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(54) Overshot fishing tools.

(57) Overshot fishing tools for removing stuck thin-wall tubing from well boreholes. The tool comprises at least one slip formed to apply a radially inwardly directed grip on the thin-wall tubing. The grip is concentrated in a longitudinally limited region of the tubing, preferably in a single circumferential line thereon. The grip concentration induces necking of the thin-wall tubing, which ultimately parts (unless previously pulled free). The slip is formed to maintain its grip even when the tubing diameter is reduced below the size at which prior art fishing tools could lose grip.

A preferred form of the overshot fishing tool has two such slips, each operatively associated with an internally tapered slip-actuating slip bowl. The upper slip bowl is preferably arranged for limited longitudinal movement inside the tool casing such that the upper slip applies a primary grip to the thin-wall tubing and moves its slip bowl down to actuate the lower slip to apply a secondary grip to the tubing.

The overshot fishing tool is particularly applicable to fishing coil tubing as used for workovers in hydrocarbon wells.

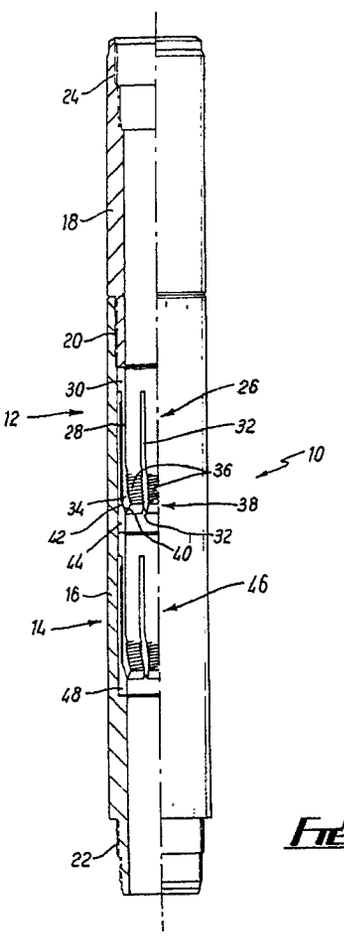

Fig.1

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OVERSHOT FISHING TOOLS

This invention relates to overshot fishing tools and relates more particularly but not exclusively to overshots for fishing coil tubing that is trapped down oil or gas wells.

The advantage of coil tubing is the ability to workover the well without the use of a drilling rig, thus saving time and workover costs.

A variety of through-tubing workover tools have been developed over the last few years which are marketed by various coil tubing operators and service companies.

Common applications for coil tubing may be:-
fluid cleanouts;
N_2 gas lifts;
cement squeeze;
acid and chemical spotting;
descaling and cement drilling;
fishing operations.

On occasion the coil tubing workstring may become stuck due to unknown circumstances within the wellbore. Several tools are available to run on coil tubing with the original workstring to permit a controlled separation of the coil from the BHA (bottom-hole assembly).

However, in certain instances the coil tubing may be parted accidentally due to operator error. This typically results in the need for what is commonly known as a "fishing operation" to retrieve the broken tubing from the well.

The purpose of the fishing operation is to locate, latch, and retrieve the stuck or severed piece of coil tubing which has been left in the wellbore. There are various tools available from a range of service companies which can be selected and attached to the bottom of a fishing string.

One very important feature of a fishing tool is the method of catch and release of the retrieving mechanism. Almost every application depends greatly on the condition in which the top of the coil has been left.

If the coil tubing has been broken in tension then the fish top is most likely to be reasonably round and clean.

This would be considerably simpler to engage with an overshot type tool as they depend on the fish being of a reasonably undistorted condition, both dimensionally and circumferentially.

In most cases coil tubing fishing tools have latching mechanisms which are designed to catch a nominal size tubing. Most are energised by upwards pull against tapered surfaces. However, such tools are designed for a nominal minimum catch size. Coil tubing, being very ductile and relatively thin walled, is quite easy to collapse. Therefore if by the time the minimum catch size has been reached on the grapple, the fish or coil tubing has not come free, the overshot or fishing tool may slip off prematurely.

