

CASTELLANOS & CO LTDA
ABOGADOS
Calle 94 A No. 7 A-09
Bogotá, D.C. – COLOMBIA

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO



No. 12-189591- -00002-0000

Fecha: 2012-12-19 15:33:27 Dep. 2020 DIR.NUEVASCR
Tra. 2 PATENTES Eve: 1 REGDEPOSITO
Act. 329 CTOINFORMACION Folios: 39

Señor

Director de la División de Nuevas Creaciones

Superintendencia de Industria y Comercio

Ministerio de Comercio, Desarrollo, Industria y Turismo

E. S. D.

Re.: Expediente No. **12 189591**

Solicitud de Patente Modelo de Utilidad para:

“GUIA PARA VARILLA DE SUCCIÓN”

Solicitante: **TENARIS CONNECTIONS LIMITED**

PRESENTACION DEL DOCUMENTO DE PRIORIDAD

Yo, **MARGARITA CASTELLANOS ABONDANO**, mayor de edad, identificada y domiciliada como aparece al pie de mi firma, obrando en mi calidad de apoderada de la sociedad solicitante de la patente citada en la referencia, atentamente me permito presentar a Uds. copia certificada del documento de prioridad de **ESTADOS UNIDOS No. 13/280444 del 25 de octubre de 2011**.

En consecuencia, solicito a Ud. se anexe dicho documento al expediente citado en la referencia, y se continúe con el trámite correspondiente a esta solicitud de Patente.

Señora Director,


Margarita Castellanos Abondano
C.C. No. **39.779.654** de Usaquén
T.P.A. No. **70819** de C.S.J.
Calle 94A No. 7A-09 – Bogotá D.C.
Teléfono: 7560770

Bogotá,
MCA/MS/P2638

19 DIC. 2012

---Traducción no oficial de documento escrito en Inglés---

ESTADOS UNIDOS DE AMERICA

A TODOS A QUIENES LOS PRESENTES LLEGAREN:

DEPARTAMENTO DE COMERCIO DE LOS ESTADOS UNIDOS

Oficina de Patentes y Marcas de los Estados Unidos

Noviembre 13, 2012

Por medio de la presente certificamos que la anexa es copia auténtica de los archivos de la Oficina de Patentes y Marcas de los Estados Unidos de estos papeles de la solicitud de patente identificada abajo que cumple con los requisitos para ser otorgada en una fecha de presentación bajo USC 35 111.

Número de Solicitud: **13/280.444**

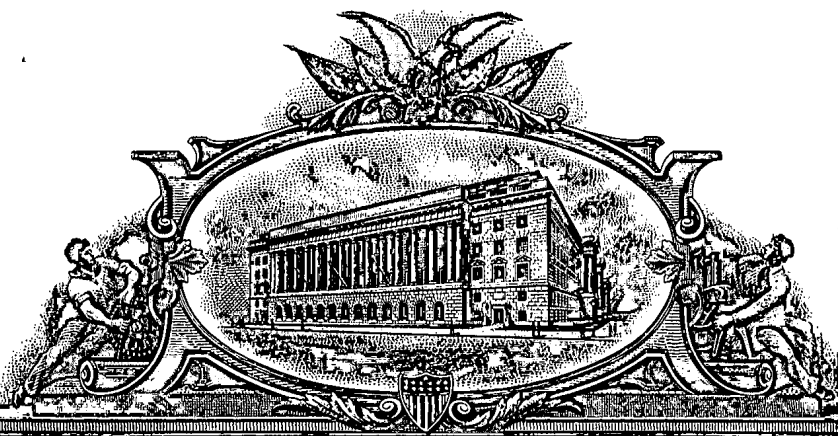
Fecha de Presentación: **Octubre 25, 2011**

El código de país y número de su solicitud de prioridad, para ser usado para la presentación en el extranjero bajo el convenio de Paris, es US13/280.444

**Por autoridad del
Secretario de Comercio para la Propiedad
Intelectual y Director de la Oficina de
Estados Unidos de Patentes y Marcas**

**(fdo)
T. WALLACE
Funcionario de certificación**

(Sello en oblea dorada)



THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

November 13, 2012

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM
THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK
OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT
APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A
FILING DATE UNDER 35 USC 111.

APPLICATION NUMBER: 13/280,444

FILING DATE: October 25, 2011

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY
APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS
CONVENTION, IS US13/280,444

By Authority of the
Under Secretary of Commerce for Intellectual Property
and Director of the United States Patent and Trademark Office




T. WALLACE
Certifying Officer

Electronic Acknowledgement Receipt	
EFS ID:	11256587
Application Number:	13280444
International Application Number:	
Confirmation Number:	9961
Title of Invention:	Sucker Rod Guide
First Named Inventor/Applicant Name:	Matias Pereyra
Customer Number:	26231
Filer:	Russel N. Rippamonti/doreen curseaden
Filer Authorized By:	Russel N. Rippamonti
Attorney Docket Number:	24692-0011001
Receipt Date:	25-OCT-2011
Filing Date:	
Time Stamp:	10:42:50
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	\$ 2580
RAM confirmation Number	9586
Deposit Account	061050
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
-----------------	----------------------	-----------	----------------------------------	------------------	------------------

1	Transmittal of New Application	246920011001Transmittal.pdf	46271 8729a69d0210e856ea570aff4aa441390482708c	no	2
Warnings:					
Information:					
2		246920011001PatentApplication.pdf	138596 db31e6f3a0112a79b6af36771f27b02020f8275f	yes	28
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	18	
	Claims		19	27	
	Abstract		28	28	
Warnings:					
Information:					
3	Drawings-only black and white line drawings	246920011001Figures.pdf	123328 7a86a25dc219cd1326772f83c62842c97363be18	no	3
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	37720 6f799a82452d4e47e2195bc27777c6548a6954f1	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			345915		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

FISH & RICHARDSON P.C.

Frederick P. Fish
1855-1930

W.K. Richardson
1859-1951

October 25, 2011

Attorney Docket No.: 24692-0011001

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Presented for filing is a new original patent application of:

Applicants: MATIAS PEREYRA; ALEJANDRO LEVRINO;
BERNARDO BOUILLARD

Title: SUCKER ROD GUIDE

Enclosed are the following papers, including those required to receive a filing date under 37 C.F.R. § 1.53(b):

	<u>Pages</u>
Specification	18
Claims	9
Abstract	1
Declaration	[To be Filed at a Later Date]
Drawings	3

Basic Filing Fee	\$380
Search Fee	\$620
Examination fee	\$250
Total Claims 38 over 20	18 x \$60
Independent Claims 4 over 3	1 x \$250
Fee for Multiple Dependent claims	\$0
Fee for each additional 50 pages of Specification and Drawings over 100	\$0
	(18+3-100)/50 = 0 x
Total Filing fee	\$2580

Please apply the filing fee and any other required fees or any credits to deposit account 06-1050, referencing the attorney docket number shown above.

If this application is found to be incomplete, or if a telephone conference would otherwise be helpful, please call the undersigned at (214) 292-4031.

Street Address
1717 MAIN STREET
SUITE 5000
DALLAS, TEXAS
75201

Mail Address
P.O. BOX 1022
MINNEAPOLIS, MINNESOTA
55440-1022

Telephone
214 747-5070

Facsimile
877 769-7945

Web Site
WWW.FR.COM



ATLANTA

AUSTIN

BOSTON

DALLAS

DELAWARE

HOUSTON

MUNICH

NEW YORK

SILICON VALLEY

SOUTHERN CALIFORNIA

TWIN CITIES

WASHINGTON, DC

FISH & RICHARDSON P.C.

Commissioner for Patents

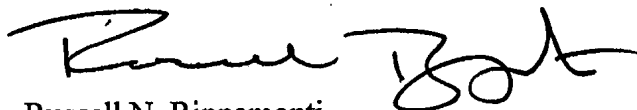
October 25, 2011

Page 2

Please direct all correspondence to the following:

PTO Customer Number 26231

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Russell N. Rippamonti". The signature is fluid and cursive, with a large, stylized "R" and "B" at the end.

