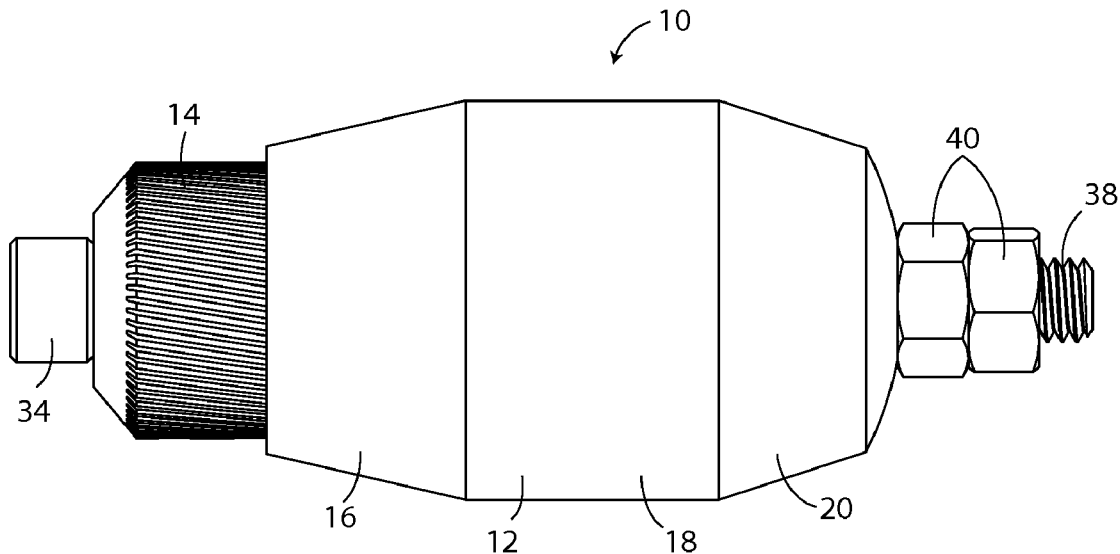




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(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2017/0128993 A1**
(43) **Pub. Date:** **May 11, 2017**(54) **FLOATING DRAW PLUG AND METHOD OF
DRAWING TUBE**(52) **U.S. Cl.**
CPC . **B21C 1/24** (2013.01); **B21C 3/16** (2013.01)(71) Applicant: **Penn Aluminum International LLC**,
Murphysboro, IL (US)(57) **ABSTRACT**(72) Inventors: **Aaron Norris**, Herrin, IL (US); **James
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A floating draw plug for shaping tube comprises a necking body and a rib forming member. The necking body has an axis and a trailing end portion. The trailing portion has a cross-section that is symmetric about the axis and that converges toward the axis as it extends downstream. The rib forming member comprises helical protrusions and helical grooves. The helical protrusions and the helical grooves are aligned with the axis. The rib forming member is connected to the necking body in a manner such that at least a portion of the helical protrusions and at least a portion of the helical grooves extend downstream of the trailing portion of the necking body and such that the rib forming member is free to rotate about the axis relative to the necking body.

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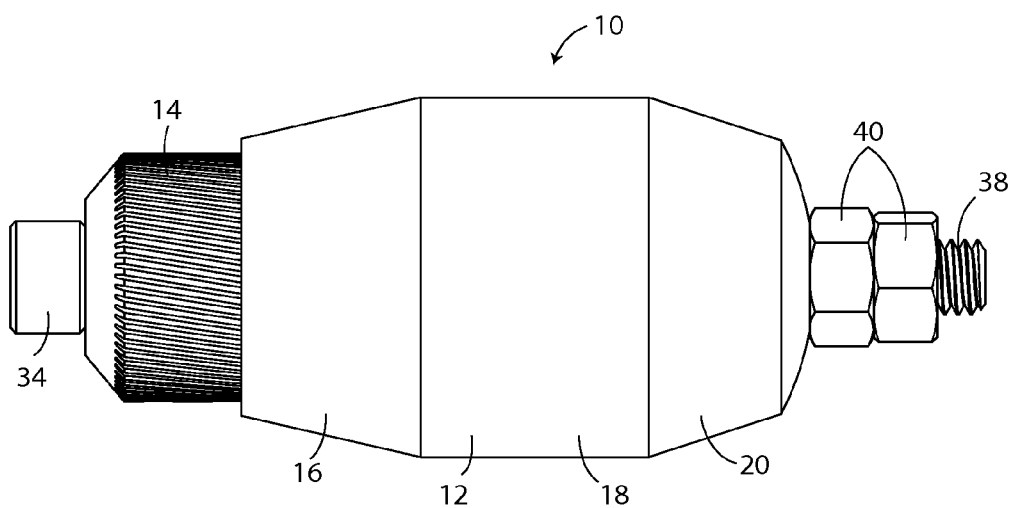