As used in the specification and the accompanying claims, the term "thin-wall tubing" refers to tubing which has a wall thickness significantly less than the wall thickness of strings, pipes, casings, and the like, which are sufficiently thick-walled as to substantially withstand radial collapsing loads applied thereto by the slip of a typical prior-art overshot fishing tool. By way of contrast, thin-wall tubing is liable to suffer a radial collapse when subjected to the radial gripping force applied thereto by the slip of a typical prior-art overshot fishing tool upon an overpull being applied in an attempt to free stuck thin-wall tubing. The term "thin-wall tubing" particularly but not exclusively includes coil tubing as employed for through-tubing workover programmes on oil or gas wells.

It is therefore an object of the invention to provide an overshot fishing tool for fishing thin-wall tubing, and which obviates or mitigates the disadvantages of prior-art overshot fishing tools when applied to fishing thin-wall tubing.

According to a first aspect of the present invention there is provided an overshot fishing tool for use on thin-wall tubing extending longitudinally through said tool, said overshot fishing tool comprising at least one slip radially actuable by a longitudinal pull on said tool to apply a radially inwardly directed grip on thin-wall tubing in a longitudinally concentrated region thereof, said slip being such that said radially inwardly directed grip is maintained on said longitudinally concentrated region of the thin-wall tubing as said region circumferentially contracts by necking of the thin-wall tubing while said longitudinal pull exceeds the longitudinal yield level of said thin-wall tubing in said longitudinally concentrated region thereof, until said thin-wall tubing longitudinally parts at said region unless said longitudinal pull previously exceeds a longitudinal force longitudinally restraining longitudinal movement of the thin-wall tubing.

Said slip preferably comprises a circumferentially distributed array of radially inwardly moveable and radially inwardly directed jaws each shaped for line contact with the thin-wall tubing along a common circumference thereof. Said slip is preferably formed by a cylindriform array of a plurality of fingers longitudinally extending from a common circumferentially extending annulus, said fingers being mutually divided by longitudinally extending slots and said jaws being formed adjacent the free ends of said fingers, one said slot preferably extending through said annulus. The free ends of said

fingers are preferably externally tapered away from said common annulus to form a generally conical external surface, and said tool preferably also comprises a substantially matchingly conical internal surface such that relative longitudinal movement of said surfaces produces a wedging action that causes said slip to apply said radially inwardly directed grip. Said conical internal surface is preferably formed on a slip bowl mounted inside said tool and operatively associated with said slip.

Said tool preferably comprises two such slips and slip bowls longitudinally spaced along the longitudinal axis of said tool with one said slip being the upper slip and having its jaws dimensioned to grip the thin-wall tubing in a primary grip prior to a secondary grip applied to the thin-wall tubing by the jaws of the other said slip, the slip bowl operatively associated with said upper slip being mounted inside said tool for limited longitudinal movement relative to said tool such that upon said primary grip being applied to the thin-wall tubing, said slip bowl undergoes longitudinal movement to engage the other said slip to drive the other said slip against the slip bowl operatively associated therewith to cause the other said slip to apply said secondary grip to the thin-wall tubing.

According to a second aspect of the present invention there is provided a fishing arrangement for fishing thin-wall tubing, said fishing arrangement comprising an overshot fishing tool according to the first aspect of the present invention, in combination with a hollow fishing string having a through bore with an internal diameter greater than the external diameter of thin-wall tubing to be fished by said arrangement, said through bore having an internal length at least equal to the length of thin-wall tubing to be swallowed thereby to the point at which the thin-wall tubing is to be gripped by said tool and potentially parted thereby.

Embodiments of the invention will now be described by way of example, with reference to the accompanying drawings wherein:-

Fig. 1 is a diametrally half-sectioned longitudinal elevation of a first embodiment of the present invention;

Fig. 2 is a diametrally sectioned elevation, to an enlarged scale, of part of the first embodiment;

Fig. 3 is a view, to a further enlarged scale, of a detail of the first embodiment; and

Fig. 4 is a schematic representation of a second embodiment of the present invention.

Referring first to Fig. 1, the first embodiment of the present invention is an overshot twin-slip fishing tool 10 having an upper slip assembly 12 and a lower slip assembly 14. The tool 10 is generally cylindrical, with a main hollow casing section 16 and an upper casing section 18 secured to the main casing section 16 by means of a screw-thread connection 20. A screw-thread connection 22 at the lower end of the main casing section 16 and a screw-thread connection 24 at the upper end of the upper casing section 18 enable the tool 10 to be screw-threadedly coupled into a hollow fishing string during use of the tool 10.