Russell N. Rippamonti

Reg. No. 39,521

Enclosures

RNR/jgb

90556656.doc

Sucker Rod Guide

FIELD OF THE INVENTION

[0001] This disclosure relates generally to the field of guides for sucker rod strings and, more particularly, to a rod guide with a polygonal body and a plurality of blades.

BACKGROUND

[0002] Rod guides for centralizing sucker rods within production tubing are well known in the art. As shown in FIG. 1, a pumping unit 8 has attached thereto a polish rod 9. The polish rod 9 is attached longitudinally to a sucker rod 10 disposed inside of a tubing (T) which is disposed in a casing string (C). At the bottom end of the sucker rod 10 is a reciprocating pump (not shown). As the pumping unit moves the sucker rod 10 down, the barrel of the reciprocating pump fills with the production fluid to be produced.

Conversely, as the pumping unit moves the sucker rod up, a valve in the reciprocating pump shuts and the production fluid in the pump barrel is lifted, displacing production fluid above it and forcing one pump-barrel's worth of production fluid out of the hole.

[0003] The sucker rod must extend from the pumping unit all the way down to the reciprocating pump, which may be several thousand feet below the surface.

Consequently, the sucker rod is subjected to a variety of stresses: compression, tension, torsion, and bending. The rod is prevented from moving sideways or wobbling by the installation of periodic rod guides 12, 14 on the rod 10 thereby controlling rod and tubing wear. The rod guides typically have a number of vanes, fins or blades which extend radially and centralize the rod within the cylindrical tubing. This prevents the rod from wearing or from other damage. Any wear will, thus, occur to the rod guide fins.

[0004] The rod guides may be fabricated from various materials, such as synthetic materials which are oil-resistant and resistant to abrasion.

[0005] It is desirable to maximize the material available for wear to maximize the life of the rod guides. Thus, the cross-sectional area of the fins/blades/vanes may be maximized for maximum wear life.

[0006] Many prior art sucker rod guides (see U.S. Patent Nos. 5,115,863; 5,358,041; and 6,152,223) include a body that is molded in intimate contact with the sucker rod. The

body has simultaneously molded therewith a plurality of “fins”, “blades” or “vanes” that extend radially from the body. Cross-sections of some prior art rod guides 12 and 14 are illustrated in Figures 1A and 1B.

SUMMARY

[0007] The present disclosure describes and illustrates a polymeric rod guide 26 for a sucker rod 10. The polymeric rod guide includes: a body 28 surrounding and coaxial with the sucker rod, said body having a polygonal cross-section molded in fixed contact with the sucker rod. The guide further includes a plurality of blades 30 longitudinally disposed and extending from the body 28, each blade having a pair of planar longitudinal side walls 40 and an exterior longitudinal edge 24, each of said blades having a first blade face 22 disposed between a first terminal end 23 of the blade and the exterior longitudinal edge 24 and a second blade face 22 disposed between a second terminal end 25 of the blade and the exterior longitudinal edge 24, and an area of the body between the longitudinal side wall 40 of a first blade and the longitudinal side wall 40 of an adjacent second blade defines a trough 32 having a plurality of planar surfaces 32a, 32b, 32c.

[0008] In some implementations the rod guide 26 further includes a first curved lead section 34 molded integral with the body 28. The lead section being disposed longitudinally about the rod and terminating at a first end on an outer surface of the rod and being disposed at a second end in integral contact with the body 28. The lead section having a curved surface 35 with a radius of curvature of between 20 and 22 mm. In some implementations, the first curved lead section 34 has an outer curved surface 35 that extends from the rod to the body. The curved surface defined by a tangent to the mid-point of the curved surface having an angle of between 5 and 20 degrees measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface 35 of the lead section 34.

[0009] In the preferred embodiment, the rod guide 26 includes 4 blades circumferentially disposed 90 degrees about the guide body 28.

[0010] In some embodiments, the exterior longitudinal edge 24 of the rod guide 26 has a convex curved surface with a radius of curvature being a same radius of curvature as an inner surface of a tube (T) into which the rod and rod guide is to be used.

[0011] In the first embodiment, the trough 32 between the longitudinal side walls includes: a first planar surface 32a that tapers away from the first terminal end 23 of the blade face 22 at an angle (a1) measured between a line parallel to the longitudinal axis of the rod and the first planar surface (a), a second planar surface 32b disposed adjacent to the first planar surface (a), and a third planar surface 32c disposed adjacent to the second planar surface, said third planar surface tapers away from the second terminal end 25 of the blade face 22 at an angle (c1) measured between a line parallel to the longitudinal axis of the rod and the third planar surface 32c. The angle (a1) is generally less than or equal to 15 degrees, and the second planar surface is generally parallel to the axis of the rod, and the angle (c1) is less than or equal to 15 degrees. In the preferred embodiment, the angle (a1) is less than or equal to 4 degrees, the second planar surface is generally parallel to the axis of the rod, and the angle (c1) is less than or equal to 4 degrees.

[0012] In the first embodiment, the blade face 22 comprises a curved surface that extends from the first terminal end 23 of the blade to the exterior longitudinal edge 24, said curved surface defined by a tangent to the mid-point of the curved surface having an angle of in the range of 10 to 40 degrees measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface of the blade face 22. The blade face 22 includes a curved surface that extends from the first terminal end 23 to the exterior longitudinal edge 24, said curved surface having a radius of curvature of in the range of 20 to 22 mm.

[0013] In the first embodiment, the second planar surface 32b has a first predetermined longitudinal length (Lb) parallel to the axis of the rod, the first planar surface 32a and the third planar surface 32c each have a longitudinal length (La, Lc) greater than the longitudinal length (Lb) of planar surface (b).

[0014] In some embodiments, the longitudinal length of the first planar surface 32a and third planar surface 32c is between 55 to 75 mm and the second planar surface 32b has a longitudinal length of between 0 and 30 mm.

[0015] In a preferred embodiment, the longitudinal length (L_b) of the second planar surface 32b can be at least twice a width of the second planar surface 32b.

[0016] In a second embodiment, a polymeric rod guide 126 for a sucker rod 110 includes a body 128 surrounding and coaxial with the sucker rod. The body has a polygonal cross-section molded in fixed contact with the sucker rod; a plurality of blades 130 longitudinally disposed and extending from the body 128; each blade having a pair of longitudinal side walls 140, each of said longitudinal side walls having a first planar surface 140a that tapers away from the first terminal end 123 of the blade face 122 at an angle (a') measured between a line parallel to the longitudinal axis of the rod and the first planar surface, a second planar surface 140b disposed adjacent to the first planar surface, and a third planar surface 140c disposed adjacent to the second planar surface, said third planar surface 140c tapering away from the second terminal end 125 of the blade face 122 at an angle (c') measured between a line parallel to the longitudinal axis of the rod and the third planar surface 140c. Each blade has an exterior longitudinal edge 124 and each of the blades has a first blade face 122 disposed between a first terminal end 123 of the blade and the exterior longitudinal edge 124, and a second blade face 122 disposed between a second terminal end 125 of the blade and the exterior longitudinal edge 124. The area of the body between the longitudinal side wall of a first blade and the longitudinal side wall of an adjacent second blade defines a trough 132 having a plurality of planar surfaces 132a, 132b, 132c.

[0017] In some embodiments, the angle (a') is less than 15 degrees, the second planar surface is generally perpendicular to the axis of the rod, and the angle (c') is less than 15 degrees.

[0018] In the preferred embodiment, the angle (a') is less than or equal to 4 degrees, the second planar surface is generally perpendicular to the axis of the rod, and the angle (c') is less than or equal to 4 degrees.

[0019] In the rod guide 126 the second planar surface 140b has a first predetermined longitudinal length ($L_{b'}$) parallel to the axis of the rod, the first planar surface 140a and the third planar surface 140c each have a longitudinal length ($L_{a'}$, $L_{c'}$) greater than the longitudinal length ($L_{b'}$) of planar surface 140b.

[0020] The longitudinal length of the first planar surface 140a and third planar surface 140c is between 55 to 75 mm and the second planar surface 140b has a longitudinal length of between 0 and 30 mm.

[0021] In a preferred embodiment, the longitudinal length (L_b') of the second planar section 140b is at least twice a width of the second planar section 140b.