FIG. 1

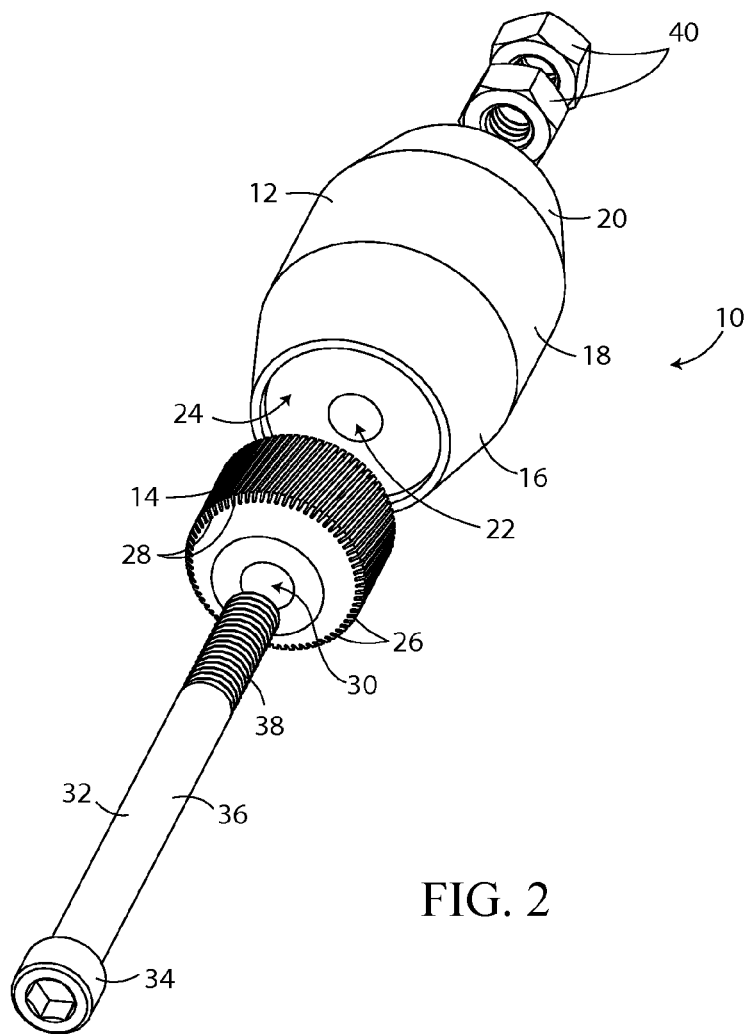


FIG. 2

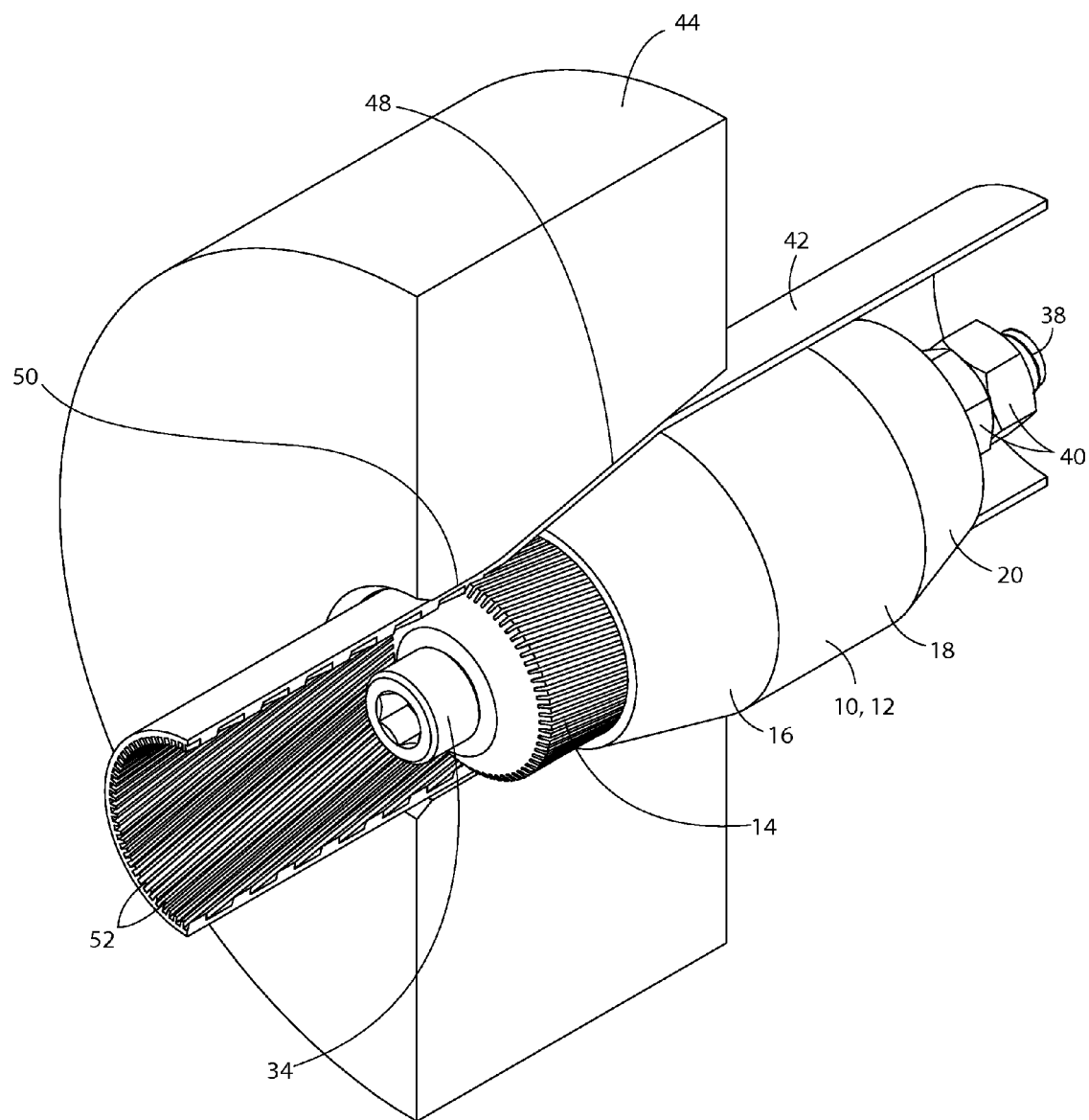


FIG. 3

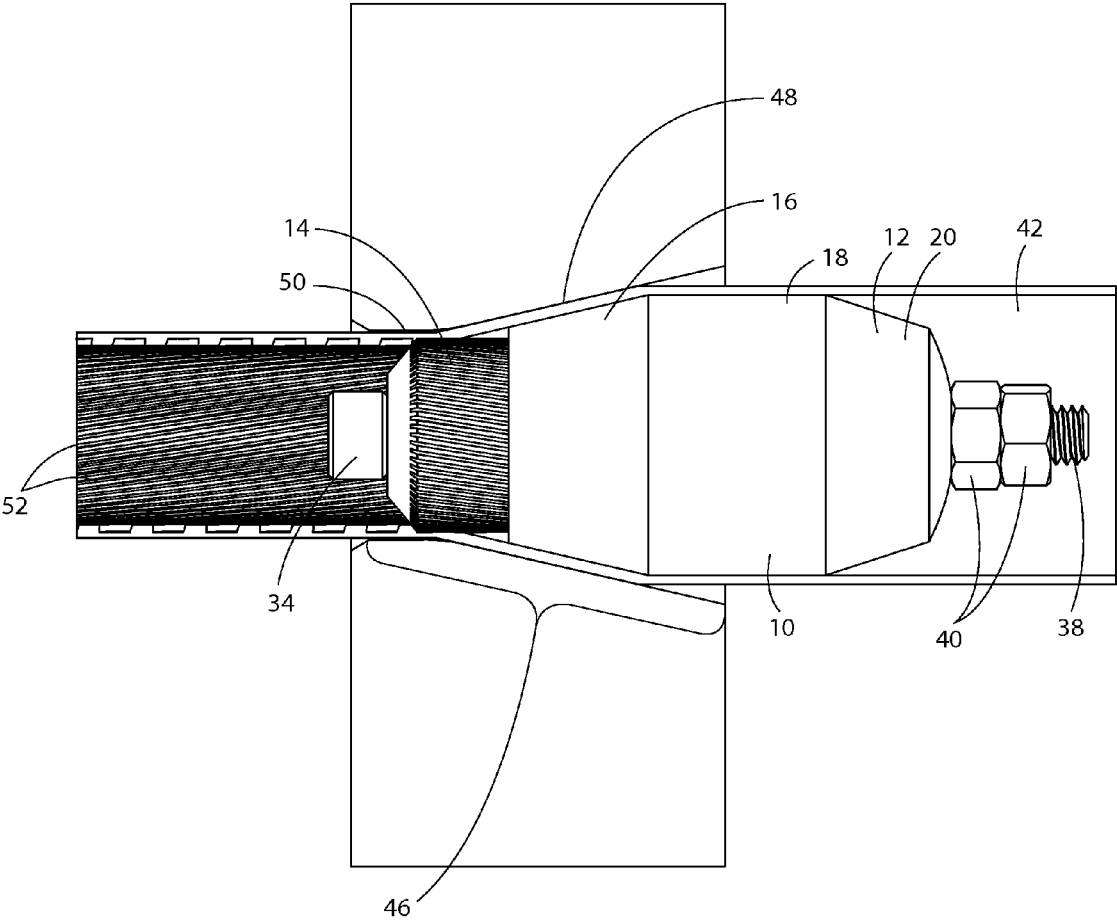


FIG. 4

FLOATING DRAW PLUG AND METHOD OF DRAWING TUBE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not Applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable.

APPENDIX

[0003] Not Applicable.

BACKGROUND OF THE INVENTION

[0004] Field of the Invention

[0005] The present invention pertains to a floating draw plug for forming internal helical ribs in tubing and a method of using the same. More particularly, the present invention pertains to a draw plug having a rib forming portion that is axially tethered to but rotationally disjoined from the necking portion of the draw plug.

[0006] General Background

[0007] Floating draw plugs are commonly used to reduce the diameter of tubing. Float drawing, as opposed to rod or fixed plug drawing, allows for infinite lengths of tubing to be drawn since no tooling needs to extend axially out of the tubing. Depending upon the pull forces and angles of taper, pulling a tube between a draw plug and die can increase or decrease the wall thickness of tubing. In some cases it is