The upper slip assembly 12 comprises a cylindriform slip 26 having six fingers 28 depending from a common circumferentially extending annulus 30. The fingers 28 are defined by and mutually separated by longitudinally extending slots 32 one of which extends through the annulus 30 to give the slip 26 as a whole circumferential elasticity, while this and the other slots 32 cause the fingers 28 to act as radially deformable resilient cantilevers rooted in the annulus 30. The free ends of the slip fingers 28 are formed with radially inwardly facing bi-conical jaws 34 with serrated upper surfaces 36. It is of particular significance, as will be detailed below, that the slip jaws 34 collectively form a single very narrow internal gripping circumference 38 in the slip 26.

The outer surfaces 40 of the free ends of the slip fingers 28 are conically tapered and are co-operatively associated with a matchingly tapered surface 42 formed on a slip bowl 44 forming the other major component of the upper slip assembly 12 besides the slip 26. The slip bowl 44 is externally cylindrical and mounted within the base of the main casing section 16 to have a limited range of longitudinal movement therein, for a purpose detailed below.

The lower slip assembly 14 similarly comprises a slip 46 and a slip bowl 48, the lower slip 46 being substantially identical to the upper slip 26, and the lower slip bowl 48 being substantially identical to the upper slip bowl 44, save that the lower slip bowl 48 is mounted within the main casing section 16 to be static therein during use of the tool 10.

In the upper and lower slip assemblies 12 and 14, the slips 26 and 46 together with the slip bowls 44 and 48 are formed of nitride case-hardened alloy steel.

A diametral section of the upper and lower slip assemblies 12 and 14 is shown to an enlarged scale in Fig. 2, while details of the serrated upper jaw surfaces 36 are shown to an even larger scale in Fig. 3.

In Fig. 2, the upper slip 26 is shown moved downwards relative to its cooperatively associated slip bowl 44 such that the tapered surfaces 40 and 42 respectively on the slip 26 and on the slip bowl 44 have interacted to force each of the slip jaws 34 radially inwards all round the slip 26, by radially inward bending of the slip fingers 28, and to a certain extent, by closing-up of the one of the longitudinal slots 32 that extends completely through the slip annulus 30. By way of contrast in

the lower slip assembly 16 as depicted in Fig. 2, the lower slip 46 is not moved towards its co-operatively associated slip bowl 48, and the lower slip 46 is fully uncontracted.

In Fig. 3, the detail is a diametral sectional view of the tip of the slip jaw 34. Not directly visible in Fig. 3 (but see Fig. 1) is the formation of the serrations 36 as a left-hand wicker thread to facilitate rotational removal of fish after use of the tool 10. This structural feature is the same on both of the slips 26 and 46.

The function of the continuous coil tubing slip-type overshot fishing tool 10 of the present invention is to swallow the coil tubing continuously up through the bore of its casing sections 16 and 18. A suitably sized workstring (fishing string) will be run above the overshot fishing tool 10 to accommodate the coil tubing fish being swallowed. Once swallowed to a sufficient extent, an upward pull of the workstring will then engage the slips 26 and 46 on to the outside diameter of the coil tubing securing it firmly.

The slips 26 and 46 are manufactured with an internally tapered wicker thread, the point 36 of which initially concentrates a radial crushing load on the circumference of the coil tubing fish to cause necking (circumference reduction) of the coil tubing. The wicker profile is case hardened to bite in to the coil tubing. Once necking has progressed to the point at which the coil tubing fish is parted, the coil tubing may then be pulled from the well. The slips have shown in practice to be capable of carrying up to 80% of the yield strength of the coil tubing as necking has been apparent on tests conducted. Once yielding has occurred then an overpull applied through the fishing string will result in a tensile failure of the coil tubing directly underneath the lower slip teeth. This controlled overpull allows the operator to govern his overpull at his own discretion during the fishing and retrieval operation.

It is also possible to use the slip-type coil tubing overshot as a latch and retrieve overshot in instances where the coil tubing is not stuck. The slip-type overshot fishing tool 10, because of its design, may be run on a stronger and suitably sized coil tubing fishing string. This gives the capacity to pull and retrieve the coil tubing, if free, or the capacity to latch and break, if the coil tubing is permanently stuck.

