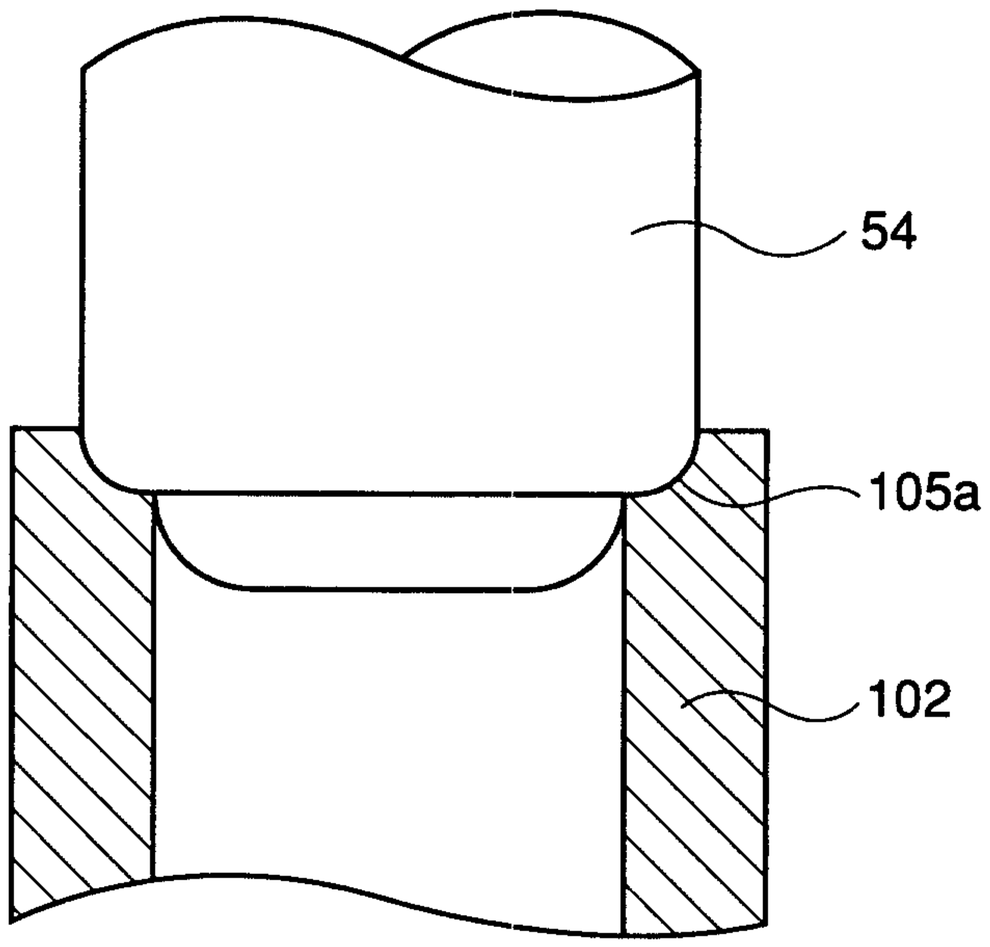


FIG. 6B

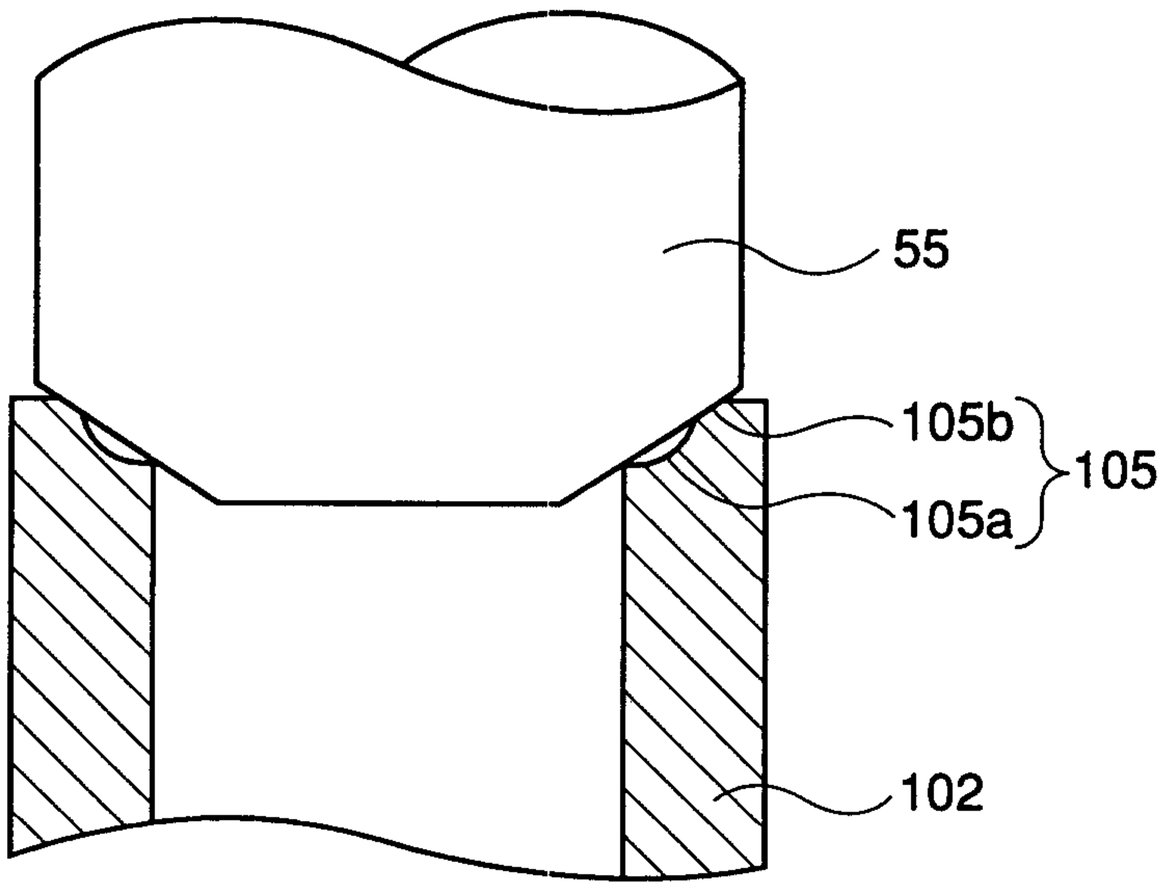


FIG. 7A

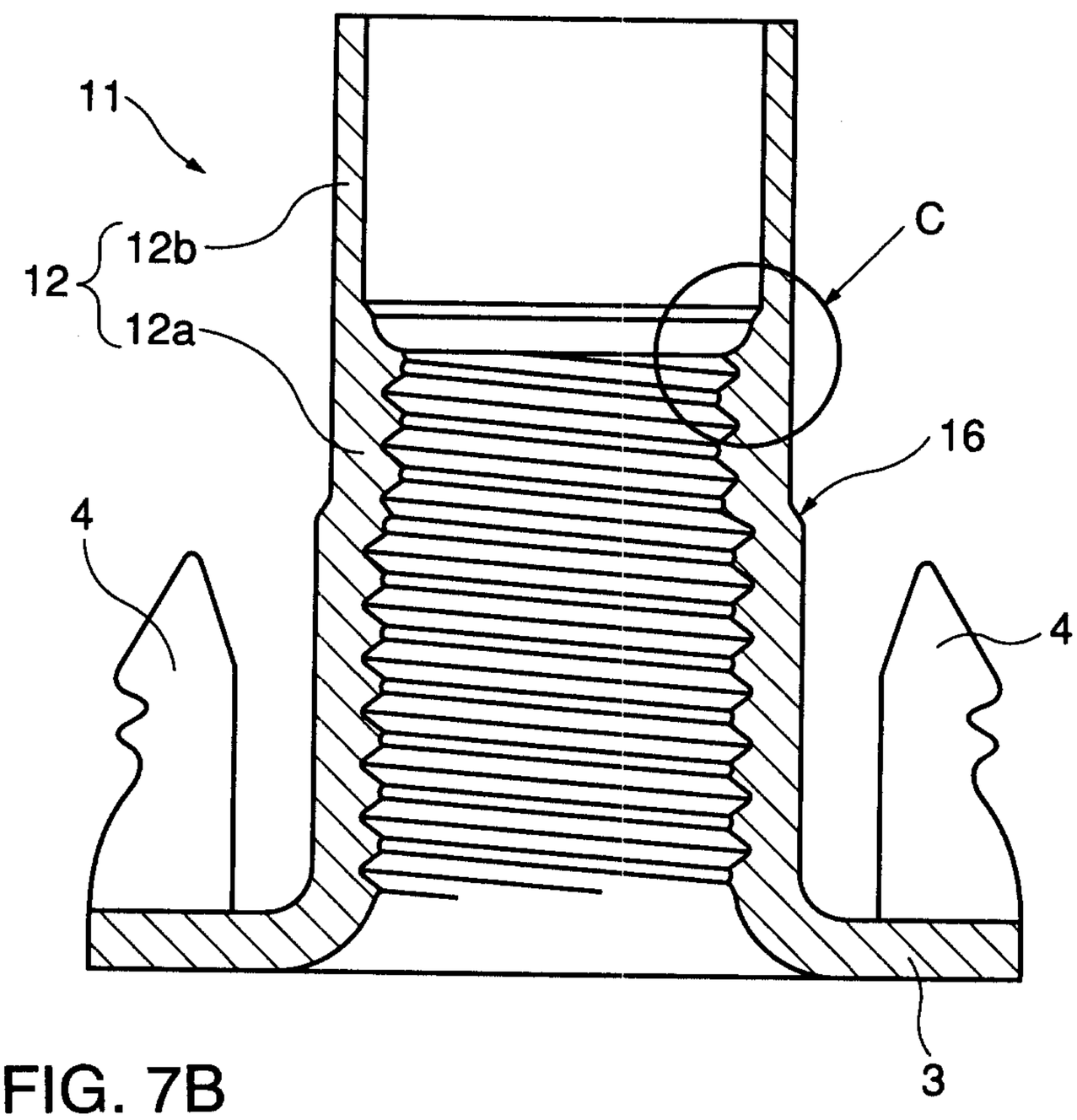


