Sept. 3, 1968 E. BURNS 3,399,548

AXIALLY EXTENSIBLE ROTARY DRIVE TOOL JOINT

Filed Dec. 29, 1966

Fig. 1.

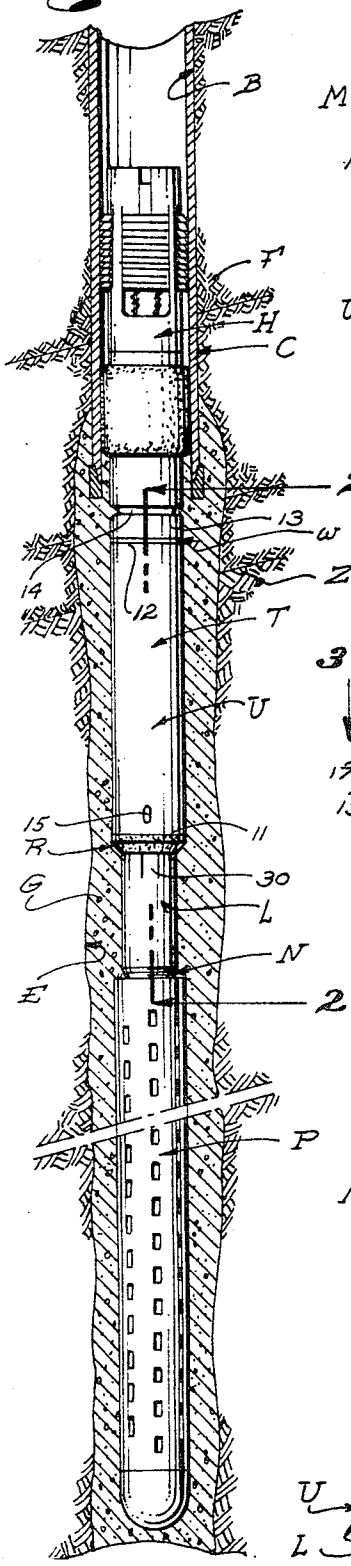


Fig. 2.

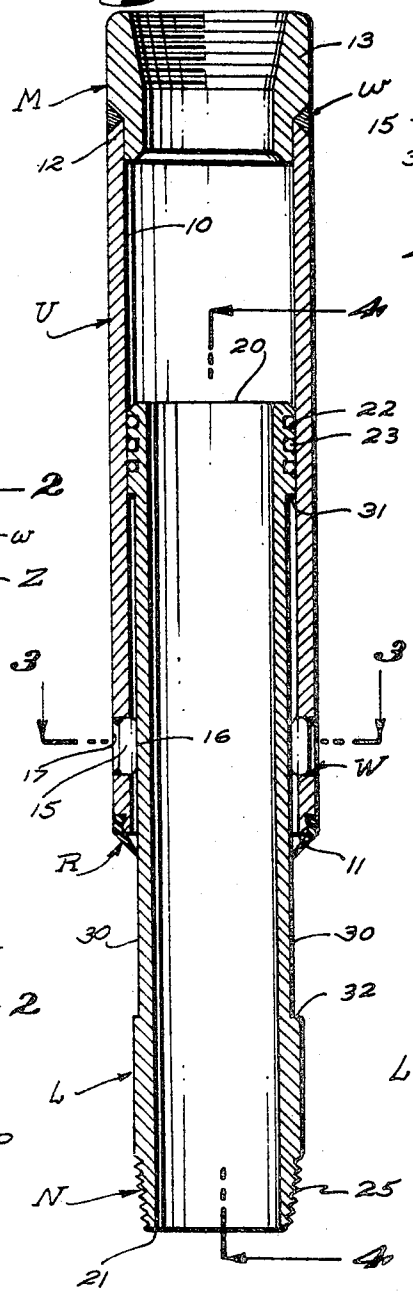


Fig. 3.

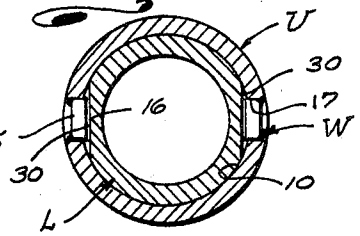


Fig. 4.

