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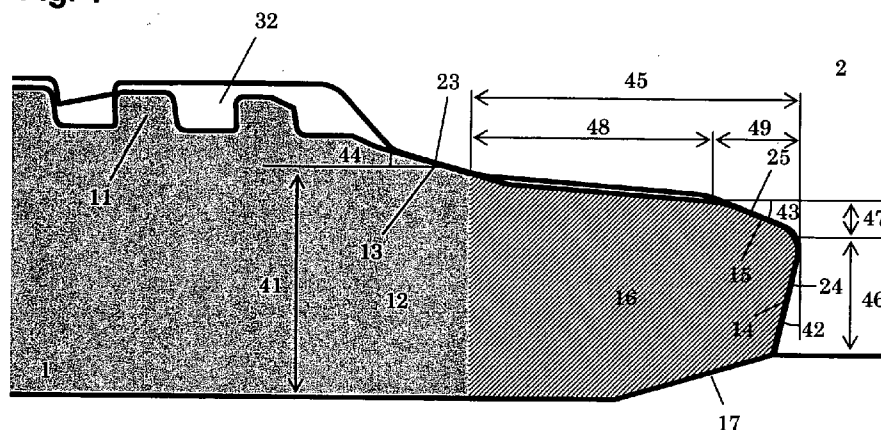
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(54) Title: **THREADED JOINT FOR STEEL PIPES**

Fig. 1



(57) Abstract: A threaded joint for steel pipes comprising a pin (1) and a box (2). The pin has a male thread (11) and a lip (12) which comprises (i) a sealing surface (13) and (ii) a nose portion (16) provided with a shoulder surface. The box has a female thread (21), a sealing surface (23) and a shoulder surface. The shoulder surface of the pin comprises two distinct adjacent surfaces, main shoulder (14) in the inner side and sub shoulder (15) in the outer side. Correspondingly, the shoulder surface of the box comprises two distinct adjacent surfaces, main shoulder (24) in the inner side and sub shoulder (25) in the outer side. The main shoulder surfaces of the pin and box are disposed such as to prevent a radially inward deformation of the lip end, and the sub shoulder surfaces of pin and box are disposed such as to limit a radially outward deformation of the lip end. The main shoulder of the pin has a greater radial dimension than said sub shoulder of the pin, and at least the main shoulder surface of the pin is in axial abutment with at least the corresponding main shoulder surface of the box.

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Description

Threaded Joint for Steel Pipes

Technical Field

This invention relates to a threaded joint for use in connecting steel pipes such as oil country tubular goods (OCTG) which include tubing and casing primarily used for the exploration and production of oil wells and gas wells, riser pipes, line pipes, and the like. More particularly, the present invention relates to a threaded joint for steel pipes of the type having a sealing surface and a shoulder surface in addition to a threaded portion and which has excellent sealing properties against internal and external pressure and excellent compression resistance when repeatedly subjected to combined loads.

Background Art

Technology used for connecting steel pipes used in equipment of the oil production industry such as oil country tubular goods, riser pipes, and line pipes includes threaded joints. Threaded joints for steel pipes are constituted by a pin having a male thread element provided at the end of a first tubular member and a box which is a female thread element provided at the end of a second tubular member. The joint is tightened by engaging the male thread and the female thread.

Standard threaded joints are prescribed by API (American Petroleum Institute) standards but in recent years, the environments for exploration and production of crude oil and natural gas are becoming more severe. As a result, there is increasing use of high performance special joints referred to as premium joints which are not prescribed by API standards.

In a typical premium joint, in addition to a tapered thread for firmly connecting steel pipes, the pin and the box have sealing surfaces which can form a metal-to-metal seal for providing sealing performance and torque shoulder surfaces for acting as stoppers during tightening.

In the past, since vertical wells were predominant, it was sufficient for a

threaded joint for OCTG to resist the tensile load due to the weight of pipes and to prevent leakage of high pressure fluid passing through it. However, in recent years, wells are becoming deeper, and deviated wells which bend underground and horizontal wells are increasing, and the development of wells in difficult
5 environments such as in the sea or in polar regions is increasing. Therefore, the properties required for threaded joints are becoming more varied and more strict as exemplified by resistance to compression, resistance to bending, ability to seal against external pressure, and ease of use in the field.

As a result, qualification tests for threaded joints are becoming more severe.
10 In the Series A test of recent ISO 13679 standards; alternances of internal pressure and external pressure combined with tension or compression (internal pressure + tension, internal pressure + compression, external pressure + tension, and external pressure + compression) (herein referred to as repeated combined loads) are applied three times. Such severe test conditions were not taken into consideration in the past
15 in the development of threaded joints.

As shown in Figure 2, a typical premium joint has a structure in which an unthreaded portion 12 referred to as a lip portion is provided at the end of a threaded portion having a tapered male thread 11 provided on a pin 1 which is a male threaded element. A sealing surface 13 for forming a metal-to-metal seal is provided on the
20 outer peripheral surface of the lip portion. A torque shoulder surface 14 is provided on the end surface of the lip portion (and accordingly on the end surface of the pin).

Naturally, a box 2 which is a corresponding female threaded element is provided with a female thread 21, a sealing surface 23, and a shoulder surface 24 at the rear of the box which correspond to or mate with the male thread 11, the sealing
25 surface 13, and the end surface shoulder surface 14, respectively, of the pin 1.

An overlap in the radial direction referred to as interference is provided between the sealing surfaces of the pin and the box. This type of threaded joint is designed so that if the joint is tightened until the shoulder surfaces of the pin and the box contact each other, the sealing surfaces of both members are in intimate contact
30 around their entire periphery and sealing is provided by metal-to-metal contact.

The above-described sealing performance is exhibited to the highest degree

when tightening is carried out with a suitable torque in the period from when the shoulders abut until the shoulders begin to undergo plastic deformation (when a normal tightened state occurs).

The shoulder surfaces act not only as stoppers for tightening but also act to
5 bear almost all of a compressive load acting on the joint. Therefore, if the shoulder surfaces are not thick or if the shoulders are not stiff, they cannot withstand a large compressive load.

Prior art for increasing the resistance to external pressure and resistance to compression of a premium joint is described in WO 2004/109173 (Patent Document
10 1). That threaded joint greatly increases resistance to external pressure by providing a portion which does not contact the box (referred to below as a nose portion) between the shoulder surface and the sealing surface of the end surface of the pin. At the same time, the taper angle of the nose portion is made 0 degrees (a cylindrical surface) or is made smaller than that of the sealing surface. Due to the provision of
15 the nose portion, a decrease in the thickness of the end surface shoulder surface is prevented, and an increase in resistance to compression can be achieved.