FIG. 7B

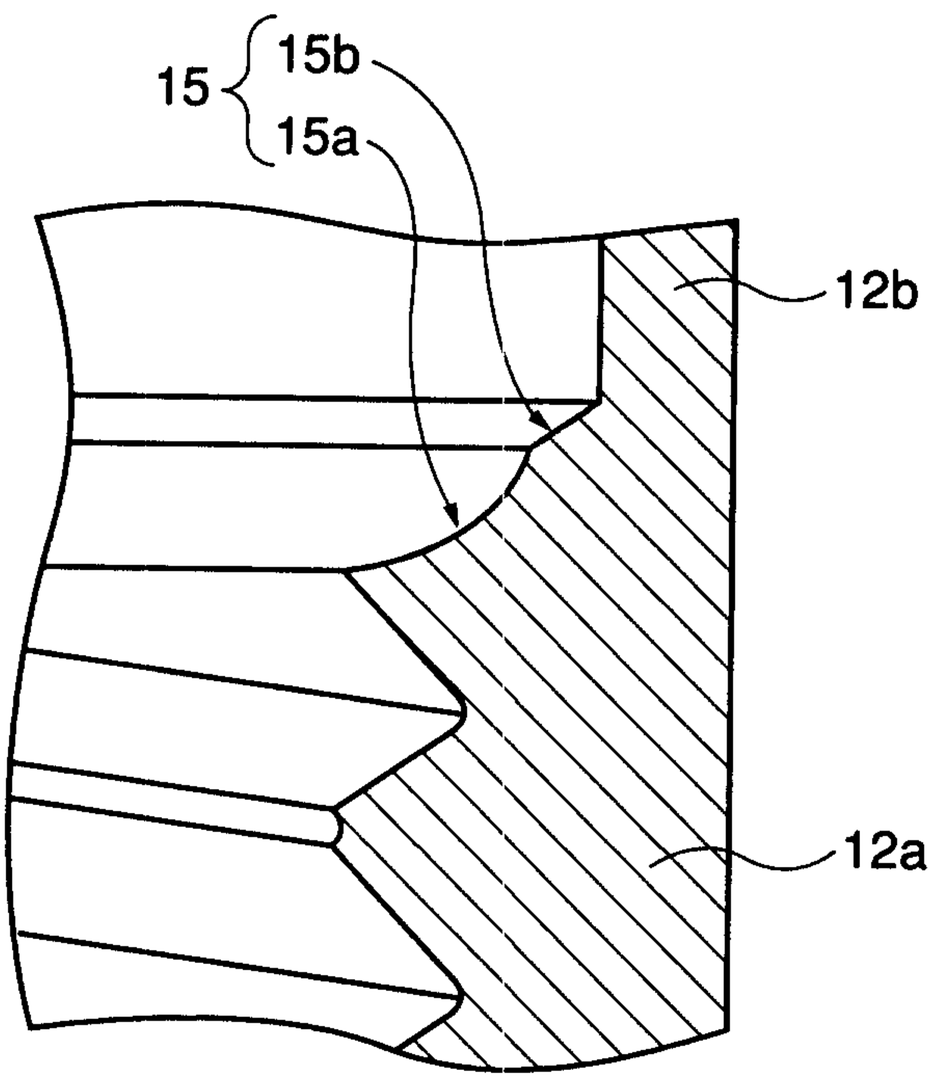


FIG. 8A

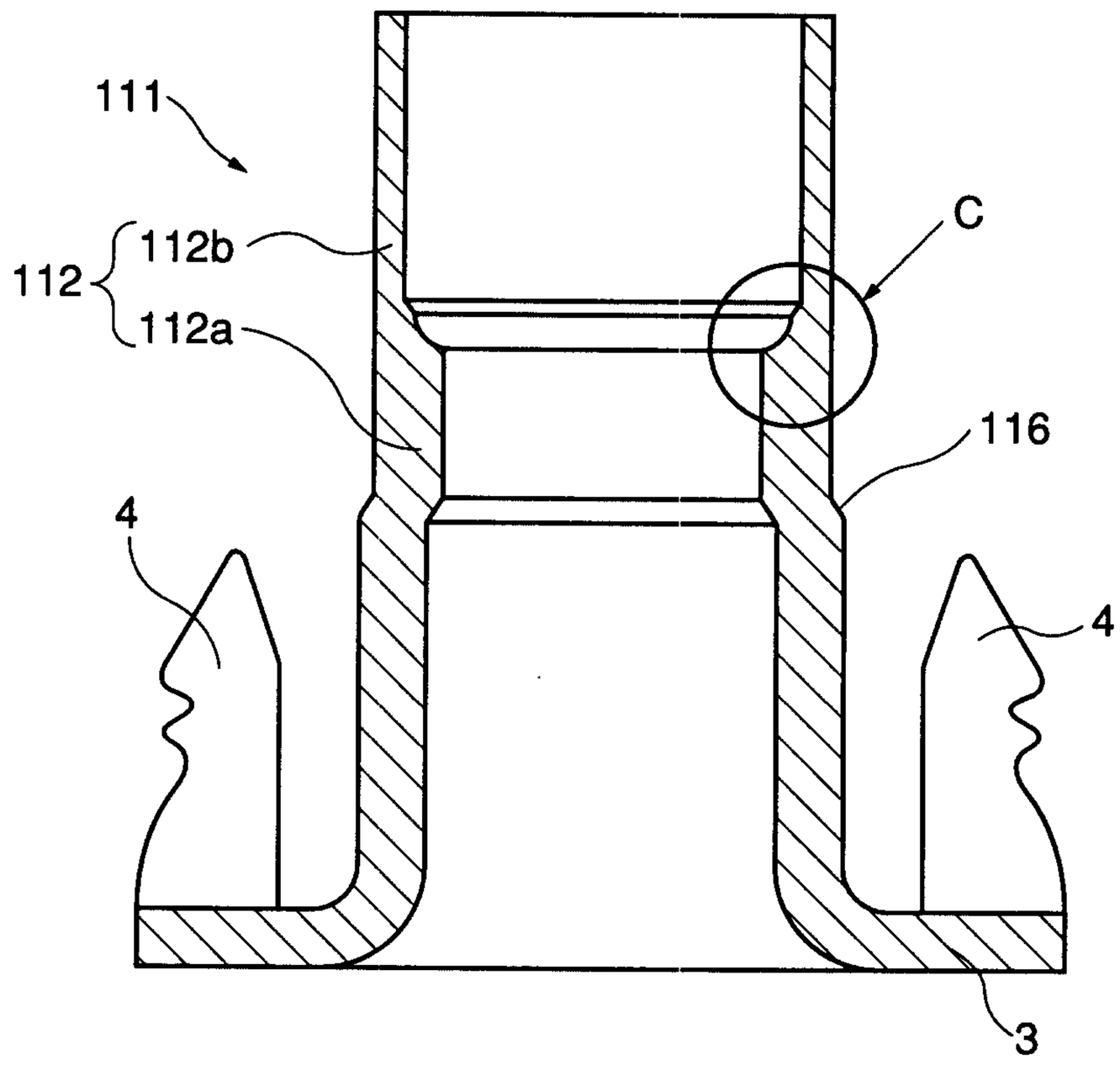


FIG. 8B

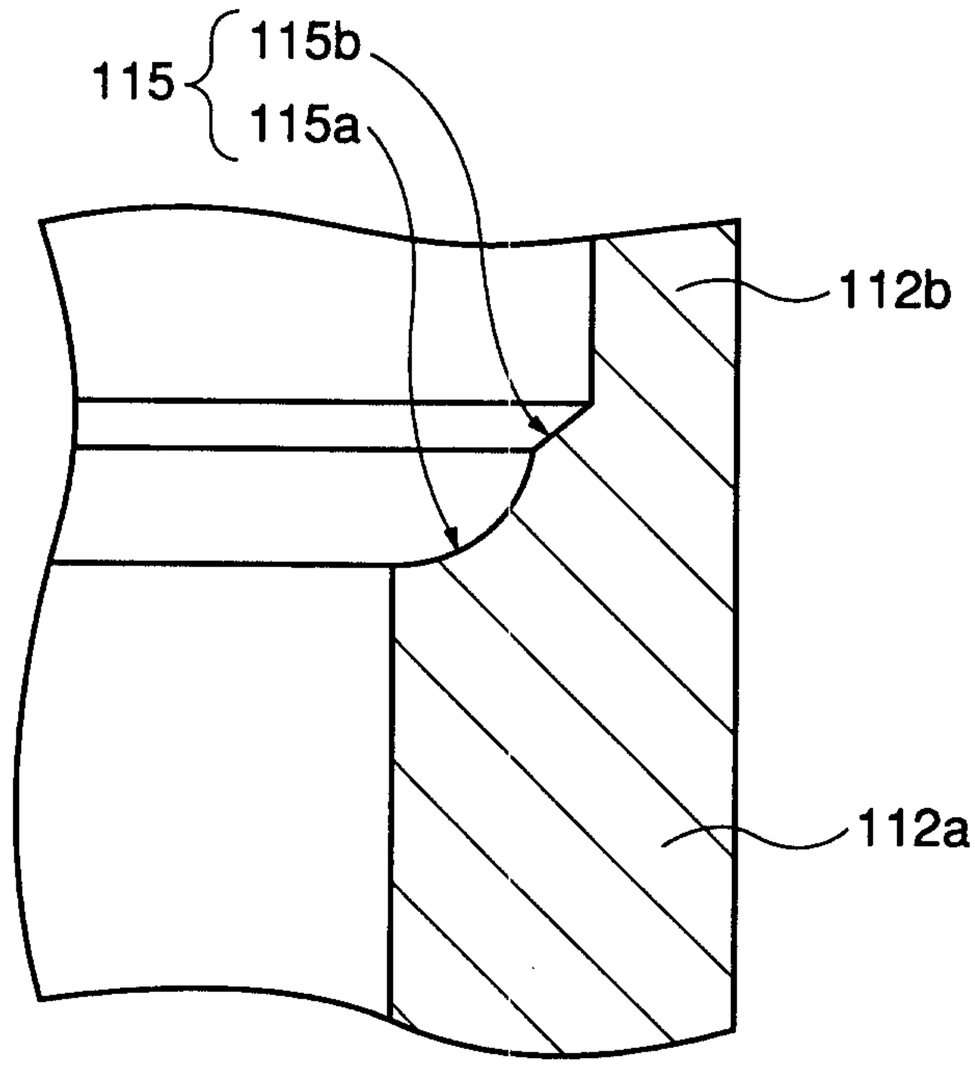