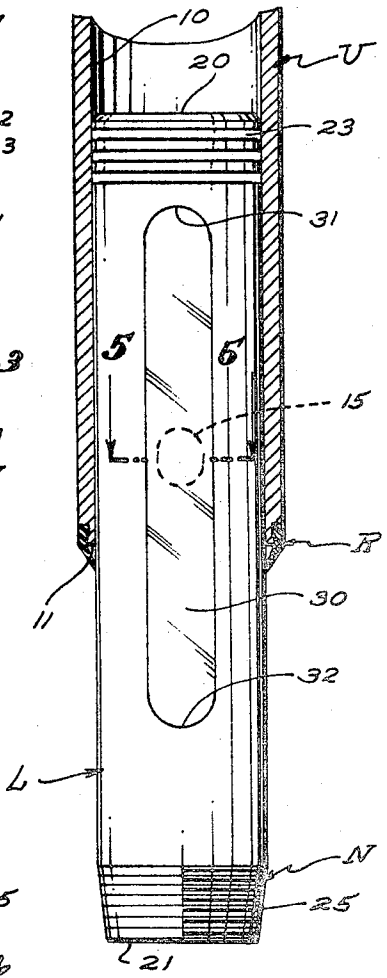
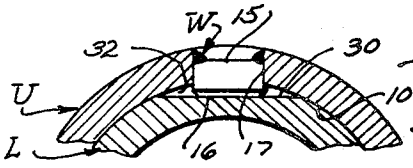


Fig. 5.



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AXIALLY EXTENSIBLE ROTARY DRIVE TOOL JOINT

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An extensible tool joint engageable between two axially aligned fluid conducting parts to allow for relative axial shifting between said part and comprising two telescopically engaged tubular sections, each engaged with one of said parts, circumferentially spaced, longitudinal flats on the inner sections, inwardly projecting flat engaging lugs on the outer section and sealing means between the sections.

The ordinary oil well structure includes, in addition to other elements and/or parts, an elongate casing suitably fixed in a well hole and terminating at an oil bearing or production formation in the earth; a liner hanger engaged in the lower end of the casing and an elongate perforated liner fixed to and carried by the liner hanger to depend from the hanger, below the casing and into a lower end portion of the well hole that extends into the production formation. The liner hanger in such structures is ordinarily provided with a packing means to seal the annulus between the casing and the upper end portion of the liner, or a suitable, separate packing tool is provided to seal said annulus.

The liners in such well structures are ordinarily held in the well holes by gravel suitably deposited and packed in the well holes about the liners, which gravel shores or supports the surrounding formation.

The ordinary liner hanger includes an elongate fluid conducting body fixed to the upper end of the liner and provided with a plurality of circumferentially spaced, wickered slips or wedges, which are selectively set to establish wedging engagement between the body and the interior of the casing about the body. The slips are arranged so that downward movement of the liner relative to the casing causes the slips to wedge tight with the casing and are such that upward shifting of the liner relative to the casing will cause the slips to release their tight engagement with the casing.

The packing means or packing tools in such structures include annular bodies of resilient, ductible or plastic sealing materials and axially spaced means operable to engage and compress the annular bodies axially to cause said bodies to distend radially and into tight sealing engagement with the casing and seal the annulus between the liner and casing.

In practice, with a structure of the type referred to above, if the upper part of the liner is caused to move upwardly relative to the casing, the hanger will release. Upon subsequent reversal of such relative movement of the liner and casing, the hanger will set or lock with the casing again. If this action is repeated several times, it will be apparent that the liner will move or be jacked up into the casing and out of the portion of the well hole in the production formation.

In practice, each time a liner is moved up in the portion of the well hole in which it is arranged and packed, as set forth above, gravel, sand and the like fill the lower end of the hole below it and prevent its subsequent movement back down and into the hole upon subsequent relative movement between the casing and liner which would otherwise permit such downward movement of the liner in the hole.

In recent years, to induce the flow of oil in the production formations in which oil wells are entered, it has become common practice to heat the formations and the oil therein, by directing and conducting super-heated steam down through the well structure and into the formation, for a predetermined period of time, to raise the temperatures to a predetermined amount and to then stop the flow of steam and allow the oil to flow into the wells. When the wells cool to an extent that the oil no longer flows as rapidly as desired, steam is again introduced into the formation, in the same manner, to reheat the formation and oil.

