

SPECIFICATION

Tool for securing tubular members

This invention relates to tools for securing tubular members. Particularly, in one form, the invention relates to a tieback tool for sealingly securing a first tubular member or riser pipe suspended from a vessel floating on a body of water to a second tubular member or casing hung in the wellbore in the bottom of the body of water.

In recent years it has become desirable to use a floating vessel from which to drill wells in marine locations. Many of these structures have been maintained on station by conventional spread catenary mooring lines, or by propulsion thruster units. One system of floating vessel receiving attention for drilling or production of wells in water is the Vertically Moored Platform (VMP), such as described in U.S. Patent 3,648, 638, issued March 14, 1972; Kenneth A. Blenkarn, inventor. A key feature of Vertically Moored Platforms is that the floating platform is connected to anchor means in the ocean floor only by elongated parallel members which are preferred to be large diameter conduits, commonly called "riser pipes". These elongated members or riser pipes are held in tension by excess buoyancy of the platform. In this system, it is preferred that there be several concentric casing strings set in the ocean floor and cemented in place.

Corresponding concentric riser pipes or casing strings will extend from the ocean floor to the floating vessel. This present invention discloses novel means of sealingly connecting the corresponding set casings to the corresponding riser casing strings extending from the mudline suspension system in the set casings to the floating vessel.

U.K. Patent Application No. 7912425, filed 9th April 1979, entitled "Vertically Moored Platform Anchoring," describes an anchoring system utilizing concentric casing strings set in the ocean floor which are connected to concentric casing strings within the riser pipe extending from the set casings to the floating vessel.

In the past, riser pipes have been connected to the casing by mechanical connectors. To our knowledge, none of these systems teach the particular J-slot connections and sealing means which we describe and claim. J-slots for lowering and recovering equipment are well known: for example, see U.S. Patent 3,605,414.

In one embodiment, the present invention concerns a tieback tool for sealingly securing a first tubular member (e.g., riser pipe) suspended from a vessel floating on a body of water to a casing hung in a wellbore and preferably cemented in the bottom of the body of water. There is provided a male tubular member having a J-slot on its exterior and the neck having a wall thickness t_1 . There is also provided a female tubular member adapted to fit over the male tubular member and having a lug on the interior thereof. The female tubular member has a neck section having a wall thickness of t_2 greater than t_1 ,

and the neck having a thickness t_1 has substantially greater radial expansion under a given internal pressure. A seal is provided between the neck of the male tubular member and the section or neck of the said female tubular member and is energized by the greater radial expansion of the neck of the male member.

In another embodiment, multi-J-slot connectors are spaced longitudinally along the wall of the connecting tubular members. There are two longitudinal slots, for example, and two mating longitudinally spaced J-lugs. Special orienting means is provided so that each lug fits in its proper J-slot. Special construction means are also provided for aligning the radially spaced J-slots.

Thus, according to the present invention, there is provided a tieback tool for sealingly securing a tubular member suspended from a vessel floating on a body of water to a casing hung in a wellbore in the bottom of the body of water, comprising:

- a male tubular member;
- a female tubular member adapted to fit over said male tubular member;

J-slot means on one of said members and co-operating lug means on the other of said members; and

a self-energizing seal between an outwardly facing surface of a portion of one member and an inwardly facing surface of a portion of the other member, said tool being constructed so that for a given internal pressure said one portion has a greater radial expansion than said other portion and the resulting differential radial expansion of the portions causes compression of the seal.

Suitably, the J-slot means is formed on the exterior of the male tubular member and the lug means on the interior of the female tubular member.

In one form, the tool comprises:

- a male tubular member having a neck with wall thickness t_1 ;
- a female tubular member adapted to fit over said male tubular member and having a section with a wall thickness of t_2 which is greater than t_1 ;
- a J-slot means on either the female member or the male member of co-operating lug means on the other member; and
- a self-energizing seal between said neck of said male tubular member and said section of said female tubular member.