desirable to form internal ribs/protrusions into tubing by floating draw plug methods. Such ribs/protrusions create grooves that can guide fluid through the tubing. Axially aligned ribs/protrusions also facilitate the manufacturing of tube-inside-tube (double-wall) products. Such products can serve well as heat exchangers. But internally ribbed tubing can also serve well as single-wall heat exchangers. However, tubing with axially aligned ribs/protrusions do not necessarily provide the optimal flow-path for fluids. In some cases, it is ideal to have tubing with helical internal ribs, but forming internal helical ribs using drawings methods has been a challenge. To form internal helical ribs into tubing using a draw plug, the draw plug or tubing necessarily needs to rotate about the tubing's lengthwise axis. When drawing long lengths of tubing, it is not practical to rotate the tubing (e.g., if it's coming off of a coil spool). However, the friction created by the radial forces of draw forming tubing inhibits the rotation of any draw plug.

[0008] The present invention allows helically ribbed tubing to be formed efficiently by draw plugs.

SUMMARY OF THE INVENTION

[0009] The invention allows for internally helically ribbed tubing to be formed efficiently by draw plugs by rotationally disjoining the forming of the helical ribs from the primary radial necking of the tubing via a multi-part draw plug. With the invention, the frictional forces suspending the necking body of the draw plug upstream of the die do not prevent the rotation of the rib forming member.

[0010] In one aspect of the invention, a floating draw plug for shaping tube comprises a necking body and a rib forming member. The necking body has an axis and a trailing end

portion. The trailing portion has a cross-section that is symmetric about the axis and that converges toward the axis as it extends downstream. The rib forming member comprises helical protrusions and helical grooves. The helical protrusions and the helical grooves are aligned with the axis. The rib forming member is connected to the necking body in a manner such that at least a portion of the helical protrusions and at least a portion of the helical grooves extend downstream of the trailing portion of the necking body and such that the rib forming member is free to rotate about the axis relative to the necking body.