However, in the threaded joint described in Patent Document 1, when a high compressive force and external pressure are simultaneously applied, and when a tensile force and internal pressure are subsequently simultaneously applied, it has
20 been found by the inventors that there can be a risk of developing a leak.

WO 00/08367 (Patent Document 2) discloses a threaded joint in which a tight contacting region is provided in two locations of a lip portion, namely, a tight contacting region near the threaded portion is defined as a sealing surface and a tight contacting region near the end surface (shoulder surface) is defined as a protecting
25 portion. The protecting portion which is a second contact region provided in a location close to the end of the lip portion has the object of supplying a first seal to internal pressure (and thus to protect the sealing surface) and to optimize the forces and moments undergone by the lip.

In the threaded joint described in Patent Document 2, the amount of
30 interference of the protecting portion is set to be higher than the amount of interference of the sealing surface (at least 1.15 times and at most 1.3 times) in order

to retain a sufficient amount of contact pressure on the protective portion while a moderate contact pressure is obtained on the sealing surface. In addition, as Patent Document 2 incites to set sufficient distances from the shoulder to the protective portion, from the protective portion to the sealing surface and from the sealing surface to the thread, the lip portion is designed to be extremely long, so a sufficient thickness (radial dimension) of the shoulder surface may not be obtained. As a result, when a high compressive load is applied, the joint may not sufficiently withstand the compressive load, and it is thought that its compressive performance may be inadequate.

10 Patent Document 1: WO 2004/109173

Patent Document 2: WO 00/08367

Disclosure of Invention

The object of this invention is to provide a premium-type threaded joint for steel pipes which solves the problems of the above-described prior art and which has excellent resistance to compression and which can greatly increase overall sealing performance when subjected to repeated combined loads.

As disclosed in Patent Document 1, it is known that resistance to external pressure is greatly improved in a premium-type threaded joint for steel pipes by providing a nose portion which does not contact the box between the sealing surface of the lip portion and the end surface shoulder surface of a pin.

However, when a high torque or a high compressive load acts on the threaded joint having a nose portion, the joint may sometimes develop leaks. The inventors have found after thorough studies that a reason for developing leaks is linked to the long nose portion which is not supported and can move in the radial direction (the direction perpendicular to the joint axis); the shoulder surface at the end surface of the lip portion of the pin thus unstably deforms in this direction, plastic deformation develops due to bending of the entire lip portion, involving a risk for the sealing performance produced by the metal-to-metal contact of the sealing surfaces located near the threads to be impaired. Accordingly, in order to obtain good sealing properties stably against internal and external pressure in a threaded joint for steel

pipes having a nose portion, a structure which prevents unstable deformation of the shoulder surface of the lip portion of the pin is necessary. Furthermore, in order to prevent unstable deformation while maintaining torque resistance and good sealing properties against internal and external pressure, a structure which guarantees the length of the pin lip portion and the thickness of the shoulder surface is necessary.

According to the present invention, deformation in the radial direction of the end surface shoulder surface of the pin lip portion can be suppressed by making a main portion of the shoulder surface (referred to below as the main shoulder surface) to have a shape to cope with deformation towards the inner surface and by providing a sub shoulder to cope with deformation towards the outer surface. Namely, the shoulder surface is immobilized so that deformation does not occur towards either the inner surface or the outer surface. In order to maintain good resistance to compression, most of the thickness of the pin shoulder surface is made the main shoulder having a gentle slope with the perpendicular surface of the axial direction of the joint. The sub shoulder receives substantially no compressive load, and it is sufficient for it to stop deformation in the outward radial direction of the end of the pin. Therefore, the thickness of the sub shoulder is preferably as small as possible. As a result, the shoulder surface of the pin is stably supported by the shoulder surface of the box at both the main shoulder and the sub shoulder, unstable deformation in the radial direction of the end of the lip portion is prevented, and good resistance to compression can be maintained.

The present invention is a threaded joint for steel pipes comprising a pin and a box, the pin having a male thread and a lip comprising (i) a sealing surface and (ii) a nose portion provided with a shoulder surface, the box having a female thread, a sealing surface and a shoulder surface, the male thread being interengaged with the female thread, the sealing surface of the pin being in sealing contact with the corresponding sealing surface of the box, the shoulder surface of the pin being arranged at an end face of the pin, the sealing surface of the pin being located on a pipe end side near the male thread, the nose portion existing between the sealing surface and the shoulder surface, said nose portion not contacting a portion of the box facing said the nose portion of the pin,

characterized in that the shoulder surface of the pin comprises two distinct adjacent surfaces, main shoulder in the inner side and sub shoulder in the outer side, and in that the corresponding shoulder surface of the box facing the shoulder surface of the pin comprises two distinct adjacent surfaces, main shoulder in the inner side and sub shoulder in the outer side, said main shoulder surfaces of the pin and box being disposed such as to prevent a radially inward deformation of the lip end, said sub shoulder surfaces of pin and box being disposed such as to limit a radially outward deformation of the lip end, said main shoulder of the pin having a greater radial dimension than said sub shoulder of the pin, at least said main shoulder surface of the pin being in axial abutment with at least the corresponding main shoulder surface of the box.

Here, "the shoulder surface of the pin comprises two distinct adjacent surfaces" means that the angles of main shoulder surface and sub shoulder surface with regard to a perpendicular to the axis of the threaded joint are distinctly different. In preferred embodiments of the present invention the main shoulder surface of the pin is a reverse shoulder surface having a negative angle with respect to a surface perpendicular to the joint axis and sub shoulder surface has a positive angle.

"The main shoulder surface of the pin is a reverse shoulder surface having a negative angle with respect to a surface perpendicular to the joint axis" means a shoulder surface having an angle of slope such that the innermost portion of the main shoulder surface is to the rear of the outermost portion (the portion adjoining the sub shoulder surface) in the advancing direction of the pin in tightening the threaded joint. Similarly "sub shoulder surface has a positive angle" means sub shoulder surface having an angle of slope with respect to its reference angle such that the outermost portion of the sub shoulder surface is to the rear of the innermost portion (the portion adjoining the main shoulder surface) in the advancing direction of the pin in tightening the threaded joint. The angle of slope is then in a range between -90 and +90 degrees.

In a preferred embodiment of the present invention, only the main shoulder surface of the pin is in axial abutment with the corresponding main shoulder surface of the box. There is then no substantial tight contact and more preferably no contact

at all between sub shoulders of the pin and the box. Sealing performance between seal surface of the pin and the box is accomplished more effectively.