FIG. 9A

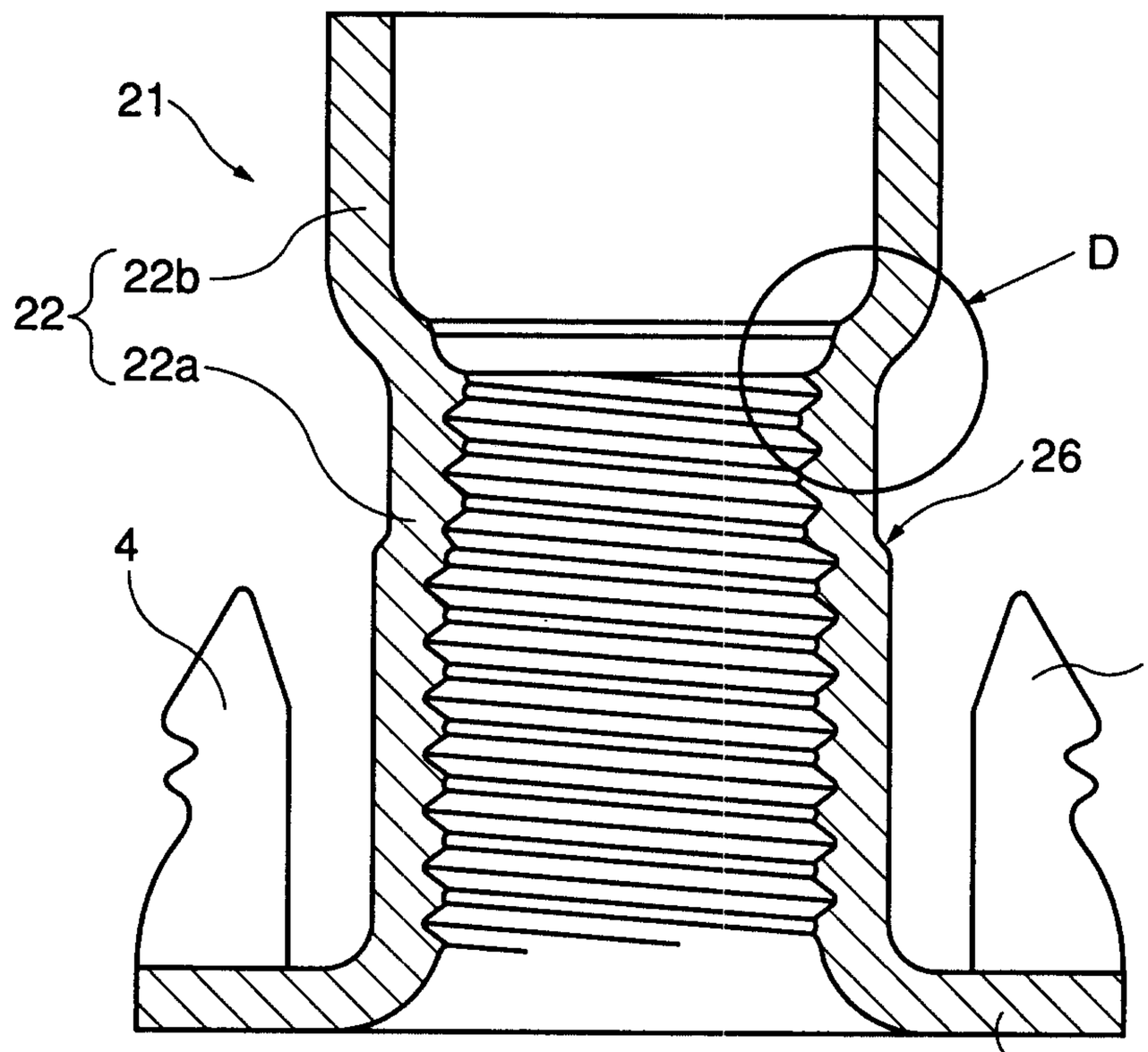


FIG. 9B

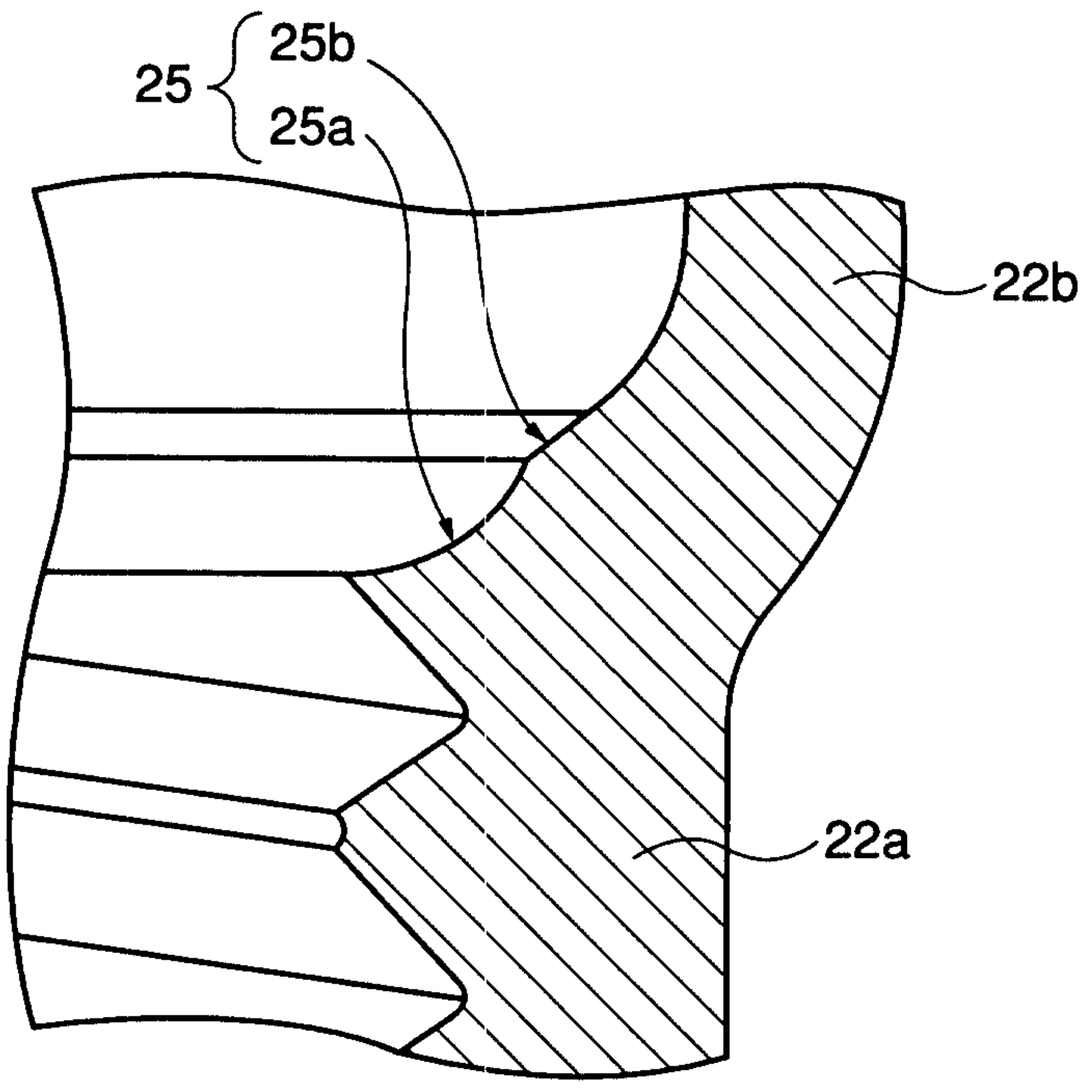


FIG. 10A

