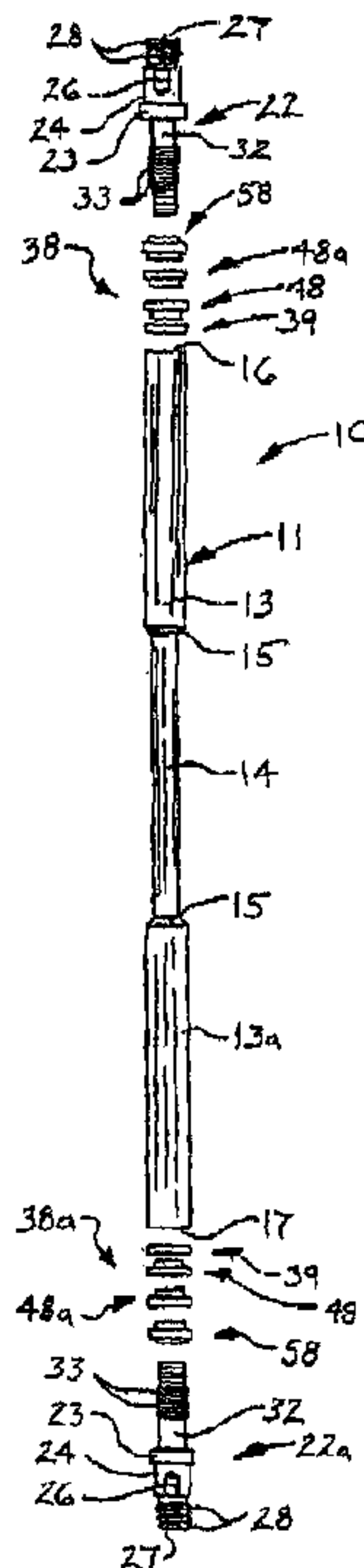




(86) Date de dépôt PCT/PCT Filing Date: 2011/03/08
(87) Date publication PCT/PCT Publication Date: 2012/04/19
(45) Date de délivrance/Issue Date: 2018/08/28
(85) Entrée phase nationale/National Entry: 2013/04/12
(86) N° demande PCT/PCT Application No.: US 2011/027584
(87) N° publication PCT/PCT Publication No.: 2012/050631
(30) Priorité/Priority: 2010/10/15 (US61/455,215)

(51) Cl.Int./Int.Cl. *F04B 47/02* (2006.01),
E21B 43/12 (2006.01), *F04B 47/12* (2006.01),
F04B 53/02 (2006.01)
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(54) Titre : PLONGEUR POUR POMPES DE FOND DE TROU
(54) Title: PLUNGER FOR DOWNHOLE PUMPS



(57) Abrégé/Abstract:

A pump plunger for a sucker rod pump includes an elongated plunger body (11) having first and second plunger body ends (18, 17) and a longitudinal plunger body bore (12) extending between the first and second plunger body ends, a first plunger end fitting (22) releasably carried by the first plunger body end (16) of the plunger body (11), a second plunger end fitting (22a) releasably carried by the second plunger body end (17) of the plunger body (11), a first plunger seal pack (38) sandwiched between the first plunger body end (16) and the first plunger end fitting (22) and a second plunger seal pack (38a) sandwiched between the second plunger body end (17) and the second plunger end fitting (22a).

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau(43) International Publication Date
19 April 2012 (19.04.2012)

PCT

(10) International Publication Number
WO 2012/050631 A1(51) International Patent Classification:
E21B 43/00 (2006.01)

(21) International Application Number:

PCT/US2011/027584

(22) International Filing Date:

8 March 2011 (08.03.2011)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/455,215 15 October 2010 (15.10.2010) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD,

[Continued on next page]

(54) Title: PLUNGER FOR DOWNHOLE PUMPS

(57) Abstract: A pump plunger for a sucker rod pump includes an elongated plunger body (11) having first and second plunger body ends (18, 17) and a longitudinal plunger body bore (12) extending between the first and second plunger body ends, a first plunger end fitting (22) releasably carried by the first plunger body end (16) of the plunger body (11), a second plunger end fitting (22a) releasably carried by the second plunger body end (17) of the plunger body (11), a first plunger seal pack (38) sandwiched between the first plunger body end (16) and the first plunger end fitting (22) and a second plunger seal pack (38a) sandwiched between the second plunger body end (17) and the second plunger end fitting (22a).

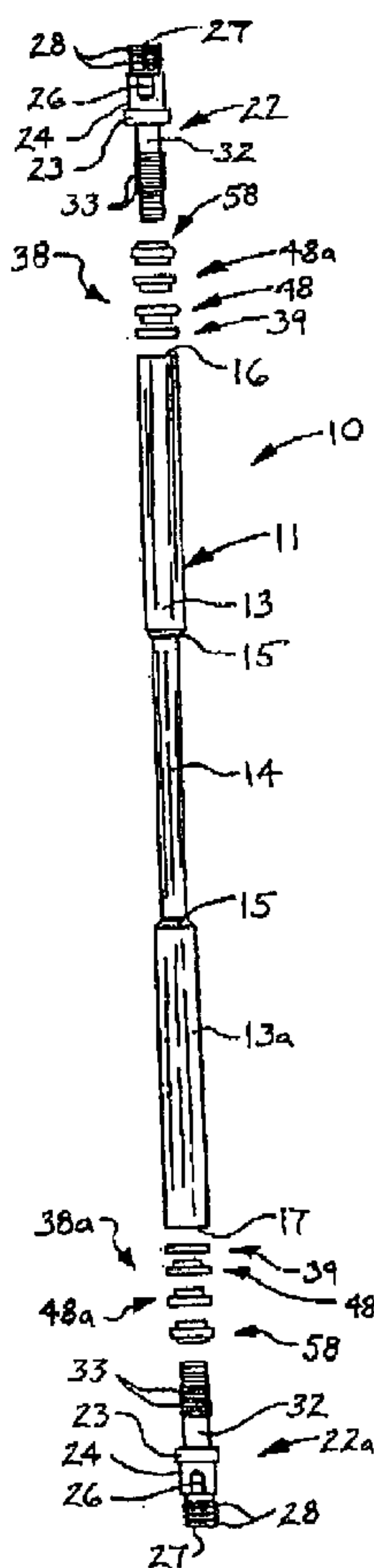


FIG. 2

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SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available):* ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

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PLUNGER FOR DOWNHOLE PUMPS

Technical Field

5 The disclosure generally relates to sucker rod pumps, including tubing pumps and insert pumps for pumping well fluids from a hydrocarbon well. More particularly, the disclosure relates to a plunger for sucker rod pumps, which plunger has enhanced and prolonged sealing characteristics.