[0011] In another aspect of the invention, a method of drawing tube forms internal helical protrusions in the tube. The method includes floating a draw plug inside the tube. The draw plug comprises a necking body and a rib forming member. The necking body has an axis and a trailing end portion. The trailing end portion has a cross-section that is symmetric about the axis and that converges toward the axis as it extends downstream. The rib forming member has helical protrusions and helical grooves. The helical protrusions and the helical grooves are aligned with the axis. The rib forming member is connected to the necking body in a manner such that at least a portion of the helical protrusions and at least a portion of the helical grooves extend downstream of the trailing portion of the necking body and such that the rib forming member is free to rotate about the axis relative to the necking body. The method further comprises pulling the tube through a die and radially between the draw plug and the die in a manner forming the internal helical protrusions into the tube.

[0012] Further features and advantages of the present invention, as well as the operation of the invention, are described in detail below with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0013] FIG. 1 depicts a side view of a preferred embodiment of a draw plug in accordance with the invention, with the leading portion being oriented toward the right and the trailing end portion being oriented toward the left.

[0014] FIG. 2 depicts an exploded assembly view of the draw plug shown in FIG. 1.

[0015] FIG. 3 depicts a perspective partial cut-away view of the draw plug in use.

[0016] FIG. 4 depicts a side view of the partial cut-away view shown in FIG. 3.

[0017] Reference numerals in the written specification and in the drawing figures indicate corresponding items.

DETAILED DESCRIPTION

[0018] A floating draw plug 10 in accordance with the invention is shown in FIGS. 1-4. The floating draw plug 10 comprises a necking body 12 and a rib forming member 14. The necking body 12 has an axial trailing end portion 16, an intermediate portion 18, and a leading end portion 20 that is symmetric about the axis of the draw plug 10. The trailing end portion 16 having a cross-section that is symmetric about the axis and that converges toward the axis as it extends downstream. The intermediate portion 18 is cylindrical and aligned with the axis. The leading end portion 20 diverges from the axis as it extends downstream. The necking body 12 also has an axial through-hole 22 and a

counter-sunk axial recess **24** at its trailing end. The axial recess **24** extends partially into the trailing end portion **16**. **[0019]** The rib forming member **14** comprises helical protrusions **26** and helical grooves **28**. The helical protrusions **26** and helical grooves **28** preferably have a constant radius about the axis. Like the necking body **12**, the rib forming member **14** also comprises an axial through-hole **30**.

[0020] The rib forming member **14** is operatively connected to the necking body **12** via a bolt **32** having a head **34**, a shaft **36**, and a threaded end **38**. The bolt **32** extends through the through-hole **22** of the necking body **12** and the through-hole of the rib forming member **14**. Preferably, a pair of nuts **40** threaded onto the threaded end **38** of the bolt **32** to thereby secure the necking body **12** and rib forming member **14** together in a manner such that the necking body and rib forming member aren't highly compressed against each other. As such, the necking body **12** and rib forming member **14** can easily rotate relative to each other, but are tied axially. Of course there are numerous other ways to achieve the same.

[0021] In use, the draw plug **10** is inserted into an end of tubing **42** and positioned upstream of a die **44** as the tube is drawn downstream sandwiched between the draw plug and die. The die **44** has a through-hole **46** that has a frustoconical leading portion **48** and a cylindrical trailing portion **50**. The leading portion **48** of the through-hole **46** of the die **44** converges as it extends downstream in a manner preferably concentric to the trailing end portion **16** of the draw plug **10** and has an upstream entry diameter slightly larger than the original outside diameter of the tubing **42** being drawn. The diameter of the intermediate portion **18** of the draw plug **10** is just slightly less than the original inside diameter of the tubing **42**. Thus, axial friction between the floating draw plug **10** and the tubing **42** forces the draw plug toward the fixed die **44** as the tubing is drawn through the die. The frustoconical leading portion **48** of the through-hole **46** of the die **44** necks the tubing **42** down as the tubing passes through the die. The cylindrical trailing portion **50** of the through-hole **46** of the die **44** is slightly larger in diameter than the helical protrusions **26** of the rib forming member **14**, but nonetheless is small enough to radially compress the tubing **42** against the helical protrusions **26** and into the helical grooves **28** of the rib forming member, thereby deforming the internal surface of the tubing in a manner such that internal helical ribs **52** are formed in the tubing. As the helical ribs **52** are formed, the rib forming member **14** rotates relative to the necking body **12**. This decouples the large circumferential frictional forces acting on the necking body **12** due to the radial compressive forces between the necking body and the frustoconical leading portion **48** of the die **44** from the rib forming member **14**. Thus, it is not necessary for the necking body **12** to rotate as the helical ribs **52** are formed in the tubing **42**. This greatly reduces to rotational resistance acting on the rib forming member **14** and thereby forms very uniform and clean internal helical ribs **52** into the tubing **42**.