Preferably, the J-slot means comprises:

- a longitudinal passage;
- an indexing and load-bearing plateau having an indexing race sloping toward said longitudinal passage;
- a guiding race at the lower end of said passage having a nonzero slope with respect to the longitudinal axis of said female tubular member;
- a locking slot beneath said indexing and load-bearing plateau; and
- an indexing plateau beneath a portion of said indexing and load-bearing plateau and adjacent said locking slot.

Advantageously, the tool includes a plurality of

circumferentially spaced J-slot means and a circumferential groove beneath said indexing and load-bearing plateaus and defining the load-bearing surface of each said load-bearing plateau.

The female tubular member may have an outer circumferential shell and an inner circumferential shell together forming an annulus into which said male member can be inserted, with the self-energizing seal located between the inner shell and the male member, and the thickness t_3 of the wall of the inner shell being less than the thickness of the wall of the male member.

The invention will now be described in more detail and by way of example with particular reference to the accompanying drawings in which:

FIGURE 1 is schematic view of a Vertically Moored Platform having riser pipes extending from the ocean floor to the floating structure;

FIGURE 2 illustrates schematically the connection between the concentric casing strings set in the bottom of the body of water and the mating concentric tubular strings extending to the floating structure;

FIGURE 3 is a vertical section through an assembly having a J-slot connector with self-energizing seal;

FIGURE 4 illustrates the special J-slot arrangement used in the device of FIGURE 3;

FIGURE 5 is similar to FIGURE 3 except FIGURE 5 has multiple longitudinally spaced J-slots;

FIGURE 6 illustrates the special J-slot assembly of FIGURE 5;

FIGURE 7 illustrates in cross-section a modification of the connector shown in FIGURE 3;

FIGURE 8 illustrates a sloping surface connection between the top of the J-lug and the lower side of the J-slot; and

FIGURE 9 is a modification of the embodiment of FIGURE 4 to provide means in the J-slot connector for transmitting a compressive force.

Reference is first made to FIGURE 1 which shows an isometric view of a Vertically Moored Platform (VMP) which comprises a floating structure 10 floating on a body of water 12 and connected by vertical riser pipes 14 to casing 16 indicated as being anchored in the soil. Ordinarily, a sufficient number of casings 16 will be set in place in the holes in the ocean bottom and anchored there such as by cementing in order to form a firm anchor. Next, the floating structure such as a VMP will be connected to casings 16 by vertical riser pipes 14. The vertical riser pipes 14 may be anywhere from as little as 180 metres or less to 1525 metres or more in length. In this concept of using riser 14 to drill through, it is necessary to form a seal-tight connection between the riser pipes 14 and the set casing 16. This invention discloses such a sealing connector. It is also pointed out that each casing 16 in reality has a plurality of concentric casing strings suspended therein; accordingly, the riser pipe indicated as 14 will normally have a plurality of inner concentric casings which are connected to the inner casings hung within casing 16.

FIGURE 2 illustrates schematically various

concentric casing strings 16, 16A, 16B and 16C, which are connected to riser pipe 14 and its inner strings of casings 14A, 14B, and 14C. Outer casing string 16 is hung off at 18 from drive pipe 20. Casing string 16 is cemented in below the mudline landing 18. A J-slot connector 24 connects casing 16 to riser pipe 14. Inner J-slot connectors 24A and 24B likewise connect casing strings 16A and 16B to casing strings 14A and 14B. Inner string 14C is shown as being continuous but it normally would also be hung off in a manner similar to that for casing string 16A. Drive pipe 20 is supported from template 15. Details of these J-slot connectors will be described in connection with the remainder of the drawings.