Background Art

10 Conventional sucker rod pumps, including tubing pumps and insert pumps, include a pump plunger which reciprocates inside a pump barrel. The reciprocating pump plunger creates a pressure differential which draws hydrocarbons and other well fluids from a subterranean well to a suitable storage reservoir which may be located at ground level. One of the problems commonly encountered in the
15 operation of conventional sucker rod pumps is that of blowback or slippage of produced fluids and solids down the pump between the reciprocating plunger and the barrel. Various types of seals and O-rings have been used to seal the void between the plunger and barrel and prevent the slippage of fluids and solids. These seals and O-rings,
20 however, have limitations on operating durability, pump speed, depth and temperature, resulting in lost pump efficiency and the need for more frequent pump repairs or replacements.

Accordingly, a pump plunger with enhanced and prolonged sealing characteristics for a sucker rod pump is needed.

25 Disclosure of the Invention

The disclosure is generally directed to a pump plunger for a sucker rod pump. An exemplary embodiment of the pump plunger includes an elongated plunger body having first and second plunger body ends and a longitudinal plunger body bore extending between the
30 first and second plunger body ends, a first plunger end fitting

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releasably carried by the first plunger body end of the plunger body, a second plunger end fitting releasably carried by the second plunger body end of the plunger body, a first plunger seal pack sandwiched between the first plunger body end and the first plunger end fitting, and
5 a second plunger seal pack sandwiched between the second plunger body end and the second plunger end fitting.

The disclosure is further generally directed to an end fitting for a pump plunger of a sucker rod pump. An exemplary embodiment of the end fitting includes an end fitting body; a threaded end fitting nipple carried by the end fitting body; a threaded end fitting shaft carried by the end fitting body; an end fitting bore extending through the end fitting body, the end fitting nipple and the end fitting shaft; and a plunger seal pack having a plurality of nesting plunger seals assembled on the end fitting shaft.
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The disclosure is further generally directed to a plunger seal pack for a pump plunger of a sucker rod pump. An exemplary embodiment of the plunger seal pack includes a lead plunger seal, at least one middle plunger seal nesting with the lead plunger seal, and a following plunger seal nesting with the at least one middle plunger seal.
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Brief Description of the Drawings 20

The features of the invention, and its technical advantages, can be seen from the following description of the preferred embodiments together with the claims and the accompanying schematic drawings, in which:

FIG. 1 is an exploded side view, partially in section, of a pump barrel and an exemplary embodiment of the pump plunger, more particularly illustrating insertion of the pump plunger into the pump barrel in assembly of a sucker rod pump;
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FIG. 2 is an exploded side view of the pump plunger;

FIG. 3 is a side view of a plunger end fitting of the pump
30

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plunger;

FIG. 4 is a longitudinal sectional view of the plunger end fitting;

5 FIG. 5 is a side view of the plunger end fitting, rotated 90 degrees with respect to the side view of the plunger end fitting illustrated in FIG. 3;

FIG. 6 is a side view of a plunger seal pack which is suitable for sealing the pump plunger in the pump barrel of the sucker rod pump;

10 FIG. 7 is an exploded, cross-sectional view of multiple seals of the plunger seal pack;

FIG. 8 is a cross-sectional view of the seals of the plunger seal pack in a seated or stacked configuration;

15 FIG. 9 is a cross-sectional view, take along section lines 9-9 in FIG. 1, of the pump plunger of the sucker rod pump; and

FIG. 10 is a longitudinal sectional view, partially in section, of the sucker rod pump.

Detailed Description of Preferred Embodiments

20 The following detailed description is merely exemplary in nature and is not intended to limit the described embodiments or the application and uses of the described embodiments. As used herein, the word "exemplary" or "illustrative" means "serving as an example, instance, or illustration." Any implementation described herein as "exemplary" or "illustrative" is not necessarily to be construed as
25 preferred or advantageous over other implementations. All of the implementations described below are exemplary implementations provided to enable persons skilled in the art to make or use the invention and are not intended to limit the scope of the invention, which is defined by the claims. Furthermore, there is no intention to be bound
30 by any expressed or implied theory presented in the preceding

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technical field, background, brief summary or the following detailed description.

Referring initially to FIG. 1 of the drawings, a typical sucker rod pump is generally indicated by reference numeral 1. The sucker rod pump 1 includes a generally elongated, cylindrical pump barrel 2 having a longitudinal pump barrel bore 2a (FIG. 1). A pump plunger 10 is mounted for reciprocation in the pump barrel bore 2a of the pump barrel 2. In some embodiments, an upper pump barrel coupling 3 and a lower pump barrel coupling 3a may be provided generally at upper and lower ends, respectively, of the pump barrel 2. The lower pump barrel coupling 3a may couple an extension nipple 4 to the pump barrel 2. The extension nipple 4 may include a tubing coupler 5 and a seating nipple 6. In some embodiments, the pump barrel 2 may have alternative designs which may or may not include the lower pump barrel coupling 3a, the extension nipple 4, the tubing coupler 5 and the seating nipple 6. The pump plunger 10 can be constructed of any suitable material including an aluminum-bronze alloy or stainless steel, in non-exclusive particular, as well as like materials commonly used in sucker rod pumps designed for oil well applications.

Referring next to FIGS. 1-10 of the drawings, the pump plunger 10 may include a generally elongated plunger body 11 having a longitudinal plunger body bore 1.2 (FIG. 9) through which the hydrocarbons and other well fluids (not illustrated) are pumped during operation of the sucker rod pump 1. The plunger body 11 of the pump plunger 10 may have an upper expanded plunger portion 13, a lower expanded plunger portion 13a and a narrowed middle plunger portion 14 which connects the upper expanded plunger portion 13 and the lower expanded plunger portion 13a. A plunger bevel 15 may extend between the middle plunger portion 14 and the upper expanded

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plunger portion 13 and between the middle plunger portion 14 and the lower expanded plunger portion 13a, respectively. As illustrated in FIG. 2, the plunger body 11 may have an upper plunger end 16 and a lower plunger end 17. As illustrated in FIG. 10, internal plunger threads 18 may be provided in the plunger body bore 12 at the upper plunger end 16 and the lower plunger end 17 of the plunger body 11 for purposes which will be hereinafter described.