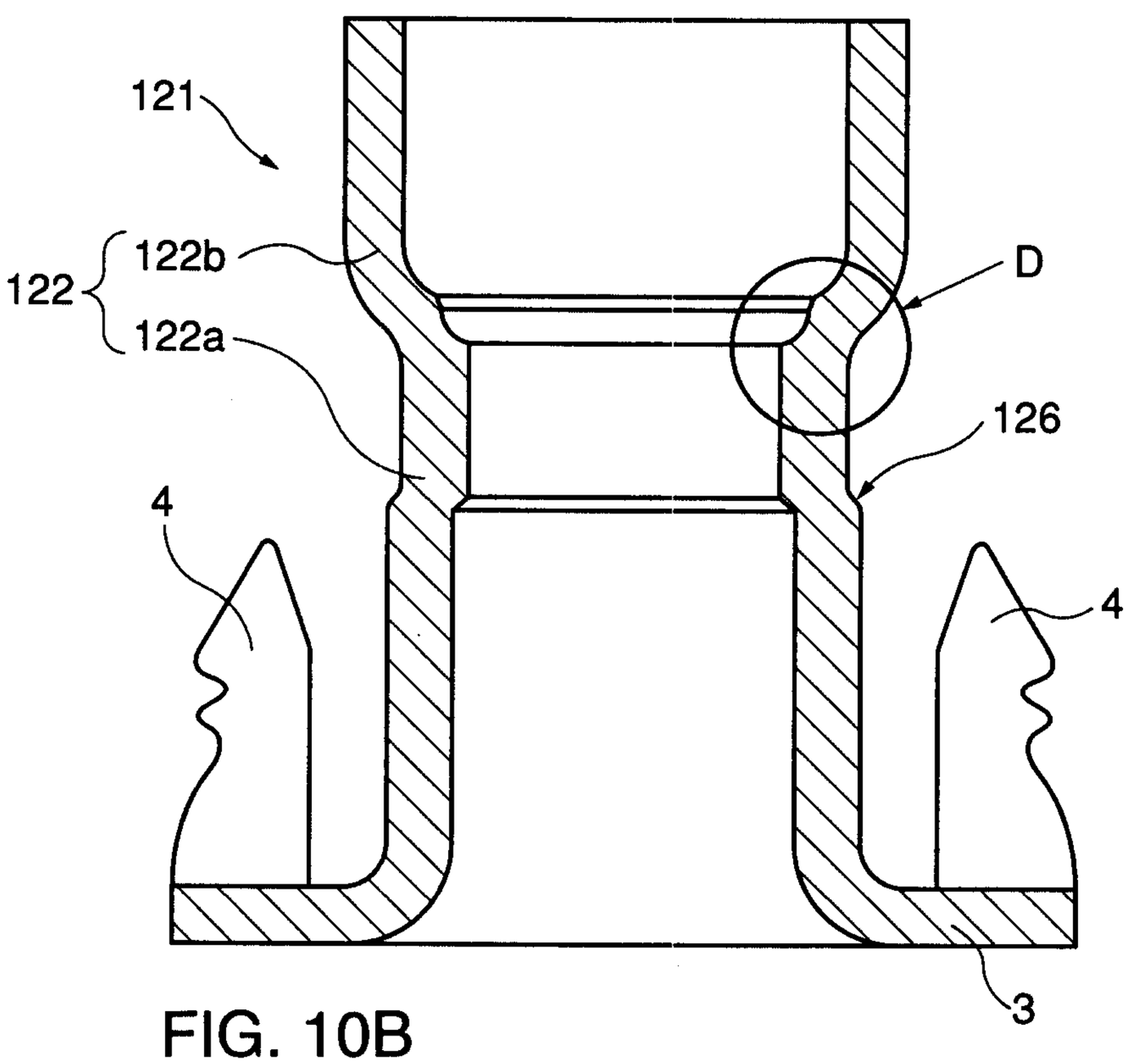


FIG. 10B

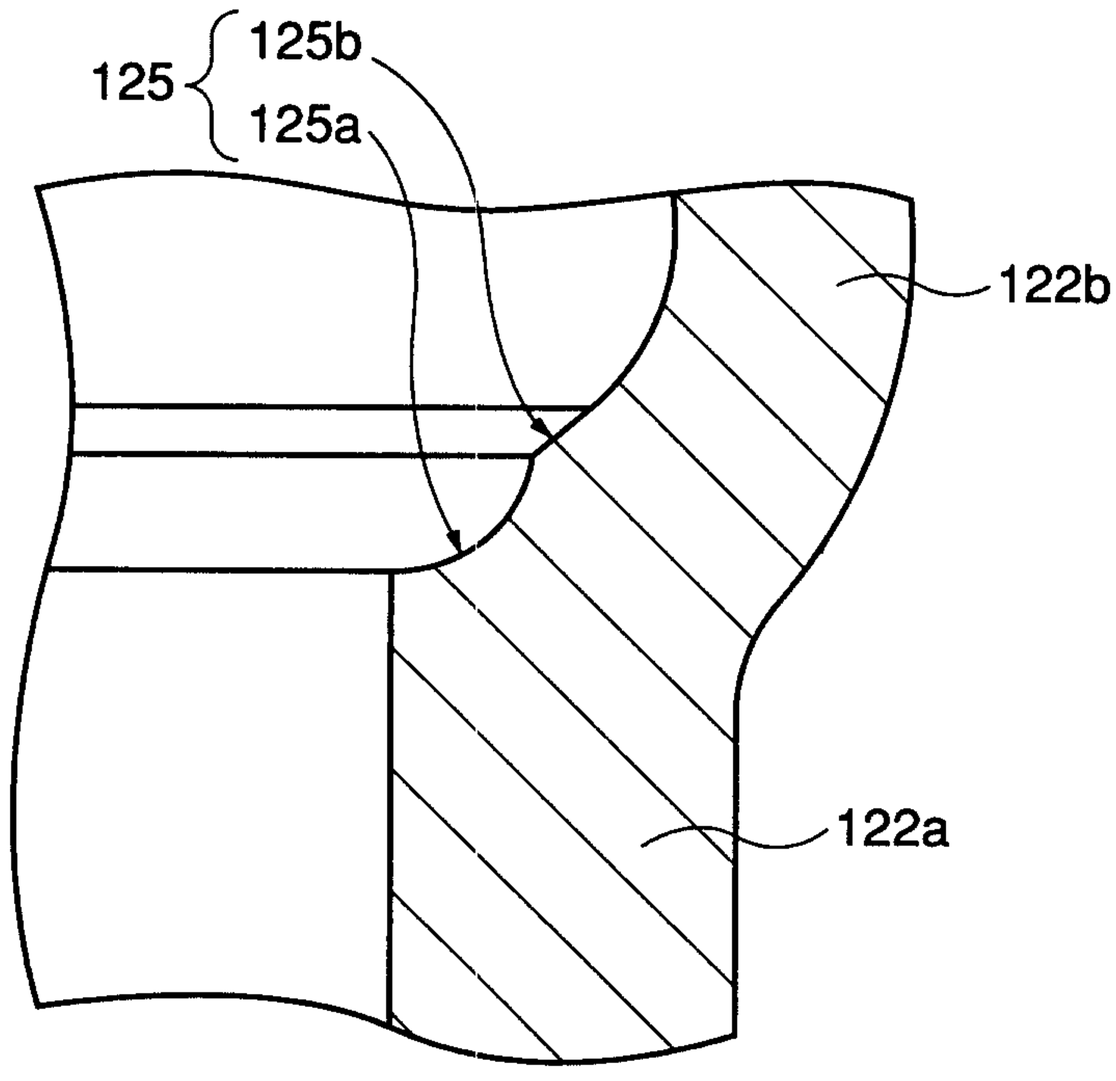


FIG. 11A

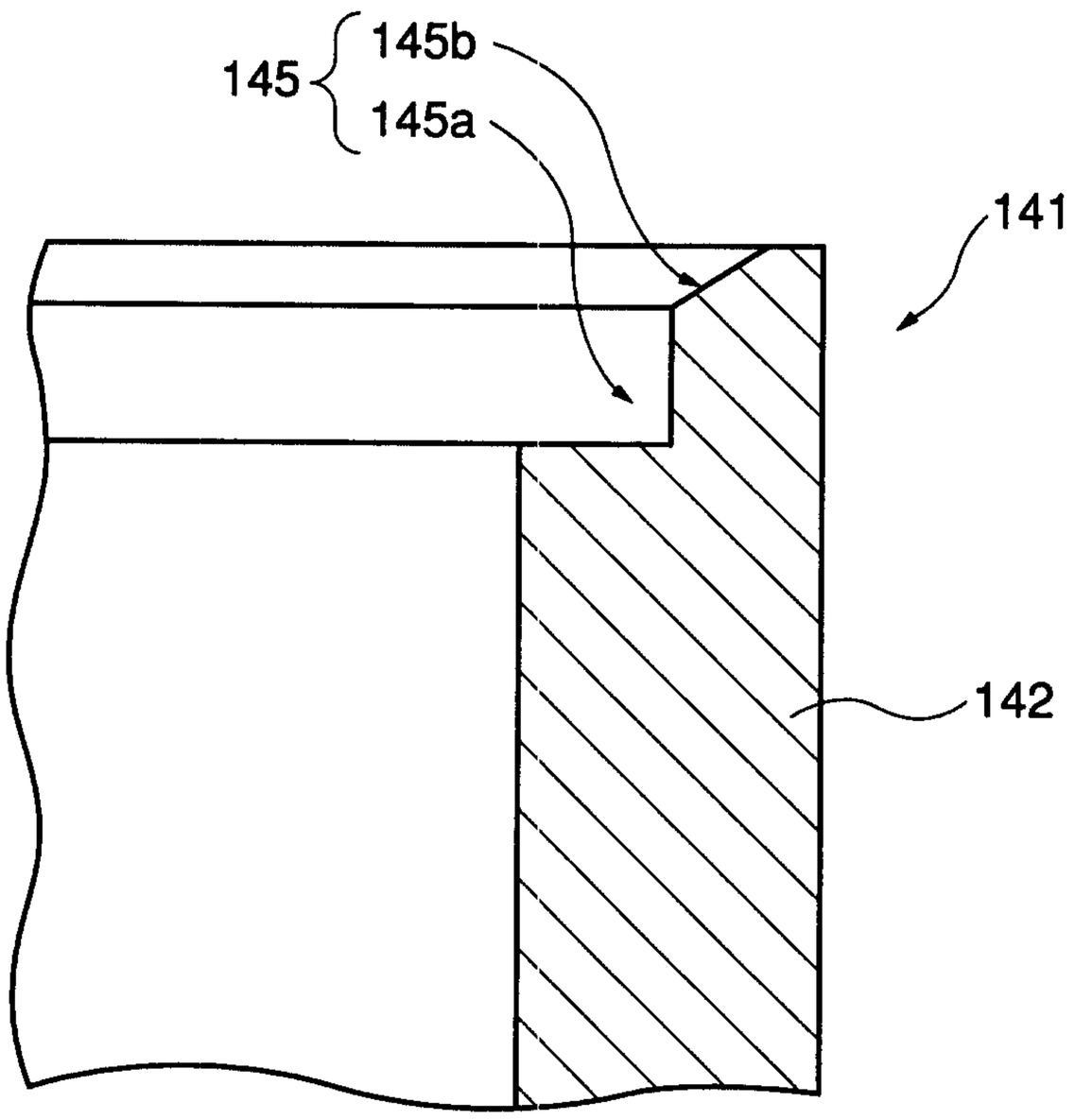


FIG. 11B