[0022] The rod guide 126 further includes a first curved lead section 134 molded integral with the body 128. The lead section is disposed longitudinally about the rod and terminating at a first end on an outer surface of the rod and disposed at a second end in integral contact with the body 128. The lead section has a curved surface 135 with a radius of curvature of between 20 and 22 mm.

[0023] The curved surface defined by a tangent to the mid-point of the curved surface having an angle of between 5 and 20 degrees measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface 135 of the lead section 34.

[0024] In the preferred embodiment, the rod guide 126 includes 4 blades circumferentially disposed 90 degrees about the guide body 128.

[0025] In some implementations, the exterior longitudinal edge 124 of the rod guide 126 has a convex curved surface with a radius of curvature being a same radius of curvature as an inner surface of a tube (T) into which the rod and rod guide is to be used.

[0026] In the second embodiment, the trough 132 between the longitudinal side walls includes: a first planar surface 132a that tapers away from the first terminal end 123 of the blade face 122 at an angle (a_1) measured between a line parallel to the longitudinal axis of the rod and the first planar surface 132a, a second planar surface 132b disposed adjacent to the first planar surface 132a, a third planar surface 132c disposed adjacent to the second planar surface 132b, said third planar surface 132c tapers away from the second terminal end 125 of the blade face 122 at an angle (c_1) measured between a line parallel to the longitudinal axis of the rod and the third planar surface 132c. The angle (a_1) is less than or equal to 4 degrees, the second planar surface is generally parallel to the axis of the rod, and the angle (c_1) is less than or equal to 4 degrees.

[0027] In the second implementation, the blade face 122 comprises a curved surface that extends from the first terminal end 123 of the blade to the exterior longitudinal edge 124. The curved surface defined by a tangent to the mid-point of the curved surface having an angle of in the range of 10 to 40 degrees measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface of the blade face 122. The blade face 122 includes a curved surface that extends from the first terminal end 123 to the exterior longitudinal edge 124.

[0028] In the second implementation, the second planar surface 132b has a first predetermined longitudinal length (L_b) parallel to the axis of the rod, the first planar surface 132a and the third planar surface 132c each have a longitudinal length (L_a , L_c) greater than the longitudinal length (L_b) of planar surface 132b. The longitudinal length of the first planar surface 132a and third planar surface 132c is in the range of 55 to 75 mm and the second planar surface 132b has a longitudinal length of in the range of 0 to 30 mm. In a preferred embodiment, the longitudinal length (L_b) of the second planar surface 132b is at least twice a width of the second planar surface 132b.

[0029] The rod guide 26 may be installed in a sucker rod in a method comprising: molding a unitary rod guide coaxial about and in fixed contact with the sucker rod, said guide comprising a body portion 28 surrounding and coaxial with the sucker rod, said body having a plurality of blades 30 longitudinally disposed and extending from the body 28, each blade having a pair of planar longitudinal side walls 40 and an exterior longitudinal edge 24, each of said blades having a first blade face 22 disposed between a first terminal end 23 of the blade and the exterior longitudinal edge 24 and a second blade face 22 disposed between a second terminal end 25 of the blade and the exterior longitudinal edge 24, and an area of the body between the longitudinal side wall 40 of a first blade and the longitudinal side wall 40 of an adjacent second blade defines a trough 32 having a plurality of planar surfaces 32a, 32b, 32c.

[0030] The method may further include concurrently molding a first lead section 34 integral with the body 28, said lead section disposed longitudinally about the rod and terminating at a first end on an outer surface of the rod and disposed at a second end in contact with the body 28, said lead section having a curved surface 35 with a radius of

curvature of between 20 and 22 mm and said curved surface further defined by a tangent to the mid-point of the curved surface having an angle of between 5 and 20 degrees measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface 35 of the lead section 34.

[0031] The method may further include preparing a section of the rod 10 by placing an epoxy based glue on a predetermined portion of the rod 10 and placing particles having a diameter in the range of 0.71 to 1.18 mm onto the epoxy glue; and direct injection molding the rod guide 26, 126 about at least a portion of the prepared section of the rod.

[0032] The rod guide 126 may be installed on a sucker rod in a method comprising: molding a unitary rod guide coaxial about and in fixed contact with the sucker rod, said guide comprising a body portion 28 surrounding and coaxial with the sucker rod, said body having a plurality of blades 30 longitudinally disposed and extending from the body 28, each blade having a pair of longitudinal side walls 140, each of said longitudinal side walls having a first planar surface 140a that tapers away from the first terminal end 123 of the blade face 122 at an angle (a') measured between a line parallel to the longitudinal axis of the rod and the first planar surface, a second planar surface 140b disposed adjacent to the first planar surface, and a third planar surface 140c disposed adjacent to the second planar surface, said third planar surface 140c tapers away from the second terminal end 125 of the blade face 122 at an angle (c') measured between a line parallel to the longitudinal axis of the rod and the third planar surface 140c, each blade having an exterior longitudinal edge 124, each of said blades having a first blade face 122 disposed between a first terminal end 123 of the blade and the exterior longitudinal edge 124, and a second blade face 122 disposed between a second terminal end 125 of the blade and the exterior longitudinal edge 124, and an area of the body between the longitudinal side wall of a first blade and the longitudinal side wall of an adjacent second blade defines a trough 132 having a plurality of planar surfaces 132a, 132b, 132c.

[0033] The method of may further include concurrently molding a first curved lead section 34 integral with the body 28, said lead section disposed longitudinally about the rod and terminating at a first end on an outer surface of the rod and disposed at a second end in contact with the body 28, said lead section having a curved surface 35 with a

radius of curvature of between 20 and 22 mm and said curved surface further defined by a tangent to the mid-point of the curved surface having an angle of between 5 and 20 degrees measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface 35 of the lead section 34.

[0034] The method may further include: preparing a section of the rod 10 by placing an epoxy based glue on a predetermined portion of the rod 10 and placing particles having a diameter between 0.71 and 1.18 mm onto the epoxy glue; and direct injection molding the rod guide 26, 126 about at least a portion of the prepared section of the rod.

[0035] The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

[0036] Fig. 1 is prior art pumping system illustrating a prior art rod guide disposed inside a tubing string;

[0037] Fig. 1A is a transverse cross-section of a prior art rod guide;

[0038] Fig. 1B is a transverse cross-section of a prior art rod guide;

[0039] Fig. 2 is a side view of a first embodiment of a rod guide of the present disclosure illustrated inside a cross-section of tubing;

[0040] Fig. 2A is a transverse cross-section of the rod guide of Fig. 2 taken at section AA;

[0041] Fig. 2B is a transverse cross-section of the rod guide of Fig. 2 taken at section BB;

[0042] Fig. 3 is a perspective view of the rod guide of Fig. 2;

[0043] Fig. 4 is a partial side view of the rod guide of Fig. 2 partially rotated forward to illustrate planar surfaces 32a, 32b and 32c of blade 30;

[0044] Fig. 4A is a transverse section view illustrating the trough 32 between the blades 30 of the rod guide of Fig. 4;

[0045] Fig. 5 is a side view of a second embodiment of a rod guide of the present disclosure illustrated inside a cross-section of tubing;

[0046] Fig. 5A is a transverse cross-section of the rod guide of Fig. 5 taken at section AA;
 [0047] Fig. 5B is a transverse cross-section of the rod guide of Fig. 5 taken at section BB;
 [0048] Fig. 6 is a perspective view of the rod guide of Fig. 5;
 [0049] Fig. 7 is a partial side view of the rod guide of Fig. 5 partially rotated forward to illustrate planar surfaces 132a, 132b and 132c and 140a, 140b and 140c of blade 30; and
 [0050] Fig. 7A is a transverse section view illustrating the trough 132 between the blades 130 of the rod guide of Fig. 7.
 [0051] Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

[0052] As used herein, the term “blade” refers to the molded portion of the rod guide that extends from the body and may guidingly contact the interior surface of production tubing.

[0053] Referring now to Figs. 2, 2A, 2B, 3, 4 and 4A wherein is illustrated a first embodiment of sucker rod guide 26 of the present disclosure. The polymeric rod guide 26 includes a body 28 surrounding and coaxial with the sucker rod. The body includes a polygonal cross-section molded in fixed contact with the sucker rod.