An upper plunger end fitting 22 may be provided on the upper plunger end 16 of the pump plunger 10. A lower plunger end fitting 22a may be provided on the lower plunger end 17 of the pump plunger 10. As illustrated in FIGS. 3-5, each of the upper plunger end fitting 22 and the lower plunger end fitting 22a may include a generally cylindrical end fitting base 23. A generally cylindrical end fitting body 24 may extend from the end fitting base 23. End fitting flats 26 may be provided in opposite surfaces of the end fitting body 24 for purposes which will be hereinafter described. An end fitting nipple 27 having nipple threads 28 may extend from the end fitting body 24.

A generally elongated, cylindrical end fitting shaft 32 may extend from the end fitting base 23 opposite the end fitting body 24. Exterior shaft threads 33 may be provided on the end fitting shaft 32 for purposes which will be hereinafter described. A longitudinal end fitting bore 25 (FIG. 4) may extend through the end fitting nipple 27, the end fitting body 24, the end fitting base 23 and the end fitting shaft 32. As illustrated in FIG. 10, the upper plunger end fitting 22 may be attached to the upper plunger end 16 of the plunger body 11 by inserting the end fitting shaft 32 of the upper plunger end fitting 22 into the plunger body bore 12 at the upper plunger end 16 and rotating the upper plunger end fitting 22 to cause engagement of the exterior shaft threads 33 on the end fitting shaft 32 with the interior plunger threads 18 in the plunger body bore 12. In like manner, the lower plunger end fitting 22a may be

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attached to the lower plunger end 17 of the plunger body 11 by inserting the end fitting shaft 32 of the lower plunger end fitting 22a into the plunger body bore 12 at the lower plunger end 17 and rotating the lower plunger end fitting 22a to cause engagement of the exterior shaft threads 33 on the end fitting shaft 32 with the interior plunger threads 18 in the plunger body bore 12. While the upper plunger end fitting 22 and the lower plunger end fitting 22a may have a design such as that set forth above, it will be recognized and understood that the upper plunger end fitting 22 and/or the lower end fitting 22a may have any alternative design or designs which is/are consistent with the functional requirements of the upper plunger end fitting 22 and the lower plunger end fitting 22a.

As further illustrated in FIGS. 2 and 10, an upper plunger seal pack 38 may be sandwiched between the upper plunger end 16 of the pump plunger 10, and the end fitting base 23 of the upper plunger end fitting 22. A lower plunger seal pack 38a may be sandwiched between the lower plunger end 17 of the pump plunger 10, and the end fitting base 23 of the lower plunger end fitting 22a. As illustrated in FIGS. 6-8, the upper plunger seal pack 38 may include a following plunger seal 39 which engages the upper plunger end 16 or the lower plunger end 17, respectively, of the plunger body 11; a lead plunger seal 58 which engages the end fitting base 23 of the upper plunger end fitting 22 or the lower plunger end fitting 22a; and at least one middle plunger seal 48 which is sandwiched between the following plunger seal 39 and the lead plunger seal 58. In some embodiments, a pair of middle plunger seals 48 and 48a, respectively, may be sandwiched between the following plunger seal 39 and the lead plunger seal 58, as illustrated. As illustrated in FIG. 10, the following plunger seal 39, the middle plunger seal 48 or seals 48, 48a and the lead plunger seal 58 may stack or nest with each other to form a fluid-tight seal between the

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plunger body bore 12 of the plunger body 11 and the pump barrel bore 2a of the pump barrel 2 as the pump plunger 10 reciprocates inside the pump barrel bore 2a of the pump barrel 2 during operation of the sucker rod pump 1. The following plunger seal 39, the middle plunger seals 48, 48a and the lead plunger seal 58 may each form an independent seal with the interior surface of the pump barrel bore 2a, preventing blowback of well fluids between the pump plunger 10 and the pump barrel 2 during operation of the sucker rod pump 1. Like the upper plunger seal pack 38, the lower plunger seal pack 38a (FIGS. 2 and 10) may have a following plunger seal 39, a lead plunger seal 58 and at least one middle plunger seal 48 sandwiched between the following plunger seal 39 and the lead plunger seal 58. While the upper plunger seal pack 38 and the lower plunger seal pack 38a have each been described as including the lead plunger seal 58, the following plunger seal 39 and at least one middle plunger seal 48, as used herein the term "plunger seal pack" includes at least one seal and may include more than four seals.

As illustrated in FIG. 7, the following plunger seal 39 of each of the upper plunger seal pack 38 and the lower plunger seal pack 38a may include an annular following plunger seal body 40 having a seal opening 44. The following plunger seal body 40 may have a generally flat or planar inside seal surface 41 and a generally flat or planar outside seal surface 42 which is parallel and spaced-apart with respect to the inside seal surface 41. An annular seal lip receptacle 43 may extend into the outside seal surface 42 for purposes which will be hereinafter described.

As further illustrated in FIG. 7, each middle plunger seal 48, 48a of each of the upper plunger seal pack 38 and the lower plunger seal pack 38a may include an annular middle plunger seal body 49 having a seal opening 53. The middle plunger seal body 49

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may have a generally flat or planar inside seal surface 50 and a generally flat or planar outside seal surface 51 which is parallel and spaced-apart with respect to the inside seal surface 50. An annular seal lip receptacle 52 may extend into the outside seal surface 51 for purposes which will be hereinafter described. An annular seal lip 54 may extend from the inside seal surface 50 of the middle plunger seal body 49 for purposes which will be hereinafter described.

The lead plunger seal 58 of each of the upper plunger seal pack 38 and the lower plunger seal pack 38a may include an annular lead plunger seal body 59 having a seal opening 64. The lead plunger seal body 59 may have a generally flat or planar inside seal surface 60 and a generally flat or planar outside seal surface 61 which is parallel and spaced-apart with respect to the inside seal surface 60. An annular O-ring receptacle 62 may extend into the outside seal surface 61 of the lead plunger seal body 59. An O-ring 63 may be seated in the O-ring receptacle 62. An annular seal lip 65 may extend from the inside seal surface 60 of the lead plunger seal body 59 for purposes which will be hereinafter described.