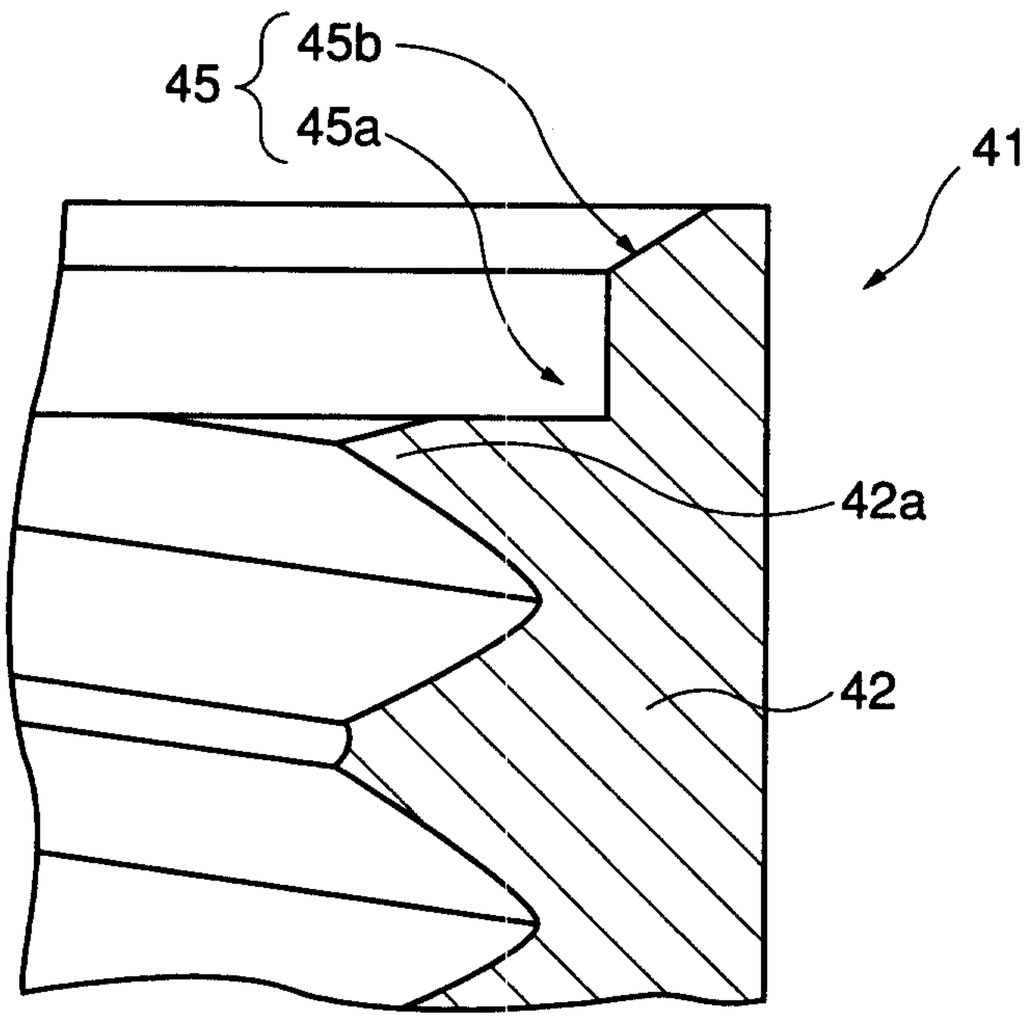


FIG. 12A

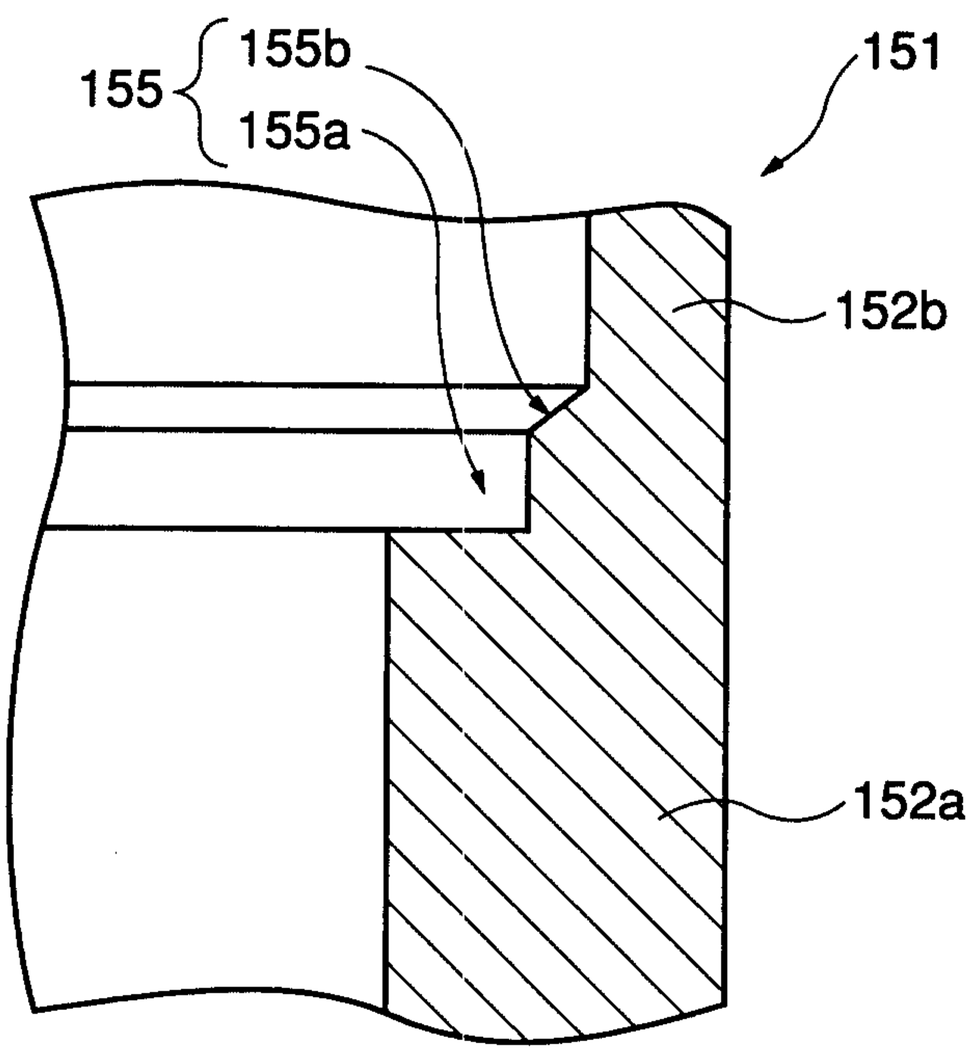


FIG. 12B

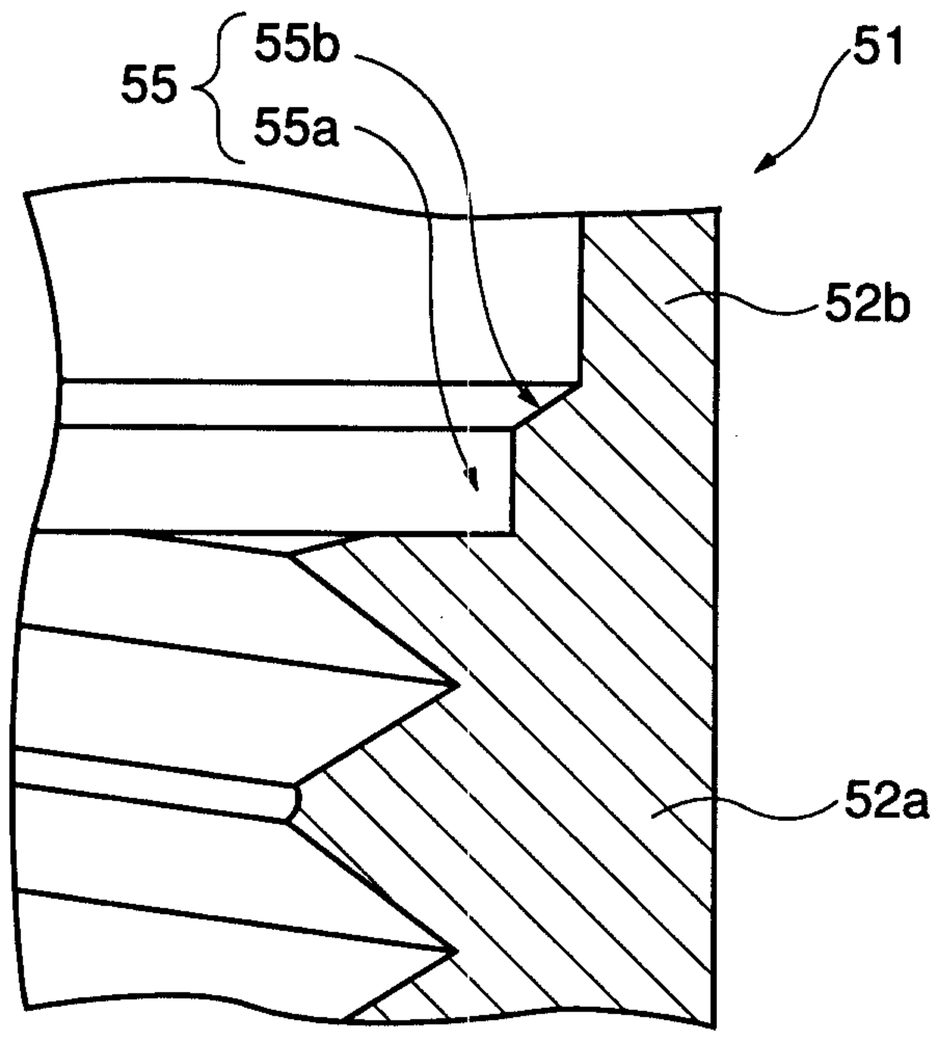


