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CA 2685399 A1 2009/01/22

(21) 2 685 399

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2008/07/15
(87) Date publication PCT/PCT Publication Date: 2009/01/22
(85) Entrée phase nationale/National Entry: 2009/10/27
(86) N° demande PCT/PCT Application No.: EP 2008/059226
(87) N° publication PCT/PCT Publication No.: 2009/010507
(30) Priorité/Priority: 2007/07/16 (EP07112536.3)

(51) Cl.Int./Int.Cl. *F16J 15/02* (2006.01),
F16L 5/04 (2006.01)

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(54) Titre : JOINT FILETE AVEC BAGUE D'ETANCHEITE ELASTIQUE
(54) Title: THREADED JOINT WITH RESILIENT SEAL RING

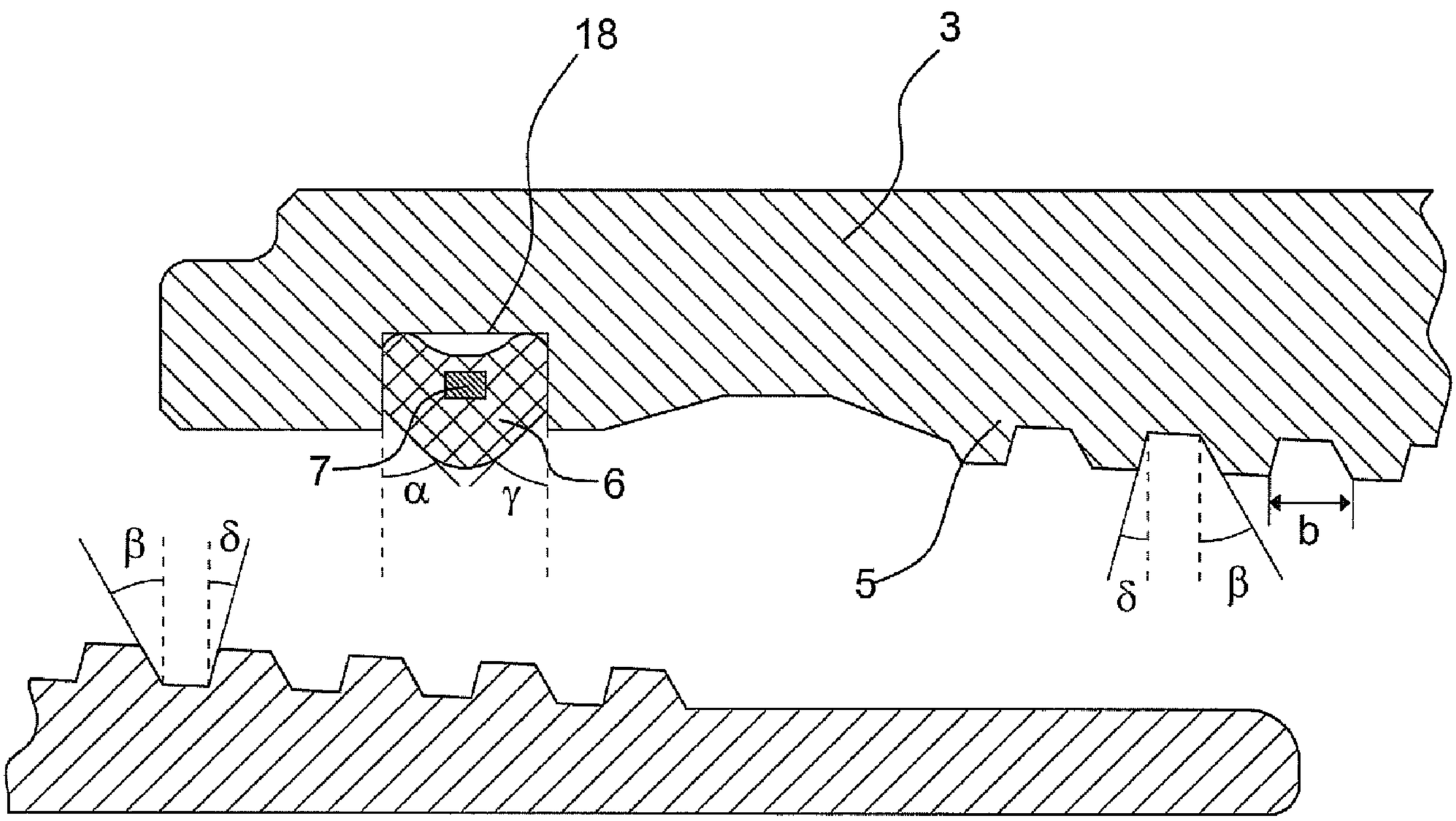


Fig. 1A

(57) Abrégé/Abstract:
A threaded joint comprises a seal ring (6) interposed between the pin and the box, and located in a groove (18) between the end of a threaded section (5) and the nose (15) of the box (3). The seal ring (6) has a first base (8), a second base (9) axially opposite to

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(57) Abrégé(suite)/Abstract(continued):
the first base, at least two protruding annular ribs (11, 12) on the external surface, and an internal surface comprising, in an unloaded position, two frustoconical annular surfaces (19, 20) tapering towards the centre of the seal ring and joined by a fillet (10).