In another preferred embodiment, at least a part of the nose portion of the pin has an outside peripheral surface which is not in prolongation of the sealing surface of the pin. "At least a part of the nose portion has an outside peripheral surface which is not in prolongation of the sealing surface" means that the shape of the outside surface of a part or the whole of the nose portion is substantially different from that of the sealing surface.

Said part of the nose portion having a different shape from the sealing surface is preferably a region extending for at least half the length in the axial direction of the nose portion and is thus named a main part of the nose portion. For example, said (main) part of the nose portion can be a cylindrical surface which is not sloped with respect to the axial direction, or it can be a tapered surface with a small angle of slope. A region which is the remainder of the nose portion is preferably a region shorter than half the axial length, and it may have the same shape as the sealing surface (namely, it may be an extension of the sealing surface).

In other preferred embodiments, the absolute value of the angle of the main shoulder surfaces of the pin and the box is from 5 to 25 degrees with respect to a surface perpendicular to the joint axis (namely, the angle of the main shoulder surface of the pin is in the range from -5 to -25 degrees), and the angle of slope of the sub shoulder surface is from 5 to 30 degrees with respect to the joint axis (from +60 to +85 degrees with respect to a surface perpendicular to the joint axis), and the angle of slope of the sealing surfaces of the pin and the box is in the range of 5 to 25 degrees with respect to the joint axis. The angle of slope of the sub shoulder surfaces (with reference to the joint axis) is preferably larger than the angle of slope of the sealing surfaces. As a result, even if the shoulder surface deforms in the axial direction, a decrease in the sealing performance due to deformation of the sealing surface is prevented.

In order to increase resistance to compression, it is preferred that the thickness (radial dimension) of the shoulder surface at the end of the pin be made as large as possible and that the cross section of the portions closer to the end than the sealing

surface (namely, the nose portion) be made as large as possible. To this end, in its main part as defined hereabove, the nose portion preferably has a smaller slope than the slope of the sealing surface and the sub shoulder surface with respect to the joint axis. Specifically, the shape of the outer surface of the main part of the nose portion
5 of the pin can be made a cylindrical surface (with a slope of 0 degrees with respect to the joint axis) or a frusto-conical surface having a slope with respect to the joint axis which is smaller than the slope of the sealing surface or the sub shoulder surface with reference to the same axis.

If the outer surface of the nose portion contacts the inner surface of the box
10 after tightening of the threaded joint, there is a risk for the sealing performance of the joint being damaged. Therefore, in order to prevent this contact with certainty, a gap (radial distance between non contacting surfaces) of at least 0.1 mm is preferably provided between these surfaces in the above-described main region of the nose portion. The inner surface of the box in this region preferably has a shape similar to
15 that of the nose portion of the pin, and the gap between the two is preferably made uniform in the main region.

As aforementioned in the explanation of "at least a part of the nose portion has an outside peripheral surface which is not in prolongation of the sealing surface", a partial surface of the nose portion of the pin adjoining the sealing surface may have
20 the same slope as the sealing surface.

The junction between the sub shoulder surface and the main shoulder surface of the pin preferably forms a rounded apex having a radius of at most 1.5 mm.

The sealing surfaces of the pin and the box may both be a frusto-conical surface, but making one of the sealing surfaces a frusto-conical surface and the other
25 sealing surface a curved surface of rotation (torical surface) having a radius of curvature of at least 20 mm or a combination of a curved surface of rotation and a frusto-conical surface increases the sealing performance of the joint.

The sub shoulder surfaces of both the pin and the box are preferably frusto-conical surfaces. The main shoulder surfaces of both the pin and the box are
30 preferably frusto-conical surfaces, but it is also possible for one to be a projecting curved surface (convex torical surface) and the other to be a recessed curved surface

(concave torical surface) or a combination of such surfaces with planes as disclosed in WO 2007/017082. As an alternative, the main shoulder surfaces may have a stepped shape as disclosed in US 4,611,838, such step shape preventing an inward deformation of the pin end.

5 The thickness (radial dimension) of the main shoulder surface is preferably at least 1.5 times the thickness of the sub shoulder surface.

 In a premium-type threaded joint for steel pipes according to the present invention, a nose portion which does not contact the box is provided at the end of the lip portion of a pin, and the shape of the shoulder surfaces of the end surfaces thereof
10 is made a double-shoulder structure having a main shoulder surface and a sub shoulder surface, whereby good compressive performance is obtained. As a result, the sealing performance when a combined load is repeatedly applied is greatly increased, and leaks no longer occur in a Series A test according to ISO 13679 standards.

15 Brief Description of the Drawings

 Figure 1 is a schematic cross-sectional view of the vicinity of the lip portion of a threaded joint for steel pipes according to the present invention in which the main portion of the nose portion is a frusto-conical surface.

 Figure 2 is a schematic cross-sectional view of a typical premium joint for
20 OCTG of the conventional coupling type, (A) being a partial view showing only one side, and (B) being a view of the entirety.

 Figure 3 is a schematic cross-sectional view of a threaded joint for steel pipes according to the present invention.

 Figure 4 is a schematic cross-sectional view of the vicinity of the lip portion of
25 a threaded joint for steel pipes according to the present invention in which the main portion of the nose is a cylindrical surface.

 Figure 5 is a schematic cross-sectional view of the shape of a thread.

Best Mode for Carrying Out the Invention

 Below, a threaded joint for steel pipes according to this invention will be

explained while referring to the drawings.

Figures 1, 3, and 4 are schematic cross-sectional views of a threaded joint for steel pipes according to the present invention. This threaded joint is one type of premium-type threaded joint comprising a pin 1 and a box 2. Accordingly, the pin 1 comprises a threaded portion having a male thread 11, and a lip portion 12 situated on the front end side of the threaded portion and having a sealing surface 13. A shoulder surface is provided on the end surface of its tip. As shown in these figures, the sealing surface 13 of the pin 1 is usually positioned adjoining or in the vicinity of the threaded portion of the lip portion 12. The box 2 has a threaded portion having a female thread 21 which meshes with the male thread 11 of the pin 1, a sealing surface 23 which can sealingly contact the sealing surface 13 of the pin (to achieve a metal-to-metal contact seal), and a shoulder surface which contacts the shoulder surface of the pin in the axial direction of the joint.