FIG. 13A

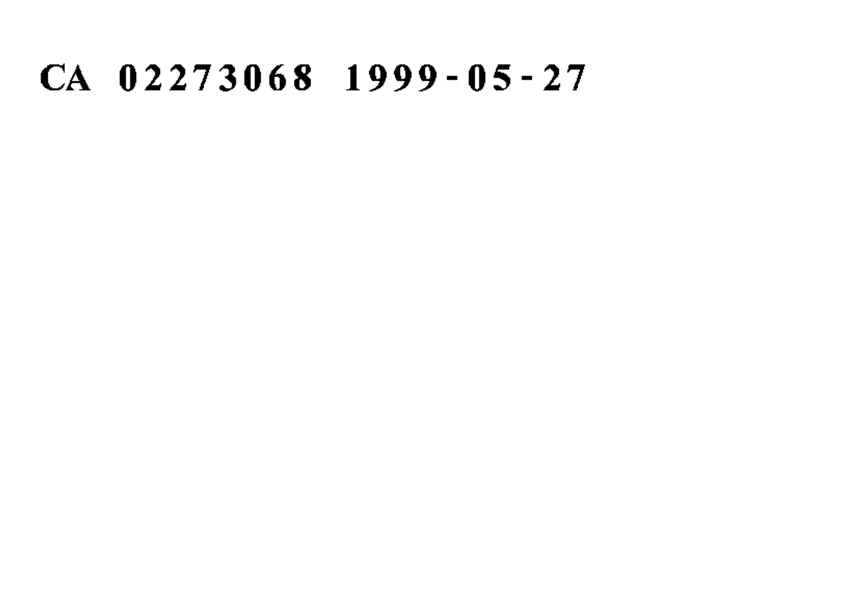


FIG. 13B

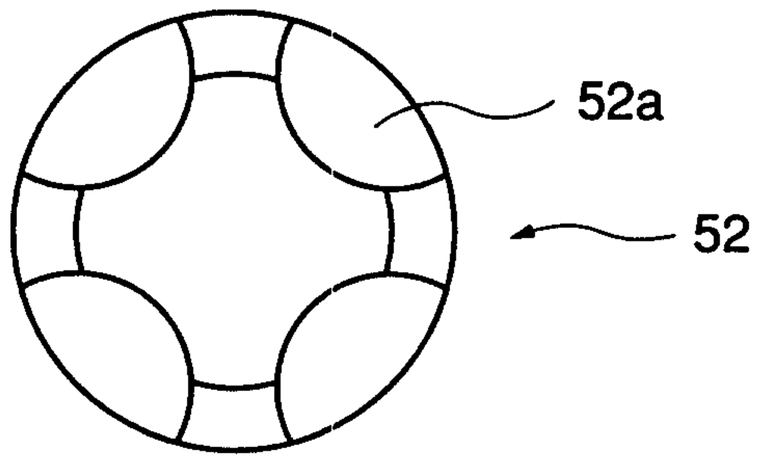


FIG. 14A

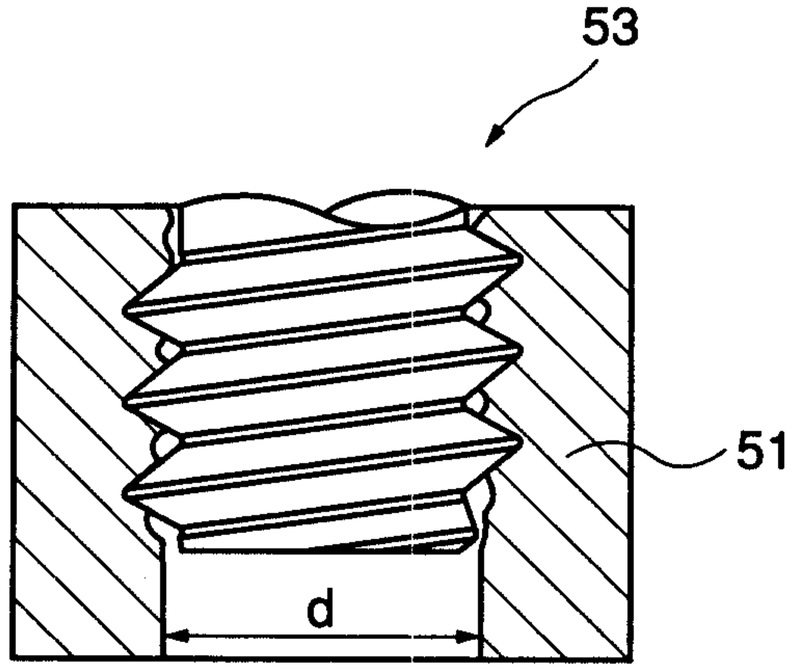