While the above noted procedure of heating wells has proven to be extremely effective with respect to the flow of oil, heating and cooling of the well structures causes axial expansion and contraction of the casing and liners, which axial expansion and contraction results in the above noted axial shifting between the liners and casings and the noted jacking up of the liners into the casings.

To allow for relative axial shifting of the liners and casings of well structures, in the manner and for the reasons set forth above, and to prevent the noted jacking up of the liners, axially extensible tool joints having been provided between the upper ends of liners and liner hangers. The extensible tool joints provided and employed by the prior art for the above application have been characterized by a pair of elongate, telescopically engaged tubular sections of pipe. One section, for example, the outer section establishes an upper section secured to the upper part or portion of the string in which the joint is engaged and the inner section establishes a lower section secured to the lower part or portion of the string in which the joint is engaged.

The upper outer sections of such joints are provided with cylindrical bores in their upper half portions and are provided with circumferentially spaced, longitudinally extending slot openings in their lower half portions. The lower inner sections are provided with sealing means about their upper ends to seal in the bores and are provided with radially outwardly projecting lugs substantially midway between their ends to engage the slot openings.

The above, typical, conventional extensible tool joint construction has several inherent shortcomings.

First, to provide the uninterrupted bore in the upper outer section (to allow for establishment of a necessary and desired seal between the sections) and to provide the upper outer section with the slot openings to allow for the necessary travel, the upper outer section must be more than twice as long as the travel to be afforded. The lower inner section must also be more than twice as long as the length of travel. This set-up results in a tool joint which is generally excessively long and a tool joint which is heavy, and uneconomical of material and costs.

Second, in the ordinarily or conventional extensible tool joint of the character referred to the slot openings in the lower half portion of the upper outer section must be established by cutting out a great amount of material, which is slow and costly, and materially weakens the outer section against torsional forces exerted onto and through the outer section by and through the lugs on the inner section.

An object of my invention is to provide an improved, axially extensible, rotary drive tool joint construction in which there are inner and outer telescopically engaged sections, the longitudinal extent of which is substantially less than twice the length of travel which is provided by the tool and a tool of the character referred to which is free of slot openings which would weaken the construction.

A further object of the present invention is to provide a tool joint of the character referred to which is such that it requires a minimum amount of material, is of minimum longitudinal extent, requires a minimum amount of machining and expenditure of time in its manufacture, and which is materially stronger, more effective and more

dependable than tool joints of a similar nature, provided by the prior art.

The foregoing and other objects and features of my invention will be fully understood from the following detailed description of a typical preferred form and carrying out of the invention, throughout which description reference is made to the accompanying drawings, in which:

FIG. 1 is a sectional view of an oil well structure with my new extensible tool joint related thereto;

FIG. 2 is an enlarged detailed sectional view as indicated by line 2—2 on FIG. 1;

FIG. 3 is a sectional view taken as indicated by line 3—3 on FIG. 2;

FIG. 4 is a detailed sectional view taken as indicated by line 4—4 on FIG. 2; and

FIG. 5 is an enlarged detailed sectional view taken as indicated by line 5—5 on FIG. 4.

The well structure shown in FIG. 1 of the drawings involves a well hole B in an earth formation F, a casing C set in the hole, an extension E of said hole entering a production zone Z in the earth formation, a combination liner hanger and packer tool H set in the lower end of the casing C, an elongate perforated liner P in the extension hole E and the tool joint T that I provide arranged between and engaged with the hanger tool H and the upper end of the liner P. The well structure further includes a packing of gravel G in the hole extension E about the line and other parts and/or portions of the structure within the hole extension E.

The extensible tool T includes an elongate, vertical, upper and/or outer, tubular fluid conducting section U and an elongate, vertical, lower and/or inner, tubular fluid conducting section L.

The upper outer section U is established of an elongate length of pipe having a straight, smooth bore **10**, an open lower end **11** and an upper end **12**.

The upper end **12** is provided with coupling means M adapted to connect the section with structure related to the upper end of the tool T, such as the hanger H. The means M can be in the form of internal or external thread in or about the pipe to cooperatively connect with a threaded port of an upper related structure, or can, as illustrated, be a ring-like, internally threaded box **13** suitably fixed to the pipe to receive a threaded pin **14** at the lower end of the hanger H.