As shown in Figure 5, the male thread 11 of the pin 1 and the female thread 21 of the box 2 are both tapered threads, with the diameter of the thread crest and the thread root gradually decreasing towards the end of the pin. Similarly, the sealing surfaces 13 and 23 of the pin 1 and the box 2 are tapered surfaces which decrease in diameter towards the end of the pin.

A portion of the male thread closer to the tip of the threaded portion of the pin 1 (the side adjoining the lip portion 12) may be a non-engaging thread which does not mesh with the female thread 21 of the box 2. In this case, as shown in the figure 3, a circumferential groove 32 is preferably formed in the portion of the box 2 corresponding to the non-engaging thread of the pin. In this manner, the stiffness of the lip is increased and the resistance of the joint to pressure is increased. With the same object, the wall thickness of the pin and the box may be increased towards the shoulder surface (the inner diameter is decreased) by swaging or upsetting.

The lip portion 12 of the pin 1 has a nose portion 16 between the sealing surface 13 and the end surface shoulder surface which is a non-contacting region which does not contact the opposing portion of the box. Therefore, the length of the lip portion is increased compared to a usual premium joint shown in Figure 2 which does not have a non-contacting region forward of the sealing surface of the pin.

In the present invention, the end surface shoulder surface of the pin 1 has a two-level structure comprising a main shoulder surface 14 on the inner surface side of the joint and a sub shoulder surface 15 on the outer surface side of the joint. The thickness 46 (the thickness projected on the above-described perpendicular surface) of the main shoulder surface 14 is larger than the thickness 47 of the sub shoulder surface. The main shoulder surface 14 of the pin 1 is a reverse shoulder surface in which the angle 42 with respect to a surface perpendicular to the joint axis is a negative angle. On the other hand, the angle of the sub shoulder surface 15 with respect to a surface perpendicular to the joint axis is positive. Of course, the shoulder surface of the box 2 which contacts the shoulder surfaces 14 and 15 of the pin 1 correspondingly comprises a main shoulder surface 24 on the inner surface side of the joint and a sub shoulder surface 25 on the outer surface side of the joint.

With a usual premium joint, compressive performance of approximately 40 to 60% of the yield strength of the pipe body is demanded, and in some oil wells, compressive performance exceeding 80% is necessary. Of course, a compressive load is borne not only by the shoulders but also by the threaded portions, and if threads having a good ability to bear a compressive load are used, the load on the shoulders can be decreased to that extent. However, the lip portion thickness 41 (the wall thickness of the pin at the middle of the sealing surface 13) is made at least 25% and preferably at least 50% of the wall thickness of the pipe body so that the lip portion will have the resistance to compression demanded of it.

The greater are the thicknesses of the sealing surface and the nose portion of the lip portion, the greater is their ability to seal against external pressure, so when a chamfer 17 is formed on the inner surface of the end of the lip portion in order to prevent turbulence by increasing circularity, the angle of the chamfer 17 with respect to the joint axis is preferably a rather small angle in the range from 9 to 30 degrees. Although this is not the case in Figure 1, 3 and 4, a chamfer with a shallow angle may similarly be provided on the inner surface of the box 2 adjoining the pin 1.

The shape of the sealing surfaces 13 and 23 of the pin 1 and the box 2 can be made a straight line which is sloped with respect to the joint axis or a curved line such as a circular arc (the former will be referred to as a frusto-conical surface and

the latter will be referred to as a curved surface of rotation), or it can be a surface of rotation formed by rotating a line segment which is a combination of both lines around the joint axis (namely, a combination of a frusto-conical surface and a curved surface of rotation). Preferably, the sealing surface of one of the pin 1 and the box 2 is made a frusto-conical surface, and the sealing surface of the other is a curved surface of rotation or a combination of a curved surface of rotation and a frusto-conical surface. As a result, the sealing performance of the joint is increased, and it becomes difficult for galling to occur.

If the slope 44 (angle of slope) of the sealing surfaces 13 and 23 with respect to the joint axis is too steep, it leads to a decrease in the sealing contact pressure at the time of a tensile load, while if the slope is too gentle, it becomes easier for galling to occur due to an increase in the sliding distance. The slope angle 44 of the sealing surfaces is in the range from 5 to 25 degrees and preferably in the range from 10 to 20 degrees. When tapered threads are used, the slope angle 44 of the sealing surfaces is larger than the slope angle of the threads 11, 21. For example, the slope angle of the threads is between 1 to 5 degrees and preferably around 1.6 degrees.

If a reverse angle of at least a certain amount is imparted to the main shoulder surfaces 14 and 24 of the pin 1 and the box 2, the deformation of the lip portion when a compressive load is applied becomes uniform spreading in the direction of radially outward, and the sealing performance of the joint increases. However, if the reverse angle is made too large, excessive plastic deformation may occur in the main shoulder surface 14 of the box, thereby impairing the effect of stabilizing deformation and decreasing the sealing performance of the joint. Therefore, the reverse angle 42 of the main shoulder surfaces 14 and 24 is such that the absolute value of the slope 42 of the main shoulder surface 14 of the pin 1 with respect to a plane perpendicular to the joint axis (which is actually a negative angle) is from 5 to 25 degrees and preferably from 10 to 20 degrees.

The gap (radial distance) between the nose surface of the pin and the box is preferably made at least 0.1 mm in the tightened position of the threaded joint so as to decrease the possibility of impairing the sealing properties caused by the contact between the nose portion of the pin and inner surface of the box after tightening. In

addition, the gap is preferably made at most 1.0 mm so as not to impair the ability of the box to guide the nose during tightening.

The sub shoulder surfaces of the pin and the box act as stoppers which suppress excessive outwards deformation of the end of the lip of the pin. Therefore, they do not contact each other in a normal tightened state. When a high compressive load is acting or an excessive tightening torque is applied, they contact and suppress outwards deformation of the lip.

However, it is permissible for the sub shoulders to contact in a normal tightened state. In this case, the contact surface pressure of the sub shoulders is made at most 50% of the contact surface pressure of the seal surfaces so as not to have an adverse effect on sealing properties.

The geometric interference (difference in diameter measured at a reference plane before tightening the pin and box) of the sub shoulders is made at most 1.1 times the seal interference, and preferably it is made substantially equal to the geometric seal interference.

In a normal tightened state, in case sub shoulder surfaces 15, 25 of the pin and the box are designed to have same interference between the seal surfaces 13, 23, the entire lip of the pin bends over (decreases in diameter) due to the effect of the interference of the sealing surfaces of the pin and the box, and the sub shoulder surface bends over by at least the same amount as the interference of seal surfaces, so contact does not take place between the sub shoulder surfaces.