FIGURE 3 illustrates in cross-sectional form the J-slot connection 24A which connects a lower casing 16A (set and cemented in the sea bed) and an upper casing string 14A which extends to the floating vessel. A neck 30 on the male tubular member extends above J-slot 24A on casing 16A. This has a wall thickness t_1 . Fitting down over neck 30 is upper casing extension 32 of the female tubular member. An O-ring seal 28 fits between neck 30 and extension 32. In extension 32 there is provided a cavity 27 which contains seal 26. At this level, the neck 30 has a wall thickness t_1 and the extension 32 has a wall thickness t_2 . t_2 is made greater than t_1 ; thus, if the two elements are made of comparable material, the inner member 30 will have a greater radial expansion than would outer member 32. For a given internal pressure, then, this results in an uneven tendency to expand, with the inner member 30 having a greater tendency to expand, thus aiding and effecting the self-energizing seal 26. The placement of the seal near the end of the male member does increase the difference in radial flexibility and thus does increase the autosealing effect.

Attention is next directed to FIGURE 4 which illustrates a preferred embodiment of the J-slot. Shown thereon is a lug 36 positioned in locking J-slot 46. It is to be noted that this is a view of the inside of the tubular members being connected and that this configuration of FIGURE 4 takes up slightly over 25 percent of the circumferential view. In other words, there are four lugs 36 and locking slots 46 spaced circumferentially on the same elevation. (There could be any number but four is the normally preferred number.) Load-bearing surface 50 is the lower side of indexing and load-bearing plateau 40 which is wedge-like in shape and has an indexing race 42. Lug 36 has a stabbing surface 48. Various advancing positions of lug 36 are shown starting with 36A which is considerably above the indexing and load-bearing plateau 40. As lug 36 is lowered, it may assume the position 36A and, if not aligned with passage or throat 47 leading to the J-slot, the stabbing surface 48B will contact indexing race 42 and cause the lug to be rotated as it is lowered until it is aligned with passage 47. The lug 36 will then assume the various positions indicated by the dotted lines

until it reaches a position 36N. When lug 36 reaches an intermediate position 36F, at least a portion of the bearing surface 48B contacts guiding race 38. This causes the lug and the pipe on which it is connected to be turned by the weight of the string of pipe supporting the lug 36. This continues until lug 36 reaches the position 36N. The upper pipe 14A which supports lug 36 is then lifted until lug 36 is forced against load-bearing surface 50. As a precautionary measure when upward force is applied to casing string 14A, a light torque is also applied to the string so that there is no chance that lug 36 will slip out of its alignment directly beneath the load-bearing surface 50 and within locking slot 46. Indexing plateau 44 aids in maintaining lug 36 in its proper position. The "sharp corners" shown in the drawings would, in construction, be rounded or shaped to reduce concentration of stresses.

A preferred guiding race 38 has two requirements: (1) it must be deep enough so that lug 36 may clear indexing plateau 44 as it is lowered; and (2) it is preferred to have a slope sufficient to cause the lug and its associated string of pipe to rotate as the lug is lowered.

As mentioned above, there is a plurality of circumferentially spaced indexing and load-bearing plateaus 40 having load-bearing surfaces 50. It is important that load-bearing surfaces 50 be at the same longitudinal position of pipe 14A as each of the other circumferentially spaced plateaus. We accomplish that by cutting them simultaneously with a lathe to form a circumferential groove 51.

Attention is next directed to FIGURE 5 which shows in vertical cross-section a "multiple J-slot" longitudinal arrangement. This concerns means for connecting a lower tubular member 52 to an upper tubular member 54. This illustrates a connecting means which, like the one illustrated in regard to FIGURE 3, will provide a seal-tight connection and transmit tension. This includes a lower J-slot system 56 and an upper J-slot system 58. Seals 59 and 60 are also provided similarly as in the system of FIGURE 3.

Attention is next directed to FIGURE 6 which illustrates the preferred embodiment of the multiple J-slot arrangement shown in FIGURE 5. In FIGURE 6, there is provided an upper lug 66 having an upper bearing surface 66A and a lower lug 62 having an upper bearing surface 62A which fit, respectively, into upper locking slot 67 having a downwardly facing bearing surface 67A and lower locking slot 63 having a downwardly facing bearing surface 63A. Upper locking slot 67 has a mouth 68 which has a vertical or longitudinal dimension L_1 which is greater than L_1 , the vertical dimension of upper lug 66, but less than the vertical dimension L_2 of the lower locking lug 62. The vertical dimension L_2 is less than the vertical dimension L_3 of the mouth of lower locking slot 63. With this relationship between the upper and lower locking lugs 66 and 62 and the opening 68 and the mouth of locking slot 63, it is impossible

for the lower lug 62 to go into upper locking slot 67.