Once latched the coil tubing maintains a round profile. This may be particularly useful in instances where a BHA is perhaps stuck further down the coil. A drop-ball release mechanism may be operated and the coil tubing pulled free from the BHA.

One other important point is, that should circulation be required through the fish, then a packoff sub may be run in conjunction with the overshot fishing tool 10 to enable latch and circulation through the complete workstring.

On retrieval, the overshot fishing tool 10 leaves the top of the coil tubing in good round clean condition for relatching, if necessary. The slips 26 and 46 in the coil tubing slip-type overshot fishing tool 10 can accommodate up to plus 20% out-of-round fish or flattened fish during initial engagement.

The dual slip design shown in Fig. 1 (and detailed in Fig. 2) allows either slip 26 or 46 to carry the ultimate breaking load of the coil tubing on the grapple legs 28, in the unlikely event that radial collapse of the coil tubing is evident beyond the designed allowable travel on the tapered slip bowls 44 and 48. Once this point is reached the external shoulder (40) on the respective slip 26 or 46 locates on the upper shoulder (42) of the slip bowl 44 or 48 and the grapple legs 28 are subjected to the overpull load. The dual slip design allows partial distribution of the load across both slips 26 and 46.

The slips 26 and 46 have mutually different catch (jaw point) diameters to induce latching in a controlled manner.

With the upper slip 26 having a smaller natural (uncontracted) jaw point (36) diameter in the free state it is designed to bite first on the coil tubing, transferring the applied axial pull down through the upper slip bowl 44 to the shoulder (annulus) of the lower slip 46 causing it to collapse down the tapered lower slip bowl 48 and bite the coil tubing for a second time.

This controlled loading mechanism allows both slips 26 and 46 to carry longitudinal fishing load. However, it is recognised that the coil tubing immediately below the lower slips 46 is subjected to the higher tensile load, therefore inducing the break in the coil tubing directly below the teeth on the lower slip 46.

Most prior art overshots have a catch and release type mechanism which requires axial or rotational movement to function. By way of contrast, the overshot fishing tool 10 of the present invention is suitable for coil tubing or other thin-wall tubing fish because the tool 10 concentrates a high radial load on a longitudinally highly localised region of the thin-wall tubing (effectively on a single circumferential line) at the point 36 where the slip jaws 34 grapple the thin-wall tubing, which ensures continued engagement even as the thin-wall tubing collapses radially inwards. The slips 26 and 46 also have an allowable radially inward jaw contraction far exceeding the equivalent maximum contraction on conventional overshots. This ensures continued slip grip until necking has progressed to the point of parting the thin-wall tubing. Prior art slips distrib-

ute their circumferential grip over a much greater axial length of the fish, as they are designed to do to avoid excessive radial load concentration. The prior art slips are also designed to have a much greater minimum diameter at which radial grip is maintained, such that when used on thin-wall tubing, such tubing will collapse to the point at which grip is lost, before necking progresses to the extent that the thin-wall tubing is parted.

Prior art fishing tools which maintain grip on tubing without load concentration may be able to pull the tubing free by breaking it by means of an overpull, but the position of the break will not be controlled and could occur anywhere, being determined only by the overpull and not by necking at a predetermined position on the tubing.

Thus the overshot fishing tool 10 of the present invention is ideal for fishing coil tubing and other thin-wall tubing, as it is designed to concentrate loading in a manner parting the tubing, and to maintain such grip despite the relatively large diameter reduction involved. If the tubing fish pulls free before being parted by necking, the result is equally satisfactory in terms of removing the fish from the borehole.

Fig. 4 depicts, in a highly schematic manner, a second embodiment 100 of overshot fishing tool in accordance with the invention, and its effect on a coil tubing fish 102. The second embodiment differs from the first embodiment (shown in Fig. 1 and detailed in Figs. 2 and 3) in that the second embodiment employs a single slip 104 (schematically depicted in Fig. 4 by a single diametral longitudinal cross-section). The slip 104 is formed to the same design as the slip 26 detailed in Fig. 2, and is cooperatively associated with an internally tapered slip bowl (omitted from Fig. 4) of the same design as the slip bowl 44 detailed in Fig. 2.