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 January 2009 (22.01.2009)

PCT

(10) International Publication Number
WO 2009/010507 A1

(51) International Patent Classification:
F16J 15/02 (2006.01) *F16L 5/04* (2006.01)

(21) International Application Number:
PCT/EP2008/059226

(22) International Filing Date: 15 July 2008 (15.07.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
07112536.3 16 July 2007 (16.07.2007) EP

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv))*

Published:
— *with international search report*

(54) Title: THREADED JOINT WITH RESILIENT SEAL RING

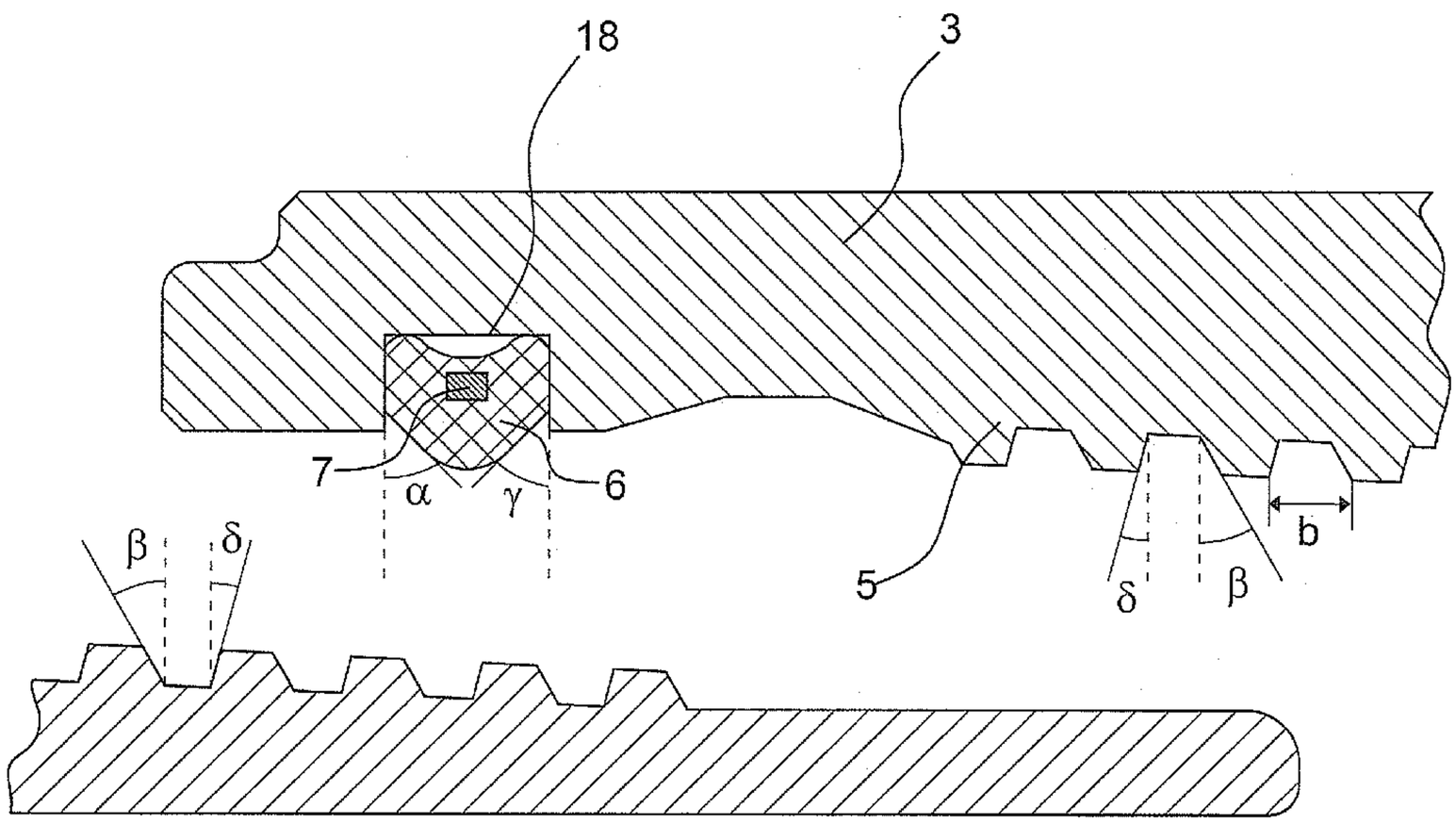


Fig. 1A

(57) Abstract: A threaded joint comprises a seal ring (6) interposed between the pin and the box, and located in a groove (18) between the end of a threaded section (5) and the nose (15) of the box (3). The seal ring (6) has a first base (8), a second base (9) axially opposite to the first base, at least two protruding annular ribs (11, 12) on the external surface, and an internal surface comprising, in an unloaded position, two frustoconical annular surfaces (19, 20) tapering towards the centre of the seal ring and joined by a fillet (10).