[0054] A plurality of blades 30 are longitudinally disposed and extend from the body 28, each blade having a pair of planar longitudinal side walls 40 and an exterior longitudinal edge 24. Each of said blades has a first blade face 22 disposed between a first terminal end 23 of the blade and the exterior longitudinal edge 24 and a second blade face 22 disposed between a second terminal end 25 of the blade and the exterior longitudinal edge 24. An area of the body between the longitudinal side wall 40 of a first blade and the longitudinal side wall 40 of an adjacent second blade defines a trough 32 having a plurality of planar surfaces 32a, 32b, 32c.

[0055] The rod guide 26 further includes first generally curved lead section 34 molded integral with the body 28. The lead section is disposed longitudinally about the rod and terminating at a first end on an outer surface of the rod and at a second end at each of the first terminal ends 23, 25 of each blade and at a terminal end of each trough 32 between

each blade 30. The lead section 34 has an outer surface 35 that extends from the rod to the body 28. The outer curved surface 35 has a small radius of curvature of between 20 and 22 mm. The taper of the curved surface 35 is defined by a tangent to the mid point of the curve having an angle of between 5 and 20 as measured between the tangent and a line parallel to the longitudinal axis of the rod and the curved surface of the lead section 34. In the preferred embodiment the angle of the tangent is 15 degrees.

[0056] In some embodiments the rod guide 26 includes four blades 30 circumferentially disposed 90 degrees about the guide body 28.

[0057] In some embodiments the exterior longitudinal edge 24 of the rod guide 26 has a convex curved surface with a radius of curvature being a same radius of curvature as an inner surface of a tube (T) into which the rod and rod guide is to be used.

[0058] As illustrated in particular in Figures 3, 4 and 4A, the trough 32 between the longitudinal side walls 40 includes: a first planar surface 32a that tapers away from the first terminal end 23 of the blade face 22 at an angle (a1) measured between a line parallel to the longitudinal axis of the rod and the first planar surface (a), a second planar surface 32b disposed adjacent to the first planar surface (a), and a third planar surface 32c disposed adjacent to the second planar surface, said third planar surface tapers away from the second terminal end 25 of the blade face 22 at an angle (c1) measured between a line parallel to the longitudinal axis of the rod and the third planar surface (c). In some embodiments the angle (a1) is less than 15 degrees, the second planar surface is generally parallel to the axis of the rod, and the angle (c1) is less than 15 degrees. In a preferred embodiment the angle (a1) is less than or equal to 4 degrees, the second planar surface is generally parallel to the axis of the rod, and the angle (c1) is less than or equal to 4 degrees. In a preferred embodiment angle a1 = angle a2. In general the trough 32 includes three sections: Section (a): having an increasing taper (from the guide end to the center of the guide); Section (b): having a substantially cylindrical configuration; and Section (c): having a decreasing taper (from the center of the guide to the end of the guide). As illustrated in Figures 2, 2A and 2B the cross-section area 44 of the cavity for fluid passage formed between blades and tubing (T) is higher at the beginning of the

sucker rod guide than in the middle of, and so providing a desired nozzle effect that will be explained hereinafter in the discussion of the advantages of the present design.

[0059] Referring again to Figs. 3, 4 and 4A, in some embodiments the blade face 22 comprises a curved surface having a small radius of curvature in the range of 20 to 22 mm. The taper of the surface is defined by a tangent to the curved surface taken in the midpoint of the curve. The angle of the tangent is between 10 and 40 degrees as measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface of the blade face 22. In a preferred embodiment, the blade face 22 comprises a curved surface having a small radius of curvature in the range of 20 to 22 mm. The taper of the surface is defined by a tangent to the curved surface taken in the midpoint of the curve. The angle of the tangent is 32 degrees or less as measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface of the blade face 22. In some embodiments there can be a planar surface between blade face 22 and the surface 35 of the lead section 34, but generally the curved surfaces join each other tangentially as illustrated in Figs. 2, 3 and 4.

[0060] The second planar surface 32b of the rod guide 26 has a first predetermined longitudinal length (L_b) parallel to the axis of the rod, the first planar surface 32a and the third planar surface 32c each have a longitudinal length (L_a , L_c) greater than the longitudinal length (L_b) of planar surface 32b. In some embodiments the longitudinal length of the first planar surface 32a and third planar surface 32c is between 55 to 75 mm (preferably 65mm) and the second planar surface 32b has a longitudinal length of between 0 and 30 mm. In a preferred embodiment, to stabilize the fluid the longitudinal length (L_b) of the second planar surface 32b is at least twice a width of the second planar surface (32b).

[0061] Referring now to Figs. 5, 5A, 5B, 6, 7, 7A wherein is illustrated a second embodiment of sucker rod guide 126 of the present disclosure. The polymeric rod guide 126 for a sucker rod 110 includes a body 128 surrounding and coaxial with the sucker rod. The body has a polygonal cross-section molded in fixed contact with the sucker rod.

[0062] Unlike the first embodiment, in this second embodiment the lateral surfaces 140 of each blade 130 are also formed by tapered surfaces, 140a, 140b and 140 c. In this

second embodiment, the rod guide 126 includes a plurality of blades 130 longitudinally disposed and extending from the body 128. Each blade having a pair of longitudinal side walls 140, each of said longitudinal side walls have a first planar surface 140a that tapers away from the first terminal end 123 of the blade face 122 at an angle (a') measured between a line parallel to the longitudinal axis of the rod and the first planar surface, a second planar surface 140b disposed adjacent to the first planar surface, and a third planar surface 140c disposed adjacent to the second planar surface, said third planar surface 140c tapers away from the second terminal end 125 of the blade face 122 at an angle (c') measured between a line parallel to the longitudinal axis of the rod and the third planar surface 140c. Each blade has an exterior longitudinal edge 124. Each blade has a first blade face 122 disposed between a first terminal end 123 of the blade and the exterior longitudinal edge 124, and a second blade face 122 disposed between a second terminal end 125 of the blade and the exterior longitudinal edge 124.

[0063] In some embodiments the angle (a') is less than 15 degrees, the second planar surface is generally perpendicular to the axis of the rod, and the angle (c') is less than 15 degrees. In a preferred embodiment the angle (a') is less than or equal to 4 degrees, the second planar surface is generally perpendicular to the axis of the rod, and the angle (c') is less than or equal to 4 degrees. In general the lateral face 140 includes three sections: Section (a): having an increasing taper (from the guide end to the center of the guide); Section (b): having a substantially cylindrical configuration; and Section (c): having a decreasing taper (from the center of the guide to the end of the guide).

[0064] The second planar surface 140b has a first predetermined longitudinal length (Lb') parallel to the axis of the rod, the first planar surface 140a and the third planar surface 140c each have a longitudinal length (La' , Lc') greater than the longitudinal length (Lb') of planar surface (b). In some embodiments the longitudinal length of the first planar surface 140a and third planar surface 140c is between 55 to 75 mm (preferably 65mm) and the second planar surface 140b has a longitudinal length of between 0 and 30 mm. In a preferred embodiment the longitudinal length (Lb') of the second planar section 140b is at least twice a width of the second planar section 140b to stabilize the fluid.

[0065] As illustrated in Figures 5, 5A and 5B the cross-section area 144 of the cavity for fluid passage formed between blades and tubing (T) is higher at the beginning of the sucker rod guide than in the middle of it, and so providing the desire nozzle effect that will be explained in the following section.

[0066] The guide further includes a first generally curved lead section 134 molded integral with the body 128. The lead section 134 is disposed longitudinally about the rod and terminating at a first end on an outer surface of the rod and at a second end at the body 128. The lead section 134 has a generally outer curved surface 135 that extends from the rod to the body 28. The outer surface 135 has a small radius of curvature of between 20 and 22 mm. The taper of the curved surface 135 is defined by a tangent to the mid point of the curve having an angle of between 5 and 20 as measured between the tangent and a line parallel to the longitudinal axis of the rod and the curved surface of the lead section 34. In the preferred embodiment the angle of the tangent is 15 degrees.