FIG. 14B

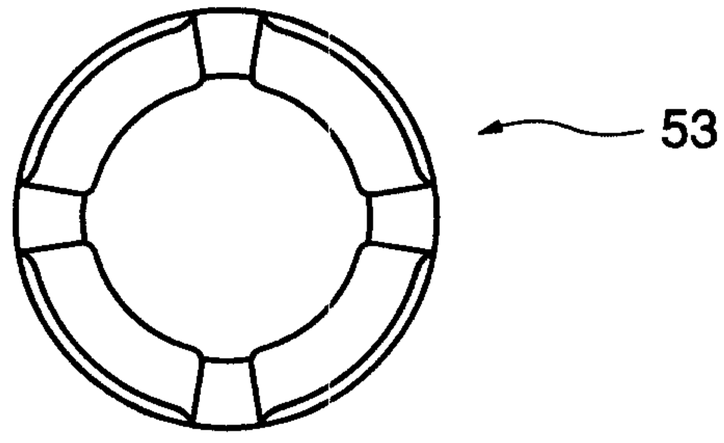


FIG. 15A

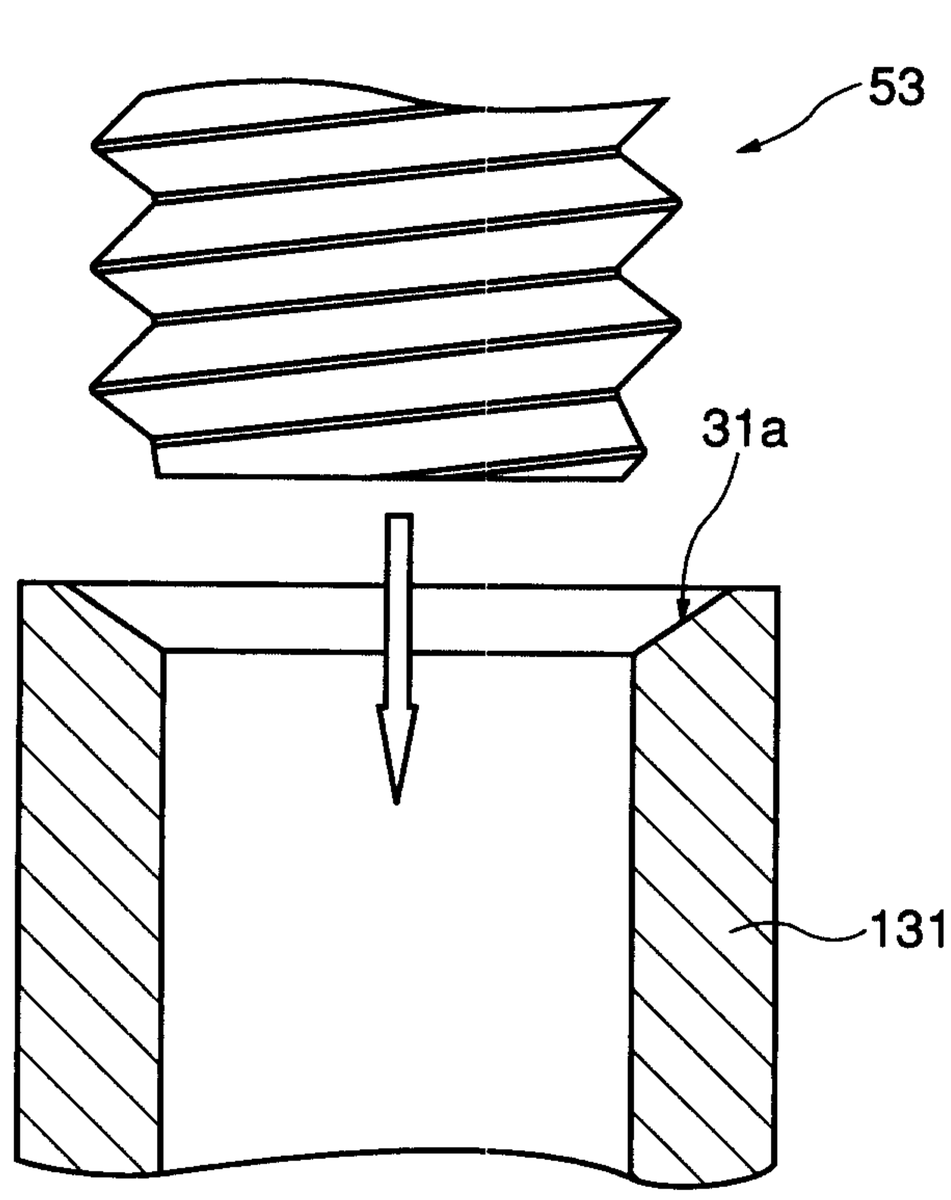


FIG. 15B