THREADED JOINT WITH RESILIENT SEAL RING

FIELD OF THE INVENTION

The present invention relates to threaded joints, in particular for connecting tubes of predefined length to make strings used in the hydrocarbon industry especially for use in the field of OCTG (Oil Country Tubular Goods) and in line pipes in offshore applications.

BACKGROUND OF THE INVENTION

Searching for oil or, more generally, hydrocarbons has become more demanding in terms of hardware and devices in recent years because oil and gas fields or reservoirs are located deeper under the earth's surface or in places difficult to reach below the sea bed. Prospecting for and exploitation of hydrocarbon fields demands hardware which is more resistant to environmental challenges such as higher loads and corrosion, which were less important in the past.

Modern joints are generally designed with metal to metal seals made by the contact between two surfaces, usually at one end or at both ends of the threaded portion of the joint, interfering in the elastic range of the modulus of elasticity for an appropriate stress magnitude. However in specific situations, resilient seals are needed instead of or in combination with metallic seals to prevent penetration of external fluids in the interstices of the threads.

It is therefore a design requirement that the joint seals resist penetration of the external fluids, or at least do not allow continuous exchange of the fluids already penetrated with the surrounding fluids, in order to reduce corrosion rate.

To solve the mentioned problems various solutions have been provided, one of which consists of inserting a seal ring made of polymeric material, e.g. an O-ring, at the extremity of the joint near the threaded portion.

It is a widespread practice to use O-rings pre-mounted onto the box, but this practice has an important disadvantage: the seal rings can be damaged during mounting of the ring and/or during make-up.

As they are pre-mounted onto the box, when making up the box the seal is dragged together with the box over the pin's threads. Due to the diametrical interferences needed between pin, box and seal dimensions for the seals to work properly, along with the geometric parameters of the connection such as thread

profile, pitch, taper angle, stab angle, etc, the seals are inevitably forced to crawl over the pin's threads, resulting in damage to the lower surfaces of the seals or in permanent deformations which later would jeopardize the sealing efficiency during operation.

Seal rings having more complicated shape have also been proposed, e.g. rings with an "H" or "U" cross-section to increase efficiency and prevent sea water from penetrating into the gaps of the joint. However such seal rings are subject to such stresses and adverse environmental conditions, both during the initial make-up operation and during operational life, that their efficiency is much reduced after some time. Even though pre-mounting on the pin would be less harmful for the seal ring, some field applications require simpler seal rings which must be pre-mounted onto the box.

US6550822 discloses a threaded joint including a water exclusion seal which is a pressure energized elastomeric seal positioned in a groove near each end of the coupling to form a radial seal between the unthreaded area at each end of the coupling and the unthreaded cylindrical area adjacent each end of the tubular section.

The shape of the ring section does not facilitate its dragging over the thread during make up. Because of its shape, the sharp corners hit the thread crests and are prone to get stuck in the thread. In the event of joint break-out it is even more easy to damage the seal ring.

In case of failure the portion of the pin with the vanishing thread remains unprotected against possible external corrosive fluids, since dope used to lubricate the joint is easily washed away.

This joint uses standard seal rings available on the market. Therefore, the same ring design must be used under different connections, and does not provide for customisation of the ring geometry for each pin taper, stab angle, thread height and pitch, etc.

The cavity between the lips fragilizes the housing, making it prone to rupture during break-out of the connection, where the lower part of the housing is dragged over the pin's threads, causing high deformation which may break it.

There have been many attempts to design improved configurations for seal rings to be housed in the vicinity of the nose of the box, but all are insufficient to with-

stand the higher requirements set for current joints.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a threaded joint which overcomes the aforementioned drawbacks.

The principal object of the present invention is to provide a joint having an innovative seal ring ensuring both a simple and reliable initial make-up and a high sealing efficiency during operation.

The above mentioned objects are achieved in accordance with the present invention by means of a threaded joint comprising a male threaded tube, defined as the pin, and a female threaded tube, defined as the box, and a seal ring, the pin being adapted to be made up in the box, the seal ring being interposed between the pin and the box, it being located on a portion of the surface of the box between the end of a threaded section and the nose of the box, and being in tight sealing contact via an external surface with an internal surface of the box and via an internal surface with an external surface of the pin, the seal ring having a first base, a second base axially opposite to the first base, at least two protruding annular ribs on the external surface, the internal surface of said seal ring comprising, in its unloaded position, two frustoconical annular surfaces tapering towards the centre of the seal ring and joined by a fillet.