[0067] In a preferred embodiment the plurality of blades 130 includes 4 blades circumferentially disposed 90 degrees about the guide body 128. In some embodiments the exterior longitudinal edge 124 has a convex curved surface with a radius of curvature being a same radius of curvature as an inner surface of a tube (T) into which the rod and rod guide is to be used.

[0068] Similar to the first embodiment, in this second embodiment an area of the body 128 between the longitudinal side wall 140 of a first blade and the longitudinal side wall of an adjacent second blade defines a trough 132 having a plurality of planar surfaces 132a, 132b, 132c. In a preferred embodiment the trough 132 between the longitudinal side walls includes: a first planar surface 132a that tapers away from the first terminal end 123 of the blade face 122 at an angle (a1) measured between a line parallel to the longitudinal axis of the rod and the first planar surface (a), a second planar surface 132b disposed adjacent to the first planar surface 132a, a third planar surface 132c disposed adjacent to the second planar surface 132b, said third planar surface 132c tapers away from the second terminal end 125 of the blade face 122 at an angle (c1) measured between a line parallel to the longitudinal axis of the rod and the third planar surface (c). The angle (a1) is less than or equal to 4 degrees, the second planar surface is generally

parallel to the axis of the rod, and the angle (c1) is less than or equal to 4 degrees. In a preferred embodiment angle $a1 = \text{angle } a2$. In general the trough 132 includes three sections: Section (a): having an increasing taper (from the guide end to the center of the guide; Section (b): having a substantially cylindrical configuration; and Section (c): having a decreasing taper (from the center of the guide to the end of the guide). As illustrated in Figures 5, 5A and 5B the cross-section area 144 of the cavity for fluid passage formed between blades and tubing (T) is higher at the beginning of the sucker rod guide than in the middle of it, and so providing the desired nozzle effect that will be explained hereinafter in the discussion of the advantages of the present design.

[0069] Referring again to Figs. 6, 7 and 7A, in some embodiments the blade face 122 has a curved surface with a small radius of curvature in the range of 20 to 22 mm. The taper of the surface is defined by a tangent to the curved surface taken in the midpoint of the curve. The angle of the tangent is between 10 and 40 degrees as measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface of the blade face 122. In a preferred embodiment, the blade face 122 comprises a curved surface having a small radius of curvature in the range of 20 to 22 mm. The taper of the surface is defined by a tangent to the curved surface taken in the midpoint of the curve. The angle of the tangent is 32 degrees or less as measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface of the blade face 122. In some embodiments there can be a planar surface between blade face 122 and the surface 135 of the lead section 134, but generally the curved surfaces join each other tangentially as illustrated in Figs. 5, 6 and 7.

[0070] The second planar surface (b) has a first predetermined longitudinal length (L_b) parallel to the axis of the rod, the first planar surface (a) and the third planar surface (c) each have a longitudinal length (L_a , L_c) greater than the longitudinal length (L_b) of planar surface (b). In some embodiments, the longitudinal length of the first planar surface (a) and third planar surface (c) is between 55 to 75 mm (preferably 65mm) and the second planar surface (b) has a longitudinal length of between 0 and 30 mm. In a preferred embodiment to stabilize the fluid, the longitudinal length (L_b) of the second planar section 132b is at least twice a width of the second planar section 132b.

[0071] The unitary rod guide 26, 126 of the present disclosure is molded coaxial about and in fixed contact with the sucker rod 10. The lead section 34, 134 is unitary with and molded concurrently with the body 28, 128.

[0072] It is known in the art that when plastic rod guides 12, 14 are molded directly onto the rod, that the contraction effect of the solidifying polymeric material over the steel rod body provides an adherence force. In deviated wellbores, the adherence force provided by the contraction of the polymeric material on the rod may be insufficient to prevent the rod guide from de-boding with the rod. It has been found that the breakaway force necessary to dislodge the polymeric rod guide may be enhanced by increasing the interference between the polymeric rod guide 26, 126 and the rod 10. It has been found that the interference may be enhanced by increasing the friction coefficient between the rod 10 and the rod guide 26, 126. In one embodiment, epoxy based glue (stable to 150 degrees C) may be placed on the rod 10 and particles having a diameter of between 0.71 and 1.18 mm (preferably 0.8 mm) (sand or synthetic spheres) placed onto the epoxy glue along each section of the rod before the polymeric rod guide 26, 126 is direct injection molded thereon. In some embodiments it has been found that if a 120 mm section of the rod is prepared as heretofore described, the breakaway force provided by the enhanced friction coefficient may be equivalent to the force obtained with direct injection over a rod that has not had such surface preparation.

SOME ADVANTAGES OF THE ROD GUIDE OF THE PRESENT DISCLOSURE

[0073] Prior art designs of Figs. 1A and 1B illustrate transition zones of concave or convex surfaces between blades of rod guides 12. In the illustrated prior art rod guides 12, 14 these transition zones have constant a cross-section along the body portion of the rod guide. In the prior art constant cross-section geometry, if it is assumed that there is zero friction conditions (between the walls of rod guide and the produced fluid), that the produced fluid will move at a constant speed along the passage through the tunnel defined by the rod guide inside of the tubing.

[0074] When considering the effect of friction between the wall of the rod guide and the produced fluid, the speed profile begins from 0 to an average value in the center of the

rod guide. This effect defines what may be referred to as “the boundary layer”. As the flow velocity decreases, it results in a decrease in the Reynolds number, which results in generating a boundary layer having a lower energization level and therefore more prone to detachment from the surface of the rod guide and tubing. Detachment of the boundary layer produces turbulent areas causing greater inefficient movement of fluid and an increase of pressure drop.

[0075] The design of the present disclosure includes a variable fluid passage 44 and 144 (a nozzle like configuration) having decreasing cross-sections (from the beginning towards the larger middle section 32b, 132b of the rod guide 26, 126 (see Figs. 2A, 2B, 3, 5A, 5B and 6). This geometry produces, due to the fact that the flow remains constant, an increase in the average speed (velocity) in the center of the section, that also increases the Reynolds number, and so, the boundary layer results in an increasing speed profile and higher levels of energization, this effect favors to keep the boundary layer adhered to the wall of the rod guide 26 and 126, and so, there are no turbulent zones increasing the pressure drop in the rod guide.

[0076] The end section 32a, 132a is a stabilization zone, directed to stabilize the speed profile of the fluid, in order to maximize efficiency of the guide. This stabilization zone is needed for a smooth change in the speed profile prior to entering into mid-zone in order to maintain the boundary layer attached to the surface of the rod guide 26, 126.

[0077] The end sections 32c, 132c area having a decreasing section allows fluid to slow down and reach the same condition as prior to entering into the flow path 44, 144 of the rod guide. The rod guide 26, 126 has a better efficiency regarding the fluid flow and regarding the general pumping system.

[0078] Additionally, with regard to embodiment 2, it is worth noting that the tapered surfaces 140a, 140b and 140c are designed to enhance the overall efficiency of the guide due to the “venturi” effect that takes place when the fluid passes through the fluid passage 144 formed between the production tubing (T), and longitudinally tapered surfaces 140a, 140b and 140c. In this embodiment, the lateral walls 140 of blades 130 become wider towards the center of the rod guide. For example referring to Figs. 5, 5A and 5B, the width of the blade 130 is larger in sections 132b and 140b than the width in sections 132a

and 140a, due to the nozzle-like form of the lateral walls of the blades present in this embodiment. The lower pressures over the centralizer due to the bigger erodible area make this centralizer more efficient in terms of life period (decreased rod guide life due to erosion).

[0079] In summary, the design of the rod guide 26 and 126 of the present disclosure has at least the following advantages:

- 1) Reduction of pumping force (contrary to the direction of motion of the string) due to decreasing the drag coefficient (C_d) of the body.

The geometries of many prior art rod guides have angles of approximately 30° in the flow edges on each side. Drag coefficients of bodies immersed in fluids that are a triangular solid of revolution of 60° have a C_d of 1.4 approx. In a triangular solids of revolution of 30° , C_d decreases to 1.0. The design of rod guides 26 and 126 of the present disclosure have lower incidence angles of approx. 15° per side. This design geometry results in an improved drag coefficient of $C_d < 1$. This improvement in drag coefficient C_d translates into a reduction of approximately 40% on the pumping force that is generated by the obstruction to the passage of fluid around each rod guide 26, 126, greatly increasing the overall efficiency of the production system because the angle of the surface 34 and 134 is about 15 degrees.