Fig. 4 schematically depicts the slip 104 having applied a radially inwardly directed and highly concentrated line load on the tubing 102 to an extent that the tubing 102 has necked and ultimately parted, so enabling fishing of coil tubing (or other thin-wall tubing) by controlled parting of the tubing at a predetermined location (the point of application of the single-slip overshot fishing tool 100). The longitudinal lift applied to the tool 100 and hence through the slip bowl to the slip 104 to contract the slip 104 causing necking and ultimate parting of the tubing 102, lifts the parted tubing 102 to remove it from the borehole.

While certain alternatives and variations of the above embodiments have been described, the invention is not restricted thereto, and other modifications and variations can be adopted without departing from the scope of the invention as defined in the appended claims.

Claims

1. An overshot fishing tool for use on thin-wall tubing extending longitudinally through said tool, said overshot fishing tool comprising at least one slip radially actuable by a longitudinal pull on said tool to apply a radially inwardly directed grip on thin-wall tubing in a longitudinally concentrated region thereof, said slip being such that said radially inwardly directed grip is maintained on said longitudinally concentrated region of the thin-wall tubing as said region circumferentially contracts by necking of the thin-wall tubing while said longitudinal pull exceeds the longitudinal yield level of said thin-wall tubing in said longitudinally concentrated region thereof, until said thin-wall tubing longitudinally parts at said region unless said longitudinal pull previously exceeds a longitudinal force longitudinally restraining longitudinal movement of the thin-wall tubing.

2. An overshot fishing tool as claimed in Claim 1 wherein said slip comprises a circumferentially distributed array of radially inwardly movable and radially inwardly directed jaws each shaped for line contact with the thin-wall tubing along a common circumference thereof.

3. An overshot fishing tool as claimed in Claim 2 wherein said slip is formed by a cylindriform array of a plurality of fingers longitudinally extending from a common circumferentially extending annulus, said fingers being mutually divided by longitudinally extending slots and said jaws being formed adjacent the free ends of said fingers.

4. An overshot fishing tool as claimed in Claim 3 wherein one said slot extends through said annulus.

5. An overshot fishing tool as claimed in Claim 3 or Claim 4 wherein the free ends of said fingers are externally tapered away from said common annulus to form a generally conical external surface, and said tool also comprises a substantially matchingly conical internal surface such that relative longitudinal movement of said surfaces produces a wedging action that causes said slip to apply said radially inwardly directed grip.

6. An overshot fishing tool as claimed in Claim 5 wherein said conical internal surface is formed on a slip bowl mounted inside said tool and operatively associated with said slip.

7. An overshot fishing tool as claimed in Claim 6 wherein said tool comprises two such slips and slip bowls longitudinally spaced along the longitudinal axis of said tool with one said slip being the upper slip and having its jaws dimensioned to grip the thin-wall tubing in a primary grip prior to a secondary grip applied to the thin-wall tubing by the jaws of the other said slip, the slip bowl operatively associated with said upper slip being mounted in-

side said tool for limited longitudinal movement relative to said tool such that upon said primary grip being applied to the thin-wall tubing, said slip bowl undergoes longitudinal movement to engage the other said slip to drive the other said slip against the slip bowl operatively associated therewith to cause the other said slip to apply said secondary grip to the thin-wall tubing.

8. A fishing arrangement for fishing thin-wall tubing, said fishing arrangement comprising an overshot fishing tool as claimed in any preceding Claim, in combination with a hollow fishing string having a through bore with an internal diameter greater than the external diameter of thin-wall tubing to be fished by said arrangement, said through bore having an internal length at least equal to the length of thin-wall tubing to be swallowed thereby to the point at which the thin-wall tubing is to be gripped by said tool and potentially parted thereby.