We will now briefly discuss how the proper distribution of loading between upper lug 66 and lower lug 62 is obtained. The J-slot 63 and lug 62 form a first load-carrying engagement A and J-slot 67 and lug 66 form a second load-carrying engagement B. That part of the tubular member (having the J-slots) between the load-bearing surfaces of the J-slots can be identified as the J-slot segment. The multiple J-slot design is required when the tensile loads cannot safely be transmitted through a single slot connector fitting in the radial clearance. The proper distribution of the loads transferred at the different stages is thus imperative. This is accomplished by adjusting the relative axial flexibility of the two pipes or tubular members between the bearing surfaces of the longitudinally spaced J-slots 63 and 67. The clearance or difference between the axial distances of the lug stages and bearing stages should be minimum. For example, in the case where only two stages are used, and load-carrying engagements A and B are each to have the same load-carrying capability, the axial stiffness K_L between the two bearing stages of the member having the lugs and the axial stiffness K_J between the two bearing stages of the member having the J-slots should be equal, $K_L = K_J$. If the design load to be carried by load-carrying engagements A and B is respectively designated F_A and F_B , and where A is closer than B to the end of the lug member, then the axial stiffness ratio of the two segments is:

$$K_J/K_L = F_A/F_B$$

In the case of three stages, the axial stiffness should be distributed as follows:

$$\frac{F_B + F_C}{F_A} K_{L1} = K_{J2}; K_{L2} = \frac{F_A + F_B}{F_C} K_{J1}$$

where

F_A = design load carried by engagement "A" formed by first lug and third J-slot;

F_B = design load carried by engagement "B" formed by second lug and second J-slot;

F_C = design load carried by engagement "C" formed by third lug and first J-slot;

K_{L1} = axial stiffness of the lug member between the middle lug and the lug stage closest to the end of the member;

K_{L2} = axial stiffness of the lug member between the middle lug stage and the lug stage farthest away from the lug member;

K_{J1} = axial stiffness of the J-slot member between the middle bearing stage and the stage closest to the end of the J-slot member; and

K_{J2} = axial stiffness of the J-slot member between the middle bearing stage and the stage farthest from the end of the J-slot member. Attention is next directed to FIGURE 7 which

shows a modification of the J-slot connection described above in relation to FIGURES 3 and 4. This likewise has a means for connecting in a sealing relationship a lower tubular member 80 to an upper tubular member 82. The upper tubular member 82 has a connecting unit including an outer cylindrical member 86 and an inner concentric cylindrical member 84. This forms an annulus 87 into which an upper male extension 83 can extend. There is shown a J-slot connection means 88 between male extension 83 and outer member 86 which is very similar to that shown in FIGURE 3, for example; however, the sealing means are located differently and are in a protected position. There is shown an O-ring seal 90 and sealing means 92 which can be self-energizing. Seals 90 and 92 are carried by extension 84. As the tool is lowered to mate with fixed member 80, these seals are in a protected position. The lower ends 94 and 93 of members 84 and 86, respectively, are flared to make the operation of stabbing over member 83 of lower conduit 80 easier. Here again, at seal 92, the wall thickness of member 84 is much less than the wall thickness of member 83, the unequal radial expansion force thus energizing seal 92.