The slope 43 of the sub shoulder surfaces 15 and 25 with respect to the joint axis is made at least 5 degrees and at most 30 degrees (namely, the slope with respect to the direction perpendicular to the joint axis is at least +60 degrees and at most +85 degrees) and is preferably greater than that of the seal (slope 44) from the standpoints of guaranteeing enough thickness of the main shoulder surfaces 14 and 24 and suppressing deformation of the shoulder surfaces in the direction perpendicular to the joint axis (the radial direction).

From the standpoints of maintaining resistance to compression and resistance to torque, the thickness of the sub shoulder surface 15 of the pin 1 (the thickness projected on a surface perpendicular to the joint axis) is made smaller than the

thickness of the main shoulder surface 14. Preferably, the thickness of the main shoulder surface 14 of the pin 1 is made at least 1.5 times the thickness of the sub shoulder surface 15, more preferably it is made at least 2.5 times and at most 6 times, and still more preferably it is made at least 3 times and at most 5 times.

5 The length 45 of the nose portion 16 of the pin 1 (namely, the length in the axial direction of the whole nose portion, that is to say, non-contacting region of the pin and the box, including sub shoulder surface region which may be contact with the box) varies with the size of the threaded joint, but if it is too short, the effect of increasing sealing properties against the external pressure disappears, while if it is
10 too long, the effect of increasing sealing properties saturates. Therefore, in the range of pipe sizes used in OCTG (an outer diameter of approximately 50 to 550 mm), it is preferably made approximately 4 to 20 mm.

 The thickness of the shoulder surface of the end of the pin 1 is made as large as possible, and the volume of the portion of the lip portion 12 closer to the end than
15 the sealing surface 13 (namely, the nose portion 16 and the shoulder surface 14, 15) is made as large as possible. In order to increase the resistance to compression, the outer surface of the nose portion is preferably a cylindrical surface (having an angle of slope with respect to the joint axis of 0 degrees) or a frusto-conical surface having a slope with respect to the joint axis which is smaller than the slope of the sealing
20 surface and the sub shoulder over a partial region thereof in the axial direction and preferably over a main region having a length of at least one half of the length in the axial direction. In this case, the inner surface of the portion of the box 2 opposing the nose portion 16 is preferably made a cylindrical surface or a frusto-conical surface (for example with the same slope or a substantially similar slope) like the
25 shape of the nose portion over at least half the length in the axial direction so as to form a uniform gap from the outer surface of the nose portion.

 In the case that the outside peripheral surface of nose portion of the pin and the inner surface of the portion of the box facing nose portion of the pin have substantially frusto-conical shape and the taper angle of them is less than 10 degree.

30 In a mode (shown in Figure 1 and Figure 3) in which the outer surface of the main part of the nose portion 16 is made a frusto-conical surface (namely, a tapered

surface), the inner surface of the box having a frusto-conical shape which opposes the main part of the nose portion forms a guide, so it becomes possible to perform tightening while centering the lip portion of the pin, the sealing surfaces 13 and 23 of the pin 1 and the box 2 stably contact, the sealing ability is increased, and galling can
5 be prevented.

On the other hand, in a mode in which the nose portion has a cylindrical surface (Figure 4), the thickness 46 + 47 of the shoulder surface and the thickness 41 of the sealing surface 13 can be made as large as possible within a limited pipe wall thickness, so the resistance to compression is increased. Even in a mode in which the
10 outer surface of the nose portion is made frusto-conical, the thickness of the shoulder surface can be maintained close to that in a mode with a cylindrical surface by making it possible for contact to take place at the sub shoulder surface at the time of tightening.

If the outer surface of the nose portion contacts the inner surface of the
15 opposing box in tightened state, there is the possibility of the sealing ability being impaired; so in order to prevent this contact with certainty, a gap of at least 0.1 mm is provided between these two surfaces in the main part of the nose portion.

However, as shown in Figure 4, a partial region of the nose portion 16 adjoining the sealing surface 13 of the pin 1 may have the same slope as the sealing
20 surface 13 (namely, it may become an extension of the sealing surface and have a clearly different shape from the main part of the nose portion 16 (a cylindrical surface in the illustrated example)) and/or a partial region adjoining the sub shoulder surface 25 in the portion of the box 2 corresponding to the nose portion may have the same slope as the sub shoulder surface 25 (it may become an extension of the sub shoulder
25 surface and have a clearly different shape from the inner surface of the portion of the box facing the main part of the nose portion of the pin). As a result, not only the effect of nose portion but also the good performance of tightening while centering the lip portion of the pin is accomplished. In this case as well, the main part of nose portion 16 clearly has a different shape from the sealing surface 13 and the sub
30 shoulder surface 15 on both sides thereof.

The junction between the main shoulder surface 14 and the sub shoulder

surface 15 of the pin 1 forms a rounded apex with a radius of at most 1.5 mm. As a result, the contact area of the main shoulder surface and the sub shoulder surface can be maximized, and an increase in resistance to compression and suppression of deformation in the radial direction of the shoulder surface are achieved.

5 The shape of a threaded joint for steel pipes other than that described above may be the same as that of a conventional threaded joint for steel pipes of the premium type.

For example, the male thread 11 and the female thread 21 of the pin 1 and the box 2 of a threaded joint for steel pipes according to this invention may be tapered
10 threads like those of a typical conventional threaded joint for steel pipes (such as a trapezoidal thread specified by an API buttress thread or a thread having trapezoidal shape derived from the API Buttress thread shape). There have been many proposals concerning the shape (for example, the angles of slope of the stabbing flank and the load flank of the thread, the chamfer, the gap between stabbing flanks, the separation
15 between crest surfaces and root portions, and the radius of curvature of rounded portions) of a tapered thread for a threaded joint for steel pipes, and any of these may be employed. For example, although not shown in Figure 5, a chamfer (a change in level produced by beveling) may be provided in the stabbing flank (the side surface of the thread on the right side in Figure 5) of one or both of the male thread and the
20 female thread.

In a tapered thread of the male thread 11 and the female thread 12, the crest surface and the root portion of each crest can be made parallel to the taper of the tapered thread, but preferably they are made parallel to the axial direction of the joint. By doing so, problems due to deviations of the stabbing angle at the time of
25 connecting operations in the field can be decreased.