In the nested, sealing configuration of the upper plunger seal pack 38 (FIG. 6) and the lower plunger seal pack 38a, the seal lip receptacle 43 of the following plunger seal 39 receives the complementary-shaped seal lip 54 of the middle plunger seal 48. The inside seal surface 50 of the middle plunger seal 48 engages the outside seal surface 42 of the following plunger seal 39. The seal lip receptacle 52 of the middle plunger seal 48 receives the complementary-shaped seal lip 54 of the middle plunger seal 48a. The inside seal surface 50 of the middle plunger seal 48a engages the outside seal surface 51 of the middle plunger seal 48. The seal lip receptacle 52 of the middle plunger seal 48a receives the complementary-shaped seal lip 65 of the lead plunger seal 58. The

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inside seal surface 60 of the lead plunger seal 58 engages the outside seal surface 51 of the middle plunger seal 48a. Each of the following plunger seal 39, the middle plunger seal or seals 48, 48a and the lead plunger seal 58 of each of the upper plunger seal pack 38 and the lower plunger seal pack 38a may have an annular exterior sealing surface 66 which is adapted to engage the interior surface of the pump barrel bore 2a in a fluid-tight seal when the pump plunger 10 is inserted in the pump barrel bore 2a of the pump barrel 2. As illustrated in FIGS. 7 and 8, each exterior sealing surface 66 may have a generally flat or linear configuration in cross-section.

When the upper plunger seal pack 38 is installed in place between the upper plunger end 16 of the plunger body 11 and the end fitting base 23 of the upper plunger end fitting 22, as illustrated in FIG. 10, the inside seal surface 41 (FIG. 8) of the following plunger seal 39 engages the upper plunger end 16 in a fluid-tight seal. The O-ring 63 on the lead plunger seal 58 of the upper plunger seal pack 38 engages the end fitting base 23 of the upper plunger end fitting 22 in a fluid-tight seal. Likewise, when the lower plunger seal pack 38a is installed in place between the lower plunger end 17 of the plunger body 11 and the end fitting base 23 of the lower plunger end fitting 22a, as further illustrated in FIG. 10, the inside seal surface 41 of the following plunger seal 39 engages the lower plunger end 17 in a fluid-tight seal. The O-ring 63 on the lead plunger seal 58 of the lower plunger seal pack 38a engages the end fitting base 23 of the lower plunger end fitting 22a in a fluid-tight seal. The exterior sealing surface 66 of each of the following plunger seal 39, the middle plunger seal or seals 48, 48a and the lead plunger seal 58 of each of the upper plunger seal pack 38 and the lower plunger seal pack 38a engages the interior surface of the pump barrel bore 2a in a fluid-tight seal. While the following plunger seal 39, the middle plunger seal or seals 48, 48a and the lead plunger seal 58

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may have the particular structures set forth above, it will be recognized and understood that any or each of the following plunger seal 39, the middle plunger seal or seals 48, 48a and the lead plunger seal 58 may include any alternative structure(s) or design(s) which is/are consistent with the functional requirements of the upper plunger seal pack 38 and the lower plunger seal pack 38a.

As illustrated in FIG. 2, the pump plunger 10 may be assembled by initially assembling the upper plunger seal pack 38 on the end fitting shaft 32 of the upper plunger end fitting 22.

This may be accomplished by extending the end fitting shaft 32 of the upper plunger end fitting 22 through the registering seal openings 64, 53 and 44 (FIG. 8) of the lead plunger seal 58, middle plunger seal or seals 48, 48a and following plunger seal 39, respectively. The end fitting shaft 32 of the upper plunger end fitting 22 is attached to the plunger body 11 of the pump plunger 10 by inserting the end fitting shaft 32 in the plunger body bore 12 and rotating the upper plunger fitting 22 with respect to the plunger body 11 to threadably engage the exterior shaft threads 33 on the end fitting shaft 32 with the interior plunger threads 18 in the plunger body bore 12. The end fitting base 23 of the upper plunger end fitting 22 may be tightened against the O-ring 63 (FIG. 8) on the lead plunger seal 58 of the upper plunger seal pack 38 by engaging a wrench (not illustrated) with the end fitting flats 26 on the end fitting body 24 and rotating the wrench typically in the conventional manner. Accordingly, the following plunger seal 39, the middle plunger seal or seals 48, 48a and the lead plunger seal 58 of the upper plunger seal pack 38 are disposed in the nested configuration (FIG. 8) and may be compressed between the upper plunger end 16 of the plunger body 11 and the end fitting base 23 of the upper plunger end fitting 22. The lower plunger seal pack 38a may be assembled at the lower plunger end 17 of the plunger body 11 and

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the lower plunger end fitting 22a attached to the plunger body 11 in a similar manner.

Each of the following plunger seal 39, the middle plunger seal or seals 48, 48a and the lead plunger seal 58 of each of the upper plunger seal pack 38 and the lower plunger seal pack 38a may be any durable, heat-resistant, resilient or semi-resilient material which is suitable for imparting a fluid-tight seal between the pump plunger 10 and the interior surface of the pump barrel bore 2a. In some embodiments, the following plunger seal body 40 (FIG. 7) of the following plunger seal 39 may include polyether ether ketone (PEEK). In some embodiments, the middle plunger seal body 49 of each of the middle plunger seals 48, 48a may include carbon fiber-filled polytetrafluoroethylene (PTFE), or TEFLON®. In some embodiments, the lead plunger seal body 59 of the lead plunger seal 58 may include carbon fiber-filled polytetrafluoroethylene (PTFE), or TEFLON®. The O-ring 63 of the lead plunger seal 58 may include perfluoroelastomer (FFKM). In other embodiments, each of the following plunger seal 39, the middle plunger seal or seals 48, 48a and the lead plunger seal 58 may be any alternative durable, heat-resistant, resilient or semi-resilient materials which are suitable for imparting a fluid-tight seal between the pump plunger 10 and the interior surface of the pump barrel bore 2a.

The following plunger seal 39, the middle plunger seal or seals 48, 48a and the lead plunger seal 58 may be fabricated in any API (American Petroleum Institute) size depending on the diameter and size of the pump plunger 10 and the plunger end fittings 22 and 22a. While the following plunger seal 39, the middle plunger seal or seals 48, 48a and the lead plunger seal 58 may have the particular materials set forth above, it will be recognized and understood that any or each of the following plunger seal 39, the middle plunger seal or seals 48,

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48a and the lead plunger seal 58 may include any alternative material or materials which is/are consistent with the functional requirements of the upper plunger seal pack 38 and the lower plunger seal pack 38a.

The sucker rod pump 1 may be assembled as follows.

5 The upper plunger seal pack 38 and the upper plunger end fitting 22 may be assembled on the upper plunger end 16 of the plunger body 11. This may be accomplished by first placing the upper plunger seal pack 38 on the end fitting shaft 32 of the upper plunger end fitting 22 and then threading the end fitting shaft 32 of the upper plunger end fitting 22 into the upper plunger end 16 of the plunger body 11.