Attention is next directed to FIGURE 8 which illustrates a refinement on the relationship between the upper surface of the locking lug and the lower holding or load-bearing surface of the J-slot. Shown therein is an upper surface 94 of the lug which makes an angle α with a plane perpendicular to the tubular member on which lug is placed. The lower surface 96 of the J-slot which engages surface 94 has an angle so that the surface 96 mates with surface 94. A suitable or preferred angle α is between about 20 and 0 degrees. A preferred angle is 15 degrees. This tends to prohibit the pulling apart of the lugged member and the J-slotted member. The contact force between the lugs and the plateaus generate bending moments in the wall of the two pipes which tend to separate the lugs from the plateaus by including the contact surfaces between the lugs and the plateau. A radial component of the contact force is generated which brings the lugs and the plateaus together. An auto-locking effect is created.

In most of the contemplated uses of the J-slot connection described in this specification, the upper section of pipe such as section 54 of FIGURE 5 will be in tension; however, there may be some situations where the upper section of pipe will be under compression. A modification of the J-slot connector which will take care of this compressive force is shown in FIGURE 9. The main difference between this J-slot connector and those of the other figures is in the modification of the indexing plateau 104. Indexing plateau 104 has been modified to have horizontal extension or leg 106 which has an upper facing bearing surface 108. This is designed to mate with a portion of the downwardly facing bearing surface 110 of lug 102. Lug 102 has a vertical dimension so it can be rotated into the vertical space between leg 106

and the lower surface 112 of indexing and load-bearing plateau 100. In operation, the upper string of pipe supporting lug 102 is lowered from an upper position such as 102A downwardly.

Indexing and load-bearing plateau 100 causes the pipe to rotate so that the lug 102 is in the vertical passage 114 of the J-slot. Continual lowering of the upper pipe results in the lug eventually reaching the position 102N. Thus far, the operation is similar to that shown in FIGURE 4. When the lug is in position 102N, tension is applied to the upper string of pipe to pull the pipe upward where the lug reaches the position 102M. At this point, proper torque is applied to the pipe supporting lug 102 to move it into the position shown in FIGURE 9. If desired, a slight torque may be left on the upper section of the pipe to assure that the lug 102 is maintained in the position shown in FIGURE 9. If tension is ever lost on the upper string of pipe, the bearing surface 108 of leg 106 of indexing plateau 104 will resist downward movement.

Our co-pending Application No. 8220429 describes and claims a tool for securing a first tubular member to a second tubular member comprising:

- a male tubular member;
- a female tubular member adapted to fit over said male tubular member;
- a first J-slot and a second J-slot on either the interior of said female tubular member or on the exterior of said male tubular member, said J-slots being longitudinally spaced apart along such tubular member, said first J-slot being nearest the end of such tubular member;

- a first lug and a second lug on the tubular member not having the J-slots, said lugs being spaced apart longitudinally along such tubular member, the longitudinal distance between the bearing surfaces of said J-slots and the longitudinal distance between the bearing surfaces of said lugs being about equal, said first lug being nearest the end of such tubular member and said first J-slot being nearest the end of said J-slot member; and

- said first lug and said second J-slot forming a load-carrying engagement A and said second lug and said first J-slot forming a load-carrying engagement B, the design load carried by A and by B respectively designated F_A and F_B , and in which

$$K_J/K_L = F_A/F_B$$

where

K_L = axial stiffness of said tubular member having said lugs and between the lug-bearing surfaces; and

K_J = axial stiffness of said tubular member having said J-slots and between the J-slot bearing surfaces. It also describes and claims a tool having three longitudinal spaced J-slots.

CLAIMS

1. A tieback tool for sealingly securing a tubular



shows a modification of the J-slot connection described above in relation to FIGURES 3 and 4. This likewise has a means for connecting in a sealing relationship a lower tubular member 80 to an upper tubular member 82. The upper tubular member 82 has a connecting unit including an outer cylindrical member 86 and an inner concentric cylindrical member 84. This forms an annulus 87 into which an upper male extension 83 can extend. There is shown a J-slot connection means 88 between male extension 83 and outer member 86 which is very similar to that shown in FIGURE 3, for example; however, the sealing means are located differently and are in a protected position. There is shown an O-ring seal 90 and sealing means 92 which can be self-energizing. Seals 90 and 92 are carried by extension 84. As the tool is lowered to mate with fixed member 80, these seals are in a protected position. The lower ends 94 and 93 of members 84 and 86, respectively, are flared to make the operation of stabbing over member 83 of lower conduit 80 easier. Here again, at seal 92, the wall thickness of member 84 is much less than the wall thickness of member 83, the unequal radial expansion force thus energizing seal 92.