As is well known, threaded joints for steel pipes include coupling types and integral types. In a typical coupling type, a pin is formed on the outer surface of both ends of steel pipes to be connected, and a box is formed on the inner surface of both sides of a coupling, which is a separate member. In an integral type, a pin is formed
30 on the outer surface of one end of a steel pipe, a box is formed on the inner surface of the other end, and steel pipes are connected without using a coupling. The present

invention can be applied to either of these two types of threaded joints for steel pipes.

Examples

In order to illustrate the effects of this invention, a Series A test according to ISO 13679 standards was carried out on the five test pipes shown in Table 1.

5 Test pipes #1 to #5 shown in Table 1 have the basic shape of a coupling-type threaded joint (T&C joint) for OCTG shown in Figure 2. They were three sizes of casing measuring 9-5/8 inches, 53.5# (outer diameter of 244.48 mm and wall thickness of 13.84 mm), 10-3/4 inches, 60.7# (outer diameter of 273.05 mm, wall thickness of 13.84 mm), and 10-3/4 inches, 65.7# (outer diameter of 273.05 mm, wall
10 thickness of 15.11 mm).

The material of the pipes was an L80 material (carbon steel) of API (American Petroleum Institute) standards. For comparison, #4 was a Q125 material (carbon steel) according to API standards. The length in axial direction of the nose portion 45 and the length in axial direction of the non-contacting main region of nose portion
15 48 of the pin are shown in Table 1. The outer surface of the nose portion and the opposing inner surface of the box were both a frusto-conical surface over the main region thereof as shown in Fig.1 for test pieces #1 to #4 and a cylindrical surface as shown in Fig.4 for test piece #5. The separation between the pin and the box in the main part of the nose portion was 0.2 mm for test pieces #1 to #4 and 0.9mm for test
20 piece #5. The angle of chamfered portion 17 is 15 degree for all test pieces. The test results of a Series A test according to ISO 13679 standards are also shown in Table 1.

Table 1

#	Size	Joint material	Angle (°)			Thickness ratio of shoulder surfaces (main/sub)	length in axial direction of nose portion (mm)		Test results	Comments
			sealing surface	sub shoulder surface	main shoulder surface		non-contacting region 48	whole nose portion 45		
1	9-5/8", 53.5#	L80	14	20	-15	3.7	10.2	13.5	Good	This Invention
2	10-3/4", 60.7#	L80	14	20	-15	3.6	12.2	15.5	Good	This Invention
3	10-3/4", 65.7#	L80	14	20	-15	4.7	6.2	9.5	Good	This Invention
4	9-5/8", 53.5#	Q125	14	20	-15	3.7	10.2	13.5	Good	This Invention
5	9-5/8", 53.5#	L80	14	none	0	--	14.0	14.0	Internal pressure leak	Comparative example

As shown in Table 1, even if the size or material of a joint according to the present invention changed, there was no occurrence of leaks whatsoever, and there was a clear difference in performance compared to a joint outside the scope of the present invention, for which leaks occurred.

5 The present invention was explained above with respect to a specific mode, but this explanation is no more than an example, and the present invention is not limited thereto.

10 In particular the ones specialized in the art will understand that the present invention may symmetrically apply pin and box with a box sealing surface located on a lip extending at the free end of the box and a box shoulder located at the free end of the box, all features disclosed hereabove being transferred from the pin to the box and vice versa.

Claims

1. A threaded joint for steel pipes comprising a pin and a box, the pin having a male thread and a lip comprising (i) a sealing surface and (ii) a nose portion provided with a shoulder surface, the box having a female thread, a sealing surface and a shoulder surface, the male thread being interengaged with the female thread, the sealing surface of the pin being in sealing contact with the corresponding sealing surface of the box, the shoulder surface of the pin being arranged at an end face of the pin, the sealing surface of the pin being located on a pipe end side near the male thread, the nose portion existing between the sealing surface and the shoulder surface, said nose portion not contacting a portion of the box facing said the nose portion of the pin,

characterized in that the shoulder surface of the pin comprises two distinct adjacent surfaces, main shoulder in the inner side and sub shoulder in the outer side, and in that the corresponding shoulder surface of the box facing the shoulder surface of the pin comprises two distinct adjacent surfaces, main shoulder in the inner side and sub shoulder in the outer side, said main shoulder surfaces of the pin and box being disposed such as to prevent a radially inward deformation of the lip end, said sub shoulder surfaces of pin and box being disposed such as to limit a radially outward deformation of the lip end, said main shoulder of the pin having a greater radial dimension than said sub shoulder of the pin, at least said main shoulder surface of the pin being in axial abutment with at least the corresponding main shoulder surface of the box.

2. A threaded joint according to claim 1, wherein the main shoulder surface of the pin is a reverse shoulder surface having a negative angle with respect to a surface perpendicular to the joint axis.

3. A threaded joint according to claim 1 or 2, wherein the sub shoulder surface of the pin has a positive angle with respect to a surface perpendicular to the joint axis.

4. A threaded joint according to any of claims 1 to 3, wherein only the main shoulder surface of the pin is in axial abutment with the corresponding main shoulder surface of the box.

5. A threaded joint according to any of claims 1 to 4, wherein at least a part
5 of the nose portion of the pin has an outside peripheral surface which is not in prolongation of the sealing surface of the pin.

6. A threaded joint according to any of claims 1 to 5, wherein the sub
shoulder surface of the pin is designed to interfere with the sub shoulder surface of
the box, the geometrical diametric interference between the sub shoulder surfaces of
10 the pin and box being equal to or less than 1.1 times the geometrical diametric
interference between the sealing portions of the pin and box.

7. A threaded joint according to claim 6, wherein the geometrical diametric
interference between the sub shoulder surfaces of the pin and box is substantially
equal to the geometrical diametric interference between the sealing portions of the
15 pin and box.

8. A threaded joint according to any of claims 1 to 7, wherein the angle of
the reverse shoulder with respect to a surface perpendicular to the joint axis is
between 5 and 25 degrees.

9. A threaded joint according to any of claims 1 to 8, wherein the shoulder
20 surfaces are substantially frusto-conical.

10. A threaded joint according to any of claims 1 to 9, wherein the main
shoulder surface of the pin is fully supported by the corresponding main shoulder
surface of the box.

11. A threaded joint according to any of claims 1 to 10, wherein the sealing

surfaces are sloping with regard to the axis of the threaded joint of an angle comprised between 5 and 25 degrees.

12. A threaded joint according to any of claims 1 to 11, wherein the sub shoulder surface are sloping with regard to the axis of the threaded joint of an angle
5 comprised between 5 and 30 degrees.

13. A threaded joint according to any of claims 1 to 12, wherein the slope of the sub shoulder surface is greater than the slope of the sealing surfaces.