10 During assembly of the upper plunger seal pack 38 and the upper plunger end fitting 22 on the upper plunger end 16, the pump plunger 10 may be immobilized in a vice or the like (not illustrated). A top cage (not illustrated), a valve rod adapter (not illustrated) or a pull tube adapter (not illustrated) may be attached to the end fitting nipple 27 of the upper plunger end fitting 22. A pull rod or a pull tube (not illustrated) may be attached to the top cage, the valve rod adapter or the pull tube adapter which is attached to the upper plunger end fitting 22.

20 The pump barrel 2 may be immobilized in a vice or the like, after which the interior surfaces of the pump barrel bore 2a may be swabbed clean and lubricated with a liberal coating of lubricant such that a heavy film of the lubricant coats the interior surfaces of the pump barrel bore 2a. The outer surfaces of the plunger body 11, the upper plunger seal pack 38 and the upper plunger end fitting 22 may also be coated with the lubricant. Next, the lower plunger end 17 of the plunger body 11 may be inserted into the pump barrel bore 2a of the pump barrel 2. The plunger body 11 may be pushed through the pump barrel bore 2a until approximately one-half the length of the plunger body 11 protrudes from the opposite end of the pump barrel bore 2a. In the

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case of a tubing pump (in which a pull rod is not attached to the plunger body 11), a pony rod or other long rod (not illustrated) may be used to push the plunger body 11 through the pump barrel bore 2a. Next, with the lower plunger end 17 protruding from the pump barrel bore 2a of the pump barrel 2, the lower plunger seal pack 38a and the lower end fitting 22a may be assembled on the lower plunger end 17 as was heretofore described with respect to assembly of the upper plunger seal pack 38 and the upper plunger end fitting 22. A friction wrench or the like (not illustrated) may be used to immobilize the plunger body 11 during assembly of the lower plunger seal pack 38a and the lower end fitting 22a on the plunger body 10. Lower cages or other connections (not illustrated) may be attached to the end fitting nipple 27 of the lower plunger end fitting 22a.

The pump plunger 10 may then be pushed back a short distance into the pump barrel bore 2a of the pump barrel 2, leaving the lower plunger end fitting 22a, the lower plunger seal pack 38a, the lower expanded plunger portion 13a and about 1/2 inch of the middle plunger portion 14 of the plunger body ii protruding from the pump barrel bore 2a. A piece of paper or plastic (not illustrated) may be cupped under and around the protruding end of the pump plunger 10 and the end of the pump barrel 2, after which a lubricant may be poured through the opening into the recessed area between the interior surface of the pump barrel bore 2a and the middle plunger portion 14 of the pump plunger 10 until the lubricant substantially fills the recessed area. The cupped paper or plastic may be held around the pump plunger 10 and the pump barrel 2 as the pump plunger 10 is pushed back into the pump barrel bore 2a. Fittings (not illustrated) may be attached to the pump barrel 2 and the pump plunger 10 may be stroked substantially the entire length of the pump barrel bore 2a to ensure that the upper seal pack 38 and the lower seal pack 38a are

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properly placed on the plunger body 11. The pump barrel 2 may be rolled over halfway and the pump plunger 10 pulled through the pump barrel bore 2a again to ensure that the lubricant has coated the entire interior surface of the pump barrel bore 2a. Assembly of the sucker rod pump 1 may then be completed according to the knowledge of those skilled in the art.

In some embodiments, the lubricant which is utilized as a lubricating material in the pump plunger 10 may be a PTFE-containing liquid lubricant which may include corrosion inhibitors. The PTFE ingredient in the lubricant forms a dry film and bonds to the porous metal surfaces of the pump plunger 10 and the inside surfaces of the pump barrel 2 to lubricate the pump plunger 10 inside the pump barrel 2 in reciprocating relationship. This lubricating capability reduces friction between the pump plunger 10 and the pump barrel 2. It will be appreciated by those skilled in the art that a variety of PTFE-containing lubricants known by those skilled in the art may operate to achieve the desired lubricating results according to the knowledge of those skilled in the art.

In exemplary application, the sucker rod pump 1 may be used as a tubing pump in which the pump barrel 2 is attached to a tubing string (not illustrated) which is extended into a subterranean hydrocarbon well (not illustrated) or as an insert pump which is inserted into a tubing string for operation. A traveling valve (not illustrated) may be attached to the nipple threads 28 of the lower plunger end fitting 22a and a standing valve (not illustrated) may be placed in the pump barrel 2 beneath the traveling valve. In operation of the sucker rod pump 1, the pump plunger 10 is reciprocated in the pump barrel bore 2a of the pump barrel 2 to pump fluid hydrocarbons and other well fluids (not illustrated) from the subterranean hydrocarbon well (not illustrated) in which the sucker rod pump 1 is placed.

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As the pump plunger 10 reciprocates in the pump barrel bore 2a of the pump barrel 2, the following plunger seal 39, the middle plunger seals 48, 48a and the lead plunger seal 58 of the upper plunger seal pack 38 and the lower plunger seal pack 38a, respectively, each forms an independent seal with the interior surface of the pump barrel bore 2a, preventing blowback of well fluids between the pump plunger 10 and the pump barrel 2 during operation of the sucker rod pump 1. This sealing capability of the upper plunger seal pack 38 and the lower plunger seal pack 38a prevents the leakage or "slippage" of recovered fluids past the pump plunger 10 on both the upstroke and downstroke of the pump plunger 10, thus providing complete plunger efficiency for the life of each plunger seal pack 38, 38a. Furthermore, the independent sealing capability of the following plunger seal 39, the middle plunger seals 48, 48a and the lead plunger seal 58 prolong the sealing efficacy of each plunger seal pack 38, 38a. Moreover, the upper plunger seal pack 38 and the lower plunger seal pack 38a seal out abrasive elements and contaminants from the interface between the pump plunger 10 and the interior surfaces of the pump barrel bore 2a of the pump barrel 2. Additionally, the upper plunger seal pack 38 and the lower plunger seal pack 38a allow the lubricant to remain encased in the lubrication chamber 14 (FIG. 2), enabling the interior surfaces of the pump barrel bore 2a to be lubricated on every stroke. This reduces wear, pump sticking and the accumulation of deposits between the pump plunger 10 and the pump barrel 2.

It will be appreciated by those skilled in the art that the pump plunger 10 may be fabricated in standard API (American Petroleum Institute) spray metal plunger sizes. In the event that the upper plunger seal pack 38 or the lower plunger seal pack 38a fails, the pump plunger 10 will operate as a "new" spray metal plunger in the

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pump barrel 2. This feature will alleviate the necessity of more frequent pump replacements.