Attention is next directed to FIGURE 8 which illustrates a refinement on the relationship between the upper surface of the locking lug and the lower holding or load-bearing surface of the J-slot. Shown therein is an upper surface 94 of the lug which makes an angle α with a plane perpendicular to the tubular member on which lug is placed. The lower surface 96 of the J-slot which engages surface 94 has an angle so that the surface 96 mates with surface 94. A suitable or preferred angle α is between about 20 and 0 degrees. A preferred angle is 15 degrees. This tends to prohibit the pulling apart of the lugged member and the J-slotted member. The contact force between the lugs and the plateaus generate bending moments in the wall of the two pipes which tend to separate the lugs from the plateaus by including the contact surfaces between the lugs and the plateau. A radial component of the contact force is generated which brings the lugs and the plateaus together. An auto-locking effect is created.

In most of the contemplated uses of the J-slot connection described in this specification, the upper section of pipe such as section 54 of FIGURE 5 will be in tension; however, there may be some situations where the upper section of pipe will be under compression. A modification of the J-slot connector which will take care of this compressive force is shown in FIGURE 9. The main difference between this J-slot connector and those of the other figures is in the modification of the indexing plateau 104. Indexing plateau 104 has been modified to have horizontal extension or leg 106 which has an upper facing bearing surface 108. This is designed to mate with a portion of the downwardly facing bearing surface 110 of lug 102. Lug 102 has a vertical dimension so it can be rotated into the vertical space between leg 106

and the lower surface 112 of indexing and load-bearing plateau 100. In operation, the upper string of pipe supporting lug 102 is lowered from an upper position such as 102A downwardly. Indexing and load-bearing plateau 100 causes the pipe to rotate so that the lug 102 is in the vertical passage 114 of the J-slot. Continual lowering of the upper pipe results in the lug eventually reaching the position 102N. Thus far, the operation is similar to that shown in FIGURE 4. When the lug is in position 102N, tension is applied to the upper string of pipe to pull the pipe upward where the lug reaches the position 102M. At this point, proper torque is applied to the pipe supporting lug 102 to move it into the position shown in FIGURE 9. If desired, a slight torque may be left on the upper section of the pipe to assure that the lug 102 is maintained in the position shown in FIGURE 9. If tension is ever lost on the upper string of pipe, the bearing surface 108 of leg 106 of indexing plateau 104 will resist downward movement.

Our co-pending Application No. 8220429 describes and claims a tool for securing a first tubular member to a second tubular member comprising:

- a male tubular member;
- a female tubular member adapted to fit over said male tubular member;
- a first J-slot and a second J-slot on either the interior of said female tubular member or on the exterior of said male tubular member, said J-slots being longitudinally spaced apart along such tubular member, said first J-slot being nearest the end of such tubular member;

- a first lug and a second lug on the tubular member not having the J-slots, said lugs being spaced apart longitudinally along such tubular member, the longitudinal distance between the bearing surfaces of said J-slots and the longitudinal distance between the bearing surfaces of said lugs being about equal, said first lug being nearest the end of such tubular member and said first J-slot being nearest the end of said J-slot member; and

- said first lug and said second J-slot forming a load-carrying engagement A and said second lug and said first J-slot forming a load-carrying engagement B, the design load carried by A and by B respectively designated F_A and F_B , and in which

$$K_J/K_L = F_A/F_B$$

where

- K_L = axial stiffness of said tubular member having said lugs and between the lug-bearing surfaces; and

- K_J = axial stiffness of said tubular member having said J-slots and between the J-slot bearing surfaces. It also describes and claims a tool having three longitudinal spaced J-slots.