The provision of the box **13** in the form of the invention illustrated affords connecting the section U to a threaded part having a diameter which is considerably less than the inside diameter of the section U. The box **13** of the means M is an extremely simple and inexpensive part to manufacture and, as illustrated, can be fixed in and to the upper end **12** of the section by welding W.

The lower end portion of the section U is provided with a pair of circumferentially spaced, radially inwardly projecting lugs **15**, which lugs have flat, radially inwardly disposed inner surfaces **16**.

In the case illustrated, the lugs **15** are established as separate parts arranged in radial openings **17** establish in the lower end portion of the section U and fixed therein by welding W.

The inner or lower section L is established of an elongate, straight length of pipe having open upper and lower ends **20** and **21**. The section L is substantially equal in outside diameter with the inside diameter of the section U and is adapted to be freely slidably engaged into the section U at the lower open end **11** thereof.

The upper end **20** of the section L is provided with a plurality of axially spaced, radially outwardly opening annular grooves **22** in which O-ring seals **23** are arranged. The seals **23** serve to seal between the bore **10** of the section U and the upper end of the section L.

The lower end of the section L is provided with coupling means N to facilitate connecting the section L to the structure related to the lower end of the tool T. In the case illustrated, the means N is simple threads **25** about the exterior of the section, establishing a pin for engagement in a threaded box (not shown) at the upper end of the perforated liner P.

Finally, the section L is provided with a pair of circumferentially spaced, radially outwardly disposed, longitudinally extending flats **30** extending between a point spaced below the grooves and O-rings at the upper end portion of the section L and a point above the means N at the lower end of the section L.

The flats **30** are established by a simple, fast and economic milling operation and are such that they establish axially downwardly and axially upwardly disposed upper and lower stop shoulders **31** and **32** at their upper and lower ends.

The lugs **15** carried by the section U project into the space defined by the flats **30** and the bore **10**, with the flat surfaces **16** of the lugs establishing flat, slidable engagement on the flats **30**.

The lugs **15** are preferably elongated, longitudinally of the construction, have rounded upper and lower ends and are chamfered about the edges of their flat surface **16**, as clearly illustrated in the drawings.

Further, the lateral extent of the lugs **15** is less than the lateral extent of the flats **30**, as clearly illustrated in FIG. 5 of the drawings, and so that the inner longitudinal side edges thereof are at all times clear of and spaced from the longitudinal corners established by the flats and the adjacent portions of the bore **10** in the section U and cannot wedge and bind therein in a manner which would prevent or impede free longitudinal shifting of the lugs along the flats.

In practice, the lugs **15** are welded and fixed in position after the section L is engaged in the section U.

In practice, the lower stop shoulders **32** can be spaced below the upper end **20** of the section L so that when the section L is moved upwardly the lugs stop against the shoulders **32** before the upper end **20** engages the box **13** of the means M or can be so spaced that the upper end **20** of the section L can engage and stop against the box, as desired or as circumstances require.

It will be apparent that the upper stop shoulders **31** engage the lugs **15** upon downward shifting of the section L relative to the section U and prevent axial separation of the sections.

It is to be noted that the flats **30** remove a minimum amount of stock from the section L and are such that they do not materially structurally weaken the section, as would slot openings and the like.

It will be further apparent that the lugs **15** related to the flats **30**, are such that the section L is free to shift axially in and relative to the section U, within the limits of the stop shoulder, but is not free to rotate relative thereto. The presence of the lugs in the space defined by the bore **10** and flats **30** effectively and positively prevents relative rotative movement of the sections U and L.

While the moments of force exerted by the lugs **15** on the flats **30**, upon the application of relative rotative forces between the sections, is resolved somewhat radially inwardly and in a manner that would tend to collapse the section L, it has been determind that the resulting structure is materially stronger than similar tools, where lugs are engaged in slot openings, in which the equivalent moments of force are resolved tangentially of the slotted sections. In the latter case, the slotted sections are so weakened by the establishing of the slots therein that they readily twist and collapse when subjected to torsional forces.