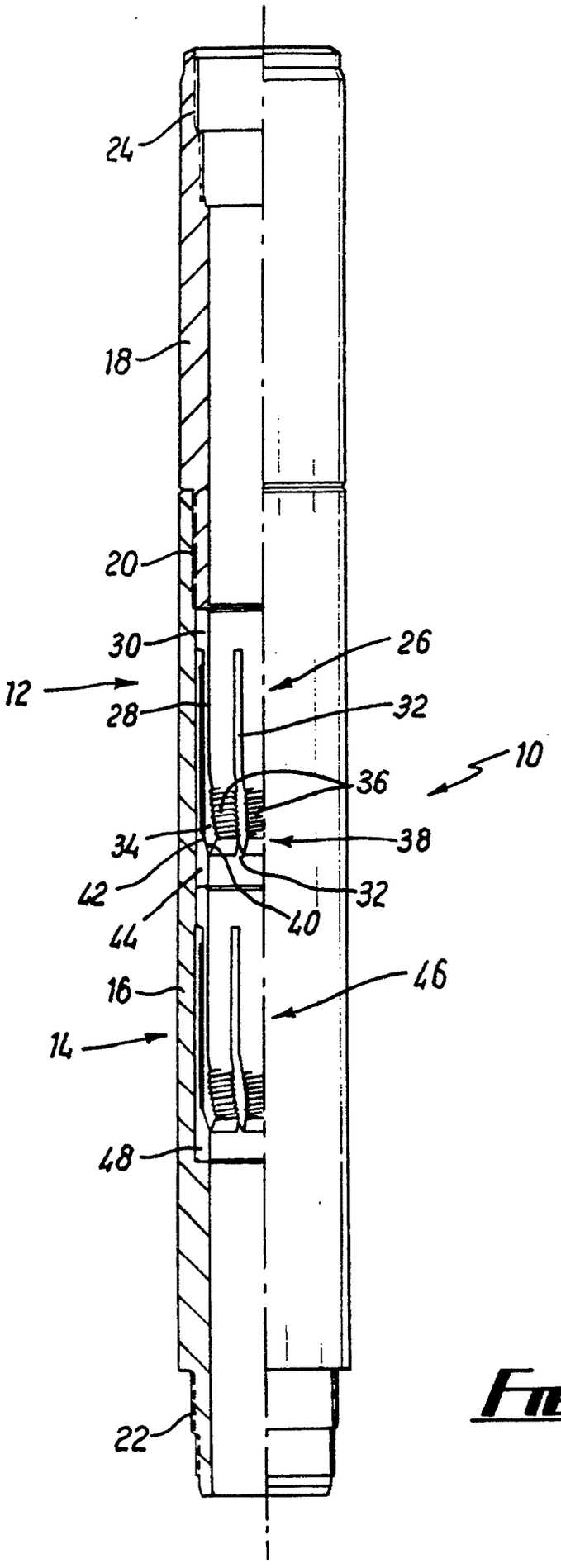

FIG. 1

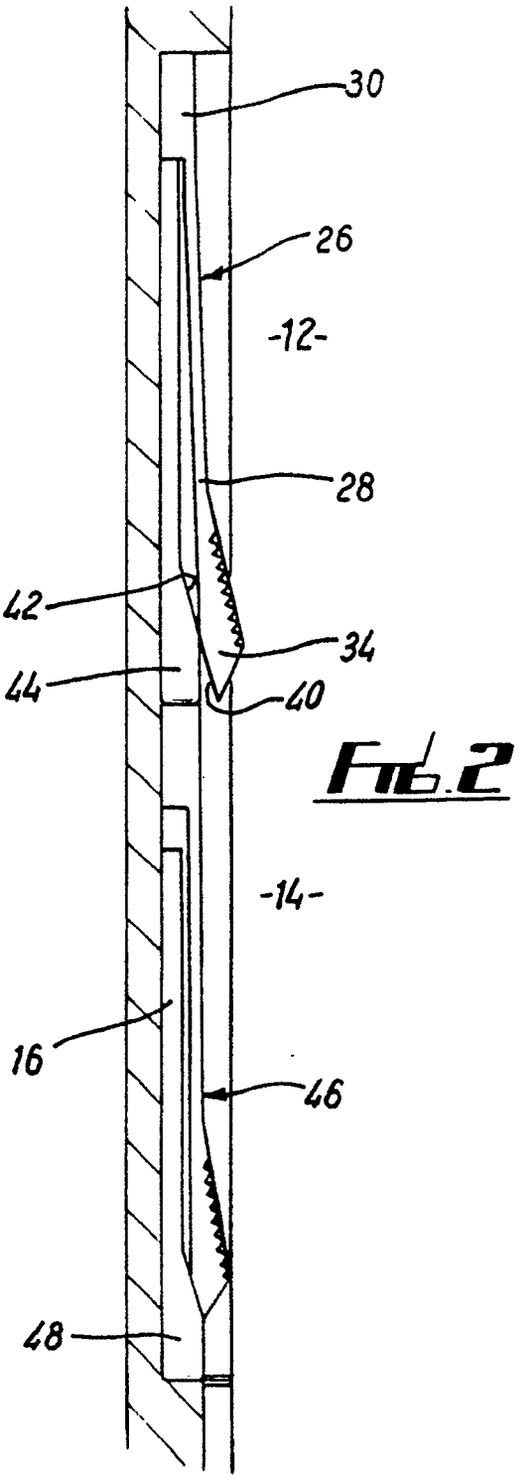

FIG.2

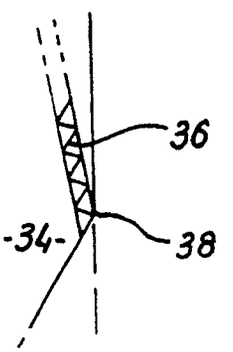

FIG.3

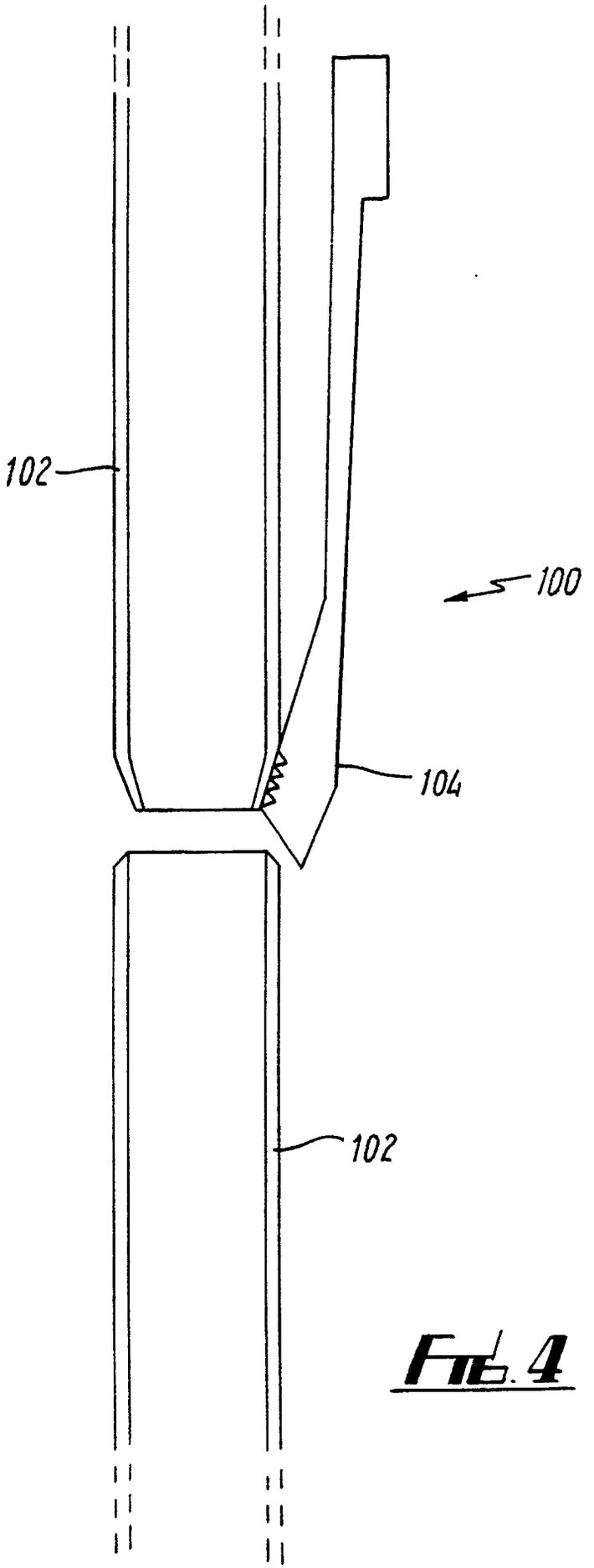

FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 30 9982

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-3 174 548 (D.D.WEBB) * column 4, line 75 - column 5, line 20 *	1	E 21 B 31/18
A	US-A-3 727 967 (E.V.ANASTASIU ET AL.) * abstract *	7	
A	US-A-4 185 865 (W.T.TAYLOR) * abstract *	1-3	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E 21 B

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	13 December 90	RAMPELMANN K.

CATEGORY OF CITED DOCUMENTS

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