[0022] In view of the foregoing, it should be appreciated that the invention has several advantages over the prior art.

[0023] As various modifications could be made in the constructions and methods herein described and illustrated without departing from the scope of the invention, it is intended that all matter contained in the foregoing description or shown in the accompanying drawings shall be

interpreted as illustrative rather than limiting. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims appended hereto and their equivalents.

[0024] It should also be understood that when introducing elements of the present invention in the claims or in the above description of exemplary embodiments of the invention, the terms "comprising," "including," and "having" are intended to be open-ended and mean that there may be additional elements other than the listed elements. Additionally, the term "portion" should be construed as meaning some or all of the item or element that it qualifies. Moreover, use of identifiers such as first, second, and third should not be construed in a manner imposing any relative position or time sequence between limitations. Still further, the order in which the steps of any method claim that follows are presented should not be construed in a manner limiting the order in which such steps must be performed, unless such an order is inherent or explicit.

What is claimed is:

1. A floating draw plug for shaping tube, the draw plug comprising:

a necking body, the necking body having an axis and a trailing end portion, the trailing end portion having a cross-section that is symmetric about the axis and that converges toward the axis as it extends downstream; and,

a rib forming member, the rib forming member comprising helical protrusions and helical grooves, the helical protrusions and the helical grooves being aligned with the axis, the rib forming member being connected to the necking body in a manner such that at least a portion of the helical protrusions and at least a portion of the helical grooves extend downstream of the trailing portion of the necking body and such that the rib forming member is free to rotate about the axis relative to the necking body.

2. A floating draw plug in accordance with claim 1 wherein the helical protrusions have a constant radius from the axis as they extend downstream.

3. A floating draw plug in accordance with claim 1 wherein the necking body has an axial downstream recess and a portion of rib forming member extends therein.

4. A floating draw plug in accordance with claim 1 wherein the rib forming member is attached to the necking body via a threaded fastener.

5. A floating draw plug in accordance with claim 4 wherein the necking body has an axial through-hole and a shaft member extends through the axial through-hole in a manner connecting the rib forming member to the necking body, and the shaft member is configured and adapted to rotate relative to at least one of the necking body and the rib forming member.

6. A floating draw plug in accordance with claim 1 wherein the necking body has a leading end portion that diverges from the axis as it extends downstream.

7. A floating draw plug in accordance with claim 6 wherein the necking body has an intermediate cylindrical portion that extends axially between the leading portion and the trailing portion of the necking body.

8. A method of drawing tube in a manner forming internal helical protrusions in the tube, the method comprising:

floating a draw plug inside the tube, the draw plug comprising a necking body and a rib forming member, the necking body having an axis and a trailing end portion, the trailing end portion having a cross-section that is symmetric about the axis and that converges toward the axis as it extends downstream, the rib forming member comprising helical protrusions and helical grooves, the helical protrusions and the helical grooves being aligned with the axis, the rib forming member being connected to the necking body in a manner such that at least a portion of the helical protrusions and at least a portion of the helical grooves extend downstream of the trailing portion of the necking body and such that the rib forming member is free to rotate about the axis relative to the necking body; and pulling the tube through a die and radially between the draw plug and the die in a manner forming the internal helical protrusions into the tube.

9. A method of drawing tube in accordance with claim **8** wherein the rib forming member rotates about the axis relative to the necking body as the tube is drawn.

10. A method of drawing tube in accordance with claim **9** wherein the die forces the tube radially inward toward the axis against the helical protrusions and into the helical grooves as the tube is drawn.

11. A method of drawing tube in accordance with claim **8** wherein the helical protrusions have a constant radius from the axis as they extend downstream.

12. A method of drawing tube in accordance with claim **8** wherein the necking body has an axial downstream recess and a portion of rib forming member extends therein.

13. A method of drawing tube in accordance with claim **12** wherein the rib forming member is attached to the necking body via a threaded fastener.

14. A method of drawing tube in accordance with claim **8** wherein the necking body has an axial through-hole and a shaft member extends through the axial through-hole in a manner connecting the rib forming member to the necking body, and the shaft member is configured and adapted to rotate relative to at least one of the necking body and the rib forming member.

15. A floating draw plug in accordance with claim **8** wherein the necking body has a leading end portion and an intermediate cylindrical portion, the leading end portion diverges from the axis as it extends downstream, and the intermediate cylindrical portion that extends axially between the leading portion and the trailing portion of the necking body.

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