- 2) Stable boundary layer

The geometry of the flow channels in the rod guides 26 and 126 favors an increase in speed in the fluid flowing around the body 28, 128 (increasing velocity gradient).

Therefore, the boundary layer remains in contact with the body 28, 128 of the guide 26, 126, and thus preventing detachment of flow and pressure losses.

- 3) Effect of particles sweep and scale

As discussed in point 2), the geometry of the flow channels generates, in the first half, an increasing velocity gradient that favors the sweep of particles preventing scale formation on the surface of the rod guide.

- 4) Increased external surface area for longer wearing surface against the tubing wall

In this embodiment, due to the fact that blades 30, 130 are wider in the middle section than prior art blades, the contact area or erodible area of the rod guide is larger.

[0080] A number of implementations have been described. Nevertheless, it will be understood that various modifications may be made. Accordingly other implementations are within the scope of the following claims:

WHAT IS CLAIMED IS:

- 1 1. A polymeric rod guide for a sucker rod, said polymeric rod guide comprising:
2 a body surrounding and coaxial with the sucker rod, said body having a polygonal
3 cross-section molded in fixed contact with the sucker rod; and
4 a plurality of blades longitudinally disposed and extending from the body,
5 each blade having a pair of planar longitudinal side walls and an exterior longitudinal
6 edge, each of said blades having a first blade face disposed between a first terminal end
7 of the blade and the exterior longitudinal edge and a second blade face disposed between
8 a second terminal end of the blade and the exterior longitudinal edge, and an area of the
9 body between the longitudinal side wall of a first blade and the longitudinal side wall of
10 an adjacent second blade defines a trough having a plurality of planar surfaces.
11
12 2. The rod guide of claim 1 wherein the rod guide further includes a first curved lead
13 section molded integral with the body, said lead section disposed longitudinally about the
14 rod and terminating at a first end on an outer surface of the rod and disposed at a second
15 end in integral contact with the body, said lead section having a curved surface with a
16 radius of curvature of in the range of 20 to 22 mm.
17
18 3. The rod guide of claim 1 wherein the rod guide further includes a first curved lead
19 section molded integral with the body, said lead section having an outer curved surface
20 that extends from the rod to the body, said curved surface defined by a tangent to the
21 mid-point of the curved surface having an angle of between 5 and 20 degrees measured
22 between a line parallel to the longitudinal axis of the rod and the tangent to the curved
23 surface of the lead section.
24
25 4. The rod guide of claim 1 wherein the plurality of blades includes 4 blades
26 circumferentially disposed 90 degrees about the guide body.
27

5. The rod guide of claim 1 wherein the exterior longitudinal edge has a convex curved surface with a radius of curvature being a same radius of curvature as an inner surface of a tube into which the rod and rod guide is to be used.

6. The rod guide of claim 1 wherein the trough between the longitudinal side walls includes:

a first planar surface that tapers away from the first terminal end of the blade face at an angle (a1) measured between a line parallel to the longitudinal axis of the rod and the first planar surface,

a second planar surface disposed adjacent to the first planar surface, and

a third planar surface disposed adjacent to the second planar surface, said third planar surface tapers away from the second terminal end of the blade face at an angle (c1) measured between a line parallel to the longitudinal axis of the rod and the third planar surface.

7. The rod guide of claim 6 wherein the angle (a1) is less than or equal to 15 degrees, the second planar surface is generally parallel to the axis of the rod, and the angle (c1) is less than or equal to 15 degrees.

8. The rod guide of claim 6 wherein the angle (a1) is less than or equal to 4 degrees, the second planar surface is generally parallel to the axis of the rod, and the angle (c1) is less than or equal to 4 degrees.

9. The rod guide of claim 1 wherein the blade face comprises a curved surface that extends from the first terminal end of the blade to the exterior longitudinal edge, said curved surface defined by a tangent to the mid-point of the curved surface having an angle of in the range of 10 to 40 degrees measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface of the blade face.

10. The rod guide of claim 1 wherein the blade face comprises a curved surface that extends from the first terminal end to the exterior longitudinal edge, said curved surface having a radius of curvature of in the range of 20 to 22 mm.

11. The rod guide of claim 6 wherein the second planar surface has a first predetermined longitudinal length (Lb) parallel to the axis of the rod, the first planar surface and the third planar surface each have a longitudinal length (La, Lc) greater than the longitudinal length (Lb) of the second planar surface.

12. The rod guide of claim 11 wherein the longitudinal length of the first planar surface and third planar surface is in the range of 55 to 75 mm and the second planar surface has a longitudinal length of in the range of 0 to 30 mm.

13. The rod guide of claim 11 wherein the longitudinal length (Lb) of the second planar surface is at least twice a width of the second planar surface.

14. A polymeric rod guide for a sucker rod, said polymeric rod guide comprising:
a body surrounding and coaxial with the sucker rod, said body having a polygonal cross-section molded in fixed contact with the sucker rod; and
a plurality of blades longitudinally disposed and extending from the body;
each blade having a pair of longitudinal side walls, each of said longitudinal side walls having a first planar surface that tapers away from the first terminal end of the blade face at an angle (a') measured between a line parallel to the longitudinal axis of the rod and the first planar surface, a second planar surface disposed adjacent to the first planar surface, and a third planar surface disposed adjacent to the second planar surface, said third planar surface tapering away from the second terminal end of the blade face at an angle (c') measured between a line parallel to the longitudinal axis of the rod and the third planar surface,
each blade having an exterior longitudinal edge,

each of said blades having a first blade face disposed between a first terminal end of the blade and the exterior longitudinal edge, and a second blade face disposed between a second terminal end of the blade and the exterior longitudinal edge, and

an area of the body between the longitudinal side wall of a first blade and the longitudinal side wall of an adjacent second blade defines a trough having a plurality of planar surfaces.

15. The rod guide of claim 14 wherein the angle (a') is less than or equal to 15 degrees, the second planar surface is generally perpendicular to the axis of the rod, and the angle (c') is less than or equal to 15 degrees.

16. The rod guide of claim 14 wherein the angle (a') is less than or equal to 4 degrees, the second planar surface is generally perpendicular to the axis of the rod, and the angle (c') is less than or equal to 4 degrees.

17. The rod guide of claim 14 wherein the second planar surface has a first predetermined longitudinal length (Lb') parallel to the axis of the rod, the first planar surface and the third planar surface each have a longitudinal length (La', Lc') greater than the longitudinal length (Lb') of the second planar surface.

18. The rod guide of claim 17 wherein the longitudinal length of the first planar surface and third planar surface is in the range of 55 to 75 mm and the second planar surface has a longitudinal length of in the range of 0 to 30 mm.

19. The rod guide of claim 17 wherein the longitudinal length (Lb') of the second planar section is at least twice a width of the second planar section.

20. The rod guide of claim 14 wherein the rod guide further includes first curved lead section molded integral with the body, said lead section disposed longitudinally about the rod and terminating at a first end on an outer surface of the rod and disposed at a second

end in integral contact with the body, said lead section having a curved surface with a radius of curvature of in the range of 20 to 22 mm.

21. The rod guide of claim 20 wherein the rod guide further includes a first curved lead section molded integral with the body, said lead section having outer curved surface that extends from the rod to the body, said curved surface defined by a tangent to the mid-point of the curved surface having an angle of in the range of 5 to 20 degrees measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface of the lead section, said curved surface having a radius of curvature of in the range of 20 and 22 mm.

22. The rod guide of claim 14 wherein the plurality of blades includes 4 blades circumferentially disposed 90 degrees about the guide body.

23. The rod guide of claim 14 wherein the exterior longitudinal edge has a convex curved surface with a radius of curvature being a same radius of curvature as an inner surface of a tube into which the rod and rod guide is to be used.