In practice, if desired, a rubber wiper sleeve ring R can be provided at the lower end **11** of the section U to engage and wipe about the exterior of the section L to prevent the entry of abrasives into the construction which might damage the bore and adversely affect the seal established by the O-rings **23**.

It will be apparent that the tool joint that I provide is

neater and more compact than ordinary or conventional tool joints of the same or similar character, is lighter and more economical of material and yet stronger and more durable than the noted conventional tool joints, and is far easier and more economical to manufacture than such conventional expansible tool joints.

Having described only a typical preferred form and application of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any modifications and/or variations that may appear to those skilled in the art and which fall within the scope of the following claims.

Having described my invention, I claim:

1. An extensible tool joint including, an elongate, vertically extending upper outer section with a longitudinal cylindrical bore, coupling means at its upper end to connect with a related fluid conducting upper structure and circumferentially spaced, radially inwardly projecting lugs at its lower end, and elongate, cylindrical, vertically extending lower inner section with a central flow passage slidably engaged in the outer section with its lower end portion depending therefrom, sealing means carried by the upper end of the inner section and sealing between that section and the bore, coupling means at the lower end of said inner lower section to connect with a related fluid conducting lower structure and circumferentially spaced, longitudinally extending radially outwardly disposed flats in the central portion of the inner lower section spaced from and opposing the bore in the outer section and slidably engaging the lugs.

2. A structure as set forth in claim 1 in which the lugs have flat, radially inwardly disposed surfaces opposing and establishing flat sliding engagement on the flats.

3. A structure as set forth in claim 1 in which said flats terminate at the opposite end portions of the inner section and define axially downwardly and upwardly disposed upper and lower stop shoulders to engage the lugs and to limit relative axial shifting of the inner and outer sections.

4. A structure as set forth in claim 1 in which said sealing means includes axially spaced radially outwardly opening, annular grooves in the upper end portion of the inner section and O-rings in the grooves and sealing between said inner and outer sections.

5. A structure as set forth in claim 1 in which the lugs have flat, radially inwardly disposed surfaces opposing and establishing flat, sliding engagement on the flats, the lateral extent of the lugs being less than the lateral extent of the flats and arranged with their central longitudinal axes in the same radial planes as the central longitudinal axes of the flats.

6. A structure as set forth in claim 1 in which the lugs have flat, radially inwardly disposed surfaces opposing and establishing flat, sliding engagement on the flats, the lateral extent of the lugs being less than the lateral extent of the flats and arranged with their central longitudinal axes in the same radial planes as the central longitudinal axes of the flats, said flats terminating at the opposite end portions of the inner section and defining axially downwardly and upwardly disposed upper and lower stop shoulders to engage the lugs and to limit relative axial shifting of the inner and outer sections.

7. A structure as set forth in claim 1 in which the lugs have flat, radially inwardly disposed surfaces opposing and establishing flat, sliding engagement on the flats, the lateral extent of the lugs being less than the lateral extent of the flats and arranged with their central longtiudinal axes in the same radial planes as the central longitudinal axes of the flats, said flats terminating at the opposite end portions of the inner section and defining axially downwardly and upwardly disposed upper and lower stop shoulders to engage the lugs and to limit relative axial shifting of the inner and outer sections, said sealing means including axially spaced radially outwardly opening, annular grooves in the upper end portion of the inner section and O-rings in the grooves and sealing between said inner and outer sections.

8. A structure as set forth in claim 1 wherein said lower end of the outer section has circumferentially spaced, radial lug receiving openings, said lugs comprising block members slidably engaged in said openings as fixed therein by welding.

9. A structure as set forth in claim 1 in which the lugs have flat, radially inwardly disposed surfaces opposing and establishing flat, sliding engagement on the flats, the lateral extent of the lugs being less than the lateral extent of the flats and arranged with their central longitudinal axes in the same radial planes as the central longitudinal axes of the flats, said flats terminating at the opposite end portions of the inner section and defining axially downwardly and upwardly disposed upper and lower stop shoulders to engage the lugs and to limit relative axial shifting of the inner and outer sections, and sealing means including axially spaced radially outwardly opening, annular grooves in the upper end portion of the inner section and O-rings in the grooves and sealing between said inner and outer sections, said lower end of the outer section having circumferentially spaced, radial lug receiving openings, engaged in said openings as fixed therein by welding.

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