The joint of the invention with a seal ring of novel design ensures reusability of the seal ring, or at least it is more reliable in cases where no spare O-rings are available. In contrast, after break-out most prior art threaded joints, incorporating well-known O-rings with circular cross-section, damage the original O-ring and a new seal ring must be used for the new make up operation, because the original one has been damaged both by the first make up and by break-out.

The advantage of the invention is to provide a threaded joint reliable in real field operative conditions, where reliability is crucial and reduction in operative costs in terms of time and tasks are desirable.

The housing for the seal ring of the joint is configured to match in the best manner the shape of the seal ring, and vice versa, whereby the seal ring works synergistically with the housing both during and after make up.

Advantageously, this synergy is obtained without increasing costs since the groove of the invention is easy to make and is not more complex or expensive to

produce than the currently used groove configurations, which house standard O-rings of circular cross-section. In addition the simple shape of the housing cross-section combined with that of the seal ring reduces the overall dimensions of the groove when compared to the dimensions of those grooves for O-rings of circular cross-section since the diameter of the circular cross-section determines the depth of the groove. As is explicatory shown in figure 1, which represents two standard O-rings mounted on state of the art joints, since an O-ring of large diameter would be preferable to avoid getting stuck between two adjacent crests of the pin thread during make up, this entails machining a deeper groove (example on the right), and the thickness of the wall w of the box in that portion would be significantly reduced as well as joint wall strength compared to an O-ring of smaller diameter (left example) which entails a wall thickness w'.

Advantageously a coating can be applied to the surfaces involved by the seal ring for protecting the machined surface of the pin close to the vanishing thread region of the joint which is likely to be exposed to contact by corrosive external agents.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects will become more readily apparent by referring to the following detailed description and the appended drawings in which:

Figure 1 shows an enlarged view of a detail of a threaded joint with an O-ring of the prior art,

Figure 1A shows a sectional view on an axial plane of the joint in accordance with the present invention before make up,

Figure 2 shows a sectional view on a longitudinal axial plane of the joint in accordance with the present invention after make up,

Figure 3 shows a sectional view of the seal ring of the joint of Fig. 1A in its unloaded position.

DETAILED DESCRIPTION

With particular reference to the figures 1A to 3, there is shown a threaded joint indicated overall by reference numeral 1, connecting two tubes, a male tube, commonly called a pin 2, with a nominal external diameter D, and a female tube also called a box 3, of external diameter D1, equal to or greater than D.

The pin 2 has a threaded portion 4 with male threads of appropriate profile, e.g. trapezoidal, and the box 3 has an internal threaded portion 5 with female threads.

The common axis of the pin 2 and box 3 is indicated with A. The box ends with a nose 15.

The portion of the box 3 near the end of the thread 5 comprises an annular groove 18 between box nose 15 and the thread end. This groove 18 is the housing of a seal ring 6.

With particular reference to figure 3, which shows a section of the ring 6 in the unloaded position located in its housing 18 in the box 3, the seal ring 6 has an external surface with two annular ribs 11, 12 separated by an annular furrow 13. The ribs 11, 12 have crests preferably rounded or of any other appropriate shape. When positioned in the housing 18 the external side of the ring 6 contacts the bottom of the groove. This bottom is preferably flat in the axial direction, to make machining easier.

The furrow 13 and the ribs 11, 12 present two main advantages:

- on one side the furrow 13 works as a lung, providing the needed radial deformation to allowing the internal surface of the ring 6 to be squeezed more easily.
- on the other side the ribs 11, 12 generate a load concentration, thus increasing sealing contact and acting as double independent sealing barriers.

The seal ring 6 has two bases 8, 9 axially opposite to each other. One or both bases 8, 9 are substantially, but not exclusively, flat.

The internal surface of the seal ring 6 has two frustoconical surfaces or flanks 19, 20 that are V-shaped, when seen in the axial section. The taper angle **α** of the surfaces 19, 20 can be defined as a function of thread parameters, i.e. taper, stab angle, etc. A preferred value for the angle **α** is 45°.

The taper of each surface 19 and 20 can also have different values for the taper angles **α** and **γ**. This embodiment is shown in particular in figure 3.

In a further particularly advantageous embodiment of the joint, the seal ring 6 has a section with specific dimensions.

The thickness “t” of the seal ring in the axial direction is defined by the thread width, the thickness “t” of the ring 6 being larger than the axial length of the void “b” between two crests of the thread. This facilitates jump over of the crests by the seal ring apex 10 during make up.

The depth “d” of the groove 18 of the box 3 in the radial direction is preferably comprised between 3 and 15 mm. The groove 18 should house about 75% of the

thickness of the seal ring 6 in the radial direction.