24. The rod guide of claim 14 wherein the trough between the longitudinal side walls includes:

a first planar surface that tapers away from the first terminal end of the blade face at an angle (a1) measured between a line parallel to the longitudinal axis of the rod and the first planar surface,

a second planar surface disposed adjacent to the first planar surface, and

a third planar surface disposed adjacent to the second planar surface, said third planar surface tapers away from the second terminal end of the blade face at an angle (c1) measured between a line parallel to the longitudinal axis of the rod and the third planar surface.

145 25. The rod guide of claim 24 wherein the angle (a1) is less than or equal to 4 degrees,
146 the second planar surface is generally parallel to the axis of the rod, and the angle (c1) is
147 less than or equal to 4 degrees.

148
149 26. The rod guide of claim 24 wherein the blade face comprises a curved surface that
150 extends from the first terminal end of the blade to the exterior longitudinal edge, said
151 curved surface defined by a tangent to the mid-point of the curved surface having an
152 angle of in the range of 10 to 40 degrees measured between a line parallel to the
153 longitudinal axis of the rod and the tangent to the curved surface of the blade face.

154
155 27. The rod guide of claim 14 wherein the blade face comprises a curved surface that
156 extends from the first terminal end to the exterior longitudinal edge.

157
158 28. The rod guide of claim 24 wherein the second planar surface has a first predetermined
159 longitudinal length (Lb) parallel to the axis of the rod, the first planar surface and the
160 third planar surface each have a longitudinal length (La, Lc) greater than the longitudinal
161 length (Lb) of the second planar surface.

162
163 29. The rod guide of claim 24 wherein the longitudinal length of the first planar surface
164 and third planar surface is in the range of 55 to 75 mm and the second planar surface has
165 a longitudinal length of in the range of 0 to 30 mm.

166
167 30. The rod guide of claim 24 wherein the longitudinal length (Lb) of the second planar
168 surface is at least twice a width of the second planar surface.

169
170 31. A method of installing a rod guide on a sucker rod comprising: molding a unitary rod
171 guide coaxial about and in fixed contact with the sucker rod, said guide comprising a
172 body portion surrounding and coaxial with the sucker rod, said body having a plurality of
173 blades longitudinally disposed and extending from the body, each blade having a pair of
174 planar longitudinal side walls and an exterior longitudinal edge, each of said blades

175 having a first blade face disposed between a first terminal end of the blade and the
176 exterior longitudinal edge and a second blade face disposed between a second terminal
177 end of the blade and the exterior longitudinal edge, and an area of the body between the
178 longitudinal side wall of a first blade and the longitudinal side wall of an adjacent second
179 blade defines a trough having a plurality of planar surfaces.
180

181 32. The method of claim 31 further including concurrently molding a first lead section
182 integral with the body, said lead section disposed longitudinally about the rod and
183 terminating at a first end on an outer surface of the rod and disposed at a second end in
184 contact with the body, said lead section having a curved surface with a radius of
185 curvature of in the range of 20 to 22 mm and said curved surface further defined by a
186 tangent to the mid-point of the curved surface having an angle of in the range of 5 to 20
187 degrees measured between a line parallel to the longitudinal axis of the rod and the
188 tangent to the curved surface of the lead section.
189

190 33. The method of claim 31 wherein the trough between the longitudinal side walls
191 includes:

192 a first planar surface that tapers away from the first terminal end of the blade face
193 at an angle (a1) measured between a line parallel to the longitudinal axis of the rod and
194 the first planar surface,

195 a second planar surface disposed adjacent to the first planar surface, and
196 a third planar surface disposed adjacent to the second planar surface, said third
197 planar surface tapers away from the second terminal end of the blade face at an angle (c1)
198 measured between a line parallel to the longitudinal axis of the rod and the third planar
199 surface.
200

201 34. The method of claim 31 further including;

202 preparing a section of the rod by placing an epoxy based glue on a predetermined
203 portion of the rod and placing particles having a diameter in the range of 0.71 to 1.18 mm
204 onto the epoxy glue; and

direct injection molding the rod guide about at least a portion of the prepared section of the rod.

35. A method of installing a rod guide on a sucker rod comprising: molding a unitary rod guide coaxial about and in fixed contact with the sucker rod, said guide comprising a body portion surrounding and coaxial with the sucker rod, said body having a plurality of blades longitudinally disposed and extending from the body, each blade having a pair of longitudinal side walls, each of said longitudinal side walls have a first planar surface that tapers away from the first terminal end of the blade face at an angle (a') measured between a line parallel to the longitudinal axis of the rod and the first planar surface, a second planar surface disposed adjacent to the first planar surface, and a third planar surface disposed adjacent to the second planar surface, said third planar surface tapers away from the second terminal end of the blade face at an angle (c') measured between a line parallel to the longitudinal axis of the rod and the third planar surface, each blade having an exterior longitudinal edge, each of said blades having a first blade face disposed between a first terminal end of the blade and the exterior longitudinal edge, and a second blade face disposed between a second terminal end of the blade and the exterior longitudinal edge, and an area of the body between the longitudinal side wall of a first blade and the longitudinal side wall of an adjacent second blade defines a trough having a plurality of planar surfaces.

36. The method of claim 34 further including concurrently molding a first curved lead section integral with the body, said lead section disposed longitudinally about the rod and terminating at a first end on an outer surface of the rod and disposed at a second end in contact with the body, said lead section having a curved surface with a radius of curvature of in the range of 20 to 22 mm and said curved surface further defined by a tangent to the mid-point of the curved surface having an angle of in the range of 5 to 20 degrees measured between a line parallel to the longitudinal axis of the rod and the tangent to the curved surface of the lead section.

235

236 37. The method of claim 34 wherein the trough between the longitudinal side walls
237 includes:

238 a first planar surface that tapers away from the first terminal end of the blade face
239 at an angle (a1) measured between a line parallel to the longitudinal axis of the rod and
240 the first planar surface,

241 a second planar surface disposed adjacent to the first planar surface, and
242 a third planar surface disposed adjacent to the second planar surface, said third planar
243 surface tapers away from the second terminal end of the blade face at an angle (c1)
244 measured between a line parallel to the longitudinal axis of the rod and the third planar
245 surface.

246

247 38. The method of claim 34 further including:

248 preparing a section of the rod by placing an epoxy based glue on a predetermined
249 portion of the rod and placing particles having a diameter in the range of 0.71 to 1.18 mm
250 onto the epoxy glue; and

251 direct injection molding the rod guide about at least a portion of the prepared
252 section of the rod.

ABSTRACT

A polymeric rod guide for a sucker rod, said polymeric rod guide having a body surrounding and coaxial with the sucker rod and molded in fixed contact with the rod.

The body having a polygonal cross-section and a plurality of blades longitudinally

5 disposed and extending from the body, each blade having a pair of planar longitudinal side walls and an exterior longitudinal edge, each of said blades having a first blade face

disposed between a first terminal end of the blade and the exterior longitudinal edge and

a second blade face disposed between a second terminal end of the blade and the exterior

longitudinal edge, and an area of the body between the longitudinal side wall of a first

10 blade and the longitudinal side wall of an adjacent second blade defines a trough having a plurality of planar surfaces.