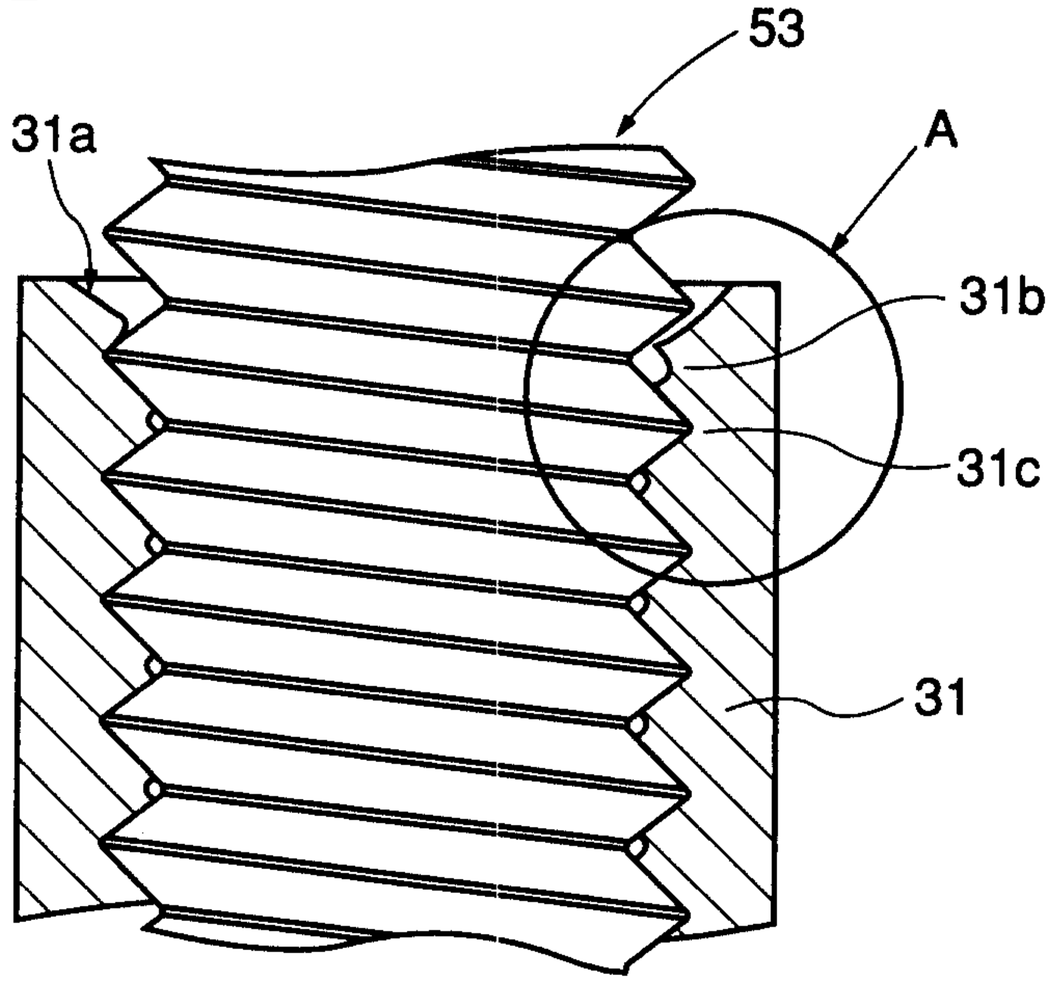


FIG. 16

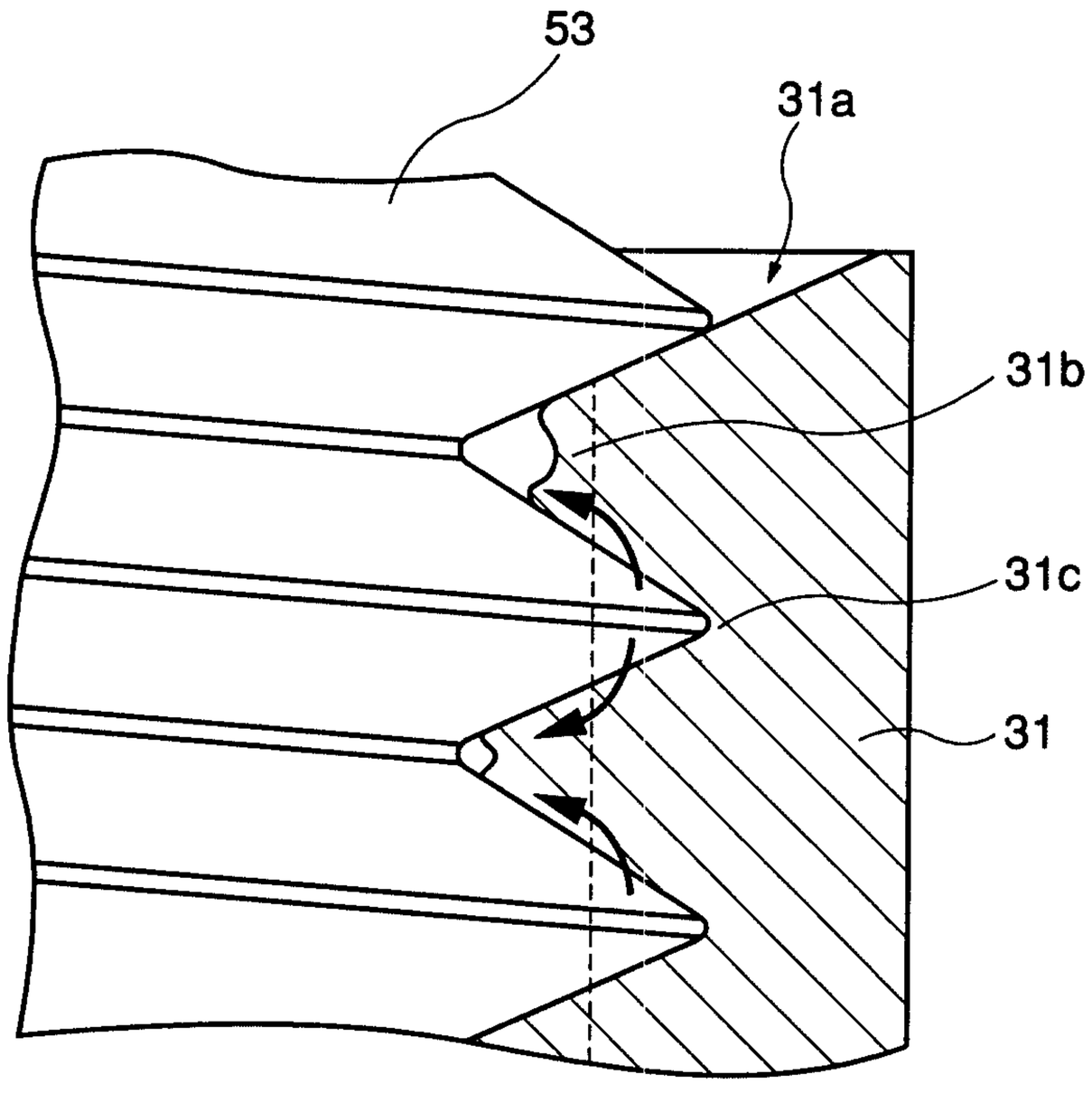


FIG. 17A

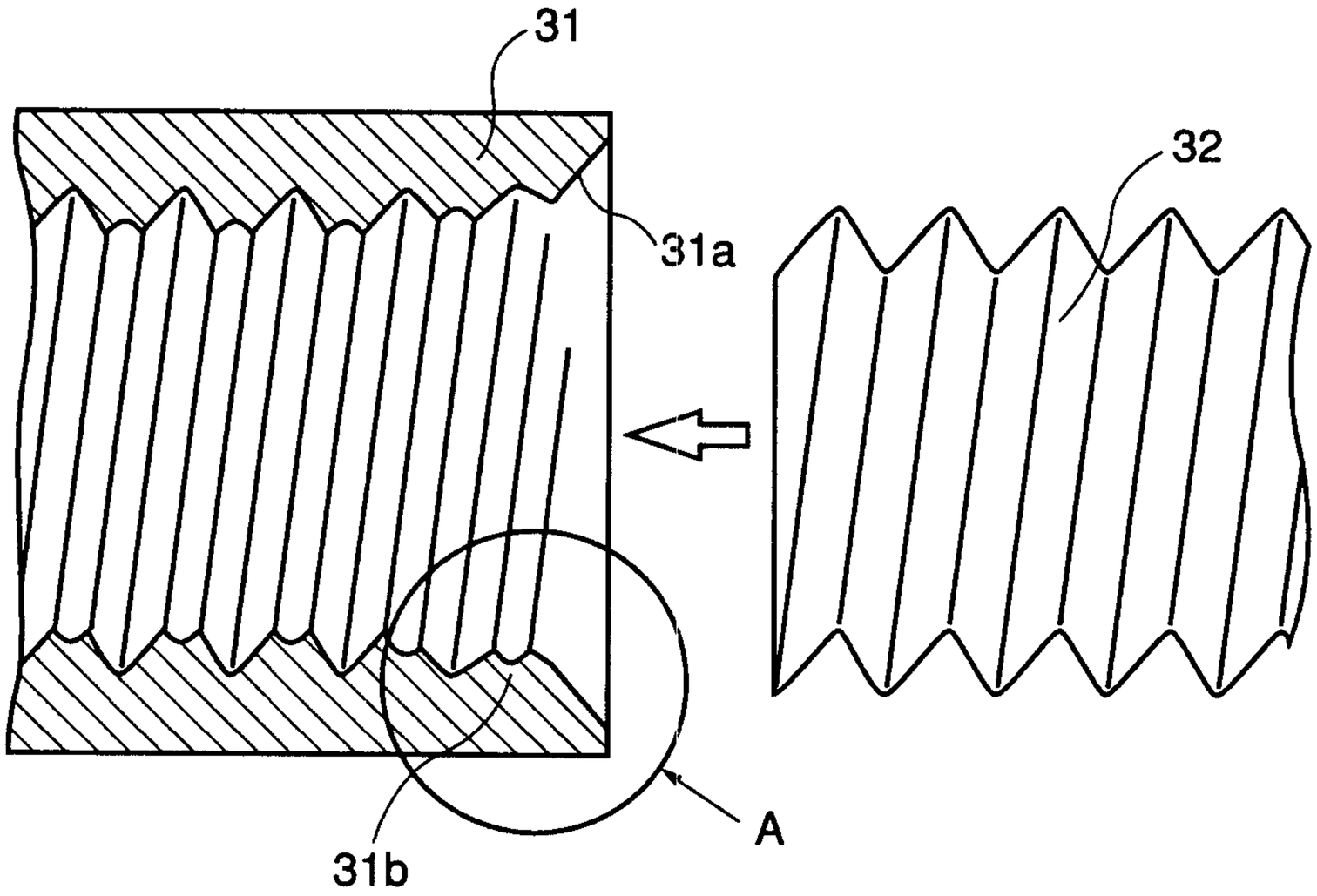


FIG. 17B