The taper angles **α** and **γ** of the flanks 19 and 20 are chosen with magnitudes such that the following relationships with the stab angle **β** and load angle **δ** of the thread flanks are satisfied

α > β and

γ > δ.

The apex 10 of the ring where the two tapered frustoconical surfaces 19 and 20 meet has preferably a rounded shape like a fillet when seen in section. The seal ring 6 is a simple but effective improvement over conventional O-rings currently used in the field. Main advantages consist in its frustoconical annular surfaces 19, 20, tapering towards the centre of the seal ring and joined by the apex or fillet 10 therebetween, which facilitate forward or backward movement of the seal ring over the threads, thus avoiding damage. Moreover, the internal surface of the seal ring 6 also generates a load concentration thus increasing sealing contact and therefore improving sealability of the seal ring when made up.

The seal ring can be made of elastomeric materials, which in this application is intended to include any natural or synthetic material having elastic properties including rubbers, plastics, polymers, etc.

The joint defines an inner space 16, containing the axis A of the pin and box, in which the fluid, for example a hydrocarbon, such as natural gas or petroleum or other similar fluid, flows and an outer space 17 which can be in contact with fluids of various kinds such as sea water in some applications.

The ring 6 offers an important protection to the joint 1, on the outside of the joint since it is located at the extremity of the box, thus preventing external fluids which occupy the space 17 from leaking into the threaded zone of the joint 1.

In an advantageous embodiment, a reinforcement ring 7 of different material, preferably metal, stronger than the plastic material of the seal ring can be added, by embedding such a reinforcement ring inside the body of the seal ring 6.

Advantageously a coating is applied to those surfaces of both the pin and box which remain in contact with the seal ring 6.

The threaded joint of the invention offers improved sealability and protection

against make up and break-out damage by virtue of the aforementioned features. The joint is to be used preferably in the field of OCTG and line pipe connections for the oil & gas industry, especially in offshore applications. It can be employed at depths up to 3500m, at which the threaded part still remains protected from external water infiltration.

CLAIMS

1. Threaded joint comprising

a male threaded tube (2), defined as the pin, a female threaded tube (3), defined as the box, and a seal ring (6), the pin being configured to be made up in the box, the seal ring being interposed between the pin and the box, it being located in a portion of the surface of the box (3) between the end of a threaded section (5) and the nose (15) of the box (3), and being in tight sealing contact via an external surface (11, 12, 13) with an internal surface of the box (3) and via an internal surface (10, 19, 20) with an external surface of the pin (2), the seal ring (6) having

a first base (8),

a second base (9) axially opposite to the first base,

at least two protruding annular ribs (11, 12) on the external surface,

the internal surface of said seal ring (6) comprising, in an unloaded position, two frustoconical annular surfaces (19, 20) tapering towards the centre of the seal ring and joined by a fillet (10).

2. Threaded joint according to claim 1, wherein said frustoconical annular surfaces (19, 20) have respective taper angles of equal value.

3. Threaded joint according to claim 1, wherein said frustoconical annular surfaces (19, 20) have respective taper angles (α, γ) of different values.

4. Threaded joint according to claim 3, wherein said frustoconical annular surfaces (19, 20) have angles (α, γ) with values satisfying the relationship

$\alpha > \beta$ and

$\gamma > \delta$,

where β is the stab angle and δ is the load angle of the thread flanks.