14. A threaded joint according to any of claims 1 to 13, wherein the nose portion of the pin is in a clearance fit with the facing portion of the box with a
10 minimum clearance fit value of 0.1 mm on diameters.

15. A threaded joint according to any of claims 1 to 14, wherein the sealing surface of the pin, the outside surface of the nose portion of the pin and sub shoulder surface of the pin are not aligned and wherein the sealing surface of the box, the inner surface of the portion of the box facing the outside surface of the nose portion
15 of the pin and the sub shoulder surface of the box are not aligned.

16. A threaded joint according to any of claims 1 to 15, wherein the slope of the sealing surface of the box, the inner surface of the portion of the box facing the outside surface of the nose portion of the pin, and the sub shoulder portion of the box is monotonic.

20 17. A threaded joint according to any of claims 1 to 16, wherein the pin comprises a rounded apex between the sub shoulder surface and the main shoulder surface, with a radius lower than 1.5 mm.

18. A threaded joint according to any of claims 1 to 17, wherein one of the sealing surface of the pin and of the sealing surface of the box is a frusto-conical

surface and the other sealing surface comprises a torical surface having a radius of curvature larger than 20 mm or the combination of the said torical surface and a frusto-conical surface.

19. A threaded joint according to any of claims 1 to 17, wherein both sub
5 shoulder surfaces of pin and box are frusto-conical surfaces.

20. A threaded joint according to any of claims 1 to 19, wherein the radial dimension of the main shoulder is at least 1.5 times greater than the radial dimension of the sub shoulder.

21. A threaded joint according to any of claims 1 to 20, wherein the outside
10 peripheral surface of the nose portion of the pin and the inner surface of the portion of the box facing said the nose portion of the pin have substantially cylindrical shape.

22. A threaded joint according to any of claims 1 to 20, wherein the outside
peripheral surface of the nose portion of the pin and the inner surface of the portion
of the box facing said the nose portion of the pin have substantially frusto-conical
15 shape, the taper angle is less than 10 degree.

1/2

Fig. 1

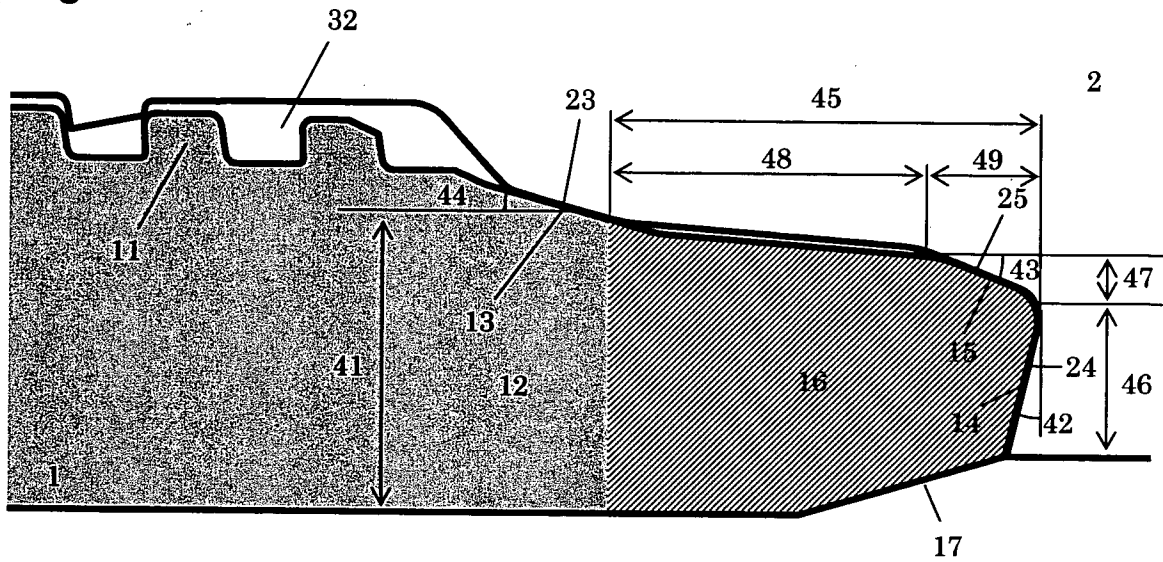


Fig. 2(A)

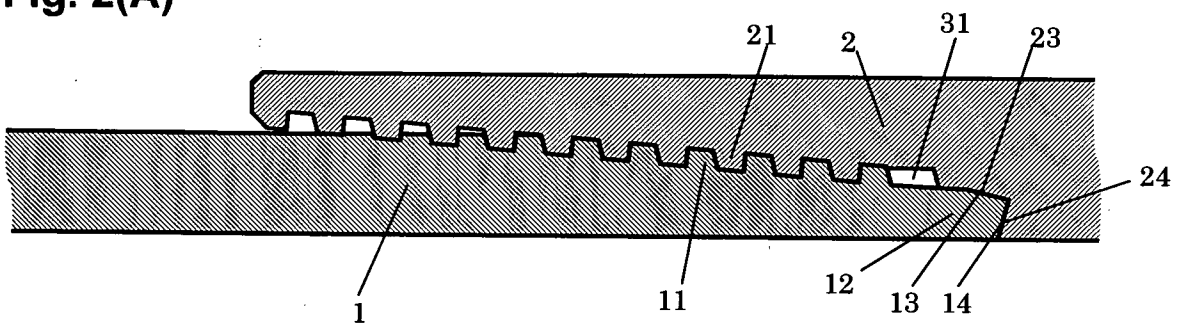
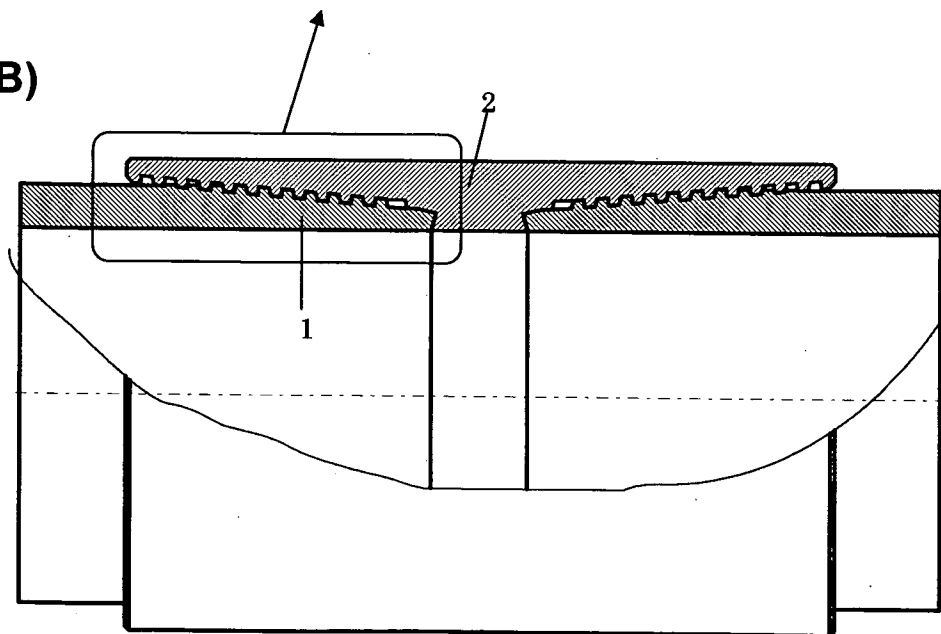