90554783.doc

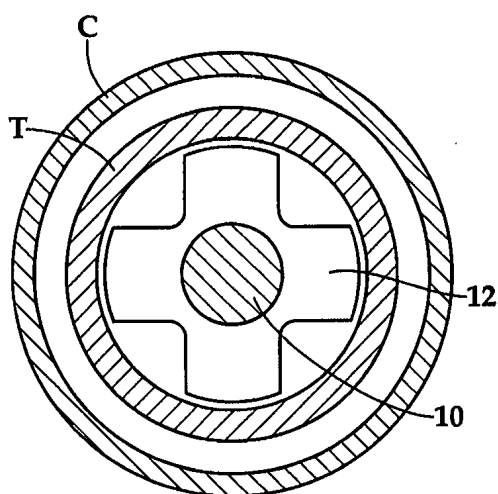
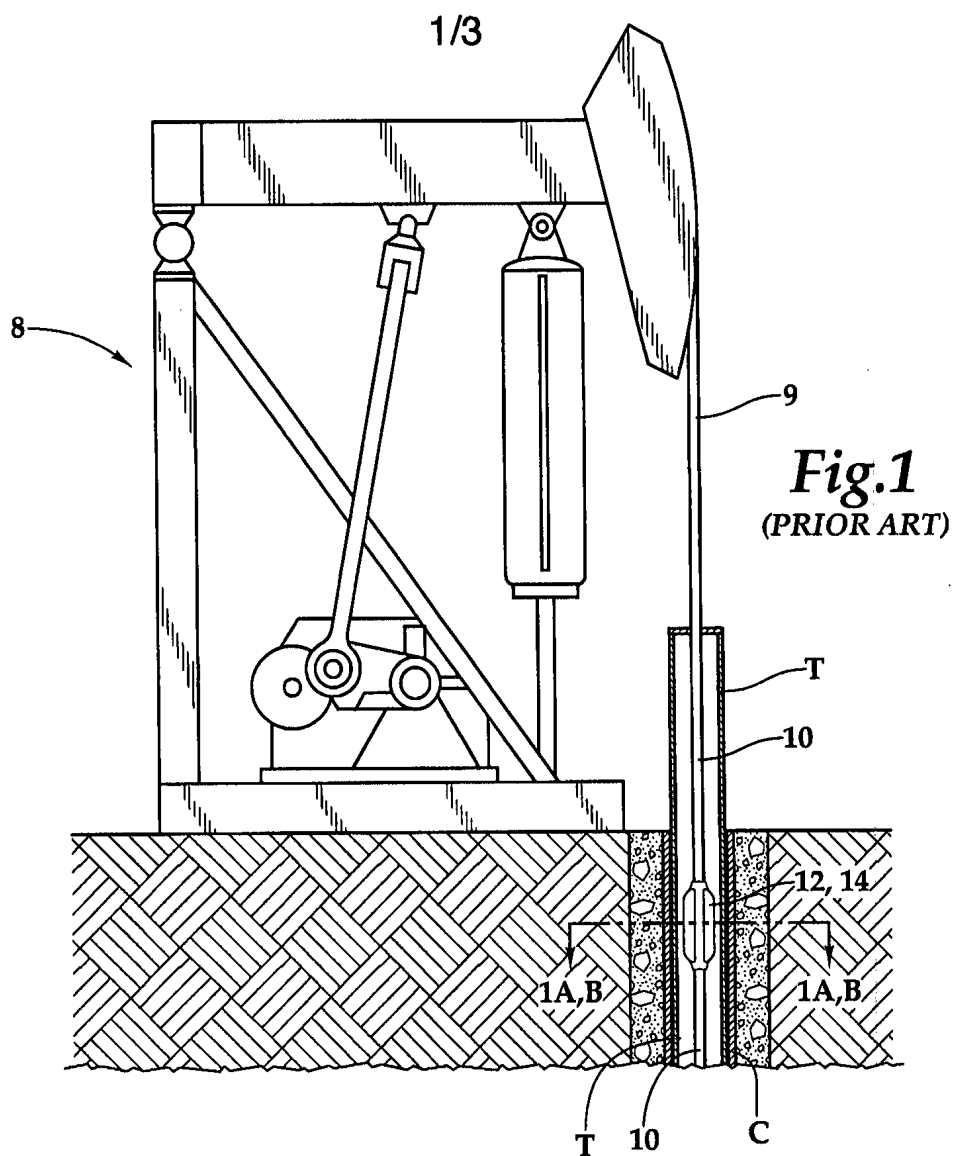


Fig. 1A
(PRIOR ART)

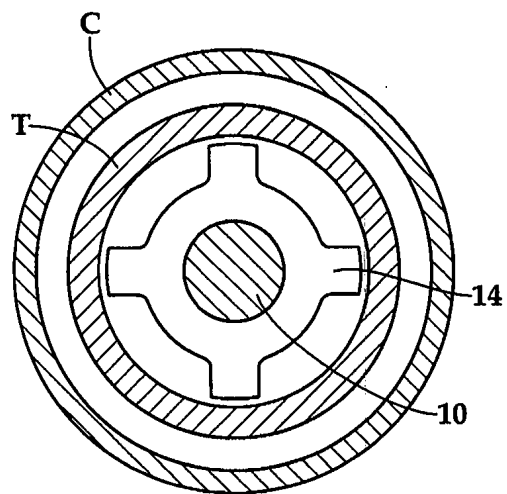
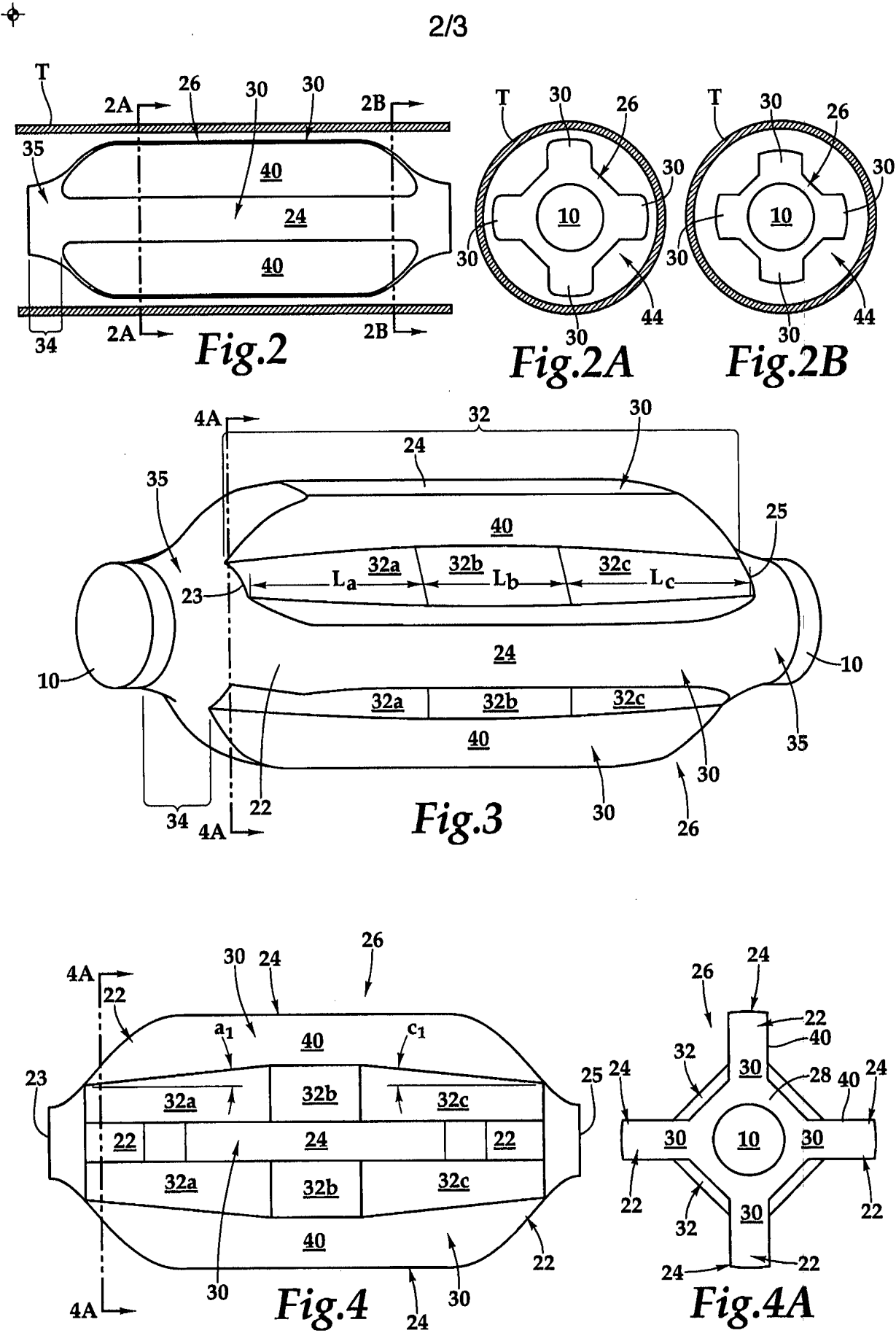


Fig. 1B
(PRIOR ART)



3/3