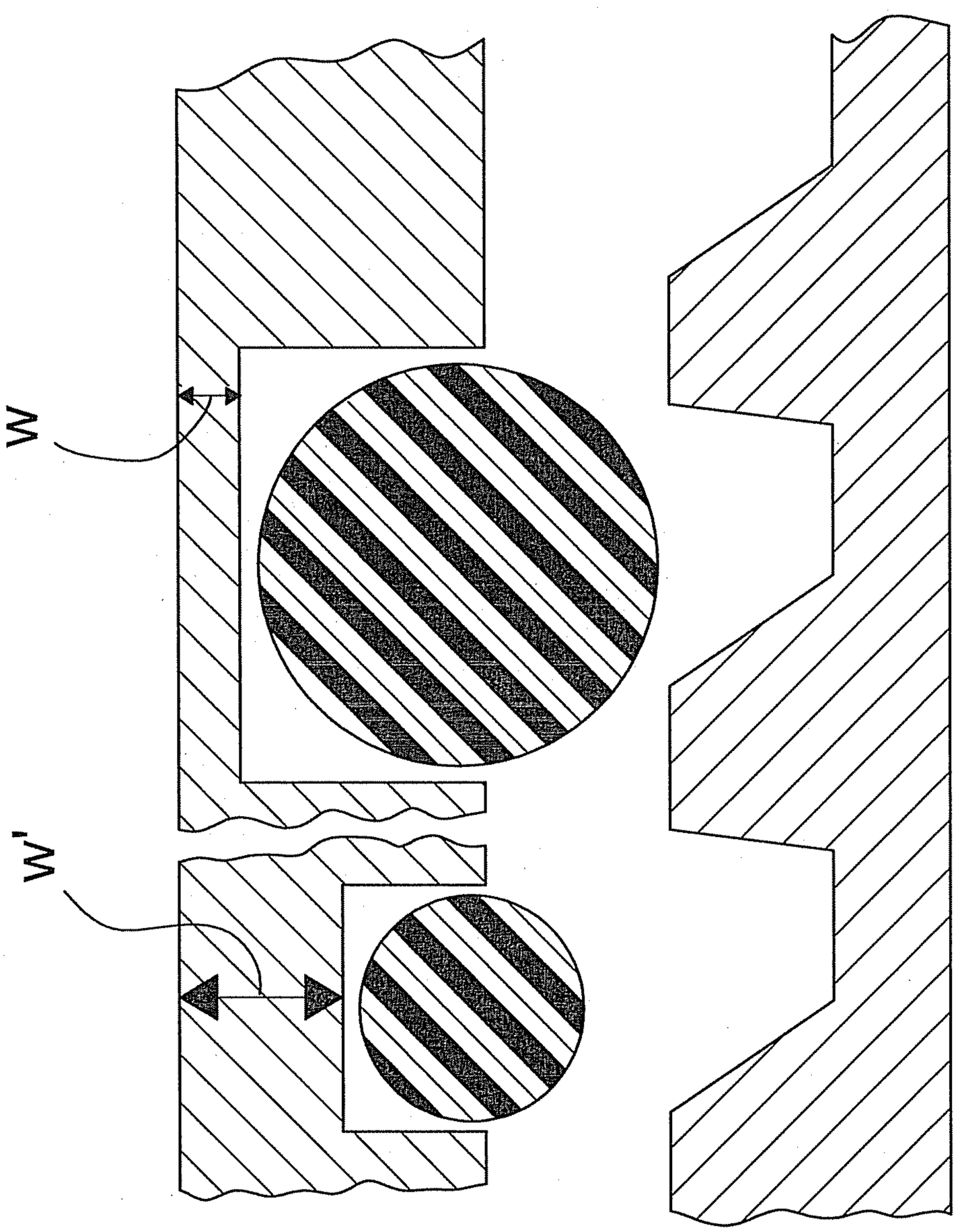
5. Threaded joint according to claim 3, wherein the thickness “t” of the seal ring in the axial direction is larger than the void “b” between two crests of the thread.

6. Threaded joint according to claim 1, wherein a reinforcement ring (7) is provided inside the body of the seal ring (6).

7. Threaded joint according to claim 1, wherein the seal ring (6) is made of elastomeric material.

8. Threaded joint according to any preceding claim, wherein the first base (8) is substantially plane.

9. The joint according to any preceding claim, wherein a coating is applied to those surfaces of both the pin and box which remain in contact with the seal ring (6).