It will be further appreciated by those skilled in the art that the pump plunger 10 is characterized by simplicity of design, having the plunger body 11, the upper plunger end fitting 22 and the lower plunger end fitting 22a. The upper plunger seal pack 38 and the lower plunger seal pack 38a can be easily placed on the end fitting shaft 32 of the upper plunger end fitting 22 and the lower plunger end fitting 22a, respectively, and each end fitting shaft 32 threaded into the plunger body bore 12 (FIG. 10) to assemble the pump plunger 10 without the use of extra tools for the purpose. Moreover, the simple design of the pump plunger 10 allows for a variety of metallurgies on the upper plunger end fitting 22 and the lower plunger end fitting 22a depending on operating condition requirements. This may allow for the replacement of only the upper plunger end fitting 22, the lower plunger end fitting 22a, the upper plunger seal pack 38 and/or the lower plunger seal pack 38a without the need to also replace the plunger body 11 during repair. The pump plunger 10 is sufficiently resistant that it can be run in any type of pump barrel 2 including but not limited to a Chrome ID barrel. The upper plunger seal pack 38 and the lower plunger seal pack 38a allow the sucker rod pump 1 to be run at virtually any depth, pressure, temperature or speed of operation.

While various illustrative embodiments have been described above, it will be recognized and understood that various modifications can be made and the appended claims are intended to cover all such modifications which may fall within the spirit and scope of the disclosure.

CLAIMS:

1. A pump plunger for a sucker rod pump, comprising:

an elongated plunger body having first and second plunger body ends and a longitudinal plunger body bore extending between said first and second plunger body ends;

a first plunger end fitting releasably carried by said first plunger body end of said plunger body;

a second plunger end fitting releasably carried by said second plunger body end of said plunger body;

wherein each of said first plunger end fitting and said second plunger end fitting comprises an end fitting body, a threaded end fitting nipple having exterior nipple threads carried by said end fitting body at a first end of said end fitting body, and a threaded end fitting shaft with exterior shaft threads carried by said end fitting body at a second end of said end fitting body and threadably engaging said plunger body;

at least one end fitting flat in said end fitting body;

a first plunger seal pack sandwiched between said first plunger body end and said first plunger end fitting; and

a second plunger seal pack sandwiched between said second plunger body end and said second plunger end fitting.

2. The pump plunger of claim 1, wherein said plunger body comprises a pair of expanded plunger portions and a middle plunger portion connecting said expanded plunger portions.

3. The pump plunger of claim 1, wherein said first plunger seal pack comprises a first plurality of nesting plunger seals and said second plunger seal pack comprises a second plurality of nesting plunger seals.

4. The pump plunger of claim 3, wherein each of said first plurality of nesting plunger seals and said second plurality of nesting plunger seals comprises a respective lead plunger seal engaging a corresponding one of said first plunger end fitting and said second plunger end fitting, a respective following plunger seal engaging said plunger body, and at least one respective middle plunger seal, especially a pair of middle plunger seals, sandwiched between said lead and following plunger seals.

5. An end fitting for a pump plunger of a sucker rod pump, comprising:

an end fitting body;

a threaded end fitting nipple having exterior nipple threads carried by said end fitting body;

a threaded end fitting shaft having exterior shaft threads carried by said end fitting body;

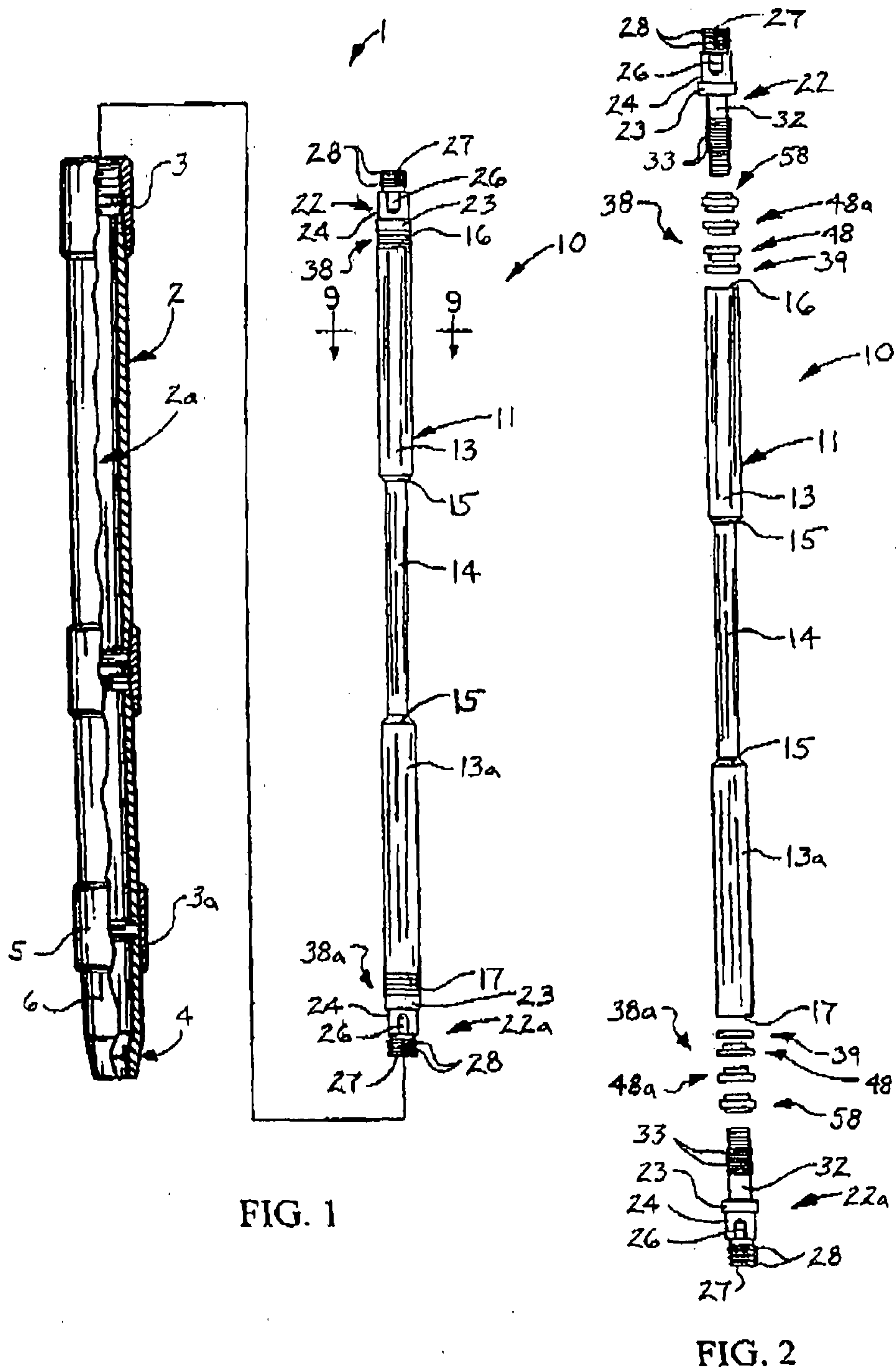
an end fitting bore extending through said end fitting body, said end fitting nipple and said end fitting shaft; and

a plunger seal pack having a plurality of nesting plunger seals assembled on said end fitting shaft; and,

at least one end fitting flat in said end fitting body.