CLAIMS

1. A tieback tool for sealingly securing a tubular

member suspended from a vessel floating on a body of water to a casing hung in a wellbore in the bottom of the body of water, comprising:

- a male tubular member;
- 5 a female tubular member adapted to fit over said male tubular member;
- J-slot means on one of said members and co-operating lug means on the other of said members; and
- 10 a self-energizing seal between an outwardly facing surface of a portion of one member and an inwardly facing surface of a portion of the other member, said tool being constructed so that for a given internal pressure said one portion has a greater radial expansion than said other portion and the resulting differential radial expansion of the portions causes compression of the seal.
- 15 2. A tieback tool according to Claim 1 comprising:
 - 20 a male tubular member having a neck with wall thickness t_1 ;
 - a female tubular member adapted to fit over said male tubular member and having a section with a wall thickness of t_2 which is greater than t_1 ;
 - 25 a J-slot means on either the female member or the male member and co-operating lug means on the other member; and
 - a self-energizing seal between said neck of said male tubular member and said section of said female tubular member.
- 30 3. A tool as defined in Claim 1 or Claim 2, in which said J-slot means comprises:
 - a longitudinal passage;
 - 35 an indexing and load-bearing plateau having an indexing race sloping toward said longitudinal passage;
 - a guiding race at the lower end of said passage having a nonzero slope with respect to the longitudinal axis of said female tubular member;
 - 40 a locking slot beneath said indexing and load-bearing plateau; and
 - an indexing plateau beneath a portion of said indexing and load-bearing plateau and adjacent said locking slot.
- 45 4. A tool as defined in Claim 3, including a plurality of circumferentially spaced J-slot means and a circumferential groove beneath said indexing and load-bearing plateaus and defining the load-bearing surface of each said load-bearing plateau.
- 50 5. A tieback tool as defined in Claim 1 or Claim 2, in which said J-slot means comprises:
 - an upper indexing and load-bearing plateau

having an indexing race thereon;

- 55 a lower load-bearing plateau;
- a vertical passage extending adjacent to said upper load-bearing plateau;
- an upper locking slot beneath said upper load-bearing plateau having a mouth opening into said vertical passage, the longitudinal dimension of said mouth being L_1 ;
- 60 a lower locking slot beneath said lower load-bearing plateau and having a mouth having a longitudinal dimension L_3 opening into said vertical passage;
- 65 and said lug means comprises:
 - an upper lug having a longitudinal dimension L_1 and a lower lug adapted to fit into said lower locking slot and having a longitudinal dimension L_2 ,
 - 70 said lower lug having a stabbing surface at the lower end thereof;
 - and wherein
 - L_1 is less than L_2 ; and
 - L_2 is greater than L but less than L_3 and L_1 is less than L .
- 75 6. A tool as defined in Claim 5, in which the lower end of said passage has a nonzero slope with respect to the longitudinal dimension of said slot between said upper and lower locking slots.
- 80 7. A tool according to Claim 6, in which the axial stiffness K_L of the member having the lug means between the two lugs is equal to the axial stiffness K_B of the member having the J-slot means between the two load-bearing plateaus.
- 85 8. A tool as defined in Claim 1, in which said female tubular member has an outer circumferential shell and an inner circumferential shell together forming an annulus into which said male member can be inserted, with the self-energizing seal being located between the inner shell and the male member, and the thickness t_3 of the wall of said inner shell is less than the thickness of the wall of said male member.
- 90 9. A tool as defined in any preceding claim, in which the lug means comprises a lug with an upper surface having a slope with respect to the horizontal plane perpendicular to the longitudinal axes of said female and male members and the J-slot means comprises a J-slot having a surface mating with said upper surface.
- 100 10. A tool as defined in Claim 10, in which the angle is between 0° to 20° .
11. A tieback tool substantially as hereinbefore described with reference to any of Figures 2 to 9 of the accompanying drawings.
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