PRIOR ART

Fig. 1

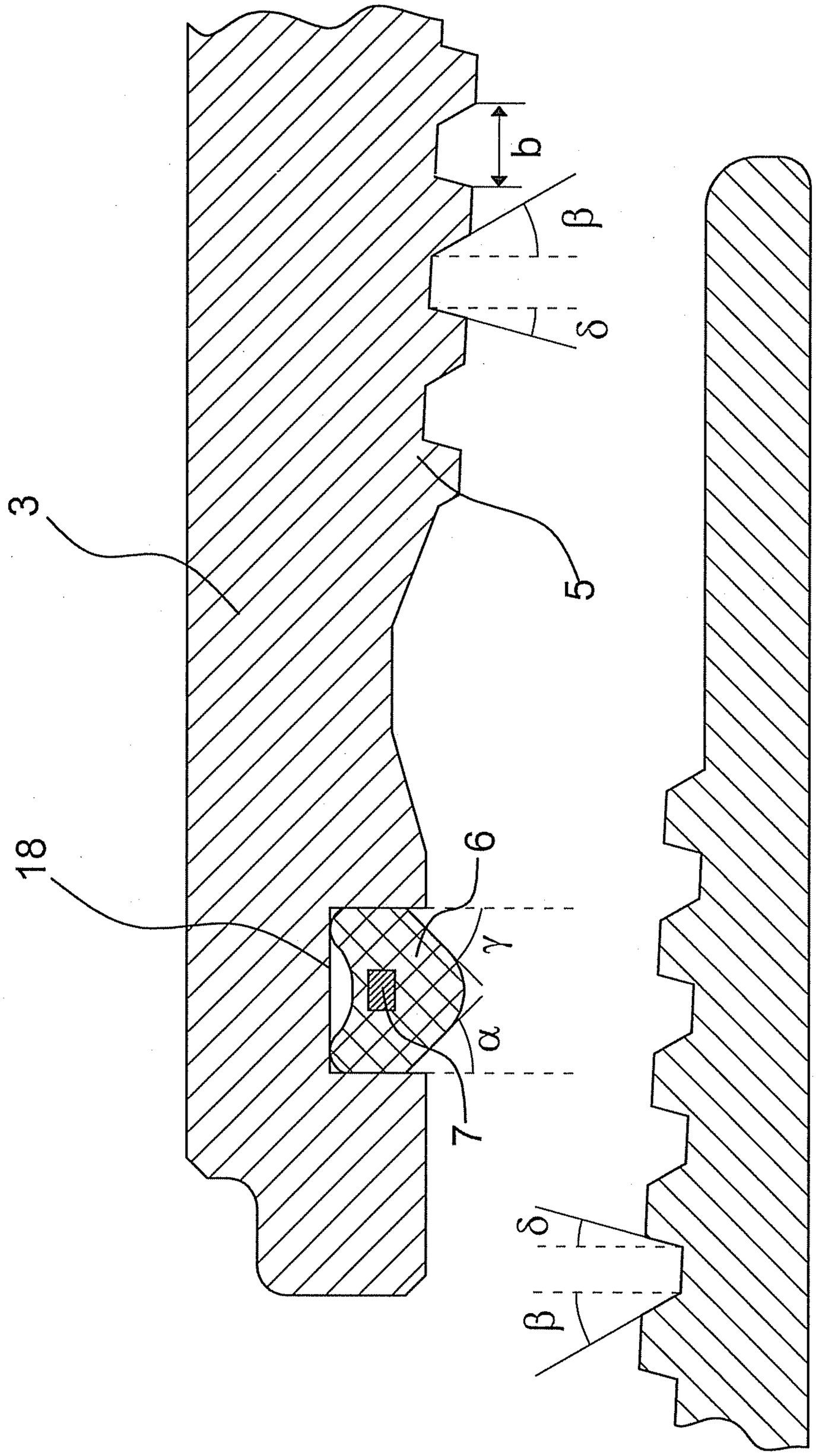


Fig. 1A