6. The end fitting of claim 5, wherein said plunger seal pack comprises a lead plunger seal, a following plunger seal, and at least one middle plunger seal,

especially a pair of middle plunger seals, sandwiched between said lead plunger seal and said following plunger seal, wherein said end fitting further comprises an end fitting base, and wherein said end fitting body and said end fitting shaft extend from opposite sides of said end fitting base.



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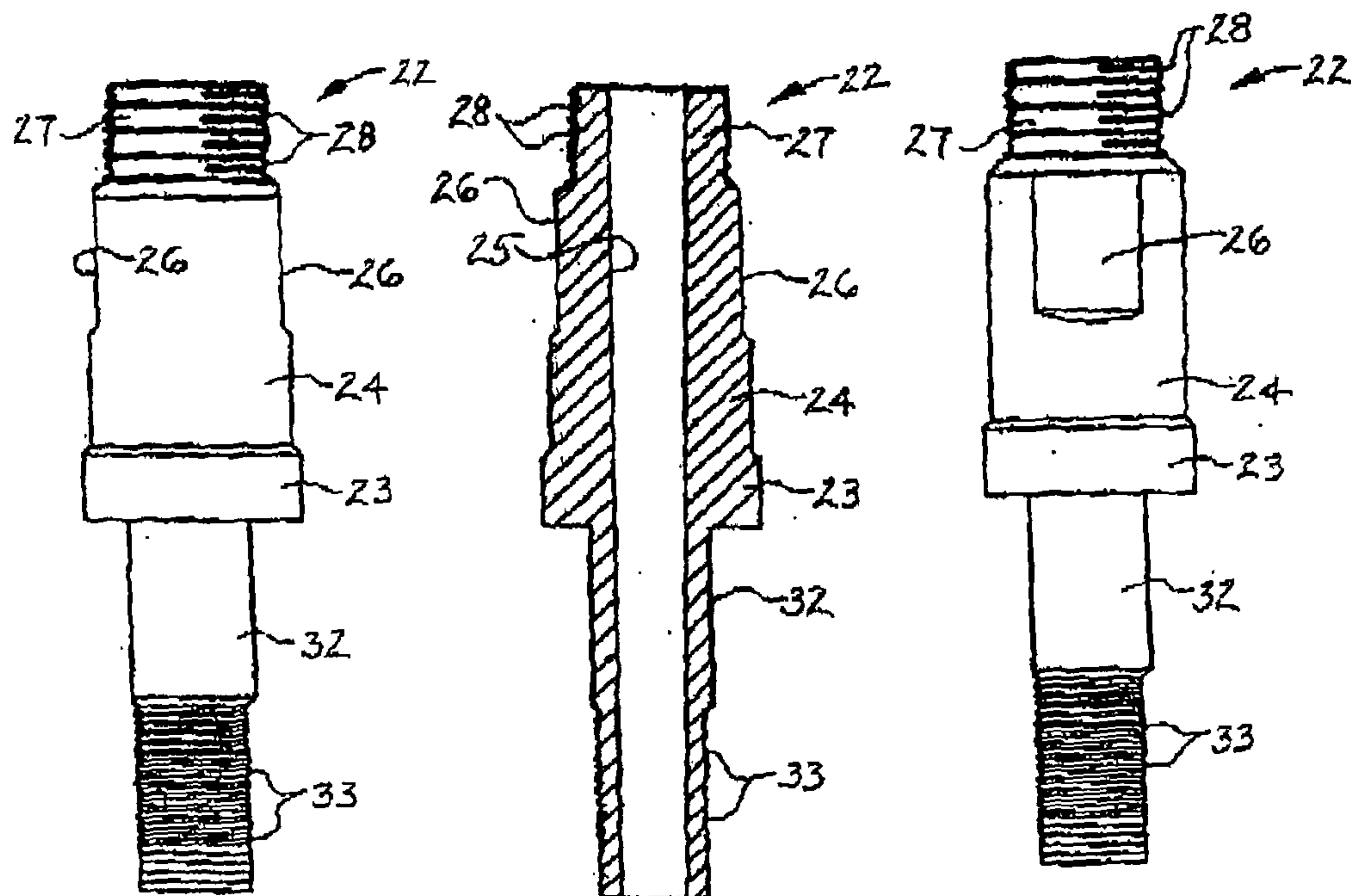