Fig. 2(B)



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Fig. 3

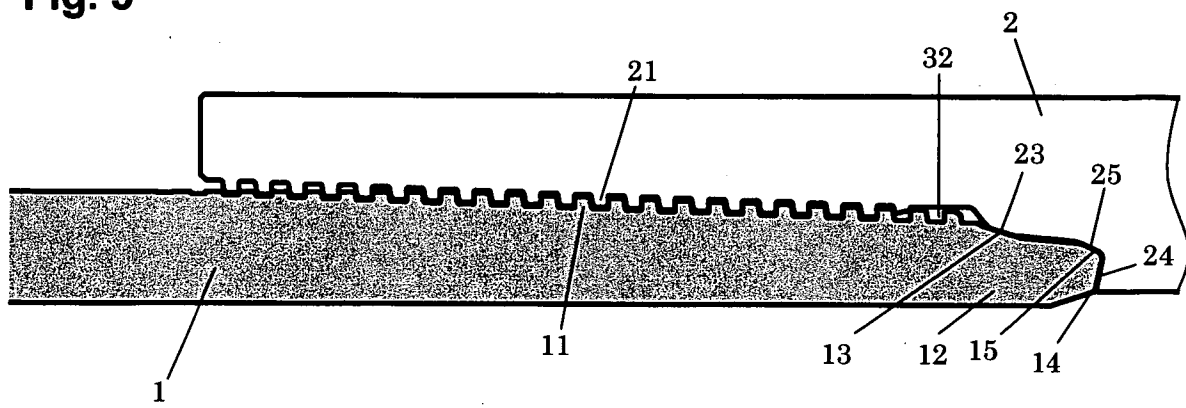


Fig. 4

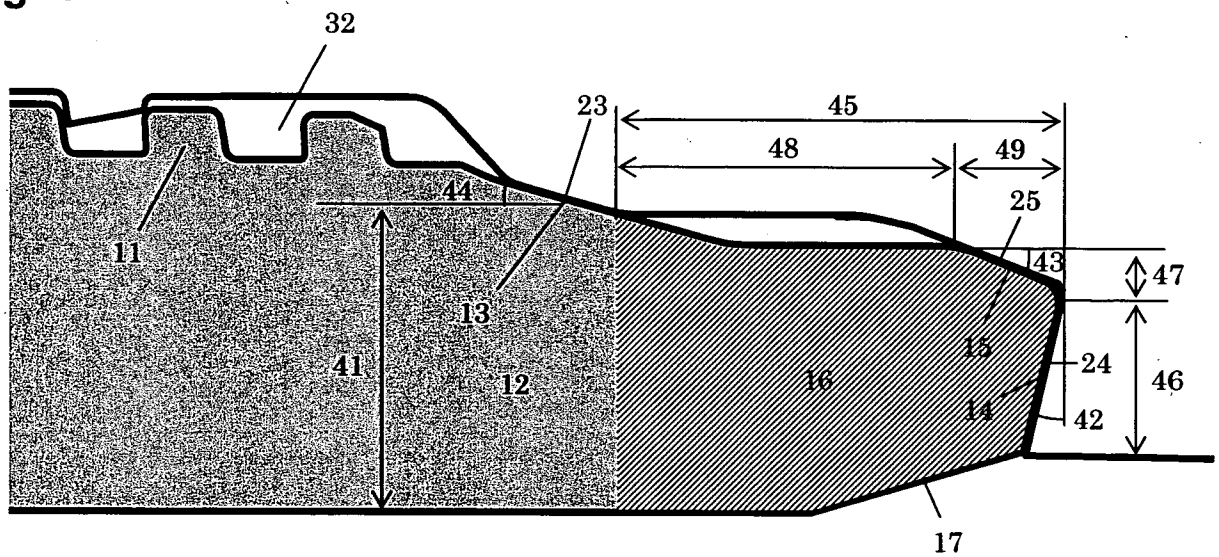
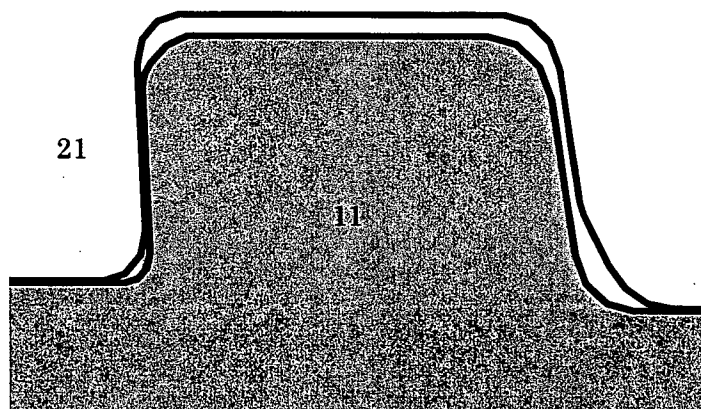


Fig. 5



INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2007/072231

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16L15/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 473 245 A (RAULINS GEORGE M [US] ET AL) 25 September 1984 (1984-09-25) column 2 - column 5; figure 2	1-5, 8-10,13, 15,16, 19-22
X	US 3 489 437 A (DURET JEAN LOUIS ALBERT) 13 January 1970 (1970-01-13) column 1 - column 4; figures 3,4	1-5, 8-16, 19-22
X	DE 44 46 806 C1 (MANNESMANN AG [DE]) 30 May 1996 (1996-05-30) column 5 - column 6; figure 5	1-10,13, 14,16, 19,20,22
	-/--	

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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19 September 2008

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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