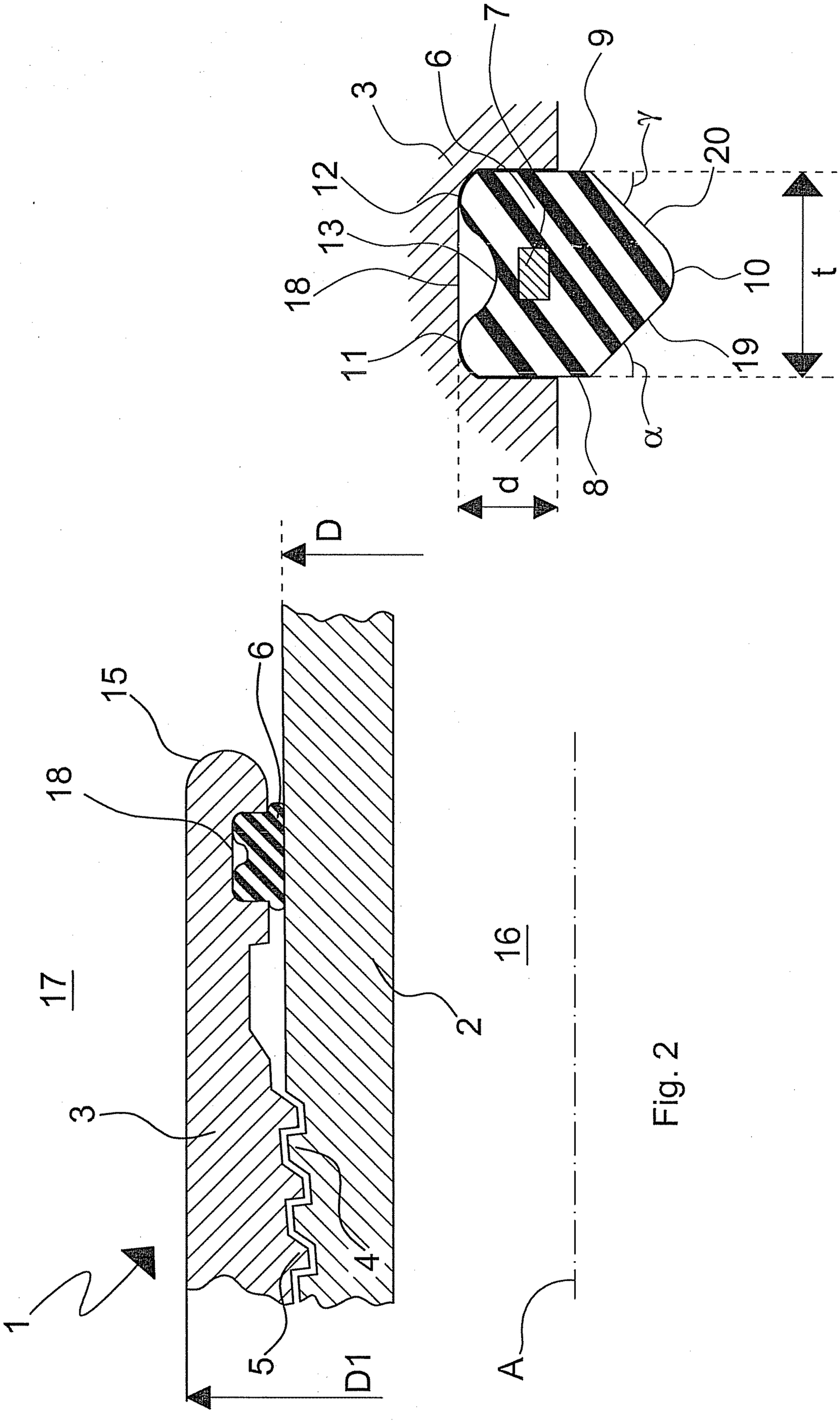


Fig. 2

Fig. 3

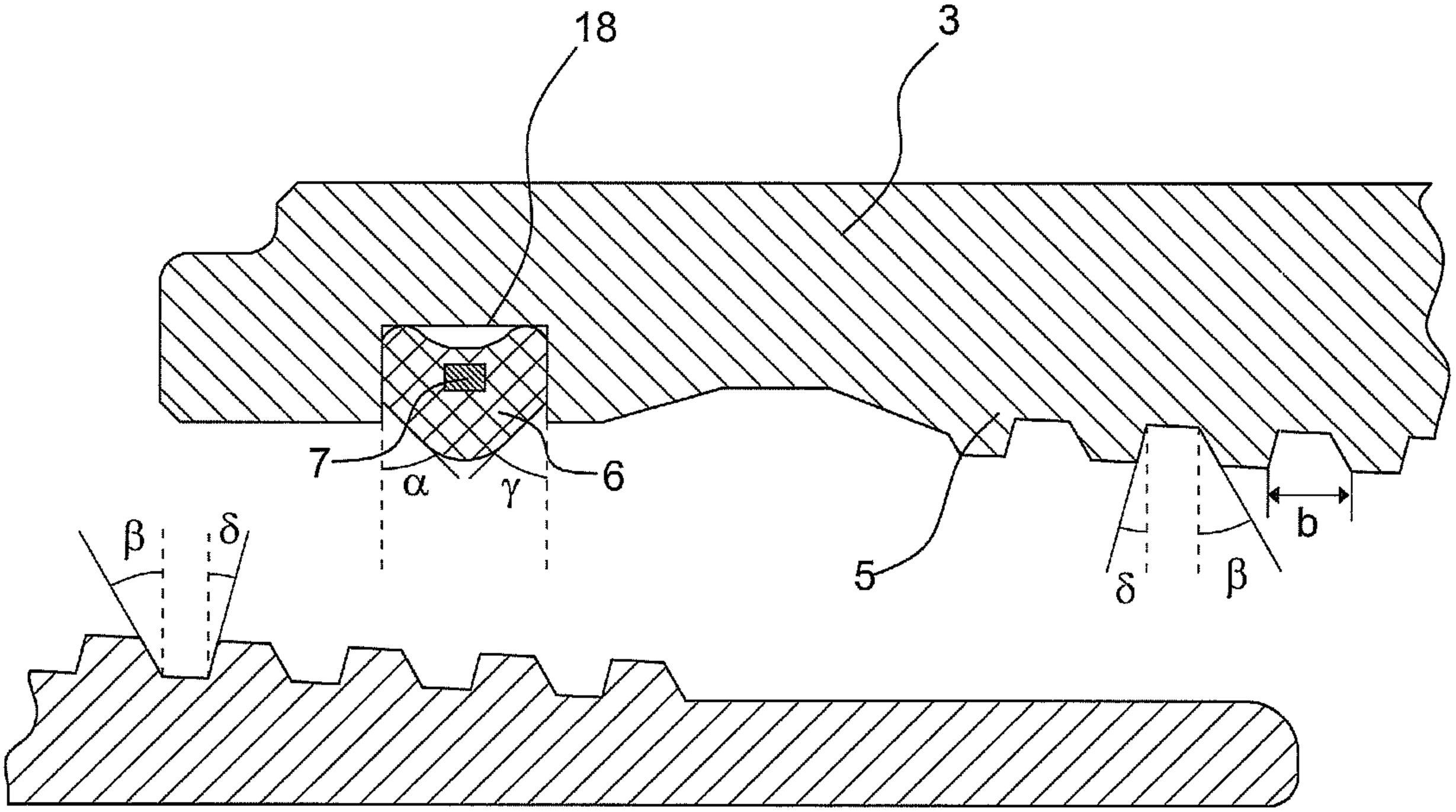


Fig. 1A