FIG. 3

FIG. 4

FIG. 5

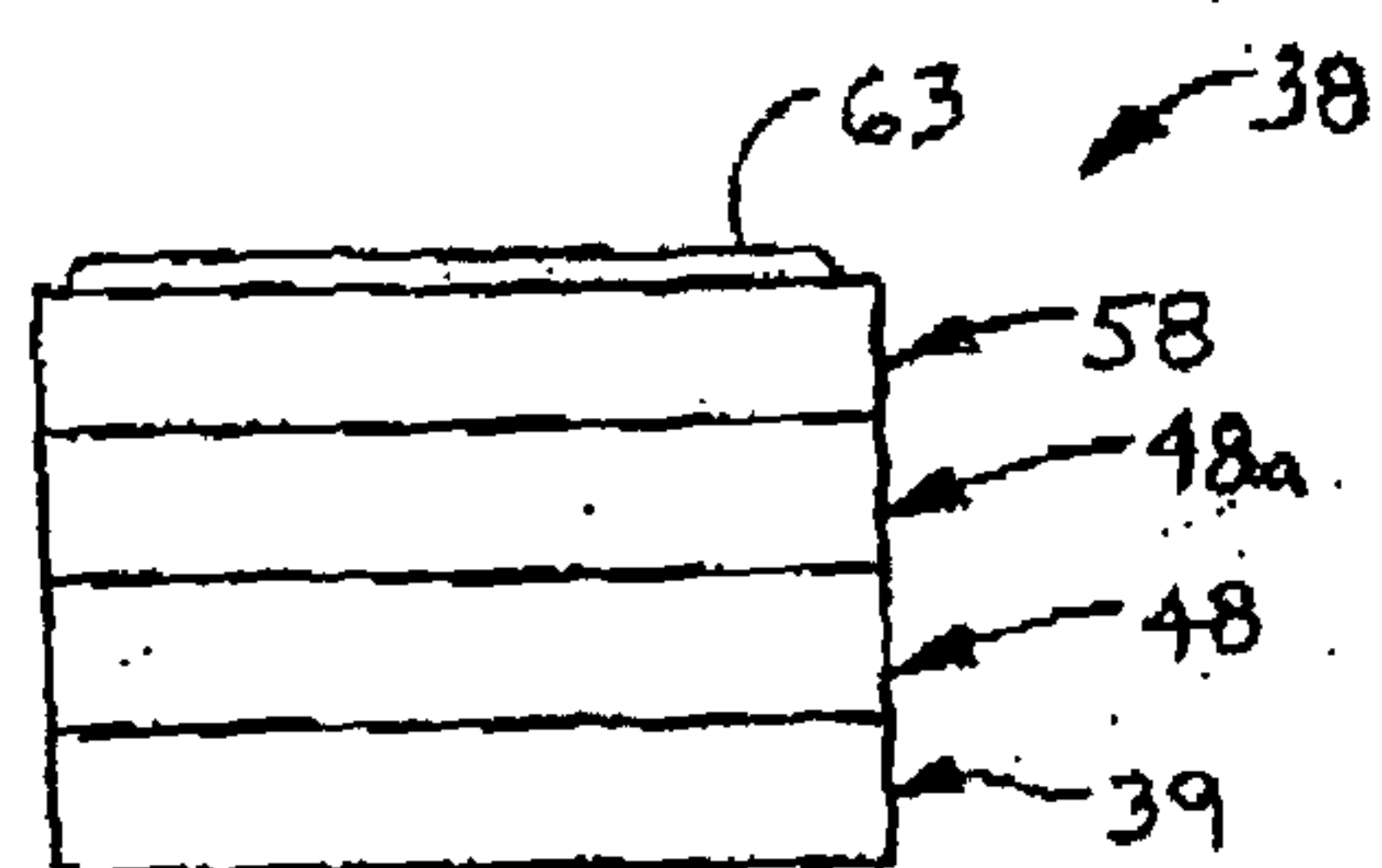


FIG. 6

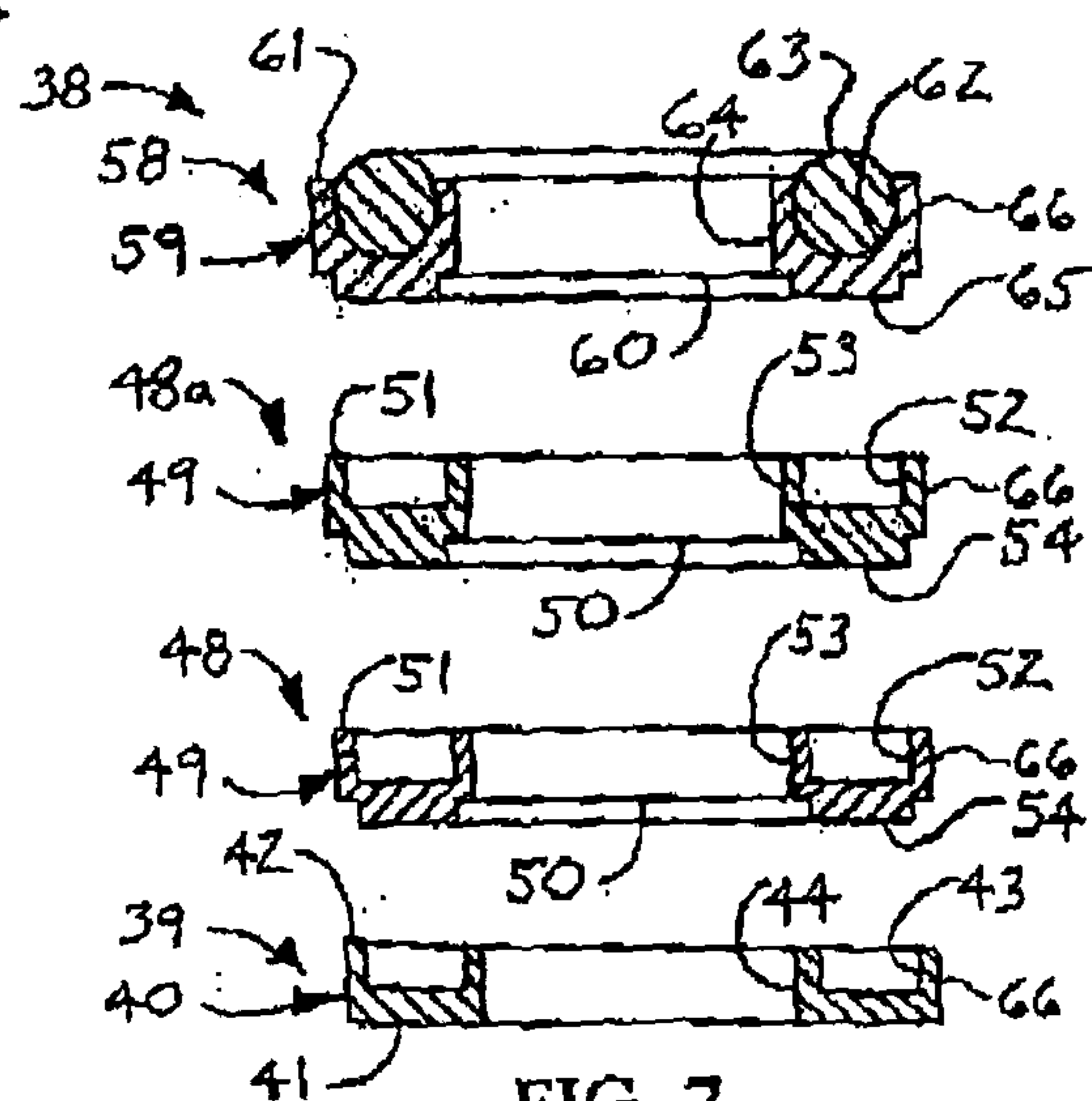


FIG. 7

